National Recovery Strategy

for the

LEATHERBACK TURTLE (*Dermochelys coriacea*)

in

Pacific Canadian Waters

Draft (September 2003)

DISCLAIMER

The National Recovery Strategy for the Leatherback Turtle in Pacific Canadian Waters has been prepared by the Pacific Leatherback Turtle Recovery Team in consultation with participants and observers to identify recovery actions that are deemed necessary, based on sound biological principles, to protect and recover the species. It does not necessarily represent the positions of agencies and/or the views of individuals involved in the plan's preparation. The goals, objectives, and recovery actions identified in the recovery document are subject to the priorities and budgetary constraints of participating jurisdictions and organizations, as well as modifications to accommodate new objectives or findings.

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RECOMMENDED CITATION

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EXECUTIVE SUMMARY

A genetically distinct, nationally significant population of the leatherback turtle occurs seasonally in coastal British Columbia. This large, highly migratory reptile makes foraging migrations from nesting sites in the Western and Eastern Pacific. It is threatened with extinction by a long list of factors, including accidental capture, nesting beach habitat loss, killing of nesting females and harvest of eggs. While many of the threats are not present along the Pacific coast of Canada, the fact that leatherback recovery will only occur as the result of a concerted international effort means that a Canadian recovery strategy cannot ignore threats that occur outside Canadian waters.

In B.C., the major threats are probably accidental capture and entanglement, collision with boats and ingestion of debris, although a critical lack of information on basic turtle biology and sightings makes it very difficult to assign risk to any particular threat. Within the leatherback's Pacific Canadian range, the main knowledge gaps concern the animal's occurrence, distribution, behaviour and interaction with fishing gear. This lack of information presently makes it impossible to identify critical habitat in B.C., which will in any event move with the animal's food supply.

The Recovery Strategy recommends opportunities for immediate action as well as the urgent need for more research, and places both in the context of international cooperation. The **goal** of the Strategy is the long-term viability of the leatherback turtle population(s) that frequent Pacific Canadian waters. The goal will be reached through five **objectives** aimed at filling knowledge gaps through stand-alone Canadian research and through Canadian contribution to research efforts in other countries; summarizing what we know of the occurrence of leatherbacks off coastal B.C. and their interactions with people; mitigating threats throughout the leatherback's range; and creating the public and professional awareness needed for recovery. The objectives are designed to take advantage of Canadian expertise not only in the Canadian part of the leatherback's range but also in the remainder of the species' nesting, rearing and foraging habitat. Canada has a role both at home and abroad for the recovery of this species.

Until the population biology and status of leatherbacks that frequent Pacific Canadian waters are known it is difficult to predict the likelihood of a return to viability. The species' capacity to rebound is influenced by its lifetime reproductive capacity, which is unknown. Availability of quality foraging habitat off coastal B.C. does not appear to be limiting, and Canadian capability for alleviating the major known threats in our waters is high. However, the fate of the Pacific leatherback turtle rests on much more than its transient life in B.C. waters, and this Strategy stresses the need to take advantage of international conventions and to collaborate with governments, research organizations and civil society throughout the leatherback's range.

1. INTRODUCTION

This Recovery Strategy concerns an animal many Canadians may never have heard of, but all will find extraordinary. What little is known about the leatherback turtle offers tantalizing glimpses into a remarkable physiology and life history. The adult leatherback is not only the most migratory of all sea turtles but also the largest and widest ranging reptile, capable of annual journeys of more than 15,000 km. From an evolutionary perspective, the leatherback turtle is unique among extant turtles and the sole surviving representative of the family *Dermochelyidae*, thought to be at least 100 million years old. The species is an important component of marine biodiversity, with a diet that places it at the top of a marine food chain responsible for more than half the primary productivity of pelagic waters.

Genetically distinct Pacific and Atlantic stocks of leatherbacks make extensive feeding migrations to Canadian coastal waters from nesting beaches and rearing areas in tropical seas. The species' occurrence in Canadian waters and its increasing global rarity demand aggressive conservation measures that involve not only actions in Canada but also the participation of Canadians in international programs and projects. This *Recovery Strategy for the Leatherback Turtle in Pacific Canadian Waters* complements one being developed for leatherback turtles in Atlantic Canadian waters.

Adult Pacific leatherbacks are often seen foraging off the coast of B.C. between July and September. Although sightings are not frequent, a database presently being compiled by Fisheries and Oceans Canada shows the animals to range along the entire B.C. coast, including inshore waters. The collapse of the Pacific stock means that the accidental removal of even a few adults may slow or jeopardize recovery of the species.

This National Recovery Strategy is a legal requirement under the *Species at Risk Act* (SARA). The SARA came into force on June 5, 2003. The purposes of the Act are:

> "… to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of a wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened."

Leatherback turtles are listed as *Endangered* under Schedule I of SARA which results in legal protection and mandatory recovery requirements. Protection under the Act prohibits killing, harming and harassing of individuals and also prohibits the damaging or destroying of their residence and protection for critical habitat (once identified in a recovery strategy and/or action plan). The Minister of Fisheries & Oceans, as a "competent minister" under SARA for leatherback turtles, is responsible the development of "recovery strategies" and "action plans" for each of the listed species under the Act.

The Recovery Strategy summarizes what is known of the biology and status of the Pacific leatherback turtle, and reflects not only our limited knowledge about this animal but also the need for international cooperation in its recovery. The Strategy is accompanied by the Action Plan, also a requirement under the Act. The Action Plan lists the measures that are

to be taken over the next 5 years to implement the Recovery Strategy. Fortunately, Canadians have a great deal to contribute to recovery activities, ranging from participation of coastal British Columbians in surveys and industry-specific measures to contributions to international research and policy efforts.

2. BACKGROUND[1]

2.1 Current status

Common name:	Leatherback turtle
Scientific name:	*Dermochelys coriacea*
Assessment summary:	May 2001
COSEWIC 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.
Occurrence in Canada:	Pacific and Atlantic coasts
Status history:	First listed as endangered in 1981

A more detailed review of the causes of the decline in the Cultus sockeye population, including information subsequent to the COSEWIC assessment summary (May 2003) may be found later in this recovery Strategy ("Threats to population viability and habitat").

2.2 Taxonomy and description

2.2.1 Species and populations

The leatherback turtle *Dermochelys coriacea* is one of only two species of sea turtle regularly seen in Canadian waters (the other is the loggerhead *Caretta caretta*).

The leatherback is the only member of the family Dermochelyidae (Bustard 1972). Although Atlantic and Pacific subspecies of leatherback turtles have been described, morphologic distinctions are questionable (Pritchard 1979). More recent analysis of mitochondrial DNA sequence divergence confirms that Atlantic and Pacific populations should be considered as genetically distinct lineages of a single species (Dutton et al. 1999). However, the same study indicates there is much less genetic differentiation among leatherback populations than has been observed among populations of other sea turtles.

[1] *SARA* requires that the recovery strategy identify "a description of the species and its needs that is consistent with the information provided by COSEWIC" [*SARA* s.41(1)(a)].

Atlantic leatherbacks nest primarily on beaches in Central and South America, the southern Caribbean and in Western Africa and are sighted year-round off Atlantic Canada. For management purposes, the main nesting populations of the Pacific leatherback belong to two genetically distinct populations (Dutton et al. 1999):

- *Eastern Pacific*, nesting primarily in Mexico and Costa Rica and including Guatemala, Nicaragua and Panama;
- *Western Pacific,* nesting primarily in Papua (formerly Irian Jaya), Malaysia, the Solomon Islands and Papua New Guinea.

Preliminary evidence suggests that leatherback turtles seen foraging in the North Pacific are from the Western Pacific population (Dutton et al. 1999), so it is likely that most leatherbacks in Pacific Canadian waters also belong to the western Pacific population. However, this conclusion is based on small sample size and needs to be confirmed through additional research. In the interim, this Recovery Strategy considers the viability of both Western and Eastern Pacific populations of leatherback turtles.

2.2.2 Appearance

The leatherback is the only sea turtle that lacks a bony shell. It is the largest living reptile and can grow as long as 2 m and weigh as much as 900 kg (Zug and Parham 1996). The adult's carapace is a leathery, oil-saturated connective tissue layer, ridged and tapered at the rear and overlying a mosaic of loosely interlocking dermal bones (Pritchard 1971). The front flippers are proportionately longer than in other sea turtles (half the carapace length and up to 270 cm) and are roughly three times the length of the back ones (Brown 1976).

The leatherback has no scales or claws and lacks the crushing and chewing plates characteristic of other sea turtles that feed on hard-bodied prey (Pritchard 1971). The jaw of the leatherback has two tooth-like projections on the upper jaw that interlock with a single "tooth" on the lower mandible. The edges of the mandibles are adapted for cutting soft tissue and the long esophagus has backward-pointing spines that help the animal swallow the hydromedusae that are their main diet (Bleakney 1965).

Dorsally, adult leatherbacks are almost completely black with some white spotting, while the ventral surface is usually whitish. Hatchlings are black with lighter undersides, but they also have small bead-like scales that are lost within the first six months of life (Pritchard 1971). Each leatherback turtle has an apparently unique, patterned pink spot on the dorsal surface of its head, directly over the pineal organ, which has been used to identify individuals (McDonald and Dutton 1996).

There are no major differences in the average size of mature males and females. However, the sexes can be differentiated by tail length. The male's tail usually extends beyond the end of the rear flippers while the female's does not (Pritchard 1971).

2.2.3 Physiology

Leatherbacks differ from other turtles in being facultative homeotherms that can maintain a core body temperature higher than the surrounding water temperature (Frair et al.1972). This unusual ability may result from a number of anatomical and physiological adaptations including thermal inertia in retaining the heat generated by constant swimming, large body mass, insulating and brown adipose tissue, and counter-current exchange in flippers (Mrosovsky and Pritchard 1971; Davenport 1998; Eckert 2002b). The leatherback's broad temperature tolerance allows it to range as far north as the Barents Sea and as far south as Chile and New Zealand (Eckert 1993).

Leatherbacks are highly adapted for diving, and adults have been recorded deeper than 1200 m in tropical latitudes (Eckert et al. 1996; Lutcavage et al. 1992). Such deep diving may be for nocturnal foraging on soft-bodied invertebrates that migrate vertically (Eckert et al. 1989), and probably increases their chances of contact with fishing gear.

2.2.4 Swimming and migration

Adult leatherbacks swim continuously at a constant rate of around 0.65 m/sec. They cover roughly the same distance each day, although horizontal distance depends on how much diving they do. Swim speed and distance studies indicate that leatherbacks average 45-65 km per day. Adult leatherbacks do not appear to bask or rest during the day, and continue to move forward even when near the surface. When moving long distances they tend to swim just below the surface (Eckert 2002b).

Leatherbacks appear to migrate to feed, and are locally more abundant where jellyfish, their primary prey, are at higher densities (Grant et al. 1996). After nesting, the turtles appear to migrate from tropical to temperate waters, following thermal fronts and oceanic gyres and seeking areas of high productivity for soft-bodied invertebrates (Lutcavage 1996).

The movements of turtles are studied using a variety of tagging methods. Earlier methods of flipper tagging suffered because of poor tag retention but nonetheless demonstrated prodigious migrations. For example, a leatherback tagged in French Guiana was recorded 128 days later at Fox Harbour, Newfoundland, a straight line distance of more than 5,000 km at 39 km/day (Goff et al. 1994). More recently, radio transmitters whose signal can be received by mobile VHF antenna or satellite have yielded more information, especially when combined with swim speed and dive recording data-loggers (Eckert 1995). Newer tracking methods mean that tagging is no longer restricted to females that can be captured and tagged as they come ashore to nest, and have showed that these turtles make very long (11,000 km) annual southern migrations with a predetermined destination. The longest post-nesting satellite tracks of leatherbacks to date were collected by Eckert (1998), in which two female leatherbacks were followed for over a year after tagging in Trinidad.

Attaching tracking instruments at sea is more difficult than tagging turtles on the nesting beach. However, the technique has the advantage of allowing males, non-nesting females and juvenile leatherbacks to be tracked. The first adult male leatherback turtle

was satellite tagged off Cape Breton Island in 1999 (James and Eckert 2002). Six additional males have since been satellite tagged in Eastern Canadian waters (M. James 2002, pers. comm.). In the Pacific, five males have been satellite tagged and tracked from Monterey Bay, California (S. Eckert 2002, pers. comm.).

The distribution and developmental habitats of juvenile leatherbacks were poorly known until recently. Eckert (2002a) analyzed the available data on sightings and found that turtles smaller than 100 cm (carapace length) were found only in waters 26°C or warmer, but that larger turtles were found in waters as cold as 12°C. In Canada however, leatherbacks often occur in northern waters off Newfoundland in temperatures from 0 to 15°C (Goff and Lien 1988). Leatherbacks thus appear to spend the first part of their lives in warm waters, and may venture into cooler climates as they develop thermoregulating capacity. Frair et al. (1972) observed that a captive leatherback in 7.5°C water maintained a body temperature of 25.5°C, suggesting considerable cold water tolerance. Much more research is needed to determine the movements of juvenile leatherback turtles during the years between hatching and their first foraging migrations as adults.

2.3 Distribution

2.3.1 Global (Fig. 1)

The adult leatherback is not only the most migratory of all sea turtles but also the widest-ranging reptile (Pritchard and Trebbau 1984). It is found in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans (Gulliksen 1990; Ernst and Barbour 1989). Adults swim more than 15,000 km per year for foraging and, as in the case of the leatherbacks that occur off B.C., can traverse entire oceans (Eckert 2002b). In addition to the major Pacific nesting sites in Mexico, Costa Rica, Papua, Papua New Guinea, Solomon Islands and Malaysia (James 2001), additional nesting occurs throughout Central America and in the western insular areas around the Solomon Islands, Vanuatu, Fiji, as well as in Australia (NMFS and USFWS 1998).

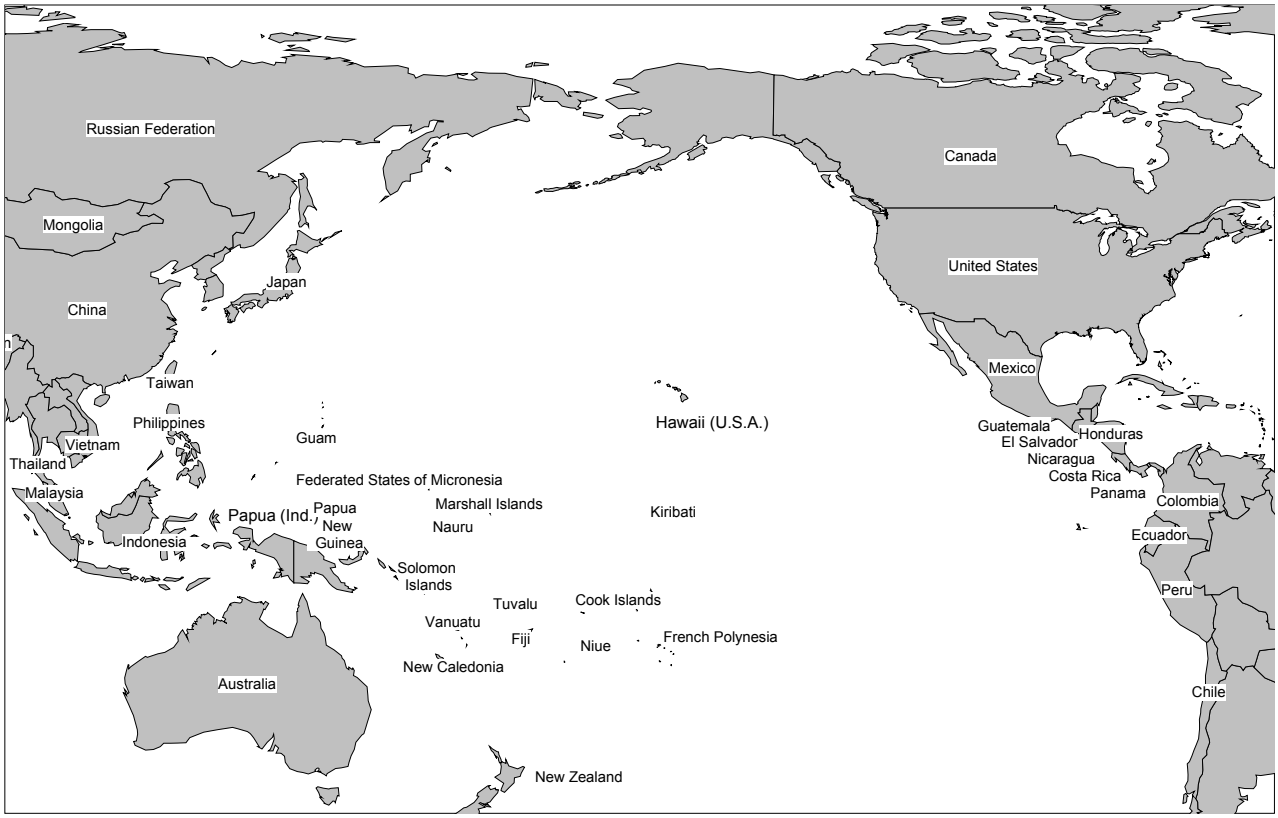

Figure 1. Pacific Ocean showing place names mentioned in the text

2.3.2 Pacific Canada (Fig. 2)

In contrast to Atlantic leatherbacks, which are seen year-round off the east coast of Canada, adult Pacific leatherbacks are most often seen foraging off the coast of B.C. between July and September (Goff and Lien 1988). This timing correlates well with sightings of leatherbacks from California to Washington in the U.S. (Stinson 1984; Starbird et al. 1993). Despite a growing database of sightings, there are few areas where leatherback turtles are routinely observed.

Sightings records are anecdotal and generally made by fishermen, either through accidental capture or as a vessel passes close to a turtle feeding on jellyfish near the surface. In recent years, reported sightings by pleasure boaters have become more frequent. The leatherback's size, distinctive features and rarity mean that sightings are generally well recalled.

The first leatherback turtle recorded in B.C. waters was seen at Bajo Reef, Nootka Sound, on the west coast of Vancouver Island (MacAskie and Forrester 1962). Other west coast Vancouver Island sightings include waters from Pachena Point to Brooks Bay, as well as near the town of Bamfield in Barkley Sound and on La Perouse Bank, an important commercial fishing area about 15 km offshore. Sightings farther offshore range as far as the boundary of the Canadian Exclusive Economic Zone (EEZ).

Leatherback turtle sightings have become more frequent in recent years throughout the Queen Charlotte Islands. Multiple observations have been made throughout the southern Queen Charlotte Islands (Froom 1976), while a few have occurred at Langara Island and Skidegate Inlet. The most recent sighting took place in 2001 off Langara Island (Simkin 2001, pers. comm.).

Leatherbacks have also been observed in the protected waters of Georgia and Hecate Straits (Gregory and Campbell 1984), including near several beaches in Victoria (L. Fairley 2003, pers. comm.).

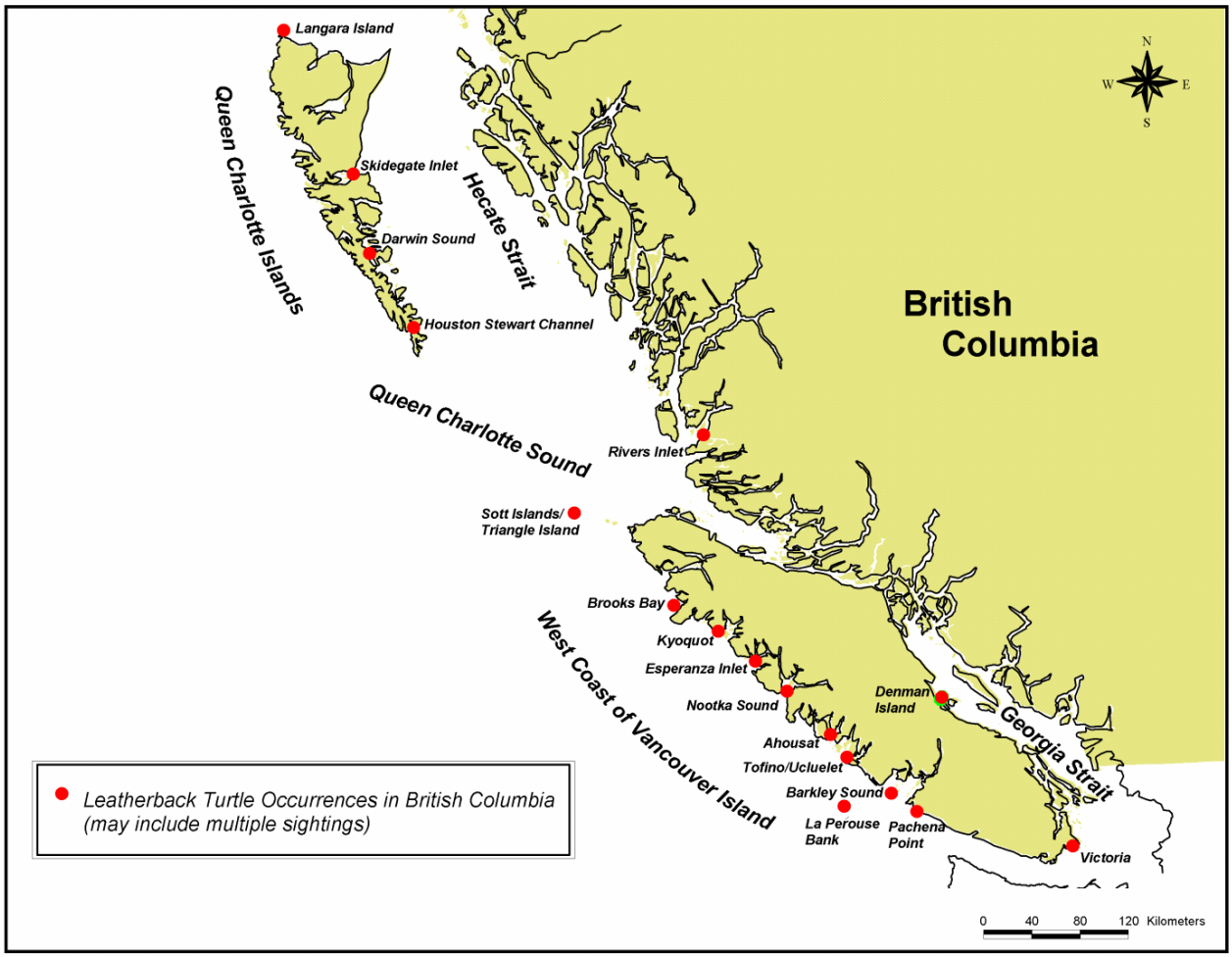

Figure 2. Leatherback turtle sightings in British Columbia

2.4 Natural history

2.4.1 Diet

Leatherbacks are pelagic animals that consume a variety of edible (and, unfortunately, inedible) slow-moving objects (Ernst and Barbour 1989). Their diet has been inferred mainly from the stomach contents of stranded animals and includes soft-bodied pelagic invertebrates like jellyfish and tunicates (Bleakney 1965; Den Hartog 1980; Davenport and Balazs 1991). This diet places them at the top of a marine food chain based on microscopic plankton that are responsible for more than half the primary productivity of pelagic waters (Eckert 2002c).

Adults forage both at the surface and during dives. Adults foraging in the North Pacific have been observed feeding on the jellyfish *Cyanea* and *Aurelia*, the latter massing in large shoals that are ideal for grazing. Because jellyfish are very high in water content and low in nutritional value, leatherbacks must range widely to find areas rich in jellyfish, which

are often along coastal upwelling areas and oceanic frontal systems (Lutcavage and Lutz 1986; Shoop and Kenney 1992).

The diet and foraging behaviour of hatchling and juvenile leatherbacks is very poorly known, and the low survival of captive juveniles makes their study difficult. Their rapid growth rate, however, suggests that they feed as voraciously as adults.

2.4.2 Reproduction and early development

The life span of the leatherback turtle is not known, nor is its age at sexual maturity. Estimates based on growth rate (which is expected to be much higher than other marine turtles; Rhodin 1985) and analysis of ocular ossicles (Zug and Parham 1996) range from maturity at 2-3 years (earlier than other sea turtles) to 14 years – a clear indication of the incomplete nature of our understanding of the biology of this species.

It is unclear where mating occurs. For most sea turtle species, mating can occur off the nesting beaches as well as along migration corridors (Meylan et al. 1992). Leatherback mating is probably similar, though scientific observation is rare (Eckert and Eckert 1988; Godfrey and Bareto 1998).

Pacific leatherbacks lay their eggs on sandy tropical beaches with a deep-water approach that reduces the amount of travel on land (Eckert 1987). They prefer beaches with little or no offshore reefs or rock. Nesting is long, laborious and usually nocturnal. Inseminated females return several times to the beach during nesting season, making short feeding excursions in between (the so-called inter-nesting period).

Females excavate a suitable site for egg deposition using their rear flippers (Pritchard 1971). Once the nest is deep enough a clutch of around 100 eggs is deposited, including up to half as many yolkless eggs whose function is unknown. Eggs are buried and the nest compacted followed by the female's return to the ocean. The whole process takes 80 to 120 minutes (Pritchard, 1971). Females average 4-6 clutches per season, at 8-12 day intervals.

The incubation time is 60-65 days (Ernst et al. 1994) and sex determination is temperature-dependent. The temperature producing roughly equal numbers of males and females has been established for some nesting sites used by Atlantic leatherbacks and is within a very narrow range (29.25-29.5°C; Mrosovsky et al. 1984). Temperatures below and above this range produce all-male and all-female clutches respectively (Chan and Liew 1996). Temperature-dependent sex ratio has also been investigated by Binckley et al. (1998). Hatchlings are 5-6 cm long and emerge at night, orienting toward the ocean because of its higher illumination relative to land.

Leatherbacks of the Western Pacific population nest at different times of the year, depending on the beach. Two different beaches in Papua, for example, are active in May-August and November-January (NMFS 2001). Nesting occurs every two to three years and the females return to the same beach every nesting season (NRC 1990; Hughes 1996).

2.5 Nationally Significant Populations

Leatherback turtles frequenting Pacific Canadian waters are considered to be genetically distinct from the turtles occurring in Atlantic Canadian waters. This distinction was first suggested by Pritchard (1979) and confirmed through analysis of sequence divergence in mitochondrial DNA by Dutton et al. (1999). The Pacific stock comprises (at least) two reproductively isolated populations, namely the Western and Eastern Pacific populations described in section 2.2.1. Each of these may warrant recognition as a nationally significant population, but it is not yet known whether turtles from the Eastern Pacific population frequent Pacific Canadian waters. Both populations are considered in this Recovery Strategy.

2.6 Population Status and Trends

2.6.1 Global

Population estimates for leatherbacks are based on numbers of nesting females, hence are relative rather than absolute and may be affected by skewed sex ratios. Nevertheless, the trends are clear. When both Pacific and Atlantic stocks are considered, the global number of nesting female leatherbacks fell from an estimated 115,000 in 1980 (Pritchard 1982) to 34,500 by 1995 (Spotila et al. 1996). This alarming decline is unevenly distributed, with nesting falling off more severely in Pacific populations, where some beaches had annual adult mortality as high as 33% (Spotila et al. 2000). Large numbers of turtles were killed in high seas fishing operations (Wetherall 1993; Eckert and Sarti 1997), while egg harvest, the killing of nesting females and nesting beach habitat destruction were also important factors (Chan and Liew 1996). Nesting activity in the Atlantic may be more stable, but still has periods of increase and decrease which make the trends more difficult to decipher.

The leatherback turtle is listed by IUCN as Critically Endangered (80% reduction in numbers in ten years or three generations). It is also listed under CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), an international agreement that ensures trade in wild animal and plant species does not threaten their survival, and in Appendix 1 of the Convention on Migratory Species, which classifies the species as endangered.

The following sections present status and trends for Eastern and Western Pacific populations; the latter may be more directly relevant to Canadian waters.

Eastern Pacific nesting populations

Until recently the largest known population of leatherbacks nested on the Pacific coast of Mexico. These turtles, whose known forage grounds include areas to the south off Peru and Chile, have severely declined in recent years. Mexiquillo Beach, an index beach on the Mexican coast, has seen a decline in nests from 5,000 in the 1980s to less than 100, and this decline is believed representative of the entire Eastern Pacific population (Sarti 2002). The 2001-2002 nesting season was the worst in twenty years, both in terms of

numbers of females and numbers of nests. The decline is believed due primarily to egg harvest and accidental capture in fisheries.

Western Pacific nesting populations

The Western Pacific population of leatherbacks, which is the presumed source of most of the adults foraging off Pacific Canada, includes populations that nest in Malaysia, Indonesia (Papua), Papua New Guinea and the Solomon Islands, with lesser contributions from beaches in Vanuatu, Fiji, China and Australia. The most important sites are Indonesia and Papua New Guinea. Unfortunately the population trends are not as well known as for the Eastern Pacific populations, and published reports are few and conflicting.

Terengganu, one of the east coast states of peninsular Malaysia, was once a major leatherback nesting area but has declined drastically. The Rantau Abang population has decreased from about 10,000 nests in the 1950s to fewer than 20 in recent years (Liew 2002). The declines appear to have occurred in two waves, one coinciding with rapid development of the fishing industry in Terengganu in the mid-1970s, and the second with introduction of the Japanese high seas squid driftnet fishery in the North Pacific in 1978. The nesting beaches were also subject to severe overharvest of eggs (often approaching 100%) since the 1940s. Since these events, the decline has averaged 16% annually. Only two females were recorded nesting in 1994 (Chan and Liew 1996).

The other major nesting sites in the Western Pacific are on beaches in Papua (formerly Irian Jaya), a part of the Indonesian archipelago that shares a land mass with New Guinea. In the 1980s smaller areas of nesting in Indonesia occurred on western Sumatra and southeastern Java (Suarez and Starbird 1996). Most of the turtles in Papua nest at Jambursba Medi Beach (Hitipeuw 2002; Putrawidjaja 2000), where over 80% of the nests are affected by poaching, predation by wild pigs, and erosion (Hitipeuw 2002; Suarez and Starbird 1996). The number of leatherback clutches deposited at Jambursba Medi beach has been reported to be stable between 1993 and 1996 (Hitipeuw 2002; Dermawan 2002); however, the long term trends are unclear and possibly declining (Hitipeuw 2002).

2.6.2 Pacific Canada

Information on sightings in B.C. coastal waters is extremely limited and it is not currently possible to draw any conclusions on population trends.

2.7 General Habitat requirements

Habitats that need to be considered include nesting, breeding and foraging habitats. Very little is known about distribution patterns in foraging habitats and migration routes and about the years between hatching and sexual maturity.

In nesting habitat, females require a sandy beach with a deep ocean approach and few obstructions like rock or coral (Pritchard 1971; Ernst and Barbour 1989). Habitat requirements for hatchlings and juveniles appear to be almost exclusively tropical until the

turtles exceed 100 cm in carapace length (Eckert 2002a). Large juveniles and subadults probably share habitats with adult leatherbacks.

Adults frequent cooler waters, including the continental shelves off Canada and the northeastern United States (Shoop and Kenney 1992). They follow oceanic frontal systems where productivity is high and results in high concentrations of prey (Lutcavage 1996). The coast of British Columbia provides foraging habitat; however, no studies have been done to verify specific foraging habitat areas important to leatherback turtles. Therefore it is impossible to identify either the habitat currently occupied by leatherback turtles in Pacific Canadian waters, or the amount of critical habitat needed to recover and support a viable population.

2.7.1 Critical Habitat[2]

SARA, under section 2, defines critical habitat as 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*." It is difficult to define critical habitat for turtles, as each life stage has different requirements distributed over large ocean basins. Although the knowledge base to help determine critical habitat is increasing with new research projects, at this time it is not possible to identify critical habitat for this species. As set out in the Act, if information is inadequate to identify critical habitat within the recovery strategy, a schedule of studies must be prepared. This schedule, once implemented, will yield new information that will help to identify the species' critical habitat in the future.

The schedule of studies, which is essentially a list of habitat research projects, identified for the pacific leatherback turtle can be found in Appendix 1. Upon completion of these projects, it is hoped that the results will allow Fisheries and Oceans Canada to be able to identify critical habitat for this species in a recovery action.

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2.8 Ecological role

Adult leatherbacks feed voraciously on jellyfish and other soft-bodied pelagic invertebrates that consume large quantities of zooplankton and fish larvae. They thus occupy an important position in the marine food chain. It may be assumed that leatherbacks play an important ecosystem role, helping maintain the balance between the numbers of their prey and the organisms that feed on that prey. They are also important components of terrestrial ecosystems in providing nutrients through unhatched and broken eggs and eggshells, and the eggs themselves are food for terrestrial animals who carry the nutrients inland (Eckert 2002c).

[2] SARA requires recovery strategies to include "an identification of the species' critical habitat, to the extent possible, based on the best available information, including information provided by COSEWIC" [SARA, s.41(c)].

2.9 Social and economic considerations

There is very limited directed fishery on adult leatherbacks anywhere in the world as the flesh is not generally considered palatable. However, the people of the Kai Kecil Islands in Indonesia have a ritual hunt for adult leatherbacks (Suarez and Starbird 1996). Many people that live near nesting areas eat and sell leatherback eggs.

Leatherbacks have limited socio-economic value in Pacific Canada. They probably do not occur close enough to land or in sufficient numbers to be of any importance to tourism. Although coastal First Nations are familiar with the animal, very limited anecdotal information from Clayoquot Sound, centrally located in the Pacific Canadian foraging range, suggests no evidence of any special use or significance (Webster 2002, pers. comm.). If an ethnographic study of the significance of leatherbacks to coastal First Nations were to be done it would need to include groups throughout the known range of sightings.

2.10 Biologically limiting factors

Identifying biological factors that may limit recovery is difficult for a species about which so little basic biological information is known. Because the leatherback's life span and age at maturity are unknown, it is difficult to assign any special risk to either characteristic. If, as some researchers believe, the leatherback is long-lived and slow to mature it is clearly at greater risk than rapidly maturing species. The time between nesting periods may also work against recovery, since these turtles appear to nest only every 2 to 3 years.

High risk behaviours other than reproductive behaviour include the leatherback's preference for long distance swimming just under the surface (risk of collision); its proclivity for ingesting floating objects; its preference for sandy beaches that are also attractive to humans for development; and the hatchlings' orientation to light, which can lead them away from the ocean rather than toward it.

2.11 Threats[3]

The list of threats to leatherback turtles is long and reflects their unique behaviours and wide geographic distribution. While many of the threats are not present along the Pacific coast of Canada, the fact that leatherback recovery will only occur as the result of a concerted international effort means that a Canadian recovery plan cannot ignore threats that occur outside Canadian waters. In the discussion below, threats are organized according to where they occur (foraging environment *vs* nesting environment). Threats in the foraging environment include those that are well known and those whose importance, especially in B.C., remains to be determined. One of the main thrusts of the Recovery Strategy is to evaluate the threats described below.

Threats in B.C. occur only in the foraging environment and are hard to quantify because they occur over a large area and the number of animals is low. Both factors make observation and recording much more difficult than at a nesting beach. Nevertheless, because of the precarious status of the Pacific populations of leatherbacks, the loss of even a few mature animals anywhere in the world, including B.C. coastal waters, may be significant to the viability of the Pacific stock. Adults foraging in Canadian waters are the largest, most cold-tolerant and most fecund individuals, and thus are more significant to the viability of the species than their numbers alone would suggest.

2.11.1 Threats in the foraging environment

Known threats

Accidental capture and entanglement: Leatherback turtles are caught accidentally in nets and on lines, especially in fisheries in pelagic and coastal foraging areas and in migratory corridors. Leatherbacks are especially vulnerable to entanglement in fishing gear because of their massive front flippers (James 2001) and are vulnerable not only to gear in use (especially un-monitored gear), but also to abandoned gear. Entangled turtles will drown if unable to free themselves, but may also lose limbs or become more vulnerable to predation. Turtles that break free may still be encumbered by trailing gear (NMFS 2001).

Many types of fisheries pose threats, with pelagic (floating) longline, gillnet and driftnet fisheries prominent (now prohibited, some driftnet fisheries continue illegally). Leatherbacks are intercepted by pelagic longline gear (McCracken 2000) and may be attracted to bait or simply snagged. There are large pelagic longline fisheries operated by many nations on both sides of the Pacific and in the South China Sea (although not presently in B.C.). Pelagic longlining for swordfish, shark and tuna results in significant bycatch of adult leatherbacks, although per cent mortality is not always reported (Balazs and Pooley 1994) and may be delayed after turtles are released (Witzell 1984).

Reduction of longline bycatch is a high priority and new approaches are being rapidly developed. The risk to leatherbacks presently appears to be highest where longlines are set at night in shallow water and lights are used to attract the target species, most

[3] *SARA* requires that the recovery strategy identify "…threats to the survival of the species that is consistent with information provided by COSEWIC." [*SARA* s.41(1)(*b*)].

commonly swordfish and sharks. Although there is some interest in developing a pelagic longline tuna fishery off B.C, the Recovery Team believes such a fishery would present a threat to leatherbacks.

The U.S. trawl fishery for shrimp also creates a significant turtle bycatch. Turtle Excluder Devices (TEDs) can reduce the number of turtles caught in shrimp trawl nets by giving them an escape route (US Environmental Protection Agency 1999), and TED regulations were amended in 2003 to increase the size of the escape opening, a change that will benefit leatherbacks (www.mslabs.noaa.gov/teds.html).

In B.C., crab and other pot fisheries may pose the threat of entanglement in vertical lines, and both large and small mesh gillnets can trap the animal. The main period of fisheries interception is probably between July and September, when the hake mid-water trawl and salmon gillnet and troll fisheries coincide with leatherback appearance in B.C. waters. The severity of all accidental capture-related threats from fisheries in B.C. waters is presently impossible to quantify due to limited sightings data.

Ingestion of debris: In B.C. coastal waters, debris arises from many sources, including coastal development and vessel traffic. Leatherbacks will eat inedible objects such as plastic bags, balloons, and tar balls that may resemble jellyfish, their intended prey (Mrosovsky 1981). They will also eat fishing nets (Starbird 2000). The effects of plastic bag ingestion on leatherback physiology and behaviour, including impaction and death, are reviewed by Fritts (1982).

Collisions with boats: Turtles can be injured or killed if struck by boats and propellers. Leatherbacks may be particularly at risk because of their habit of swimming just beneath the surface. Perhaps the largest concern in B.C. arises from transiting vessels. It is not known whether offshore collisions with large ships occur. However, given the slow swimming of leatherbacks and the often high speeds of vessels, these types of impact could cause mortality.

Leatherbacks have been sighted in several popular fishing, transportation and recreational boating areas in B.C., including near-shore waters. In 1999 a leatherback was hit by a sport fishing vessel (Lisa Fairley 2003, pers. comm.). No damage appears to have resulted to either party; nevertheless, the incident suggests significant potential for ship strikes in B.C. waters, especially during the busy summer months and fishing seasons.

Potential threats

In addition to the threats noted above, a number of additional potential threats exist. Severity of the following threats can only be assigned after further research. They include:

Diseases and parasites: Little is known about diseases and parasites in leatherbacks, including in Canadian waters. Fibropapillomatosis is a neoplastic disease that primarily affects green turtles. The etiologic agent has not been isolated or characterized. Fibropapilloma tumours have recently been observed in leatherbacks in Mexico (Huerta et al. 2002; Murakawa and Balazs 2002).

Predation: Sharks and killer whales have been reported to attack adult leatherbacks (Sarti et al. 1994; Caldwell and Caldwell 1969).

Oil exploration and extraction: Oil extraction from the seabed carries risks of spills, blowouts, and increased marine traffic. Oil exploration may also pose indirect threats to foraging habitat, including the effects of drilling, anchoring, explosives and pollution.

Environmental contamination: Leatherbacks visiting Pacific Canadian waters are exposed to the same pollutants as are other forms of marine life. In B.C. these include sewage and agricultural and industrial chemicals. Bioconcentration of chemical pollutants in the prey of leatherbacks has not been studied and their impact is not known. Accumulation of heavy metals and PCBs has been demonstrated (Davenport et al. 1990).

Aquaculture: Salmon farms are concentrated in the inside passage between Vancouver Island and the mainland. Environmental threats posed by salmon farms include noise from predator-scaring devices, fecal pollution, anchoring systems and the possibility of parasite transmission. However, the potential for leatherbacks to interact with salmon farming operations in coastal B.C. cannot be estimated without a more complete record of sightings.

2.11.2 Threats in the nesting environment

Threats in the nesting environment are relevant to international projects and conventions involving Canada. Despite their remoteness from Canada, threats in the nesting environment may outweigh those in foraging areas, and thus may be critical to any Canadian collaborative actions. The population of leatherback turtles most likely to frequent B.C. waters nests in the tropical Western Pacific Ocean. However, it is possible that leatherback turtles from the Eastern Pacific population also visit B.C. waters.

Fisheries on adults and juveniles: Adult leatherbacks nesting in Malaysia and Indonesia are subject to incidental take in various fisheries throughout their habitat, and possibly the directed take by the villagers of the Kai Kecil Islands who have traditionally hunted leatherbacks for food and ritual purposes (Suarez and Starbird 1996). However, there is limited harvest of adult and juvenile turtles and the extent to which populations are affected is unknown.

Harvest of eggs: The eggs of leatherback turtles, like those of other sea turtles, are aggressively harvested for subsistence and sale. Continued harvesting ensures reduced recruitment. In Malaysia, for example, decades of excessive egg collection have decimated turtle populations, and their collection in Terengganu, the most productive state, is now illegal (Liew 2002). Egg harvest is controllable through social programs and beach protection as practiced, for example, in Mexico (Sarti 2002).

Nest predation and parasitism: Many natural predators, such as rats, mongoose, birds, monitor lizards, snakes, crabs, and other invertebrates eat turtle eggs. Domesticated species such as cats, dogs, and pigs also pose a threat. Nest destruction by feral pigs is one of the biggest problems for Western Pacific leatherback populations, especially in

Papua (NMFS 2000). Nesting beach parasite loads (i.e., insects such as fly larvae and crickets) are another natural threat.

Increased human presence: Human activities on nesting beaches can disturb nesting females and their eggs. Females may abort nesting attempts, shift nesting beaches, delay egg-laying and select poor sites. Compaction of sand from people walking over nests can slow hatchling emergence.

Light sources such as flashlights and campfires can disorient hatchlings and females, making it more difficult for them to find their way to the sea. Vehicles driving on the beaches compact sand and nests, unearth nests, and create ruts that hatchlings can get trapped in on their seaward migration.

Habitat loss: A variety of activities result in elimination or degradation of nesting habitat. They include:

- *Construction and mining*: Buildings, piers, jetties, etc. are obstacles for turtles and can increase natural erosion. Sand and coral rubble removal and other beach mining severely affects a nesting beach.

- *Beach armouring:* sea walls, rock revetments, riprap, sandbags, groins, and jetties affect nesting by preventing females from reaching good nesting grounds, and can trap or delay hatchlings and females on the journey back to sea, increasing exposure to predators. Armouring may also increase beach erosion.

- *Beach nourishment:* Attempts to replace sand lost to erosion can cause problems for leatherback nesting. Nests may become too deeply buried. New sand may be unsuitable for nesting. Heavy machinery used to clean and rake beaches can destroy nests. The machinery used to haul and distribute sand can compact the beach, destroy nests and cause difficulties in digging new ones.

Artificial lighting: Hatchlings and adults, once on land, rely on illumination to orient toward the sea. Land-based lights from buildings, streets and vehicles can cause turtles to migrate inland rather than back to the sea. Whitherington (1992) found that white mercury vapour (MV) lights and other broad-spectrum lights could disrupt nesting of loggerhead and green turtles and recommended yellow, low-pressure sodium vapour (LPS) lights as an alternative. These same recommendations may apply to leatherbacks.

Exotic vegetation: Introduced plants can displace natural vegetation and proliferate on nesting beaches. Increased shade from introduced plants can result in cooler temperatures within nests and may alter sex ratios of hatchlings (see Section 2.4.2). Roots may entangle eggs and hatchlings. Nesting females can also become tangled in vegetation, slowing or preventing their return to the sea.

Contamination and pollution: Beaches tend to concentrate some of the same kinds of debris and pollution as are hazardous at sea. Examples include plastics, abandoned netting, and spilled oil.

Sharma (2000) provides a recent discussion of destruction of nesting habitat in peninsular Malaysia including the once-significant rookery at Rantau Abang.

2.12 Knowledge gaps[4]

Within the leatherback's Pacific Canadian range, the main knowledge gaps concern the animal's occurrence, distribution, behaviour and vulnerability to specific threats. One important outcome of the research needed to fill these gaps will be predictive models that will help set and prioritize management goals (Chaloupka 2003, pers. comm.).

2.12.1 Survey requirements

Reports of leatherbacks in B.C. waters are few and anecdotal. Those that exist need to be collated and analyzed, and new reports need to be systematically gathered (see Section 3, Recovery). Collaboration with the international research community is needed to confirm or disprove the hypothesis that most of the leatherbacks off B.C. originate in Western Pacific rookeries. One outcome of such research may be predictive models of leatherback occurrence. Questions related to abundance and migration include:

- Where, when and for how long do leatherbacks occur in Pacific Canada?
- How many leatherbacks utilize Pacific Canadian waters and what proportion of the total population does this represent?
- What migration corridors do the turtles use to enter and leave Pacific Canada?
- Do the leatherbacks in Pacific Canada contribute significantly to the viability of the populations to which they belong?

2.12.2 Biological/ecological research requirements

Inferences about mortality rate, the relative importance of nesting versus marine hazards, and predictions about population trends depend on assumptions about the turtle's age distribution and life span. Inferences on something as basic as life span are currently hampered by a lack of data. Gaps in our knowledge of population biology include:

- life expectancy;
- lifetime reproductive potential (age of first nesting, frequency of nesting, fecundity and egg survival);
- population viability assessment: How many individuals can a population lose and still be expected to recover?

To determine the critical habitat of the leatherback in Canadian waters we must investigate:

- location of foraging activity;
- metabolic rate and food requirements;

[4] *SARA* requires that the recovery strategy identify "a statement about whether additional information is required about the species" [*SARA* s.41(1)(*f*)'].

- relationship with principal prey species - distribution, species eaten and their caloric value;
- water quality in foraging areas.

2.12.3 Threat clarification research requirements

Systematic collection and analysis of sightings information will help define critical leatherback habitat, clarify threats to leatherbacks in Canadian waters, and contribute to overall understanding of the life cycle of this population. Currently there is little information about occurrence or incidental capture of sea turtles off the coast of British Columbia. Studies are needed to determine:

- number and kind of interactions with fisheries or maritime activities in Pacific Canada;
- mortality rate from interactions with fisheries or marine activities;
- potential for boat collisions and damaged caused;
- potential impact of oil and gas pollution (spills, leakage, etc);
- threats from disease (information from necropsies);
- potential for interaction with aquaculture operations.

2.12.4 Critical Habitat

See General Habitat Section 2.7 and Appendix I.

3. RECOVERY

It is important to realize that, because of the lack of information on leatherbacks in Pacific Canadian waters, recovery of this species will initially follow a staged and adaptive approach. Mitigation, for example, will have to be tailored to our emerging understanding of threats. Hence it is unrealistic at the outset to expect all recovery objectives to have measurable outputs; instead, these will emerge as research proceeds.

Recovery objectives are currently focused on obtaining fundamental baseline information on the basic biology and distribution of this species in Pacific Canadian waters, and the threats it faces. As this information becomes available, the Recovery Strategy will be updated with specific measurable recovery objectives, within five years. Furthermore, because leatherback turtles in Pacific Canadian waters are likely from the same genetic stocks as those in Pacific U.S. waters, Canada will consider making its measurable recovery objectives consistent with the Recovery Criteria outlined in the Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (NMFS and FWS 1998 and future revisions; see Objective 1 below).

3.1 Recovery goal[5]

[5] *SARA* requires that the recovery strategy identify "a statement of the population and distribution objectives that will assist the survival and recovery of the species" [*SARA* s.41(1)(*d*)].

The **goal** of this Recovery Strategy is the long-term viability of the leatherback turtle population(s) that frequent Pacific Canadian waters.

3.2 Recovery objectives[6]

The goal of this Recovery Strategy will be reached through five objectives. Objective 1 is to fill knowledge gaps through stand-alone Canadian research and through Canadian contribution to research efforts in other countries. Objective 2 is to summarize what we know of the occurrence of leatherbacks off coastal B.C. and their interactions with people. Objective 3 is to mitigate threats in B.C. waters, while Objective 4 promotes mitigation in all the other parts of the leatherback's range. The fifth objective is aimed at creating the public and professional awareness needed for recovery.

Canadians have expertise that will be invaluable not only in the part of the leatherback's range that happens to be in Canada, but also in those parts that are "overseas" for Canadians. Hence there is some overlap in activities, because stewardship for an animal that migrates 15,000 km clearly knows no international boundaries.

The five objectives are:

Objective 1: Conduct and support research that makes possible the development of measurable recovery criteria, within five years, for leatherback turtle population(s) that frequent Pacific Canadian waters[7]

Objective 2: Identify and understand threats to the leatherback turtle and its habitat resulting from human activities in Pacific Canadian waters

Objective 3: Mitigate human-caused threats to leatherback turtles in Pacific Canadian waters and protect their critical migratory and foraging habitats

Objective 4: Support the efforts of other countries to promote the recovery of the leatherback turtle population(s) that frequent Pacific Canadian waters

Objective 5: Raise awareness of Pacific leatherbacks and engage Canadians in stewardship projects

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[6] *SARA* requires that the recovery strategy identify "a description of the broad strategy to address those threats" [SARA s.41(1)(*b*)] and "a general description of the research and management activities needed to meet those objectives" [*SARA* s.41(1)(*d*)].

[7] As leatherback turtles in Pacific Canadian waters are likely to be from the same stocks as those in Pacific U.S. waters, Canada will develop measurable recovery criteria that take into account (but may not be identical to) the Recovery Criteria outlined in the 'Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle'(NMFS and FWS 1998, and any future revisions). In particular, the Canadian recovery criteria will need to address the identification of source beaches, minimum viable stock size, and long term stability or growth of nesting populations (U.S. Recovery Criteria 1, 2 and 3).

3.3 Strategies to achieve recovery

3.3.1 **Research** (Objective 1): Conduct and support research that makes possible the development of measurable recovery objectives, within five years, for leatherback turtle population(s) that frequent Pacific Canadian waters.

Strategies:

(a) Conduct research in Canada to identify critical habitat important to the recovery of leatherbacks in Pacific waters;

(b) Contribute to and collaborate in projects to identify population(s) of leatherbacks that are found in Pacific Canadian waters and distinguish them from other Pacific populations;

(c) Contribute to projects on basic demographic parameters for leatherbacks in order to predict the effectiveness of actions to promote recovery;

(d) Contribute to projects on the basic biology, physiology and behaviour of the Pacific leatherback turtle.

3.3.2 **Threat clarification** (Objective 2): Identify and understand threats to the leatherback turtle and its habitat resulting from human activities in Pacific Canadian waters.

Strategies:

(a) Synthesize existing data on activities that potentially harm leatherbacks that frequent Pacific Canadian waters;

(b) Implement programs to collect information on leatherback turtle sightings in Pacific Canadian waters;

3.3.3 **Mitigation** (Objective 3): Mitigate human-caused threats to leatherback turtles in Pacific Canadian waters and protect their critical migratory and foraging habitats.

The following strategies are broad, as their further development depends closely on currently unidentified threats. As information from Objective 1 becomes available, the Recovery Strategy for Leatherback Turtles in Pacific Canadian waters will be updated to provide more specific strategies and associated actions under Objective 2, with measurable outputs. The Recovery Team believes that leatherback-fishing encounters in Pacific Canadian waters are infrequent and do not presently justify fisheries restrictions. Recovery of the leatherback turtle is more likely to be aided by the kinds of activities described below, including working collaboratively with the maritime industry and general public to gather much-needed data on sightings and interactions with humans in Canada and facilitating international research and conservation efforts that target the nesting beaches.

At present, the broad strategies include, but may not be limited to:

(a) In consultation with the maritime industry, implement mitigation measures to reduce threats to leatherback turtles in Pacific Canadian waters once they are better understood (threats as identified through programs implemented under Objective 2);

(b) Once identified, protect the critical habitats of leatherback turtles in Pacific Canadian waters (see Objective 1 for determination of critical habitat);

(c) Develop and implement recovery procedures for strandings and/or entanglements, and, as appropriate, other emergency planning and response procedures (e.g. regarding oil spills).

3.3.4 **International cooperation** (Objective 4): Support the efforts of other countries to promote the recovery of the leatherback turtle population that frequent Pacific Canadian waters.

Strategies:

(a) Ratify, respect and/or contribute to international instruments (conventions, treaties, memoranda of understanding, codes of conduct) that promote leatherback protection and recovery;

(b) Initiate agreements and collaborative projects with countries that share populations of leatherbacks that frequent Pacific Canadian waters;

(c) Make use of existing bilateral and multilateral donor programs such as CIDA and IDRC to support collaborative research, training and awareness, including community participation in leatherback recovery;

(d) Provide Canadian expertise and other support to protect nesting leatherbacks, their eggs, and nesting beaches (e.g., public education, law enforcement, monitoring of coastal construction, alteration/reduction of artificial lighting, measures to improve hatching success);

(e) Facilitate participation of Canadians (government, academia, industry and NGOs) in international research and recovery programs (e.g. through letters of reference, permits, visas, internships, secondments).

3.3.5 **Stewardship and awareness** (Objective 5): Raise awareness of Pacific leatherbacks and engage Canadians in stewardship activities that support leatherback turtle recovery in Canada.

Strategies:

(a) Develop a public awareness campaign on the leatherback turtle that covers identification, life-cycle and biology, threats, Canadian recovery efforts, and what individuals can do to minimize threats at home and abroad;

(b) Promote professional awareness of Pacific leatherback issues in government departments;

(c) Facilitate participation of Canadians in stewardship projects throughout the leatherback's Pacific range.

3.4 Considerations for recovery

3.4.1 Recovery Feasibility[8]

It is not currently possible to fully predict recovery feasibility, and making this determination must be an integral part of this recovery strategy. In the meantime, this recovery strategy takes a precautionary approach and suggests that recovery for the Pacific leatherback turtle is feasible in the absence of information that would prove otherwise.

The Pacific leatherback turtle ranges widely, and its recovery demands an international effort. The ecological and technical feasibility of recovery may be high, but will not be realized without international cooperation. This plan complements one for the recovery of Atlantic leatherbacks in Canadian waters (Draft National Recovery Strategy for the Leatherback Turtle in Atlantic Canadian Waters, 2003), as well as existing plans for populations of Pacific leatherbacks in U.S. waters (National Marine Fisheries Service and US Fish and Wildlife Service 1998). Because of the knowledge gaps around the leatherback and its migrations and populations structure, the present plan contains a significant research component.

Until the population biology and status of leatherbacks that frequent Pacific Canadian waters are known it is difficult to predict the likelihood of a return to viability. The species' capacity to rebound depends on its lifetime reproductive capacity, which is not known. Therefore, it is difficult to predict the potential for recovery of the species. Availability of quality foraging habitat off coastal B.C. does not appear to be limiting, and Canadian capability for alleviating the major known threats in our waters is high. However, progress will require a correspondingly high level of effort because of the amount of fact-finding and

[8] *SARA* requires that "the competent minister must determine whether the recovery of the listed wildlife species is technically and biologically feasible. The determination must be based on the best available information, including information provided by COSEWIC" [*SARA* s.40].

research required, and the need to collaborate with governments and organizations in other parts of the leatherback's range.

As has already been stated in this Plan, the fate of the Pacific leatherback turtle rests on much more than its transient life in B.C. waters. The main barriers to alleviating problems in B.C. waters are (1) lack of knowledge and (2) the political and social will to create and enforce new regulations. Fishing regulations in particular need to be developed cooperatively with the industry. Barriers to global success are political and social, and reflect the difficulty of getting all players to agree to the same measures. For example, pelagic longline fishing is accepted as a major threat, but restrictions adopted by one fishing nation may be ineffective if other nations do not follow suit, so that well-intentioned efforts in one geographic area may be negated elsewhere. Collection of eggs on nesting beaches is another example, and people are unlikely to give up a source of food and income unless they are consulted, motivated and, policed.

It is not presently possible to state quantitatively whether implementing recovery efforts under this strategy will lead to recovery of leatherback turtles. Implementation of the recommendations contained herein will provide population biologists with the information required to more clearly understand recovery feasibility of leatherback turtles in the Pacific region.

3.4.2 Recommended approach/scale for recovery

The two most obvious global threats to Pacific leatherbacks are mortality in fishing gear and egg collection and mortality on nesting beaches. Overlying both is a vast knowledge gap about the biology of an internationally pelagic species. Hence while some immediate recovery actions are possible (and, given the right social and political climate, can be very effective), the call for "more research" cannot be ignored. The strategy recommended here reflects the opportunities of 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.

Conservation activities in the rest of the leatherback's range are likely to benefit other species of sea turtles as well. There is also an excellent opportunity to link leatherback recovery actions in B.C. with those for cetaceans, especially in the development of networks for reporting sightings and for observers on fishing vessels.

3.5 Actions completed or underway

3.5.1 Actions in Pacific Canada

Pacific Leatherback Turtle Recovery Team. The Recovery Team was formed in 2002 and, in addition to producing the present Strategy and its associated Action Plan, will continue to monitor and coordinate Pacific leatherback turtle recovery programs. The team, which is coordinated by Fisheries and Oceans Canada, includes representatives from Fisheries and Oceans Canada, the University of British Columbia, Dalhousie University, the Vancouver Aquarium Marine Science Centre, World Fisheries Trust, the Canadian

commercial fisheries sector, Hubbs Seaworld Research Institute, the National Marine Fisheries Service, and the University of Alaska.

Sightings data collection and management. To obtain information on leatherback turtle distribution, abundance and potential threats in Pacific Canadian waters, Fisheries and Oceans Canada and the Vancouver Aquarium Marine Science Centre are developing a sightings reporting network for Pacific leatherback turtles. Leatherback turtle sightings information will be linked with the British Columbia Cetacean Sightings Network (begun 1999) and includes collaboration with the public, industry and local organizations. In 2002, Fisheries and Oceans Canada and the Vancouver Aquarium Marine Science Centre began compiling historical sightings and developing a database to store both historical and new sightings ($25K).

Education and outreach. As part of a 2002 Habitat Stewardship project the Vancouver Aquarium Marine Science Centre has implemented awareness and stewardship programs on the Pacific leatherback turtle. Web-based publishing and interpretive displays, including an animated computer game, have been developed onsite at the Vancouver Aquarium and as travelling exhibits, to communicate information on biology, behaviour, physiology and threats. Interactive presentations conducted at schools and festivals in six coastal communities of western Vancouver Island raise awareness of the presence of leatherbacks, their threats and the positive conservation efforts communities can involve themselves in. A toll-free sightings phone number has also been established and promoted through the distribution of posters and stickers to increase the number of reported sightings of leatherbacks ($45K).

Research on biology and behaviour. Researchers at the University of British Columbia will use funding from NSERC and NMFS to study energetics and behaviour of gravid females nesting in the East Pacific. Estimating energy requirements is a necessary first step in any attempt to determine the effects of changes in prey distribution and abundance on leatherback turtles. Weighing and body condition assessment will be performed on 8 turtles for field energetic measurements. These animals will also be instrumented with data loggers to monitor diving and foraging behaviour. Dive profiles will provide an idea of how much time is spent submerged and to what depths. Swim velocity measurements will tell how much time at sea is spent swimming or resting. By monitoring stomach temperature, food ingestion will be determined and the proportion of time spent foraging indirectly estimated.

3.5.2 Actions in Atlantic Canada

A Recovery Plan for the Atlantic leatherback turtle is under development by DFO. A research program on the Atlantic leatherback turtle was begun in 1998 at Dalhousie University (James 2001). The program has studied threats in Atlantic Canada, including the kind and incidence of fisheries interactions and ingestion of plastics, and includes satellite telemetry studies to track turtle movements. Other research, management and awareness initiatives in Atlantic Canada include:

- quantification of incidental capture in any Canadian pelagic longline fishery through increased observer coverage and implementation of new protocols for recording

specifics of incidental capture (based on protocol used by National Marine Fisheries Service);
- coastal community outreach through public education initiatives focusing on the fishing community;
- a marine turtle sightings program;
- stranding response and necropsies;
- satellite telemetry program.

3.5.3 International actions

This Recovery Strategy is not an exhaustive review of actions taken on behalf of the Pacific leatherback in all countries. The following summaries provide an insight into activities in selected countries. Not included, for example, are actions in Costa Rica and efforts to monitor and protect leatherbacks in Papua, Papua New Guinea and the Solomon Islands.

International agreements. A variety of international instruments, including conventions, non-binding agreements and codes of conduct, are relevant to conservation of the Pacific leatherback turtle. Within the Convention on Migratory Species there are specific Memoranda of Understanding on sea turtles in the Indian Ocean, Southeast Asia and the Atlantic coast of Africa. Leatherbacks are considered under the Inter-American Convention for Protection and Conservation of Sea Turtles.

Actions in the United States. A U.S. Recovery Plan has already been completed for leatherbacks (NMFS and USFWS 1998). Actions identified for leatherback conservation include (not in order of priority):

- Eliminate incidental take of leatherbacks in U.S. and international commercial fisheries;
- Support the efforts of Mexico and the countries of Central America to census and protect nesting leatherbacks, their eggs, and nesting beaches;
- Determine movement patterns, habitat needs and primary foraging areas for the species throughout its range;
- Determine population size and status in U.S. waters through regular aerial or on-water surveys;
- Identify stock home ranges using DNA analysis.

The Pacific Drift Gillnet Observer Program, started in 1990, focuses on swordfish and thresher shark, but also provides information on sea turtles (http://swr.ucsd.edu/pacdgobs.htm).

The Hawaii Longline Observer Program was set up by the National Marine Fisheries Service to document the incidental take of sea turtles (http://swr.ucsd.edu/piao/).

The National Marine Fisheries Service requires trawl fishermen to use Turtle Excluder Devices (TEDs) (www.yoto98.noaa.gov/books/turtles/turtle2.htm).

The U.S. has closed some fisheries for certain time periods or in certain areas in an attempt to decrease the incidental capture of leatherbacks and other sea turtles. Areas include waters off parts of California and Oregon (NMFS 2000; 2001).

Actions in Mexico. Aerial surveys of nesting beaches began in 1996 and now include other parts of central America. In 1986 the nesting beaches of Mexiquillo (Michoacan), Tierra Colorada (Guerrero), and Chacahua (Oaxaca) were established as Sea Turtle Reserve areas (NMFS and USFWS 1998). Conservation efforts within these reserves include relocation of eggs to protected areas, protection and tagging of nesting females, and gathering of biological information. Only Mexiquillo Beach has been monitored continuously for numbers of nests and females (over 12 years). These data indicate that the nesting population has declined (NMFS and USFWS 1998).

Actions in Malaysia. Conservation of leatherbacks in Malaysia started in 1961 when the Malayan Nature Society proposed the establishment of a hatchery in Rantau Abang (Balasingam 1965; Chan and Liew 1996). In 1967 the Fisheries Department of Terengganu started a leatherback tagging program (Chua 1988). In 1985 Universiti Kolej Terengganu started a major research and conservation project on sea turtles. In 1987 local authorities convened a National Workshop on Sea Turtle Conservation and Management. In 1987 the State Legislature of Terengganu amended the Turtles Enactment of 1951 to increase protection and management of sea turtles.

In 1988, the Rantau Abang Turtle Sanctuary and the Turtle Sanctuary Advisory Council were established. The state government banned the commercial sale and consumption of leatherback eggs in Terangganu in 1988 following the crash in leatherback abundance. In 1989, World Wildlife Fund Malaysia started the "Save the Sea Turtles" Campaign. Fisheries Regulations were amended in 1989 to ban the use of large-meshed driftnets throughout coastal waters of Malaysia, and again in 1991 to provide offshore protection to leatherbacks during the internesting period (Chan and Liew 1996).

The Fisheries Department has set aside a 10-km stretch of coastline south of Rantau Abang beach. Eggs that are laid here are collected and reburied at hatcheries at the Ma'Daerah Turtle Sanctuary. The sanctuary also provides educational and public awareness activities (www.arbec.com.my/sea-turtles/turtleshaven.php).

3.6 Action plans in relation to recovery strategy[9]

Recovery actions for the leatherback turtle in Pacific Canadian waters are outlined in the *National Recovery Action Plan for the Leatherback Turtle (Dermochelys coriacea) in Pacific Canadian Waters.*

3.7 Evaluation (five-year)

Category of Activity	Indicators of Progress
Research	▪ **Critical and important habitat in Pacific**

[9] *SARA* requires that the recovery strategy include "a statement of when one or more action plans in relation to the recovery strategy will be completed" [*SARA* s.41(1)(*g*)]..

	Canada identified ▪ **Populations frequenting Pacific Canada identified** ▪ **Contributions to the scientific literature on biology, physiology, behaviour and demographics**
Threat Clarification	▪ **Historic and current sightings compiled and organized in a maintained database** ▪ **Report produced on human activities known to affect leatherbacks in Pacific Canada**
Mitigation	▪ **Draft plan for protection of critical habitat in Pacific Canada** ▪ **Recovery and emergency response procedures implemented, along with specific threat reduction measures**
International Cooperation	▪ **Canada a signatory to Bonn Convention** ▪ **DFO a participant in international fora on sea turtles, in consultation with Environment Canada (Biodiversity Convention Office) and Foreign Affairs and International Trade** ▪ **Canadian experts seconded to international projects**
Stewardship and Awareness	▪ **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.**

4. REFERENCES

Balazs, G.H. 1982. Driftnets catch leatherback turtles. Oryx 16(5):428-430.

Balazs, G. H. and S. G. Pooley (Editors). 1994. Research plan to assess marine turtle hooking mortality: results of an expert workshop held in Honolulu, Hawaii, November 16-18, 1993. NOAA Technical Memorandum NMFS-SWFSC-201. U. S. Dept. Commerce.

Balasingam, E. 1965. The Giant Leathery Turtle Conservation Programme – 1964. Malayan Nature Journal 19(2&3): 145-146.

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

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

Brown, V. 1976. Sea Mammals and Reptiles of the Pacific Coast. Macmillan Publishing Co. Inc, New York. P256-258.

Bustard, R. 1972. Sea Turtles Their Natural History and Conservation. Taplinger Publishing Company, New York. p 34-35, 89-93.

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

Caldwell, D. K. and Caldwell, M. C. 1969. Addition of the leatherback sea turtle to the known prey of the killer whale, *Orcinus orca*. Journal of Mammalogy **50**, 636.

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

Chua, T. H. 1988. Nesting Population and Frequency of Visits in *Dermochelys coriacea* in Malaysia. Journal of Herpetology. Vol.22, no. 2, p.192-207.

Davenport, J. 1998. Sustaining endothermy on a diet of cold jelly: energetics of the leatherback turtle Dermochelys coriacea. British Herpetological Society Bulletin 62: 4-8.

Davenport, J. and Balazs, G. 1991. 'Fiery Bodies'- are pyrosomas an important component of the diet of leatherback sea turtles. British Herpetological Society Bulletin **37: 33-38**.

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

Den Hartog, J. C. 1980. Notes on the food of sea turtles: *Eretmochelys imbricata* (L) and *Dermochelys coriacea* (L). Netherlands Journal of Zoology **30**, 595-610.

Dermawan, A. 2002. Marine turtle management and conservation in Indonesia. In: Kinan, I. (editor). 2002. Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop. February 5-8, 2002, Honolulu, Hawaii. Western Pacific Regional Fishery Management Council. pp 67-77.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan, and S.K. Davis. 1999. Global phylogeography of the leatherback turtle, Dermochelys coriacea: shallow phylogenetic history in an ancient organismal lineage. Journal of Zoology 248:397-409.

Eckert, K. L. 1987. Environmental unpredictability and leatherback sea turtle Dermochelys coriacea nest loss. Herpetologica 43(3):31 5-323.

Eckert, K. L. 1993. The biology and population status of marine turtles in the North Pacific Ocean,, pp. 155. Honolulu, HI: U.S. Department of Commerce, NOAA-TM-NMFS-SWFSC-186.

Eckert, S. A. 1995. Telemetry and behavior of sea turtles. In *The biology and conservation of turtles*, (ed. K. A. Bjorndal), pp. 583-584. Washington, DC: Smithsonian Institution Press.

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. In *Seventeenth Annual Sea Turtle Symposium*, eds. S. P. Epperly and J. Braun), pp. 294. Orlando, FL: U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-415.

Eckert, S. A. 1999. Habitats and migratory pathways of the Pacific leatherback sea turtle. Final report to the National Marine Fisheries Service, Office of Protected Resources., pp. 15. San Diego, CA: Hubbs Sea World Research Institute Technical Report 99-290.

Eckert, S. A. 2002a. Distribution of juvenile leatherback sea turtle *Dermochelys coriacea* sightings. Marine Ecology Progress Series 230, 289 - 293.

Eckert, S. A. 2002b. Swim speed and movement patterns of gravid leatherback sea turtles (*Dermochelys coriacea*) at St. Croix, U.S. Virgin Islands. Journal of Experimental Biology 205: 3689 - 3697.

Eckert, S.A. 2002c**.** Safeguarding Pacific Sea Turtles in the Oceanic Commons. Testimony before the U.S. Commission on Ocean Policy, 13 May 2002.

Eckert, K. L. and Eckert, S. A. 1988. Pre-reproductive movements of leatherback sea turtles (*Dermochelys coriacea*) nesting in the Caribbean. Copeia **2**: 400-406.

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

Eckert, S.A., H.C. Liew, K.L. Eckert, and E.H. Chan. 1996. Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conservation and Biology 2(2): 237-243.

Ernst, C.H., and Roger W. Barbour. 1989. Turtles of the World. Smithsonian Institution Press, Washington, DC. P117-118.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC. In press.

Frair, W., R. G. Ackman, and N. Mrosovsky. 1972. Body temperature of Dermochelys coriacea: Warm Turtle from Cold Water. Science 177: 791-793.

Fritts, T. 1982. Plastic bags in the intestinal tract of leatherback marine turtles. Herpetological Review 13(3): 72-73.

Froom, B. 1976. The Turtles of Canada. McClelland and Stewart Ltd, Toronto. P 98-100.

Godfrey, M. H. and Barreto, R. 1998. *Dermochelys coriacea* (Leatherback Sea Turtle). Copulation. Herpetological Review **29**: 40-41.

Godley, B., and A. Broderick. 2001. Recent Change in the Status Listing of Leatherback Sea Turtles (*Dermochelys coriacea*) and Mediterranean Green Turtles (*Chelonia mydas*). Marine Turtle Newsletter 93: 34.

Goff, G. P., and J Lien. 1988. Atlantic Leatherback Turtles, *Dermochelys coriacea*, in Cold Water off Newfoundland and Labrador. Canadian Field Naturalist 102(1): 1-5.

Goff, G. P., J. Lien, G. B. Stenson, and J. Fretey. 1994. The Migration of a Tagged Leatherback Turtle, *Dermochelys coriacea*, from French Guiana, South America, to Newfoundland, Canada, in 128 Days. Canadian Field Naturalist 108: 72-73.

Grant, G. S., H. Malpass, and J. Beasley. 1996. Correlation of Leatherback Turtle and Jellyfish Occurrence. Herpetological Review 27(3): 123-125.

Gregory, P. T., and R. W. Campbell. 1984. The Reptiles of British Columbia. British Columbian Provincial Museum Handbook Series. No. 44: 37-39.

Gulliksen, B. 1990. Observation of the Leatherback Turtle in Northern Norway (Nord-Troms) autumn 1989. Fauna 1990, vol.43, no.1, pp.43-45.

Hitipeuw, C. 2002. Jamursba-medi nesting beach, North coast of Bird's head Peninsula, Papua. In: Kinan, I. (editor). 2002. Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop. February 5-8, 2002, Honolulu, Hawaii. Western Pacific Regional Fishery Management Council. pp161-177.

Huerta, P., H. Pineda, A. A. Aguirre, T. Spraker, L. Sarti, and A. Barragán. 2002 in press. First confirmed case of fibropapilloma in a leatherback turtle (Dermochelys coriacea). In Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation, February 29-March 4, 2000, Orlando, Florida. NOAA Tech. Memo. NMFS-SEFSC. p 193

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.

James, M. C. 2001. Updated Status Report on the leatherback turtle, *Dermochelys coriacea*, in Canada. Reviewed by COSEWIC.

James, M.C. and Eckert, S.A. 2002. First satellite tracking of a male leatherback turtle (Dermochelys coriacea) captured at sea off Nova Scotia, Canada. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation, A. Mosier, A. Foley and B. Brost, compilers. NOAA Technical Memorandum NMFS- SEFSC-477, p. 32.

Liew, H.C. 2002. Status of marine turtle conservation and research in Malaysia. In: Kinan, I. (editor). 2002. Proceedings of the Western Pacific Sea Turtle Cooperative

Research and Management Workshop. February 5-8, 2002, Honolulu, Hawaii. Western Pacific Regional Fishery Management Council. Pp 51-56.

Lutcavage, M. E. 1996. Planning your next meal: leatherback travel routes and ocean fronts. In J. Keinath, D. Barnard, J. A. Musick, and B. A. Bell (compilers), Proceedings of the fifteenth
annual symposium on sea turtle biology and conservation, p. 174–178. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-387.

Lutcavage, M., P.L. Lutz. 1986. Metabolic Rate and Food Energy Requirements of the Leatherback Sea Turtle, *Dermochelys coriacea*. Copeia 1986 (3): 796-798.

Lutcavage, M. E., Bushnell, P. G. and Jones, D. R. 1992. Oxygen transport in the leatherback sea turtle *Dermochelys coriacea*. Physiological Zoology 63: 1012-1024.

McDonald. D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification 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.

McCracken, M.L. 2000. Estimation of the sea turtle take and mortality in the Hawaiian longline fisheries. Administrative Report H-00-06, Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii. pp: 1-29.

MacAskie, I. B. and Forrester, C. R. (1962). Pacific Leatherback Turtles (*Dermochelys coriacea*) off the Coast of British Columbia. Copeia (3): 646.

Meylan, P. A., Meylan, A. B., Yeomans, R. 1992. Interception of Tortuguero-bound green turtles at Bocas Del Toro Province, Panama **IN:** Salmon, M. ,Wyneken, J. (Compilers)., Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-302.; 1992, p. 74

Morreale, S. J., E. A. Standora, J. R. Spotila, and F.V. Paladino. 1996. Migration Corridor for Sea Turtles. Nature 384: 319-320.

Morreale, S.J., E. A. Standora, F. V. Paladino, and J. R. Spotila. 1994. Leatherback migrations along deepwater bathymetric contours. In B. A. Schroeder and B. E. Witherington (compilers), Proceedings of the thirteenth annual sympo-sium on sea turtle biology and conservation, 109–
110. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC- 341. [NTIS Accession No. PB95239554/ll.]

Mrosovsky, N. 1981. Plastic jellyfish. Marine Turtle Newsletter 17: 5-7.

Mrosovsky, N. 1994. Sex ratios of sea turtles. Journal of Experimental Zoology 270:16-27.

Mrosovsky, N., and P. C. H. Pritchard. 1971. Body temperatures of Dermochelys coriacea and other sea turtles. Copeia 1971(4):624-631.

Mrosovsky, N., P. H. Dutton and C. P. Whitmore. 1984. Sex ratios of two species of sea turtle nesting in Suriname. Can. J. Zool. 62(11):2227-2239. N. Mrosovsky, Dept. Zoology, Univ. Toronto, Toronto M5S IAI, Canada.

Murakawa, S. and G. Balazs. 2002. Bibliography of fibropapillomas in marine turtles. /www.turtles.org/nmfsbib.htm

National Marine Fisheries Service. 2000. California/Oregon Drift Gillnet Fishery Biological Opinion. Conducted by Endangered Species Division, Office of Protected Resources, NMFS.

National Marine Fisheries Service. 2001. Biological Opinion on Proposed Authorization of Pelagic Fisheries under the Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region. Conducted by the Endangered Species Division.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for the U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). National Marine Fisheries Service, Silver Spring, MD.

National Research Council. 1990. Decline of the Sea Turtles: causes and prevention. National Academy Press, Washington, DC. p. 39-40, 61-117.

Pritchard, Peter, C.H. 1971**.** The Leatherback or Leathery Turtle *Dermochelys coriacea*. IUCN Monograph 1:1-39.

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. The turtles of Venezuela. Society for the Study of Amphibians and Reptiles.

Putawidjaja, M. 2000. Marine Turtles in Irian Jaya, Indonesia. Marine Turtle Newsletter 90: 8-10.

Rhodin, A. G. J. 1985. Comparative chondro-osseous development and growth in marine turtles. Copeia 1985:752-771.

Sarti, L.M. 2002**.** Current population status of Dermochelys coriacea in the Mexican Pacific Coast. **In:** Kinan, I. (editor). 2002. Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop. February 5-8, 2002, Honolulu, Hawaii. Western Pacific Regional Fishery Management Council. pp 87-90.

Sarti, L., Flores, L. and Aguayo, A. 1994. Evidence of predation of killer whale (*Orcinus orca*) on a leatherback sea turtle (*Dermochelys coriacea)* in Michoacan, Mexico. Mexico Rev. Inv. Cient: 23-26.

Sharma, D.S. 2000. Impacts from development, nesting population trends and the future of marine turtles at Paku-Kertih, Terengganu. In: Kalb, H. and Wibbels, T. (compilers). Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-443: 88-92.

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

Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin, and F. V. Paladino. 2000. Pacific Leatherback Turtles Face Extinction. Nature 405: 529-530.

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

Starbird, C. 2000. *Dermochelys coriacea* (Leatherback Sea Turtle) Fishing Net Ingestion. Herpetological Review 31(1): 43.

Starbird, C. H., Baldridge, A. and Harvey, J. T. (1993). Seasonal occurence of leatherback sea turtles (*Dermochelys coriacea*) in the Monterey Bay region, with notes on other sea turtles, 1986-1991. California Fish and Game 79:54-62.

Stinson, M. L. (1984). Biology of sea turtles in San Diego Bay, California and in the northeastern Pacific Ocean. Master of Science Thesis, *Department of Biology*. San Diego State University.

Suarez, A., and C. H. Starbird. 1996. Subsistence Hunting of Leatherback Turtles, *Dermochelys coriacea*, in the Kei Islands, Indonesia. Chelonian Conservation and Biology 2(2): 190-195.

US Environmental Protection Agency 1999. www.epa.gov/fedrgstr/EPA-SPECIES/1999/May/Day-12/e11985.htm1990.

Wetherall, J. A., Balazs, G. H., Tokunaga, R. A. and Yong, M. Y. Y. (1993). Bycatch of marine turtles in North Pacific high-seas driftnet fisheries and impacts on the stocks. Bulletin of the North Pacific Commission 53: 519-538.

Witherington, B. E. 1992. Beharioral Responses of Nesting Sea Turtles to Artificial Lighting. Herpetologica 48(1): 31-39.

Witzell, W. N. 1984. The incidental capture of sea turtles in the Atlantic U.S. Fishery Conservation Zone by the Japanese tuna longline fleet, 1978–1981. Marine Fishieries Review 46:56–58.

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

5. ADDITIONAL INFORMATION

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5.3 Record of Co-operation & Consultation [10]

Leatherback turtles are an aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada.

Fisheries and Oceans Canada worked in cooperation with NGO's, academics and international experts as members on the recovery team. Broad consultations were also undertaken on the recovery strategy to gain input and advice. The recovery team met on a number of occasions throughout 2002 and 2003 and continues to be the main group to coordinate recovery activities. The draft Leatherback Recovery Strategy was made available publicly via the Fisheries and Oceans Canada webpage: (http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/leatherback-turtles/default_e.htm). Notice of the web posting was made via a DFO news release, notice to all commercial fishing industries (DFO 'notice to industry'), and in collaboration with the Vancouver Aquarium Marine Science Center a news release was issued via *Aquanews* and information posted on the Vancouver Aquarium's webpage (http://www.vanaqua.org/). The document was also distributed through an international listserv via the Sea Turtle Biology and Conservation mailing list ('CTURTLE') and a Marine Mammal mailing list ('Marmam'). DFO also requested comments directly from several experts in the field of sea turtle ecology, industry members, First Nations and other government Departments including BC Ministry of Water, Land and Air Protection, Parks Canada, WWF Canada, BC Aboriginal Fisheries Commission, Canadian Sablefish Association, and the Pacific Halibut Management Association. Peer reviews were sought from several experts including Cynthia Vernon (Monterey Bay Aquarium), Milani Chaloupka (University of Queensland), Frank Paladino (Purdue University), Kitty Simonds (Western Pacific Regional Fishery Management Council), Col Limpus (Queensland Parks and Wildlife Service, Australia) and Alan Bolton (Archie Carr Center for Sea Turtle Research, University of Florida).

The Recovery Team considered input from written submissions and external reviewers and incorporated many useful suggestions in the final document.

[10] *SARA* requires that to the extent possible the recovery strategy must be prepared in cooperation with others [*SARA* s.39(1)] and in consultation with those whom the competent minister considers to be directly affected by the strategy [*SARA* s.39(3)].

APPENDIX 1: SCHEDULE OF STUDIES[11]

SARA allows for a schedule of studies to be developed to identify critical habitat where available information is inadequate [s.41 (1) (c.1)]. In order to identify critical habitat and habitat that is important to the recovery of leatherback turtles in Pacific waters, research is needed both in Canadian waters and in other parts of the species' range. The following outlines the activities required for habitat identification, an average per year, and estimated timing. The purpose of undertaking these activities is to help yield information that will allow for critical habitat for the species to be identified. It is important to note that activities outlined in this schedule are recommendations that are subject to priorities and budgetary constraints of the participating jurisdictions and organizations.

Study	Timeframe (5 years)
Evaluate seasonality of occurrences in BC and assess distribution	2003 -2005
Collaborate in international research programs to identify migratory routes	2005
Identify and investigate distribution of prey/food sources	2004 - 2005
Model biotic and abiotic factors that influence the distribution of leatherbacks in Pacific Canadian waters in order to identify and track foraging areas and predict locations and times where leatherback turtles may be found	2004 – 2005

The above schedule of activities are underway and/or recommended and should continue for the duration of this recovery strategy.

[11] *SARA* requires that the recovery strategy identify "a schedule of studies to identify critical habitat, where available information is inadequate" [*SARA* s.41(1)(*c.1*)].