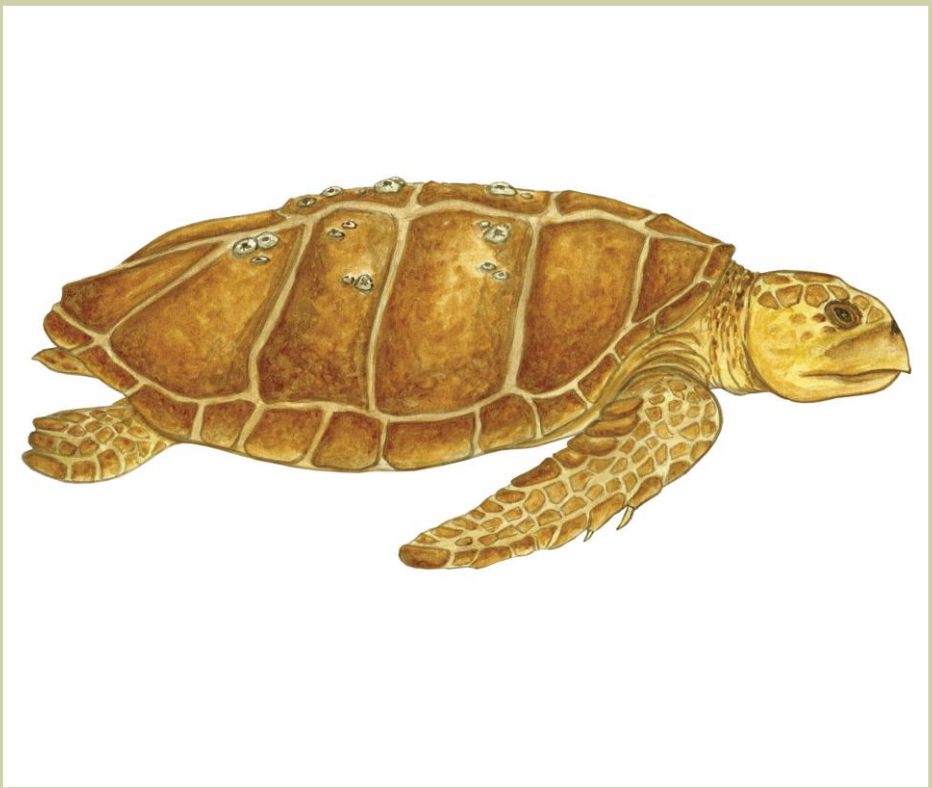
Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Loggerhead Sea Turtle (*Caretta caretta*) in Atlantic Canada

Caretta caretta



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

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Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for the protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of a recovery strategy for species listed as extirpated, endangered, or threatened and are required to report on progress five years after the publication of the final document on the Species at Risk Public Registry, and every subsequent five years following.

The Minister of Fisheries and Oceans is the competent minister under SARA for the Loggerhead Sea Turtle and has prepared this strategy, as per section 37 of SARA. In preparing this recovery strategy, the competent minister has considered, as per section 38 of SARA, the commitment of the Government of Canada to conserving biological diversity and 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 recovery strategy has been prepared in cooperation with other federal government departments, provincial governments, Indigenous organizations, and others as per section 39(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 groups that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada, or any other jurisdiction, alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Loggerhead Sea Turtle and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Fisheries and Oceans Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

Acknowledgments

Fisheries and Oceans Canada wishes to acknowledge the many individuals who provided valuable input into the development of this recovery strategy.

Executive summary

The Loggerhead Sea Turtle (*Caretta caretta*) was listed as endangered under the *Species at Risk Act* (SARA) in 2017. This recovery strategy is one in a series of documents for this species that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (2010), a recovery potential assessment (2010), the threat assessment (2017a), and one or more action plans (to be developed). Recovery of the Loggerhead Sea Turtle has been determined to be biologically and technically feasible.

The Loggerhead Sea Turtle is one of seven sea turtle species globally. This species is broadly distributed in the temperate, sub-tropical, and tropical waters of the Atlantic, Pacific, and Indian Oceans. Loggerheads nest and forage at lower latitudes and also forage at higher latitudes. Nine Distinct Population Segments (DPSs) have been identified globally. Loggerhead Sea Turtles occurring in Atlantic Canadian waters are believed to belong almost exclusively to the Northwest Atlantic Ocean DPS. When in Canadian waters during the summer, these turtles typically occur offshore along the continental shelf break and beyond, from Georges Bank to the southern Grand Banks. Their distribution is driven in part by water temperature, with warmer waters being preferred. There is currently no population estimate for the Northwest Atlantic Ocean DPS. Nesting data are used as a population index. Following a period of significant decline, nesting numbers have shown an increasing trend in recent years.

Threats to the species are described in section 5 and include: bycatch (that is, incidental capture in active fishing gear), entanglement (that is, in ghost gear or other marine debris), underwater noise, marine pollution, vessel strikes, harvesting (legal and illegal), coastal development, and artificial lighting on nesting beaches. The latter three threats do not impact Loggerhead Sea Turtles while they are in Canadian waters. In Atlantic Canada, bycatch in the pelagic longline fishery is the threat of greatest concern, as it is the only documented source of harm and mortality to Loggerhead Sea Turtles.

Setting measureable population and distribution objectives (section 6) for the Loggerhead Sea Turtle in Atlantic Canadian waters is challenging due to a number of factors. Instead, a threat-reduction approach to monitoring recovery has been adopted with the following objective:

> Ensure human-induced harm and mortality rates in Atlantic Canadian waters do not exceed levels that would impede the recovery of the Northwest Atlantic Ocean Distinct Population Segment of Loggerhead Sea Turtles. Until those levels can be quantified, take measures to reduce human-induced harm and mortality rates.

A description of the broad strategies to be taken to address threats to the species' survival and recovery, as well as research and management approaches needed to meet the threat-reduction objective, are included in section 7. These will help inform the development of specific recovery measures in one or more action plans.

The identification of critical habitat for the Loggerhead Sea Turtle is not possible at this time, given currently available information. The schedule of studies outlines the research required to identify critical habitat (section 8).

An action plan will be completed within three years of posting the final recovery strategy.

Recovery feasibility summary

Section 40 of the *Species at Risk Act* states the following:

> "In preparing the recovery strategy, the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. The determination must be based on the best available information, including information provided by COSEWIC."

Recovery of the Loggerhead Sea Turtle is considered technically and biologically feasible because it meets the following four criteria established in the *Species at Risk Act* Policies (Government of Canada 2009):

1. **Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or increase its abundance.**

   The number of adult females in the Northwest Atlantic Ocean Distinct Population Segment (DPS) is estimated to exceed 30,000 (Richards et al. 2011), and the current population trend[1] is thought to be increasing overall (Ceriani and Meylan 2015).

2. **Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**

   The range of the Northwest Atlantic Ocean DPS is vast, and includes numerous nesting beaches and expansive marine habitat extending from the equator to 60°N. Loggerhead Sea Turtles are considered prey generalists and are not limited by the availability of specific prey species.

3. **The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**

   The primary threat to the species in Atlantic Canadian waters is bycatch in the pelagic longline fishery. Measures are already in place to mitigate this threat (for example, mandatory circle hook use; mandatory sea turtle disentanglement/dehooking training). Licence conditions for this fishery include all known feasible measures that can be implemented at this time. Mitigation measures will be adjusted as needed over time based on international best practices.

   The primary threats outside of Canada, such as those affecting nesting beaches, can also be mitigated. For example, lighting ordinances and building setbacks may help address potential impacts from light pollution and coastal development. More information about threats outside of Canada is available from the National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS-USFWS) (NMFS-USFWS 2008).

[1] This population trend is in contrast to the declining trend noted in the 2010 COSEWIC status assessment. The trend reported by Ceriani and Meylan (2015) used more recent nesting abundances to estimate the overall population trend for the Northwest Atlantic.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

A threat-reduction objective has been adopted for Loggerhead Sea Turtle which is to:

Ensure human-induced harm and mortality rates in Atlantic Canadian waters do not exceed levels that would impede the recovery of the Northwest Atlantic Ocean Distinct Population Segment of Loggerhead Sea Turtles. Until those levels can be quantified, take measures to reduce human-induced harm and mortality rates.

Feasible recovery techniques can be applied to help meet this objective. Some of these techniques are already in place (for example, mandatory reporting of incidental catch, disentanglement/dehooking equipment and training requirements, etc.) and may be enhanced over time.

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Background

1. Introduction

The Loggerhead Sea Turtle (*Caretta caretta*) was listed as endangered under the *Species at Risk Act* (SARA) on May 3, 2017.

This recovery strategy is part of a series of documents regarding the Loggerhead Sea Turtle that should be taken into consideration together, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report (COSEWIC 2010), the recovery potential assessment (RPA) (DFO 2010a), the threat assessment (DFO 2017a), and the subsequent action plan(s) (to be developed). A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action planning stage.

The RPA is a process undertaken by DFO Science to provide the information and scientific advice required to meet the various requirements of SARA, relying on the best available scientific information, data analyses and modeling, and expert opinions. The outcomes of this process inform many sections of the recovery strategy.

2. COSEWIC species assessment information

Date of assessment: April 2010

Common name (population): Loggerhead Sea Turtle

Scientific name: *Caretta caretta*

Status: Endangered

Reason for designation: this species is declining globally and there are well documented, ongoing declines in the Northwest Atlantic population from which juveniles routinely enter and forage in Atlantic Canadian waters. The Canadian population is threatened directly by commercial fishing, particularly bycatch in the pelagic longline fleet, and by loss and degradation of nesting beaches in the southeastern USA and the Caribbean. Other threats include bycatch from bottom and midwater trawls, dredging, gillnets, marine debris, chemical pollution and illegal harvest of eggs and nesting females.

Occurrence: Pacific Ocean, Atlantic Ocean

Status history: designated Endangered in April 2010

3. Species status information

The Loggerhead Sea Turtle has been internationally recognized as an at-risk species for several decades. Table 1 provides a summary of the various status designations assigned to this species. This list is not exhaustive, and these designations are not all associated with legally binding prohibitions to protect the species.

Table 1. Summary of existing status designations assigned to the Loggerhead Sea Turtle, and where applicable, the Northwest Atlantic population specifically.

Jurisdiction	Authority/organization	Year	Status/description
Canada	Species at Risk Act S.C. 2002, c. 29	2017	Listed as endangered in schedule 1
Canada	Committee on the Status of Endangered Wildlife in Canada	2010	Assessed as endangered
Canada	Wild Animal and Plant Protection and Regulation of the International and Interprovincial Trade Act	1996	Listed in schedule I to the Wild Animal and Plant Trade Regulations (SOR/96-263)
New Brunswick	Species at Risk Act 2012, c. 6	2013	Listed as endangered in schedule A to the List of Species at Risk Regulation (2013-38)
United States	Endangered Species Act of 1973	1978	Listed as threatened throughout its range (1978) Northwest Atlantic Ocean Distinct Population Segment listed as threatened (2009)
The Americas	Inter-American Convention for the Protection and Conservation of Sea Turtles	2001	Listed in annex I
Wider Caribbean Region	Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	1991	Listed in annex II
International	International Union for Conservation of Nature	2015	Included in the Red List of Threatened Species as vulnerable (global population) and least concern (Northwest Atlantic subpopulation)
International	NatureServe	2005	Assigned a global ranking of G3-vulnerable
International	Convention on the Conservation of Migratory Species of Wild Animals	1986	Listed in appendix I
International	Convention on the International Trade Endangered Species of Wild Fauna and Flora	1981	*Cheloniidae spp.* (that is, all hard-shelled marine turtles) listed in appendix I

Upon its listing as an endangered species under SARA, the Loggerhead Sea Turtle became protected wherever it is found in Canada by section 32 of the Act, which states:

> "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species." [s. 32(1)]
>
> "No person shall possess, collect, buy, sell or trade an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species, or any part or derivative of such an individual." [s. 32(2)]

Under section 73 of SARA, the competent minister may enter into an agreement or issue a permit authorizing a person to engage in an activity affecting a listed wildlife species, any part of its critical habitat or its residences.

4. Species information

4.1 Description

4.1.1 Taxonomy

The Loggerhead Sea Turtle is one of seven species of sea turtles globally, and one of six species in the family Cheloniidae, the hard-shelled sea turtles (Dodd 1988). It is the only species in the genus *Caretta*. Table 2 describes the basic taxonomy of the Loggerhead Sea Turtle.

Table 2. The taxonomic classification of the Loggerhead Sea Turtle. The most inclusive taxonomic rank is on the far left of the table, and the least inclusive rank is on the far right.

Kingdom	Phylum	Class	Order	Family	Genus	Species
Animalia	Chordata	Reptilia	Testudines	Cheloniidae	Caretta	*Caretta caretta*
Animals	Vertebrates	Turtles, snakes, lizards, and crocodilians	Turtles	Hard-shelled sea turtles	Loggerhead Sea Turtle (monotypic genus)	Loggerhead Sea Turtle

4.1.2 Morphology

The Loggerhead Sea Turtle is characterized by a relatively large head and beak compared to other sea turtles. The head and carapace (top shell) are typically reddish brown in colour, and may be tinged with olive (Dodd 1988; Kamezaki 2003; COSEWIC 2010). The flippers are chestnut brown, fading to yellow at the edges. The underside, or plastron, of the turtle is yellow to creamy white. The carapace is composed of several bony plates (scutes), including five vertebral scutes, five pairs of costal (lateral) scutes, and 12 to 13 pairs of marginal scutes, including the supracaudal scute above the tail (Kamezaki 2003; figure 1). This scute pattern can vary, however, and may not always be reliable for species identification purposes. A wide nuchal scute at the nape of the neck contacts the first costal scute on either side (figure 1).

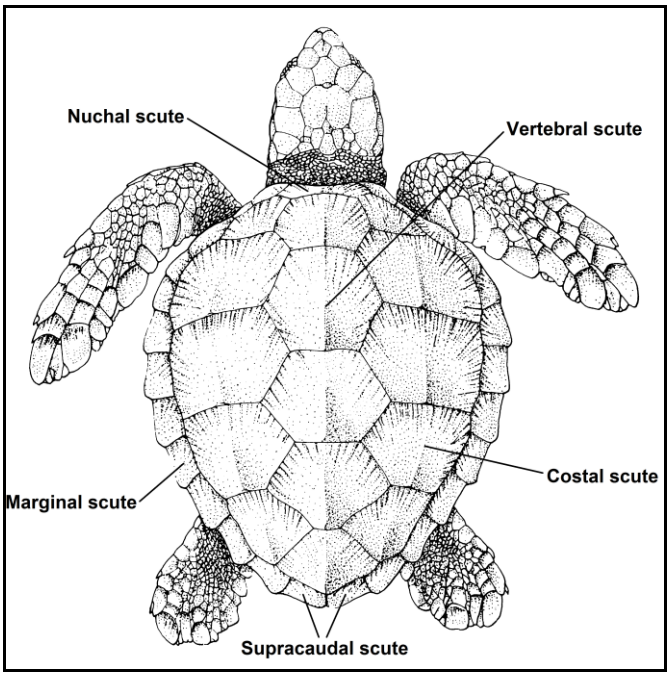

Figure 1. External morphology and scute pattern of the Loggerhead Sea Turtle (modified from Dodd 1988; COSEWIC 2010).

Based on size distribution and primary habitat, the United States (US) Turtle Expert Working Group described five life stages for the Loggerhead Sea Turtle (TEWG 2009; table 3). Size is most often measured according to straight carapace length (SCL), the length between the anterior of the carapace (near the neck) to the posterior of the carapace (near the tail). Available size distribution data for Loggerheads caught in or near Atlantic Canadian waters suggest that these turtles are juveniles (mainly stages III and IV).

Table 3. The five life stages of the Loggerhead Sea Turtle (information derived from TEWG 2009). Marine habitat use includes the oceanic (> 200 m deep) and neritic zones (<200 m deep).

Stage	Description	Habitat	Size range (SCL in cm)
I	Year one	Terrestrial to oceanic	≤15
II	Juvenile (1)	Exclusively oceanic	15 to 63
III	Juvenile (2)	Oceanic or neritic	41 to 82
IV	Juvenile (3)	Oceanic or neritic	63 to 100
V	Adult	Oceanic or neritic	≥82

Loggerhead Sea Turtles greater than 67 cm SCL typically exhibit external sexually dimorphic traits (that is, traits that distinguish males from females). Two of these traits are relatively easy to identify: (1) males have a longer tail than females, which typically extends beyond the carapace, and (2) males have larger and more strongly curved claws on their fore flippers (Dodd 1988).

4.2 Population abundance and distribution

The Loggerhead Sea Turtle is known to occur in the temperate, subtropical, and tropical waters of the Atlantic, Pacific, and Indian Oceans (Dodd 1988; figure 2). Conant et al. (2009) identified nine Distinct Population Segments (DPS) for the species globally. Each DPS is considered discrete and significant based on factors including ecology, behaviour, oceanography, and genetics. The nine DPSs are:

1) Northwest Atlantic Ocean
2) Northeast Atlantic Ocean
3) North Pacific Ocean
4) South Pacific Ocean
5) North Indian Ocean
6) Southeast Indo-Pacific Ocean
7) Southwest Indian Ocean
8) Mediterranean Sea
9) South Atlantic Ocean

The distributions of the North Pacific Ocean DPS and the Northwest Atlantic Ocean DPS include Canadian waters. These two DPSs correspond to designatable units (DUs) in accordance with COSEWIC guidelines (COSEWIC 2015). There is just one record of a Loggerhead Sea Turtle in Pacific Canadian waters (Halpin et al. 2018), therefore it is unlikely that the species regularly inhabits those waters. As such, COSEWIC (2010) focused their assessment on the Atlantic Canadian population, which is the subject of this recovery strategy. These animals are thought to belong almost exclusively to the Northwest Atlantic Ocean DPS. Oceanic juveniles (table 3) from the Northwest Atlantic Ocean DPS are also found in foraging areas within the Northeast Atlantic Ocean DPS and Mediterranean Sea DPS (Conant et al. 2009; NMFS and USFWS 2011; figure 2). In contrast, neritic juveniles (table 3) typically stay closer to their natal beaches, while adults remain entirely within the boundaries of the Northwest Atlantic Ocean DPS (figure 2).

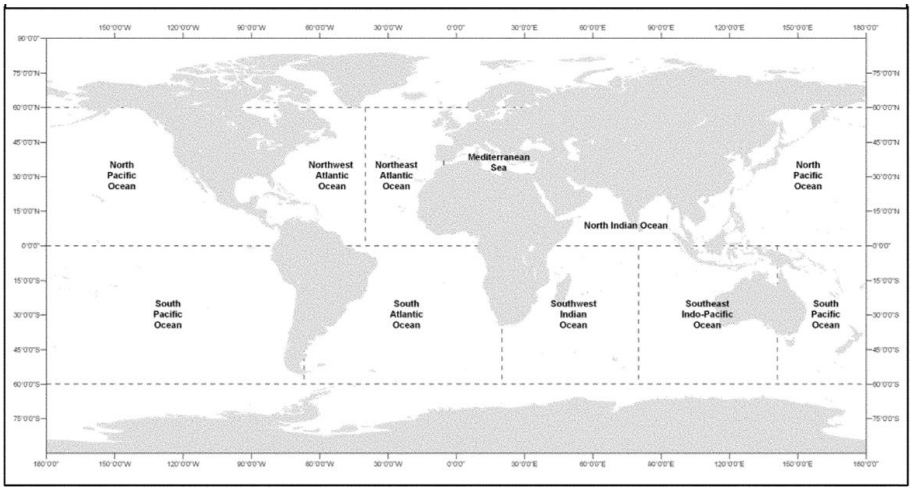

Figure 2. The nine Distinct Population Units identified by Conant et al. (2009) for the Loggerhead Sea Turtle (USFWS and NMFS 2011).

There are currently no comprehensive estimates of population abundance for any of the nine DPSs (NMFS and USFWS 2011). The status of each of these populations has been assessed

primarily using data collected from nesting beaches. Since females exhibit nesting site fidelity, these data represent the best available index of population abundance (DFO 2010a). From 2001 to 2010, an average abundance of ~38,000 adult females was estimated for the Northwest Atlantic Ocean DPS by extrapolating nesting data and taking into account breeding interval, survival, and clutch frequency (Richards et al. 2011).

The Northwest Atlantic Ocean DPS hosts one of the two most significant nesting assemblages in the world (NMFS and USFWS 2011; figure 3a). Over 85% of the nesting effort within this DPS occurs on beaches in peninsular Florida (NMFS and USFWS 2011; figure 3b). Standardized data collected over an approximate 20-year time period ending in 2008 indicate a significant declining trend in nesting in the Northwest Atlantic Ocean DPS (NMFS and USFWS 2008; Witherington 2009; TEWG 2009). These data informed the endangered status assessment by COSEWIC (2010), which cited an estimated population decline of greater than 50% over three generations (100 years). In more recent years, however, nest counts on index beaches have been increasing overall (for example, Ceriani and Meylan 2015; FFWCC 2017). The causes of the observed trends in nesting data are poorly understood, in part because the time series of available data is shorter than the generation time of Loggerhead Sea Turtles (46 years; DFO 2010a). It is also unknown how these trends correlate with at-sea abundances.

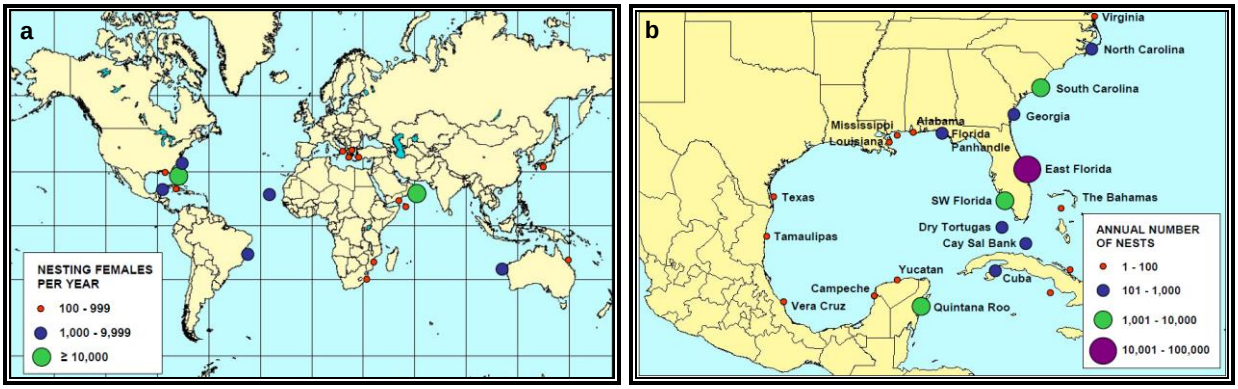

Figure 3. a) Global distribution of Loggerhead Sea Turtle nesting assemblages (NMFS and USFWS 2008); b) Loggerhead Sea Turtle nesting locations, and the corresponding annual estimated number of nests, in the Northwest Atlantic Ocean DPS, 2001-2008 (NMFS and USFWS 2008).

Loggerhead Sea Turtle abundance in Canadian waters has not been estimated (DFO 2010a). Available data are limited to opportunistic sightings, fisheries bycatch records, strandings, and irregular survey effort. In Canada, Loggerheads are thought to occur primarily along the continental slope and further offshore, with comparatively few sightings on the shelf and even fewer inshore (DFO 2010a). The species' known distribution in Atlantic Canada extends from Georges Bank to the southern Grand Banks (figure 4). LaCasella et al. (2013) analyzed the genetics of juveniles caught in the high seas area adjacent to Canadian waters. The results of their study suggested that those individuals originated almost exclusively from the Northwest Atlantic Ocean DPS (99.2%). The stock composition of the sampled turtles was thought to be influenced by large-scale oceanographic circulation patterns, and proportionate to the size of the rookeries (that is, genetically distinctive nesting assemblages within the DPS) represented in the sample group (that is, turtles from the largest nesting sites were represented in higher proportions in the sample area than those from the smaller nesting sites). There is no evidence to suggest that the composition of Loggerheads in Canadian waters would differ significantly (DFO 2010a).

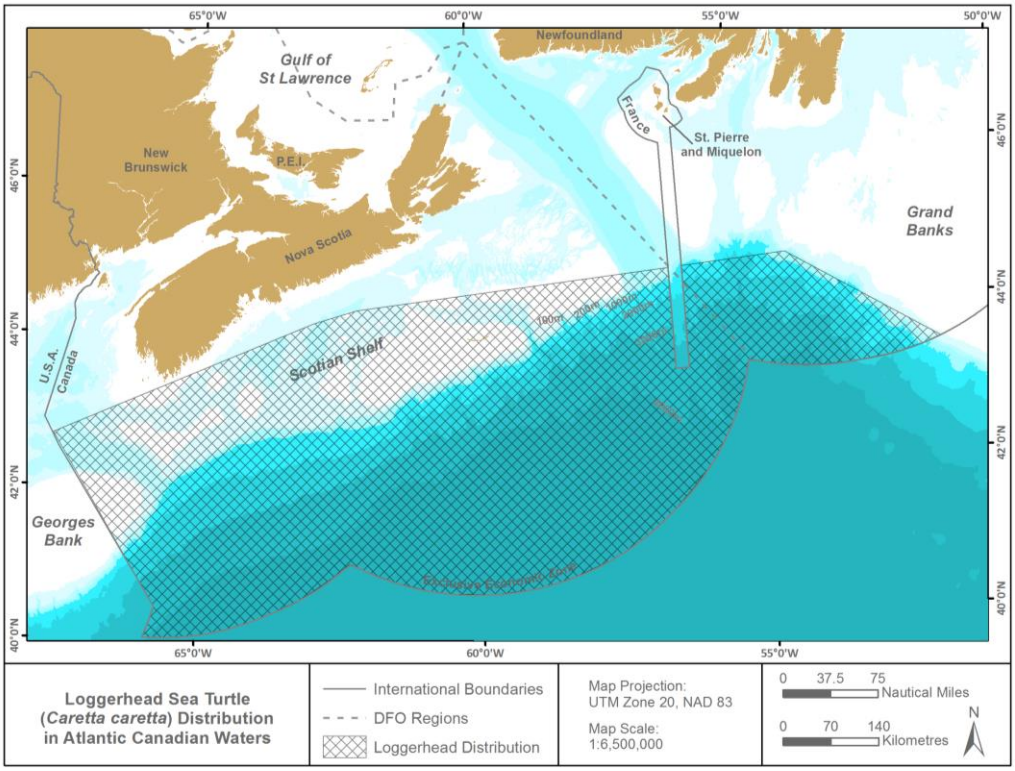

Figure 4. Regular Loggerhead Sea Turtle distribution within Atlantic Canadian waters based on available fisheries bycatch data and satellite tagging data, 2001 to 2016. This is considered a coarse representation of distribution and requires further refinement (see section 8.2).

4.3 Needs of the species

Habitat

Loggerhead Sea Turtles use both terrestrial and marine habitats during their life cycle. They use terrestrial habitat exclusively for nesting on beaches in tropical and sub-tropical latitudes outside of Canada. Marine habitat use includes the neritic (<200 m deep) and oceanic (>200 m deep) zones (Bolten 2003). When in Canadian waters during the spring, summer, and fall, Loggerheads are thought to forage mostly in the oceanic zone (Harris et al. 2010). These oceanic juveniles spend 75% of the time in the top five metres of the water column mostly feeding on a wide variety of sea jellies (jellyfish and comb jellies) and salps (Bolten 2003; Bjorndal 2003). Loggerheads are opportunistic carnivores, and oceanic juveniles have also been known to consume snails, barnacles, crabs, and other organisms.

In Canadian waters, Loggerhead habitat is defined temporally and geographically, in part, by sea surface temperature (DFO 2010a). Loggerhead Sea Turtles appear to prefer sea surface temperatures >20°C (Brazner and McMillan 2008; Carruthers and Neis 2011). Temperatures <15°C can result in impaired metabolism, movement, and feeding behaviour (Braun-McNeill et al. 2008). There are, however, rare documented cases of Loggerheads acclimating to cooler temperatures. Loggerhead bycatch rates were concentrated in waters above 22°C in a study involving Canadian pelagic longline fisheries (Brazner and McMillan 2008). In Atlantic Canada, waters >20°C are found in the oceanographically dynamic region along the shelf break and

further offshore, where the warm waters of the Gulf Stream mix with the cooler waters of the Labrador Current (DFO 2010a). The fronts and eddies that form along this highly productive transition zone can concentrate prey closer to the surface, a phenomenon often exploited by foraging Loggerheads. More information regarding the habitat needs of this species outside of Canadian waters is provided in COSEWIC (2010) and DFO (2010a).

Limiting factors

Loggerhead Sea Turtle population growth is limited by the fact that individuals become sexually mature late at 22.5 to 42 years of age (Avens et al. 2015), with a mean interval of 3.7 years between nesting seasons as estimated by Tucker (2010).

5. Threats

5.1 Threat assessment

Several known and potential anthropogenic threats to the Loggerhead Sea Turtle have been identified. A threat has been defined as any human activity or process that has caused, is causing, or may cause harm, death, or behavioural changes to a wildlife species at risk, or the destruction, degradation, and/or impairment of its habitat, to the extent that population-level effects occur (DFO 2014). Threats to the Northwest Atlantic DPS are summarized in table 4, and described in more detail in section 5.2 and DFO (2017a). Threat assessment categories are defined in appendix C.

Table 4. Threat assessment for the Northwest Atlantic Ocean Distinct Population Unit of Loggerhead Sea Turtles throughout their range and within Atlantic Canada (DFO 2017a). Rows in blue represent threats that do not occur within Canadian jurisdiction.

Threat	Geographic scale	Likelihood of occurrence	Level of impact (# mortalities[5, 6])	Causal certainty	Threat risk	Threat occurrence	Threat frequency	Threat extent
Bycatch	NW Atlantic	Known	High (12,433)	High	High	Current	Continuous	Broad
Bycatch	Atl. Canada[1]	Known	Medium (5 to 118)[7]	Low	Medium	Current	Recurrent	Narrow
Entanglement[2]	NW Atlantic	Known	Medium (127)	Low	Medium	Current	Continuous	Broad
Entanglement[2]	Atl. Canada	Remote	Low	Very low	Low	Current	Continuous	Unknown
Underwater noise	NW Atlantic	Known	Low	Very low	Low	Current	Continuous	Extensive
Underwater noise	Atl. Canada	Known	Low	Very low	Low	Current	Continuous	Extensive
Marine pollution[3]	NW Atlantic	Known	Medium (254)	Medium	Medium	Current	Continuous	Extensive
Marine pollution[3]	Atl. Canada	Likely	Unknown	Very low	Unknown	Current	Continuous	Unknown
Vessel strikes	NW Atlantic	Known	Medium (308)	Medium	Medium	Current	Continuous	Broad
Vessel strikes	Atl. Canada	Unlikely	Low	Very low	Low	Current	Continuous	Restricted
Harvesting (legal / illegal)	NW Atlantic	Known	High (1,050)	Medium	High	Current	Recurrent	Broad
Coastal development[4]	NW Atlantic	Known	Medium (183)	High	Medium	Current	Continuous	Narrow
Artificial light (nesting beaches)	NW Atlantic	Known	High (1,203)	High	High	Current	Continuous	Broad

Notes:

1. In Atlantic Canada, the only recorded incidental mortalities of Loggerhead Sea Turtles are attributed to the pelagic longline fishery targeting swordfish and tropical tunas (DFO 2010a). Comparatively in the US, gear types targeting a variety of species are known to cause incidental mortality to Loggerhead Sea Turtles including: bottom trawls, dredges, pelagic longlines, demersal longlines, gillnets and other gear types (NMFS and USFWS 2008).
2. Entanglement caused by ghost fishing or marine debris is included here. Entanglement in active fishing gear is included in “bycatch”.

3. Marine pollution includes contaminants that Loggerhead Sea Turtles may be exposed to (including from oil pollution) and debris ingestion.
4. Coastal development also includes beach use (for example, driving on beaches, human presence on beaches in general).
5. Annual mortalities in the NMFS-USFWS (2008a) threat assessment were converted into mortalities of nesting females, shown here, to account for different reproductive values at each life stage (for example, the mortality of one nesting female is equivalent to 250 hatchlings, 34.5 oceanic juveniles, or 4.3 neritic juveniles).
6. The level of impact entries that do not include the number of mortalities indicate that there was no evidence of mortality in Atlantic Canadian waters caused by that threat.
7. The NMFS and USFWS (2008) relative reproductive value (RRV) for oceanic juveniles was used to determine the nesting female equivalents of juvenile mortalities as a result of bycatch in Atlantic Canada. RRVs for each life stage are presented in table A1-5 in NMFS and USFWS (2008). Current post-release mortality estimates in the pelagic longline fishery in Atlantic Canada suggest 200 to 500 juvenile mortalities/year for the Canadian population (20 to 45% of approximately 1,200 caught annually) (DFO 2010a; Paul et al. 2010). This equates to 5 to 15 or 47 to 118 nesting females if considering oceanic juveniles or neritic juvenile RRVs, respectively, using NMFS-USFWS (2008a). Therefore, the overall range of annual nesting female equivalent mortalities in Atlantic Canadian waters is 5 to 118.

5.2 Description of threats

Threats to Loggerhead Sea Turtles are described in DFO (2017a), and briefly summarized below.

5.2.1 Bycatch

Incidental capture, or bycatch, of Loggerhead Sea Turtles in pelagic longline fisheries has been documented in all of the major ocean basins (Lewison et al. 2004). In Atlantic Canada, this threat presents the highest risk to the species (table 4), and is currently the only documented source of human-induced harm or mortality of Loggerheads in the region (DFO 2010a). The Atlantic Canadian pelagic longline fleet targets Swordfish (*Xiphias gladius*), Bigeye Tuna (*Thunnus obesus*), Yellowfin Tuna (*Thunnus albacares*), and Albacore Tuna (*Thunnus alalunga*). In Atlantic Canada, DFO issues a fixed number of licences (77) for Swordfish and other tunas (including a bycatch allowance for Bluefin Tuna) (DFO 2013a). The fishing season is yearlong, but actual fishing for these species occurs when they are in the area between April and December (Swordfish) and between May and October (other tunas).

Brazner and McMillan (2008) analyzed observer records of bycatch in Canadian pelagic longline fisheries between 1999 and 2006, and estimated that an average of 1199 Loggerhead Sea Turtles were incidentally captured each year during that period. Paul et al. (2010) arrived at a similar bycatch estimate of 1200 Loggerheads per year during the period of 2002 to 2008. Assuming a post-encounter mortality of 20 to 45%[2], approximately 200 to 500 deaths of oceanic and neritic juveniles were estimated to have occurred annually in Canada from 2002 to 2008 (DFO 2010a). These estimates represent time series that are now out of date, and work is ongoing to obtain representative bycatch estimates (section 7.1). Spatiotemporal patterns in fishing effort can influence the bycatch rate of Loggerhead Sea Turtles. As a result, sea turtle bycatch may fluctuate significantly between years or other time intervals. For example, Loggerhead Sea Turtle encounter rates in Atlantic Canada are influenced by target species and water temperature (DFO 2010a; Paul et al. 2010). A more complete understanding of how the environment and pelagic longline fishing practices affect Loggerhead Sea Turtle bycatch rates is needed. The likelihood that a Loggerhead Sea Turtle will survive an encounter with the pelagic longline fishery depends on the type of injury sustained and the release condition (for example, Ryder et al. 2006; Swimmer and Gilman 2012). The specific location of the hook in the turtle's body, and the length of line remaining upon release, are believed to be the primary factors affecting mortality.

Several other fishing gear types, in addition to pelagic longlines, have been implicated in Loggerhead Sea Turtle bycatch outside of Canada, most notably gillnets and trawl gear (for example, Conant et al. 2009). Because Loggerhead Sea Turtles mostly occupy surface habitat in waters deeper than 200 m when in Atlantic Canada, it is less likely that individuals will encounter these gear types (COSEWIC 2010).

[2] From DFO (2010a): "[The assumed mortality rate] is based on expert opinion and limited experimental evidence related to loggerhead sea turtles hooked externally, in the mouth or in the cervical oesophagus. It excludes estimates for animals that swallow the hook below the cervical oesophagus, are released still entangled in gear, or if an animal was drowned but resuscitated."

5.2.2 Entanglement

Loggerhead Sea Turtles have been found entangled in marine debris, such as monofilament line, pot/trap lines, and netting (NMFS and USFWS 2008). Most recorded entanglements have been in fishing gear, with fewer entanglements in non-fishing marine debris. The effects of entanglement may be sublethal or lethal. It can cause abrasions or the loss of limbs, or compromise a turtle's ability to feed, swim, or evade predators (Nelms et al. 2016).

5.2.3 Underwater noise

Loggerhead Sea Turtle hearing is thought to enable predator and prey detection, navigation, and environmental awareness (Dow Piniak et al. 2012). They are low-frequency specialists (Lavender et al. 2014), with hearing frequency ranges from approximately 100 Hz to 1 kHz, with best sensitivity between 100 and 400 Hz (Martin et al. 2012). This overlaps with frequencies produced by seismic airgun arrays, offshore drilling, low-frequency sonar, shipping noise, and pile driving (Dow Piniak et al. 2012).

The effects of noise on Loggerhead Sea Turtles are not fully understood and are challenging to study. The current state of knowledge has been largely derived from experiments with captive turtles (for example, Martin et al. 2012; Lavender et al. 2014). Sound exposure levels likely to cause permanent or temporary hearing loss in Loggerhead Sea Turtles are not known, nor are the effects of hearing loss on population fitness (for example, Popper et al. 2014). It is also not well understood how noise may affect turtle behaviour and stress levels. In their study of free-swimming Loggerhead Sea Turtles, DeRuiter and Larbi Doukara (2012) observed startle responses or avoidance behaviours in the majority of turtles exposed to seismic airgun arrays. Avoidance behaviours may lead to habitat displacement or changes in energy expenditure, which could have negative impacts on the health of individuals. Novel approaches to studying the behavioural responses of sea turtles to noise exposure are emerging and may help to better quantify this threat in the future (Tyson et al. 2017). Noise-related impacts on Loggerhead Sea Turtles have not been documented in Atlantic Canada; however, noise-producing activities are regularly occurring (DFO 2017a). Commercial shipping traffic is continuous on the Scotian Shelf and Slope. In April 2018, six active oil and gas exploration licences were held by two operators along the shelf break off Nova Scotia between Georges Bank and Sable Island (CNSOPB 2018); however, exploration activities vary from year to year and do not necessarily occur annually in each licence. There were also two projects in production near Sable Island preparing for eventual decommission (CNSOPB 2018).

5.2.4 Marine pollution

Contaminants and marine debris are known to affect Loggerhead Sea Turtles in a variety of ways (for example, Balazs 1985; Lutcavage et al. 1997; McCauley and Bjorndal 1999; NMFS and USFWS 2008; Camedda et al. 2014; Nicolau et al. 2016; Nelms et al. 2016; Finlayson et al. 2016), including but not limited to the following:

- ingestion of debris can lead to gut obstruction, absorption of toxic byproducts, or malabsorption of nutrients
- debris on nesting beaches may obstruct hatchlings from reaching the water or cause them to expend more time and energy to get there
- oil deposited on eggs or atop nests increases the chances of mortality or abnormal hatchling development

- prolonged exposure to oil slicks in the ocean can have physiological impacts (for example, changes in respiration, blood chemistry) on sea turtles
- persistent chlorinated hydrocarbons and heavy metals can bioaccumulate in the tissues of Loggerhead Sea Turtles with possible health implications that are not well understood

As generalist feeders that often forage in oceanic convergence zones, fronts, and eddies, Loggerhead Sea Turtles may be especially susceptible to ingesting marine debris (for example, NMFS and USFWS 2008; Nelms 2016). The relatively wide alimentary tract of sub-adults and adults may help temper the risk of blockages in those life stages. No plastics have been recorded in the guts of necropsied Loggerhead Sea Turtles in Atlantic Canada, but the sample size is currently very small (DFO 2017a). It is unknown how contaminant levels in Atlantic Canadian waters compare to other parts of the population's range. Oil and gas projects on the Scotian Shelf (section 5.2.3) pose a potential offshore spill risk that is considered low.

5.2.5 Vessel strikes

Like other air-breathing marine animals, Loggerhead Sea Turtles are susceptible to strikes by commercial and recreational vessels. Propeller wounds are frequently observed on stranded turtles in the US, particularly in Florida, where, in some years, up to 60% of stranded Loggerhead Sea Turtles have displayed these wounds (NMFS and USFWS 2008). Vessel strikes are thought to occur more often in the neritic zone, where vessel traffic is typically dense and recreational boat use is relatively high compared to the offshore. For these reasons, vessel interactions with Loggerhead Sea Turtles are not thought to be significant in Atlantic Canada. Injuries consistent with a vessel strike have not been observed in Atlantic Canadian waters to date.

5.2.6 Harvesting

*Not a threat to Loggerhead Sea Turtles while they are in Canadian waters

Loggerhead Sea Turtles are legally protected from harvest in over 70% of the countries where they occur in the Northwest Atlantic, including Canada (NMFS and USFWS 2008; DFO 2017a). Juvenile and adult turtles, rather than eggs, constitute the majority of authorized harvest in the remaining countries. Poaching of eggs, nesting females, and in-water turtles is known to occur in multiple countries throughout the range of the population (NMFS and USFWS 2008). Poaching is not known to occur in Canadian waters.

5.2.7 Coastal development

*Not a threat to Loggerhead Sea Turtles while they are in Canadian waters

Coastal development can affect Loggerhead Sea Turtle nesting activity in several ways. Beach restoration and beach nourishment may lead to changes in the characteristics of the sand, such as its level of compaction, moisture content, gas exchange, and temperature, which may in turn affect nesting success (NMFS and USFWS 2008). Beach armouring and construction of coastal infrastructure may also affect nesting success and temperature-dependent sex determination. Construction operations bring increased human traffic and equipment, which increases the risk of sand compaction, light pollution, and the formation of temporary barriers that may inhibit nesting or entrap hatchlings. Turtles encountering a barrier may return to the ocean without nesting, and those that nest may do so lower on the beach, increasing the risk of nest loss due to wave activity/erosion. Dredging, blasting, and dock construction may also affect turtles at sea in the nearshore environment (NMFS and USFWS 2008).

5.2.8 Artificial light on nesting beaches

*Not a threat to Loggerhead Sea Turtles while they are in Canadian waters

The presence of artificial lighting may deter female turtles from emerging from the ocean to attempt to nest, or cause them to abandon a nesting attempt (NMFS and USFWS 2008). Both adult females and hatchlings rely on brightness cues to navigate from the beach to the ocean. If these are overridden by artificial light sources, the turtles may become disoriented (NMFS and USFWS 2008). Disorientation can lead to dehydration, exhaustion, predation, and increased interaction with human activities (for example, vehicular traffic).

5.2.9 Climate change

Climate change was identified as a potential threat to Loggerhead Sea Turtles in the assessment and status report on the Loggerhead Sea Turtle (COSEWIC 2010) and the recovery potential assessment for Loggerhead Sea Turtle (DFO 2010a). It is not included in the threat assessment table (table 4) in accordance with guidance on assessing threats, ecological risk and ecological impacts for species at risk (DFO2014). This species may be affected by climate change in different ways throughout their range and life history stages (Witt et al. 2010). Rising sea levels will decrease the availability of suitable nesting sites, while warmer ambient temperatures could negatively influence incubation success and duration (Carthy et al. 2003; Witt et al. 2010). Furthermore, sex determination in sea turtles depends on egg temperature during incubation, with warmer temperatures producing more females. Consequently, Loggerhead sex ratios may become skewed as a result of shifting thermal regimes, with potential implications for future population growth. Increased frequency and intensity of storm events may lead to erosion of nesting habitat and loss of nests.

Less is known about how climate change may affect Loggerhead Sea Turtles in the ocean (Witt et al. 2010). Because sea surface temperature is an important factor in Loggerhead distribution, projected ocean warming is likely to affect the geographic distribution of the species, including the availability of suitable foraging habitat. Trophic relationships may also be affected, with possible implications for the abundance and location of prey. Changes in the strength or dynamics of ocean currents could affect the dispersal of Loggerhead hatchlings and the movements of juveniles and adults. To date, variability in the location and functional properties of Loggerhead habitat due to climate change have not been documented or quantified (DFO 2010a). A northward shift in the Gulf Stream and other changes in regional ocean circulation patterns could affect the Scotian Shelf, and therefore Loggerhead distribution, in the future (Shackell and Loder 2012). However, Canadian habitat is not thought to be limiting (DFO 2010a), and Loggerheads, as prey generalists, may be relatively adaptable to shifts in prey distributions should they occur (Witt et al. 2010).

Recovery

6. Population and distribution objectives

Population and distribution objectives establish, to the extent possible, the number of individuals, and their distribution, necessary for the recovery of the species. This is the preferred approach to help guide, and gauge the success of, recovery measures undertaken to benefit the species. However, for the Loggerhead Sea Turtle, setting measurable population and

distribution objectives for the portion of the population in Canadian waters is challenging for several reasons. When in Atlantic Canadian waters, the species:

- is at the northern edge of its range
- is typically associated with dynamic oceanographic features (for example, Gulf stream, eddies, and gyres)
- does not exhibit foraging site fidelity
- does not target specific prey species
- shows extreme interannual variation in abundance and distribution that is unexplained and may be independent of Canadian recovery efforts

In addition to the above, it is not known if or how the abundance of Loggerhead Sea Turtles in Atlantic Canadian waters is correlated with nesting trends. It is clear that the abundance and distribution of this species in Atlantic Canadian waters is influenced by many unpredictable and possibly unknown factors. This makes it difficult to effectively monitor these variables as they relate to recovery efforts. For example, it would be challenging to ascribe an increase or decrease in the abundance of Loggerhead Sea Turtles in Atlantic Canadian waters to recovery efforts: there are too many confounding factors. For this reason, a threat-reduction objective has been adopted:

> Ensure human-induced harm and mortality rates in Atlantic Canadian waters do not exceed levels that would impede the recovery of the Northwest Atlantic Ocean Distinct Population Segment of Loggerhead Sea Turtles. Until those levels can be quantified, take measures to reduce human-induced harm and mortality rates.

This objective may be updated as more information becomes available. Recovery will depend on rates of survival across the full range of the DPS due to the migratory behaviour of the species.

7. Broad strategies and general approaches to meet objectives

7.1 Actions already completed or currently underway

Broad strategy 1: research and monitoring

Work plan to address incidental catch in the Atlantic Canadian Swordfish/other Tuna longline fishery

In partnership with industry, DFO developed a work plan in 2009 to address incidental catch of six species, including Loggerhead Sea Turtle, in the pelagic longline fishery. The work plan includes projects in three categories: (1) observer coverage, (2) managing discards, and (3) controlling incidental mortality of non-targeted species. Several projects have been completed and others are still underway. Some of these initiatives are summarized below.

Observer coverage

Reliable, rigorous estimates of sea turtle bycatch depend on at-sea monitoring of fishing activity. For the pelagic longline fishery, at-sea coverage rates may vary, but have been approximately

10% in recent years. Work is underway to determine the level of observer coverage necessary to achieve an acceptable level of precision for bycatch estimates in the pelagic longline fishery. One area of research includes how to obtain a representative sample of fishing activity through the observer program (that is, determining a random sampling design that ensures appropriate spatial and temporal coverage). Also being investigated are different methods for scaling observed bycatch to the entire fishery. Initial analyses were presented at a 2011 Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process (DFO 2011; Hanke et al. 2012). Further analyses were presented at a follow-up CSAS meeting in 2016 (DFO 2016). This work is ongoing and considered a departmental research priority. Quantifying Loggerhead Sea Turtle bycatch is important for establishing suitable mortality thresholds to ensure the recovery of the species.

Post-release survival

Several methods for assessing the survival of released bycatch (for example, turtles, sharks) from the pelagic longline fishery were reviewed during a 2011 CSAS Regional Advisory Process (DFO 2011; Neilson et al. 2012). These included confinement, field observations, conventional tagging, telemetry, and physiological correlates of mortality. The reviewers concluded that standardized field observation, validated using telemetry, is likely the most effective approach for determining post-release survival in large bycatch species such as Loggerhead Sea Turtle. DFO Science initiated a Loggerhead telemetry study in 2011 that is currently ongoing. By its conclusion, 40 to 50 pop-up archival transmitting (PAT) tags will have been deployed on lightly and deeply hooked animals in Canadian waters. This project, which builds on previous work by Sasso and Epperly (2007), is being undertaken in collaboration with the US National Oceanic and Atmospheric Administration (NOAA).

Improving field observations

Over the past several years, DFO Science has worked with regional at-sea observer companies to develop and implement improved sea turtle handling and data collection protocols. Observer guidelines for documenting, measuring, and sampling sea turtles have been brought in line with best practices adopted by NOAA. Instructional booklets, data collection sheets, and specialized training sessions have been developed, and the necessary equipment has been provided. The expected outcome is field data that is higher in quantity and in quality.

Broad strategy 2: management and protection

Atlantic Canadian Loggerhead Turtle Conservation Action Plan

A Conservation Action Plan (CAP) for the Loggerhead Sea Turtle (DFO 2010b) was developed following the 2010 RPA for the species. The CAP recognized that steps can be taken immediately to address threats to Loggerhead Sea Turtles and reduce human-induced harm. Strategies include enhancing monitoring and data collection; international cooperation and capacity building; and mitigation of bycatch through the introduction of fishery management measures. Progress on these strategies is summarized throughout this section. Now that the species is listed under SARA, the CAP is being used as a foundation for recovery and action planning.

Sustainable Fisheries Framework

DFO's Sustainable Fisheries Framework provides the basis for ensuring Canadian fisheries are conducted in a manner that supports conservation and sustainable use. The Policy on Managing Bycatch (DFO 2013b) is one of the framework policies and seeks to minimize the risk of serious or irreversible harm to bycatch species caused by fishing activity. This policy is implemented through Integrated Fishery Management Plans (IFMPs). Incidental catch of Loggerhead Sea Turtles in the pelagic longline fishery is addressed in the Canadian Atlantic Swordfish and Other Tunas IFMP (DFO 2013a). The IFMP includes the following strategy: "Control unintended incidental mortality of leatherback and loggerhead turtles". The tactics proposed to implement this strategy include adherence to the Leatherback recovery strategy, adherence to the CAP, mandatory release, handling practices (for example, Code of Conduct for Responsible Sea Turtle Handling and Mitigative Measures [NSSA 2003], dehooking equipment, training), gear configuration (circle hooks, gangion length), and avoidance of areas where sea turtle capture rates are high. Some of these measures are currently mandated through fishing licence conditions described below.

Fishing licence conditions

In 2012, it became mandatory for the Atlantic Canadian pelagic longline fleet to use corrodible circle hooks, which have been shown to reduce the rate of bycatch and post-release mortality in Loggerhead Sea Turtles (for example, Watson et al. 2005).

When the Loggerhead Sea Turtle was listed under SARA in May 2017, the Atlantic Canadian Swordfish and Other Tunas pelagic longline fishery was authorized under section 74 of the Act to incidentally affect this species through fishing activity. This authorization was subject to several conditions of licence, including:

- completion and submission of a SARA monitoring document (logbook), where all interactions with Loggerhead Sea Turtles are to be recorded (including nil encounters)
- at least one crew member must hold a valid certificate in turtle disentanglement and dehooking
- dehooking/disentanglement equipment, with certain specifications, must be on board and accessible at all times
- removal of fishing gear from a hooked or entangled turtle in accordance with training protocols
- if a turtle cannot be brought aboard, the line must be cut as close to the hook as possible
- all incidentally captured turtles must be returned to the water in a manner causing the least harm

Area-based management measures

There are currently no area-based management measures established for the specific purpose of conserving Loggerhead Sea Turtles; however, the species may incidentally benefit from certain spatial measures that are in place for other purposes. For example, the known distribution of Loggerhead Sea Turtles in Canadian waters includes the Gully Marine Protected Area (DFO 2017b), which has a core area that is strictly protected (zone 1). Loggerhead Sea Turtles using this habitat area benefit from the elimination of threats such as bycatch. The Hell Hole, an offshore area northeast of Georges Bank, is closed seasonally to longline gear from July 1 to November 30; however, fisheries closures such as this one are not permanent and are subject to change. The Government of Canada achieved and surpassed its commitment to

conserve at least 10% of coastal and marine areas by 2020, as agreed to in 2010 as part of the UN Convention on Biological Diversity's Aichi Targets. The establishment of new protected areas in the future may contribute to the recovery of Loggerhead Sea Turtles.

Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment

The "Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment" (DFO 2007) specifies the mitigation requirements that must be met during the planning and conduct of marine seismic surveys. Marine turtles are included in the Statement; however, because these animals are more challenging to detect both visually and acoustically than cetaceans, the mitigation measures may be less effective for turtles (DFO 2004). Mitigations include but are not limited to the presence of dedicated marine mammal observers onboard, establishment and monitoring of a safety zone, ramp-up of the sound source, and immediate shut-down of operations if a marine mammal or sea turtle enters the safety zone.

Broad strategy 3: engagement, stewardship, and public outreach

Code of Conduct for Responsible Sea Turtle Handling and Mitigative Measures

In 2003, the Canadian pelagic longline fleet proactively developed and implemented a code of conduct for sea turtle handling (NSSA 2003) that was soon after added to their conservation harvesting plan (that is, a fishing plan submitted to DFO by each gear sector that identifies, among other things, harvesting methods that will minimize bycatch). Several elements in the Code of Conduct are now included in the fleet's licence conditions. The Code of Conduct includes recommendations on gear configuration, setting practices, hauling practices, avoidance of areas where sea turtle capture is high, and sea turtle handling, as well as the use of disentanglement/dehooking equipment, some of which was provided to active fleet members by the Nova Scotia Swordfishermen's Association (NSSA) in 2004.

Targeted engagement and research partnerships

The Canadian Sea Turtle Network (CSTN), a non-government organization, continues to work with the pelagic longline fleet to raise awareness about sea turtle conservation. They have hosted educational sessions in several Nova Scotia fishing communities and maintained regular contact with fleet members through meetings and phone calls to provide information on Loggerhead Sea Turtle biology and threats. In 2015, the CSTN collaborated with three pelagic longline captains who volunteered to deploy satellite tags on incidentally captured Loggerhead Sea Turtles. Data collected from these tags contributed to advancing the knowledge of Loggerhead Sea Turtle movements in Atlantic Canada. CSTN has also been working with pelagic longline fishermen to better understand the limitations of current bycatch mitigation measures with the goal of finding practical solutions. Collaborative relationships such as these continue to strengthen over time.

The pelagic longline fleet has been working in partnership with DFO to provide vessels of opportunity for science staff to deploy telemetry tags during fishing activities. In doing so, they have made a significant contribution to advancing the Loggerhead Sea Turtle research program in Canada. In addition, through this partnership, fishermen have learned more about the importance of sea turtles and how they are studied. Beginning in 2012, DFO provided training to

industry volunteers who have successfully sampled and tagged Loggerhead Sea Turtles in support of collaborative science projects.

Disentanglement and dehooking training

Since 2013, the CSTN has delivered sea turtle disentanglement and dehooking training to active pelagic longline licence holders and DFO Conservation and Protection officers. This training aligns with best practices adopted by NOAA.

Public outreach

DFO has developed public outreach materials, including stickers, bookmarks, species identification cards, and activity sheets, which feature the Loggerhead Sea Turtle. In addition, a life-size replica of a Loggerhead Sea Turtle is featured in a permanent exhibit at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. The display is part of free public tours offered during the summer. The CSTN provides information on the Loggerhead Sea Turtle at the Canadian Sea Turtle Centre, a free-of-charge educational space on the Halifax waterfront that is visited by approximately 10,000 people annually. The CSTN has other outreach and education initiatives specific to the fishing community and the general public.

Broad strategy 4: international collaboration

Research partnerships

DFO's Loggerhead Sea Turtle research program is conducted in close collaboration with NOAA, which shares its expertise and equipment to help facilitate collection of scientific information in Canadian waters.

Canada is a member of the International Working Group for the Conservation of the Northwest Atlantic Loggerhead Nesting Population, an expert working group that also includes representatives from The Bahamas, Cuba, Italy, Mexico, Morocco, Portugal (Azores), Spain, and the United States. The Working Group has convened three times since its inception in 2009 to enhance international cooperation on addressing threats to Loggerhead Sea Turtle nesting and marine habitats throughout the range of the Northwest Atlantic Ocean DPS.

International agreements

Canada has in the past participated in meetings of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), an agreement between 15 member countries in the western hemisphere. The IAC, which came into force in 2001, seeks to promote the multilateral coordination of sea turtle recovery efforts.

Regional fisheries management organizations

Canada participated in the Kobe Process, a joint initiative undertaken by five regional fisheries management organizations (RFMOs) that focus on tunas. Three joint meetings, as well as a series of technical workshops, were held between 2007 and 2011. One of the workshops was dedicated to the issue of bycatch across five taxa, including sea turtles, and resulted in a series of recommendations for the RFMOs.

In 2010, the International Commission for the Conservation of Atlantic Tunas (ICCAT), to which Canada is a contracting party, adopted a recommendation on the bycatch of sea turtles in ICCAT fisheries (ICCAT 2011). This recommendation was amended in 2013 to include more detailed items regarding safe turtle handling practices, the use of line cutters, and the use of de-hooking devices (ICCAT 2014). In 2011, a recommendation on information collection and harmonization of data on bycatch and discards in ICCAT fisheries was adopted (ICCAT 2012).

7.2 Strategic direction for recovery

Table 5 describes the broad strategies to address identified threats to the Loggerhead Sea Turtle and the research and management approaches needed to meet the objective identified in section 6. These strategies and approaches will help inform the development of specific recovery measures in one or more action plans.

Table 5. Recovery planning table. Unless otherwise specified, all approaches apply to Loggerhead Sea Turtles when they are in Atlantic Canadian waters.

General description of research and management approaches	Priority[3]	Broad strategy	Threat or concern addressed
1. Research and monitor Loggerhead Sea Turtle abundance, distribution, and movements, including as they relate to critical habitat identification (see table 6)	High	1	Knowledge gaps
2. Quantify the threat of fisheries-related harm and mortality to Loggerhead Sea Turtles	High	1	Bycatch, entanglement
3. Evaluate bycatch and entanglement prevention and mitigation methods, current and proposed	High	1	Bycatch, entanglement
4. Refine understanding of other non-fishery threats to Loggerhead Sea Turtles	Low	1	Underwater noise, marine pollution, vessel strikes, climate change
5. Ensure the protection and recovery of the Loggerhead Sea Turtle is considered in the management of all relevant ocean activities	High	2	All threats
6. Continue and adapt threat mitigation measures as new information becomes available (that is, keep current with global best practices)	High	2	All threats

[3] “Priority” reflects the degree to which the approach contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species:

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

General description of research and management approaches	Priority[3]	Broad strategy	Threat or concern addressed
7. Establish threat impact thresholds for Loggerhead Sea Turtles	Low	2	All threats
8. Work collaboratively with ocean users to develop and adopt effective threat mitigation measures for Loggerhead Sea Turtles	High	3	All threats
9. Continue and expand educational outreach to ocean users regarding Loggerhead Sea Turtles and their threats	Medium	3	All threats
10. Continue sharing data with international bodies such as the International Commission for the Conservation of Atlantic Tunas (ICCAT), and explore new opportunities to collaborate with other international bodies (for example, NAFO)	Low	4	All threats
11. Continue and develop new research partnerships with collaborators throughout the population's range	Medium	4	Knowledge gaps
12. Explore opportunities for collaboration through the Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles and other relevant international agreements or conventions	Low	4	Knowledge gaps, all threats

7.3 Narrative to support the recovery planning table

Broad strategy 1: research and monitoring

Relatively little is known about the abundance and distribution of Loggerhead Sea Turtles in Atlantic Canadian waters. To date, data collection has been mostly fishery-dependent and largely confined to particular areas of the shelf break and further offshore. Furthermore, unpredictable interannual fluctuations in Loggerhead Sea Turtle abundance and distribution, and variability in scientific sampling effort, have made it challenging to regularly sample this species in support of research. Continued and expanded survey and tagging efforts are required and could include innovative techniques, such as using new or emerging technologies. The efficiency and feasibility of dedicated vessel and aerial-based surveys could be further explored. Capacity for rapid and flexible response time will be key to maximizing probability of success. In the short term, opportunistic research platforms will be sought and used wherever possible to sample Loggerhead Sea Turtles. A short-term objective of the research program is to reduce temporal and spatial biases in the dataset. Developing and enhancing partnerships with ocean users may help build further monitoring capacity.

Long-term abundance monitoring may help determine approximately what proportion of the population typically visits Atlantic Canadian waters and to what degree it varies each year. Monitoring trends in Loggerhead Sea Turtle abundance and distribution will allow for anomalies or shifts to be recognized and addressed when required. For example, climate change could alter thermal habitat availability in Atlantic Canadian waters or shift prey species assemblages such that more Loggerhead Sea Turtles forage further north.

Determining the movements of Loggerhead Sea Turtles into and out of Atlantic Canadian waters is important for understanding how this habitat is being used by the population. It is currently unknown if the same turtles reoccur in Atlantic Canadian waters over multiple years and whether there is any predictability in their movement patterns. Because the juvenile turtles in Atlantic Canadian waters are typically large, it is possible that many recruit into neritic habitat at lower latitudes. The role of Atlantic Canadian habitat in the life cycle of the population needs to be determined.

Determining the variables (that is, habitat correlates, such as prey) that explain interannual variability will help direct survey effort. An understanding of temporal and spatial Loggerhead Sea Turtle distribution patterns is necessary to identify the areas of greatest threat risk, which in turn will guide appropriate management responses. In addition to knowing where the turtles are in time and space, work must be done to better understand the threats themselves. For example, overcoming challenges with obtaining precise estimates of Loggerhead Sea Turtle bycatch (for example, DFO 2011; 2016) is a high priority given that bycatch is the threat of greatest concern in Atlantic Canadian waters (table 4). Similarly, research into potential fishing gear modifications (for example, set time, bait type) to further reduce the likelihood of turtle interactions and minimize harm or mortality could be undertaken (for example, Moth-Poulsen 2004; Afonso et al. 2011). Other threat-related research could include acoustic monitoring of Loggerhead Sea Turtle habitat to determine ambient and anthropogenic noise levels or assessing the density and composition of marine debris in convergence zones to determine the risk of entanglement or ingestion. It will take time to establish methods to reliably and robustly quantify all identified threats to Loggerhead Sea Turtles throughout their range.

Broad strategy 2: management and protection

The Loggerhead Sea Turtle will be considered in regulatory and management decision-making through a variety of mechanisms, including project reviews, fisheries management actions, and area-based management taken under the *Fisheries Act*, SARA permitting, the *Oceans Act* (that is, marine protected area planning), and environmental assessments. Coordination and information-sharing within and across relevant government departments will be necessary.

Best practices in threat mitigation are continuously evolving as more is learned about Loggerhead Sea Turtles and how they are impacted by human activities. To ensure harm and mortality of Loggerhead Sea Turtles in Atlantic Canadian waters is avoided to the full extent possible, developments in global best practices will be monitored, evaluated, and adopted as appropriate.

Once more is known, threat impact thresholds will be set for Loggerhead Sea Turtles in Atlantic Canadian waters (that is, harm or mortality levels that, if exceeded, would compromise the recovery of the larger population). It is expected that it will be many years before the information needed to establish these thresholds is available, due to logistical challenges with research and uncertainties about threats.

Broad strategy 3: engagement, stewardship, and public outreach

Recovery of the Loggerhead Sea Turtle will benefit from collaborative partnerships and knowledge sharing (for example, Indigenous Traditional Knowledge, Local Ecological Knowledge, industry knowledge). Ocean users have unique expertise that can contribute to finding effective and economically feasible measures to reduce risk to Loggerhead Sea Turtles and collect valuable data on this species and its habitat. Increased awareness through training

and educational products is also necessary, particularly for sectors that have not been engaged previously.

Broad strategy 4: international collaboration

As a highly migratory species, Loggerhead Sea Turtles span multiple jurisdictions. International collaboration and cooperation is required to achieve recovery of the Northwest Atlantic Ocean DPS, and may occur through research partnerships or formal conventions and other agreements. Transboundary ecosystem factors influencing Loggerhead Sea Turtle distribution should be investigated.

Although Canada has in the past participated in meetings of the IAC, it has not formally joined the IAC. Canada will, however, explore how it might collaborate with the IAC on their initiatives in the future.

8. Critical habitat

Critical habitat is defined in subsection 2(1) of 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) of 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."

8.1 Identification of the species' critical habitat

For the Loggerhead Sea Turtle, the identification of critical habitat is not possible at this time because of the limited information currently available.

8.2 Schedule of studies to identify critical habitat

Further research is required to identify the critical habitat necessary to support the recovery objective for the Loggerhead Sea Turtle. This additional work includes the studies outlined in table 6. Due to the predominantly offshore and variable distribution of Loggerhead Sea Turtles in Atlantic Canadian waters, it is challenging to study this species. As such, it is expected that completion of the schedule of studies could take longer than five years. Progress will be evaluated in the first report on recovery strategy implementation in 2023.

Table 6. Schedule of studies to identify critical habitat

Description of study	Rationale	Timeline
Determine the temporal and spatial distribution of Loggerhead Sea Turtles in Atlantic Canadian waters.	Understanding the distribution of Loggerhead Sea Turtles in Atlantic Canadian waters is the first step in identifying critical habitat. Refer to section 7.3 for further explanation.	2025+
Determine Loggerhead Sea Turtle habitat preferences, including biological (for example, prey abundance, preferred prey, or prey diversity) and physical (oceanographic) drivers.	This information is needed to identify the functions, features, and attributes of Loggerhead Sea Turtle habitat in Atlantic Canadian waters.	2025+
Monitor Loggerhead Sea Turtle movements (latitudinal, longitudinal, and depth).	Little is known about the migratory routes of Loggerhead Sea Turtles into and out of Atlantic Canadian waters, nor is much known about their movements while in Atlantic Canadian waters. These studies will help identify any patterns in habitat use or migratory bottlenecks if they exist.	2025+

9. Measuring progress

The performance indicators presented below provide a way to define and measure progress toward achieving the recovery objective outlined in section 6.

Overarching progress measure: human-induced harm and mortality rates in Atlantic Canadian waters are not exceeding levels that impede the recovery of the Northwest Atlantic Ocean DPS of Loggerhead Sea Turtles.

Interim progress measure #1: effective mitigation measures[4] have been applied and adapted as new information becomes available.

Interim progress measure #2: a system for obtaining reliable, consistent, and precise estimates of sea turtle bycatch in Atlantic Canadian fisheries has been established.

Interim progress measure #3: non-fishery threats in Atlantic Canadian waters are better understood and quantified.

Interim progress measure #4: threat impact thresholds are established for human activities affecting Loggerhead Sea Turtles in Atlantic Canadian waters.

[4] That is, resulting in a measureable reduction in the impact of a threat (for example, harm, mortality) over time; or, in the absence of a threat reduction metric, measures taken based on best practices

10. Statement on action plans

The federal government's approach to recovery planning is in two parts, the first being the recovery strategy and the second being the action plan. An action plan contains specific recovery measures or activities required to meet the objectives outlined in the recovery strategy.

An action plan for the Loggerhead Sea Turtle will be completed within three years of posting the final recovery strategy.

References

Afonso, A.S., F.H.V. Hazin, F. Carvalho, J.C. Pacheco, H. Hazin, D.W. Kerstetter, D. Murie, G.H. Burgess. 2011. Fishing gear modifications to reduce elasmobranch mortality in pelagic and bottom longline fisheries off Northeast Brazil. Fisheries Research 108: 336-343.

Avens, L., L.R. Goshe, L. Coggins, M.L. Snover, M. Pajuelo, K.A. Bjorndal, and A.B. Bolten. 2015. Age and size at maturation- and adult-stage duration for loggerhead sea turtles in the western North Atlantic. Marine Biology 162: 1749-1767.

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. pp. 387-429. *In* Shomura, R.S., and H.O. Yoshida (eds.). Proceedings of the Workshop on the Fate and Impact of Marine Debris, 26-29 November 1984, Honolulu, Hawaii. NOAA Technical Memorandum NMFS/SWFC-54.

Bjorndal, K.A. 2003. Roles of loggerhead sea turtles in marine ecosystems. pp.235-254. *In* A.B. Bolten and B.E. Witherington (eds.). Loggerhead Sea Turtles, Smithsonian Institution Press, Washington, D.C. 319 pp.

Bolten, A.B. 2003. Active swimmers – passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. pp.63-78. *In* A.B. Bolten and B.E. Witherington (eds.). Loggerhead Sea Turtles, Smithsonian Institution Press, Washington, D.C. 319 pp.

Braun-McNeill, J., C.R. Sasso, S.P. Epperly, and C. Rivero. 2008. Feasibility of using sea surface temperature imagery to mitigate cheloniid sea turtle-fishery interactions off the coast of northeastern USA. Endangered Species Research 5: 257-266.

Brazner, J.C., and J. McMillan. 2008. Loggerhead sea turtle (*Caretta caretta*) bycatch in Canadian pelagic longline fisheries: Relative importance in the western North Atlantic and opportunities for mitigation. Fisheries Research 91:310-324.

Canada-Nova Scotia Offshore Petroleum Board (CNSOPB). 2018. Lands management. [accessed January 2018].

Camedda, A., S. Marra, M. Matiddi, G. Massaro, S. Coppa, A. Perilli, A. Ruiu, P. Briguglio, G.A. de Lucia. 2014. Interaction between loggerhead sea turtles (*Caretta caretta*) and marine litter in Sardinia (Western Mediterranean Sea). Marine Environmental Research 100: 25-32.

Carruthers, E.H., and B. Neis. 2011. Bycatch mitigation in context: Using qualitative interview data to improve assessment and mitigation in a data-rich fishery. Biological Conservation 144: 2289–2299.

Carthy, R.R., A.M. Foley, and Y. Matsuzawa. 2003. Incubation environment of Loggerhead Turtle nests: effects on hatching success and hatchling characteristics. pp. 144-153. *In* A.B. Bolten and B.E. Witherington (eds.). Loggerhead Sea Turtles, Smithsonian Institution Press, Washington, D.C. 319 pp.

Ceriani, S.A., and A.B. Meylan. 2015. *Caretta caretta* (North West Atlantic subpopulation). The IUCN Red List of Threatened Species. [accessed November 2017].

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. *Endangered Species Act*. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010. COSEWIC assessment and status report on the Loggerhead Sea Turtle *Caretta caretta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 75 pp.

COSEWIC. 2018. Guidelines for recognizing designated units. [accessed August 2017].

DeRuiter, S., and K. Larbi Doukara. 2012. Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research 16: 55–63.

Dodd, C.K. 1988. Synopsis of the biological data on the Loggerhead Sea Turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14): viii + 110 pp.

DFO. 2004. Review of scientific information on impacts of seismic sound on fish, invertebrates, marine turtles and marine mammals. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/002.

DFO. 2007. Statement of Canadian practice with respect to the mitigation of seismic sound in the marine environment. Fisheries and Oceans Canada. 5 pp.

DFO. 2010a. Recovery potential assessment for Loggerhead Sea Turtles (*Caretta caretta*) in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/042. 11 pp.

DFO. 2010b. Atlantic Canadian Loggerhead Turtle conservation action plan. [accessed June 2018].

DFO. 2011. Considerations for the estimation of incidental catch in the eastern Canadian swordfish/other tunas longline fishery. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/057. 11 pp.

DFO. 2013a. Canadian Atlantic Swordfish and other tunas integrated fisheries management plan. 112 pp.

DFO. 2013b. Policy for managing bycatch, Sustainable Fisheries Framework. Accessed February 16, 2016.

DFO. 2014. Guidance on assessing threats, ecological risk and ecological impacts for species at risk. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/013. 21 pp. (*Erratum: June 2016*)

DFO. 2016. Proceedings of the Regional Science Peer Review Assessment of Incidental Catch in the Atlantic Canadian Swordfish/Other Tuna Longline Fishery; February 24-25, 2016. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2016/054.

DFO. 2017a. Threat assessment for loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic population. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/014. 33 pp.

DFO. 2017b. The Gully marine protected area management plan. Oceans and Coastal Management Division, Fisheries and Oceans Canada, Dartmouth, NS. 65 pp.

Dow Piniak W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the Leatherback Sea Turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35pp.

FFWCC (Florida Fish and Wildlife Conservation Commission). 2017. Index nesting beach survey totals (1989-2016). [accessed August 2017].

Finlayson, K.A., F.D.L. Leusch, and J.P. van de Merwe. 2016. The current state and future directions of marine turtle toxicology research. Environment International 94: 113-123.

Government of Canada. 2009. *Species at Risk Act* Policies [Draft]. Species at Risk Act, Policies and Guidelines Series. Ottawa, Ontario. Environment Canada. 48 pp.

Halpin, L.R., J.A. Seminoff, and G.F. Hanke. 2018. First photographic evidence of a loggerhead sea turtle (*Caretta caretta*) in British Columbia. Northwestern Naturalist 99: 73-75.

Hanke, A.R., I. Andrushchenko, and G. Croft. 2012. Observer coverage of the Atlantic Canadian swordfish and other tuna longline fishery: an assessment of current practices and alternative methods. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/049. iii + 84 p.

Harris, L.E., W.E. Gross, R.K. Smedbol, and L.H. Bondt. 2010. Loggerhead Sea Turtles (*Caretta caretta*) in Atlantic Canada: Biology, status, recovery potential, and measures for mitigation. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/089: viii + 36 p.

ICCAT (International Commission for the Conservation of Atlantic Tunas). 2011. Report for biennial period, 2010-2011, Part I (2010) – Vol. 1. Madrid, Spain. ii + 391 pp.

ICCAT. 2012. Report for biennial period, 2010-2011, Part II (2011) – Vol. 1. Madrid, Spain. iii + 481 pp.

ICCAT. 2014. Report for biennial period, 2012-2013, Part II (2013) – Vol. 1. Madrid, Spain. iii + 451 pp.

Kamezaki, N. 2003. What is a loggerhead sea turtle? The morphological perspective. pp. 28-43. *In* A.B. Bolten and B.E. Witherington (eds.). Loggerhead Sea Turtles, Smithsonian Institution Press, Washington, D.C. 319 pp.

LaCasella, E.L., S.P. Epperly, M.P Jensen, L. Stokes, and P.H. Dutton. 2013. Genetic stock composition of loggerhead turtles *Caretta caretta* bycaught in the pelagic waters of the North Atlantic. Endangered Species Research 22: 73-84.

Lavender, A.L., S.M. Bartol, and I.K Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in Loggerhead Sea Turtles (*Caretta caretta*) using a dual testing approach. The Journal of Experimental Biology 217: 2580-2589.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7: 221-231.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival. pp. 387-409. *In* P.L. Lutz and J.A. Musick (eds.). The Biology of Sea Turtles, CRC Press, Boca Raton, FL.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. The Journal of Experimental Biology 215(17): 3001-3009.

McCauley, S.J., and K.A. Bjorndal. 1999. Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling Loggerhead Sea Turtles. Conservation Biology 13(4): 925-929.

Moth-Poulsen, T. 2004.Update on recent modifications of fishing gear and fishing procedures to reduce bycatch of sea turtles in longline fishery. Food and Agriculture Organization of the United Nations. TC:STCF/2004/DMA.2.

Neilson, J.D., S.D. Busawon, I.V. Andrushchenko, S.E. Campana, E.H. Carruthers, L.E. Harris, and M. Stokesbury. 2012. A review of approaches to assess survival of released catch from Canadian large pelagic longline fisheries. DFO. Can. Sci. Advis. Sec. Res. Doc. 2011/091: iv + 33 p.

Nelms, S.E., E.M. Duncan, A.C. Broderick, T.S. Galloway, M.H. Godfrey, M. Hamann, P.K. Lindeque, and B.J. Godley. 2016. Plastic and marine turtles: a review and call for research. ICES Journal of Marine Science 73(2): 165–181.

Nicolau, L., A. Marçalo, M. Ferreira, S. Sá, J. Vingada, and C. Eira. 2016. Ingestion of marine litter by loggerhead sea turtles, *Caretta caretta*, in Portuguese continental waters. Marine Pollution Bulletin 103:179-185.

NMFS and USFWS (National Marine Fisheries Service and U.S. Fish and Wildlife Service). 2008. National Marine Fisheries Service and U.S. Fish and Wildlife Service. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 2011. Endangered and threatened species; determination of nine distinct population segments of loggerhead sea turtles as endangered or threatened. Final Rule. Federal Register 76(184): 58868-58952, September 22, 2011.

NSSA (Nova Scotia Swordfishermen's Association). 2003. Code of conduct for responsible sea turtle handling and mitigative measures. 11 pp.

Paul, S.D., A. Hanke, S.C. Smith, and J.D. Neilson. 2010. An examination of Loggerhead Sea Turtle (*Caretta caretta*) encounters in the Canadian swordfish and tuna longline fishery. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/088: vi + 32 p.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, W.N. Tavolga. 2014. ASA S3/SC1.4 TR-2014 Sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-accredited standards committee S3/SC1 and registered with ANSI. SpringerBriefs in Oceanography, DOI 10.1007/978-3-319-06659-2.

Richards, P.M., S.P. Epperly, S.S. Heppell, R.T. King, C.R. Sasso, F. Moncada, G. Nodarse, D.J. Shaver, Y. Medina, and J. Zurita. 2011. Sea turtle population estimates incorporating uncertainty: a new approach applied to western North Atlantic loggerheads *Caretta caretta*. Endangered Species Research 15: 151-158.

Ryder, C.E., T.A. Conant, and B.A. Schroeder. 2006. Report of the workshop on marine turtle longline post-interaction mortality. NOAA Technical Memorandum NMFS-F/OPR-29. 36 pp.

Sasso, C.R., and S.P. Epperly. 2007. Survival of pelagic juvenile loggerhead turtles in the open ocean. The Journal of Wildlife Management 71(6): 1830-1835.

Shackell, N., and J. Loder. 2012. Climate change and its effects on ecosystems, habitats and biota. pp. 142-163. *In* M. MacLean, H. Breeze, J. Walmsley, and J. Corkum (eds.). State of the Scotian Shelf report. Can. Tech. Rep. Fish. Aquat. Sci. 3074: xvi + 352 pp.

Swimmer, Y., and E. Gilman. 2012. Report of the sea turtle longline fishery post-release mortality workshop, November 15-16, 2011. NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-34. 31 pp.

TEWG (Turtle Expert Working Group). 2009. An assessment of the loggerhead turtle population in the Western North Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-575. xii + 131 pp.

Tucker, A.D. 2010. Nest site fidelity and clutch frequency of loggerhead turtles are better elucidated by satellite telemetry than by nocturnal tagging efforts: Implications for stock estimation. Journal of Experimental Marine Biology and Ecology 383: 48-55.

Tyson, R.B., W. Dow Piniak, C. Domit. 2017. Novel bio-logging tool for studying fine-scale behaviors of marine turtles in response to sound. Frontiers in Marine Science 4 (Article 219): 1-11.

Watson, J.W., S.P. Epperly, A.K. Shah, and D.G. Foster. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Canadian Journal of Fisheries and Aquatic Sciences 62: 965-981.

Witherington, B., P. Kubilis, B. Brost, and A. Meylan. 2009. Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19(1): 30-54.

Witt, M.J., L.A. Hawkes, M.H. Godfrey, B.J. Godley, and A.C. Broderick. 2010. Predicting the impacts of climate change on a globally distributed species: the case of the loggerhead turtle. The Journal of Experimental Biology 213: 901–911.

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 strategy itself, but are also summarized below.

The potential for this recovery strategy to inadvertently lead to adverse effects on other species or the environment was considered. Such adverse effects are not anticipated. In the event that new fishing gear configurations are adopted to further minimize interactions with Loggerhead Sea Turtles, it is possible that the bycatch of other species could also be affected. Bycatch will be monitored to determine whether the rates of incidental capture of another species increase as a result of measures taken to benefit Loggerhead Sea Turtles. Implementation of this recovery strategy is expected to benefit other species that share similar threats and habitat, including the Leatherback Sea Turtle, which is listed as endangered under the *Species at Risk Act.* It is also 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

Recovery strategies are to be prepared in cooperation and consultation with other jurisdictions, organizations, affected parties and others as outlined in SARA section 39. DFO hosted an early engagement workshop at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia on September 26, 2017. The purpose of the workshop was to collaborate on setting the recovery direction for the Loggerhead Sea Turtle and provide a forum for sharing ideas on potential research and management approaches to achieve recovery. Input from this workshop has been considered in the development of this recovery strategy. Invitations to attend the workshop were extended to government departments, First Nations and other Indigenous organizations, industry, and non-government organizations. Workshop participants included representatives from the following groups:

Canada-Newfoundland and Labrador Offshore Petroleum Board
Canada-Nova Scotia Offshore Petroleum Board
Canadian Sea Turtle Network
Canadian Wildlife Federation
Ecology Action Centre
Florida Fish and Wildlife Conservation Commission
Newfoundland and Labrador Department of Fisheries and Land Resources
Maliseet Nation Conservation Council
Maritime Aboriginal Peoples Council
Mi'gmawe'l Tplu'taqnn Incorporated
Mi’kmaw Conservation Group
National Oceanic and Atmospheric Administration
Nova Scotia Swordfishermen’s Association
Woodstock First Nation

A draft version of the recovery strategy was sent to relevant government departments (federal, provincial, and international), Indigenous organizations, and stakeholders for a targeted external review period held from August to October 2018. Feedback from this external review period was considered and incorporated into the proposed recovery strategy where appropriate.

The proposed recovery strategy was posted on the Species at Risk Public Registry for a 60-day public comment period beginning July 2, 2020. The comments received were considered in the development of the final version of the document.

Appendix C: threat assessment categories (DFO 2014)

Likelihood of occurrence	Definition
Known or very likely to occur	This threat has been recorded to occur 91 to 100%.
Likely to occur	There is 51 to 90% chance that this threat is or will be occurring.
Unlikely	There is 11 to 50% chance that this threat is or will be occurring
Remote	There is 1 to 10% or less chance that this threat is or will be occurring.
Unknown	There are no data or prior knowledge of this threat occurring now or in the future.

Level of impact	Definition
Extreme	Severe population decline (for example, 71 to 100%) with the potential for extirpation.
High	Substantial loss of population (31 to 70%) or Threat would jeopardize the survival or recovery of the population.
Medium	Moderate loss of population (11 to 30%) or Threat is likely to jeopardize the survival or recovery of the population.
Low	Little change in population (1 to 10%) or Threat is unlikely to jeopardize the survival or recovery of the population.
Unknown	No prior knowledge, literature or data to guide the assessment of threat severity on population.

Causal certainty	Definition
Very high	Very strong evidence that threat is occurring and the magnitude of the impact to the population can be quantified.
High	Substantial evidence of a causal link between threat and population decline or jeopardy to survival or recovery.
Medium	There is some evidence linking the threat to population decline or jeopardy to survival or recovery.
Low	There is a theoretical link with limited evidence that threat is leading to a population decline or jeopardy to survival or recovery.
Very low	There is a plausible link with no evidence that the threat is leading to a population decline or jeopardy to survival or recovery.

Threat occurrence	Definition
Historical	A threat that is known to have occurred in the past and negatively impacted the population.
Current	A threat that is ongoing, and is currently negatively impacting the population.
Anticipatory	A threat that is anticipated to occur in the future, and will negatively impact the population.

Threat frequency	Definition
Single	The threat occurs once.
Recurrent	The threat occurs periodically, or repeatedly.
Continuous	The threat occurs without interruption.

Threat extent	Definition
Extensive	71 to 100% of the population is affected by the threat.
Broad	31 to 70% of the population is affected by the threat.
Narrow	11 to 30% of the population is affected by the threat.
Restricted	1 to 10% of the population is affected by the threat.

Likelihood of occurrence: refers to the probability of a specific threat occurring for a given population over 10 years or 3 generations, whichever is shorter.

Level of impact: refers to the magnitude of the impact caused by a given threat, and the level to which it affects the survival or recovery of the population.

Causal certainty: reflects the strength of evidence linking the threat to the survival and recovery of the population. Evidence can be scientific, traditional ecological knowledge or local knowledge.

Threat occurrence: refers to the timing of the occurrence of the threat and describes whether a threat is historical, current and/or anticipatory for a given population.

Threat frequency: refers to the temporal extent of a given threat over the next 10 years or 3 generations, whichever is shorter.

Threat extent: refers to the proportion of the population affected by a given threat.