

Action Plan for the North Atlantic Right Whale (*Eubalaena glacialis*) in Canada

North Atlantic Right Whale



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For copies of the action plan, or for additional information on species at risk, including Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, residence descriptions, recovery strategies, and other related recovery documents, please visit the [Species at Risk Public Registry](#).

Cover illustration: The cover illustration depicts a female North Atlantic Right Whale known as Arpeggio, catalogue number 2753. Born in 1997, Arpeggio is a poster child for what Right Whales do, what they are exposed to, and what tools researchers use to learn about their life history and the threats facing their recovery. She has ranged from the calving ground along the coast of eastern Florida to the Bay of Fundy and the Gulf of St. Lawrence, and has been photographed in each year of her life in several different habitat areas. She was entangled briefly in 1999 at the age of 2½, and survived a hit by a small vessel at the age of eight. Arpeggio has been exposed to almost every type of research: tagging to learn about dive profiles and response to sound playback, skin biopsy sampling to learn about her genetic profile, and ultrasound measurements of blubber thickness to assess her health. Arpeggio gave birth to her first calf in 2007 at the age of 11. She had her second calf in 2013. She was observed in Canada in the Gulf of St. Lawrence annually between 2016 and 2018. Arpeggio was seen close to the shore of Cape Breton Island, in September 2019, after being observed in the Gulf of St. Lawrence in July and August that year. In December 2019, she was sighted in the calving grounds off the southeast U.S., but no calf was seen. Illustration credit: Scott Landry, Provincetown Center for Coastal Studies.

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Statement on the Government of Canada's North Atlantic Right Whale initiatives

The North Atlantic Right Whale (Right Whale) was listed as endangered under the *Species at Risk Act* (SARA) in 2005. Fisheries and Oceans Canada (DFO) works with its partners to plan and implement the recovery of this species, according to the requirements of SARA. A SARA recovery strategy was published in 2009 (Brown et al. 2009) and updated in 2014 (DFO 2014). An action plan addressing the threat of fishery interactions was nearing completion in 2016. In 2018, the scope of the action plan was expanded to include all threats to Right Whales identified in the SARA recovery strategy.

Right Whale mortalities have been documented in Canadian waters since 1987 (Knowlton and Kraus 2001; Sharp et al. 2019). Since 2015, the rate of identified mortalities has increased throughout their range (Bourque et al. 2020). The majority of identified mortalities since 2015 occurred in 2017 and 2019, when unprecedented numbers of Right Whales were discovered dead or entangled in the Gulf of St. Lawrence. The Government of Canada responded in 2017 with increased and expanded surveillance for Right Whales, and with management measures designed to reduce entanglement risk and vessel collision risk to Right Whales. Since 2017, DFO and Transport Canada (TC) have continued to refine those measures with the input of scientists and partners in the fishing and marine transportation industries.

The Government of Canada has demonstrated its commitment to the protection and recovery of Right Whales through several investments in recent years. In 2016, the Government of Canada announced a \$1.5 billion investment in the Oceans Protection Plan, which includes measures to address threats to marine mammals in Canadian waters. Budget 2018 included \$167.4 million over five years to help protect and recover endangered whale species in Canada, specifically the North Atlantic Right Whale, the Southern Resident Killer Whale, and the St. Lawrence Estuary Beluga. This includes funding for science activities to help better understand factors affecting the health of these whale populations, as well as actions to help address the threats arising from human activities and enhance incident response capacity.

This SARA action plan is a detailed extension of the recovery strategy, identifying more specific measures needed to address threats to the Right Whale and achieve recovery. It is a forward-looking, holistic framework to guide and coordinate all internal and external recovery efforts for this species. SARA requires the Government of Canada to report on recovery implementation: recovery strategies must be reported on every five years, and action plans must be reported on five years following final publication.

More information on the Government of Canada's work to monitor Right Whales and reduce threats to them in Canadian waters can be found at these links:

- [Fishery management measures to reduce risk of entanglement in fishing gear](#)
- [Measures to reduce risk of a vessel strike](#)
- [North Atlantic Right Whale detections and survey effort](#)
- [Canadian Science Advisory Secretariat](#)
- [North Atlantic Right Whale species profile](#)

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 protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of action plans for species listed as extirpated, endangered, or threatened for which recovery has been deemed feasible. They are also required to report on progress five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Fisheries, Oceans and the Canadian Coast Guard is the competent minister under SARA for the North Atlantic Right Whale and has prepared this action plan to implement the recovery strategy, as per section 47 of SARA. In preparing this action plan, the competent minister has considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and to the principle that, if there are threats of serious or irreversible damage to the listed species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty. To the extent possible, this action plan has been prepared in cooperation with other federal government departments, provinces, Indigenous partners, and stakeholders, as per section 48(1) of SARA.

As stated in the preamble to SARA, success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions and actions set out in this action plan and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction, alone. The cost of conserving species at risk is shared amongst many groups. All Canadians are invited to join in supporting and implementing this action plan for the benefit of the North Atlantic Right Whale and Canadian society as a whole.

Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in the recovery strategy for the species. The plan outlines recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations to help achieve the population and distribution objectives identified in the recovery strategy. Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

Fisheries and Oceans Canada acknowledges the many individuals and organizations that have contributed to North Atlantic Right Whale recovery efforts, including the development of this action plan (appendix B). Their continued commitment to Right Whale recovery is critical to the successful implementation of this action plan.

Executive summary

The North Atlantic Right Whale (*Eubalaena glacialis*) was listed as endangered under the *Species at Risk Act* (SARA) in 2005. This action plan is part of a series of documents regarding the North Atlantic Right Whale that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, the recovery potential assessment, the recovery strategy, and any progress reports on recovery strategy implementation.

The North Atlantic Right Whale is a large baleen whale that occurs in coastal and shelf waters along the eastern seaboard of North America, from Florida to Newfoundland and Labrador. Atlantic Canadian waters are important foraging grounds for the species, which feeds on the copepods *Calanus*.

This action plan outlines measures that provide the best chance of achieving the recovery goal and objectives for the species, including measures to be taken to address identified threats and monitor recovery. The recovery goal for the North Atlantic Right Whale is “to achieve an increasing trend in population abundance over three generations”. Seven recovery objectives support this goal, and address reducing anthropogenic mortality and injury, population monitoring, research, collaboration, education, and stewardship. Fifty-four recovery measures to meet those objectives are described in this action plan. For each measure, a priority level, status, timeline, and list of potential partners have been identified. The measures are organized in three tables reflecting the lead roles and/or partners involved.

In the recovery strategy for the North Atlantic Right Whale, critical habitat was identified to the extent possible using the best available information. The critical habitat is protected through a SARA Critical Habitat Order made under subsections 58(4) and (5), which invoked the prohibition in subsection 58(1) against the destruction of identified critical habitat. Any future changes or additions to identified critical habitat would occur through an amendment to the recovery strategy.

An evaluation of the socio-economic costs of implementing the action plan and the benefits to be derived from its implementation is provided in section 3.

Recovery of the North Atlantic Right Whale depends on the commitment and cooperation of many organizations that will implement the measures set out in this action plan.

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1. Recovery actions

1.1 Context and scope of the action plan

The North Atlantic Right Whale (*Eubalaena glacialis*) was listed as endangered under the *Species at Risk Act* (SARA) in 2005. This action plan is part of a series of documents regarding the North Atlantic Right Whale (hereafter referred to as “Right Whale”) that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) [status report](#) (COSEWIC 2013), the [recovery potential assessment](#) (RPA) (DFO 2007a), the [recovery strategy](#) (Brown et al. 2009; DFO 2014), and the five-year progress report on recovery strategy implementation covering the period between 2009 to 2014 ([DFO 2016](#)). A second progress report covering the period between 2015 to 2020 is currently under development. Under SARA, an action plan provides the detailed recovery planning that supports the strategic direction set out in a recovery strategy for the species. A recovery strategy also provides background information on the species and its threats, and information on its critical habitat. An action plan for Right Whale, specifically addressing the threat of fisheries interactions, was published as proposed on the Species at Risk Public Registry in 2016. The current action plan addresses all identified threats to the species and reflects the content of the 2016 action plan. This final action plan supersedes the 2016 action plan.

The Right Whale is a large baleen whale that occurs in coastal and shelf waters along the eastern seaboard of North America, from Florida to Newfoundland and Labrador. Occasionally observations are made outside of this range, such as near Norway (Jacobsen et al. 2004), Iceland (Knowlton et al. 1992; Kraus et al. 2007; Hamilton 2018), and in the Bay of Biscay off the coast of France (Pettis 2019), and Greenland (Mellinger et al. 2011). The species has been detected acoustically in Canadian waters year-round, with the fewest detections in the winter (DFO 2019). The largest aggregations of Right Whales in Canadian waters occur during the summer and fall. The primary driver of Right Whale distribution in Canada is the density and availability of their copepod prey, *Calanus* copepods (DFO 2019). The distribution of Right Whales in Canadian waters has shifted since 2010 (Davis et al. 2017; Davies et al. 2019; Record et al. 2019), and they are using previously predictable habitat areas, such as the Bay of Fundy, less frequently (Davis et al. 2017; Davies et al. 2019). Large aggregations of Right Whales have been observed in the southern Gulf of St. Lawrence since 2015; however, it is not clear if the increase in sightings between 2015 and 2017 resulted from a change in Right Whale distribution, increased survey effort, or both (DFO 2019). Long-term acoustic data has shown that Right Whale calls in the Gulf of St. Lawrence increased substantially after 2015 compared to 2011 to 2014 (Simard et al. 2019), which is most likely indicative of increased abundance during this time period.

Historically, commercial whalers targeted Right Whales and depleted the species. In the post-whaling era¹, threats to the species include entanglement in fishing gear, vessel collisions, contaminants, acoustic disturbance, vessel presence disturbance, and changes in food supply (COSEWIC 2013; DFO 2014). Entanglement and vessel strikes are the leading causes of human-induced serious injuries and mortalities (Knowlton and Kraus 2001; Knowlton et al. 2012; Knowlton and Costidis 2013; van der Hoop et al. 2013; Robbins et al. 2015; Knowlton et al. 2016; Kraus et al. 2016; Sharp et al. 2019; Bourque et al. 2020). Studies indicate the incidence and severity of injuries due to entanglements are increasing throughout their range,

¹ Hunting Right Whales was banned internationally in 1935.

vessels of all sizes can cause serious injury or mortality (Kelley et al. 2020), and collisions from large vessels may be lethal even when travelling at reduced speeds (Kelley et al. 2020). (Robbins et al. 2015; Knowlton et al. 2016). There is growing concern about sub-lethal impacts of entanglements and vessel strikes (Knowlton and Costidis 2013; Schick et al. 2013; Robbins et al. 2015; Knowlton et al. 2016; Rolland et al. 2016; van der Hoop et al. 2016, 2017; Pettis et al. 2017).

The “Recovery Strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian Waters” (Brown et al. 2009; DFO 2014) (hereafter the “recovery strategy”) defined the following recovery goal: “To achieve an increasing trend in population abundance over three generations.” In the case of the Right Whale, three generations is approximately 60 years.

The recovery strategy includes seven recovery objectives to support the recovery goal:

1. reduce mortality and injury as a result of vessel strikes
2. reduce mortality and injury as a result of fishing gear interactions (entanglement and entrapment)
3. reduce injury and disturbance as a result of vessel presence or exposure to contaminants and other forms of habitat degradation
4. monitor population and threats
5. increase understanding of life history characteristics, low reproductive rate, habitat and threats to recovery through research
6. support and promote collaboration for recovery between government agencies, academia, environmental non-government groups, Indigenous partners², coastal communities and international agencies and bodies
7. develop and implement education and stewardship activities that promote recovery

The RPA advised that there is no scope for allowable human-induced mortality and that any level of non-lethal harm that may impede population productivity would put recovery at risk (DFO 2007a). Given this, the recovery strategy did not exempt any activities under subsection 83(4) of SARA.

Since 2010, the population has been in steady decline due to increased mortality and decreased reproduction (Kraus et al. 2016; Corkeron et al. 2018; Pace et al. 2017; Pettis et al. 2018a, 2018b, Pettis et al. 2020, Pettis et al. In Review). Preliminary population estimates developed for the October 2020 North Atlantic Right Whale Consortium meeting following Pace et al. (2017) indicated that as of January 2019 approximately 366 individuals remained (Pettis et al. 2021).

Of particular concern is the disproportionate sex ratio, with females numbering far fewer than males (Pace et al. 2017), which appears to be driven by an increase in adult female mortality from human causes (Corkeron et al. 2018). Currently there is little evidence indicating average mortality rates are decreasing (Pace et al. 2017), and it is predicted the species will become extinct in as little as 30 years if the long-term average mortality rate is not significantly reduced (Meyer-Gutbrod et al. 2018). The severity of the Right Whale population decline was recognized by the International Union for the Conservation of Nature (IUCN), which up-listed the Right Whale from endangered to critically endangered in July 2020.

² Originally referred to as Aboriginal groups in the recovery strategy

It is recognized that the current state of population decline must first be halted and reversed before the recovery goal identified in the recovery strategy can be achieved. Any changes or additions to the recovery goal or the recovery objectives for the Right Whale would occur through an amendment to the recovery strategy.

Under section 47 of SARA, the competent minister must prepare one or more action plans based on the recovery strategy. Action planning for species at risk recovery is an iterative process and the implementation schedule in this document (section 1.2.2) may be modified in the future to reflect progress towards recovery.

DFO prepared a science-based review of recovery activities for the Right Whale as part of Canada's Oceans Protection Plan (OPP) (DFO 2017). The review examined the degree to which activities underway or proposed directly contribute to abating threats to Right Whales. It concluded that the most effective recovery activities, which provide immediate and direct benefits to the species, are typically those that remove the threat from areas where Right Whales are present (that is, spatiotemporal avoidance). The report also emphasized the importance of indirect measures that support the implementation of such high-impact measures. The DFO review informed the development of this action plan, and will continue to guide management actions moving forward.

Starting in 2017, high numbers of Right Whale mortalities have been documented throughout their range. These deaths have collectively been declared an Unusual Mortality Event (UME) by the National Oceanic and Atmospheric Administration (NOAA) under the U.S. *Marine Mammal Protection Act* (NOAA 2020). In 2020, NOAA included individuals identified as having a serious injury (defined by NOAA as a whale that is likely to die from the injuries documented at their last sighting) in the UME count.

In 2017, 17 Right Whale mortalities were documented throughout their range in Canadian and U.S. waters. Twelve of the deaths occurred in the Gulf of St. Lawrence, where five live entanglements also were recorded. Seven of the 12 individuals found dead in the Gulf of St. Lawrence were necropsied. The seven necropsies attributed four mortalities to vessel strikes and two to acute entanglement. The cause of death was inconclusive in one of the necropsies, and examination of five carcasses was determined not to be feasible. In 2018, three Right Whale deaths were detected in their range, all in U.S. waters. Three entangled Right Whales were sighted in Canada in 2018. In 2019, eight Right Whale mortalities were confirmed in Canadian waters, with a reported ninth whale that could not be confirmed by the Department. Four Right Whales were observed to be entangled in fishing gear in Canadian waters in 2019. Five of the eight carcasses underwent necropsy, and the causes of death were concluded as follows: three were probable collisions with ships, one was considered a suspected collision, and one could not be determined. Four of five had evidence of severe acute trauma. Detailed examination of the other three carcasses was determined not to be feasible. Detailed information pertaining to the necropsies and entanglements in 2017 and 2019 can be found in the incident reports (Daoust et al. 2018; Bourque et al. 2020). Of the entangled Right Whales observed in Canadian waters between 2017 and 2019, some are considered newly observed entanglements, while others were previously identified as entangled in other jurisdictions prior to being observed in Canadian waters.

The Right Whale deaths in 2017 heightened concern for recovery of the species, and the Government of Canada implemented seasonal management measures to reduce the risk of entanglement and vessel strikes in Canadian waters. These management measures continue to

be refined and implemented, and have been and will continue to be informed and guided by peer-reviewed science advice (for example, DFO 2019; DFO 2020a).

Right whales are migratory animals that cross international boundaries, most notably between Canada and the United States. This action plan aims to address threats throughout the range of the species in Atlantic Canadian waters, while also contributing to international research and conservation initiatives.

1.2 Measures to be taken and implementation schedule

Successful recovery of Right Whales depends on the actions of many different jurisdictions, organizations, and individuals. It requires the commitment and cooperation of these groups to implement the measures described in this action plan.

This action plan describes the measures that provide the best chance of achieving the recovery goal and objectives for the Right Whale, including measures to be taken to address threats to the species and monitor its recovery. These measures will guide activities to be undertaken by Fisheries and Oceans Canada (DFO) and its partners. As new information becomes available, these measures and their priority level may change. DFO strongly encourages all Canadians to participate in the conservation of the Right Whale by undertaking measures outlined in this action plan.

In section 1.2.1, recovery measures are grouped according to responsibility in a three-table implementation schedule. Section 1.2.2 provides additional details on select measures.

1.2.1 Implementation schedule

Table 1 identifies the measures to be undertaken by DFO to support recovery of the Right Whale.

Table 2 identifies the measures to be undertaken collaboratively by DFO and its partners. Implementation of these measures will be dependent on a collaborative approach, in which DFO is a partner in recovery efforts, but cannot implement the measures alone.

As all Canadians are invited to join in supporting and implementing this action plan, table 3 identifies the remaining measures that represent opportunities for other jurisdictions, organizations, or individuals to lead. If your organization is interested in participating in one of these measures, please contact the Species at Risk Maritimes Region office at speciesatrisk.xmar@dfo-mpo.gc.ca or 1-866-891-0771.

Implementation of this action plan is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations. Federal funding programs for species at risk may provide opportunities to obtain funding to carry out some of the outlined activities. These programs include, but are not limited to, the [Habitat Stewardship Program for Species at Risk](#), the [Aboriginal Fund for Species at Risk](#), the [Sustainable Fisheries Solutions and Retrieval Support Contribution Program](#) and the [Interdepartmental Recovery Fund](#). Each recovery measure has been assigned a priority level, based on national definitions, reflecting the degree to which the measure is expected to contribute directly to the recovery of the species, or is an essential precursor to a measure that is expected to contribute to the recovery of the species. All measures included in this action plan are considered important, and they are

included because of their expected contribution toward Right Whale recovery. The definitions of the priority levels are as follows:

- "high" priority measures are considered likely to have an immediate and/or direct influence on the recovery of the species
- "medium" priority measures are important but considered to have an indirect or less immediate influence on the recovery of the species
- "low" priority measures are considered important contributions to the knowledge base about the species and mitigation of threats

Each recovery measure listed in the implementation schedule is linked to one or more of the seven recovery objectives identified in the recovery strategy (section 1.1 of this document).

The status of each recovery measure is designated as either "not started" or "underway".

One of four timelines is assigned to each recovery measure: <2 years; 2 to 5 years; >5 years; or continuous (that is, the activity is to be carried out on an ongoing basis or every time an opportunity arises, with no fixed completion date). Timelines should be interpreted based on the publication date of the action plan. For example, a measure with an assigned timeline of <2 years may be reasonably expected to be completed within two years of the publication of the action plan.

Partners identified in tables 2 and 3 are broad groups or specific organizations that have either a known or potential role in implementation of each measure. When a specific organization is named, it is not meant to be exclusive, but rather reflects a past or future commitment to an activity of the same or similar nature. Indigenous partners (Indigenous harvesters and/or Indigenous communities and organizations) are invited to participate in all measures.

This action plan does not present specific work planning details for each measure, but is rather meant to guide more detailed work planning processes within DFO and its partner organizations by identifying actions that may be taken to advance the recovery of the Right Whale in Canada.

The following acronyms are used in the implementation schedule (tables 1 to 3):

CCG	Canadian Coast Guard
CMARA	Canadian Marine Animal Response Alliance
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
CSA	Canada Space Agency
CWI	Canadian Whale Institute
DAL	Dalhousie University
DFO	Fisheries and Oceans Canada
ECCE	Environment and Climate Change Canada
GREMM	Group for Research and Education on Marine Mammals
IAA	Impact Assessment Act
IAAC	Impact Assessment Agency of Canada
IMO	International Maritime Organization
MI	Marine Institute, Memorial University
MICS	Mingan Island Cetacean Study
NEAq	New England Aquarium
NGO	Non-government organization
OPP	Oceans Protection Plan

NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ROMM	Réseau d'observation de mammifères marins
SLGO	St. Lawrence Global Observatory
SMU	Saint Mary's University
TC	Transport Canada
UNB	University of New Brunswick
WHOI	Woods Hole Oceanographic Institution

The following terms are used in the implementation schedule (table 1 to 3) and throughout this document.

Industry	Shipping industry <i>and</i> non-Indigenous commercial harvesters (fishing industry). The shipping industry and fishing industry are referenced independently as appropriate
Response organization	Individual group directly involved in coordinating response efforts for dead/distressed Right Whales
Response network	Group composed of several response organizations

Table 1. Measures to be undertaken by Fisheries and Oceans Canada.

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline
1	Lead and provide administrative support to a Right Whale implementation and recovery network	Medium	6	Underway / continuous
2	Develop and implement fishery management measures to reduce the risk of Right Whale mortality, serious injury, and sub-lethal effects from entanglement in fishing gear	High	2, 4, 5, 6, 7	Underway / continuous
3	Continue and enhance the Marine Mammal Response Program to support the operation of incident response networks across Atlantic Canada and Quebec	High	2, 4, 6	Underway / continuous
4	Develop and implement robust internal protocols to facilitate effective response to Right Whale incidents and mortalities in Canadian waters, including necropsies	High	1, 2, 3, 4, 5	Underway / continuous
5	Collaborate and coordinate with other countries on recovery planning, management, and research	Medium	6	Underway / continuous
6	Facilitate regular meetings with internal and external scientists to coordinate field and analytical studies in Canadian waters (at least annually), and share information with interested parties	Medium	6	Underway / continuous
7	Continue to implement the Schedule of Studies to identify and refine critical habitat as outlined in the recovery strategy	Medium	5	Underway / continuous
8	Review the recovery strategy in light of updated science with a view to amending the recovery strategy if necessary	Medium	N/A	Underway / 2 to 5 years

Table 2. Measures to be undertaken collaboratively between Fisheries and Oceans Canada and its partners.

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Partners (alphabetical order)
9	Develop and implement annual vessel traffic management measures to reduce the risk of Right Whale mortality, serious injury, and sub-lethal effects from vessel strikes	High	1, 3, 4, 5, 6	Underway / continuous	DFO / CCG / industry / NGOs / TC
10	Identify and implement long term vessel traffic management measures to reduce the risk of Right Whale mortality, serious injury, and sub-lethal effects from vessel strikes	High	1, 3, 4, 5, 6	Underway / continuous	DFO / IMO / industry / TC
11	Develop and implement acoustic monitoring and analysis programs to detect Right Whale calls/vocalizations and monitor anthropogenic noise levels in known or potential habitat areas	High	1, 2, 3, 4, 5	Underway / continuous	DAL / DFO / eSONAR Inc / other academia / MI / NOAA / TC / UNB / WHOI
12	Record vocalizations, received sounds, and three-dimensional dive profiles using passive acoustic tags to monitor Right Whale behaviour	Medium	4, 5	Underway / 2 to 5 years	Academia / DFO / NGOs
13	Develop and implement visual surveillance programs (vessel-based and aerial) used to detect Right Whales and investigate the development of new surveillance technologies	High	1, 2, 3, 4, 5	Underway / continuous	CSA / CWI / DFO / Earth Observation industry / ECCC / NEAq / MICS / NOAA / TC / UNB
14	Provide training on whale species identification to DFO fishery officers, CCG personnel, marine mammal observers, and other mariners. Collaborate with existing programs to avoid duplication and achieve consistency.	Medium	4	Underway / continuous	Consulting companies / DFO / NGOs
15	Promote regional free-swimming whale sightings phone lines and email addresses with ocean users	Low	4, 5, 7	Underway / continuous	DFO / GREMM / other NGOs / ROMM
16	Maintain and coordinate cetacean sightings and acoustics databases to build long-term data sets	Medium	4	Underway / continuous	CWI / DAL / DFO / GREMM / industry / MICS / ROMM / SLGO
17	Maintain and coordinate Right Whale sightings and acoustics database used for near-real time management measures	High	1, 2, 4, 5	Underway / continuous	CWI / DAL / DFO / NGOs / industry / other academia / TC

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Partners (alphabetical order)
18	Ensure the ongoing operation and capacity of regional marine animal response organizations and networks, and toll-free incident reporting hotlines operating 365 days/year	High	2, 4, 6	Underway / continuous	DFO / Indigenous partners / response networks / response organizations
19	Produce and distribute outreach materials that promote reporting of entangled, dead, or injured whales	Low	4, 5, 7	Underway / <2 years	DFO / response networks / response organizations
20	Develop and refine Right Whale habitat suitability models to predict potential areas of occurrence	Medium	4, 5	Underway / continuous	Academia / CSA / DFO / Earth Observation industry / NGOs / TC
21	Record broad-scale two-dimensional movements over periods of several months using safe and reliable tagging technologies to gather information on habitat use, migration, and other movement patterns	Medium	4, 5	Underway / 2 to 5 years	Academia / DFO / industry / NGOs
22	Conduct visual health assessments of Right Whales (for example assess body condition using photogrammetry) to monitor health trends at the individual and species level	Medium	4, 5	Underway / continuous	Academia / DFO / NEAq / NOAA / other NGOs
23	Collect tissue, blow, and fecal samples to support hormonal and genetic studies of reproduction, reproductive health, nutritional state, and stress levels	Medium	4, 5	Underway / continuous	Academia / DFO / NGOs
24	Conduct entanglement risk analyses for habitat areas where fishing activities and Right Whales co-occur, and use the resulting analyses to inform fisheries management decisions to reduce entanglement risk. Collaborate on entanglement risk analyses, as appropriate.	High	2, 5	Underway / continuous	Academia / DFO / fishing industry / Indigenous partners / NGOs / NOAA
25	Explore, develop, and implement entanglement prevention and mitigation measures, including gear innovation or modified gear configurations	High	2	Underway / continuous	DFO / fishing industry / Indigenous partners / NGOs / NOAA / private sector / provinces
26	Develop and implement effective gear marking and gear reporting systems	Medium	2	Underway / 2 to 5 years	DFO / fishing industry / Indigenous partners / NOAA

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Partners (alphabetical order)
27	Develop and implement protocols for retrieval, storage, analysis, and documentation of fishing gear from entangled Right Whales and coordinate with efforts range-wide	Medium	2, 5	Underway / <2 years	DFO / fishing industry / Indigenous partners / response organizations / NGOs / NOAA
28	Examine the mechanisms of Right Whale entanglement to better inform prevention and mitigation measures	Low	2, 5	Underway / 2 to 5 years	Academia / DFO / fishing industry / Indigenous partners / NGOs
29	Remove abandoned, lost, or otherwise discarded fishing gear (ALDFG) from Right Whale habitat to reduce risk of entanglement	High	2	Underway / continuous	DFO / fishing industry / Indigenous partners / NGOs
30	Conduct vessel strike risk analyses for areas where vessel traffic and Right Whales co-occur	High	1, 4	Underway / 2 to 5 years	DAL / DFO / TC
31	Improve and expand vessel-based Right Whale detection using new sensor technologies, passive acoustic monitoring, marine mammal observers, or other methods	High	1	Underway / 2 to 5 years	DFO / industry / TC
32	Develop and implement a system for providing near real-time detection and notifications of Right Whale presence	High	1, 2, 3	Underway / 2 to 5 years	Academia / DFO / Indigenous partners / industry / TC
33	Communicate proactively and regularly with mariners about management measures in place to reduce the risk of vessel strikes with Right Whales	High	1, 2, 7	Underway / continuous	CCG (MCTS) / DFO / industry / NGOs / TC
34	Assess the impacts of anthropogenic noise on Right Whales	Medium	3, 4, 5	Underway / >5 years	Academia / DFO / industry
35	Explore, develop, and apply noise mitigation measures to minimize impacts on Right Whales	Medium	3, 4, 5	Underway / continuous	DFO / industry / other regulators / TC
36	Survey, monitor, and predict the locations of <i>Calanus</i> aggregations	High	1, 3, 4, 5	Underway / continuous	Academia / DFO / NOAA

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Partners (alphabetical order)
37	Determine and monitor contaminant levels in Right Whales and their <i>Calanus</i> prey, and identify potential sources	Low	3, 4	Not started / 2 to 5 years	Academia / DFO / NGOs / response organizations
38	Enhance regulatory capacity and policies as needed to prevent and mitigate threats to Right Whales (for example through statutory amendments, new regulations, or new policies/guidelines)	Medium	1, 2, 3	Underway / continuous	DFO / TC
39	Conduct compliance monitoring and enforcement of mandatory threat prevention and mitigation measures, and monitor conformity with voluntary measures	High	1, 2, 3, 4	Underway / continuous	CCG (MCTS) / DFO / TC
40	Develop and distribute educational materials for ocean user groups on whale identification, critical habitat, best practices in threat prevention and mitigation, and management measures in place to protect Right Whales	Medium	7	Underway / continuous	CWI / DFO / Indigenous partners / industry / NGOs / other academia / other NGOs / TC / UNB
41	Ensure the protection of Right Whales and their habitat is considered in all relevant regulatory review processes for proposed activities, such as those conducted under the <i>Impact Assessment Act</i> , <i>Fisheries Act</i> , and <i>Species at Risk Act</i>	High	1, 2, 3, 4	Underway / continuous	CNSOPB / DFO / IAAC / NGOs / other regulators / TC
42	Consider Right Whales and their habitat in relevant marine protected area and marine spatial planning initiatives	Medium	1, 2, 3, 6	Underway / continuous	DFO / Indigenous partners / industry / NGOs / other government departments
43	Evaluate the effectiveness of existing management/mitigation measures and adapt them to reflect emerging scientific information, risk analyses, emerging threats, and international best practices	High	1, 2, 3	Underway / continuous	Academia / DFO / Indigenous partners / industry / NGOs / other regulators / response organizations / TC
44	Complete a population viability analysis	Low	4, 5	Underway / <2 years	DFO / NGOs / NOAA / other government departments (U.S.)
45	Conduct scenario planning to prepare for uncertain future environmental conditions and vulnerabilities	Medium	1, 2, 3	Underway / 2 to 5 years	DFO / NOAA

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Partners (alphabetical order)
46	Explore Indigenous Knowledge on Right Whale ecology and historic and current distribution	Medium	4, 5, 6	Not started / 2 to 5 years	DFO / Indigenous partners
47	Monitor, report, and respond to pollution incidents in Right Whale habitat areas	Medium	4	Underway / continuous	CCG / DFO / ECCC / mariners / response organizations / TC

Table 3. Measures that represent opportunities for other jurisdictions, organizations, or individuals to lead.

#	Recovery measure	Priority	Recovery objective(s) addressed	Status / timeline	Suggested jurisdictions / organizations
48	Maintain the North Atlantic Right Whale Consortium databases, including the sightings and identification (for example, photo-identification, sightings, genetics) databases	High	4, 5	Underway / continuous	NEAq / SMU / University of Rhode Island
49	Assess and monitor population size, age-sex structure, and trends	Medium	4, 5	Underway / continuous	Academia / NEAq / NGOs / NOAA
50	Monitor scarring rates as an indicator of effectiveness in preventing and mitigating entanglement	Medium	2, 5	Underway / continuous	Academia / NEAq / NGOs
51	Increase the scope of mandatory automatic identification system (AIS) use for Canadian vessels to facilitate Right Whale vessel strike risk analyses and mitigation measures	High	1, 3, 4, 5	Underway / <2 years	TC
52	Identify, test, and implement engineering, operational, and maintenance improvements for ships to reduce noise emissions	Medium	1, 3	Underway / >5 years	IMO / industry / TC
53	Develop, promote, and inform recognition programs or other incentives for industries to take steps to reduce their threats to Right Whales, including noise, vessel strikes, and entanglements	Low	1, 3	Underway / >5 years	DFO / IMO / Indigenous partners / industry / NGOs / port authorities / TC
54	Assess the impacts of anthropogenic noise on <i>Calanus</i>	Low	5	Not started / >5 years	Academia

1.2.2 Narrative to support the implementation schedule

The implementation tables (tables 1 to 3) contain 54 recovery measures that will contribute to meeting all seven recovery objectives for the Right Whale (section 1.1). Eight of the measures are in table 1, thirty-nine are in table 2, and seven are in table 3. The majority of measures are already underway. Implementation of several measures in this action plan are expected to also benefit other species at risk, particularly other whales and sea turtles.

Selected recovery measures are explained further in this section where additional context, history, or information was deemed useful for interpretation. The inclusion of a narrative is not meant to imply a measure is of higher priority, nor is it meant to suggest that progress is more or less advanced than it is for a measure without a narrative. The narratives below are numbered in accordance with the numbers assigned in the implementation schedule (tables 1 to 3).

1. Lead and provide administrative support to a Right Whale implementation and recovery network

The Right Whale Recovery Network has provided a forum for information-sharing, feedback, discussion, and coordination of Right Whale recovery planning and implementation beginning in 2009. It succeeded the previous Recovery Teams that prepared the SARA recovery strategy and the pre-SARA recovery strategy (WWF/DFO 2000). DFO co-chairs the Network, which has included representatives from federal and provincial government departments, the U.S. National Marine Fisheries Service (NMFS), Indigenous partners, industry stakeholders, academia, and non-government organizations. Historically, the network focused largely on the Maritimes Region, because most Right Whale observations in Canadian waters were in and near the two critical habitat areas identified in the recovery strategy (DFO 2014). Some Gulf of St. Lawrence partners were involved, as occasional Right Whale sightings had been made in that area in previous decades. With shifts in the species' distribution, the structure and function of the Right Whale Recovery Network needs to be revisited to include interests and expertise from across Atlantic Canada and Quebec. The Network provides a mechanism to share information with interested and affected parties about research underway and resulting information, management measures, and initiatives undertaken by Indigenous partners and industry, among other kinds of information, in support of the Government of Canada's implementation of the SARA recovery program for Right Whales. The Canadian Recovery Network will also provide a forum to liaise with the Right Whale Implementation Teams in the United States. The terms of reference for this group will be reviewed and updated accordingly.

2. Develop and implement fishery management measures to reduce the risk of Right Whale mortality, serious injury, and sub-lethal effects from entanglement in fishing gear

DFO uses several types of fishery management measures that are designed to prevent (eliminate risk of happening) or mitigate (reduce the duration and/or severity) Right Whale entanglements. Adaptive fishery management measures implemented since 2018 include: the closure of areas to fisheries where and when Right Whales are detected throughout Atlantic Canada and Quebec, adjusting fishing seasons (for example, earlier opening in the southern Gulf snow crab fishery in 2018), mandatory requirements to report lost gear, and mandatory rope colour marking for all fixed gear fisheries (including lobster and crab) in Atlantic Canada and Quebec. In recent years, DFO has also focused on increasing the Right Whale presence and distribution information available to inform management decisions.

To help reduce the duration or severity of entanglements if they occur, DFO is phasing in a requirement for lower breaking points in rope vertical lines. This can be achieved through the use of rope that is manufactured to have a lower breaking strength, or through gear modifications that introduce weak sections into lines. In 2020, DFO supported “ropeless” and “weak link” gear trials and plans to require, through regulations, weak rope or weak breaking points in fixed gear fisheries by the end of 2021.

For static and dynamic management areas, the regulating authority (DFO) establishes the size and location of the areas to be managed and the criteria that will trigger a management response. In 2018 and 2019 DFO implemented a season-long area closure (referred to as the “static zone”) in a section of the Gulf of St. Lawrence for all non-tended fixed gear fisheries during the snow crab and lobster fishing seasons. Beginning in 2018, DFO identified dynamic management areas in the Gulf of St. Lawrence and in the Grand Manan Basin and Roseway Basin Right Whale critical habitat areas. The whale density ‘trigger’ for closures during this time period was based on visual detections of Right Whales within a defined area and time (DFO 2019). In 2020, the entire Gulf of St. Lawrence was subject to a new season-long protocol, which was triggered where and when persistent right whale detections occurred. In 2020, the dynamic closure area was expanded to include the entire Bay of Fundy, inclusive of the Right Whale critical habitat area in the Grand Manan Basin. Unlike the previous pre-set (static) season-long closure area in the Gulf of St. Lawrence in 2018 and 2019, season-long closures were applied to areas in the Gulf of St. Lawrence where whales were detected more than once in 15 days. Detection capabilities in 2020 were enhanced by using both visual (aircraft and vessel) and acoustic platforms (underwater hydrophones and glider technologies) to trigger closures.

Effective dynamic management, an important component of Right Whale entanglement prevention measures, relies on the ability to detect Right Whales and remove gear from detection areas reliably and efficiently. Depending on visual surveillance alone presents challenges. Poor weather conditions can limit or prevent the ability to undertake visual surveillance to confirm Right Whale presence and therefore can impede decisions to close or re-open areas. Poor weather can also limit or prevent the ability to safely and rapidly remove gear from the water when detections occur. Combining visual and acoustic detection methods to support management measures, such as what was done in 2020, may increase detection probability, as well as monitoring effectiveness and efficiency (Durette-Morin et al. 2019; Johnson et al. 2020).

Fishery management decisions are informed by visual and acoustic detections, and the latest scientific advice, in addition to other factors. The Canadian Science Advisory Secretariat (CSAS), which coordinates the scientific peer review and science advice for DFO, review of Right Whale information in 2017, 2018 and 2019 (DFO 2017; DFO 2018a; DFO 2019; DFO 2020a), as well as information gathered during engagement sessions (see recovery measure #25) informed the development of the management measures implemented during the 2019 and 2020 fishing seasons. Fishery management measures will continue to be adapted and refined with input from the scientific community, Indigenous partners, the fishing industry, while also taking into consideration technological advancements.

3. Continue and enhance the Marine Mammal Response Program to support the operation of incident response networks across Atlantic Canada

DFO is responsible for supporting marine mammals in distress, including Right Whales. Under the umbrella of the National Marine Mammal Response Program (MMRP), DFO collaborates

with non-government organizations across the country to respond to marine mammal incidents, including dead, entangled, or otherwise injured (for example, from vessel strike) whales. In addition to providing expert care and assistance to distressed animals, these response networks provide valuable data that can be used to help quantify threats to species at risk. DFO is committed to protecting endangered whales through ongoing programs and investments that will develop and maintain internal and external response capacity, such as expanding disentanglement training efforts and purchasing critical equipment.

4. Develop and implement robust internal protocols to facilitate effective response to Right Whale incidents and mortalities in Canadian waters, including necropsies

Clear, concise, and systematic protocols for responding to reports of Right Whale incidents or mortalities are of critical importance. These protocols must identify all relevant contacts (internal and external), areas of expertise (for example, carcass drift analysis), and the availability and location of material assets (for example, vessels, satellite tags, specialized disentanglement equipment, and heavy equipment resources for necropsies) that may be needed to respond. Roles and responsibilities must be clear, as should the lines of communication. Procedures for mobilizing resources and funding should be included. Response and necropsy protocols must be robust to changing scenarios (for example, response after-hours or on the weekend; equipment failure; inclement weather). Necessary training for affected DFO staff (for example, fishery officers, marine mammal coordinators) should be standardized, tracked, and regularly refreshed, with consideration given to training in Incident Command System principles. Cross-region jurisdictional cooperation and collaboration is needed, and common protocols should be adopted. Internal DFO response protocols should complement those used by external response networks. Significant progress has been made on internal protocol development and implementation since 2017, and is continuing (see DFO 2018b). These protocols support effective, timely, and safe response to marine mammal incidents and include regular collaboration between DFO and external partners.

When logistically feasible, necropsies will be conducted on all deceased Right Whales in Canada regardless of the condition of the carcass. Valuable information can be gleaned from even highly decomposed individuals (see Moore et al. 2013; Sharp et al. 2019). Post-mortem examinations are the sole means of determining cause of death, and provide important information on population ecology and injuries. The results can help evaluate the effectiveness of management measures (see van der Hoop et al. 2015). DFO will continue to work with expert response partners to establish and implement an incident response protocol that includes considerations such as suitable necropsy and disposal sites, the consistent application of existing sampling protocols, sample storage, supply and equipment needs, and logistics. Collaboration with experienced partner organizations is vital to the success of necropsies. Identifying and following clear pathways of communication when incidents occur will support efficient and effective response to all incidents.

Protocols should be discussed, agreed to, and followed by affected DFO staff and external response partners. Response information should be consolidated into as few documents as possible, for consistency of approach, and reviewed on a regular basis.

5. Collaborate and coordinate with other countries on recovery planning, management, and research

DFO collaborates with the U.S. government, through several initiatives. The Canada-U.S. Transboundary Resources Steering Committee meets biannually to discuss integrated

ecosystem management issues associated with the Gulf of Maine and Georges Bank. The Committee includes a Species at Risk Working Group that focuses on research and management initiatives related to transboundary species such as the Right Whale throughout its Canadian and U.S. range. In 2017, the United States and Canada Bilateral Cetacean Working Group was formed to increase coordination and collaboration on cross-border whale conservation issues, with an immediate focus on Right Whales.

DFO and U.S. National Marine Fisheries Service (NMFS) staff participate on each country's Right Whale recovery teams, scientific working groups, and other initiatives to share information and collaborate on projects. In 2020, TC joined DFO on the U.S. North East Implementation Team (NEIT), a multi-disciplinary advisory team that assists NOAA with the implementation of the North Atlantic Right Whale recovery plan (NMFS 2005).

Canada also shares a maritime border with Saint-Pierre and Miquelon, an overseas collectivity of France located off southern Newfoundland. DFO will continue to work with its counterpart department in Saint-Pierre and Miquelon to advance Right Whale recovery and monitoring.

The Government of Canada shares information and collaborates with international partners through the North Atlantic Right Whale Consortium. The consortium meets annually and includes more than 200 members from the U.S. and Canadian governments, academia, non-government organizations, Indigenous partners, and industry. DFO and TC will continue to participate in these and other collaborative bodies, as appropriate, to support Right Whale recovery.

6. Facilitate regular meetings with internal and external scientists to coordinate field and analytical studies in Canadian waters (at least annually), and share information with interested parties

Each year, DFO science staff host a coordination session for research organizations planning to undertake fieldwork or analytical studies on cetaceans, including Right Whales, in Canadian waters. Because collaboration is a vital part of Right Whale research, this provides an opportunity for information sharing about the timing and location of vessel- and aircraft-based projects, and how collaboration can be optimized. It supports collaboration among organizations undertaking sampling and analysis of live and dead Right Whales, helping ensure that collected data and samples are shared and distributed effectively, thus building understanding of the species' health, genetics and population structure. Broader or emerging research needs, objectives and avenues for collaboration may also be discussed.

7. Continue to implement the Schedule of Studies to identify and refine critical habitat as outlined in the recovery strategy

Roseway Basin and the Grand Manan Basin were identified as Right Whale critical habitat in the recovery strategy based on their features and attributes that support Right Whale functions of foraging, socializing, and calf-rearing. Right whales were known to shift their relative use of these two areas over periods of several years, as prey availability changed (reviewed in DFO 2007a).

When the identification of critical habitat for a species is not considered complete, SARA recovery strategies include a Schedule of Studies to outline the research needed to adequately identify critical habitat, including studies needed to refine existing critical habitat. The Schedule of Studies for Right Whale critical habitat includes an evaluation of their use of the Gaspé area

in the Gulf of St. Lawrence, where sightings and acoustic data indicated the presence of Right Whales. Right whales have shifted their distribution in Canadian waters, appearing in greater numbers in the Gulf (DFO 2019). The most likely reason for this is a change in the abundance and availability of their prey. Right whale mother-calf pairs were seen in the Gulf in the summers of 2015, 2016, 2019, and 2020. Further studies are necessary to help understand whether this pattern of habitat use by Right Whales in the Gulf reflects the presence of characteristics that would be identified as critical habitat. Any future changes or additions to identified critical habitat, in the Gulf of St. Lawrence or elsewhere, would be made through an amendment to the recovery strategy.

9. Develop and implement annual vessel traffic management measures to reduce the risk of Right Whale mortality, serious injury, and sub-lethal effects from vessel strikes

All opportunities to reduce the risk of vessel strikes on Right Whales should be assessed. The measures taken to date fall broadly into two categories and align with those taken in other jurisdictions (see Leaper and Calderan 2015): (1) vessel re-routing to avoid co-occurrence with whales and (2) vessel speed reductions.

The risk of a lethal vessel strike increases with vessel speed, and the probability of a vessel-whale encounter (Vanderlaan and Taggart 2007). Consequently, speed reductions to 10 knots or less in areas where whales and vessels co-occur can help reduce the likelihood of lethal encounters. In 2017, 2018 and early 2019, static speed restrictions for vessels over 20 metres in length were implemented in a large area of the Gulf of St. Lawrence and dynamic speed restrictions were applied to the shipping lanes north and south of Anticosti Island. Dynamic speed restrictions are speed restrictions put in place when a Right Whale is detected in the shipping lanes or on a precautionary basis when TC is unable to conduct effective surveillance of the shipping lanes for a period of time. Unlike static speed restrictions, which are in place throughout the season, dynamic speed restrictions may be implemented and lifted multiple times throughout the season. In July 2019, TC expanded these vessel traffic management measures to vessels greater than 13 metres in length, and increased the size of the management zones. Among several factors for this expansion was preliminary research, which has since been published (Kelley et al. 2020), suggesting that vessels of all sizes pose a threat to seriously injure or kill whales.

In 2020, the Minister of Transport issued Interim Orders implementing similar static and dynamic speed restrictions in various zones in the Gulf of St. Lawrence, as well as an additional measure, a Restricted Area in and near the Shediac Valley aimed at protecting Right Whale aggregations gathering for feeding and surface activity in this area. In 2020, TC also implemented a trial voluntary slowdown in the Cabot Strait. This precautionary trial slowdown aimed to provide additional protection in a migratory passageway, while helping to inform the safety considerations for vessels transiting through this challenging corridor as it relates to the development and implementation of management measures.

The unpredictable movement of the Right Whale population presents a significant challenge to vessel management, which is why these management measures continue to be adapted and refined annually, or as needed mid-season, in consultation with stakeholders, and considering the latest scientific advice, navigational safety, and economic impacts. TC will continue to conduct monitoring and enforcement of the mandatory vessel management measures and to monitor conformity with voluntary slowdown measures (see recovery measure #43).

Improvements in the near real-time detection and communication of Right Whale sightings will allow for greater preparedness among mariners and managing authorities to make real-time management measures feasible. TC will work with industry to determine what is expected of vessels when they receive an alert about Right Whale detections outside of pre-defined mandatory or voluntary management areas.

10. Identify and implement long-term vessel traffic management measures to reduce the risk of Right Whale mortality, serious injury, or sub-lethal effects from vessel strikes

Longer-term measures may be accomplished in a variety of ways, including measures implemented through the International Maritime Organization (IMO) (Silber et al. 2012). Several long-term measures have been implemented within Canadian waters to reduce the risk of vessel strikes on Right Whales. For example, an amendment to the Bay of Fundy Traffic Separation Scheme and the designation of a seasonal recommendatory Area to Be Avoided (ATBA) in the Roseway Basin (Vanderlaan et al. 2008). The Bay of Fundy Traffic Separation Scheme was amended in 2002 to reduce the probability of interactions between ships and Right Whales. For similar reasons, the Roseway Basin ATBA was adopted by the IMO and implemented by Canada in 2007 as a voluntary routing measure. The process for any measure to be adopted by the IMO and implemented can take several years. Should an alteration of traffic separation schemes in the Gulf of St. Lawrence be undertaken, it would require extensive risk assessment before action at the IMO would be considered. In the meantime, other voluntary options could be considered, such as recommended routes to avoid Right Whale aggregations.

11. Develop and implement acoustic monitoring and analysis programs to detect Right Whale calls/vocalizations and monitor anthropogenic noise levels in known or potential habitat areas

Acoustic detection of distinctive Right Whale calls is being used increasingly to infer the species' spatial and temporal distribution (DFO 2019; Johnson et al. 2020). These acoustic monitoring methods have several advantages that complement visual surveillance efforts (recovery measure #13), including the ability to monitor areas that are not covered by dedicated visual surveillance (for example, to gain a better understanding of whale presence in data poor and/or higher risk areas), and the ability to monitor when visual surveillance is not possible (for example, in poor weather conditions or overnight). Near-real time acoustic data is currently being used to inform management decisions such as fishery closures (see recovery measure #2) and vessel speed reductions (see recovery measure #9).

Near real-time and long-duration acoustic recorders also are used to monitor inshore and offshore anthropogenic noise sources and levels in the marine environment. The OPP includes a commitment to better understand and address the cumulative effects of shipping noise on marine mammals, including Right Whales, in Canada. DFO has developed a research plan that includes establishing a noise baseline and enhancing knowledge of the species' seasonal occurrence off Atlantic Canada and Quebec using acoustic detection and other methods. The research program is building and expanding upon previous acoustic monitoring efforts, which have included bottom-mounted passive acoustic monitoring (PAM) systems and Slocum gliders equipped with near real-time acoustic sensors. All acoustic recordings collected will be analyzed for Right Whale calls. Currently, acoustic monitoring technologies can detect the presence of calling whales only; however, means of counting individual whales using acoustic techniques is also being explored outside of the OPP research program.

In addition to monitoring the spatiotemporal occurrence of Right Whales, DFO is monitoring the soundscape (ambient noise plus anthropogenic contributions) in certain locations, and using these data to ground-truth noise models under construction for wider areas. The initial focus of this work is on characterizing shipping noise, with an examination of other noise sources (for example, seismic surveys, sonar) to follow. These data layers and modelling tools are necessary to study the potential risk and impact of noise on the species. Plans are also in place to assess the detection ranges for Right Whale calls, and how this varies in space and time with the acoustic environment, of the various monitoring systems.

13. Develop and implement visual surveillance programs (vessel-based and aerial) used to detect Right Whales and investigate the development of new surveillance technologies

Visual surveillance from aircraft and vessels is used to gather information including, but not limited to, location, abundance, individual identity, residency, and distribution of Right Whales throughout Atlantic Canada and Quebec, including in special management zones, as well as to detect entangled, injured, and dead whales. The data collected can help answer research questions and inform management decisions such as area closures to fisheries or vessel speed reductions. An effective visual surveillance program requires trained marine mammal observers and consistent data collection protocols. Each type of survey platform and survey design has strengths and weaknesses, suited to address different needs. Survey methods and coverage (spatial and temporal) should be designed to meet multiple objectives and information needs (DFO 2019).

Since 2017, visual surveillance efforts for Right Whales in Canada have increased significantly and become more coordinated. These efforts include dedicated systematic whale surveys and collection of sightings from opportunistic platforms (for example, Canadian Coast Guard vessels, research vessels, DFO Conservation and Protection vessels and aircraft), which leverage the expertise and resources of multiple partner organizations. In addition to traditional aircraft, TC has also tested and evaluated the use of Remotely Piloted Aircraft Systems to support Right Whale monitoring efforts in the Gulf of St. Lawrence. Ongoing maintenance and capacity-building within the visual surveillance program is required. Other methods of detection, such as remote sensing, are also being explored. For this purpose, a collaborative initiative in direct alignment with [Canada's Space Strategy](#), known as smartWhales, has been established by the CSA, in partnership with DFO and TC (the users). This initiative will allow the Earth Observation industry to investigate and develop improved whale detection and monitoring solutions with the use of space-based data during the 2021 to 2024 time period.

16. Maintain and coordinate cetacean sightings and acoustics databases to build long-term data sets

Ongoing maintenance, enhancement, and coordination of cetacean sightings and acoustics databases is needed to ensure comprehensive and reliable sources of Right Whale data in Atlantic Canadian and Quebec waters. There are currently three regional DFO databases, as well as several databases maintained by non-government organizations and academic institutions, that include systematic and opportunistic observations from multiple sources, such as DFO fishery officers, fisheries observers, marine mammal observers, research scientists, whale watch vessels, and other mariners (for instance, through the free Whale Alert mobile phone app).

17. Maintain and coordinate Right Whale sightings and acoustics database used for near-real time management measures

Right whale sightings and near-real time acoustic detections are currently entered into [WhaleMap](#), a web-based application managed by Dalhousie University that displays integrated Right Whale observation and near real-time acoustic data from all trusted sources in Canadian waters. A system for consolidating and standardizing diverse data streams into a centralized, national cetacean sightings database is in development, and standard operating procedures for establishing formal data sharing agreements, and dedicated financial support for its maintenance are needed.

18. Ensure the ongoing operation and capacity of regional marine animal response organizations and networks, and toll-free incident reporting hotlines operating 365 days/year

Several marine mammal response organizations (for example, [Marine Animal Response Society](#), [Campobello Whale Rescue Team](#), [Whale Release and Strandings – Newfoundland and Labrador](#)) and broader response networks (for example, [Réseau Québécois d'Urgences pour les Mammifères Marins](#), [Maritime Marine Mammal Animal Response Network](#), [Canadian Marine Animal Response Alliance](#)) operate in Atlantic Canada and Quebec. The regional roles and capacities of the response organizations and networks vary, but can include: operating toll-free reporting hotlines; coordinating response to incidents (including Right Whale entanglements and mortalities) with partners, DFO and other agencies; sample collection; providing research capacity; assessing the effectiveness of mitigation measures; providing education and training programs; and, supporting capacity-building.

Collaboration among Canadian government departments and agencies and the response organizations/networks supports consistent, timely responses to deaths and entanglements of Right Whales and other large whale species, which is important for understanding the causes of such incidents and ultimately trying to prevent them. DFO provides continuing support for response organizations through contracts and capacity-building funds under the Department's National Marine Mammal Response Program (see recovery measure #3) and their participation in broader coordinating networks will help ensure that information derived from response to Right Whale incidents will contribute to ongoing research and measures to protect Right Whales.

20. Develop and refine Right Whale habitat suitability models to predict potential areas of occurrence

Habitat suitability models (HSMs) are statistical tools used to evaluate the relationship between species occurrence and oceanographic, ecological, or other environmental variables, and can be developed in specific ecosystems for cetacean species with limited distribution data (Redfern et al. 2006; Redfern et al. 2017). HSM outputs can help predict habitat use over broad areas and can support management measures. They are valuable tools in data-poor areas; for example, when whale density data is not available, an HSM can provide insight into where whales might be expected to aggregate. Gómez-Salazar and Moors-Murphy (2014) explored HSM methods to predict cetacean distribution on the Scotian Shelf using opportunistic sightings data. Ongoing refinement of species distribution models is being pursued. HSM modelling in Atlantic Canada is currently limited to water depths greater than 50 metres due to a lack of inshore sightings and environmental data. An exploration of how these data gaps could be filled is required to determine Right Whale habitat suitability close to shore. For this purpose, a

collaborative initiative, in direct alignment with [Canada's Space Strategy](#) known as smartWhales, has been established by the CSA, in partnership with DFO and TC (the users) (see recovery measure #13).

21. Record broad-scale two-dimensional movements over periods of several months using safe and reliable tagging technologies to gather information on habitat use, migration, and other movement patterns

Right Whales are highly migratory, and different demographic components of the population (for example, reproductive females, adult males, juveniles) use different habitat areas at different times of year. While several critical habitat areas have been identified in the U.S. and Canada, the migratory pathways between them are not well known, and the whales' use of additional habitat areas is poorly understood. Understanding the movements, migratory pathways, and locations of Right Whales would be valuable for monitoring the species, understanding threats to them, and refining management measures to protect them.

Right Whales' anatomy and behaviour make the successful deployment of long-term tags (for example, satellite linked) to monitor the species' movements and migration a challenge. They lack a dorsal fin (which is an attachment point for tags on other cetacean species), and their highly tactile behaviour dislodges external tags fairly quickly. Implanted tags have been used, but the use of some of the most invasive models have been discontinued due to concerns about Right Whale health.

As technology continues to improve, the development and application of safe and reliable tracking technologies could provide longer term information about their foraging behaviour, vulnerability to ship strike and entanglement, as well as on their larger-scale movements and migration pathways.

22 and 23. Conduct visual health assessments of Right Whales (for example, assess body condition using photogrammetry) to monitor health trends at the individual and species level; and Collect tissue, blow, and fecal samples to support hormonal and genetic studies of reproduction, reproductive health, nutritional state, and stress levels

Many organizations based in Canada, the U.S., and elsewhere conduct research on Right Whales in Canadian waters, including studies to understand Right Whale health, rates of injury and mortality, and sub-lethal effects of anthropogenic threats. This work supports several of the recovery objectives in the SARA Right Whale recovery strategy, and is necessary for measures such as recovery measure #43, to evaluate the effectiveness of management measures designed to reduce risk to Right Whales. Organizations undertaking this work include universities, other research organizations, government scientists, and non-profit organizations including response organizations. All participate in the North Atlantic Right Whale Consortium (NARWC), an informal body whose participants coordinate the management and sharing of data and facilitate collaborations and annual meetings.

24. Conduct entanglement risk analyses for habitat areas where fishing activities and Right Whales co-occur and use the resulting analyses to inform fisheries management decisions to reduce entanglement risk. Collaborate on entanglement risk analyses, as appropriate.

To quantify and assess the risk to Right Whales from fishing gear entanglement, information is needed on (1) fishing gear types, configurations, and locations; (2) Right Whale distribution,

density, movements and behaviour; and (3) gear types previously implicated in Right Whale entanglements. The above information is currently sparse for much of the species' range in Atlantic Canada and Quebec. Some initial risk analyses have been completed (see Vanderlaan et al. 2011; Brillant et al. 2017; DFO 2019) or is under development; however, more comprehensive analyses are required. Inadequate Right Whale density data is currently the greatest barrier preventing broader analysis. Increased aerial and vessel-based survey effort, as well as acoustic monitoring, will contribute to filling these data gaps. In the longer term, understanding Right Whale behaviour including feeding behaviour, social interactions, mating and calf-rearing, in different areas and conditions, may help refine entanglement risk analyses. In the interim, an effort is underway to estimate entanglement risk across Atlantic Canada using a habitat suitability model in lieu of Right Whale density. DFO is gathering fishery information that could inform risk analyses. For example, information on gear configurations is being gathered in the Maritimes Region through consultations with Indigenous partners and the fishing industry. Requiring rope colour marking (see recovery measure #26) also could help inform the evaluation of relative risk across fisheries and possible mitigation measures.

Entanglement risk analyses should be repeated or updated as new information becomes available, or when there are significant shifts in Right Whale distribution, foraging habitat, and/or fishing effort. Collaboration on entanglement risk analyses should be pursued as appropriate.

25. Explore, develop, and implement entanglement prevention and mitigation measures, including gear innovation or modified gear configurations

DFO, its partners (Indigenous communities), and stakeholders, (fishing industry, researchers, technology companies, gear manufacturers, suppliers) are collaborating to explore, develop, and implement prevention and mitigation measures intended to reduce entanglement risk to Right Whales. This work includes efforts to develop, modify and test new fishing gear technologies and gear configurations both to reduce entanglement risk, and to reduce the duration and severity of entanglements. These efforts may inform DFO fishery management decisions (see recovery measure #2), as well as voluntary Right Whale mitigation strategies implemented by industry.

The design and testing of gear technology to reduce the risk of whale entanglement, including “ropeless” fishing gear, is underway in both the U.S. and Canada (see Myers et al. 2019). Organizations representing several fisheries and fishing areas in Atlantic Canada and Quebec have received government funding to conduct pilot studies of innovative gear technology such as “ropeless” and rope-on-demand gear, to reduce entanglement risk, and methods to reduce rope breaking strength to reduce the duration and severity of entanglements should they occur (for example, use of low breaking strength weak-linked ropes may reduce the time a whale is involved in entangling gear, and in turn reduce the severity and complexity of the entanglement (Knowlton et al. 2016; Knowlton 2020)). The [Atlantic Fisheries Fund](#) is a joint federal-provincial funding program that supports this innovation by industry, researchers, and other partners.

DFO is continuing to work with partners to identify and implement management approaches and fishing practices that support Right Whale recovery while minimizing potential socio-economic impacts. DFO has undertaken multiple engagement sessions with Indigenous partners, the fishing industry, provincial governments, researchers, and NGOs on protecting Right Whales from entanglement, including annual roundtable meetings held since 2017. These meetings inform DFO fishery management decisions (see recovery measure #2). DFO hosted a gear innovation summit in February 2020, bringing together government, Indigenous partners, and stakeholders to share information and discuss how to reduce the risk of Right Whale

entanglement in fishing gear ([DFO 2020b](#)). DFO will continue to engage provincial governments in the development and implementation of measures to reduce entanglement risk. Provincial fishery departments have an important role in liaising with and supporting the fishing sector as well as other sectors that may be affected by measures, such as the tourism and transport industries.

26. Develop and implement effective gear marking and gear reporting systems

Gear marking (for example, distinctive rope colour markings unique to individual fisheries) is used to trace the type of gear, origin, ownership, and/or position of fishing gear (He and Suuronen 2018). If effectively and widely implemented, a gear marking system would help maximize the learning potential from Right Whale entanglements across their range. This knowledge would help refine threat assessments and design better prevention and mitigation measures.

In July 2018, the Food and Agriculture Organization (FAO) Committee on Fisheries endorsed the “Voluntary Guidelines on the Marking of Fishing Gear” (FAO 2018), which will be an important resource as Canada expands its gear marking systems. A coordinated approach across jurisdictional regions is needed. NOAA’s Atlantic Large Whale Take Reduction Team (ALWTRT), which currently includes a Weak Rope and Gear Marking Subgroup, has been implementing gear marking for several years (ALWTRT 2018). Gear marking regimes (specifically, sequential buoy numbering and coloured rope) were implemented in certain Atlantic Canadian fisheries in 2018. In 2020, rope colour marking became mandatory for all non-tended, fixed gear fisheries (including lobster and crab) in Atlantic Canada and Quebec. Rope colour marking requirements enable gear to be identified by country, region, fishery, and for crab and lobster fishers only, by fishing area. Because the origin of most Right Whale entanglements remains difficult to identify, effective rope colour marking will involve methods whereby the rope retains the marking, such that it is identifiable if it becomes part of an entanglement. This includes the durability of the marking materials, and adequate quantity and placement of marks such that they will be retained if only part of the rope becomes involved in an entanglement. Rope colour marking supports efforts to distinguish between Canadian and U.S. gear in cases of marine mammal entanglements.

Standardized gear reporting requirements (that is, information on when, where, and how much gear is being set) will help maximize the learning potential from Right Whale entanglements across their range. Information collected will help refine threat assessments and design better prevention and mitigation measures.

27. Develop and implement protocols for retrieval, storage, analysis, and documentation of fishing gear from entangled Right Whales and coordinate with efforts range-wide.

Fishing gear should be documented and retrieved from entangled Right Whales by persons authorized by DFO (for example, authorized disentanglement and necropsy teams) in all cases when it is safe to do so. Documentation and retrieval should be done using consistent and systematic standardized protocols developed to ensure the most information can be gained to learn from past entanglements. Retrieval and transport of the fishing gear must follow a chain of custody protocol that needs to be established and implemented throughout Atlantic Canada and Quebec. As soon as possible following retrieval of the gear by DFO fishery officers or DFO-authorized response organizations, ideally within 1 to 2 days, an initial examination should be conducted, including labelling and documentation of the gear. A dedicated indoor storage space is required to preserve the gear for future analysis. A systematic cataloging protocol for the

retrieved gear must also be developed. This work should be undertaken in close collaboration between DFO, response groups, and other relevant partners. NOAA has extensive experience in these areas and will continue to be a valuable partner as the Canadian protocols evolve. Because Right Whales are a transboundary species that transport gear across borders, the adoption of common procedures in both countries is optimal for maximizing efficiencies, data collection, and analysis.

Careful analysis of retrieved fishing gear is of critical importance to determine the type of gear and where it came from, how the entanglement occurred, and how future entanglements can be prevented (see Johnson et al. 2005; van der Hoop et al. 2016; Knowlton et al. 2016). A multi-stakeholder working group, coordinated by DFO, consisting of whale scientists, Indigenous partners, fishing industry, and other technical experts should be formed to examine fishing gear retrieved from entanglements occurring in Canada or suspected to be of Canadian origin. Collaboration with the U.S. is needed to enhance range-wide understanding of the entanglement threat and techniques to reduce it. Once an analysis is completed, a standardized report should be prepared and submitted to a centralized database.

28. Examine the mechanisms of Right Whale entanglement to better inform prevention and mitigation measures

Little is known about how Right Whales become entangled in fishing gear, including the specific behavioural factors that lead to wraps around the head, mouth, body, pectoral fins, tail, or some combination thereof. Howle et al. (2018) developed an interactive entanglement simulator to help determine the mechanisms of Right Whale entanglements. This tool was designed to reverse engineer entanglements and model the effects of new or modified gear types on the rate and severity of entanglements.

Gear marking (see recovery measure #26) may contribute to understanding the mechanisms and relative risk of entanglement in certain fisheries and, when feasible, specific gear components (for example, endlines versus groundlines). This could help determine, for example, which elements of the fishing gear configuration pose the most risk to Right Whales in a given area, and how best to mitigate these risks (see Brillant and Trippel 2010; Hamilton and Kraus 2019).

The factors influencing gear behaviour in certain oceanographic conditions have been studied in the past (see Brillant and Trippel 2010). Additional studies of this nature, as well as more information on the specific gear configurations used in Atlantic Canada and Quebec, could further refine entanglement risk assessments and entanglement simulations.

29. Remove abandoned, lost, or otherwise discarded fishing gear (ALDFG) from Right Whale habitat areas to reduce risk of entanglement

While data suggest that known Right Whale entanglements have occurred in actively fished gear and not ALDFG (that is, “ghost gear”) (see Johnson et al. 2005; Asmutis-Silvia 2017; Henry et al. 2017), the removal of ALDFG is an important component of removing debris and rope from Atlantic Canadian waters. DFO has committed to removing ALDFG from Canadian waters, prioritizing areas where ALDFG pose a threat to species at risk such as the Right Whale, and to implementing initiatives to prevent gear loss.

Canada led the development of the 2018 [G7 Ocean Plastics Charter](#), within which signatories committed to accelerating implementation of the 2015 G7 Leaders’ Action Plan to Combat

Marine Litter. That action plan included a commitment to make targeted investments to retrieve ALDFG. The Government of Canada is a participant in the [Global Ghost Gear Initiative](#) (GGGI). The Fundy North Fishermen's Association, also a GGGI participant, has been retrieving ALDFG from the Bay of Fundy for several years. The [Sustainable Fisheries Solutions and Retrieval Support Contribution Program](#) (the Ghost Gear Fund) was established to encourage Canadians to take actions to reduce ALDFG in the marine environment. This fund will support Indigenous partners and industry in preventing fishery-related debris from entering the water, and in removing lost gear from the water.

An expansion of mandatory reporting of lost gear to DFO was recently implemented through conditions of licence for commercial fish harvesters. Timely reporting of lost gear increases the chances of re-location and retrieval before it can impact marine wildlife (for example, through entanglement). Reporting of retrieved gear that was previously reported lost will help estimate the amount of gear lost by the commercial (including communal commercial) fishing industry each year.

30. Conduct vessel strike risk analyses for areas where vessel traffic and Right Whales co-occur

Work is underway to evaluate the relative probabilities of vessel-whale encounters, and the likely lethality of those encounters, in the Gulf of St. Lawrence (DFO 2019). This builds upon a similar study focused on the Bay of Fundy and Roseway Basin areas (Vanderlaan et al. 2008). Analyses will be completed using Automatic Identification System (AIS), Vessel Monitoring System (VMS), and Right Whale sightings data. Vessel strike risk in the Gulf of St. Lawrence will be compared to the risk in the Bay of Fundy and Roseway Basin, where critical habitat is identified for the species. Past and potential risk reduction strategies (for example, speed restrictions, re-routeing) will be evaluated and modelled to determine how effective they are in reducing the likelihood of (lethal) encounters. The frequency with which additional vessel strike risk analyses are completed will depend on shifts in whale distribution and/or vessel traffic patterns.

32. Develop and implement a system for providing near real-time detection and notifications of Right Whale presence

Near real-time (that is, within hours to days) detection and communication of Right Whale sightings can help inform decisions about dynamic threat prevention or mitigation measures. Continued development of near real-time detection capabilities within Atlantic Canadian waters, as well as the means of communicating that information to mariners is needed. This could play an important role in measures to reduce the risk of a lethal vessel strike (see recovery measure #31), as well as increase vigilance among fish harvesters and other resource users conducting work in the marine environment. Priority areas for real-time detection should be those where Right Whales and human activities are known to co-occur.

Near real-time detection methods currently in use off Atlantic Canada and Quebec include visual detection from various platforms and sources (for example, aerial surveys, vessel-based surveys, opportunistically-reported sightings) and acoustic detections from autonomous ocean gliders. A pop-up near real-time detection acoustic buoy is also currently in development.

The Whales, Habitat and Listening Experiment (WHaLE) project, part of the Marine Environmental Observation Prediction and Response (MEOPAR) Network, uses several autonomous Slocum gliders equipped with passive acoustic recorders that can detect Right

Whale vocalizations and transmit detection data via satellite to a shore-based lab in near real-time, where they are validated. Under OPP, other real-time detection technologies are being tested by DFO and partners, including fixed and pop-up acoustic buoys and shore-cabled systems, as well as Remotely Piloted Aircraft Systems equipped with video cameras.

The WHaLE project has also worked on a near real-time whale alert system to transfer information about Right Whale detections to mariners. Reimer et al. (2016) engaged the commercial shipping industry to determine their preferred communication format for receiving whale alerts. The majority of respondents preferred to receive communications via Navigational Telex (NAVTEX)³ or AIS. The latter option is more conducive to near real-time notifications in the commercial shipping industry and could be explored in the future. Other tools are currently available to provide public access to verified Right Whale visual and acoustic detections in near real-time, such as WhaleMap (see recovery measure #17).

33. Communicate proactively and regularly with mariners about management measures in place to reduce the risk of vessel strikes with Right Whales

The Canadian Coast Guard's (CCG) Marine Communications and Traffic Services (MCTS) are responsible for screening vessels entering Canadian waters and delivering information to mariners, such as special management measures mandated by TC. These measures might include, for example, mandatory vessel speed reductions like those implemented since 2017 in the Gulf of St. Lawrence to protect Right Whales. Management measures are communicated to Indigenous partners and industry using a variety of mechanisms, including Notices to Mariners (NOTMARs) and Navigational Warnings⁴ (NAVWARNs). Large vessels (≥ 20 metres length) entering Canadian waters are notified of special management zones at least twice during their journey and often three times: during their security clearance, at their mandatory check-in upon arrival in Canadian waters, and one hour prior to arrival in a special management zone. This ensures applicable management measures are repeatedly conveyed to and acknowledged by the captain in real-time. MCTS monitors compliance with management measures and forwards infractions to TC for investigation.

The most effective means of engaging with operators of smaller vessel types including recreational vessels on voluntary management measures should be explored and implemented.

34. Assess the impacts of anthropogenic noise on Right Whales

In conjunction with work being completed under recovery measure #11, the impacts of shipping noise on Right Whale communication space, health (including stress responses) and behavioural responses will be investigated by DFO and partners using a combination of field measurements, modelling, and analysis methods. Other anthropogenic noise sources (for example, seismic surveys, sonar) can also impact Right Whales, and will need to be considered.

The Government of Canada is committed to developing an [Ocean Noise Strategy for Canada](#) by building on current federal and other collaborative initiatives in Canada's oceans that are improving our understanding and management of underwater ocean noise. All marine species,

³ An automated direct-printing service used to deliver warnings, forecasts, and urgent marine safety information to ships.

⁴ Previously referred to in Canada as NOTSHIPs (Notices to Shipping)

including Right Whales, will be included in the scope of the document. In addition, The Government of Canada is undertaking multiple science and technology, management, and outreach activities related to the issue of ocean noise (for example, through initiatives such as the [OPP](#), the [Whales Initiative](#), and the [Marine Environmental Quality Science Initiative](#)).

36. Survey, monitor, and predict the locations of *Calanus* aggregations

An understanding of the factors that aggregate Right Whale prey (*Calanus* spp., that is large, energy-rich copepod zooplankton) is necessary to monitor and predict changes in the species' food supply and related distributional shifts. Right Whale foraging habitat is characterized by high concentration layers of *Calanus*. These features develop in areas where relatively high *Calanus* abundances are further concentrated through interactions between vertical migration behaviour and local ocean circulation features. Robust, reliable models and operational tools for predicting Right Whale foraging habitat are needed to inform management decisions and help prevent threats to Right Whales by anticipating changes in foraging habitat availability across Atlantic Canada and Quebec. Prey forecasting ability can be improved by coupled biological-physical models of regional-scale *Calanus* population abundance levels and local-scale *Calanus* aggregation mechanisms. Field and remote sensing observations are being used to build and ground-truth coupled models (see Brennan et al. 2019), providing both estimates of the supply of prey to potential Right Whale foraging areas, and a framework to examine population responses to future environmental changes (including in the context of scenario planning as per recovery measure #43). These models also can be used to examine changes in prey quality, that is *Calanus* size and energy content. Local-scale observations and modelling are under development to predict where interactions between *Calanus* vertical migration behaviour and circulation features are likely to generate high concentration layers of *Calanus*. The ability to forecast the distribution, abundance, energy content, and seasonal timing of *Calanus* will become increasingly important as the climate changes. Right whale bio-energetic modelling (see Gavrilchuk et al. 2020) has been used to determine prey requirements for population growth, providing complementary information needed to assess foraging habitat suitability.

38. Enhance regulatory capacity and policies as needed to prevent and mitigate threats to Right Whales (for example through statutory amendments, new regulations, or new policies/guidelines)

Several existing laws and regulations protect Right Whales and their habitat either directly or indirectly. There may, however, be opportunities to further modernize or expand those legislative tools to provide additional flexibility and capacity (for example, as new gear technologies are developed). Any regulatory gaps or barriers should be identified and addressed to the extent possible.

Amendments to the *Canada Shipping Act, 2001* came into force in December 2018. These amendments provide authority for the making of regulations to protect the marine environment from the impacts of navigation and shipping activities. Among other things, this authority strengthens the Government of Canada's ability to regulate marine vessels and navigation to protect endangered whale populations.

An initiative is being explored that would allow more flexibility in fishing gear identification. In certain circumstances, the use of a single tag, float, or buoy to identify a string or trawl of multiple traps would be permitted. This initiative, if pursued, is meant to help reduce the number of vertical lines in the water column and is needed before commercial use of ropeless fishing

gear can occur. Increased flexibility to allow for the broad retrieval of ALDFG is also being explored.

In 2019, major amendments to the *Fisheries Act* were approved by Parliament. Among other things, these amendments created a fisheries management order power that allows for rapid responses to urgent and unexpected threats arising during a fishery (such as during the 2017 Right Whale mortality and entanglement event).

The 2018 amendments to the *Marine Mammal Regulations* clarified what it means to disturb a marine mammal and established a mandatory general approach distance of 100 metres (or 200 metres for resting and/or mother/calf pairs) for most cetaceans, including Right Whales. In the St. Lawrence Estuary and the Saguenay River the approach distance is 400 metres for threatened and endangered cetaceans.

44. Complete a population viability analysis

Population viability analysis (PVA) includes a variety of assessment methods used to estimate the persistence of a species under future condition scenarios (Gerber and González-Suárez 2010). A PVA can help increase understanding of population dynamics, threats, and the potential outcomes of different management actions on the recovery or survival of a species. In 2018, NOAA established a Population Evaluation Tool (PET) Subgroup of the North Atlantic Right Whale Recovery Plan U.S. Implementation Team. The objective of the PET subgroup, with participation from DFO Science, is to develop a PVA or other assessment tool to characterize extinction risk and evaluate under what conditions the population trajectory is likely to improve. This will include the development of demographically-based recovery criteria, which can be used to derive the demographic conditions indicating the level of extinction risk, or progress toward recovery. This work is expected to be available in 2020. If and when the PVA becomes obsolete (for example, model parameters or methodologies change significantly), it should be updated or redone to support recovery planning.

45. Conduct scenario planning to prepare for uncertain future environmental conditions and vulnerabilities

Scenario planning can be used as a framework for developing resilient management decisions in the face of short- and long-term uncertainties (Peterson et al. 2003; Rowland et al. 2014). It is an iterative process that requires periodic revisiting as new information becomes available. This tool has proven valuable in conservation planning, leading to an increased understanding of uncertainties and better preparation for surprises. This is important, especially in light of climate change. NOAA recently developed a new initiative, conducting a scenario planning exercise for Right Whales, and the Agency is preparing a summary report. DFO will also explore how scenario planning could be used for similar purposes in Atlantic Canada, and in doing so will collaborate with NOAA. Linking scenario planning with DFO critical habitat studies (see recovery measure #7) and habitat suitability modeling (see recovery measure #20) will help inform management decisions.

46. Explore Indigenous Knowledge of Right Whale ecology, and historic and current distribution

Incorporating Indigenous Knowledge (IK) to further help fill gaps and strengthen data will be explored using a Two-Eyed Seeing approach (Etuaptmumk). Two-Eyed Seeing refers to learning to see from one eye the strengths of Indigenous Knowledges and ways of knowing, and

from the other eye the strengths of Western Knowledges (scientific data) and ways of knowing. Two-Eyed Seeing is about co-learning and co-production of knowledge, and it implies collaboration between different knowledge systems.

All aspects of gathering, use, and protection of IK regarding Right Whales should be completed in a culturally appropriate manner with all interested Indigenous communities and organizations.

52. Identify, test, and implement engineering, operational, and maintenance improvements for ships to reduce noise emissions

Commercial vessels are a well-recognized source of underwater noise, particularly low frequency noise (Hildebrand 2009). The IMO developed voluntary guidelines to reduce noise levels and mitigate impacts on marine life, such as whales (IMO 2014). These guidelines include general considerations for ship design (propellers, hulls, etc.), onboard machinery, refits, maintenance (for example, propeller cleaning, underwater hull surface), and operations (selection of ship speed, routing decisions, etc.). As the organization responsible for regulating shipping in Canadian waters, TC contracted Green Marine to produce a detailed report and recommendations on the issue of underwater noise and how to address it (Nolet 2017). Recommendations included:

- initiate or collaborate on efforts to understand how noise from commercial vessels relates to ship design (length, draft, number of hulls, hull form coefficients, etc.) and to ship operation and maintenance (service speed, cavitation inception speed)
- initiate or collaborate on efforts aimed at testing recognized mitigation measures known to reduce noise from vessels, for example compare radiated noise before and after hull and propeller maintenance

TC currently manages a research, development and deployment program that responds to the recommendations above. For example, TC has supported a statistical analysis of vessel source noise level data held by the Vancouver Fraser Port Authority's Enhancing Cetacean Habitat and Observation (ECHO) program, in an effort to identify linkages in noise emissions with readily available general vessel design and operational characteristics. In addition, Transport Canada has funded three projects to evaluate the noise-reduction benefits of hull and propeller maintenance activities. Furthermore, Transport Canada launched the Quiet Vessel Initiative in 2019, a 5-year initiative to test the most promising technologies, vessel designs, retrofits and operational practices to make vessels quieter.

The amendments to the *Canada Shipping Act, 2001* (see recovery measure #38) clarify and strengthen the Government of Canada's authority to make regulations concerning, among other things, the design, construction, manufacture, and maintenance of vessels for the purpose of protecting the marine environment from the impacts of navigation and shipping. While Canada can set design and construction requirements for Canadian vessels, the prevalence of international vessel traffic in Canadian waters requires the engagement of the IMO to see broader and widespread adoption of quiet vessel design in international fleets. To this end, TC has been advancing efforts at the IMO, and in 2019 tabled a proposal to add the issue of underwater noise from vessels to the work program of the IMO.

Green Marine encourages the shipping industry to reduce their environmental footprint by offering an environmental certification program (Green Marine 2014). Reduction of underwater noise is one of the performance indicators for this program. Over 90% of Canada's domestic fleet are members of Green Marine.

2. Critical habitat

2.1 Identification of the species' critical habitat

Critical habitat is defined in SARA as "...the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan for the species." [subsection 2(1)]

Also, SARA defines habitat for aquatic species as "... spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced." [subsection 2(1)]

Critical habitat for the Right Whale is identified to the extent possible in the recovery strategy, which provides details about the geographic location (that is, Grand Manan Basin and Roseway Basin) and the biophysical functions, features, and attributes. The Schedule of Studies to refine and identify critical habitat includes: evaluating prey distribution; evaluating Right Whale use of habitat areas outside of Grand Manan and Roseway Basins; and determining Right Whale migratory routes. Right Whales' shift in habitat use to the southern Gulf of St. Lawrence is reflected in the schedule of studies recommendation to review additional critical habitat areas. DFO and its partners are continuing to collect information to support such a review and potential identification of additional Right Whale critical habitat. Any changes or additions to identified critical habitat will occur through an amendment to the recovery strategy. Right Whale foraging habitat is dynamic in nature and would benefit from continued monitoring and potential adaptation of critical habitat over time.

2.2 Activities likely to result in the destruction of critical habitat

Examples of activities likely to result in destruction of Right Whale critical habitat are described in section 1.9.5 of the recovery strategy.

2.3 Proposed measures to protect critical habitat

Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a final recovery strategy or action plan and included in the Species at Risk Public Registry. Right whale critical habitat is protected by a SARA [Critical Habitat Order](#) made under subsections 58(4) and (5). The Order, which came into effect in 2017, invokes the prohibition in subsection 58(1) against the destruction of the identified critical habitat.

3. Evaluation of socio-economic costs and benefits

SARA section 49(1) requires that an action plan include an evaluation of the socio-economic costs and benefits to be derived from the implementation of the action plan. This evaluation attempts to address the incremental and non-incremental socio-economic costs of implementing the action plan within Canada as well as the social and environmental benefits that would occur if the action plan were implemented in its entirety, recognizing that not all aspects of its implementation are under the jurisdiction of the federal government. It does not address cumulative costs of species recovery in general, nor does it attempt a cost-benefit analysis. Neither does the analysis address the costs associated with social and cultural loss of access to

the species by Canadians, including Indigenous peoples. The intent of this evaluation is to inform the public and to guide decision-making on the implementation of the action plan by DFO and its partners.

3.1 Background

In Canada, the Right Whale was listed in 2005 as endangered under Schedule 1 of SARA. As such, the species benefits from legal protection and mandatory recovery requirements which are administered by DFO.

Progress toward implementing the Right Whale recovery strategy has been made possible by collaborations among governments, Indigenous partners, industry, environmental organizations, universities, and other organizations/groups. Future recovery efforts, such as those detailed in this action plan, are dependent upon continued collaboration.

3.2 Methodology

This evaluation of socio-economic costs and benefits identifies the anticipated socio-economic impacts associated with the measures listed in tables 1, 2, and 3 of the action plan. The evaluation attempts to address the costs and benefits expected to occur if the action plan is fully implemented. It is not intended to be a detailed analysis of all costs and benefits. An order-of-magnitude estimate of potential costs and benefits is provided where sufficient information is available; otherwise, a qualitative statement regarding potential impacts is provided. This evaluation examines incremental and non-incremental actions separately.

Many of the measures listed in this action plan represent a continuation of current activities or responsibilities and commitments of DFO and/or other groups into the foreseeable future (that is, designated as underway). Given these activities would continue regardless of the action plan, they are considered non-incremental to the action plan and carry no incremental costs. In addition, measures that are currently in the planning phase may carry additional, but still non-incremental, costs in the future as the measures move into the implementation phase. For this evaluation, only the costs of measures not currently in the planning phase or underway are considered incremental.

An analysis of the incremental impacts associated with the protection of Right Whale critical habitat was completed as part of the regulatory process associated with the Critical Habitat Order (see section 2.3). As such, costs and benefits associated with the identification and protection of critical habitat for the Right Whale are not considered in this evaluation.

3.3 Socio-economic costs of implementing this action plan

Underway non-incremental costs

Many measures in the action plan have been initiated before the publication of this action plan (that is, are non-incremental) by governments, Indigenous partners, industry, environmental organizations, universities, and other organizations/groups to help protect and recover the Right Whale. Although a number of these actions are known to have a high cost associated with them (for example, in excess of \$1 million each annually), the costs for a variety of others are currently unknown or unquantifiable but could also be significant. The cost to Canadians for those recovery measures that are underway and quantifiable is estimated to be in excess of \$10

million per year. The total cost of all recovery measures underway is assumed to be significantly higher although the specific value is unknown. In addition, there may be impacts on Indigenous people and their communities associated with some recovery measures. DFO will continue to work with Indigenous groups, partners, and industry to analyse the costs associated with ongoing and future recovery measures. These underway costs are expected to continue and remain similar for at least the short-term.

The fishing and shipping industries, and the communities they support, are believed to have been significantly impacted by measures that have been taken to protect Right Whales since 2017, including dynamic and static area closures, vessel speed reductions, and changes to fishing gear. Some of these measures may have also had impacts on Indigenous communities and their fisheries. The costs of these actions for fishing-related industries in Atlantic Canada and Quebec have yet to be fully quantified but are anticipated to be significant. For example, it is estimated that the Quebec lobster harvesting and processing sectors lost slightly under \$3 million in revenue due to restricted catches in 2018. Also, preliminary estimates for the Quebec snow crab fishery suggest nearly \$3 million in lost revenue due to unharvested quota in 2018. Marine transportation industries and dependent communities have also seen impacts as a result of measures taken in 2017, 2018 and 2019 to reduce threats to Right Whales from vessel strikes. The shipping industry experienced an increase in fuel and time costs, while some communities lost tourism revenues as cruise lines cited the speed restriction measures when cancelling ports of call.

Of the ongoing measures where cost estimates were available, the most significant quantified cost is related to the vessel and aerial-based surveillance activities to detect the presence of Right Whales (recovery measure #13). Implementation of this measure is estimated to have a cost exceeding \$3 million annually in fuel, maintenance and staffing costs, although some costs can fluctuate greatly depending on time and resources deployed (for example, aircraft and vessels), and the price of fuel. There are certain measures where current costs are between \$500,000 and \$1 million annually. Most of these measures include key field research initiatives to detect, monitor, and study the Right Whale. Examples include research undertaken to study Right Whale presence and anthropogenic noise levels through acoustic monitoring (recovery measure #11), and utilizing passive acoustic tags to monitor Right Whale behaviour (recovery measure #12). There are a number of measures that have current costs between \$50,000 and \$500,000 annually, where resources are allocated to conduct essential research (for example, recovery measure #24) and perform preventative actions, such as the removal of ALDFG (ghost gear) to mitigate risk to Right Whales (recovery measure #29). There are also many recovery measures associated with the duties of DFO and its partners (for example, recovery measures #1, 4, 18, 41) that mainly involve administrative costs of less than \$50,000 per year.

Many recovery measures in the action plan that are currently underway have costs that will continue into the future. These costs are expected to remain similar to current levels. There are some measures attached to funding that is set to expire in 2023 (for example, measures #11, 21, 34) and further funding will need to be secured for these measures to continue.

In addition, some measures will result in additional costs over the next five years. However, some of these costs are not considered incremental as they are part of measures already underway or planned (for example, recovery measures #4 and 31). The quantified, additional, non-incremental costs are anticipated to total less than \$300,000 per year.

Still other measures with additional costs are anticipated but cannot be quantified at this time. Most of these measures are underway or are in their planning and developmental phases (that

is, non-incremental). Some of these measures are anticipated to result in future costs for industry because they may involve further area closures, adopting new fishing gear, and gear marking by industry.

Incremental costs

Other measures will have additional costs that are considered incremental as they have not yet started (for example, recovery measures #37, 46 and 54) and would not be undertaken in the absence of the action plan. The quantified incremental measures mainly entailing scientific research and administrative costs (for example, recovery measures #37 and 46 are anticipated to total less than \$300,000 per year). Recovery cost for measure #54 is unknown and cannot be monetized at this time.

3.4 Benefits of implementing this action plan

The overall goal of the Right Whale recovery strategy is to achieve an increasing trend in population and abundance over three Right Whale generations (or 60 years). It is expected that the implementation of this action plan would make a contribution towards achieving this goal. Recovery of the Right Whale would be facilitated by meeting the seven recovery objectives outlined in section 1.1. The measures set out in this action plan (detailed in section 1.2) support each of the recovery objectives.

Many of the benefits derived from biodiversity conservation, including the protection and recovery of species at risk, are non-market commodities that are difficult to quantify but could be significant. SARA recognizes that “wildlife, in all its forms, has value in and of itself and is valued by Canadians for aesthetic, cultural, spiritual, recreational, educational, historical, economic, medical, ecological, and scientific reasons”. A review of the literature confirms that Canadians place significant value on the preservation and conservation of species in and of themselves. Actions taken to preserve a species, such as habitat protection and restoration, are also valued. In addition, the more an action contributes to the recovery of a species, the higher the value the public places on such actions (Loomis and White 1996; DFO 2007b). Self-sustaining and healthy ecosystems, with their various elements in place, including species at risk, contribute positively to the livelihoods and the quality of life of all Canadians.

The conservation of species at risk is an important component of the Government of Canada’s commitment to conserving biological diversity under the international Convention on Biological Diversity. The Government of Canada has also made a commitment to protect and recover species at risk through the Accord for the Protection of Species at Risk. Implementation of this action plan will contribute to meeting these commitments.

Efforts to mitigate whale interactions may have other positive benefits, such as continued or improved access to markets requiring certain standards to be met. This includes the U.S. marketplace. Among other things related to the import of fish, the *Marine Mammal Protection Act* (MMPA) requires banning the import of fish caught with commercial fishing technology which results in the incidental killing or incidental serious injury of marine mammals in excess of U.S. standards. These provisions of the Act are implemented by the *Regulations Governing the Taking and Importing of Marine Mammals* which, simply put, require exporting nations to demonstrate that they have a regulatory program with respect to a fishery that is comparable in effectiveness to the MMPA for reducing marine mammal bycatch incidental to commercial fisheries.

3.5 Distributional impacts

As outlined in section 1.2, implementation of this action plan will require collaboration among many organizations and groups. The action plan includes contributions from government, Indigenous partners, non-governmental organizations, industry stakeholders, universities, and others. It is also possible that new groups would become involved in future recovery efforts. Probable partners for each measure are noted in tables 2 and 3. At this time it is not possible to determine the extent to which each of these groups would contribute (financially or otherwise) to the implementation of this action plan. Likewise, precise costs and benefits to individual groups cannot be estimated.

Given that the abundance and distribution of Right Whales in Canadian waters may shift over time, the costs incurred when implementing the recovery measures in this action plan may also change. The Government of Canada will monitor the impacts of these measures as efforts continue to protect this iconic species.

4. Measuring progress

The performance indicators presented in section 2.4 of the recovery strategy provide a way to define and measure progress towards achieving the population and distribution objectives (in the case of the Right Whale recovery strategy, this is a recovery goal and supporting recovery objectives). A report on the progress of recovery strategy implementation for the period 2009 to 2014 has been completed (DFO 2016). A second progress report on recovery strategy implementation covering the period between 2015 to 2020 is being developed.

Reporting on implementation of the action plan (under section 55 of SARA) will be done by assessing progress towards the recovery objectives and strategies.

Reporting on the ecological and socio-economic impacts of the action plan (under section 55 of SARA) will be done by assessing the results of monitoring the recovery of the species and its long-term viability, and by assessing the implementation of the action plan.

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Appendix A: effects on the environment and other species

In accordance with the [Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals](#) (2010), SARA recovery planning documents incorporate strategic environmental assessment (SEA) considerations throughout the document. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or achievement of any of the [Federal Sustainable Development Strategy's](#) (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general; however, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the action plan itself, but are also summarized below.

The potential for this action plan to inadvertently lead to adverse effects on other species or the environment was considered. Such adverse effects are not anticipated. Measures taken to protect and recover the North Atlantic Right Whale, particularly those reducing vertical and floating line in the water, are expected to benefit other at-risk species, such as the Leatherback Sea Turtle. The displacement of fishing effort resulting from spatiotemporal closures will need to be monitored to ensure it does not impact the rate of interactions with Right Whales or other species outside of those areas. Implementation of the Action Plan for the North Atlantic Right Whale is expected to contribute to achieving the following 2016 to 2019 FSDS goals:

- healthy coasts and oceans: coasts and oceans support healthy, resilient and productive ecosystems
- healthy wildlife populations: all species have healthy and viable populations

Appendix B: record of cooperation and consultation

An early engagement workshop was held at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia on February 23 and 24, 2011 to discuss recovery measures addressing the threat of Right Whale entanglement in fishing gear. Input from the workshop has been considered in the development of this action plan. Invitations to attend the workshop were extended to government departments, Indigenous partners, industry, and non-government organizations. Workshop participants included representatives from the following groups:

Acadia University
Canadian Whale Institute
Canadian Wildlife Federation
Dalhousie University
Grand Manan Fishermen's Association
Grand Manan Whale and Seabird Research Station
Fundy North Fishermen's Association
Licence holders from Lobster Fishing Areas 34 and 36
Maritime Aboriginal Peoples Council
National Oceanic and Atmospheric Administration
New England Aquarium
Saint Mary's University
South Shore Gillnet Fisherman's Association
Trent University
World Wildlife Fund Canada

A second early engagement workshop was held at the Bedford Institute of Oceanography on January 26 and 27, 2016 to discuss recovery measures addressing the following threats: vessel strikes, acoustic disturbance, and changes in food supply. Input from the workshop has been considered in the development of this action plan. Invitations to attend the workshop were once again extended to government departments, Indigenous partners, industry, and non-government organizations. Workshop participants included representatives from the following groups:

Canadian Association of Petroleum Producers
Canadian Coast Guard
Canada-Nova Scotia Offshore Petroleum Board
Canadian Whale Institute
Canadian Wildlife Federation
Confederacy of Mainland Mi'kmaq
Dalhousie University
Defence Research and Development Canada
Encana
Grand Manan Whale and Seabird Research Station
Green Marine
Irving Oil Limited
JASCO Applied Sciences
Maliseet Nation Conservation Council
M – Expertise Marine
Marine Animal Response Society
Maritime Aboriginal Peoples Council

National Defence Canada
Natural Resources Canada
New England Aquarium
Nova Scotia Department of Energy
Shipping Federation of Canada
Transport Canada
World Wildlife Fund Canada

In addition, targeted consultation on the draft action plan was undertaken during June through August 2019, when DFO invited Indigenous partners, industry, provincial governments, the U.S. government, and academic and other experts to provide comments on the draft action plan. The action plan was posted as Proposed on the Species at Risk Public Registry for a 90-day public comment period beginning on May 11, 2020. All of the comments received during these consultation processes were considered and incorporated in the Final version of this document, as appropriate.