RECOVERY POTENTIAL ASSESSMENT FOR LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN ATLANTIC CANADA

Photo: Sean Smith

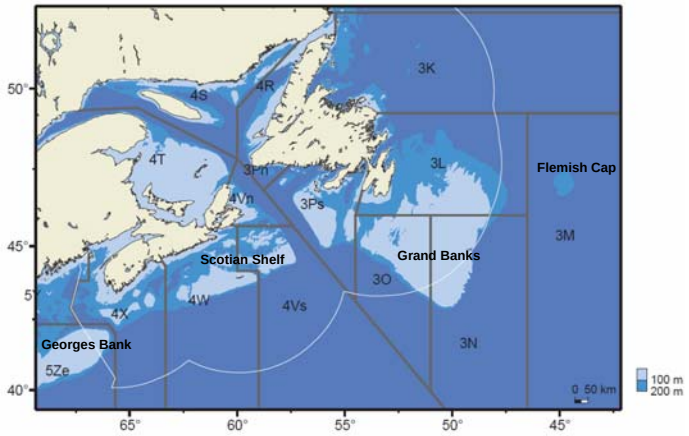

Figure 1: Area of occurrence of loggerhead sea turtles in Atlantic Canada. Grey lines delimit North Atlantic Fisheries Organization (NAFO) divisions and white line delimits the Exclusive Economic Zone (EEZ).

Context:

Loggerhead sea turtles (Caretta caretta) in Atlantic Canada occur in offshore waters from Georges Bank to the Flemish Cap. Most of their life is spent at sea; however, mature females return to land to nest. No nesting occurs within Canada. Although available data are limited, most loggerhead sea turtles in Atlantic Canadian waters are thought to be oceanic/neritic juveniles whose genetic origins are likely the nesting beaches in the Northwest Atlantic.

In April, 2010, the loggerhead sea turtle was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This recovery potential assessment (RPA) will inform the Species at Risk Act (SARA) listing decision by the federal Governor in Council (GIC), socio-economic analyses, and consultations with the public. Should the loggerhead sea turtle be listed as threatened or endangered under SARA, the RPA will also inform the recovery strategy.

In anticipation of the COSEWIC assessment of the loggerhead sea turtle, originally scheduled for May 2006, an RPA was initiated by Fisheries and Oceans Canada in 2006; however, neither the RPA nor the COSEWIC assessment were completed. A second RPA was undertaken 16-17 February 2010, to provide information and advice on current loggerhead sea turtle population status and trends, the impact of human activities on the species, possible management measures to mitigate these impacts, and the potential for recovery in anticipation of COSEWIC's scheduled assessment in April 2010. This Science Advisory Report is the product of that RPA.

SUMMARY

- There are currently no estimates of loggerhead sea turtle abundance in Atlantic Canadian waters. A paucity of data precludes estimation of the overall Northwest Atlantic population abundance in oceanic habitat. However, because females exhibit nesting site fidelity, trends in nests can be used as a proxy for trends in mature female abundance. The total estimated number of nests on Northwest Atlantic nesting beaches has fluctuated between 47,000 and 90,000 nests per year over the last decade. There appears to have been a decline in the number of nests since 1998, notably in the largest breeding unit in the Atlantic (Peninsular Florida).
- The estimated range of loggerhead sea turtles in Atlantic Canadian waters extends from Georges Bank, along the edge of the Scotian Shelf and Grand Banks, to the limits of the Exclusive Economic Zone, with occasional forays into waters on the shelf.
- Atlantic Canadian loggerhead sea turtle habitat appears to be defined geographically and temporally, in part, by sea surface temperature. They are encountered in waters greater than 15°C, especially between 20-25°C, favouring a distribution in thermally dynamic waters along the shelf break and offshore. The primary use of habitat in Atlantic Canadian waters is thought to be for foraging.
- In the absence of population indices in Canada, a recovery target for abundance could not be established at this time. A reasonable recovery target for abundance would be an increase in population size over three generations. A practical management strategy (secondary target) could be to ensure that human-induced harm and mortality rates due to Canadian activities do not exceed levels that would impede population recovery (and be kept at or below current levels until the levels that would not impede population recovery are determined). A reasonable recovery target for distribution would be to maintain current distribution, as there has been no evidence that loggerhead sea turtle distribution has been reduced.
- The only documented source of human-induced harm or mortality of loggerhead sea turtles, considered to be primarily oceanic and neritic juveniles (see sources of uncertainty), in Canadian waters is the Canadian tuna and swordfish longline fishery. Based on a ratio estimation model, there were an estimated 1,200 loggerhead sea turtles (95% confidence range of 700-1,800) caught annually in Canadian tuna and swordfish longline fisheries between 2002-2008. Assuming that post-hooking mortality ranges between 20-45%, this would result in roughly 200-500 deaths of oceanic/neritic juveniles annually from this fishery.
- In the USA Recovery Plan, mortalities of oceanic and neritic juvenile loggerhead sea turtles in the Northwestern Atlantic from all sources (primarily fisheries by-catch, but including vessel strikes, dredging activities, entanglement, and oil pollution) were estimated to be in the order of roughly 10,000-100,000 oceanic juvenile turtles and roughly 14,000-140,000 neritic juvenile turtles annually over the last decade.
- Potential mitigation measures and alternatives to minimize the threat posed by the tuna and swordfish longline fishery have been identified (e.g., hook type and size, set time, bait type). Further study is required to evaluate their effectiveness.
- Published population modeling studies suggest that the Northwest Atlantic loggerhead sea turtle population is likely to continue to decline given current estimates of population growth rates and the effects of human-induced mortality. However, these studies also indicate scope for recovery if total mortality is reduced.
- Reduction or elimination of mortality in Canadian waters alone is highly unlikely to be sufficient to achieve recovery. In addition to minimizing threats to loggerhead sea turtles in Canadian waters, international cooperation to reduce threats to the population as a whole is needed to achieve recovery of this species.

BACKGROUND

Rationale for Assessment

In anticipation of COSEWIC's intention to assess the loggerhead sea turtle (*Caretta caretta*) in May 2006, Fisheries and Oceans Canada Maritimes Region initiated an RPA for the species (DFO 2006). However, COSEWIC did not proceed with its assessment as scheduled, and the recovery potential assessment (RPA) was not completed. In April 2010, the loggerhead sea turtle was assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This RPA will inform the Species at Risk Act (SARA) listing decision by the federal Governor in Council (GIC), socio-economic analyses, and consultations with the public. Should the loggerhead sea turtle be listed as threatened or endangered under SARA, the RPA will also inform the recovery strategy.

The Species at Risk Act (SARA) is intended to protect species at risk of extinction in Canada and promote their recovery. SARA includes prohibitions on killing, harming, harassing, capturing or taking individuals of species listed as threatened or endangered on Schedule 1. SARA prohibits sale or trade of individuals of such species (or their parts), damage or destruction of their residences, or destruction of their critical habitat. SARA also specifies that a recovery strategy must be prepared for species that are listed as threatened or endangered. The provisions of these recovery strategies will have to address all potential sources of harm, including harvesting activities, so that the survival and recovery of the populations concerned are not jeopardized.

Section 73 (2) of the SARA provides the competent Ministers with the authority to permit normally prohibited activities affecting a listed species, its critical habitat, or its residence, even when they are not part of a previously approved recovery plan. Such activities can only be approved if: 1) there is scientific research relating to the conservation of the species and conducted by qualified persons; 2) they will benefit the species or are required to enhance its chance of survival in the wild; or 3) affecting the species is incidental to carrying them out.

The decision to permit allowable harm must consider the species' current situation and its recovery potential, the impacts of human activities on the species and its ability to recover, as well as alternatives and measures to reduce these impacts to a level that will not jeopardize the survival and recovery of the species. Therefore, an RPA process was established by DFO Science in order to provide the information and scientific advice required to meet these various requirements. In the case of a species that has not yet been added to Schedule 1, such as loggerhead sea turtle, the scientific information also could contribute to the decision as to whether or not to add the species to the list. Consequently, the information is used when analyzing the socio-economic impacts of adding the species to the list as well as during subsequent consultations, where applicable.

Species Biology and Ecology

The loggerhead sea turtle can be recognized by its relatively large head and beak, likely adaptations for feeding on hard-shelled organisms such as crustaceans and molluscs. Its reddish-brown carapace usually has five pairs of costal scutes with the first touching the nuchal scute. The plastron is tan to yellow with dark margins. Mature males can be distinguished from mature females by a longer tail and an enlarged curved claw on both forelimbs. The mean size of first-time nesting females in the Northwest Atlantic is 91cm straight carapace length (SCL) with 113kg body weight. During the Central North Atlantic Bluefin Tuna survey (2001-2002) in

international waters off eastern Canada, 25 captured loggerhead sea turtles ranged in size from 42 to 69cm SCL, with a mean length of 53cm. Turtles caught in international waters east of the Grand Banks (Northeast Distant Statistical reporting area, NED) in USA experimental and commercial fisheries had a similar size distribution ranging from 32.4 to 72cm SCL with a mean of 56.6cm. Individuals caught in the Northeast Coastal statistical reporting area (NEC) fishery ranged in size from 47.8 to 74.9cm SCL and had a mean of 63cm. The range of sizes and geographic distribution suggest that they are mainly oceanic/neritic juveniles. However, all of these results may have been influenced by the type of gear used (longline), which tend to select for larger individuals. Fourteen individuals dip-netted in the NED ranged from 18 to 60cm SCL with a mean of 44.9cm.

Loggerhead sea turtles in the western Atlantic range from Newfoundland to Argentina. In Canada, they are associated with the warm waters of the Gulf Stream off the edge of the continental shelf. Juveniles have been sighted or caught as by-catch from Georges Bank, along the edge of the Scotian Shelf and the Grand Banks and further offshore to areas beyond our Exclusive Economic Zone (EEZ). There are few records of loggerhead sea turtles in the coastal waters of Atlantic Canada. When they occur on the shelf, they are thought to be associated with ephemeral oceanographic features such as warm core rings (e.g., from the Gulf Stream) moving onto the shelf. Loggerhead sea turtle by-catch rates are highest in the summer and fall, when the species is believed to be most abundant in Atlantic Canadian waters.

Loggerhead sea turtles have both terrestrial and aquatic life stages. Most of their life is spent at sea. However, mature females return to land to nest. Males do not return to land. Female loggerhead sea turtles reach sexual maturity around 30 years of age (range of 14 to 42). At intervals of 6 to 21 days, females dig 2 to 8 nests in sandy beaches and in them lay 89 to 125 eggs per nest. No nesting occurs within Canada. The eggs incubate for approximately 2 months. The hatchlings emerge from their nests en masse and head straight to the water, where they begin a constant frenzied swimming period lasting one to several days, which takes the hatchlings to offshore currents. They eventually become entrained in the North Atlantic Gyre soon after leaving the nesting beach. Juvenile turtles are transported to oceanic foraging areas far from their natal beaches on both sides of the North Atlantic. They are opportunistic carnivores and forage epipelagically. Between the ages of 10 to 28 years, many oceanic juveniles migrate to the neritic zone and transition to a bottom-feeding subadult stage, where they remain for more than a decade before reaching maturity. Loggerhead sea turtles may switch between oceanic and neritic feeding strategies.

Mature female loggerhead sea turtles return to the vicinity of their natal beach for nesting. As a result, nesting turtles have strong population structure. However, genetic studies conducted to date show no population structure in the oceanic stage juveniles. These mixed stocks are composed of cohorts from regional nesting colonies in the approximate proportion to the size of the nesting populations. While the vast majority of loggerhead sea turtles near Atlantic Canadian waters originate from nesting beaches in the Northwest Atlantic, the potential presence of Northeast Atlantic individuals (e.g., from Cape Verde) in the population cannot be excluded.

ASSESSMENT

Current Status and Trends

There are currently no estimates of loggerhead sea turtle **abundance** in Atlantic Canadian waters. Data on turtles in Canadian waters are limited to opportunistic sightings information, fisheries by-catch, strandings, and limited survey information. At present, a paucity of data

precludes estimation of the overall Northwest Atlantic loggerhead sea turtle population abundance in oceanic habitat.

Since females exhibit nesting site fidelity, trends in nests can be used as a proxy for trends in mature female abundance and represent the best available index of population abundance for loggerhead sea turtles at this time. Estimates of the total number of nests on Northwest Atlantic nesting beaches have fluctuated between 47,000 and 90,000 nests per year over the last decade. Five recovery units have been identified in the USA Recovery Plan for the Northwest Atlantic population of loggerhead sea turtles: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean. The average number of nests in each, as well as the average trend in the number of nests, is provided in Table 1. In general, there appears to have been a decline in the number of nests in many of the recovery units since 1998, notably in the largest breeding unit in the Atlantic (Peninsular Florida). However, an important caveat is the brevity of the nesting survey time series relative to loggerhead sea turtle generation time (46 years). In addition, the trends in nest numbers may not match concurrent trends in the abundance of oceanic/neritic juvenile stages in Canadian waters or the population overall.

There have been a limited number of in-water studies in the USA, which have shown varying trends. For example, an analysis of loggerhead by-catch in the USA longline fishery in the Northeast Distant (NED) area indicated an 11-fold increase in by-catch rates in 2005-2008 compared with 1998-2000 rates. Similarly, in-water surveys of neritic juveniles in some areas along the Atlantic USA seaboard, e.g., Pamlico Sound, North Carolina (1995-2003) and the St. Lucie Nuclear Power Plant, Florida (1977-2004) indicate that catch rate trends are currently increasing. However, aerial surveys in Chesapeake Bay, Virginia (1982-2004) indicated a declining trend in loggerhead sightings.

Table 1. Average number of nests and estimated mean population growth rate for recovery units.

Northwest Atlantic Recovery Units	Years of Data (Nests)[1]	Average Number of Nests[1]	Years of Data (Trend)[2]	Arithmetic Mean of the Log Population Growth Rate [95% C.I.][2]
Northern	1989-2008	5,215	1983-2005	-0.012 [-0.079, 0.055]
Peninsular Florida	1989-2007	64,513	1989-2007	-0.026 [-0.065, 0.013]
Dry Tortugas	1995-2004	246		
Northern Gulf of Mexico (Florida Index)	1995-2007	906	1997-2007	-0.049 [-0.121, 0.022]
Greater Caribbean	1989-2005[3]	1,674[3]	1989-2006	-0.012 [-0.068, 0.043]

adapted from [1] NMFS and USFWS 2008
[2] Conant *et al.* 2009
[3] TEWG 2009

The estimated **range** of loggerhead sea turtles in Atlantic Canadian waters (based primarily on fisheries-dependent data) extends from Georges Bank, along the edge of the Scotian Shelf and Grand Banks, to the limits of the EEZ, with occasional forays into waters on the shelf.

Habitat Requirements and Residences

Atlantic Canadian loggerhead sea turtle **habitat** appears to be defined geographically and temporally, in part, by sea surface temperature. They are encountered in waters greater than 15°C, especially between 20-25°C, favouring a distribution in thermally dynamic waters along the shelf break and offshore. The primary use of habitat in Atlantic Canadian waters is thought to be for foraging. Loggerhead sea turtles exploit temporally variable fronts and eddies, which can concentrate prey to shallower depths. As epipelagic foragers, most dives (80%) are 2-5m

in depth, although they have been recorded diving greater than 250m. Oceanic loggerhead sea turtles are opportunistic carnivores that feed upon a variety of pelagic organisms including cnidaria, ctenophores, salps, pelagic gastropods, and crustaceans.

Based on the distribution of loggerhead sea turtles caught in the Canadian tuna and swordfish longline fishery, NMFS surveys and opportunistic sightings, the spatial extent of suitable habitat in Atlantic Canadian waters was estimated to extend along the edge of the Scotian Shelf, Grand Banks and Georges Bank, and to include the offshore waters to the boundary of the EEZ. They are less common inshore of the Shelf edge.

SARA defines **residence** as:

> "A *dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating*."

Loggerhead sea turtles nest outside of Canada and so do not have any known dwelling-place similar to a den or nest during any part of their life cycle within Canadian boundaries.

Targets for Recovery

At the time of this RPA, loggerhead sea turtles had not been assessed by COSEWIC, so recovery targets could not be set in the context of a COSEWIC designation. In April 2010, the loggerhead sea turtle was assessed as endangered by COSEWIC. A recovery target that would result in the downlisting of the species would be desirable.

In the absence of population indices in Canada, a recovery target for abundance could not be established at this time. A reasonable recovery target for abundance would be an increase in population size over three generations. A practical management strategy (secondary target) could be to ensure that human-induced harm and mortality rates due to Canadian activities do not exceed levels that would impede population recovery (and be kept at or below current levels until the levels that would not impede population recovery are determined).

A reasonable recovery target for distribution would be to maintain current distribution, as there has been no evidence that loggerhead sea turtle distribution has been reduced.

Sources of Harm and Mortality

Historically, there were commercial fisheries for loggerhead sea turtles in the Northwest Atlantic as well as by-catch in other fisheries. Currently, fisheries by-catch poses the most significant threat to loggerhead sea turtles in the Northwest Atlantic.

The only documented source of human human-induced harm or mortality of loggerhead sea turtles, considered to be primarily oceanic and neritic juveniles (see sources of uncertainty), in Canadian waters is the Canadian tuna and swordfish longline fishery. There is limited observer coverage in some fisheries (e.g., groundfish fixed gear) that may interact with loggerhead sea turtles, potentially resulting in an underestimate of loggerhead sea turtle encounters by Canadian fisheries.

Estimates of loggerhead sea turtle by-catch in the Canadian tuna and swordfish fisheries based on observer data were calculated using a ratio estimation method. By-catch rates were then extrapolated to the entire fishery. Data were stratified by number of yellowfin tuna caught,

quarter, and region. Two levels were defined for yellowfin tuna numbers based on a threshold of 20.5 individuals in a trip, where 'low' means less than 20.5 and 'high' means more than 20.5 fish. The three quarters were Q2 (April-June), Q3 (July-September) and Q4 (October-December), while the regions 'north' and 'south' refer to areas either side of a line that splits the Laurentian Channel and heads out into the Atlantic Ocean. There were an estimated 1,200 loggerhead sea turtles (95% confidence range of 700-1,800) caught annually in Canadian tuna and swordfish longline fisheries between 2002-2008. Data from earlier years are not of sufficient quality to be used to calculate by-catch rates. Assuming that post-hooking mortality ranges between 20-45%, this would result in roughly 200-500 deaths of oceanic/neritic juveniles annually from the Canadian tuna and swordfish longline fishery.

In the USA Recovery Plan, mortalities of oceanic and neritic juvenile loggerhead sea turtles in the Northwestern Atlantic from all sources (primarily fisheries by-catch, but including vessel strikes, dredging activities, entanglement, and oil pollution) were estimated to be in the order of roughly 10,000-100,000 oceanic juvenile turtles and roughly 14,000-140,000 neritic juvenile turtles annually over the last decade.

By-catch rates in the Canadian swordfish-directed sets were similar to those in the USA swordfish fishery conducted in adjacent waters; whereas, by-catch rates in the Canadian tropical tuna-directed fishery were higher.

Vessel strikes, pollution, ingestion of marine debris, entanglement, noise and light from offshore activities, and climate change were also named as potential human-induced threats to oceanic loggerhead sea turtles (Table 2). There are no documented cases of these threats causing harm or mortality in Canadian waters, but this may be a reflection on the paucity of information on loggerhead sea turtles rather than that none has occurred.

Climate change and trophic changes are potential threats to the functional properties of loggerhead sea turtle habitat in Canadian waters. However, no reduction of habitat in Canadian waters has been documented or quantified to date, and habitat in Canadian waters is not thought to be limiting.

Table 2. Summary of demonstrated and potential human-induced threats to loggerhead sea turtle recovery.

	Demonstrated	**Speculative**
Threats to Individuals	By-catch in Fishing Gear	Vessel Strikes Pollution and Marine Debris Entanglement Noise and Light from Offshore Activities Climate Change
Threats to Habitat		Trophic Changes Climate Change

Mitigation Measures and Alternatives

The main identified threat to loggerhead sea turtles in Canadian waters is the pelagic longline fishery for swordfish and tunas (bigeye, yellowfin and albacore). Potential mitigation measures to minimize the threat posed by this fishery include:

- Gear configuration and fishing practices that may decrease loggerhead sea turtle by-catch, such as:
    - Increased circle hook use,
    - Use of larger circle hooks (e.g., 18/0 instead of 16/0),

  - Bait type,
  - Set and soak time, and

- Practices for de-hooking/removing gear and handling of turtles to increase post-release survival and reduce harm and post-hooking mortalities, such as:
  - maximum gear removal without causing undue injury
  - allow recuperation time if required.

- Identification of locations with appreciable loggerhead sea turtle densities that would benefit from dynamic/temporary area closures, and/or implementation of measures to minimize activity in these areas for the duration of their presence.

In 2003, the Nova Scotia Swordfishermen's Association developed a Code of Conduct for Responsible Sea Turtle Handling and Mitigative Measures, which includes avoiding areas of high turtle capture rates and notifying all vessels operating in the area if high turtle capture rates are encountered; gear hauling protocols to minimize harm to turtles that may be captured; turtle handling guidelines; and usage instructions for dehooking gear. It was made a condition of license that all license holders in this fleet must follow this Code of Conduct.

Potential alternative fishing methods include the use of fishing gears other than pelagic longlines. Some alternative gear types, including harpoons and trolling gear, are already being used in the Atlantic large pelagic fishery. There is not known to be any loggerhead by-catch associated with either of these gear types.

The expected impact of the mitigation measures and alternatives proposed in this assessment on abundance and distribution of loggerhead sea turtles in Canadian waters is unknown, but these measures are intended to either reduce the likelihood of encounters of loggerhead sea turtles or reduce the impact (severity of harm) when encounters occur. Further study will be required to evaluate the effectiveness of the identified mitigation measures and alternatives.

Recovery Potential

Published population modeling studies undertaken in the USA suggest that the Northwest Atlantic loggerhead sea turtle population is likely to continue to decline given current estimates of the rates of population growth and the effects of human-induced mortality. However, these studies also indicate scope for recovery if human-induced mortality is reduced.

Reduction or elimination of mortality in Canadian waters alone is highly unlikely to be sufficient to achieve recovery. In addition to minimizing threats to loggerhead sea turtles in Canadian waters, international cooperation to reduce threats to the population as a whole is needed to achieve recovery of this species.

Sources of Uncertainty

There is limited observer coverage in some fisheries (e.g., groundfish fixed gear) that may catch loggerhead sea turtles, potentially resulting in an underestimate of turtle by-catch by Canadian fisheries. Observer coverage in the pelagic longline fishery has ranged from 2-20% over the last 8 years.

The limitations of the observer data, including observer effects, and their impact on the prediction of loggerhead sea turtle encounter rates in the Atlantic Canadian swordfish and tuna

longline fishery should be recognized. Poor or no coverage in certain strata can bias outcomes. The sensitivity of the predictions to influential observations and the unbalanced nature of the data should be explored. Due to the necessary trip-level aggregation of observer data, some variables that may impact loggerhead sea turtle encounter rates were not explored and their incorporation in future assessments may have merit.

There has been insufficient study of post-release survival rates in loggerhead sea turtles. Thus, the range of possible values provided here (20-45%), while thought to be representative, 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.

The estimates of the population growth rates for Northwest Atlantic recovery units of loggerhead sea turtles, while negative on average, have 95% confidence intervals that include positive values, indicating the possibility (however unlikely) that some recovery units may not be declining. For species conservation, however, a cautious approach is warranted, with a focus on minimizing Type II errors (i.e., avoiding a false conclusion that the population is not declining) rather than Type I errors (as represented by the 95% confidence intervals).

The lack of fishery independent surveys for loggerhead sea turtles in Atlantic Canadian waters limits the ability to adequately characterize their spatial and temporal distribution, habitat use, and estimate their abundance. Limited observer coverage in some fisheries that may encounter loggerhead sea turtles may result in incomplete habitat use estimation. Loggerhead sea turtle distribution data are, therefore, biased towards the areas and times that fisheries known to capture this species occur.

Data on turtle size distribution adjacent to the Canadian EEZ are available and have been reported here. There is no evidence to suggest that the size distribution of loggerhead sea turtles found in Atlantic Canadian waters would be different from that in adjacent waters. In addition, turtles caught using longline gear may not accurately reflect the size range of turtles present in and around Canadian waters. Turtles captured using longline gear have been found to be larger than those dip-netted at the surface, suggesting that longline gear is selective towards larger individuals.

No genetic studies have been conducted to identify the stock origin of turtles present in Atlantic Canadian waters. However, there is no evidence to suggest that the population structure of loggerhead sea turtles found in Atlantic Canadian waters (considered to be oceanic/neritic stage juveniles) would be distinct from that in adjacent waters, which has been described through mixed stock analysis of individuals from the NED.

There is no diet information available for loggerhead sea turtles in Canadian waters. Information presented here is based on studies conducted outside of Canadian waters.

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