Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada

Leatherback Turtle

December 2006

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

About the Species at Risk Act Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

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 goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada

December 2006

Recommended citation:

Atlantic Leatherback Turtle Recovery Team 2006. Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, vi + 45 pp.

Additional copies:

You can download additional copies from the SARA Public Registry (http://www.sararegistry.gc.ca/)

Cover illustration: J. Domm for Fisheries and Oceans Canada

Également disponible en français sous le titre
« Programme de rétablissement pour la tortue luth dans les eaux canadiennes de l'Atlantique »

ISBN 0-662-44263-6
Cat. no. En3-4/14-2006E-PDF

DECLARATION

The recovery strategy for the Leatherback turtle in Atlantic Canada has been prepared in cooperation with the jurisdictions described in the Preface. Fisheries and Oceans Canada has reviewed and accepts this document as its recovery strategy for the Leatherback turtle as required by the *Species at Risk Act*.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the Leatherback turtle and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

The responsible jurisdiction for the Leatherback turtle is Fisheries and Oceans Canada. Leatherback turtles occur in the Atlantic and Pacific Oceans and this document deals with the Atlantic component of this species including individuals occurring off of the coast of the following provinces and/or territories. Their respective governments also cooperated in the production of this recovery strategy:

- Québec
- New Brunswick
- Prince Edward Island
- Nova Scotia
- Newfoundland & Labrador

AUTHORS

This document was prepared by the Atlantic Leatherback Turtle Recovery Team.
The Atlantic Leatherback Turtle Recovery Team was formed in 2002 in order to develop a recovery strategy that fosters the recovery of Leatherback turtles by minimizing human-induced mortality in Canadian Atlantic waters. Team membership was sought from a variety of organizations expressing interest in the species. The Team attempted to create and maintain an inclusive and transparent process throughout its tenure. The stated role of the Team was to

'provide advice to relevant governmental agencies and stakeholders through the development of a Recovery Strategy that outlines objectives and approaches for the mitigation of human impacts on the leatherback turtles related to Canadian activities in the Atlantic Ocean.'

Membership:

Robert Jones	DFO, Science (Ottawa)
Cathy Merriman	World Wildlife Fund
Troy Atkinson	Nova Scotia Swordfishermen's Association
Sherman Boates	Nova Scotia Department of Natural Resources
Mark Butler	Ecology Action Centre
Jerry Conway	DFO, Fisheries Management (Maritimes)
Penny Doherty	Ecology Action Centre
Derek Fenton	DFO, Oceans (Maritimes)
Bert Fricker	NSLTWG/Commercial Fisherman
Patrick Gray	Atlantic Shark Association
Chris Harvey-Clarke	Dalhousie University
Andrew Hebda	Nova Scotia Museum of Natural History
Catherine Hood	DFO, Newfoundland
Justin Huston	Nova Scotia Agriculture and Fisheries
Mike James	Dalhousie University
Dave Kulka	DFO, Newfoundland Region
Kathleen Martin	Nova Scotia Leatherback Turtle Working Group (NSLTWG)
Don McAlpine	New Brunswick Museum
Jim McMillan	DFO, Science (Maritimes)
Carl Myers	DFO, Communications (Maritimes)
Mark Lanteigne	DFO, Gulf Region
Christine Penney	Clearwater
Kirsten Querbach	DFO, Species at Risk (Maritimes)
Frank Ring	DFO, Gulf Region
Murray Rudd	DFO, Policy and Economics (Maritimes)
Cheryl Ryder	U.S. National Marine Fisheries Service (NMFS) – Office of Protected Resources
Chantale Thiboutot	DFO, Quebec Region
Gary Weber	DFO, Fisheries Management (Maritimes)

ACKNOWLEDGMENTS

Fisheries and Oceans would like to acknowledge all members of the recovery team for their dedicated efforts in providing information, expertise and perspectives in the development of this recovery strategy document. In particular, DFO wishes to thank Mike James and Kathleen Martin of the Nova Scotia Leatherback turtle working group (NSLTWG) and Don McAlpine of the New Brunswick Museum for contributing information, maps and/or figures. Furthermore,

DFO wishes to recognize the invaluable input provided by the broader interested public in the consultations process.

ENVIRONMENTAL CONSIDERATIONS

Environmental considerations must be incorporated into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

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 recovery planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. Environmental considerations are incorporated directly in the strategy itself, but are also summarized as follows.

This recovery strategy will clearly benefit the environment by promoting the recovery of the Leatherback turtle. The potential for the strategy to inadvertently lead to adverse effects on other species was considered; however, because the recovery objectives recommend additional research on the species and education and outreach initiatives, the consideration of environmental effects concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects.

RESIDENCE

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*" **[SARA S2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm

PREFACE

The Leatherback turtle is a marine reptile and is under the jurisdiction of the federal government. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. The Leatherback turtle was listed as endangered under SARA in June 2003. Fisheries and Oceans Canada – Maritimes Region, led the development of this recovery strategy. The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41).

EXECUTIVE SUMMARY

The leatherback turtle (*Dermochelys coriacea)* is a marine reptile that has experienced precipitous declines in recent years. Global population estimates of nesting females suggest that leatherbacks have declined by 70% from 1980 to 1995. It is currently listed as *endangered* under the federal *Species at Risk Act* (SARA). This recovery strategy deals with the Atlantic component of this species: the Atlantic Leatherback turtle.

Atlantic leatherbacks are highly migratory and a portion of the population makes seasonal migrations from rookeries in the Caribbean and South America to northern latitudes in waters off eastern Canada. These animals appear to mainly use northern waters to forage during the summer and fall, before assuming southward migration. Several factors, or threats, are contributing to the decline of leatherbacks throughout their range. Many of the most serious threats do not occur within Canadian jurisdiction and; therefore, recovery of this species will require international cooperation.

While little is known about human activities in Atlantic Canadian waters that may impact leatherback turtles, potential threats contributing to mortality include entanglement in commercial fishing gear, vessel collision from recreational boating, ship traffic, marine pollution, and oil and gas exploration and development. The difficulty in addressing these threats stems from the general lack of information on the species' biology, distribution, life history and behaviour in addition to the lack of knowledge on the threats themselves. Further, how much any mitigation measure will contribute to the likelihood of recovery is unknown.

The recovery strategy specifies measures that can be taken under Canadian jurisdiction to promote the recovery of the Atlantic leatherback turtle. The recovery goal is to *"achieve the long-term viability of the leatherback turtle populations frequenting Atlantic Canadian waters"*. The supporting objectives outline the need to: (1) understand the threats to leatherbacks in Atlantic Canadian waters, (2) acquire further information to improve the general knowledge of the species and its habitat, (3) take further steps to identify critical habitat so that it may be protected, (4) reduce the risk of harm to leatherback turtles from anthropogenic activities, (5) educate stakeholders and the general public on ways to support recovery, and (6) work collaboratively at an international level to further recovery.

A key challenge in the recovery of the Atlantic leatherback turtle is a general scarcity of information regarding the species' biology, distribution, habitat preferences and threats to the populations. In addition, the international nature of this species makes recovery efforts more complex. As further information is collected and international efforts move forward, the potential for recovery of the Atlantic leatherback turtle will be enhanced.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. INTRODUCTION

The leatherback turtle is the sole member of the family *Dermochelyidae*. It is the largest (1.8-2.4 metres) of all the marine turtles and exhibits the deepest diving behaviour. In addition, this species travels great distances including extensive seasonal migrations northward to forage and southward to nest. Its distribution is more widespread than any other marine turtle species.

Although the leatherback turtle is designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as one species, it is suspected that two distinctive populations (suggested subspecies) exist in Canadian waters: the Atlantic population and the Pacific population. Separate recovery strategies and action plans are being developed for the species in its Atlantic and Pacific ranges, to focus on the issues specific to each region. Under the current designation, for the species to be considered "recovered" and become eligible for re-assessment by COSEWIC for de-listing, the respective recovery goals for both strategies will need to be achieved.

Leatherback turtles are listed as *Endangered* under Schedule I of SARA, which results in legal protection and mandatory recovery requirements. Automatic prohibitions were introduced in June 2004. Protection under the Act prohibits killing, harming and harassing of individuals and also prohibits the damaging or destroying of their residence. Protection of critical habitat (once identified in a recovery strategy and/or action plan) is ensured using provisions in SARA or other federal legislation within 180 days of when the recovery strategy or action plan identifying critical habitat is included in the Public Registry. The Minister of Fisheries and Oceans, as a "*competent minister*" under SARA for leatherback turtles, is responsible for the development of recovery strategies and action plans for this species. (each of the listed aquatic species under the Act.)

This recovery strategy summarizes the best available information on the biology and status of the Atlantic leatherback turtle, and reflects not only our limited knowledge about this species but also the need for international cooperation in its recovery. The strategy will be followed by the Atlantic Leatherback Turtle Action Plan (produced as a separate document), also a requirement under the Act. Action plans list the measures that are to be taken over the next 5 years to implement the recovery strategy. It is hoped that this strategy will provide a mechanism to work toward minimizing threats to leatherback turtles both nationally and internationally, eventually resulting in their recovery and delisting.

2. BACKGROUND

2.1 Current Canadian Status

Common name: Leatherback turtle

Scientific name: *Dermochelys coriacea*

Status: Endangered

Reason for designation: The leatherback turtle is undergoing a severe global decline (> 70 % in 15 years). In Canadian waters, incidental capture in fishing gear is a major cause of mortality. A long lifespan, very high rates of egg and hatchling mortality, and a late age of maturity makes this species unusually vulnerable to even small increases in rates of mortality of adults and older juveniles (COSEWIC, 2003)

Occurrence: Pacific Ocean and Atlantic Ocean

Status history: Designated Endangered in April 1981. Status re-examined and confirmed in May 2001.

This statement of designation is from the report produced by COSEWIC following assessment of leatherback turtles in both Atlantic and Pacific Canadian waters. It bears noting that incidental catch of individuals in fishing gear is the most well documented source of anthropogenic mortality to leatherback turtles in Canada, however other sources of mortality both within and outside Canadian territorial waters have contributed to overall population declines. Threats to leatherback turtles are further elaborated on under section 2.7.

2.2 Global Status History

The leatherback turtle is currently both nationally endangered (Cook, 1981; COSEWIC 2001) and globally *critically endangered* by the World Conservation Union (IUCN). It has been listed as *endangered* throughout its range since 1970 under the U.S. *Endangered Species Act* (ESA).

2.3 Legal Protection

2.3.1 Canada

Leatherback turtles are listed under Schedule 1, Part 2 of SARA and therefore, its provisions against the killing, harming, harassing, capturing or taking of individuals apply.

In addition to SARA, other federal statutes that offer legal protection for leatherbacks and their habitat in Canada include the Habitat Protection provisions of the *Fisheries Act (*1985) and the

Oceans Act (1996), which gives DFO authority to create Marine Protected Areas to protect endangered and threatened species. The leatherback is also protected under the 1996 New Brunswick *Endangered Species Act*. However, as a migratory marine species, the leatherback turtle is ultimately under federal jurisdictional responsibility.

2.3.2 Globally

Globally, the leatherback turtle receives protection under the Convention for International Trade in Endangered Species of Wild Flora and Fauna (CITES). For countries that are signatories to the Convention, including Canada, CITES is an international agreement whose goal is to ensure that international trade in products derived from wild animals and plants does not threaten their survival in the wild. Leatherback turtles were listed in Appendix I under CITES in 1990, which permits trade only under exceptional circumstances.

Leatherbacks utilize nesting beaches and waters that are shared by many nations. The *Inter-American Convention for the Protection and Conservation of Sea Turtles* (IACPST) is the only international treaty dedicated exclusively to sea turtles, setting international standards for the conservation of protected sea turtles and their habitats. Canada is not a signatory party to this convention. Further, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) has some provisions that address the harvest of endangered species.

International cooperation will be the key to effective protection of this animal. The Commission for Environmental Cooperation (CEC) has recently selected the Leatherback turtle as a pilot species for the development of a North American Conservation Action Plan. The CEC is an international organization created by Canada, Mexico and the United States to address regional environmental concerns, help prevent potential trade and environmental conflicts, and to promote the effective enforcement of environmental law. It is hoped that the Canadian Recovery Strategy will contribute to this Conservation Action Plan.

2.4 General Biology and Description

2.4.1 Phylogeny

One of only seven species of marine turtle, the leatherback (*Dermochelys coriacea*) is the sole member of the family *Dermochelyidae*, which diverged from other turtles 100-150 million years ago (Zangerl, 1980). Two subspecies have been described: *Dermochelys coriacea coriacea* (Linnaeus, 1766), the Atlantic leatherback, and *Dermochelys coriacea schlegelii* (Garman, 1884), the Pacific leatherback. However, these supposed sub-species are poorly differentiated, and distinctions based on colouration and differences in forelimb and head length are questionable (Pritchard, 1979). Therefore, one species is now generally recognized. Genetic analyses, revealing little divergence between Pacific and Atlantic populations (Dutton *et al*, 1996), have corroborated this view.

Low genetic variation between leatherbacks occupying Pacific and Atlantic waters may be a product of recent evolutionary separation between these populations. Alternatively, the

leatherback's extraordinary migratory ability (e.g., Hughes *et al*, 1998) and two to three year intervals between nesting events (e.g., Hughes, 1996) may enable gene flow between these ocean basins (Binckley *et al*, 1998).

In Canadian waters, leatherbacks are derived from multiple nesting assemblages and may be considered a single population for management purposes. Canadian recovery efforts focus on two groups based on ocean basin: (1) the Pacific leatherback turtle and (2) the Atlantic leatherback turtle.

2.4.2 Appearance

Leatherback turtles lack a bony shell, and are the only soft-shelled species among all seven marine turtles. They may attain a carapace (or shell) length of nearly two metres. The tapered carapace has a four-centimetre-thick covering of tough, oil-saturated connective tissue covering a mosaic of thousands of small dermal bones (Pritchard, 1971). The body mass of the leatherback typically does not exceed 500kg (Zug & Parham, 1996) and the immense paddle-shaped front flippers often equal or exceed half the carapace length.

Leatherbacks lack the hard mandible structure of hard shelled turtles. Instead, the upper jaw has two tooth-shaped projections, flanked by deep cusps for cutting soft tissue. Their oesophagus is also lined with backward pointing spines to aid them in swallowing their jellyfish prey. The carapace of the turtle is black, or bluish-black, with scattered white and pink blotches, while the plastron is predominantly white. Each adult leatherback has a uniquely patterned "pink spot" on the top of the head (McDonald & Dutton, 1996).

The only visual way to distinguish male from female adult leatherbacks is by examining the tail length. The male's tail typically extends beyond the length of the rear flippers, while the female's tail is shorter than the flippers (Pritchard 1971).

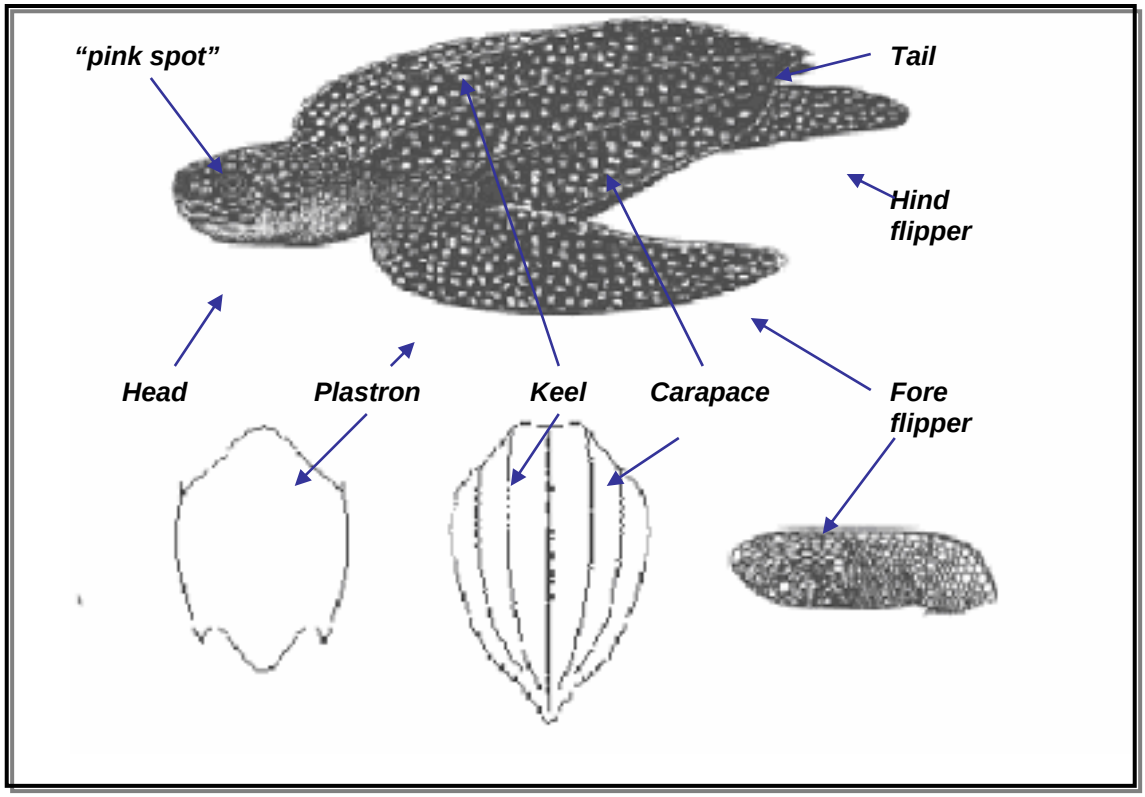

Figure 1. Schematic depicting a mature adult leatherback turtle and key morphological features.

2.4.3 Foraging Ecology

Leatherbacks feed primarily on jellyfish (medusae) and other soft-bodied pelagic invertebrates (e.g., Lazell, 1980; Lutcavage & Lutz, 1986, Grant *et al*., 1996). Necropsies have identified many small fish, crabs, amphipods and other crustaceans in the digestive tracts of leatherbacks (Hartop & Van Nierop, 1984; Frazier *et al.*, 1985). These may be jellyfish prey or commensal to jellyfish and are likely ingested incidentally by leatherbacks (Frazier *et al.*, 1985).

The leatherback exhibits several adaptations for its diet of soft-bodied prey including a sharp-edged beak and backward-pointing spines in the throat, which likely assist in swallowing slippery prey (Bleakney, 1965). Since these soft-bodied prey are energy poor, consisting of about 95% sea water, small leatherbacks may have to consume an amount equal to their weight daily in order to maintain a normal metabolic rate (Lutcavage & Lutz, 1986). Therefore, leatherbacks must locate dense patches of food, which might explain why these turtles are numerous in coastal areas and along oceanic frontal systems where prey productivity is high (Shoop & Kenney, 1992).

Leatherbacks also exhibit deep diving behaviour at night in tropical waters, which reflects their foraging on medusae (Eckert *et al*, 1989). In eastern Canada, the distribution and movements of leatherback are thought to be closely associated with seasonally abundant prey, particularly

Cyanea sp., their principal jellyfish prey (Bleakney, 1965; Goff & Lien, 1988; Shoop & Kenney, 1992; James, & Herman 2001).

2.5 Distribution

2.5.1 Global Range

Leatherback turtles are capable of tolerating a wide range of water temperatures and have the most extensive geographic range of any reptile species. Leatherbacks undertake extensive migrations throughout the tropical and temperate waters of the Atlantic, Pacific and Indian oceans, with a northernmost recorded latitude of 70°15'N (Gulliksen, 1990) and a southernmost of approximately 27° S (Boulon *et al.*, 1988).

The largest Atlantic nesting colonies are located in French Guiana and Suriname in South America, and Gabon in Africa. Nesting also occurs in lower densities throughout the Caribbean and in Brazil. Florida is the only state in the continental U.S. known to support a significant number of nests (Calleson *et al*, 1998). Rabon *et al.* (2003) recently summarized leatherback nesting activity north of Florida and reported seven confirmed nests from the state of North Carolina. This is the northern extent of the nesting range in the northwest Atlantic. It is believed that all major nesting sites for this species are known and nesting activity has been intensively monitored at most of these sites for several years (Spotila *et al.*, 1996).

At the end of the nesting season, an unknown portion of the population of leatherbacks migrates northward to temperate waters. In the course of these migrations, individual turtles may attain speeds of over 9km/h (Keinath & Musick, 1993). Studies of leatherbacks in the Gulf of Mexico (e.g., Fritts *et al.*, 1983), off the Atlantic coast of the United States (e.g., Lazell 1980; Shoop & Kenney, 1992) and off the east coast of Canada (James, 2000; Lawson and Gosselin 2003) suggest that these turtles may preferentially inhabit continental shelf waters. Offshore, leatherbacks are regularly present along thermal fronts, including the edges of oceanic gyre systems (e.g., Collard, 1990; Lutcavage, 1996). These are highly productive areas, concentrating jellyfish and other soft-bodied invertebrates on which leatherbacks feed.

New data regarding leatherback turtle distribution continues to be gathered through a number of tagging methods (i.e., flipper tagging, internal Passive Integrated Transponder (PIT) tags and satellite tagging). Through flipper tagging, leatherbacks from the western Atlantic population (Guiana) have been recorded off west Africa, in the Gulf of Venezuela, in the Gulf of Mexico and on the Atlantic coast of the United States (Pritchard, 1976). Since 1978, others have been captured along the eastern United States, between Florida and South Carolina (Girondot & Fretey, 1996). Leatherbacks tagged in French Guiana have also been captured in the northeast Atlantic off the coasts of France, Spain and Morocco, less than 12 months after nesting (Girondot & Fretey, 1996). In 1987, a leatherback tagged 128 days previously in French Guiana was discovered entangled in fishing nets in Placentia Bay, Newfoundland (Goff *et al.*, 1994). The turtle had travelled a minimum straight-line distance of over 5000km. The northernmost records for Atlantic Canada are of leatherbacks entangled in gear (2, 1986 and 2004) or free-swimming (1, 1986 at almost 54 N) along the coast of Labrador (DFO, 2005b).

Through satellite tracking (e.g., Eckert *et al*, 1989; Morreale *et al.*, 1996; Hughes *et al.*, 1998), more direct studies of leatherback distribution and migration have been undertaken. One study revealed long-distance movements from tropical nesting beaches to temperate waters of the north Atlantic (Eckert, 1998). Two leatherbacks tagged on a nesting beach in Trinidad migrated north to waters between 40 and 50 degrees latitude before swimming south to the coast of Mauritania, Africa (Eckert, 1998). More recently, 39 leatherbacks satellite-tagged in eastern Canadian waters were tracked on their migrations to subtropical and tropical waters (James, unpublished data). Ten of these turtles represent the first male leatherbacks to be tracked via satellite telemetry.

Relevant information has also been obtained through studies of the barnacles that leatherbacks host. For example, Zullo & Bleakney (1966) reported barnacles, typical of tropical and subtropical waters (*Stomatolepas elegans*), on the skin of leatherbacks recovered off Nova Scotia.

In Canada, leatherbacks from the Pacific population are found seasonally off the coast of British Columbia, foraging between July and September (Stinson, 1984). Although more sightings occur every year, there are a limited number of areas where leatherbacks are routinely observed, and sightings are generally made by fishers. Recently, reports by recreational boaters have become more frequent. These observations have been recorded through the Queen Charlotte Islands and increasingly throughout the protected waters of the Georgia and Hecate Straits (Pacific Leatherback Turtle Recovery Strategy, 2005).

2.5.2 Range in Atlantic Canada

Although leatherbacks do not nest in Canada, adult turtles occur annually in Atlantic Canadian waters to forage, with the majority of turtles present between June and November (Figure 2). Figure 2 includes a compilation of published and previously unpublished distributional records for the leatherback turtle in Atlantic Canada. This data is based on individual stranding and entanglement records of both live and dead turtles, as well as at-sea sightings.

With the observed variability in numbers of individuals that migrate annually through Canadian waters and the difficulty in censusing the population at sea, documentation of leatherbacks in Atlantic Canada has been limited. This has resulted in conservative historical evaluations of leatherback abundance (e.g., Cook, 1981; Gilhen, 1984). Yet, a relatively large seasonal population has recently been identified through efforts described below.

Bleakney (1965) was the first to document scientifically the occurrence of leatherbacks in eastern Canada and his analysis of 26 records of leatherbacks in this region (1889-1964) suggested a seasonal, rather than accidental, movement of the species into the cold waters of the northwest Atlantic. Recent research by James (2000; James *et al*. 2005a, 2005b) and DFO scientists (unpublished) supports the conclusion that leatherbacks regularly enter temperate waters off eastern Canada. Peak leatherback occurrences in Canadian waters occur during August-September but there are records for leatherbacks in Canadian waters for most months of the year (McAlpine *et al*., 2004).

Specifically, leatherbacks have been recorded off the coasts of Nova Scotia (e.g., Bleakney, 1965; James, 2000), Newfoundland (e.g., Goff & Lien, 1988; Lawson and Gosselin, 2003), and

Labrador (Threlfall, 1978; DFO, 2005b). Reports from New Brunswick come from turtles sighted in the Bay of Fundy, the Northumberland Strait and the Gulf of St. Lawrence. In Prince Edward Island, a small number of records come from coastal strandings and reports made by fishers. Leatherbacks have also been reported in the Gulf of the St. Lawrence off Quebec (e.g., D'Amours, 1983; Bosse, 1994). Cultural artefacts from Baffin Island suggest that leatherbacks are occasionally encountered in that region of the north Atlantic (Shoop, 1980).

There has been some question as to whether juvenile leatherbacks occur in Canadian waters. Based on a review of all sightings of leatherback sea turtles of <145cm curved carapace length (ccl), Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm. These results lead us to believe that it is unlikely that juveniles venture into Atlantic Canadian waters.

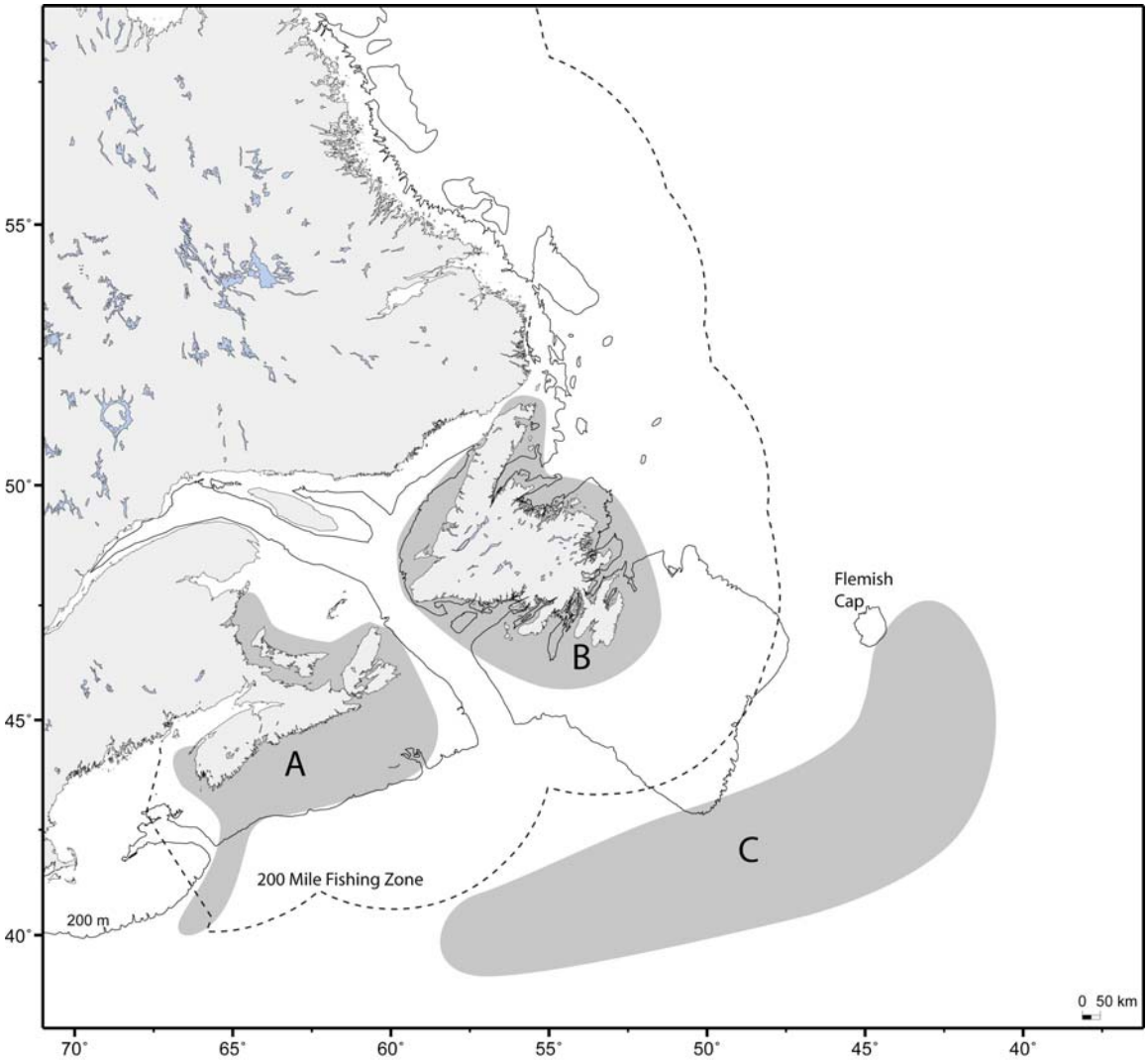

Figure 2. Occurrence of the leatherback turtle, *Dermochelys coriacea*, off eastern Canada. Shaded areas show the location of concentrations of observations and are taken from Goff and Lien (1988; A), Witzell (1999 and DFO, 2005; B), and James (2000; C).

2.6 Population Size and Trends

2.6.1 Global Population

As above, the leatherback turtle is difficult to census in the marine portion of its life cycle, as it is largely pelagic. Therefore, current population estimates are based on surveys of adult females encountered on monitored nesting beaches. Pritchard (1982) estimated that the overall world population was approximately 115,000 nesting females in 1980. In 1995, a study incorporating information from 28 nesting beaches throughout the world yielded a revised estimate of approximately 34,500 females; the lower limit was 26,200 and the upper limit was 42,900 (Spotila *et al.*, 1996).

These figures reflect dramatic declines at several nesting locales, particularly in the Pacific (Chan & Liew, 1996; Steyermark *et al.*, 1996; Eckert & Sarti, 1997) where recent trends suggest that this population is facing imminent extinction (Spotila *et al.*, 2000). For example, there were 3103 leatherbacks nesting at Terengganu, Malaysia in 1968, 200 turtles in 1980, and only 2 in 1994 (Chan & Liew, 1996). Similar declines are occurring in Playa Grande, Costa Rica, where annual mortality of nesting females is over 30% (Spotila *et al.*, 2000).

Although some nesting populations (e.g. St. Thomas, etc.) have been extirpated, the status of existing nesting population in the eastern Atlantic and in the Caribbean appears to be stable. Data collected in southeast Florida indicate an increasing in nesting, although it is important to note that there was an increase in survey effort (rather than area).

The largest leatherback rookery in the western Atlantic remains along the northern coast of South America in French Guiana and Suriname, and the nesting population in the trans-boundary region has been declining since 1992 (Chevalier & Girondot, 1998). Recent information suggests that western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila *et al.*, 1996) to 15,000 nesting females by 2000 (Spotila, pers. comm.).

While leatherback turtles may have shifted their nesting from French Guiana to Suriname due to beach erosion, it appears that the overall area trend of nests has been negative since 1987 (NMFS SEFSC 2001). Without information to determine whether turtles are nesting elsewhere, it can be assumed that that the western Atlantic portion of the population is being subjected to mortality beyond sustainable levels.

A number of studies have used aerial and shipboard surveys to estimate the seasonal occurrence of leatherbacks in waters off the continental United States (e.g., Hoffman & Fritts, 1982; Shoop & Kenny, 1992; Epperly *et al.*, 1995). Shoop and Kenney (1992) found (after three survey years) that an average of 6.85 turtles are located in every 1000 km from near Nova Scotia to Cape Hatteras, North Carolina. The mean sighting latitude for leatherbacks was 40°05’N and the mean sea temperature was 20.4 °C. Total study area population during the summer was estimated to be 100-900 leatherbacks; this is a minimum surface estimate. Similar abundance estimates are not yet available for Canadian waters, as the limited linear aerial or transect-based shipboard surveys undertaken have been focused on cetaceans. Data have been gathered opportunistically from volunteer commercial fishers, who record sightings of leatherbacks while fishing or

travelling to and from fishing grounds. Sightings and entanglement data have also been collected through phone and mail surveys, and through the entanglement and stranding networks.

2.6.2 Population in Atlantic Canada

Existing data on leatherback distribution reveal relatively large numbers of sightings in several popular fishing areas along the Scotian Shelf (James, 2000; James *et al.*, 2005a & 2005b) and along the southeast coast of Newfoundland (DFO, 2005), however these sightings are biased toward areas where fishing activity occurs. Therefore, sightings and incidental captures of leatherbacks are most likely to occur in the heavily fished areas off the Scotian Shelf and the Newfoundland south coast. General baseline data about the abundance and distribution of the species throughout the region are lacking. With these limitations, it is not possible to precisely assess abundance in eastern Canadian waters.

In 1998 and 1999, 300 leatherback turtle sightings were documented by a fisher-scientist collaborative venture entitled the Nova Scotia Leatherback Turtle Working Group (NSLTWG). The NSLTWG group was initiated in Atlantic Canada to investigate the distribution of leatherback turtles in the northwest Atlantic (James, 2000). These numbers suggest that summer leatherback densities in eastern Canada may be higher than the estimate of 100 to 900 leatherbacks per summer reported by Shoop & Kenney (1992) for a much larger study area along the coast of the northeastern United States.

Moreover, abundance estimates based on aerial or shipboard surveys must be considered conservative, as these only include observations of turtles at the surface; they do not account for those turtles present at various depths (Shoop & Kenney, 1992). Given the lack of offshore aerial survey data and fishery bycatch data on leatherbacks in Atlantic Canada, leatherback population size and trends in this area have yet to be determined.

2.7 Biological Limiting Factors

A number of biological (and behavioural) factors affect leatherback turtles by limiting their potential for population growth. These limiting factors have been grouped into those observed in the marine environment, and those that exist in the nesting beach habitat.

2.7.1 Marine environment

Leatherbacks depend on prey with very little nutritive content and since this species' diet of jellyfish is high in water and low in organic content, they must consume large quantities of food (Lutcavage, 1996) to fulfil their food energy requirements. This is the only known biological limiting factor in Canadian waters.

2.7.2 Nesting beach habitat

Leatherbacks prefer to nest on exposed, open beaches, adjacent to deep water and typically unprotected by fringing reefs. In some years large numbers of nests on such beaches are lost to flooding and erosion (e.g., Whitmore & Dutton, 1985; Leslie *et al.*, 1996). In addition, the

leatherback turtle is unique in producing numerous yolkless eggs in each clutch for which a selective advantage remains to be identified. The yolkless eggs may not have a function and thus may be a potential cost to reproduction (Rostal *et al*., 1996).

Further, Leatherbacks are thought to be a long-lived species but life expectancy is unknown; the age at maturity is estimated at 5-14 years (Zug & Parham, 1996). This, coupled with a 2-3 year interval between nestings (Hughes, 1996), may limit the ability of populations to rebound in times of low survival rates.

2.8 Threats

Researchers have observed a decline of over 70% in the leatherback turtle population on its nesting beaches. While there are known (and probably unknown) threats to leatherbacks in migratory and feeding habitat, these are not well understood. Threats occur both in nesting habitat and at sea. Because this strategy focuses on those known and potential threats that occur in Atlantic Canadian waters, it more specifically addresses threats that occur at sea.

2.8.1 Threats in the Marine Environment

Entanglement in fishing gear

Leatherback turtles are incidentally captured in nets and entangled in lines in fisheries operating in pelagic and coastal foraging areas and in migratory corridors. Of all the Atlantic sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear such as pelagic longlines, lines associated with fixed pot gear and gillnets, buoy anchor lines, and other ropes and cables (e.g., Chan *et al*., 1988; Goff & Lien, 1988; NMFS, 1992; Cheng & Chen, 1997; Godley *et al*., 1998).

Interactions between leatherback turtles and fishing gear are expected to differ depending on gear type. Although little observer data exist to document leatherback interactions with different gear types in Atlantic Canadian waters, O'Boyle (2001) identifies the gears with high potential for interactions (Table 1).

Table 1. Summary of the gear types with high potential for sea turtle interactions

Gear	Targeted Species	Area/Season	Comment
Longline	Groundfish	All areas and seasons	Hooks set close to bottom but entanglement a concern
	Pelagic	Atlantic Coast	Observations available
Gillnet	Herring	Newfoundland	Bait fishery; not regularly tended
	Groundfish	5Z	Cod fishery
	Mackerel	4X	Bait fishery all year
Trap	Lobster	4VWX5Z Offshore	Turtles in this area
	Groundfish/Pelagic	All areas and seasons	Entanglement a concern

Gear	Targeted Species	Area/Season	Comment
Pot	Snow Crab	3L (April-September)	Entanglement occurred in 2004
	Snow Crab	4VW (April- September)	Entanglement a concern

Table 1. Summary of the gear types with high potential for sea turtle interactions. In many cases there is little or no observer data to document the incidence of sea turtle interactions with these gear types (O'Boyle 2001).

Incidental interaction of marine turtles in pelagic longlines is evident from observer data for the Canadian pelagic longline fisheries. These fisheries have implemented the broadest observer coverage to date among Atlantic fisheries that have been identified as posing a risk of interaction with leatherback sea turtles.

Turtle interactions do not appear to occur in Canadian pelagic longline fisheries targeting shark (Javitech 2003C), but are well documented in longline fisheries targeting swordfish and tunas (28 individuals – swordfish 2001; 33 individuals – swordfish 2002; 4 individuals – offshore tuna 2002). During a two-year programme of enhanced observer coverage levels of 20%, live release was observed in all cases for leatherback turtles in the swordfish fisheries. Similar results were observed in the offshore tuna fishery where observer coverage levels were 100% in 2002.

From observations in the swordfish fishery, hooks and gangion line remained attached to turtles in 48.8% of all cases in 2001 and 74.5% of all cases in 2002. Just hooks remained attached in 5.6% of all cases in 2001 and 24.1% of all cases in 2002. All hooks and gangion line were removed from 33.3% of all cases in 2001 and 1.4% of all cases in 2002. In all of the above cases, post-release mortality is not known (Javitech 2002, 2003A and 2003B).

Unfortunately, no observer information exists regarding interactions between the leatherback turtle and fixed gear. However, valuable information is available through strandings. The Nova Scotia Leatherback Turtle Working Group reported 87 records of stranded leatherbacks from 1995-2002 – turtles entangled in fixed fishing gear and turtles found floating dead in shelf waters off Atlantic Canada.

Of the 87 records, 74% provided direct or indirect evidence of leatherbacks interacting with fixed fishing gear and 62% were associated with specific types of gears. Snow crab, rock crab, inshore lobster, offshore lobster and whelk fisheries were associated with 29% of the records, 22% of the records involved mooring or buoy lines associated with bottom gill nets, bait nets and pound nets of other fish traps. Three percent were associated with vertical lines in the groundfish longline gear.

Leatherback turtles are also entangled in U.S. Atlantic waters. For example, 92 leatherbacks were entangled in fixed pot gear from New York through Maine for the period 1990-2000 (Dwyer et al., 2002). Additional leatherbacks are stranded with line wraps or evidence of prior entanglement (Dwyer et al, 2002). Further, leatherback interactions have been observed in the shrimp trawl and other bottom trawl fisheries. Historically, interactions were observed in the

drift gillnet fishery for swordfish. However, in January 1999, the U.S. National Marine Fisheries Service (NMFS) issued a Final Rule to prohibit the use of driftnets (i.e. permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630).

Although NMFS promulgated regulations requiring the use of turtle excluder devices (TEDs) in shrimp trawl fisheries in 1990, Epperly et al. (2002) in a review of sea turtle stranding data, found that the TED openings were much too small to exclude leatherbacks and larger loggerhead and green turtles. In 2003 NMFS amended the regulations to require larger TED openings in U.S. Atlantic and Gulf of Mexico waters. In addition to the TED regulations, the U.S. also established a leatherback turtle Conservation Zone in 1995 to restrict trawl activities on the Atlantic coast during periods when leatherbacks are concentrated.

The susceptibility of leatherbacks to entanglements may result from their large body size, long pectoral flippers and soft shell. Entanglement of leatherbacks in lines or cable can result in serious injuries, infection, necrosis or death. These entangled turtles are generally limited in their ability to feed, dive, breathe or perform any other behaviour essential to survival (Balazs, 1985).

Collisions

While no incidences of collisions with boats are documented in Atlantic Canada, they have been known to occur in some areas of the U.S. and may have an impact on the leatherback turtle population that also uses Canadian waters. In areas where recreational boating, commercial fishing and ship traffic are concentrated, propeller and collision-related injuries may represent a source of mortality (NMFS, 1992). However, in situations where there is evidence of a collision, it is difficult to infer whether the collision itself led to the death of the turtle in question, or if the turtle was hit after it died of other causes. Leatherback turtles are known to bask at the surface for extended periods of time when foraging in temperate waters and, therefore, may be vulnerable to collisions with marine traffic.

Marine Pollution

The effect of marine pollution on sea turtles is not well quantified, and therefore the magnitude of pollution-related mortality is unknown. Leatherback sea turtles may be more susceptible to marine debris ingestion than other turtle species due to their pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding areas and migration (Lutcavage et al., 1997; Shoop & Kenney 1992).

Leatherbacks are known to ingest a variety of anthropogenic marine debris, including plastic bags, balloons, plastic and Styrofoam pieces, tar balls, plastic sheeting, and fishing gear (e.g., Sadove, 1980; Hartog &Van Nierop, 1984; Lucas, 1992; Starbird, 2000). Ingestion of such materials may interfere with metabolism or gut function and lead to blockages in the digestive tract, which could result in starvation or in the absorption of toxic byproducts (Plotkin & Amos, 1989).

Leatherbacks may serve as an indicator of the degree of contamination of the oceanic food web by bio-accumulating substances such as heavy metals and polychlorinated biphenyls (PCBs)

found in plankton-feeding jellyfish (Davenport & Wrench 1990). Metal and PCB levels in the leatherback are expected to represent a biomagnification of concentrations found in their prey; however, to date, tissue samples derived from leatherbacks in European waters have not revealed evidence of significant chemical contamination (Davenport et al., 1990; Godley et al., 1998).

Acoustic disturbances

Little is known about the hearing ability of the leatherback turtle and its response to acoustic disturbance. Studies involving adult green, loggerhead and Kemp's ridley turtles suggest that sea turtles detect sounds in the low frequency sound range, with the greatest hearing sensitivity between 250-700 Hz (Ridgway et al., 1969; Lenhardt et al., 1983; Bartol et al., 1999).

The effects of exposure to increased noise, based largely on studies involving marine mammals, may include habituation, behavioural disturbance (including displacement), temporary or permanent hearing impairment, acoustic masking, and mortality (Richardson el al., 1995). Studies on sea turtles have shown that certain levels of exposure to low frequency sound may cause displacement from the area near the sound source and increased surfacing behaviour (O'Hara & Wilcox, 1990; Lenhardt et al., 1983). This raised the concern that turtles may be displaced from preferred foraging areas (e.g., O'Hara & Wilcox, 1990; Moein et al., 1994).

There are a range of sources of anthropogenic noise in the marine waters of Atlantic Canada that produce underwater sounds within the frequency range detectable by sea turtles. These include oil and gas exploration and development, shipping, fishing, military activity, underwater detonations, and shore based activities (Davis et al., 1998; Greene & Moore, 1995; Lawson et al., 2000). Concerning the exposure to seismic airguns used in exploration, studies to date describe behavioural responses such as; increased swimming speed, increased activity, change in swimming direction and avoidance (DFO, 2004). Startle responses and erratic swimming behaviour was observed by McCauley et al. (2000). A study by Moein et al., (1994), noted a temporary reduction in hearing capability and temporarily increased physiological parameters (e.g., glucose, white blood cells and creatinine phosphokinase) which is suggestive of damaged tissues or altered physiology. Overall, based on the available information, it is considered unlikely that sea turtles are more sensitive to seismic operations associated with oil and gas exploration than cetaceans or some fish (DFO, 2004). Seismic operators currently use mitigation techniques, such as "ramp-up" procedures to encourage species such as marine mammals to move away from survey areas, and use "shut down" procedures when a species is identified as too close to survey. However, mitigation focused on detection are expected to be less effective for turtles given that they are more difficult to identify both visually and acoustically. Noise from offshore hydrocarbon production platforms and exploration drilling generally tend to be of low frequency (<500 Hz) (Richardson et al., 1995); however there are no published studies on the potential impacts of production or drilling operations on sea turtles. Sea turtles may react to noise from vessel traffic and helicopter overflights with a startle response (NRC, 1990; NOAA, 2002). Although it is assumed that turtles close to the surface can hear aircraft noise and may subsequently change their behaviour, there are no published studies to confirm this (NOAA, 2002).

2.8.2 Threats to the Nesting Environment

Poaching

The harvest of nesting adult females and their eggs for consumption or other uses continues to be a serious threat to leatherbacks throughout much of their range. The loss of nesting adults can lead to local extirpations, while the collection of eggs reduces the number of hatchlings available for future recruitment. To protect eggs from harvest, a number of conservation programs have developed hatcheries. While this may increase the total number of hatchlings released into the wild, artificial incubation - which is typically done at lower ambient beach temperatures - may result in the production of increased numbers of males (Morreale, *et al.*,1982; Mrsovsky, 1982; Dutton *et al.*, 1985). The long-term recovery implications of this altered sex ratio have not been quantified.

While leatherback meat is considered unpalatable by most, poaching of free-swimming and nesting turtles for meat and/or oil does occur in some areas, including the British Virgin Islands, Dominican Republic, Jamaica, Puerto Rico and the U.S. Virgin Islands (Fleming 2001). A larger, more widespread problem is the collection of leatherback eggs for sale in local and/or foreign markets in the aforementioned countries as well as the Bahamas (Fleming 2001).

Coastal Construction

Coastal development and the resultant beach armouring (seawalls, revetments, riprap, sand bags, groins, and sand fences) put in place to protect upland structures from erosion can interfere with access to suitable nesting sites during construction, throughout the duration of the armouring and when structures deteriorate. Erosion associated with hard armouring structures also leads to the loss of nesting habitat (NMFS, 1992). Soft armouring such as beach nourishment can result in beaches unsuitable for nesting due to compaction or severe scarping and may also result in an altered physical nesting environment that can adversely impact hatchling development and hatching success.

Artificial Light

Artificial lighting associated with coastal development, construction activities and roads can result in the disorientation of nesting adults and emerging hatchlings, resulting in failed nesting attempts and mortality of hatchlings. Adult females may avoid nesting on beaches with intense artificial lighting or ambient glow. When they do successfully nest on these beaches, hatchlings are attracted toward the artificial light source, which disrupts their natural sea finding behaviour, resulting in stress, dehydration, and predation (Witherington, 1992; Witherington & Bjorndal, 1991).

Climate Change

According to Davenport (1997), global warming is predicted to have deleterious effects on marine turtles, as it could potentially influence temperature-dependent sex determination. It can also be argued that increased hurricane activity associated with global climate change could result in increased nest loss due to amplified wind and wave erosion on leatherback nesting beaches. Lastly, alterations in ocean current patterns may accompany climate change, thereby affecting the migration and dispersal of marine turtles (Davenport, 1997).

Other Potential Threats

Other important threats to nesting habitats include: beach erosion, nest predation, beach driving, beach cleaning, beach mining, and exotic vegetation.

2.9 Habitat Requirements

To protect and recover leatherback turtles, it is essential to understand the full range of habitats required and how these habitats are utilized both spatially and temporally. For the endangered leatherback turtle, the full range of habitat use is poorly understood (COSEWIC, 2001). The details of leatherback migrations remain elusive, in part because the turtles occur far from land and travel such great distances (Lutz, 2003). However, recent and ongoing studies will soon yield more specific information on the habitat requirements of the leatherback turtle in the northwest Atlantic.

Nesting

Little is known about the breeding habitats of leatherbacks, although Eckert and Eckert (1988) proposed that mating takes place outside of the nesting grounds, prior to female migrations to their nesting beaches. Adult female leatherbacks nest every 2-3 years on high energy, open access, sandy beaches in the tropics that tend to be adjacent to deeper waters. The largest leatherback nesting colony in the Western Atlantic is located in French Guiana and Suriname (Pritchard and Trebbau, 1984). In the Atlantic and Caribbean, other significant leatherback nesting assemblages are found in the U.S. Virgin Islands (principally St. Croix), Puerto Rico, southeastern Florida, Guiana, Columbia, Panama and Costa Rica (NMFS and USFWS, 1992). Little is known about the habitat requirements of post-hatchlings and juveniles.

Foraging

Leatherbacks normally inhabit areas where prey productivity is high, along oceanic frontal systems and along vertical gradients located at oceanic fronts (Lutcavage, 1996). Doctoral thesis work by James (pers comm.) suggests that adult turtles aggregate at oceanic fronts and in specific areas with unique ocean circulation characteristics: shelf slope fronts, upwelling fronts, and western current boundary edges (James *et al.* 2005a). This behaviour is likely related to the concentration of jelly-plankton in these areas. Therefore, adult leatherback habitat may be determined by prey abundance, with turtles moving from offshore waters into coastal areas to exploit the seasonal production of jellyfish.

Eastern Canadian waters represent a common destination for sub-adult and adult leatherback turtles undertaking lengthy migrations from southern latitudes. While the proportion of the Atlantic leatherback population utilizing Canadian waters is not known, each year large numbers of turtles from nesting areas in Florida and South and Central America (including French Guiana, Suriname, Costa Rica, Panama, Trinidad and the Antilles) aggregate here to feed. As such, Atlantic Canada provides important foraging habitat for this species, and may offer seasonal densities of prey that are not widely available in other areas of the northwest Atlantic.

Sightings data, telemetry data and fisheries observer data suggest that most leatherbacks enter shelf and shelf slope waters from late May to September, although they may remain in Canadian waters for several months and depart as late as the middle of December. Some turtles move from shelf waters to pelagic feeding areas in the fall before assuming a southward migration. There is some evidence (Goff and Lien, 1988) to suggest that small numbers of turtles may be present in Canadian waters during the winter months; however, such behaviour does not conform to the typical migratory pattern for the species.

During the summer and fall foraging period, leatherbacks are broadly distributed in shelf waters off the northeastern United States, Nova Scotia, and southern Newfoundland. While there appears to be significant inter-annual variation in both leatherback abundance and in the temporal and spatial characteristics of preferred foraging areas in Canadian waters, some areas do appear to be used by turtles every year.

Leatherbacks occur off the southwest coast of Nova Scotia throughout the foraging period and off the south and east coasts of Cape Breton in late summer and fall. The species is rarely observed in the northern half of the Gulf of Maine and the Bay of Fundy. Turtles regularly enter waters off the south coast of Newfoundland, and off the Magdalen Islands and north coast of Cape Breton Island (Gulf of St. Lawrence) during their foraging period.

While some turtles spend long periods of time foraging in specific areas (e.g., slope waters east of the Fundian Channel), other turtles may forage for several weeks in multiple, often disparate locations, including waters corresponding to both Canadian and American jurisdictions. Data from turtles equipped with satellite tags in shelf waters seldom indicates subsequent extensive foraging in temperate waters far beyond the shelf break; however, as leatherbacks are incidentally captured in pelagic fisheries operating at high latitudes (Witzell, 1999; Lewison *et al.*, 2004), it is reasonable to expect that some animals move onto the shelf after foraging in pelagic habitats, while others may migrate to and remain in these areas throughout the summer and fall foraging period (Eckert, 1998).

The diet of leatherbacks in northern waters of the Atlantic has been studied, and the species of jellyfish which they prey upon have been identified (Hartog & Nierop, 1984; Holland *et al.*, 1990; Bleakney, 1965; James & Herman, 2001). However, relatively little is known about the biology of these jellyfish in this region. Changes in the distribution and abundance of jellyfish may help explain annual variation in the number of turtles using Canadian waters and the timing and locations of turtle aggregations.

3. CRITICAL HABITAT

Critical habitat as defined under section 2 of SARA is the "*habitat necessary for the survival and recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*".
While the state of knowledge on habitat requirements of leatherback turtles in Canadian waters is increasing as new scientific evidence becomes available, it is currently not possible to identify critical habitat for this species. As set out in SARA, if information is inadequate to identify

critical habitat within the recovery strategy, a schedule of studies must be prepared. Such a schedule, when implemented, will yield new information to enable the species' critical habitat to be described.

Appendix II includes a list of research and monitoring activities that collectively, constitute a schedule of studies. It is hoped that the results of this work will allow Fisheries and Oceans to be able to identify the critical habitat for Atlantic leatherback turtle in a recovery action plan, which will be developed once the activities outlined in the Appendix has been completed.

4. RECOVERY

4.1 Recovery Feasibility

This recovery strategy takes a precautionary approach and suggests that recovery for the Atlantic leatherback turtle is feasible in the absence of information that would prove otherwise.

Many biological parameters, necessary to model recovery feasibility, are not understood for the leatherback. The species' capacity to rebound depends on fecundity, life span, age at maturity and survivorship, none of which are currently known. Therefore, it is difficult to predict the potential for recovery of the species. More specifically, it is not presently possible to state quantitatively whether implementing recovery efforts under this strategy will lead to the de-listing of leatherback turtles.

Furthermore, the full range of threats to the species in Atlantic Canadian waters is not completely understood, and much needs to be determined to understand how effective mitigation measures would be coordinated. International efforts will be critical to protect the species throughout their global migratory, foraging, breeding, nesting and developmental habitats.

Nonetheless, most of the observed decline has been in the Pacific population. A recent evaluation of trends at Pacific nesting beaches suggests a much greater rate of decline in the Pacific population of leatherbacks than in the Atlantic (Spotila *et al*., 2000). Therefore, current recovery efforts by nations interacting with Atlantic leatherbacks, and now Canadian efforts, generate guarded optimism for the species in the Atlantic. Implementation of the recommendations contained herein will provide population biologists with the information required to more clearly understand recovery feasibility of leatherback turtles in Atlantic Canada.

Information on the status of the entire population in the Atlantic is not available. While the number nesting appears to be stable or increasing in the US Virgin Islands, Puerto Rico and Florida, the overall trend for the major nesting rookery in the French Guiana/Suriname region has been negative since 1987 (NMFS SEFSC, 2001), and is therefore suggestive that leatherbacks in the western Atlantic continue to experience mortality rates that exceed sustainable levels. Therefore Canadian efforts, in conjunction with the efforts of all nations having an impact on leatherbacks, are required for the recovery of Atlantic leatherbacks. Implementation of the recommendations contained in the Recovery Strategy will provide

biologists and managers with the information required to better understand recovery feasibility of the Atlantic population of the leatherback turtle.

4.2 Recovery Goal

The goal for the recovery strategy is to *'increase the population such that the long-term viability of the leatherback turtles frequenting Atlantic Canadian waters is achieved'.*

4.3 Recovery Objectives

Creating and maintaining the necessary conditions both within Canadian territory and abroad in efforts to achieve a viable population of Atlantic leatherback turtles will be accomplished by implementing the following recovery objectives:

- **Objective 1:** Understanding Threats. *Identify and understand anthropogenic threats to leatherback turtles in Atlantic Canadian waters.*
- **Objective 2:** Understanding Leatherback Turtle Life History Characteristics. *Support research and monitoring that will fill knowledge gaps concerning general organismal traits of leatherback turtles in Atlantic Canadian waters.*
- **Objective 3:** Habitat Identification and Protection. *Identify and protect habitat of leatherback turtles in Atlantic Canadian waters.*
- **Objective 4:** Risk Reduction. *Minimize risk of harm to leatherback turtles from anthropogenic activities under Canadian jurisdiction.*
- **Objective 5:** Education. *Develop and implement education activities that support leatherback turtle recovery in Canada.*
- **Objective 6:** International Initiatives. *Promote international initiatives contributing to the recovery of leatherback turtles.*

Following each objective is a series of strategies that, when implemented, will directly respond to their corresponding objective. These strategies attempt to provide sufficient level of detail in order to facilitate the next step of recovery planning, which is the development of recovery action plans.

The six recovery objectives and their respective strategies are as follows:

Objective 1: Understanding Threats. *Identify and understand anthropogenic threats to leatherback turtles in Atlantic waters.*

Rationale: The current state of knowledge about threats to leatherback turtles in Canadian waters is poor. Much more information, and synthesis of information, are needed to guide recovery activities, and to guide communication about them. Implementation of the following strategies will enhance the ability to assess and evaluate these threats and to work towards developing

appropriate mitigation measures.

Strategies:

a) Synthesize and evaluate existing data on commercial fishing activities known to, or having the potential to, impact survival and recovery.

b) Synthesize and evaluate existing data on offshore development activities known to, or having the potential to, impact survival and recovery.

c) Identify and understand the level of threat to leatherback turtles from marine debris and pollution.

d) Identify and understand other activities that may pose a threat to leatherback turtles (e.g. vessel interactions, military activities).

Objective 2: Understanding Leatherback Turtle Life History Characteristics. *Support research and monitoring that will fill knowledge gaps concerning general organismal traits of leatherback turtles in Atlantic Canadian waters.*

Rationale: The current state of knowledge about the basic biology and ecology of leatherback turtles in Atlantic Canadian waters is poor. More understanding is required for recovery efforts to be most effective.

Strategies:

a) Synthesize existing knowledge from research and monitoring activities undertaken regarding leatherback turtles.

b) Support research on basic knowledge gaps identified from (a) including, but not limited to, foraging ecology, diving behaviour, life history, distribution, and demographics.

Objective 3: Habitat Identification and Protection. *Take steps to identify and protect habitat utilized by leatherback turtles in Atlantic Canadian waters.*

Rationale: The lack of information about the biology and ecology of leatherback turtles is paralleled by what is not known of their habitat requirements, especially in Atlantic Canada. The following strategies will attempt to acquire further information about habitat so that it may be protected in the future. A schedule of studies regarding critical habitat identification can be found in Appendix B.

Strategies:

a) Undertake research to identify habitat use by leatherback turtles in Atlantic Canada

b) Assess the distribution and abundance of leatherback turtle prey (and/or develop oceanographic proxies for turtle prey that can be assessed using remote sensing or sampling).

c) Assess the extent that critical habitat exists in Atlantic Canadian waters.

d) Assess and evaluate tools for habitat protection.

Objective 4: Risk Reduction. *Minimize risk of harm to leatherback turtles from anthropogenic activities under Canadian jurisdiction.*

Rationale: Once threats and risks have been identified (Objective 1), it will be necessary to develop activities to mitigate those threats. Lack of full knowledge or understanding of threats should not preclude proactive work to reduce risk to the turtles. Many mitigation activities, including stewardship, will be developed based on outcomes of research activities and threats identified in the above Objectives.

Strategies:

a) Implement, when practical, mitigation measures to minimize human-induced mortality.

b) Further develop measures that will reduce known harm from human activities (e.g. vessel strikes and entanglement in fishing gear, stranding response teams, entanglement and stranding response teams).

c) Utilize stewardship programmes developed under Objective 5 to engage stakeholders in the implementation of mitigation measures.

Objective 5: Education. *Develop and implement education activities that support leatherback turtle recovery in Canada.*

Rationale: Education is an important tool to further recovery efforts through both stakeholders and the general public. Specific documents and programmes should be developed, targeting a variety of audiences. This kind of education programme should result in improved marine environmental health overall.

Strategies:

a) Develop programmes for educating Canadians about leatherback turtle conservation.

b) Develop initiatives to educate and train stakeholders about their role in leatherback turtle conservation.

Objective 6: International Initiatives. *Promote international initiatives contributing to the recovery of leatherback turtles.*

Rationale: Canada has the opportunity to play a role in conservation of leatherback turtles throughout their range. A variety of Canadian organizations and agencies can influence activities in other countries, ultimately contributing to improvements in the conservation status of the species throughout its range.

Strategies:

a) Investigate options for Canadian participation in and promotion of international agreements and conventions that promote leatherback turtle protection and recovery.

b) Collaborate with U.S. agencies, other range nations, and international bodies, on leatherback turtle conservation initiatives, when possible.

4.4. Performance Indicators

Measurable performance indicators will be a critical component of the recovery action plan for the Atlantic leatherback turtle to gauge the extent that recovery activities are successful in contributing to the stated recovery goal for the species. For the strategies identified under each of the six recovery objectives in this recovery strategy, a set of progress indicators should be devised. At this stage, many of the indicators will reflect the current lack of knowledge about leatherback turtles, and will be related to research activities. During regular or scheduled intervals when the recovery strategy and action plan will be reviewed, progress indicators should be revised to reflect increasing knowledge. Indicators outlined in table 2 therefore are preliminary, represent our current thinking and subject to change as recovery actions are implemented.

Table 2. List of general indicators of progress to assist in determining the extent that recovery is being achieved.

Recovery Objective	Indicators of Progress
Understanding Threats	▪ Potential/known interactions of leatherback turtles and fishing industry activities identified and documented. ▪ Post-release survivorship determined. ▪ Potential biological removal limit assessed. ▪ Potential/known threats of offshore development activities on leatherback turtles identified and documented. ▪ Report produced on human activities known to, or having the potential to, threaten leatherbacks in Atlantic Canada, with recommendations for actions.
Research	▪ Populations frequenting Atlantic Canadian waters identified. ▪ Historic and current sightings compiled and organized in a centralized database. ▪ Knowledge from research and monitoring activities compiled in a comprehensive, living, reference document that is regularly updated and accessible to a broad range of user groups. ▪ Research initiated on foraging ecology, movements and behaviour of leatherbacks in Canadian waters. ▪ Research initiated on the oceanographic correlates that relate to the spatial/temporal distribution of leatherbacks in Canadian waters. ▪ Survey programme established to develop indices of abundance (e.g., long term in-water population trends in northwest Atlantic waters).
Habitat Identification and Protection	▪ Critical and/or important habitat in Atlantic Canada identified to the extent possible. ▪ Tools for habitat protection assessed and evaluated. ▪ Draft plan for protection of critical habitat in Atlantic Canada developed.
Threat Mitigation and Risk Reduction	▪ Mitigation measures developed to reduce known harm from human activities. ▪ Recovery and emergency response procedures implemented, along with specific threat reduction measures.

Recovery Objective	Indicators of Progress
	▪ Programmes developed to engage stakeholders in the implementation of mitigation measures.
Education and Outreach	▪ Information on leatherbacks produced and distributed to federal and provincial government departments ▪ Public awareness materials produced and distributed, including but not limited to briefing kits, web resources, brochures. ▪ Initiatives developed to educate and train stakeholders about their role in leatherback turtle conservation (e.g. continuation of fishers outreach/research via NS Leatherback Turtle Working Group).
International Initiatives	▪ Collaboration with other nations on leatherback turtle conservation initiatives.

Table 2. List of general indicators of progress to assist in determining the extent that recovery is being achieved. Each set of indicators corresponds to a specific recovery objective.

5. IDENTIFICATION OF KNOWLEDGE GAPS

There are a number of gaps in our knowledge about the Atlantic leatherback turtle in Canadian waters. These gaps occur in areas of biology and ecology, habitat requirements, and potential threats. The following is a list of efforts that are required in order to fill the knowledge gaps.

5.1 Ecology and Biology

1. Conduct surveys to determine seasonal leatherback distribution and abundance and to identify foraging habitats that are of significant importance to the recovery of leatherback populations in Atlantic Canada.
2. Identify and investigate distribution of prey/food sources to improve our understanding of leatherback/prey relationships.
3. Model biotic and abiotic factors (e.g. oceanographic correlates) that may influence the seasonal distribution of leatherbacks in Canadian waters.
4. Conduct research on the basic biology and physiology of the leatherback to better understand how these turtles function in relation to their environment.
5. Investigate diving depth, duration, and frequency to provide dive correction factors for aerial survey assessments and to guide management measures pertaining to commercial fisheries.
6. Determine the spatial and temporal overlap of commercial fisheries and leatherbacks to determine where and when leatherbacks may have the potential to interact with commercial fisheries.
7. Analyse data from existing fishery observer programmes and identify where observer coverage may be needed to provide statistically valid bycatch estimates for leatherbacks taken in commercial fisheries.
8. Fully capitalize on all opportunities for leatherback necropsy in Atlantic Canada to learn more about basic biology and disease, identify sources of mortality, and obtain samples for archiving and to support other studies.
9. Investigate seasonal foraging and migratory movements of leatherbacks in Canadian and International waters.
10. Establish long-term indices of leatherback abundance in Canadian waters.

11. Conduct research to determine the nesting beach assemblages represented in the mixed foraging population that frequents Atlantic Canadian waters.

5.2 Habitat

1. Consolidate information from all jurisdictions on threats to habitats utilized by leatherback turtles.
2. Continue to conduct studies that will identify habitats that are critical to leatherback turtles in Canadian waters.
3. Use available oceanographic data to determine how sea surface temperature and chlorophyll are measures of primary productivity and proxies for leatherback prey, and can be correlated with leatherback distribution.
4. Conduct research on the distribution and abundance of leatherback prey (jellyfish) and leatherback turtles in Atlantic Canadian waters.
5. Identify leatherback turtle migration pathways by various means including satellite telemetry.
6. Determine what activities are occurring or have potential to occur that impact the habitat utilized by the leatherback turtle.

5.3 Threats

1. Quantify known or potential threats to leatherback turtles on foraging grounds and along migratory routes.
2. Estimate prospects for recovery at various levels of mortality based on knowledge of reproductive fitness.
3. Estimate the bycatch associated with all fisheries known to incidentally take leatherback turtles.
4. Recommend the adaptation of the current pelagic longline sampling protocol for the Canadian East Coast Observer Program to include turtle data collection in other gear sectors where observer coverage should be targeted.
5. Evaluate the impact of all fishing gear types currently in use and rank according to impact (note gear types listed in U.S. plan).
6. Evaluate/adopt the use of fishing gear modifications to reduce incidence of LBT-gear interactions/mortality.
7. Investigate handling procedures to minimize harm to leatherback turtles incidentally taken in commercial fishing gear.
8. Investigate post-release mortality from commercial fishing gear.
9. Investigate the potential impact of seismic activities in foraging areas and migration pathways and evaluate the effectiveness of current or proposed mitigation measures for seismic activity.
10. Investigate the potential impact of military activity on the leatherback turtle and its prey.

11. Evaluate the impact of discharges associated with exploration and production drilling, particularly discharge of produced water (investigate Gulf of Mexico experience)
12. Investigate the potential impact of contaminants and pollutants on the leatherback turtle.
13. Determine the level of mortality and injury associated with marine debris (consider U.S. data).
14. Evaluate vulnerability of leatherback turtles to vessel strikes and assess the incidence of vessel strikes as a cause of mortality in Canadian waters (consider U.S. data).
15. Investigate options for mitigation of any gear related threats.

6. ACTIONS COMPLETED OR UNDERWAY[1]

Many recovery efforts to date have been initiated by the Nova Scotia Leatherback Turtle Working Group (NSLTWG) with financial support from the Government of Canada's Habitat Stewardship Program for Species at Risk (HSP). The NSLTWG is a collaborative marine turtle research and conservation initiative involving volunteer commercial fishers, tour boat operators, naturalists, coastal community members, and university-affiliated scientists in Atlantic Canada.

Since 1997, the NSLTWG and its many fisher representatives have worked with coastal community members in Nova Scotia to increase public awareness of marine turtle biology and conservation issues, and to study the biology of marine turtles in the North Atlantic. The group has been successful in contributing new information that is crucial to the conservation of these species. Sighting data collected by fisher-members of the Nova Scotia Leatherback Turtle Working Group as well as data summarized in McAlpine *et al*. (2004), revealed that eastern Canadian waters are within the regular range of large numbers of leatherbacks. In addition, NSLTWG fishers remain committed to effecting practical conservation for the leatherback at sea, particularly through their efforts to disentangle accidentally entrapped turtles.

Further recovery efforts by fishers include extensive work conducted by the Canadian large pelagic longline industry during the 2001 and 2002 fishing seasons. By 2002, the scope of the project included the entire Canadian large pelagic longline industry (swordfish, tuna and shark fleets). Through funding from the Habitat Stewardship Program, these groups (*Atlantic Shark Association in 2002, IVY Fisheries Ltd. in 2002 and the Nova Scotia Swordfishermen's Association in 2001 and 2002*) have been investigating the potential for and nature of interactions between pelagic longline gear and leatherback turtles. Observers collected data to document (1) gear configuration parameters and their rates of interactions with leatherback turtles, (2) current release methods, (3) whether or not all gear was removed upon release, (4) the number, species and size of turtles captured and, (5) spatial and temporal distribution of interactions. This has led to a better understanding of the distribution of the leatherback turtle in Canadian waters, the nature of any interactions with pelagic longline gear, and release methods in practice.

1 Since the writing of this recovery strategy, additional scientific work has been completed or initiated by various organizations such as Amphibia-Nature. As scientific data becomes available it will be examined during the development of the recovery action plans.

Since 1995, a large portion of the swordfish longline fleet have used circle hooks, which reduce bycatch and maximize the chances of leatherback turtle survival. This gear is configured to allow turtles to stay at the surface until they are released. In addition, the gear uses primarily circle hooks to decrease the chances of hooking the turtles. These methods are currently being adopted by other international pelagic longline fleets to prevent sea turtle bycatch. In 2003-2004, the Nova Scotia Swordfishermen's Association, with funding from the Habitat Stewardship Program, assessed the effectiveness of new de-hooking kits for releasing turtles in a humane manner.

In addition to efforts by fishers, Dalhousie University has conducted research to study leatherback turtles using satellite-linked time-data recorders (SLTDRs) since 2000. This multi-year project has tracked leatherback turtles to gain information about migration and feeding (diving and foraging) behaviour. Dalhousie researchers and fisher members of the NSLTWG, led by Mike James, have been able to live-capture free-swimming leatherback turtles and attach the SLTDRs using a harness fitted to the animal. In September 1999, the Dalhousie - NSLTWG project became the first in the world to satellite-tag a leatherback turtle at sea, and the first to ever satellite-tag a male leatherback.

During 2000-01, DFO provided Species at Risk programme funding through a joint agreement with Dalhousie University to assist in the purchase of satellite transmitter tags. Preliminary results from this work have revealed coastal and offshore foraging movements (characterized by shallow dives of short duration) in Canadian and U.S. waters, with extensive feeding in slope waters east of the Fundian Channel and George's Bank. Residency time in Canadian waters has varied considerably as some animals depart soon after tagging while others remain foraging in Canadian waters for three to four months. Tagged leatherback turtles have migrated to Caribbean waters adjacent to nesting sites, to pelagic waters at low latitude, and to shelf waters off the southeastern United States. Data collected through this ongoing research will assist in evaluating the vulnerability of this species to human activities occurring in Canadian waters and throughout its north Atlantic range.

In an effort to mitigate potential threats posed by commercial fishing gear, a marine animal disentanglement and stranding programme was established in Newfoundland through funding provided under the Government of Canada's Habitat Stewardship Programme. It was established to mitigate impacts of inshore fisheries on leatherback turtles as well as to promote sea turtle conservation through outreach and education.

Beginning in 2003, a multifaceted research programme (portions of which are a cooperative with Memorial University) has been supported by DFO's Species at Risk funds. Studies are underway to address issues such as distribution and abundance of leatherbacks (aerial surveys in 2002 and 2003), proximate composition and distribution of jellyfish in the Region, amalgamation of historic and current turtle sightings, interview studies to investigate distribution and sources of mortality, and support and contribute to public education programmes through the Department and with provincial and international NGOs.

There are a variety of actions that other countries are taking to recover the leatherback turtle and these activities will be outlined more fully in the action plan.

7. STATEMENT OF WHEN ONE OR MORE RECOVERY ACTION PLANS WILL BE COMPLETED

Recovery action plans are the documents that lay out how recovery strategies are to be implemented. The action plans take recommendations from the recovery strategy, either individually or collectively, and chart out who needs to be involved and to what extent in carrying out the proposed activities.

Following the approval of this recovery strategy under SARA and posting on the public registry, a recovery action plan for the Atlantic population of leatherback turtle will be developed within **three years**. In the interim, many of the strategies in this document can be acted on and therefore, recovery implementation will be an ongoing activity that can occur in the absence of any formal action plan.

8. SOCIO-ECONOMIC CONSIDERATIONS

Under SARA, one or more action plans must be prepared to implement the recovery strategy. The action plan(s) must include an evaluation of the socio-economic costs of the action plan and the benefits derived from its implementation [Section 49(1)(e)]. Because it is not currently possible to identify the preferred suite of leatherback turtle recovery tools, it is only possible to make general statements about the costs and benefits of leatherback turtle conservation and recovery at this time.

The costs of conservation tend to be 'upfront' costs and are often concentrated geographically or by industry sector. The benefits of conservation, on the other hand, tend to be diffuse across society and may not be realized until some time in the future.
For the public sector, the costs associated with conservation and recovery may include the costs of gathering information (including scientific investigation), consultations, negotiations, monitoring and enforcement. Care must be taken to properly account for the net costs and benefits of various sectors – one person's 'cost' may be another person's 'benefit'. A second important consideration is that monitoring and enforcement can rapidly become prohibitively expensive when resource users do not 'buy in' to action plans. This highlights the potential importance of public sector investments in conservation awareness programmes, consultation, and trust-building activities as part of broad conservation and recovery programmes.

The benefits of leatherback turtle conservation and recovery accruing to Canadian society could include: Non-consumptive direct use value (e.g., wildlife viewing tours); Indirect use value (e.g., contributions by the animal to the regulation of ecosystem services); Information value (e.g., the value of documenting key life history parameters that could be used for population modeling and better management in the future); Value to future generations; and Existence value (i.e., the value of leatherback turtles to Canadians who will never 'use' them in any way).

9. ACTIVITIES PERMITTED BY THE RECOVERY STRATEGY

Subsection 83(4) of SARA enables recovery strategies, action plans and management plans to exempt persons engaging in certain activities from the general prohibitions under SARA. In order for this provision to apply, individuals must also be authorized under another Act of Parliament to be carrying out such activities.

In the case of fishing activities that are known to incidentally capture leatherback turtles in Atlantic Canadian waters, DFO hosted a Regional Advisory Process (RAP) review in May 2004 to review the estimates of mortality that would not jeopardize survival or recovery of leatherback turtles. Participants included DFO scientists and fisheries managers, scientists from academia and the US National Marine Fisheries Service and representatives from the fishing and environmental communities. As a result of these consultations, a formal document entitled "Allowable Harm Assessment for Leatherback Turtle" was prepared. This document, along with the Proceedings of the consultation is available on the Department of Fisheries and Oceans website, under the Canadian Science Advisory Secretariat (CSAS) at: http://www.dfo-mpo.gc.ca/csas/csas/Publications/Pub_Index_e.htm

Estimates discussed in the report indicate that the size of the Atlantic leatherback turtle population likely exceeds several hundred thousand individuals. As above under section '*2.6.2 Population in Atlantic Canada'*, there is no estimate of what fraction of the population may migrate into Canadian waters.

Estimates of incidental capture of leatherback turtles in the entire Atlantic Ocean range from 30,000 to 60,000 for one gear sector (offshore pelagic longline fleets) in 2000 (Lewison. *et al.*, 2004). Although these estimates should be considered tentative, because of the assumptions underlying the calculations, they support the conclusion that tens of thousands of leatherbacks are incidentally captured each year in the Atlantic Ocean.

The Canadian contribution to incidental captures is largely unknown, but available data from the Canadian offshore pelagic longline fleet indicates about 170 incidental captures per year. As outlined above under '*2.8.1 Threats in the Marine Environment*', quantitative data on incidental capture exists only for this fleet and on-board observers reported no mortalities in this fishery during the 2001-2003 fishery. However, based on estimated encounter rates from DFO observer data and post-encounter mortality estimates drawn from studies in the US, a small number of leatherback turtle mortalities may have occurred each year in the Canadian fishery.

Given that the population likely exceeds several hundred thousand animals, and may be larger, that the geographic extent of the population has not changed (suggesting that suitable habitat is available to permit population growth), and model results suggest that the population can sustain human-induced mortality up to about 1%, the RAP review concluded that there was scope for human-induced mortality without jeopardizing survival or recovery of this species.

The recovery strategy adopts this conclusion and, in accordance with subsection 83(4) of SARA, permits commercial fishers in Atlantic Canada to carry out activities authorized under the federal

Fisheries Act that are known to incidentally capture leatherback turtles. A scientific review of the estimates of leatherback turtle mortality in Atlantic Canadian waters will be undertaken every 5 years to ensure that the survival or recovery of the species is not jeopardized.

To minimize the impact of encounters with commercial fishing operations in Canada, fishers must take every reasonable effort to ensure that entangled leatherback turtles be released in the least harmful manner. As well, mandatory reporting of encounters with leatherback turtles is required to document the impact of these fisheries on the Atlantic leatherback turtle population. This information will also enable the Department to assess the effectiveness of recovery efforts and work cooperatively with the fishing industry to find further solutions to assist leatherback turtle recovery.

10. ANTICIPATED CHALLENGES FOR RECOVERY

As has been illustrated throughout this document, a major challenge facing the recovery of Atlantic leatherbacks is the lack of general knowledge about the species, its abundance (both in Canadian waters and on the high seas) and appropriate measures to mitigate any negative human-induced effects. While there has been significant progress in narrowing these knowledge gaps in recent years, it is widely accepted that research efforts must continue and increase. Accordingly, areas where more information is needed have been identified in this strategy (Section 5.0).

Targeted studies in the implementation phase of recovery are expected to yield a better understanding of what is needed to achieve a viable population (and hence recovery) of leatherback turtles in Atlantic waters. In the absence of complete information, however, recovery actions are possible and are promoted as key objectives in this strategy. Through an iterative and adaptive approach to recovery, it should be accepted that new data will inform the development of mitigation measures and strategies for recovery implementation.

In addition to knowledge gaps, the highly migratory and pelagic habits of the species present a significant challenge for recovery. Recovery of the leatherback turtle will require significant international coordination to reduce or remove the negative impacts of human activities across the species' range. While some progress is being made in this area, with the establishment of bilateral and multi-lateral agreements between range states, international coordination still poses a special challenge. Canada can play an important role on the international stage in promoting conservation efforts for this species, and will need to examine the ways in which this can be most effectively achieved.

The strategies recommended here reflect opportunities for immediate action as well as the urgent need for more research, and places both in the context of international cooperation. Canada has a role both at home and abroad for the recovery of this species.

11. REFERENCES

Bacon, P.R. 1981. The status of sea turtle stocks management in the western Central Atlantic. West Central Atlantic Fisheries Commission (WECAF) Studies 7:1-38.

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-54: 387-429.

Bartol, S.M., J.A. Musick and M.L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia 1999(3): 836-840.

Binckley, C.A., J.R. Spotila, K.S. Wilson and F.V. Paladino. 1998. Sex determination and sex ratios of Pacific leatherback turtles, *Dermochely coriacea*. Copeia 2: 291-300.

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Canadian Field Naturalist 79: 120-128.

Boulon, R.H., K.L. Eckert, and S.A. Eckert. 1988. *Dermochelys coriacea* (leatherback sea turtle) migration. Herpetological Review 19(4):88.

Brongersma, L.D. 1982. Marine turtles of the Eastern Atlantic. *In*, Bjorndal, K. (Ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C., 407-416.

Calleson, T.J., G.O. Bailey and H.L. Edmiston. 1998. Rare nesting occurrence of the leatherback sea turtle, *Dermochelys coriacea*, in northwest Florida, USA. Herpetological Review 29(1): 14-15.

Campbell, C.L., C.J. Lagueux and J.A. Mortimer. 1996. Leatherback turtle, *Dermochelys coriacea*, nesting at Tortuguero, Costa Rica, in 1995. Chelonian Conservation and Biology 2(2): 169-172.

Chan E. and H. Liew. 1996. Decline of the leatherback population in Terengganu, Malaysia, 1956-1995. Chelonian Conservation and Biology 2(2): 196-203.

Chan, E.H., H.C. Liew and A.G. Mazlan. 1988. The incidental capture of sea turtles in fishing gear in Terengganu, Malaysia. Biological Conservation 43(1):1-7.

Cheng, I.J. and T.H. Chen. 1997. The incidental capture of five species of sea turtles by coastal setnet fisheries in the eastern waters of Taiwan. Biological Conservation 82(2): 235-239.

Chevalier, J. and M. Girondot. 1998. Dynamique de ponte des tortues marines en Guyane française pendant la saison 1997. Bulletin de la Société Herpétologique de France 85-86 : 5-19.

Collard, S.B. 1990. Leatherback turtles feeding near a watermass boundary in the eastern Gulf of Mexico. Marine Turtle Newsletter 50: 12-14.

COSEWIC 2001. COSEWIC assessment and update status report on the leatherback turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 25 pp.

Cook, F.R. 1981. Status report on the leatherback turtle, *Dermochelys coriacea*. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 17 pp.

D'Amours, D. 1983. A leatherback turtle (*Dermochelys coriacea*) on the coast of Quebec. Naturaliste Canadien 110 (4): 481.

Davenport, J. 1997. Reptilia. pp. 325-326, In: The species directory of the marine fauna and flora of the British Isles and surrounding seas, C.M. Howson and B.E. Picton (Eds). Ulster Museum and The Marine Conservation Society: Belfast & Ross on Wye.

Davenport, J. and J. Wrench. 1990. Metal levels in a leatherback turtle (*Dermochelys coriacea*). Marine Pollution Bulletin 21(1):40-41.

Davenport, J., J. Wrench, J. McEvoy and V. Camacholbar. 1990. Metal and PCB concentrations in the Harlech leatherback. Marine Turtle Newsletter. 48: 1-6.

Davis, R.A., D.H. Thomson and C.I. Malme. 1998. Environmental assessment of seismic exploration on the Scotian Shelf. Report by LGL Ltd. to Mobil Oil Properties Ltd., Shell Canada Ltd., Imperial Oil Ltd. and Canada-Nova Scotia Offshore Petroleum Board, Halifax, NS.

DFO, 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. Habitat Status Report 2004/002, September 2004.

DFO. 2005a. Pacific Leatherback Turtle Recovery Strategy. .

DFO. 2005b. Marine megafauna sightings and strandings database. St. John's, NL (Jack Lawson, contact).

Dixon, J. A., and S. Pagiola. 1998. Economic analysis and environmental assessment. Environmental Assessment Sourcebook Update 23. Washington, DC: World Bank. 14 pp.

Dutton P.H., T.G. Davis and D. Owens. 1996. Molecular phylogeny for marine turtles based on sequences of the ND4-Leucine tRNA and control region of mitochondrial DNA. Molecular Phylogenetics and Evolution 5: 511-521.

Dutton, P.H., C.P. Whitmore and N. Mrosovsky. 1985. Masculinization of leatherback turtle *Dermochelys coriacea* hatchlings from eggs incubated in Styrofoam boxes. Biological Conservation 31: 249-264.

Dwyer, K., Ryder, C. and Prescott, R. 2002. Anthropogenic mortality of leatherback turtles in Massachusetts waters. In Proceedings of the Twenty-Second Annual Symposium on Sea Turtle Conservation and Biology. In Press NMFS 1992.

Eckert, S. A., 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year-long tracking of leatherback sea turtles, p. 294. *In:* Proceedings of the Seventeenth Annual Sea Turtle Symposium. S.P. Epperly and J. Braun (eds.).

Eckert, S. A., Bowles, A. and Berg, E. (1998). The effect of seismic airgun surveys on leatherback sea turtles (*Dermochelys coriacea*) during the nesting season. Report submitted to BHP Petroleum. San Diego, CA.: Hubbs-Sea World Research Institute.

Eckert, S. A. and L.M. Sarti. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78, 2-7.

Eckert, S.A. 1999. Global distribution of juvenile leatherback sea turtles. Hubbs Sea World Research Institute Technical Report 99-294. 13 pp.

Epperly, S.P., J. Braun and A. Veishlow. 1995. Sea turtles in North Carolina waters. Conservation Biology 9:384-394.

Epperly, ShP and W.G. Teas. 2002. Turtle excluder devices – Are the escape openings large enough. Fishery Bulletin 100 (3): 466-474.

Fleming, E.H. 2001. Swimming against the tide: Recent surveys of exploitation, trade, and management of marine turtles in the northern Caribbean. TRAFFIC North America, Washington D.C., 161 p.

Frazier, J., M.D. Meneghel and F. Achaval.1985. A clarification on the feeding habits of *Dermochelys coriacea*. Journal of Herpetology 19(1): 159-160.

Fretey, J. and J.P. Malaussena. 1991. Sea turtle nesting in Sierra Leone, west Africa. Marine Turtle Newsletter 54:10-12.

Frick, M.G. K.L. Williams and D.C . Veljacic. 2002. A record of the northernmost, verified leatherback sea turtle nesting event on the east coast of the USA. Marine Turtle Newsletter 97: 12-13.

Fritts, T. H., W. Hoffman, and M. A. McGehee. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. Journal of Herpetology 17:327-344.

Garman, S. 1884. Contributions to the natural history of the Bermudas. Reptiles. United States National Museum Bulletin 25:1-353.

Gilhen, J. 1984. Amphibians and reptiles of Nova Scotia. Nova Scotia Museum, Halifax., 162 p.

Girondot, M. and J. Fretey. 1996. Leatherback turtles, *Dermochelys coriacea*, nesting in French Guiana, 1978-1995. Chelonian Conservation and Biology 2(2): 204-208.

Godley, B.J., M.J. Gaywood, R.J. Law, C.J. McCarthy, C.J. McKenzie, I.A.P. Patterson, R.S. Penrose, R.J. Reid and H.M. Ross. 1998. Patterns of marine turtle mortality in British waters (1992-96) with reference to tissue contaminant levels. Journal of the Marine Biological Association of the United Kingdom 78: 973-984.

Goff, G. P. and J. Lien.1988. Atlantic leatherback turtles, *Dermochelys coriacea* , in cold water off Newfoundland and Labrador. Can. Field Nat. 102:1-5.

Greene, C.R. and S.E. Moore. 1995. Man-made noise. Pgs 101-158 *In* W.J. Richardson, C.R. Greene, Jr., C.I. Malme and D.H. Thomson. Marine Mammals and Noise. Academic Press, San Diego.

Hartog, J.C. den and M.M. Van Nierop. 1984. A study on the gut contents of six leathery turtles *Dermochelys coriacea* (Linnaeus) (Reptilia: Testudines: Dermochelyidae) from British waters and from the Netherlands. Zoologische Verhandelingen (Leiden) No. 209.

Holland, D. L., J. Davenport, and J. East. 1990. The fatty acid composition of the leatherback turtle *Dermochelys coriacea* and its jellyfish prey. Journal of the Marine Biology Association of the United Kingdom. 70:761-770.

Hosier, P.E., M. Kochhar, and V. Thayer. 1981. Off-road vehicle and pedestrian track effects on the sea-approach of hatchling loggerhead turtles. Environmental Conservation 8: 158-161.

Hughes, G.R. 1996. Nesting of the leatherback turtle (*Dermochelys coriacea*) in Tongaland, KwaZulu-Natal, South Africa, 1963-1995. Chelonian Conservation and Biology 2 (2):153-158.

Hughes, G.R., P. Luschi, R. Mencacci and F. Papi. 1998. The 7000-km oceanic journey of a leatherback turtle tracked by satellite. Journal of Experimental Marine Biology and Ecology 229(2): 209-217.

James, M.C. 2000. Distribution of the leatherback turtle (*Dermochelys coriacea*) in Atlantic Canada: Evidence from an observer program, aerial surveys, and a volunteer network of fish harvesters. M.Sc. Thesis. Biology Department. Acadia University, Wolfville, Nova Scotia, 71pp.

James, M. C. and T. B. Herman. 2001. Feeding of *Dermochelys coriacea* on Medusae in the northwest Atlantic. Chelonian Conservation and Biology. 4(1): 202-205.

James, M., C. Ottensmeyer, and R. Myers. 2005a. Identification of high-use habitat and threats to leatherback sea turtles in northern waters: new directions for conservation. Ecology Letters 8:195-201

James, M., R. Myers, and C. Ottensmeyer. 2005b. Behaviour of leatherback sea turtles, *Dermachelys coriacea*, during the migratory cycle. Proceedings of the Royal Society B 272:1547-1555.

Javitech Limited 2002. Report on sea turtle interactions in the 2001 pelagic longline fishery; submitted to Nova Scotia Swordfishermen's Association & Environment Canada, March 28, 2002.

Javitech Limited 2003 (A). Report on sea turtle interactions in the 2002 pelagic (ITQ) longline fishery; submitted to Nova Scotia Swordfishermen's Association & Environment Canada, February 14, 2003.

Javitech Limited 2003 (B). Report on sea turtle interactions in the 2002 pelagic (offshore) longline fishery, submitted to Ivy Fisheries Limited & Environment Canada, February 14, 2003.

Javitech Limited 2003 (C). Report on sea turtle interactions in the 2002 Porbeagle shark longline fishery; submitted to Atlantic Shark Association & Environment Canada, February 14, 2003.

Keinath, J.A. and J.A. Musick. 1993. Movements and diving behavior of a leatherback turtle, *Dermochelys coriacea*. Copeia 4:1010-1017.

Lawson, J.W., R.A. Davis W.J. Richardson and C.I. Malme. 2000. Assessment of noise issues relevant to key cetacean species (northern bottlenose whales and sperm whales) in the Sable Island Gully Area of Interest. Prepared for Oceans Act Coordination Office, Maritimes Region, Department of Fisheries and Oceans.

Lawson, J.W., and J.-F. Gosselin. 2003. SARCEP 2002 pilot cetacean survey - Atlantic Canada. Department of Fisheries and Oceans, SARCEP. 14 p.

Lazell, J.D., Jr. 1980. New England waters: critical habitat for marine turtles. Copeia 1980:290-295.

Lenhardt, M.L.1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). Pp. 238-240 *In* K.A. Bjorndal, A.B. Bolten, D.A. Johnson and P.J. Eliazar (eds.), Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS SEFSC 351.

Lenhardt, M.L., S. Bellmud, R.A. Byles, S.W. Harkins and J.A Musick. 1983. Marine turtle reception of bone-conducted sound. Journal of Auditory Research 23: 119-125.

Leslie, A., Penick, D.N., Spotila, J.R., and F. Paladino. 1996. Leatherback turtle,

Dermochelys coriacea, nesting and nest success at Tortuguero, Costa Rica, in 1990 1991. Chelonian Conservation and Biology 2 (2):159-168.

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.

Linnaeus, C.1766. Systema Naturae, 12th ed. Salvius, Stockholm

Lutcavage, M. 1996. Planning your next meal: leatherback travel routes and ocean fronts. Pp. 174-178 *In* Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and conservation, Keinath, J.A., Barnard, D.E., Musick, J.A., and Bell, compilers. NOAA Technical Memorandum NMFS-SEFSC-387.

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

Lutcavage, M. and P.L. Lutz. 1986. Metabolic rate and food energy requirements of the leatherback sea turtle, *Dermochelys coriacea*. Copeia 1986 (3): 796-798.

McAlpine, D.F., James, M.C., Lien, J. and Orchard, S.A. 2004. Status and conservation of marine turtles in Canadian waters. In C.R. Seburn and C.A. Bishop (eds.). Ecology, conservation and status of Canadian Reptiles. Herpetological Conservation 2. Society for the Study of Amphibians and Reptiles. St. Louis, Missouri.(in press).

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch and K. McCabe. 2000. Marine seismic surveys—A study of environmental implications. APPEA Journal 2000: 692-708.

McDonald. D.L. and P.H. Dutton. 1996. Use of PIT tags and photo identification to revise remigration estimates of leatherback turtles(*Dermochelys coriacea*) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2(2), 148-152.

Moein, S. E., Musick, J. A., Keinath, J. A., Barnard, D. E., Lenhardt, M. and George, R. 1994. Evaluation of seismic sources for repelling sea turtles from hopper dredges: final report submitted to the U.S. Army Corps of Engineers waterways experiment station., pp. 33. Gloucester Point, VA.: Virginia Institute of Marine Science, College of William and Mary.

Morreale, S.J., G.J. Ruiz, J.R. Spotila and E.A. Standora. 1982. Temperature-dependent sex determination: Current practices threaten conservation of sea turtles. Science, 216:1245-1247.

Morreale, S.J., Standora, E.A., Spotila, J.R. and Paladino, F.V. 1996. Migration corridor for sea turtles. Nature 384 (6607): 319-320.

National Marine Fisheries Service Southeast Fisheries Science Center. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. U.S. Department of Commerce NOAA Technical Memorandum NMFS-SEFSC-455, 343 p.

National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NMFS-SEFC-415, Miami.

National Oceanic and Atmospheric Administration (NOAA) 2002a. Atlantic Highly Migratory Species; Pelagic Longline Fishery; Shark Gillnet Fishery; Sea Turtle and Whale Protection Measures – Final Rule. Federal Register, Vol. 67, No. 131, Tuesday July 9, 2002, Rules and Regulations.

National Oceanic and Atmospheric Administration (NOAA). 2002b. Endangered Species Act – Section 7 Consultation. Biological Opinion for Gulf of Mexico Outer Continental Shelf Multi-Lease Sale (F/SER/2002/00718). NOAA Fisheries, Southeast Regional Office.

National Oceanic and Atmospheric Administration (NOAA). 2004. Proposed Rule to reduce bycatch and bycatch mortality of sea turtles caught incidentally in the Atlantic and Gulf of Mexico HMS pelagic longline fisheries. Federal Register 69: 6621-6635.

National Research Council (NRC). 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C. 259 p.

O'Boyle, R.O. 2001. Meeting on turtle by-catch in Canadian Atlantic fisheries. Department of Fisheries and Oceans, Science Division. 31 pp.

O'Hara, J. and J.R. Wilcox. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia 1990(2): 564-567.

Pritchard, P.C.H. 1971. The leatherback or leathery turtle *Dermochelys coriacea*. IUCN Monographs 1: 39.

Pritchard, P.C.H. 1976. Post-nesting movements of marine turtles (Cheloniidae and Dermochelyidae) tagged in the Guianas. Copeia 1976: 749-754.

Pritchard, P.C.H. 1979. Encyclopedia of Turtles. T. F. H. Publications, Inc. Neptune, New Jersey. 895 pages.

Pritchard, P. C. H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea*, in Pacific Mexico, with a new estimate of the world population status. Copeia 1982(4): 741-747.

Pritchard, P. C. H., and P. Trebbau. 1984. Family Dermochelyidae, *Dermochelys coriacea*. In The turtles of Venezuela, Society for the Study of Amphibians and Reptiles. Contribution to Herpetology 2: 249-267.

Rabon, D.R., S.A. Johnson, R. Boettcher, M. Dodd, M. Lyons, S. Murphy, S. Ramsey, S. Roff and K. Stewart. 2003. Confirmed leatherback turtle (*Dermochelys coriacea*) nests from North Carolina, with a summary of leatherback nesting activities north of Florida. Marine Turtle Newsletter No. 101, p. 4-6).

Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin and J.H. Anderson. 1969. Hearing in the Giant Sea Turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences 64: 884-890.

Rostal, D.C., F.V. Paladino, R. Patterson and J.R. Spotila. 1996. Reproductive physiology of nesting leatherback turtles (*Dermochelys coriace*a) at Las Baulas National Park, Costa Rica. Chelonian Conservation and Biology. 2(2): 230-236).

Ruckdeschel, C. and C.R. Shoop. 1982. *Dermochelys coriacea* (leatherback sea turtle) nesting. Herpetological Review 13: 126.

Shoop, C.R. 1980. Sea turtles in the northeast. Maritimes 24(4): 9-11

Shoop, C.R. and R.D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the north eastern United States. Herpetological Monographs 6: 43–67.

Soto, J.M.R., R.C.P. Beheregaray and R.A.R. de P. Rebello. 1997. Range extension: nesting by *Dermochelys* and *Caretta* in southern Brazil. Marine Turtle Newsletter 77:6-7.

Spotila, J. R., Reina, R. D., Steyermark, A. C., Plotkin, P. T. and F. V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature 405:529-530.

Spotila, J.R., Dunham, A.E., Leslie, A.J., Steyermark, A.C., Plotkiin, P.T. and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelonian Conservation and Biology 2 (2):209-222.

Starbird, C. 2000. *Dermochelys coriacea* (leatherback sea turtle) fishing net ingestion. Herpetological Review 31(1): 43.

Steyermark, A.C., K. Williams, J.R. Spotila, F.V. Paladino, D.C. Rostal, S.J. Morreale, M.T. Koberg and R. Arauz. 1996. Nesting leatherback turtles at Las Baulas National Park, Costa Rica. Chelonian Conservation and Biology 2(2): 173-183.

Stinson, M.L. 1984. Biology of sea turtles in San Diego Bay, California and in the northeastern Pacific Ocean. MSc. Thesis, San Diego State University, California.

Threlfall, W. 1978. First record of the Atlantic leatherback turtle (*Dermochelys coriacea*) from Labrador. Canadian Field-Naturalist 92(3): 287.

Whitmore, C. P., and P. H. Dutton. 1985. Infertility, embryonic mortality and nest-site selection in leatherback and green sea turtles in Suriname. Biological Conservation 34:251-272.

Witherington, B. E. 1992. Behavioural responses of nesting sea turtles to artificial lighting. Herpetologica 48(1): 31-39.

Witherington, B.E. and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles *Caretta caretta*. Biological Conservation 55: 139-149.

Witzell, W. N. 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western north Atlantic Ocean, 1992-1995. Fish. Bull. 97:200-211.

Zagerl, R. 1980. Patterns of phylogenetic differentiation in the toxochelyid and cheloniid sea turtles. American Zoologist 20(3): 585-596.

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtle *Dermochelys coriacea* (Testudines: Dermochelyidae): A skeletochronological analysis. Chelonian Conservation and Biology 2(2): 244-249.

APPENDIX A - GLOSSARY

Amphipod: A small flat-bodied crustacean of the order Amphipoda.

Bioaccumulation: The accumulation of a substance, such as a toxic chemical, in the tissues of a living organism.

Biomagnification: The increasing concentration of a substance, such as a toxic chemical, found in the tissues of a living organism as you move up the food web. Simple organisms such as algae can absorb and bioaccumulate minute quantities of a substance which are transferred through the food chain to higher living species such as fish, bird, etc. Biomagnification along a food chain will result in the highest concentrations of a substance being found at the top of the food chain.

Bycatch: The harvest of fish or shellfish other than the species for which the fishing gear was set.

Carapace: A bony or chitinous case or shell covering the back or part of the back of an animal.

Commensal: Having benefit for one member of a two-species association but neither positive nor negative effect on the other.

Critical Habitat: 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 the recovery strategy or in an action plan for the species.

Delisting: The removal of a species from the list of species at risk following its recovery.

Endangered Species: a wildlife species that is facing imminent extirpation or extinction.

Food Chain: a community of organisms where each member is eaten in turn by another member.

Forage: the act of searching for food and provisions.

Gene flow: Transfer of genes from one population to another of the same species.

Gangion: A short line attached to a trawl.

Groin: a protective structure of stone or concrete; extends from shore into the water to prevent a beach from washing away.

Gyre: a great, circular motion of water in each of the major ocean basins centered on subtropical high-pressure region, with circulation clockwise in the northern hemisphere and counterclockwise in the southern hemisphere.

Hatchling: Newly hatched fish or reptile.

Mandible: The lower jaw of vertebrates.

Medusae: The tentacled, bell-shaped, and sexually mature stage in the life cycle of a jellyfish and other members of the Coelentera.

Mortality: Death rate.

Necrosis: Localized death of cells or tissues through injury or disease.

Pelagic: Pertaining to animals that live at the surface of the ocean, away from the coast.

PIT tag: Passive Integrated Transponder tags are microchips that are injected into an animal's muscle tissues using a hand-held applicator gun.

Plastron: The front, or ventral part, of the shell of a turtle.

Rookery: A breeding colony of birds or animals.

Revetment: A sloping surface of stone, concrete or other material used to protect an embankment, natural coast or shoreline against erosion.

Riprap: A rubble sustaining wall, often used along shorelines to prevent erosion.

Seawalls: A wall of stone, concrete, or other sturdy material, built along the shoreline to prevent erosion even by the strongest and highest of waves.

Seismic Exploration: The use of seismic energy to probe beneath the surface of the earth.

Stewardship: The wide range of voluntary actions that people are taking to care for the environment.

Telemetry: The automatic measurement and transmission of data from remote sources, by radio or other means, for recording and analysis.

Upwelling: A process through which cold and usually nutrient-rich waters rise from the bottom of the ocean to its surface.

APPENDIX B – SCHEDULE OF STUDIES TO IDENTIFY CRITICAL HABITAT

In the absence of sufficient information on habitat use to identify the critical habitat of leatherback turtles in Atlantic Canadian waters within this recovery strategy, SARA requires under section 41.1c.1 that a 'Schedule of Studies' be prepared. The following research activities in Table 1 target key knowledge gaps on the habitat requirements of this species while seasonally resident or migrating through Canadian waters. Accompanying each activity is an assessment of the overall priority, potential partners, and estimated timing. It is hoped that implementing the following schedule will yield information to eventually allow for the critical habitat for this species to be described. It is important to note that activities outlined in this schedule are subject to priorities and budgetary constraints of the participating jurisdictions and organizations. Consequently, these activities may not necessarily be completed within the timelines as established below.

RESEARCH ACTIVITIES	PRIORITY	START DATE	ESTIMATED TIMING				
		2006	YR 1	YR 2	YR 3	YR 4	YR 5
Critical habitat identification							
Evaluate the spatial and temporal distribution and foraging ecology of leatherback turtles in Canadian waters.	Primary	ongoing	×	×	×	×	×
Conduct satellite telemetry studies to identify seasonal foraging areas in Atlantic Canadian waters and migratory routes in the Western Atlantic.	Primary	ongoing	x	x	x	×	×
Identify prey species and assess their spatial and temporal distribution in Canadian waters.	Primary	ongoing	×	×	×	×	×
Identify and model oceanographic processes that influence the spatial and temporal leatherback distribution in Canadian waters.	Secondary	ongoing	x	×	×	×	×

Note: Potential partners for the above activities could include but are not limited to the following :

Department of Fisheries and Oceans
Nova Scotia Leatherback Turtle Working Group
Dalhousie University
Memorial University of Newfoundland
National Marine Fisheries Service
Aboriginal People Representatives
Other Non- Governmental Environmental/Research Organizations

APPENDIX C - RECORD OF CONSULTATIONS

The leatherback turtle is an aquatic species under the federal jurisdiction of Fisheries and Oceans Canada. There are few people in Canada with scientific, traditional, or local knowledge of this species as sightings are typically limited to shelf and offshore observations by the fishing industry.

To assist in the development of this Recovery Strategy, DFO brought together a group of experts and representatives from multiple levels of government, including the US National Marine Fisheries Service, environmental non-government organizations, and industry groups. Specific members and their affiliations can be found on page iv of the preamble to this recovery strategy.

Comments on this strategy were sought from three members of the international scientific community who have expertise on this species. In addition, Section 9.0 of this strategy was subject to a full peer review through the Canadian Science Advisory process.

The strategy was also reviewed by relevant provincial government Directors from Quebec, Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland.

Consultation with industry groups that may be affected by this Recovery Strategy occurred at the October 2005 Atlantic Large Pelagic Advisory Committee meeting. All comments received have been incorporated.

Additional input on this strategy was sought from members of the Atlantic Policy Congress of First Nation Chiefs in February 2006. No specific comments on the Recovery Strategy were received.

Comments received on the proposed recovery strategy during the public registry comment period were incorporated in the final version of the document.