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Assessment of Leatherback Turtle (*Dermochelys coriacea*) Fisheries and Non-Fisheries Related Interactions in Atlantic Canadian Waters

Évaluation des interactions entre les tortues luth (*Dermochelys coriacea*) et les activités liées ou non à la pêche dans les eaux du Canada atlantique

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ABSTRACT

In support of a five-year review of the Atlantic Leatherback (*Dermochelys coriacea*) Recovery Strategy, this study evaluated the threats posed by nine fisheries (Whelk pot, large pelagic longline, Snow Crab trap, groundfish gillnet, Herring gillnet, groundfish longline, Lobster trap, Atlantic Halibut longline and Turbot gillnet) and three non-fisheries (maritime transport, marine debris and seismic surveys) activities. The study benefited from recent advancements in knowledge and understanding of Leatherback Turtle biology and distribution. The observational dataset available on Leatherback encounters off Atlantic Canada consists of a wide array of collection activities, some of which have highly standardized sampling protocols, while others are based on opportunistic reporting. In many cases, sampling intensity was relatively low. These issues, combined with the low observation rate of Leatherbacks in the zone, prevented estimation of cumulative threat. It was only possible to rank threats within fisheries and non-fisheries based on the scale of the threat, evidence of encounters and the temporal trend of the threat. Further observations will be required to further elucidate the relative and cumulative impacts of human activities on Leatherback Turtles of Canada's east coast.

RÉSUMÉ

Dans le cadre de l'examen quinquennal du programme de rétablissement de la tortue luth de l'Atlantique (*Dermochelys coriacea*), cette étude a évalué les menaces posées par neuf pêches (pêche du buccin, pêche pélagique à la palangre, pêche du crabe des neiges au casier, pêche du poisson de fond au filet maillant, pêche du hareng au filet maillant, pêche du poisson de fond à la palangre, pêche du homard au casier, pêche du flétan de l'Atlantique à la palangre et pêche du flétan noir au filet maillant) et par trois activités non liées à la pêche (transport maritime, débris marins et levés sismiques). L'étude a bénéficié des récentes avancées en matière de connaissance et de compréhension de la biologie et de la répartition de la tortue luth. Les ensembles de données d'observation sur les rencontres avec des tortues luth au large du Canada atlantique comprennent de nombreuses activités de collecte, certaines d'entre elles devant respecter des protocoles d'échantillonnage fortement normalisés, tandis que d'autres sont basées sur des rapports sporadiques. Dans de nombreux cas, l'intensité d'échantillonnage était relativement faible. Ces problèmes, ainsi que le faible taux d'observation des tortues luth dans la zone ont empêché l'évaluation d'une menace cumulative. Il n'a été possible de classer les menaces dans le cadre des pêches et des activités non liées à la pêche qu'en fonction de l'ampleur de la menace, la preuve des rencontres et la tendance temporelle de cette menace. D'autres observations seront requises pour mieux déterminer les répercussions relatives et cumulatives des activités humaines sur les tortues luth de la côte est du Canada.

INTRODUCTION

The Leatherback Turtle (*Dermochelys coriacea*) in Canadian waters was first assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1981 (Look 1981), which was re-affirmed by COSEWIC (2001). When the *Species at Risk Act* (SARA) was enacted in 2003, the species was immediately included in its Schedule 1. In response, a recovery strategy plus action plan was developed (ALTRS 2006), which outlined efforts to protect the species from human impacts off Canada's East Coast. Under SARA, it is required to review recovery plans every five years.

The current report is in support of the five-year review of the recovery plan being undertaken by Fisheries and Oceans Canada (DFO). It considers the potential sources of fishery and non-fishery interactions with Leatherback Turtles and provides an indication of whether or not these sources are increasing, stable, or decreasing. Given the paucity of information on many of the potential sources of interaction, the overall approach was to consider the spatial and temporal distribution of Leatherbacks, the information available on sources of threats, and where possible, provide estimates of the degree of interaction.

LEATHERBACK TURTLE DISTRIBUTION

Since the 2001 assessment by COSEWIC, there has been considerable advancement in the knowledge of the seasonal distribution of Leatherback Turtles off Canada's East Coast. This is summarized by DFO (2012), so only a general synopsis will be provided here.

In the first of a series of papers, James et al. (2005) comprehensively document the annual migration of Leatherbacks from the Caribbean and coast of South America to the waters off Nova Scotia and Newfoundland, based upon satellite tracking of 38 turtles. Most turtles depart southern waters during February – March and typically arrive off Eastern Canada during June (range: 25 March – 16 August). Turtles usually arrive off Atlantic Canada within several hundred kilometers of where they had occurred the year before. For the southern migration, Leatherbacks first concentrate in the waters off eastern Canada and Northeastern USA before starting the southward migration. While the migration south starts sometime during 12 August – 15 December, most turtles leave the area during October. While present in Canadian waters, there are areas where turtles were more concentrated than others. These include areas off the Burin Peninsula on the southern coast of Newfoundland, in the middle of the southern Gulf of St. Lawrence around the Magdalen Islands, off Cape Breton in the Cabot Strait, on the eastern Scotian Shelf and off Southwest Nova Scotia (Figure 1, DFO 2012; Figure 2, James et al. 2006b). It is important to note that prior to James et al. (2005), Leatherbacks were not thought to migrate extensively into the Gulf of St. Lawrence. Thus, the more recent work is a significant addition to knowledge on Leatherback distributions off Atlantic Canada.

During the southward migration, Leatherbacks use a broad expanse of the Atlantic Ocean with no one preferred route evident (Figure 2). Genetics and tag-recapture data confirm that Leatherbacks in Canadian waters originate from nesting beaches in the wider Caribbean, South and Central America, and Florida rather than eastern Atlantic nesting beaches (James et al. 2007).

James et al. (2005) noted that conservation efforts of DFO have focused on mitigation measures to reduce Leatherback encounters in the large pelagic (Swordfish and Tuna) longline fishery. However, they noted that Leatherback Turtles caught in large pelagic longline gear are most often entangled or hooked externally and are usually capable of swimming to the surface to breathe. James et al. (2005) were the first to highlight interaction with coastal fixed gear fisheries. They considered that fishing fixed gear anchored to the bottom in shelf waters off Atlantic Canada may lead to relatively higher mortality per interaction because turtles entangled at depth or at the surface at low tide would almost certainly drown.

Additional observations on the distribution of Leatherbacks off Canada's East Coast were reported by James et al. (2006a). These were based upon a volunteer strandings / sightings network established in 1998 to promote the reporting of sea turtle sightings by commercial and other mariners in Nova Scotia (Martin and James 2005). During 1998 – 2005, the network received 851 georeferenced sightings of free-swimming or entangled Leatherbacks off Atlantic Canada. Sightings principally corresponded to the Scotian Shelf, mainly reflecting reporting by fishers in Nova Scotia. However, smaller numbers of sightings were reported outside of the principal study area, including coastal Newfoundland and slope waters south of Nova Scotia. The most northerly records corresponded to the coast of mainland Quebec and the north coast of Newfoundland. Relatively few Leatherbacks were reported in the Bay of Fundy and northern Gulf of St. Lawrence.

The first reported sightings of the year typically occurred in June and often corresponded to waters in the vicinity of Georges Bank. Leatherbacks were not regularly sighted until July. In July and August, Leatherbacks were reported along most of the Scotian Shelf. Sightings off Cape Breton Island, and further to the north, increased in August, and remained frequent in this area later into the season as reporting decreased in more southern areas. There was a marked decrease in sightings during late September and October, and of the few sightings reported in October and November, many corresponded to waters in the southern Gulf of St. Lawrence. No live turtles were reported as being seen during the months of January to April.

James at al. (2006a) provide a number of reasons why Atlantic Canada supports a large foraging population of Leatherbacks. The species primarily feeds on soft-bodied, gelatinous organisms, such as medusae (sea jellies), salps, and siphonophores, prey that are seasonally abundant in temperate shelf and slope waters off eastern Canada. In addition to the high zooplankton and gelatinous zooplankton productivity in the area, Leatherbacks proceeding northwards along both the coast of the United States and up the western Atlantic are 'channeled' onto the Scotian Shelf. James et al. (2006a) consider that few turtles likely proceed further north after arriving in the area due to the cold waters of the Labrador Current. Although the Labrador Current does not act as an absolute thermal barrier to Leatherbacks, their association with this current may principally be limited to areas where it meets warmer water masses, such as on the Grand Banks or the east coast of Newfoundland where such frontal zones are known to concentrate gelatinous zooplankton, and, therefore, create favorable foraging conditions for leatherbacks.

Sightings networks have also been established off Newfoundland (Ledwell and Lawson 2011) and in the Gulf of St. Lawrence (http://www.amphibia-nature.org/fr/projets/tortues-marines/). While the data for the latter were not available for this research document, the former suggest that Leatherbacks are observed further north than suggested by James et al. (2006a) (Figure 3). These are reflected in the 75 fixed gear entanglement observations reported to the network during 1976 – 2010 (Table 1). A small number of Leatherbacks are reported from Northwest Atlantic Fisheries Organization (NAFO) divisions 2J, 3K and 3L (Figure 4). Interestingly, there are reports of Leatherbacks occurring off Newfoundland during January – May (which is unexpected and should be investigated further). Most of these are in the latter part of this period. There are also sightings from November – December, although the numbers are low. Notwithstanding this, these observations generally agree with James et al. (2006a) that Leatherbacks primarily inhabit the Canadian Atlantic east coast during June – October.

Regarding the start of the southward migration, Sherrill-Mix et al. (2008), explored the individual timing of 27 Leatherbacks equipped with satellite-linked transmitters and determined that the probability of movement south was highest in the north (off south coast of Newfoundand) in late September, shifting to mid-November in the south (on Georges Bank).

Finally, observer reports for the 143 encounters with large pelagic longline and Snow Crab trap gear during 2001 – 2010 (Table 2) generally suggest that Leatherbacks are rare off Atlantic Canada before June and after October.

In summary, a variety of information sources suggest that Leatherback Turtles reside in the waters of Atlantic Canada year round but are most abundant during June – October. While there no doubt more detailed monthly movements within this period, the observations are not available to determine what these might be. During this period, Leatherbacks are seen to form concentrations in the following areas (see Figure 4 for DFO unit area boundaries), which are referred to hereafter as Leatherback areas of concentration:

- Off the south coast of Newfoundland off the Burin Peninsula (DFO unit areas 3Psc, 3Pse and 3Psf.
- In the central part of the southern Gulf of St. Lawrence around the Magdalen Islands (DFO unit area 4Tf) and off Cape Breton (4Tg).
- Off Cape Breton in the Laurentian Channel (DFO unit area 4Vn) and towards Sable Island (DFO unit areas 4Wd, 4We and 4Wf).
- Along the central coast of Nova Scotia (DFO unit area 4Xm and 4Xo) and along the Scotian Shelf edge off southwest Nova Scotia (DFO unit areas 4Xl, 4Xx and 5Zem.

James et al. (2007), in their analysis of 152 turtles collected off Nova Scotia, determined that the size distribution in Canadian coastal waters (Curved Carapace Length or CCL = 111.8 to 171.8 cm) was principally comprised of large sub-adult and adult individuals. Only one turtle less than 125 cm was observed. The average length of 148.1 cm was larger than that observed off the coast of France (139.8 cm). The sex ratio off Nova Scotia was 1.86, highlighting the dominance of females in the area. James et al. (2007) speculate that the prey of smaller turtles may be more limited to southern, warmer areas. The sex ratios were hypothesized as being a combination of climate effects (sex determination of developing embryos is determined by temperature) and increased female survival off nesting beaches.

Of the 143 Leatherbacks observed off Canada’s East Coast during fishing operations during 2001 – 2010, 133 were measured for length with weights also available for many of these. However, these measurements were based upon the observer’s visual estimate as Leatherbacks are not brought on board the vessel. As well, observers estimated straight length of the whole turtle (not just shell) in centimeters and not the CCL. A conversion from straight length to CCL is not available (James, pers. comm.). As well, the observed Leatherback weights are also likely overestimates and of limited scientific use (James, pers. comm.). Therefore, the lengths and weights of Leatherbacks reported by observers are not reported here. It is considered that the size and sex information provided by James et al. (2007) is of more utility. James (pers. comm.) reported that there likely have not been significant changes in the length and weight of Leatherbacks since those documented in James et al. (2007).

FISHERY THREATS

BACKGROUND

Until recently, there has been relatively little study of the interaction between Canadian East Coast fisheries and Leatherback Turtles. Based upon discussion by a group of experts at a workshop, O'Boyle (2001) rated the relative potential impact of a wide range of gear types used on Canada's East Coast. Overall, it was considered that gears such as dredges (Scallop and Clams), trawls (groundfish and Shrimp), purse seine and weirs (Herring) were a low threat. Gears which were moored to the bottom, including longline (groundfish and large pelagic), gillnets (groundfish and Herring), traps (Lobster) and pots (Snow Crab) represented a higher risk, somewhat mitigated by the spatial and seasonal distribution of the gear. Since then, a number of studies have been conducted that provide further understanding of the interaction between fishing gear and Leatherback Turtles.

Gavaris et al. (2010) conducted a comprehensive analysis of bycatch in commercial fisheries in NAFO divisions 4VWX5Z during 2002 – 2006. It was concluded that current levels of at-sea observer coverage for many of the principle fisheries was too low and intermittent to give confidence in the reliability of discard estimates. This was the case for the groundfish longline, groundfish gillnet, offshore Lobster trap and Tuna / Swordfish large pelagic longline fisheries. Good information was judged to exist on the Snow Crab trap fishery. Notwithstanding this, some broad patterns were evident. The fisheries for which Leatherback Turtle bycatch was identified as an issue were the 4VW large pelagic longline, 4VW Snow Crab trap and 4X5Y large pelagic longline fisheries. Unfortunately, the study did not estimate numbers of Leatherbacks encountered in the fisheries, with only weight provided and these based upon observer visual estimates. During 2002 – 2006, assuming an average turtle weight of 392.6 kg (based on James et al. 2006a), an average of 145.6 Leatherbacks were encountered per year (Table 3). This provides the magnitude of Leatherback encounters with commercial fisheries operating in NAFO divisions 4VWX5. The Gavaris et al. (2010) analysis is currently being updated for specific fisheries, including 4X-5Y groundfish, inshore Lobster trap and inshore Scallop dredge, which will shed light on bycatch in these fisheries. These are being compiled into a regional DFO bycatch report (S. Quigley, pers. comm.).

Two additional analyses have been undertaken to describe the interaction between Leatherbacks and fisheries off Canada's East Coast, also primarily in NAFO divisions 4VWX5. An analysis of the opportunistic encounters reported to the Canadian Sea Turtle Network updates that of James et al. (2006a) (K. Martin, pers. comm.), while an in-depth analysis of the temporal and spatial interaction between Leatherbacks and commercial fisheries operating in NAFO divisions 4TVWX5 that were considered by DFO (2011a) (S. Brilliant, pers. comm.) is being developed. The latter is using data similar to that employed in this report but at a higher spatial resolution.

Two further studies deserve mention. Dyer (unpublished manuscript) and Paon (unpublished manuscript) undertook in-depth analyses of the seasonal distribution of fixed gear on the Scotian Shelf, in the Gulf of St. Lawrence and off Newfoundland. Both studies provide a wealth of information not only on the seasonal distribution of fixed gear, albeit for only one year (2003), but also on the operation and configuration of these gears. For this reason, it was decided not to present descriptions of fixed gear in this report.

SOURCES OF INFORMATION

DFO Observer Program

One of the most important sources of information on Leatherback – fisheries interactions is the observer program conducted by DFO in each region (Newfoundland, Gulf, Quebec and Maritimes). This program provides detailed information on fishing trips carrying an observer. While the program has been conducted since 1977, it is only since 2001 that protocols have been introduced to ensure that Leatherback encounters are accurately recorded, including species identified, encounter method categorized and release state reported (P. Comeau, DFO Maritimes, J. Firth, DFO Newfoundland and L. Savoie, DFO Gulf, pers. comm.).

An overview of the data available in this dataset is provided in Table 4. This provides the number of observed sets by fishery, species sought and fishing gear in each of the DFO regional programs. During 2001 – 2010, the Maritimes, Quebec/Gulf (common database except for 4T snow crab) and Newfoundland regions programs observed 46,161, 30,908 and 69,573 fishing sets, respectively. Coverage primarily focused on a subset of all fisheries including Snow Crab trap, large pelagic longline, Halibut longline, Turbot gillnet and a number of groundfish longline and gillnet fisheries.

An important feature of these data is that the species sought on a set or trip are recorded by the observer. This, along with the most common species (representing the majority of the catch) observed on a set, and gear type were used to classify a fishery.

In the Newfoundland observer dataset, there has been only one report of an encounter between Leatherback Turtles and fishing gear. This was in 2000 on a Swordfish directed fishing trip. This was before standardized protocols for the reporting of Leatherback encounters were instituted and, thus, this observation will not be considered further in this report.

In the joint Quebec/Gulf observer database, there is only one recorded encounter between a Leatherback Turtle and fishing gear. This was in August 2008 when a Redfish bottom trawler reported having to release a Leatherback from its gear while fishing in Unit Area 4Tf (in the vicinity of the Magdelan Islands).

The most observed encounters with Leatherback Turtles have been reported by the Maritimes observer program. During 2001 – 2010, a total of 143 Leatherbacks were reported as being encountered (Table 5). Of these, 138 were reported from the large pelagic longline fishery (roughly split evenly between the Swordfish directed and Tuna/Swordfish directed fisheries, and five were reported from the Scotian Shelf Snow Crab trap fishery.

DFO – Industry Sentinel Survey Program

Another important source of information is the sentinel and cooperative DFO-Industry surveys which have been conducted in each DFO region since the early 1990s. The protocols of the sentinel surveys are provided in a number of reports (see Gillis 2002; O’Boyle et al. 1995). These surveys were instituted in all DFO regions soon after the collapse of the groundfish fisheries in 1992/93 as a means to provide ongoing monitoring of the stocks using fixed gear fisheries, mostly longline and gillnet. Significantly, these surveys have maintained a consistent sampling protocol over time. In the Maritimes Region, the 4Vn and 4VsW sentinel surveys employ a stratified random design of longline sets (no. 12 circle hook) during June – September and March – October, respectively. Since 2001, about 56 and 53 sets have been conducted in NAFO divisions 4Vn and 4VsW, respectively (Table 6).

A DFO – Industry Atlantic Halibut survey has also been conducted in Maritimes Region since 1998. This survey employs a fixed station design of 52 – 62 fixed gear sets (no. 14 or greater circle hook) during late May – late July each year. In the Gulf of St. Lawrence, two sentinel surveys have been conducted, one using longline and the other gillnet gear. These have employed a modified fixed station design using a standardized sampling protocol (see Gillis 2002, for details). The longline survey is more extensive than that using gillnet gear, employing about 360 – 625 sets (Table 7). The gillnet survey has not been conducted since 2005. Longline and gillnet sentinel surveys have also been conducted in Newfoundland Region, again using standardized sampling protocols (see Gillis 2002, for details). The number of sets employed has ranged 200 – 400 for the longline survey and 2100 – 2800 for the gillnet survey (Table 8).

A sense of the distribution of the sets in these surveys is provided in Figure 5. This shows the distribution of sets in each survey for 2010.

None of these surveys have reported encounters with Leatherback Turtles since standardization of Leatherback observer recording protocols in 2001. Notwithstanding this, during the March 2012 review meeting of Leatherback interactions with human uses (DFO 2012), a concern was raised that, while the new observer protocols were in place for these surveys, there may need to be further follow-up work with these programs to ensure that they are being appropriately implemented.

DFO *Species at Risk Act* (SARA) Logbooks

In response to the 2003 *Species at Risk Act*, DFO introduced SARA permits that allowed fishermen to catch listed species within allowable harm limits established by DFO Science. Associated with these permits was a SARA log reporting requirement to record by encounter the location, time, gear, and release condition of the SARA-listed species. The implementation of these logs has varied between and within DFO regions, as well as by fishery. For instance, in Maritimes Region, SARA logs are currently required (as a condition of license) to be completed by the Swordfish (longline and troll), shark (longline), Jonah Crab, Rock Crab, Sea Cucumber, inshore and offshore Lobster, Snow Crab, Herring, Mackerel and groundfish fisheries. These logs are not as yet required to be carried by the Bluefin Tuna, Swordfish harpoon, inshore Clam, offshore Clam, inshore Scallop, offshore Scallop, Shrimp, Hagfish, Sea Urchin, marine worm, diadromous species (Salmon, Eel, Gaspereau, Shad, Smelt, Sturgeon, etc.) and recreational fisheries (e.g. groundfish). A similar roll out process has occurred in the other DFO regions.

From discussion with regional SARA logbook coordinators, compliance with the SARA logbooks has been low. This is particularly the case of groundfish fixed gear trips. An indication of this is provided in the compliance report provided by the Maritimes Region (Table 9). Thus, it is considered that the information in these logbooks is of limited utility until coverage and compliance issues are resolved. Notwithstanding this, a general overview of the observations available in these logs is provided below.

The SARA logbook was introduced in the Newfoundland Region in 2005. From interpretation of these logbooks, there were 10 encounters during 2005 – 2009 (Table 10). Six of the encounters were with fixed gear while four were with mobile gear. Eight were reported to have been released alive (one unknown).

In the Gulf Region, during 2007 – 2010, there was only one report of a Leatherback encounter. This was in August 2010 with a Mackerel trap. It is reported to have been released alive. There is no record of the position of this encounter.

SARA logbook information on Leatherback encounters from Quebec Region indicate that, since initiation of the program in 2005, a total of 18 Leatherbacks have been encountered across a range of gear types (Table 11). Location information was available for many of these encounters. They indicate that virtually all these encounters occurred in the vicinity of the Magdalen Islands during August – September (Figure 6). These data present a few surprises. First, there are two instances of trawl encounters, one with an Atlantic Halibut trawl and the other with a Redfish trawl. There were two encounters with handline gear, one for Cod and one for Mackerel. The majority of encounters were recorded in the Whelk trap fishery. The release condition of these 18 Leatherbacks is noted for only five of these encounters, where it is indicated that four were released alive and one dead.

The Maritimes regional SARA logbooks indicate that, during 2007 – 2011, the number of Leatherbacks encountered ranged from 7 – 29 per year (Table 12) with all, except one (see below), reported by the large pelagic longline fishery. Unfortunately, the positional information on these encounters is not available. It is interesting to note that there are more encounters reported in the SARA logs than in the DFO Maritimes observer dataset during 2007 – 2010 (Table 5). The exception noted above was an encounter reported by a Lobster Fishing Area (LFA) 29 (Chedabucto Bay) Lobster licence in June 2010. All these Leatherbacks were reported as being released alive although their state of entanglement and release (e.g. hooked or not) is not reported.

Overall, the SARA logbooks show promise of being a valuable future source of information on encounters between SARA-listed species, such as Leatherbacks, and fishing gear. The program is still relatively new, with reporting and compliance issues and, thus, the data at present provide an uneven representation of Leatherback encounters across the DFO regions.

Strandings / Sightings Networks

A number of opportunistic stranding and sightings networks have been established in Atlantic Canada, which have also recorded encounters between Leatherback Turtles and fishing gear. Martin and James (2005) describe the Canadian Sea Turtle Network (CSTN), which was established in the late 1990s to enhance awareness and promote reporting of Leatherbacks among commercial fishermen and other mariners. The CSTN collects information on stranded Leatherbacks from across Atlantic Canada, although its primary source of observations has been Nova Scotia. An example of the type and use of information available from the CSTN is provided by James et al. (2006a), which is the Leatherback distributional information summarized above. Data available from the CSTN post-2006 are being analyzed separately from this report.

Leatherback sightings and stranding data from the Gulf of St. Lawrence have been collected for a few years by the Turtle Observation Network (see website at http://www.amphibia-nature.org/fr/projets/tortues-marines/). These data are not in the CSTN database and are currently being prepared for scientific publication. As a consequence, these data are not available for this report and will not be discussed further.

Whale Release and Strandings is a non-profit group operating in Newfoundland and Labrador that responds to whales, Leatherback Turtles and Basking Sharks entrapped in fishing gear or ice, or stranded on the shoreline (see website at http://www.newfoundlandwhales.net). The group also conducts research projects and provides education outreach to fishers, community groups and schools on marine animal life in Newfoundland and Labrador waters. It has been collecting observations on Leatherback Turtles since 1976. Since then, it has recorded

75 encounters (an average of about two Leatherbacks per year) with a range of small fixed gear licence holders, most gillnetters, around Newfoundland, with many of these occurring during the first half of the year when Leatherbacks are considered to be rare in the region (Tables 13 and 14). Of the 70 Leatherbacks encountering fixed gear, 16 or 22.9% were reported as being dead, whereas all five of the Leatherbacks encountered by mobile gear (including trawl lines) were dead (Table 15).

In addition to the above, in 2001 and 2002, there were reports of 28 and 39 Leatherbacks encountered, respectively, by large pelagic fishing gear.

The positional information associated with these observations is, as expected, from inshore areas around Newfoundland (Figure 7). It is interesting to note the presence of observations on the Labrador coast, which is generally north of the primary Leatherback habitat off Atlantic Canada determined by James et al. (2005).

In considering the Newfoundland strandings information, it is important to note that no adjustment for potential bias due to the opportunistic nature of these data has been made. It is not possible to compensate for spatial and temporal coverage and, thus, they should be used with caution. Notwithstanding this, they provide valuable insight into fishery – Leatherback interactions off Newfoundland.

CURRENT ANALYSIS

The datasets available on which to base estimates of the impact of the Canadian East Coast fisheries and Leatherback Turtles are rich and varied. Unfortunately, except for the observer and sentinel survey datasets, all do not representatively sample the fisheries. They do, on the other hand, offer insight on potential interactions that can inform the analysis.

The approach taken in this report is to describe the spatial and temporal distribution of those gear types that have the most potential to interact with Leatherback Turtles, and then consider Leatherback encounter rates by fishery to develop an estimate of a fishery-level impact. The following fixed gear fisheries were examined:

- Snow Crab trap
- Lobster trap
- Whelk pot
- Herring gillnet
- large pelagic longline
- Atlantic Halibut longline
- Greenland Halibut (Turbot) gillnet
- groundfish longline
- groundfish gillnet

The database codes used to define each of the fixed gear fisheries representing a potential threat to Leatherback Turtle are provided in Table A1. It is acknowledged that there have been observations of Leatherback encounters in other fisheries (e.g. Redfish trawl, Halibut trawl and Mackerel purse seine). However, based on previous work (James et al. 2005; O'Boyle 2001) that indicates fixed gear fisheries could be an important source of interaction with Leatherbacks, it is considered that the above nine fixed gear fisheries present the greatest potential threat to Leatherbacks.

In one case (large pelagic longline fishery), analyses have been conducted to provide estimates of the Leatherback encounters with the fishery. The results of these analyses are reported here. In all other cases, no such analyses have been undertaken and it was necessary to use expert judgment on the potential impact of the fishery on Leatherbacks.

In conducting these analyses, access to the landings and effort of each DFO region was required. DFO Science annually compiled a combined dataset of each region's landings and effort data up to the mid-2000s. Termed the Zonal Interchange Fisheries File (ZIFF), it had been used as a data input in DFO stock assessment analyses. This file is now prepared by DFO Headquarters Region. Prior to 2006, there was no identifier for fishing trip in the file and, thus, the analysis focused on the 2006 – 2010 data.

Landings were computed as the sum of all species kept on a fishing trip, with the trip type defined by the codes in table A1. A trip was defined by Commercial Fishing Vessel (CFV), trip number and date landed (year, month, day). This allowed the possibility of multiple trips per day although there were few of these. The percent observer coverage was estimated as the ratio of the observer kept weight (t) to the reported landings weight (t) from the ZIFF file. No attempt was made to match observer and logbook trips. Thus, it was not possible to use the ratio of observed to total official (dockside monitored weighout) landings to prorate observer estimates of Leatherback encounters to the fishery level, as was done by Gavaris et al. (2010). This is the preferred approach but is a task far too large to be undertaken here. Rather, as per Hanke et al. (2012), the observer estimate of the kept catch ('unofficial' landings) was used. While this is an approximation, the analysis of Hanke et al. (2012) of the large pelagic longline fishery indicated that estimates of total encounters produced using the observer estimates of kept weight were comparable to those based on effort (number of trips, sets or sea days) and, thus, by inference, to those based on the official landings.

In the tables below, the winter – spring season refers to the months of January – May and November – December of the same year while the summer – fall season refers to the June – October period. Also, mention is made of the percent of a fishery's landings and trips that take place within Leatherback areas of concentration (see p. 3).

Snow Crab Trap Fishery

The Snow Crab trap fishery is split roughly evenly between the summer – fall and winter – spring seasons (Table 16). There are three major components to the summer – fall fishery – one operating in NAFO divisions 3K – 3L, another in 4T and a third in 4VW (Table 17).

The unit area information in the ZIFF indicates that during 2006 – 2010, 19.4% of the landings and 26.3% of the fishery's trips were reported from Leatherback areas of concentration (Table A2). The fishery off Newfoundland is prosecuted in a large part of the region, with that in NAFO Division 3Ps being a relatively small component. In the Gulf, the fishery is prosecuted in most unit areas, including 4Tf (in the vicinity of the Magdalen Islands). The fishery on the Scotian Shelf primarily occurs in the eastern area, with that in Sydney Bight a small fraction of the whole.

The spatial extent of the summer – fall fishery is illustrated by the set location (latitude and longitude) information available in the ZIFF, aggregated for 2006 - 2010 (Figure 8). Positional data were available for more than 80% of the landings during this period (Table 17).

The percent observer coverage of this fishery ranged from 2 – 18% during 2006 – 2010 dependent on the region. In the Newfoundland fishery, it ranged from 2.3 - 17.7% with the highest coverage in NAFO Division 3N. The observer data for the Gulf fishery was not available. The target observer coverage for this fishery is 25% of all sets (Hebert et al. 2011). Moriyasu (pers. comm) indicated that, during 2006 – 2010, observer coverage of this fishery averaged 12.4%. On the Scotian Shelf, the target coverage is 10% (J. Choi, pers comm). Observer coverage of this fishery ranged from 8 - 10% during 2006 – 2010 with the highest rates in 4Vn. These rates are consistent with the 8 -10% range during 2002 – 2006 reported by Gavaris et al. (2010) for 4VW. Overall, coverage rates are considered adequate to record potential Leatherback encounters with the fishery.

No Leatherback encounters have been observed in either the Newfoundland or Gulf fisheries. In the Scotian Shelf fishery, during 2001 – 2010, five Leatherback Turtles (one in 2001 from 4Wd, two in 2005 from 4Vn and 4Wd, one in 2006 from 4Wd and one in 2010 from 4Vc) were reported to have been encountered. Unfortunately, the release condition of these Leatherbacks is not reported. At a rate of 0.5 encounters per year and observer coverage averaging 9.1% (Table 18), the Scotian Shelf fishery would be encountering about 5.5 Leatherbacks per year.

No Leatherbacks have been reported encountering Snow Crab trap gear in any of the regional DFO SARA logbooks.

From the Whale Release and Strandings network, in the 35 years since 1976, there have been two encounters in Snow Crab trap gear off Newfoundland, both of which were reported to have been released alive.

Interaction between Leatherbacks and Snow Crab trap gear appears to be a relatively rare occurrence. The only quantitative estimate that can be made was for the Scotian Shelf fishery which was 5.5 encounters per year. Similar encounters may be occurring elsewhere, based on the Newfoundland stranding network data.

Lobster Trap Fishery

The Canadian East Coast Lobster fishery is primarily prosecuted during the winter – spring season (Table 19), although the intensity varies by area, consistent with DFO’s management regime (Figure 9). During the summer – fall, the largest fishery is in NAFO divisions 4T, 4Vn and offshore of the Scotian Shelf (4VWX, which is the area of a year-round fishery) (Table 20). During 2006 – 2010, 37.2% of the landings and 36.8% of the trips were reported from Leatherback areas of concentration. Other than the unit area designation, there are few sets (<2.5% of the landings; Table 20) in this fishery for which latitude and longitude data are available.

The comparison of observer estimates of kept catch to ZIFF landings for the summer – fall fishery (Table 21) indicates that there is no coverage of the fisheries in the Southern Gulf and around Newfoundland. Off Nova Scotia, coverage during 2006 – 2010 ranged from 0.3 – 6% with the highest rates in 5Z. Gavaris et al. (2010) reported that observer coverage rates in the inshore Lobster trap fishery was zero during 2002 – 2006 while for the offshore fishery, it ranged from 4 – 8%. The overall lower rates reported here are likely due to the combination of the two fisheries in this analysis. The intent here is to provide an overall indication on the level of observer coverage for the whole fishery, which is very low.

There were no reported encounters of Leatherbacks in the Scotian Shelf lobster fishery.

From SARA logs, during 2007 – 2011, there was one report of a Leatherback encounter in the Maritimes SARA logs (in LFA 29). In the Gulf, during 2007 – 2010, there was one report in a

Lobster trap (2010), while off Newfoundland, there were no reported encounters in the SARA logs.

The Whale Release and Strandings network off Newfoundland also records no interactions between this fishery and Leatherbacks.

Whelk Pot Fishery

The Whelk pot fishery on the Canadian east coast occurs almost exclusively in the summer – fall (Table 22) with the most intense fishing in NAFO Division 3P (Table 23). This is an area frequented by Leatherbacks and is close to Burin Peninsula. This is confirmed by the unit area data (Table A4), which indicates that 44.5% of the landings during 2006 – 2010 were reported from Leatherback areas of concentration. However, the number of trips reported from these areas averaged 19.7% during this period.

Latitude and longitude information on each set during 2006 – 2010 is available for 73 – 95% of the landings (Table 23). These data provide a more detailed impression of where the fishery is prosecuted. Off Newfoundland, it occurs primarily around the Burin Peninsula and in the Gulf around the Magdalen Islands. It also occurs along both sides of the St. Lawrence Estuary (Figure 10).

Observer records of this fishery are limited, with 192, 90 and 16 sets observed by the DFO Newfoundland, Quebec/Gulf and Maritimes programs, respectively. Thus, a very small percent of the landings has been observed. There have been no reports of Leatherback encounters in the observed component of the fishery.

From SARA logbooks, there are no reported encounters in the Maritimes Region records, but there are in the Newfoundland and Labrador Region (2) and Quebec Region (10) records. The Quebec Region records are mostly from around the Magdalen islands, and the Newfoundland records are from 3Ps. The Whelk fishery represents the most encounters of SARA logs submitted from the fixed gear fishery (12 during 2005 – 2011 or 1.7 per year). Note that this does not consider the unknown SARA log compliance rate. The condition of these turtles at release is not consistently recorded.

From the Whale Release and Strandings network, there were five reported encounters off Newfoundland during 1976 – 2010. Two of these were released alive and three dead (Tables 14 and 15).

Overall, the Whelk pot fishery occurs in Leatherback areas of concentration, primarily in the Gulf (4Tf) and off Newfoundland (3Ps). It is not possible to state what the level of this threat is but, based on the SARA logs, it may be larger than that posed by other fixed gear fisheries given the spatial focus of the fishery.

Herring Gillnet Fishery

The Canadian East Coast Herring gillnet fishery is most intense during the summer – fall (Table 24), with much of this fishery occurring in NAFO Division 4T (Table 25) and a smaller component in the Scotian Shelf – Bay of Fundy area.

Information on the location of the fishery is primarily at the unit area scale (Table A5) as opposed to the set scale (Table 25), the latter indicating that only 7 – 12% of the landings during 2006 – 2010 had associated latitude and longitude data. Based on the unit area data, much of the Gulf fishery occurs around Prince Edward Island (4Tg and 4Th) and not around the Magdalen islands (4Tf). The fishery in the Scotian Shelf-Bay of Fundy area is predominantly in the inshore unit areas. There does not appear to be any fishery in NAFO Division 3Ps. During 2006 – 2010, 21.1% of the landings and 24.2% of the trips were reported from Leatherback areas of concentration.

The only observer coverage of this fishery was of eight sets conducted off Newfoundland. None of these reported Leatherback encounters.

From SARA logs, there are no reported encounters from the Newfoundland and Labrador Region, only one (2008) from the Quebec Region (Table 11), and none from the Maritimes Region.

From the Whale Release and Strandings network, there have been four reports of a Leatherback encounter off Newfoundland in the 35 years since 1976.

Overall, while the possibility exists for interaction between this fishery and Leatherbacks, evidence of this is sparse.

Large Pelagic Longline Fishery

The large pelagic longline fishery occurs almost exclusively during summer – fall (Table 26) with much of this occurring off the Scotian Shelf (Table 27). During 2006 – 2010, 26% of the landings and 25.7% of the trips were reported from Leatherback areas of concentration, primarily off Southwest Nova Scotia (Table A6). During this period, over 97% of the landings per year have associated set latitude and longitude data (Table 27).

An impression of the spatial distribution of the summer – fall fishery is given in Figure 11 (see Paul et al. 2010 for a comprehensive description of the annual spatial distribution of the fishery). The fishery extends from Georges Bank south of Nova Scotia to beyond the Flemish Cap east of Newfoundland when Swordfish, the main species targeted, migrate into and adjacent to the Canadian Exclusive Economic Zone (EEZ). Longline fishing effort generally progresses from west to east and back again and from offshore to inshore along the edge of the continental shelf following Swordfish movements associated with seasonal warming trends of surface water temperature, and a northward movement of the edge of the Gulf Stream. Swordfish migrate into the Canadian EEZ during summer and fall to feed in the productive waters of the continental shelf slope and shelf basins, areas where water temperatures form a distinct thermocline.

As noted above, both O’Boyle (2001) and Gavaris et al. (2010) identified the large pelagic longline fishery as an important potential source of Leatherback mortality. DFO convened a meeting in the summer of 2010 to consider analyses of Leatherback encounters in the Canadian East Coast’s Swordfish and Tuna large pelagic fisheries (DFO 2011b). The meeting reviewed an analysis by Hanke et al. (2012), which considered both the adequacy of observer coverage in the large pelagic longline fishery, as well as provided estimates of Leatherback bycatch based upon the 2002 – 2010 observer and landings (MARFIS, which is a subset of ZIFF) databases.

As with Gavaris et al. (2010), Leatherback bycatch was estimated based upon the Ratio Method in which the observed bycatch per unit of observed landings (of target or all species) or effort (hooks, sea days or sets) on a trip is prorated up to the fishery level based upon the census of the landings and effort. Whereas Gavaris et al. (2010) had used the landings of all species on a trip to do the proration, Hanke et al. (2012) explored both landings and effort-based prorations.

On the other hand, while Gavaris et al. (2010) had matched the observed trips with those in the MARFIS database, Hanke et al. (2012) had defined fields and codes in each dataset to perform the matching. Hanke et al. (2012) concluded that, while overall observer sampling levels may be adequate, there were time periods and areas for which there was no observer coverage. Thus, the sampling levels did not always produce a representative profile of bycatch in the fishery, especially at observer levels of about 5%. This analysis indicated that estimates of Leatherback encounter rates in the large pelagic longline fishery must be considered coarse until the observer allocation plan is adjusted.

Since 2002, observer coverage rates have increased in NAFO divisions 4VWX, 5 and 6 and have decreased in NAFO divisions 3KLOMN, 3P and 4V (Table 28). Estimates of observer coverage were similar regardless of the proration factor (trips, sets or sea days) used (Table 29). Overall rates for the fishery ranged from 5 – 30% during 2002 – 2010.

Based upon these observer coverage rates, Hanke et al. (2012) estimated that the total number of Leatherbacks encountered per year in the large pelagic longline fishery has declined from about 145 individuals in 2002 to 16 individuals in 2010 (Table 30 and Figure 12). The estimates (120 – 188) during 2002 – 2006 are within the range of those estimated using the Gavaris et al. (2010) data (52 – 266; Table 3) with the mean of the latter for this period being slightly higher (152.8).

This analysis implies that observed Leatherback encounters with the large pelagic fishery have dramatically dropped since 2006. As Hanke et al. (2012) have noted, the coefficients of variation (CV) during the more recent period were high, on average across the proration factors being in the order of 60 – 80%. As well, their analysis highlighted issues with observer coverage that need to be resolved. When considering the number of Leatherbacks observed (not corrected by proration factor), it is evident that, since 2006, the number of recorded encounters has declined (Table 31). Most of the recent observations were made in NAFO divisions 4W and 4X, where much of the large pelagic fleet fishing effort has been (Figure 13). However, there remains the concern that unrepresentative sampling may partly account for the estimated decline in encounters.

As noted by Hanke et al. (2012) and as seen from Table 28, there has been a decline in observer coverage in NAFO divisions 3KLOMN, while that in NAFO divisions 4WX has increased. It is possible that the decline in estimated Leatherback encounters since 2007 is due to sampling. On the other hand, the overall number of trips in the summer – fall large pelagic fishery has declined (from 561 to 2006 to 390 in 2010; Table A6), so some reduction in Leatherback encounter rates would be expected. However, the estimates of 19 and 16 for 2008 and 2010, respectively (Table 30) seem out of line with the other estimates since 2006 (89 and 62 for 2007 and 2009, respectively). Given the issues with observer coverage noted by Hanke et al. (2012), it is prudent to consider that, while Leatherback encounter rates in the large pelagic longline fishery have declined from the 120 – 188 range since 2006, more recent encounter rates are likely in the 60 – 90 range.

Atlantic Halibut Longline Fishery

The Atlantic Halibut longline fishery in the Canadian zone is split about evenly between the winter – spring and summer – fall seasons (Table 32). During the summer – fall, much of this fishery occurs in NAFO divisions 3Ps to 4X (Table 33).

During 2006 – 2010, 18.3% of the landings and 22.3% of the trips were reported from Leatherback areas of concentration (Table A7). Set positional data are available for 78 – 88% of the landings during this period (Table 33), which highlight the areas where the fishery is most intense (Figure 14).

The comparison of observer kept weights to the landings in the ZIFF file highlighted anomalies in either or both datasets (e.g. greater than 100% coverage in 3NO). These could not be resolved and, thus, this analysis must be considered with caution. In NAFO divisions 4RST, observer coverage ranged from 3.5 – 22% during 2006 – 2010 (Table 34). For the Scotian Shelf and Southern Grand Bank stock (NAFO divisions 3NOPs4VWX5Zc), Trzcinski et al. (2011) reported that, during 2007 – 2010, 11.7% of the longline landings were observed. The rates for the Scotian Shelf reported here are much lower, ranging from 0 – 2.5% (Table 34). Trzcinski et al. (2011) noted that coverage of this fleet is highest in January and lowest in the autumn, which may be the source of the difference. This requires further exploration. Assuming that the rates reported by Trzcinski et al. (2011) are correct, there has been a reasonable amount of observer coverage of this fishery.

There are no records of interaction of this fishery in the observer programs of the four DFO regions. This is also the case for the SARA logs and the Whale Release and Strandings network. Also, there has been no reported interaction between Leatherbacks and the DFO – Industry Halibut longline survey off the Scotian Shelf.

Thus, while the fishery occurs in areas where Leatherbacks may occur, posing a potential for interaction, there is no evidence of interaction, yet this may reflect, in part, the majority of observer effort targeting months when leatherbacks are not regularly present in Canadian waters.

Greenland Halibut (Turbot) Gillnet Fishery

The Canadian East Coast Turbot gillnet fishery is prosecuted primarily during the summer – fall (Table 35). During this season, much of the fishery occurs north of the Scotian Shelf with a large fishery in the Gulf and off Newfoundland (Table 36). A negligible portion of the 2006 – 2010 landings and trips were reported from Leatherback areas of concentration (Table A8). There is good set positional data on this fishery, with over 90% of the landings represented (Table 36). These data highlight the focus of the fishery in the northern part of the Canadian zone (Figure 15).

Observer coverage during 2006 – 2010 ranged from 3.2 – 54.5% depending on the area (Table 37), with the highest rates off Newfoundland.

There are no observer records of encounters of Leatherbacks with this fishery. There were two records of interactions in the Newfoundland SARA logbooks (released alive) in 2006.

It is likely that this fishery does not significantly interact with Leatherbacks.

Groundfish Longline Fishery

The Canadian East Coast groundfish longline fishery consists of a wide array of species both directed for and caught. The main component of this fishery directs for Cod, Haddock, Pollock and White Hake. While directing for these species, a wide range of species are caught, a list that varies by NAFO division. For the purposes of this report, it was decided to select those sets for which the species caught were these four main groundfish species and then to select only groundfish from the caught species list, which resulted in exclusion of some pelagic species

(Table A1). Regarding gear type, longline and handline gears are both used in this fishery but, given the desire to document Leatherback interactions, only longline gear was selected.

The majority of the fishery occurs during the summer – fall season (Table 38). Much of the summer – fall fishery occurs in NAFO divisions 3P, 4R, 4X and 5Ze (Table 39). During 2006 – 2010, 14.6% of the landings and 13.0% of the trips were reported from Leatherback areas of concentration (Table A9). There is a reasonable level (67 – 77.2%) of set positional data for this fishery (Table 39), which is illustrated in Figure 16.

During 2006 – 2010, observer coverage averaged 1.2 – 31.5% in 3NO, 12.5 – 19.5% in 4RST and 1.9 – 11.6% in 4X and 5Z (Table 40). Gavaris et al. (2010) estimated that during 2002 – 2006, observer coverage averaged 1.5% in 4VW and 4X and 8% in 5Z. These rates are comparable to those estimated here. As well, Dochherty (pers. comm.) noted that DFO has increased observer coverage on this fishery in recent years.

There have been no reported interactions between this fishery and Leatherback Turtles in the zonal observer dataset since 2001.

The sentinel surveys conducted since the late 1990s were designed primarily as standardized groundfish longline surveys to measure abundance and distributional changes. These surveys have also not reported any interactions with Leatherbacks.

From SARA logbooks, there have been no reported interactions with this fishery from the Newfoundland and Labrador, Gulf, and Maritimes regions. During 2005 – 2011, there were three reports (one in 2006 and two in 2008) from the Quebec Region, with these being in the area of the Magdalen Islands (Figure 6).

From the Whale Release and Strandings network, there have been 10 reports of interaction with this fishery in the 35 years since 1976, with four of the 10 reported dead (Table 14).

Overall, while there is the possibility of interaction between this fishery and Leatherbacks, it appears to be rare. What interaction has been documented is in NAFO Division 4T and along coastal Newfoundland.

Groundfish Gillnet Fishery

Like the Canadian East Coast groundfish longline fishery, the groundfish gillnet fishery, while directed at the traditional groundfish (Cod, Haddock, Pollock, White Hake), catches a wide array of groundfish species, with this varying by NAFO division. As with the longline fishery, it was decided to select those sets for which the species caught is Cod, Haddock, Pollock or White Hake and to select only groundfish from the species caught list (Table A1). This resulted in the exclusion of some pelagic species. The gear type chosen was gillnet.

The fishery is prosecuted mostly in the summer – fall period (Table 41). Much of the summer – fall landings were reported from NAFO divisions 3L, 3P, 4R and 4X (Table 42). During 2006 – 2010, 28.9% and 23.2% of the landings and trips were reported from Leatherback areas of concentration (Table A10).

Less than 50% of the landings have associated set positional data (Table 42), which is illustrated in Figure 17. There is a large component of the fishery along the Newfoundland coast and in NAFO Division 3Ps. In the Gulf, it is mostly restricted to coastal NAFO divisions 4R and

4S with little harvesting around the Magdalen Islands. There is a large component of the fishery off Southwest Nova Scotia.

During 2006 – 2010, observer coverage was 15.8% in 3O but only 0.4 – 1.4% in 3K and 3L (Table 43). In 3Ps, it was 1.4% while in 4RST, it ranged from 0.7 – 20.8%. Off Nova Scotia, rates averaged 10.1% in 5Z but ranged 0 - 2% elsewhere. The latter are comparable to the 2002 – 2006 estimates of Gavaris et al. (2010): 0 to 2% in 4VWX and an average of 9.4 % in 5Z.

There have been no reported interactions between this fishery and Leatherback Turtles in the zonal observer dataset since 2001.

From SARA logbooks, for the Newfoundland Region, during 2005 – 2009, there were two encounters reported in 2005 (area unknown), with both turtles released alive. There were no reports of Leatherback encounters from any of the three (Gulf, Quebec and Maritimes) other regions.

According to the Whale Release and Strandings network, encounters with groundfish gillnet gear in the 35 years since 1976 represented the highest number (33) of all 75 recorded. Thus, this fishery represents a high potential source of interaction, especially off Newfoundland.

Encounter Mortality

The encounter rates provided above for each fishery do not necessarily result in Leatherback mortality. Mortality can occur as a consequence of the entanglement or hooking with the fixed gear but can also occur post-release due to injury. In relation to the first cause of mortality, James et al. (2005) assert that there may be elevated risk for Leatherbacks entangled in fixed gear due to the possibility of drowning as a consequence of the tidal cycle, and or because many entanglements not only involve one or both front flippers, but also often the neck. In relation to the second cause of mortality (termed Post Capture Mortality or PCM), Ryder et al. (2006) provides estimates based on six injury categories and four release conditions (Table 44). A 2011 workshop considered an update to these criteria but concluded that none was required at this time (Swimmer, pers. comm). According to these criteria, if Leatherbacks are released entangled from large pelagic longline fisheries, 60% are expected to die. This drops to only 2% if the turtle is fully disentangled. It is assumed that, if release condition is undetermined, mortality is 100% and, if injury category is undetermined, mortality is 95% (S. Epperly, pers. comm). For leatherbacks entangled in fixed gear, corresponding mortality rates may be higher, as entanglements may involve vascular constriction, with accompanying necrosis, and subsequent loss of limbs, infection, etc.

Both direct and PCM mortality needs to be considered in estimating encounter mortality.

There are limited observations on encounter mortality in the datasets considered in this report. The most information that exists is for the large pelagic fishery in the Maritimes observer program database. These data include turtle capture type according to six categories based upon a combination of hooking type and gear entanglement. During 2001 – 2011, information was available for 138 individuals (Table 45), of which it was not possible to determine release state and/or capture type of 21 individuals. As per the criteria stated above, release condition for these was assumed dead (6 individuals), leaving the capture type of 15 individuals undetermined. Of the remaining 117 individuals, 19 were hooked externally (not in the mouth) and were either released with all gear removed or with a hook attached. Sixty were entangled with no hook involved and released with or without disentanglement. Thirty eight were mouth hooked, released with or without a hook.

The Maritimes observer and National Marine Fisheries Service (NMFS) criteria were compared to develop an overall estimate of encounter mortality of Leatherbacks encountered in the Canadian large pelagic longline fishery. Only the 2006 – 2010 data were used as release protocols were introduced into the fishery in 2006. This reduced the dataset to 36 individuals. In this comparison, only the Maritimes observer capture type was used as the release state is not relevant. Also, as noted above, it was assumed that the mortality rate of the Leatherbacks for which capture type was unknown was 95%. In undertaking this comparison, judgment was made on how best to align the two systems of criteria. This analysis suggests an overall PCM estimate of 49.3% (Table 46). If it is assumed that the unobserved distribution of capture type and release condition are the same as that observed, this implies that, of the 60 – 90 Leatherbacks encountered per year since 2006, about half (30 – 44) would have died.

For the remaining fixed gear types, there is very limited data on encounter mortality. There is no record of the condition of the five Leatherbacks caught in the Snow Crab trap gear. Of the six Newfoundland and 16 Quebec fixed gear encounters reported in SARA logs, 20% resulted in mortality. Of the one Gulf and one Maritimes encounter, neither Leatherback died. According to the Whale Release and Strandings network (Newfoundland and Labrador), of the 70 Leatherbacks that encountered fixed gear since 1976, 22.9% were dead. These observations, albeit limited, suggest that direct mortality as a consequence of interaction with inshore fixed gear could be in the order of 20 – 30%, or even higher. Dependent on the extent of entanglement upon release, and using the criteria in Table 44, subsequent PCM could be 2 - 60%. Taken together, encounter mortality could be in the order of 20 – 70%.

NON-FISHERY THREATS

Leatherback Turtles are exposed to a number of non-fishery threats that can result in lethal and sub-lethal effects and that are hard to both identify and quantify. The range of possible non-fishery impacts is large and it is necessary to focus on those that pose the most potential threat. Regarding ocean floor human uses, the potential impacts associated with offshore petroleum exploration and development is the most important source of harm to consider. Mineral extraction is another possible source although, thus far, there has been no activity and it will not be considered further. Regarding water column uses, vessel strikes pose a lethal threat, while pollution has a spectrum of potential impacts, the most pertinent of which is the ingestion of marine debris.

OFFSHORE PETROLEUM EXPLORATION AND DEVELOPMENT

In response to the potential lifting of the moratorium on oil and gas exploration of Georges Bank, DFO undertook a comprehensive review of the potential range of threats posed by this activity (Lee et al. 2011). This included consideration of seismic noise, drilling muds, produced water, natural seepage / blowouts and impacts associated with infrastructure construction, operation and decommissioning. Overall, seismic noise was judged to pose the most immediate risk to turtles. It was concluded that the effects of drilling muds would be restricted to benthic communities within one kilometer of a well. It was also concluded that there would be only a limited potential for acute toxicity from produced water beyond the immediate vicinity of Atlantic Canadian rig sites. While continual long-term chronic exposure to drilling byproducts may cause sub-lethal changes in organisms (including decreased community and genetic diversity, lower reproductive success, decreased growth and fecundity, respiratory problems, behavioural and physiological disorders, decreased developmental success, and endocrine disruption), these effects remain unquantified. Finally, the effects of construction, operation and blowouts pose a range of threats that would require specific mitigation measures to avoid.

Lee et al. (2011) provides a comprehensive overview of the state of knowledge of the potential impacts of seismic noise produced by geological surveys (see also DFO 2004). The latter use sound waves to gather information about geological structures lying beneath the surface of the earth to locate rock formations that could potentially contain hydrocarbons. The general procedure is for a vessel to transit along straight line transects while towing an array of air guns at a predetermined depth. The air guns emit a signal capable of penetrating deep into the seabed, with the sound signal reflecting back from interfaces within the geological structure. The return signals are registered by hydrophones encased in a buoyant cable several kilometers in length that trails behind the seismic vessel. The data are processed into an acoustic image of the underlying geological strata from which probable concentration areas of petroleum resources can be identified.

Typically, arrays of 12 – 48 air guns are towed at a depth of 3 - 10 m. The guns operate at pressures of approximately 2,000 pounds per square inch and fire every 10 - 15 seconds. While source sound level can be used to predict pressures in the 'far field' of the array, a seismic array constitutes a distributed rather than point source with the result that 'near field' maximum zero-to-peak pressure levels are normally limited to about 190-250 dB relative to 1 μPa. Most seismic surveys conducted in Canadian marine waters are either two-dimensional (2D) or three-dimensional (3D) surveys. The objective of a 2D survey is to provide a broad picture of the geological characteristics of an area, including the type and size of the geological structures present. In conducting a 2D survey, a seismic vessel typically tows a single air source array and a single set of receivers along a set of parallel and transverse lines, spaced up to five kilometres apart, creating a grid sampling pattern. A 3D seismic survey is conducted over a smaller area, to obtain more detailed geological information to identify potential targets for hydrocarbon drilling. Three-dimensional surveys also use a grid sampling pattern, but generally use two or more air source arrays and multiple sets of receivers trailing the vessel close together.

Seismic surveys off Canada's East Coast are coordinated by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) and Canada-Newfoundland Offshore Petroleum Board (CNLOPB) for the waters on the Scotian Shelf – slope and Newfoundland shelf – slope, respectively. Since 1996, over 40 seismic surveys have been conducted in the area of the CNSOPB (Table 47), with these roughly split between 2D and 3D surveys. Most surveys were conducted during 1998 – 2005 with no activity since then (Figure 18). Surveys can occur over extended periods (i.e. months) and generally have taken place during the summer – fall when weather conditions are conducive to surveying.

For the CNLOPB mandate area, information on fifty-one 2D and 3D seismic surveys conducted since 1990 is available (Table 48). In this case, only the length (km) of the transects conducted in each survey was available. Overall, 3D surveys conducted in this area exhibit much longer summed transects than 2D surveys. As on the Scotian Slope, most survey activity was conducted during the summer – fall of the 1998 – 2003 period (Figure 19).

The annual geographic coverage of the CNSOPB and CNLOPB seismic surveys has been variable. During 1990 – 1996, there was virtually no survey activity on the Scotian Shelf with activity in the CNLOPB area restricted to the west coast of Newfoundland and the eastern part of the Grand Banks (Figure 20). During 1997 – 1999, seismic surveys occurred along the length of the Scotian Slope, in the month of the Laurentian Channel and on the eastern Grand Banks. This pattern was also present during 2000 – 2002 with relatively diminished survey activity off

Newfoundland. By 2003 – 2005, most seismic survey activity occurred on the southern part of the Scotian Shelf.

The information on the temporal and spatial distribution of seismic surveys conducted during the 1990s and 2000s suggests that there could have been an interaction with Leatherback Turtles. During 1997 – 1999, most survey activity was offshore of Leatherback areas of concentration but certainly in the vicinity of where they are observed to occur. This is also the case during 2000 – 2002, although survey activity is closer inshore and could be impacting DFO unit area 4Wf. During 2003 – 2005, most survey activity was off the southwest Scotian Shelf with the possibility of encountering Leatherbacks in DFO unit areas 4Xl and 4Xx. Overall, though, the seismic surveys do not appear to have exerted significant sampling effort in Leatherback areas of concentration.

Knowledge on the impact of seismic energy on sea turtles is limited (Lee et al. 2011; DFO 2004; McCauley et al. 2000). Relatively little is known about the sensitivity of Leatherbacks to sound, including seismic noise. Studies indicate that sea turtles are able to detect and respond to sound frequencies in the range generated during seismic surveys. Studies that have been conducted to date (see Lee et al. 2011 for a list of these) have provided evidence of a short-term physical response (e.g. change in hearing sensitivity), a physiological response (e.g. increased levels of creatine phosphokinase, glucose, and white blood cell counts), and behavioural responses (e.g. increased swimming speed and activity) of caged turtles within 500 m of an airgun source. A few studies have included observations of sea turtles and sea turtle behaviour in the vicinity of seismic surveys. For example, Eckert et al. (1998, cited in Lee et al. 2011) attempted a behavioural study of free ranging leatherback turtles in the proximity of a seismic survey; however, limited reporting of experimental detail make results difficult to interpret. This study also attempted to estimate possible the broader scale response of sea turtles to seismic noise based on information available from non-seismic related studies. Using the peak pressure level required to obtain a temporary threshold shift in a Desert Tortoise (approximately 120 dB above best hearing threshold with repeated exposure) and the reported sensitivity of the Green Turtle in air (65-79 dB re 1 μPa), it was predicted that repeated exposure to airgun pulses above 185-199 dB re 1 μPa (conservative estimate) could have long-term effects on hearing, although Lee et al. (2011) had concerns with the experimental design of this study. Turtles were observed during the June 2002 – August 2003 seismic operations off Brazil in which there did not appear to be significant differences in the behaviour of Green Sea, Loggerhead and Leatherback Turtles based on whether or not the airguns were active, though swimming velocity and direction was not recorded. Visual observations of marine turtles during eleven Lamont-Doherty Earth Observatory seismic surveys conducted since 2003 indicated that sea turtles undertook localized avoidance during large and small-source surveys. Observations of turtles (Olive Ridley, Leatherback and Loggerheads) made during two 3D seismic surveys off northern Angola during August 2004 - May 2005 indicated that there was no significant difference in the median distance of turtle sightings during active airgun use as compared to quiet periods. While a slightly higher proportion of turtles dived during active airgun use (12.5%) as compared to quiet periods (11%), most turtles (77% during seismic and 83% during quiet) continued to remain at the surface as the vessel passed. Diving reactions were also observed in response to visual detection of the vessel, the towed surface floats, and the inactive airgun array.

Based on studies conducted to date, Lee et al. (2011) considered that it is unlikely that sea turtles are more sensitive to seismic operations than cetaceans or fish. Regarding the latter, the effects of seismic noise are observed to be local and short-term (Worcester 2006) with the primary response being movement away from the noise source. There are few studies on the consequences of seismic noise at the population level. Payne et al. (2008) reviewed the literature appearing during 2003 – 2008 and noted that a few studies indicated an absence of effects at the population level. They note, however, that if seismic surveys are having effects on fish or shellfish (and by inference Leatherbacks) at the population level, they would not be readily measurable due to confounding factors such as natural variability, fishing pressure and animal migration.

In addition to impacts from seismic noise itself, there is also the potential for impacts to sea turtles as a result of direct interaction with seismic vessels and gear. There have been reports of such interactions during seismic surveys in other parts of the world, particularly with regards to interactions with seismic tail buoys (Lee et al. 2011). This is a subset of the potential impacts of marine transport to be discussed below.

There is a lack of research on the acoustic sensitivity of sea turtles and on the importance of the acoustic environment for sea turtles. Differences in functional morphology and hearing capabilities among species and life history stages are not well documented, with investigations on the potential impacts of seismic noise only conducted for a limited number of species. Studies on the potential for noise induced hearing damage in turtles, including structural damage or damage to hair cells, are extremely limited. Studies on the responses of free ranging turtles to seismic noise are also limited and are dominated by observations from seismic vessels.

Overall, it is not possible to state how many turtles may have died due to seismic noise off Canada's East Coast since 2001. However, given the area covered by these surveys and the limited knowledge of potential impacts, it is likely that mortality has been low. Off both Nova Scotia and Newfoundland, it can be stated that the level of impact, whatever it has been, has diminished since 2005, reflecting a decline in seismic exploration.

MARITIME TRANSPORT

Leatherbacks are known to bask at the surface for extended periods when foraging in temperate waters (ALTRS 2006). James et al. (2006b) and Jonsen et al. (2006, 2007) studied the diel patterns of Leatherbacks, comparing daily activity in northern and southern latitudes. In general, there were very minor diel differences in the foraging area off Atlantic Canada with about two thirds of their activity occurring in the top six meters of the water column (Figure 21). Maximum dive depths seldom exceed 50 m, and about 50% of day and evening hours (0900-2100) at the surface (James et al. 2006b). Dive behaviour off the shelf is characterized by deeper maximum dive depths and longer dive durations, likely due to changes in foraging behavior (James et al. 2006b), and shifts accompanying the initiation of southward migration (Jonsen et al. 2006). This behavior is in contrast to the diel behaviour during the southward migration. James et al. (2006a) suggest that this behaviour may be related to the location of jellyfish prey in the water column and likely changes as the jellyfish distribution changes. This behaviour puts them at risk to collision with marine traffic, particularly is waters adjacent to large urban coastal communities. This is corroborated by Dwyer et al. (2003) and Eckert et al. (2009), the latter who noted that 20% of the stranded Leatherbacks on the coast of Florida had propeller marks.

A significant amount of international and domestic commercial shipping traffic occurs off the East Coast of Canada. Commercial shipping in this area is generally in the form of tankers and general, bulk and containerized cargo carriers. Container ships typically have a draft of 10 m dependent on whether or not they are fully loaded (T. Thompson, Navigation Architect, pers. comm). The area is also transited by a range of fishing vessels, cruise ships and various government vessels. The primary commodities being moved in the region include crude oil and gas, minerals and chemicals, paper and forest products, coal and coke, and various containerized goods.

Figure 22 illustrates a 12-month composite (March 2010–February 2011) of vessel track counts per 2 x 2-minute grid cell within Canada's Atlantic region based on Long Range Identification and Tracking (LRIT) system data (Koropatnick et al. 2012). In general, several distinct regional traffic patterns are highlighted:

- international shipping over the Scotian Shelf without a Canadian port of call as part of the "great circle route" (i.e., shortest distance over the Earth's surface) between Europe and the eastern seaboard of the United States and Canada. Several predominant offshore USA-Europe routes are apparent, including one along the continental shelf break south of Georges Bank, and a USA-Northern Europe route that passes mid-shelf north of Sable Island,
- international and domestic shipping along the coast of Nova Scotia bound to and from the United States, Bay of Fundy, Gulf of St. Lawrence and Newfoundland,
- shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes, dominant vessel routes through the Cabot Strait transit Sydney Bight, east of Cape Breton, and east-west along Newfoundland's south coast, and
- traffic associated with the major ports of Halifax, Port Hawkesbury (Strait of Canso), and Sydney, Nova Scotia; Saint John, New Brunswick; and Come-by-Chance in Placentia Bay, Newfoundland.

The recent updating of Atlantic Canada's vessel traffic maps by Koropatnick et al. (2012) provides information on the temporal and spatial distribution of shipping activity and highlights the application of LRIT data for potential threat assessment of shipping activity in important/critical habitat areas for at-risk species. LRIT data promises to help better understand and characterize large scale potential threats posed by shipping trends and patterns. Many of the traffic routes go through Leatherback areas of concentration, which indicates a high potential source of interaction. Further spatial and temporal analysis could provide more insight into potential interactions between Leatherback Turtle foraging areas and dominant shipping routes.

Fishing vessels are also a potential source of collisions with Leatherbacks. Breeze and Horsman (2005) comprehensively map the distribution of landings of various species caught on the Scotian Shelf during 1999 – 2003, an example of which (groundfish) is shown in Figure 23. Collectively, these maps indicate very heavy use of areas that are used by Leatherbacks. A similar conclusion can be derived for the rest of the East Coast.

While it is likely that maritime traffic is a threat to Leatherbacks, it is difficult to state what the level of impact is. For instance, there may be a behavioural response to vessel noise that somewhat mitigates this threat. No doubt, some collisions and consequent mortality are occurring, the evidence of which is limited. The observations by Eckert et al. (2009) of strikes off Florida are, however, suggestive. The overall level of vessel activity off the Atlantic coast is large and thus, this could be a significant threat. There may be information in the regional strandings datasets that can provide some indication as to the level of this threat.

MARINE DEBRIS

With human population increase has come increasing amounts of marine debris, and with this a wide spectrum of potential impacts on the ecosystems and the organisms that inhabit them.

There is growing recognition that human-sourced debris is posing a risk to marine ecosystems and their inhabitants, including turtles. A number of initiatives have emerged to both disseminate information on marine debris (for instance, see the Marine Affairs Research and Education initiative of the University of Washington at website http://marineaffairs.org/index.html), as well as provide indices for longterm monitoring. An example of the latter is the US National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program (see website at http://marinedebris.noaa.gov/about/welcome.html), which was instituted to support national and international efforts to research, prevent and reduce the impacts of marine debris. To date, a long-term index of coastal marine debris has not been established (D. Parker, pers. comm.). However, the Sea Education Association (SEA) of Woods Hole, Massachusetts, has been studying in the incidence of debris in the offshore off the North American coast for nearly 30 years. Samples of debris are routinely collected on SEA sailing research vessels using a standardized neuston surface net protocol (335 µm mesh and 0.5 m x 1.0 m opening towed for 1 nm at two knots). During 1986 – 2008, more than 6,100 neuston tows were conducted from which more than 64,000 plastic pieces of debris were detected (Law et al. 2010). The highest concentrations of plastic were observed between 22^{o} and 38^{o} N (Figure 24) where 82% of the total plastic pieces were collected. Comparatively low plastic concentrations were measured in tows closest to land. The region of highest plastic concentration is associated with the large scale subtropical convergence created by wind-drive Ekman currents and geostrophic circulation (Figure 25). Law et al. (2010) report that, based on the movement of 1,666 drifters, most of the plastic retained in this region originated from the US eastern seaboard, indicating that debris from this area could be entrained in the convergence within a relatively quick 40 – 60 days.

Interestingly, Law et al. (2010) could not detect any longterm trend in plastic concentration in the 22 year dataset (Figure 26) despite a doubling of discarded plastic in US municipal solid waste (MSW) during the same period. This led to speculation on abiotic and biotic processes that may be removing plastic from the surface of the ocean including plastic fragmentation (due to photo-, oxidative and hydrolytic degradation) sedimentation, shore deposition and ingestion by marine organisms. Moret-Ferguson et al. (2010), in their study of the changes in the size, mass and composition of plastic debris in the western North Atlantic determined that fragments made up the vast majority of material along the whole coast, with pellets and fishing lines being important components dependent on latitude (Figure 27). The overall average size of a particle was small, ranging 3 - 30 mm depending on the latitude and decade (Table 49). In relation to the latter, there was an observed decline in the average of a particle between 1991 - 1995 and 2004 – 2007, again leading to speculation on the degradatory processes similar to those noted by Law et al. (2010) above. Overall, these studies indicate that significant amounts of anthropogenic plastic debris are entering the migratory pathways of Leatherback Turtles off the East Coast of North America.

In Canada, the Great Canadian Shoreline Cleanup (CSC) program (see website at http://shorelinecleanup.ca/en) has been tracking the type and extent of marine debris since 2003 through a national network of volunteers that report the number of debris items by location (province, city, latitude and longitude) and type (shoreline and recreational, ocean and waterway, smoking-related, dumping and medical/hygene activities – see Table 50 for classification of non-plastic and plastic items).

While the time series is short, it will ultimately provide an invaluable time series of marine debris along Canada's shoreline and, by inference, oceans. Already, this dataset is providing valuable insight. At a national level, the amount of beach waste has increased over time. Garbage bags rank third in the number of items collected, cigarettes/cigarette filters and food wrappers/containers being first and second, respectively. Not surprising, beach waste generally decreases with distance from a population centre. For Atlantic Canada, information collected during 2008 – 2011 from a wide range of locations (Figure 28) suggests that just under 20% of all debris items consist of plastic (Table 51). Of this, about 60%, 20%, 9% and 13% of shoreline, ocean, smoking and medical origin, respectively. In Halifax Harbour, 54% of the debris was plastic (DFO Ocean Management Division, pers. comm.)

Information on marine debris in the Canadian offshore is limited. Surveys of marine debris have been conducted on Sable Island during 1984 – 1986 (Lucas 1992) and in the Gully in the 1990s (Dufault and Whitehead 1994). During the Sable Island surveys, a total of 11,183 persistent litter items were collected and sorted, representing 219 items/km/month. Ninety-two percent of this total was plastic material such as tampon applicators, polystyrene cups, packing materials, bags, liquor and soft drink bottles, light bulbs, rope and fishing gear. Lucas (1992) identified 30% of the items to be of domestic origin, with 20% clearly originating from the fishing industry (i.e. gear, nets, etc.). Lucas (1992) documented deposition rates as being fairly consistent from year to year and site to site, and extrapolated from this study that waste is accumulating at a monthly rate of 219 items per km, or over 18,000 items per month on the entire island. The Gully surveys, conducted visually and by net, suggested that from 1990 – 1999, there was a continuous drop in the quantity and density of marine debris. Small plastic debris was found in 90% of the garbage tows.

Lucas (pers. comm.) did not continue the Sable surveys but indicated that they would be started again in 2012. The Gully surveys were also not continued. In both cases, no long-term index of marine debris was developed.

It is evident that marine debris poses a threat to Leatherbacks due to their almost entire dependence on jellyfish and other gelatinous zooplankton for food. Planktonic plastic can be mistaken as jellyfish, and the ingestion of marine debris by leatherbacks can result in both sub-lethal (e.g. interference with metabolism or gut function) and/or lethal effects (e.g. blockages in the digestive tract leading to starvation). In perhaps the only study on the incidence of plastic in the stomachs of Leatherbacks, Mrosovsky et al. (2009), based on necropsy records of 408 individuals, spanning 1885 – 2007, reported that plastics were found in 34% of the cases, with the percent dramatically increasing since the 1950s (Figure 29), paralleling the increase in the use of plastics in human society.

Mrosovsky et al. (2009) discuss the implications of plastic ingestion by Leatherbacks. First, jellyfish is not a very nutritious food and, thus, consuming ersatz food items will have energetic implications for the turtles that are getting ready for their southward migration. Second, Leatherbacks need to consume a lot of jellyfish to build up their energy stores in preparation for the migration. Reductions on Leatherbacks could have food chain consequences beyond their direct mortality.

It is not possible to state with any certainty how many Leatherbacks might die each year through the ingestion of marine debris. No doubt, it is occurring and, given the geographical extent of marine debris, it could be significant. Given human population trends, it is likely that this threat is increasing.

SYNOPSIS

The analysis of the human threats facing Leatherback Turtles on the East Coast of Canada faced a number of challenges. First, while knowledge is increasing on Leatherback habitat, much is still to be learned about its small scale distribution off Canada’s East Coast.

Leatherbacks appear to use broad areas of the zone but with a focus on certain areas (i.e. Magdalen islands, Sydney Bight and deepwater off Southwest Nova Scotia, and Burin Peninsula), this perhaps influenced by the presence of prey species such as jellyfish. Overall, incidence of interactions with fishing gears is poorly understood. Second, while data are comprehensive on the distribution of the fishery at the NAFO division and unit area scale, such is not the case at the scale of fishing sets, for which limited data are available. This restricts interpretation of potential interaction to a coarse geographic scale. Third, for the SARA logs and Newfoundland Whale Release and Strandings network, while there is evidence of fisheries interaction, there are no estimates of the reporting rate which prevents scaling of the threat from the sample to population level. In addition, compliance issues seriously limit the utility of the SARA log book program. Fourth, there are little or no estimates of potential impact of any of the non-fishery threats. Finally, there are a number of data associated issues that hinder analysis. DFO does not maintain a zonal database that explicitly links the catch and effort information in logbooks to the set information recorded by the observers. While explicit links have recently been introduced into these datasets, there is no joint landings / observer database. There are also no zonal SARA logbook and strandings /sightings databases that would include data from programs throughout the Atlantic coast.

Given these issues, it was only possible to provide a qualitative ranking of the threats to Leatherbacks. For fisheries threats, the ranking was based on the spatial overlap of the threat and Leatherbacks, the evidence of encounter, and the general direction in the level of the threat (Table 52). In relation to the spatial overlap, two aspects were explored. The first is the overall scale of the threat. This is estimated by the total number of trips that the fishery undertook during 2006 – 2010. Ideally, the number of fishing gear lines deployed by each fishery would have been used. Unfortunately, the effort data in the ZIFF dataset is in number of units which vary by fishery and complicate interpretation. Trips is used here as a proxy for the quantity of fishing gear that might interact with Leatherbacks. The second aspect is the percent of the total trips that occur in the Leatherback areas of concentration. Evidence of encounter was based upon the fisheries observer program, SARA log and Newfoundland sightings network datasets. In each case, the numbers encountered were expressed as a numbers per year. The observer encounter rates have been adjusted for the percent coverage while the encounter rates for the SARA logs and Newfoundland sightings network have not been adjusted for reporting rate. The encounter rates were not adjusted for mortality which, in the case of the large pelagic fishery, was estimated to be about 50% and ranging from 20 – 70% for the other fishing gear types. Finally, the temporal trend of the threat was estimated based on the total number of trips in the fishery during 2006 – 2010.

There is good evidence from the observer program that the large pelagic longline and Snow Crap trap fisheries interact with Leatherbacks, with the rate of encounter higher in the former. This is corroborated by evidence from the SARA logs and Newfoundland sightings network. An issue is that, while the observer coverage rates in the Gulf are comparable to those on the Scotian Shelf, there are no reported encounters with Leatherbacks. This implies either a reporting problem or small spatial scale processes causing differences between the two regions. Regarding trends in these threats, while the number of trips in the large pelagic longline fishery declined during 2006 – 2010, it was relatively stable in the Snow Crab fishery.

There is some evidence of encounter with Whelk pot, groundfish and Herring Gillnet, groundfish longline and Lobster trap, all based on the SARA log and Newfoundland sightings network data. If reported encounter rates are used to rank these fisheries (as in Table 52), Whelk pot appears be the highest in this group and Lobster trap the lowest. However, if one were to use the scale of threat to rank these fisheries, Lobster trap would be on top and Whelk on the bottom. It is, thus, prudent to consider all these fisheries as posing the same overall level of threat until more information is collected. Regarding the temporal trends of these fisheries, during 2006 – 2010, the number of trips in most was relatively stable (or at least variation with no obvious trend) with a decline in the groundfish gillnet fishery,

For two fisheries (Halibut longline and Turbot gillnet), there is no evidence, from any information source, of interaction with Leatherbacks. In the case of the Turbot gillnet fishery, it is highly likely, given its northern focus, that it does not encounter Leatherbacks to any great extent. While there is no evidence of interaction with the Halibut longline fishery, it is possible that there are some encounters. This would have to be confirmed through further observation. Regarding temporal trends in these fisheries, the number of trips in the Halibut longline fishery was relatively stable during 2006 – 2010 while that for the Turbot gillnet exhibited a decline.

Regarding the three non-fishery threats (maritime transport, marine debris and seismic survey), there is limited evidence of encounter although their scale suggests that some interaction is likely (Table 53). Only in the case of the seismic survey is it possible to state that these do not interact with Leatherbacks in their areas of concentration to any great extent. Unfortunately for these threats, there could be a significant level of encounter but it would be very difficult to quantify this. Regarding the temporal trends of these threats presented earlier in this report, one is likely increasing (maritime transport), one stable (marine debris) and one decreasing (seismic survey).

CONCLUDING REMARKS

To estimate the current impact of Canadian fishery and non-fishery threats to the recovery of the Atlantic Leatherback Turtles, one needs to examine data on reported encounters, estimate the rate of observation that produced these encounters, and then prorate the reported encounters to the population level to produce an estimate of the cumulative impact of all threats. It was only possible to undertake this approach for a subset of the threats and even here only to a limited degree. The observational data available on Leatherback encounters off Atlantic Canada is based on a wide array of collection activities, some of which have highly standardized sampling protocols while others are based on opportunistic reporting. In many cases, sampling intensity was relatively low. These issues, combined with the low observation rate of Leatherbacks in the zone, prevented estimation of cumulative threat. It was only possible to rank threats within fisheries and non-fisheries based on the scale of the threat, evidence of encounters and the temporal trend of the threat. Further observations will be required to further elucidate the relative and cumulative impacts of human activities on Leatherback Turtles of Canada’s East Coast.

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Table 1. Reports of Leatherback Turtles entangled in fixed gear off Newfoundland and Labrador during 1976 – 2011 (from W. Ledwell, pers. comm.).

NAFO Area	Jan - May	June - July	Aug	Sept	Oct	Nov - Dec	Total
2J	1	1	1				3
3K	2	1	2	8	1		14
3L	3	2	6	5	2	1	19
3Ps	5	6	10	5	1	2	29
3Pn			2				2
4R	1	1	1	2		2	7
4Vn	1						1
Total	13	11	22	20	4	5	75

Table 2. Observer reports of Leatherback Turtles interacting with large pelagic longline and Snow Crab trap gear during 2001 – 2010.

NAFO	Jan-May	June-July	Aug	Sept	Oct	Total
3M		1	2	1		4
3N		3	1		1	5
3O		6	3	3		12
4Vs	1	10	5	6		22
4W		20	16	7	3	46
4X	2	11	6	8	1	28
5Z		3	6	6		15
SA6	2					2
ICCAT 3			5	4		9
Total	5	54	44	35	5	143

Table 3. Leatherback Turtle bycatch in commercial fisheries operating in NAFO divisions 4VWX5 during 2002 – 2006; top panel indicates percent observer coverage (observed kg / landed kg for all species); bottom panel provides estimated kg of Leatherbacks encountered based on proration of percent observer coverage to total landings (from Gavaris et al. 2010).

% observer coverage						
Fishery	**2002**	**2003**	**2004**	**2005**	**2006**	
4VW Snow Crab Trap	9	9	8	10	8	
4VW Swordfish Longline	10	4	5	3	3	
4VW Tuna Longline	100	69	0	5	86	
4VW Swo/Tuna Longline		0	66		0	
4X Swordfish Longline	12	6	0	2	0	
4X Tuna Longline	0	0	0	100	58	
5Z Swordfish Longline	27	4	0	0	10	
Kg Leatherback Turtles						
Fishery	**2002**	**2003**	**2004**	**2005**	**2006**	
4VW Snow Crab Trap				6268	2396	
4VW Swordfish Longline	8677	25844	19729	40531	6199	
4VW Tuna Longline					581	
4VW Swordfish/Tuna Longline			611			
4X Swordfish Longline	29273	24023		18399	72789	
4X Tuna Longline				210	1039	
5Z Swordfish Longline	7757				21523	
Total (kg)	45707	49867	20340	65408	104527	Mean
Total (no: 392.6kg/turtle)	116	127	52	167	266	145.62

Table 4. Inventory of number of sets by fishery, species sought and fishing gear in the Maritimes, Quebec/Gulf and Newfoundland DFO observer program databases; shaded cells indicate fisheries of relatively high coverage.

Newfoundland

Fishery	Species Sought	Gear	No observed sets
Invertebrates	Snow Crab	Pot	45253
	Hyas Crab	Pot	5
	Lobster	Trap	4
	Squid	Trap	21
	Whelk	Pot	192
Small Pelagics	Herring	Gillnet	8
		Trap	5
	Capelin	Trap	30
	Mackerel	Gillnet	27
Large Pelagics	Bluefin Tuna	Handline	60
Groundfish	Cod	Trap	1
		Gillnet	5069
		Longline	1360
		Handline	362
	Halibut	Longline	1333
		Gillnet	46
	Turbot	Gillnet	6190
		Longline	456
	White Hake	Gillnet	1390
		Longline	467
	Flatfish	Gillnet	526
	Monkfish	Gillnet	5442
	Skates	Gillnet	404
		Longline	204
	Eelpout	Gillnet	180
	Lumpfish	Gillnet	533
	Pollock	Gillnet	4
	Hagfish	Pot	1
		Total	69573

Maritimes

Fishery	Species Sought	Gear	No observed sets
Invertebrates	Snow Crab	Pot	22444
	Lobster	Trap	5303
		Gillnets	2
	Shrimp	Trap	1
	Whelk	Pot	16
Large Pelagics	Tuna, Swordfish	Longline	948
		Handline	472
		Troll	497
	Swordfish	Longline	595
	Porbeagle	Longline	59
Groundfish	Cod, Haddock, Pollock	Longline	7180
		Handline	6
		Gillnet	1061
		Trap	152
	Halibut	Longline	6492
	Turbot	Gillnet	64
		Longline	85
	White Hake	Gillnet	138
		Longline	141
	Flatfish	Gillnet	141
	Skate	Longline	77
	Hagfish	Trap	64
	Dogfish	Longline	12
	Other	Pot	180
		Longline	31
		Total	46161

Quebec - Gulf

Fishery	Species Sought	Gear	No observed sets
Invertebrates	Snow crab	Pot	15015
	Hyas crab	Pot	242
	Whelk	Pot	90
Large Pelagics	Bigeye tuna	Longline	46
	Bluefin tuna	Longline	113
	Porbeagle	Longline	1
Groundfish	Atlantic cod	Longline	5370
		Handline	57
		Gillnet	2338
		Trap	42
	Halibut	Longline	2584
	Turbot	Gillnet	4816
		Longline	114
	Flatfish	Gillnet	36
		Longline	2
	Spiny dogfish	Longline	42
		Total	30908

Table 5. Reports of Leatherback encounters in the DFO Maritimes observer database.

Year	CRAB	SWORDFISH	TUNA, SWORDFISH	Total
2001	1	18	10	29
2002		16	24	40
2003		8	5	13
2004		3	6	9
2005	2	7	5	14
2006	1	4	10	15
2007		3	3	6
2008			1	1
2009		2	6	8
2010	1	3	4	8
Total	5	64	74	143

Table 6. Inventory of longline sets in 4Vn (top panel) and 4VsW (bottom panel) DFO – industry sentinel surveys.

4Vn Sentinel Survey										
	April	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Total**
2001	6	12	4	10	10	44	89	12	6	193
2002					5	54	134	2		195
2003	3				10	198	84			295
2004					16	178	64			258
2005					47	172	104	1		324
2006	3				33	144	42			222
2007						112				112
2008						56				56
2009						56				56
2010						56				56

4VsW Sentinel Survey								
	April	**July**	**August**	**September**	**October**	**November**	**December**	**Total**
2001		5	1	185	111	12		314
2002	3		13	209	60	23		308
2003	3			239	23			265
2004				40	13			53
2005				36	17			53
2006				53				53
2007				41	12			53
2008				18	25	10		53
2009				53				53
2010				56	8			64

Table 7. Inventory of longline (top panel) and gillnet (bottom panel) sets in Gulf sentinel surveys.

	Gulf Longline Sentinel Survey					
	July	August	September	October	November	Total
2001	103	228	190	98	6	625
2002	95	172	186	79	14	546
2003	53	167	211	129	10	570
2004	56	158	206	127	10	557
2005	54	160	174	117	2	507
2006	54	183	208	80		525
2007	82	162	167	104	4	519
2008	76	179	186	52	6	499
2009	98	98	131	52	6	385
2010	74	115	106	54	12	361

	Gulf Gillnet Sentinel Survey				
	July	August	September	October	Total
2001	106	156	100	21	383
2002	111	280	205	40	636
2005	2				2

Table 8. Inventory of longline (top panel) and gillnet (bottom panel) sets in Newfoundland sentinel surveys.

	Newfoundland Longline Sentinel Survey									
	January	February	March	April	May	June	July	August	September	October	Total
2001	25	24	10	12	1		28	37	169	138	444
2002	23	18	6	6	2			55	175	124	409
2003	10	10	9	4	2	4	12	47	116	63	277
2004	4		10				12	48	98	54	226
2005	9		8		2	12	27	74	86	61	279
2006	8	2	8		4	8	22	75	83	59	269
2007	6		8				28	63	92	89	286
2008	12		8			8	16	60	112	51	267
2009	5		8			12	16	48	101	49	239
2010	6		8			7	20	73	61	26	201

	Newfoundland Gillnet Sentinel Survey										
	January	February	March	April	May	June	July	August	September	October	Total
2001	33	4	4	8	12	282	894	1003	368	163	2771
2002	16		3		2	173	916	988	446	131	2675
2003	15	4		3	3	158	712	792	367	108	2162
2004	10					290	750	915	396	89	2450
2005	15	2	4			321	839	1008	251	104	2544
2006	10	7			44	447	793	793	304	105	2503
2007	15				4	259	723	936	355	98	2390
2008	7				10	253	912	782	389	111	2464
2009	15				3	219	730	720	393	75	2155
2010	9	2			35	300	667	736	227	124	2100

Table 9. Maritimes Region SARA logbook compliance report; note that compliance is measured according to those trips which carried SARA logs and not as a percent of all trips in fishery (from L. Hussey, pers. comm).

Fishery	2007				2008				2009			
	Sara Docs	No Sara Docs	Total Trips	Total Compliance	Sara Docs	No Sara Docs	Total Trips	Total Compliance	Sara Docs	No Sara Docs	Total Trips	Total Compliance
CRAB, JONAH	0	1	1	0%								
CRAB, SNOW									1	0	1	100%
GROUNDFISH	180	9051	9231	2%	121	7727	7848	2%	150	6552	6702	2%
HERRING	0	18	18	0%	0	12	12	0%	0	10	10	0%
MACKEREL					0	1	1	0%				
SCALLOP, SEA					0	2	2	0%	0	1	1	0%
SHARK, UNSPECIFIED	0	17	17	0%	5	11	16	31%	1	8	9	11%
SHRIMP, PANDALUS BOREALIS	0	46	46	0%	0	32	32	0%	0	29	29	0%
SWORDFISH	52	120	172	30%	24	118	142	17%	25	106	131	19%
TUNA	72	767	839	9%	64	743	807	8%	65	447	512	13%
TUNA, BLUEFIN	0	392	392	0%	0	556	556	0%	0	72	72	0%

Fishery	2010				2011			
	Sara Docs	No Sara Docs	Total Trips	Total Compliance	Sara Docs	No Sara Docs	Total Trips	Total Compliance
CRAB, SNOW	10	0	10	100%	59	0	59	100%
GROUNDFISH	156	5932	6088	3%	404	4814	5218	8%
LOBSTER	51	0	51	100%	45	0	45	100%
SHARK, UNSPECIFIED	0	5	5	0%	0	2	2	0%
SHRIMP, PANDALUS BOREALIS	0	30	30	0%	0	23	23	0%
SWORDFISH	31	134	165	19%	28	136	164	17%
TUNA	62	439	501	12%	57	437	494	12%
TUNA, BLUEFIN	0	59	59	0%	0	60	60	0%

Table 10. Newfoundland SARA logbook records of Leatherback encounters during 2005 – 2009.

Year	Month	NAFO	Fishery	Gear	No observed	Condition
2005	August	?	Cod	gillnet	2	Alive
2006	October	4R	Mackerel	purse seine	1	Alive
2006	August	3L	Turbot	gillnet	1	Alive
2006	August	3L	Turbot	gillnet	1	Alive
2006	Sept	3Ps	Whelk	pot	1	?
2007	Sept	3Ps	Whelk	pot	1	Dead
2008	Sept	3K	Mackerel	purse seine	2	Alive
2009	August	3L	Shrimp	trawl	1	Alive
				Total	10	

Table 11. Reports of Leatherback Turtle encounters with mobile and fixed gear from DFO Quebec Region.

Year	Whelk Trap	Cod Longline	Halibut Trawl	Herring Gillnet	Lobster Trap	Mackerel Handline	Redfish Trawl	Total
2005	4							4
2006		1						1
2007	1							1
2008	4	2		1		1	1	9
2010			1		1			2
2011	1							1
Total	10	3	1	1	1	1	1	18

Table 12. Number of Leatherback Turtles reported as being encountered in the DFO Maritimes Region's SARA logbooks.

Year	No. of Leatherback encounters
2007	28
2008	29
2009	25
2010	11
2011	7

Table 13. Seasonal observations of Leatherback Turtle encounters off Newfoundland by small fixed gear licence holders as recorded by the Whale Release and Strandings network; data provided by W. Ledwell and J. Lawson); note that 2001 and 2002 observations of 28 and 39 encounters with large pelagic fishing gear are not shown.

	Jan - May	June - July	Aug	Sept	Oct	Nov - Dec	Total
1976	1			1			2
1977		1					1
1981	1			1			2
1982			2				2
1983		1	1				2
1984			1				1
1985	1		1	1	1		4
1986	2	1	2	3		2	10
1987		1	1	1	1		4
1988				1			1
1989	2		2	1			5
1990	3			2	1		6
1991			1				1
1993		1					1
1998			1			1	2
1999					1		1
2000	1						1
2002		1					1
2004			1	1			2
2005		1	1			2	4
2006	1		4	1			6
2008	1	1	2	2			6
2009		3		2			5
2010			2	3			5
						Total	75
						Average	2.1

Table 14. Observations of Leatherback Turtle encounters in fishing gear off Newfoundland during 1976 – 2010 as recorded by Whale Release and Strandings network by gear type (data provided by W. Ledwell and J. Lawson); note that 2001 and 2002 observation of 28 and 39 encounters in large pelagic fishing gear are not shown.

Gear	Jan - May	June - July	Aug	Sept	Oct	Nov - Dec	
Snow Crab Gear	1	1					2
Crab Pot	1	2	2				5
Whelk Pot		1	4				5
Mussel farm rope				1			1
Herring Gillnet	3		1				4
Mackeral Gillnet	1	1		1		1	4
Mackeral Trap			2				2
Groundfish Gillnet	3	3	11	11	3	2	33
Gillnet	1			1		2	4
Cod Trap			1				1
Longline				1			1
Groundfish Trawl				1			1
Trawl Line	3	1	1	3	1		9
Salmon net		1		1			2
NK		1					1
	13	11	22	20	4	5	75

Table 15. Condition of Leatherback Turtles encountered in fishing gear off Newfoundland during 1976 – 2010 (data provided by W. Ledwell and J. Lawson).

Gear	Alive	Dead	Total
Snow Crab Gear	2		2
Crab Pot	2	3	5
Whelk Pot	2	3	5
Mussel farm rope		1	1
Herring Gillnet	4		4
Mackeral Gillnet	2	2	4
Mackeral Trap	2		2
Groundfish Gillnet	27	6	33
Gillnet	4		4
Cod Trap		1	1
Longline	1		1
Groundfish Trawl		1	1
Trawl Line	5	4	9
Salmon net	2		2
NK	1		1
Total	54	21	75

Table 16. Landings (t) of the Snow Crab trap fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	26,718	47,400	74,118
2007	38,442	37,092	75,534
2008	46,924	33,216	80,140
2009	46,359	35,602	81,960
2010	38,523	35,194	73,717

Table 17. Landings (t) of the summer – fall Snow Crab trap fishery, by year and NAFO division, in reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
2H	152	193	124	157	96
2J	1,181	2,276	2,007	2,234	1,411
3K	772	6,954	5,201	13,076	5,325
3L	12,655	13,768	16,854	9,896	14,875
3M			23		1
3N	1,755	1,821	1,657	785	1,431
3O	633	447	771	1,293	1,974
3P	227	579	672	411	1,880
4R	65	159	94	66	52
4S		3			
4T	4,293	7,060	11,128	8,013	1,569
4V	3,171	3,248	4,759	5,741	6,084
4W	1,813	1,934	3,630	4,685	3,820
5Y					3
OU			4		
Total	26,718	38,442	46,924	46,359	38,523
% Positions	84.5%	80.0%	84.0%	94.6%	96.2%

Table 18. Observer coverage of the Snow Crab trap fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings (t); an empty cell indicates no coverage; note that observer data for 4T snow crab were not available (shaded).

Landings, t	2006	2007	2008	2009	2010
2H	152	193	124	157	96
2J	1,181	2,276	2,007	2,234	1,411
3K	772	6,954	5,201	13,076	5,325
3L	12,655	13,768	16,854	9,896	14,875
3M			23		1
3N	1,755	1,821	1,657	785	1,431
3O	633	447	771	1,293	1,974
3P	227	579	672	411	1,880
4R	65	159	94	66	52
4S		3			
4T	4,293	7,060	11,128	8,013	1,569
4V	3,171	3,248	4,759	5,741	6,084
4W	1,813	1,934	3,630	4,685	3,820
4X					
5Y					3
Total	26,718	38,442	46,924	46,359	38,523

Observer Kept, t	2006	2007	2008	2009	2010
2H	14	22			5
2J	99	156	78	164	70
3K	56	328	316	821	161
3L	1,086	984	1,773	635	1,189
3M					
3N	320	373	265	167	178
3O	51	64	27	48	106
3P	2	15	33	5	35
4R	3	1		1	1
4S	113	174	146	265	198
4T					
4V	358	311	483	652	584
4W	114	146	276	431	316
4X			5		
5Y					
Total	2,215	2,574	3,402	3,189	2,842

% Coverage	2006	2007	2008	2009	2010	Avg
2H	9.1%	11.6%			5.2%	8.7%
2J	8.4%	6.9%	3.9%	7.3%	5.0%	6.3%
3K	7.3%	4.7%	6.1%	6.3%	3.0%	5.5%
3L	8.6%	7.1%	10.5%	6.4%	8.0%	8.1%
3M						
3N	18.2%	20.5%	16.0%	21.2%	12.4%	17.7%
3O	8.0%	14.2%	3.5%	3.7%	5.3%	7.0%
3P	0.8%	2.7%	4.9%	1.3%	1.8%	2.3%
4R	4.1%	0.3%		2.2%	1.0%	1.9%
4S						
4T						
4V	11.3%	9.6%	10.2%	11.4%	9.6%	10.4%
4W	6.3%	7.5%	7.6%	9.2%	8.3%	7.8%
4X						
5Y						

Table 19. Landings (t) of the Lobster trap fishery by year and season, as reported in ZIFF.

	Summer-Fall	Winter-Spring	Total
2006	12,644	41,998	54,642
2007	15,187	33,279	48,466
2008	17,167	41,415	58,583
2009	16,470	41,615	58,085
2010	16,413	46,815	63,227

Table 20. Landings (t) of the summer – fall Lobster trap fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
3K	99	110	65	71	63
3L	69	73	76	68	76
3P	234	301	350	287	273
4R	219	400	374	312	184
4S	99	119	113	144	155
4T	8,081	10,035	10,185	10,414	10,134
4V	985	1,071	1,803	1,253	1,410
4W	985	1,333	1,754	1,551	1,233
4X	1,770	1,649	2,366	2,263	2,686
5Y	55	36	50	73	136
5Z	47	60	32	30	65
Total	12,644	15,187	17,167	16,467	16,413
% Positions	2.3%	2.3%	1.5%	1.1%	2.3%

Table 21. Observer coverage of the Lobster trap fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings; an empty cell indicates no coverage.

Landings, t	2006	2007	2008	2009	2010
3K	99	110	65	71	63
3L	69	73	76	68	76
3P	234	301	350	287	273
4R	219	400	374	312	184
4S	99	119	113	144	155
4T	8,081	10,035	10,185	10,414	10,134
4V	985	1,071	1,803	1,253	1,410
4W	985	1,333	1,754	1,551	1,233
4X	1,770	1,649	2,366	2,263	2,686
5Y	55	36	50	73	136
5Z	47	60	32	30	65
Total	12,644	15,187	17,167	16,467	16,413

Observer Kept, t	2006	2007	2008	2009	2010
3K					
3L					
3P					
4R					
4S					
4T					
4V				4	
4W				10	
4X	8		10	4	10
5Y					
5Z				3	1
Total	8		10	22	11

% Coverage	2006	2007	2008	2009	2010	Avg
3K						
3L						
3P						
4R						
4S						
4T						
4V				0.3%		0.3%
4W				0.6%		0.6%
4X	0.4%		0.4%	0.2%	0.4%	0.4%
5Y						
5Z				10.8%	1.1%	6.0%

Table 22. Landings (t) of the Whelk pot fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	4,041	121	4,162
2007	3,848	128	3,975
2008	6,766	269	7,035
2009	5,638	606	6,244
2010	5,499	30	5,529

Table 23. Landings (t) of the summer – fall Whelk pot fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
2J	213	136	155	149	142
3K	5	12	3		20
3L	145	90	71	127	105
3P	3,647	3,601	5,682	4,492	5,222
4R	21	8	12	11	10
4S			384	632	
4T	11		458	227	0
4V			0	0	
Total	4,041	3,848	6,766	5,638	5,499
% Positions	72.9%	81.0%	85.3%	89.5%	94.9%

Table 24. Landings (t) of the Herring gillnet fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	56,712	2,312	59,023
2007	50,370	2,175	52,545
2008	42,566	1,660	44,226
2009	55,458	1,730	57,188
2010	49,115	937	50,052

Table 25. Landings (t) of the summer – fall Herring gillnet fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
3L	21	40	28	37	1
3M					4
3O					1
3P	79	10	8	12	9
4R	427	65	1	0	523
4S	36	70	48	117	83
4T	48,845	43,674	39,042	45,345	42,722
4V	83	6	11	12	1
4W	3,337	3,641	2,302	6,019	2,415
4X	3,885	2,865	1,126	3,916	3,355
5Y				1	
Total	56,712	50,370	42,566	55,458	49,115
% Positions	11.7%	12.0%	7.2%	16.0%	10.6%

Table 26. Landings (t) of the large pelagic longline fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	1,822	25	1,847
2007	1,690	1	1,691
2008	1,493	51	1,545
2009	1,308	3	1,311
2010	1,553	33	1,585

Table 27. Landings (t) of the summer – fall large pelagic longline fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
3M	0	12			0
3N	3	3	39	3	
3O	255	278	128	178	10
3P	0	9			0
4V	78	226	261	258	114
4W	712	679	394	222	698
4X	582	368	421	423	339
5Y		5			
5Z	192	93	248	223	389
6D		14	0	0	
6E		2		0	
ICCAT 3	0	4	1		2
Total	1,822	1,690	1,493	1,308	1,553
% Positions	97.7%	98.8%	98.3%	99.4%	98.6%

Table 28. Nominal estimates of observer coverage (%) for the pelagic longline fishery within NAFO divisions during 2002 – 2010 (from Hanke et al. 2012).

Year	3KLOMN	3P4V	4W	4X	5ZY6DE
2002	50.0	30.0	16.4	18.4	42.3
2003	13.3	3.0	7.0	5.8	4.2
2004	19.0	16.7	4.6	0.7	3.3
2005	5.4	6.5	6.1	5.1	3.4
2006	22.7	13.3	7.0	3.0	2.9
2007	11.1	4.8	6.2	1.5	2.3
2008	8.7	-	7.1	2.1	5.4
2009	4.0	11.1	14.3	12.4	14.6
2010	5.6	-	17.9	7.0	2.0

Table 29. Nominal estimates of observer coverage (%) during 2002 – 2010 for the large pelagic longline fishery by proration factor (from Hanke et al. 2012).

	SETS		TRIPS		SEADAYS	
Year	Obs/Total	Coverage (%)	Obs/Total	Coverage (%)	Obs/Total	Coverage (%)
2002	334/1459	22.9	48/213	22.5	601/2022	29.7
2003	117/1407	8.3	18/194	9.3	214/1955	10.9
2004	80/1560	5.1	12/239	5.0	138/2216	6.2
2005	102/1775	5.7	13/247	5.3	171/2567	6.7
2006	131/1803	7.3	17/268	6.3	208/2604	8.0
2007	87/1501	5.8	12/212	5.7	138/2231	6.2
2008	49/1174	4.2	11/157	7.0	85/1683	5.1
2009	115/1081	10.6	19/155	12.3	189/1601	11.8
2010	108/971	11.1	19/166	11.4	166/1454	11.4

Table 30. Total annual estimates and associated percent coefficients of variations of Leatherback Turtles encountered in the Canadian large pelagic longline fishery by proration factor (from Hanke et al. 2012).

a) Total annual estimates						
	Total	**Target**	**Sets**	**Hooks**	**Seadays**	**Average**
2002	116	169	161	147	134	145
2003	104	120	138	122	118	120
2004	169	156	170	151	144	158
2005	189	227	184	173	165	188
2006	136	122	188	146	175	153
2007	88	76	101	83	97	89
2008	16	15	23	20	20	19
2009	64	62	60	67	59	62
2010	16	15	18	15	18	16
b) % CV						
	Total	**Target**	**Sets**	**Hooks**	**Seadays**	**Average**
2002	38%	28%	26%	28%	32%	30%
2003	47%	46%	29%	33%	36%	38%
2004	46%	54%	44%	51%	52%	49%
2005	50%	53%	44%	50%	52%	50%
2006	65%	83%	42%	59%	46%	59%
2007	43%	48%	39%	48%	40%	44%
2008	91%	106%	60%	68%	67%	78%
2009	58%	61%	64%	57%	65%	61%
2010	73%	73%	66%	76%	67%	71%

Table 31. Annual number of Leatherback observations made in the large pelagic longline fishery by NAFO division during 2001 – 2010.

NAFO	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3M		2	2								4
3N	2	2					1				5
3O	3	4				4	1				12
4Vs	5		1	4	2	1	1		6		20
4W	11	7	3	5	4	2	3	1	2	5	43
4X	4	11	5		3	3				2	28
5Z		8			3	4					15
SA6		2									2
ICCAT 3	3	4	2								9
Total	28	40	13	9	12	14	6	1	8	7	138

Table 32. Landings (t) of the Halibut longline fishery year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	753	532	1,285
2007	889	558	1,446
2008	904	522	1,425
2009	1,006	707	1,713
2010	1,041	804	1,845

Table 33. Landings (t) of the Halibut longline fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
3K	2				
3M		0			
3N	27	131	31	28	80
3O	9	7	40	14	12
3P	81	55	56	83	76
4R	99	97	134	206	158
4S	53	118	96	98	77
4T	98	99	127	145	191
4V	66	72	75	60	84
4W	78	96	119	107	117
4X	240	201	208	259	244
5Y	0	1	1	5	2
5Z		11	16	0	0
Total	753	889	904	1,006	1,041
% Positions	83.3%	87.8%	78.1%	77.9%	83.3%

Table 34. Observer coverage of the Atlantic Halibut longline fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings (t); an empty cell indicates no coverage.

Landings, t	2006	2007	2008	2009	2010
3K	1.53				
3M		0.025			
3N	27.063	131.364	30.893	28.141	80.149
3O	9.406	6.604	40.407	14.303	12.047
3P	80.713	55.005	55.646	82.9	75.723
4R	99.217	96.551	134.351	206.322	158.308
4S	53.276	118.328	96.349	98.229	77.103
4T	97.679	98.915	126.87	144.644	190.688
4V	66.229	72.102	74.711	60.487	83.947
4W	78.234	96.388	118.903	106.535	116.557
4X	239.503	200.54	207.836	258.993	244.478
5Y	0.459	1.243	1.265	5.002	2.086
5Z		11.444	16.404	0.037	0.054
Total	753.309	888.509	903.635	1005.593	1041.14

Observer Kept, t	2006	2007	2008	2009	2010
3K					
3M					
3N		111.922	79.357	23.513	28.049
3O	15.909	11.685		0.986	1.206
3P	10.693	35.123	18.932		0.339
4R	0.452	5.098	5.872	7.92	
4S	13.009	40.25	17.413	28.052	3.263
4T	2.147	2.863	17.436	20.096	17.542
4V	0.438		0.532	0.987	0.628
4W					
4X	2.189		0.788	2.348	19.142
5Y					
5Z					
Total	44.837	206.941	140.33	83.902	70.169

% coverage	2006	2007	2008	2009	2010	Avg
3K						
3M						
3N		85.2%	256.9%	83.6%	35.0%	115.2%
3O	169.1%	176.9%		6.9%	10.0%	90.7%
3P	13.2%	63.9%	34.0%		0.4%	27.9%
4R	0.5%	5.3%	4.4%	3.8%		3.5%
4S	24.4%	34.0%	18.1%	28.6%	4.2%	21.9%
4T	2.2%	2.9%	13.7%	13.9%	9.2%	8.4%
4V	0.7%		0.7%	1.6%	0.7%	0.9%
4W						
4X	0.9%		0.4%	0.9%	7.8%	2.5%
5Y						
5Z						

Table 35. Landings (t) of the Turbot gillnet fishery by season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	7,866	1,601	9,467
2007	7,567	947	8,515
2008	6,336	632	6,968
2009	7,998	726	8,725
2010	8,174	973	9,147

Table 36. Landings (t) of the summer – fall Turbot gillnet fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
0B	1,590	1,373	1,012	1,102	1,438
2G		3		54	31
2H	366	134	158	97	25
2J	217	633	263	398	776
3K	1,063	1,327	1,342	1,760	1,288
3L	1,422	994	637	967	1,100
3O	23	88			0
3P	53	33	60	123	116
4R	732	882	694	1,268	1,152
4S	1,531	1,524	1,235	1,455	1,538
4T	868	577	934	773	711
Total	7,866	7,567	6,336	7,998	8,174
% Positions	90.1%	93.4%	90.9%	92.7%	92.2%

Table 37. Observer coverage of the Turbot gillnet fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings (t); an empty cell indicates no coverage.

Landings, t	2006	2007	2008	2009	2010
0B	1,590	1,373	1,012	1,102	1,438
2G		3		54	31
2H	366	134	158	97	25
2J	217	633	263	398	776
3K	1,063	1,327	1,342	1,760	1,288
3L	1,422	994	637	967	1,100
3O	23	88			0
3P	53	33	60	123	116
4R	732	882	694	1,268	1,152
4S	1,531	1,524	1,235	1,455	1,538
4T	868	577	934	773	711
Total	7,866	7,567	6,336	7,998	8,174

Observer Kept, t	2006	2007	2008	2009	2010
0B	143				
3G					
2H				53	
2J	11	49		29	51
3K	55	69	168	122	56
3L	384	351	420	118	80
3O		16			
3P					
4R	25	18	50	11	29
4S	64	80	89	58	93
4T	44	44	74	37	32
Total	724	627	801	427	340

% Coverage	2006	2007	2008	2009	2010	Avg
0B	9.0%					9.0%
3G						
2H				54.5%		54.5%
2J	5.0%	7.8%		7.3%	6.5%	6.6%
3K	5.1%	5.2%	12.5%	6.9%	4.3%	6.8%
3L	27.0%	35.3%	66.0%	12.2%	7.2%	29.5%
3O		18.2%				18.2%
3P						
4R	3.4%	2.1%	7.2%	0.9%	2.5%	3.2%
4S	4.2%	5.2%	7.2%	4.0%	6.0%	5.3%
4T	5.0%	7.5%	7.9%	4.7%	4.5%	5.9%

Table 38. Landings (t) of the groundfish longline fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	10,446	3,641	14,087
2007	10,595	3,136	13,731
2008	11,964	2,899	14,864
2009	8,900	2,774	11,674
2010	7,967	2,019	9,986

Table 39. Landings (t) of the summer – fall groundfish longline fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
2J		2	2	3	1
3K	17	15	18	21	13
3L	55	12	25	33	26
3N	8	6		1	2
3O	142	384	603	270	90
3P	2,341	2,309	2,720	1,661	1,214
4R	1,216	1,608	1,565	957	650
4S	39	31	120	152	232
4T	449	279	273	66	44
4V	294	59	11	42	30
4W	57	42	60	17	38
4X	3,210	3,203	3,559	2,875	2,762
5Y	8	12		5	2
5Z	2,609	2,634	3,009	2,794	2,864
6D				2	
Total	10,446	10,595	11,964	8,900	7,967
% Positions	67.0%	72.4%	71.3%	72.5%	77.2%

Table 40. Observer coverage of the groundfish longline fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings (t); an empty cell indicates no coverage.

Landings, t	2006	2007	2008	2009	2010
2J		2	2	3	1
3K	17	15	18	21	13
3L	55	12	25	33	26
3N	8	6		1	2
3O	142	384	603	270	90
3P	2,341	2,309	2,720	1,661	1,214
4R	1,216	1,608	1,565	957	650
4S	39	31	120	152	232
4T	449	279	273	66	44
4V	294	59	11	42	30
4W	57	42	60	17	38
4X	3,210	3,203	3,559	2,875	2,762
5Y	8	12		5	2
5Z	2,609	2,634	3,009	2,794	2,864
6D				2	
Total	10,446	10,595	11,964	8,900	7,967

Observer Kept, t	2006	2007	2008	2009	2010
2J					
3K	0			0	
3L	1	0			0
3N					
3O		129	77	216	
3P	31	22	45	13	15
4R	100	280	290	71	70
4S	4	0	40	46	31
4T	74	64	44	11	11
4V					
4W					
4X	19	30	43	28	154
5Y					
5Z	190	105	543	500	306
6D					
Total	419	672	1,082	884	587

% Coverage	2006	2007	2008	2009	2010	Avg
2J						
3K	1.8%			0.2%	0.0%	0.6%
3L	1.2%	1.2%			0.2%	0.9%
3N						
3O		33.5%	12.7%	79.9%	0.0%	31.5%
3P	1.3%	0.9%	1.7%	0.8%	1.2%	1.2%
4R	8.3%	17.4%	18.5%	7.4%	10.7%	12.5%
4S	9.6%	1.4%	33.5%	30.3%	13.3%	17.6%
4T	16.5%	23.1%	16.0%	16.5%	25.3%	19.5%
4V						
4W						
4X	0.6%	0.9%	1.2%	1.0%	5.6%	1.9%
5Y						
5Z	7.3%	4.0%	18.1%	17.9%	10.7%	11.6%
6D						

Table 41. Landings (t) of the groundfish gillnet fishery by year and season, as reported in ZIFF.

Year	Summer-Fall	Winter-Spring	Total
2006	13,752	2,682	16,434
2007	15,290	1,471	16,761
2008	13,254	1,970	15,224
2009	9,413	1,459	10,872
2010	9,452	1,159	10,611

Table 42. Landings (t) of the summer – fall groundfish gillnet fishery, by year and NAFO division, as reported in ZIFF.

Landings, t	2006	2007	2008	2009	2010
2J	27	14	36	20	25
3K	794	739	1,091	718	746
3L	887	934	1,247	1,328	1,214
3O	531	274	150	63	125
3P	6,987	8,034	5,890	3,377	3,699
4R	1,968	2,635	2,307	1,454	1,303
4S	714	788	731	421	432
4T	281	102	140	3	3
4V		2			
4W	155	175	172	156	63
4X	1,160	1,356	1,128	1,419	1,403
5Y	145	59	98	62	22
5Z	102	179	263	391	417
Total	13,752	15,290	13,254	9,413	9,452
% Positions	46.0%	45.0%	37.4%	40.4%	40.7%

Table 43. Observer coverage of the groundfish gillnet fishery off Canada's east coast during summer – fall based on observer estimates of kept weight (t) and ZIFF reported landings (t); an empty cell indicates no coverage.

Landings, t	2006	2007	2008	2009	2010
2J	27	14	36	20	25
3K	794	739	1091	718	746
3L	887	934	1247	1328	1214
3O	531	274	150	63	125
3P	6987	8034	5890	3377	3699
4R	1968	2635	2307	1454	1303
4S	714	788	731	421	432
4T	281	102	140	3	3
4V		2			
4W	155	175	172	156	63
4X	1160	1356	1128	1419	1403
5Y	145	59	98	62	22
5Z	102	179	263	391	417
Total	13752	15290	13254	9413	9452

Observer Kept, t	2006	2007	2008	2009	2010
2J					
3K	2	3	4	3	4
3L	29	5	8	16	12
3O	47	36	45	9	16
3P	47	154	109	73	9
4R	19	20	18	7	7
4S	9	12	13	2	13
4T	29	31	30		
4V					
4W					
4X			18		24
5Y					
5Z	16		8	42	44
Total	198	262	253	152	129

% Coverage	2006	2007	2008	2009	2010	Avg
2J						
3K	0.3%	0.5%	0.4%	0.4%	0.5%	0.4%
3L	3.3%	0.6%	0.7%	1.2%	1.0%	1.3%
3O	8.9%	13.2%	30.2%	13.6%	12.9%	15.8%
3P	0.7%	1.9%	1.8%	2.2%	0.2%	1.4%
4R	1.0%	0.8%	0.8%	0.5%	0.5%	0.7%
4S	1.2%	1.5%	1.7%	0.5%	3.0%	1.6%
4T	10.3%	30.6%	21.4%			20.8%
4V						
4W						
4X			1.6%		1.7%	1.7%
5Y						
5Z	15.8%		3.2%	10.8%	10.4%	10.1%

Table 44. Criteria for assessing marine turtle post-interaction mortality after release from longline gear; percentages of mortality are shown for hardshelled turtles (i.e., Loggerhead, Kemp's Ridley, Olive Ridley, Hawksbill, and Green Turtle), followed by percentages for Leatherbacks (in parentheses) (from Ryder et al. 2006).

Injury Category		Release Condition			
		Released with hook and with trailing line greater than or equal to half the length of the carapace (line is trailing, turtle is not entangled)	**Released with hook and with trailing line less than half the length of the carapace (line is trailing, turtle is not entangled)**	**Released with hook and entangled (line is not trailing, turtle is entangled[1])**	**Released with all gear removed**
		Hardshell (Leatherback)	Hardshell (Leatherback)	Hardshell (Leatherback)	Hardshell (Leatherback)
I	Hooked externally with or without entanglement.	20 (30)	10 (15)	55 (65)	5 (10)
II	Hooked in upper or lower jaw with or without entanglement. Includes ramphotheca, but not any other jaw/mouth tissue parts (see Category III).	30 (40)	20 (30)	65 (75)	10 (15)
III	Hooked in cervical esophagus, glottis, jaw joint, soft palate, tongue, and/or other jaw/mouth tissue parts not categorized elsewhere, with or without entanglement. Includes all events where the insertion point of the hook is visible when viewed through the mouth.	45 (55)	35 (45)	75 (85)	25 (35)
IV	Hooked in esophagus at or below level of the heart with or without entanglement. Includes all events where the insertion point of the hook is not visible when viewed through the mouth.	60 (70)	50 (60)	85 (95)	n/a[2]
V	Entangled only, no hook involved.	Released Entangled 50 (60)			Fully Disentangled 1 (2)
VI	Comatose/resuscitated.	n/a[3]	70 (80)	n/a[3]	60 (70)

[1] Length of line is not relevant as turtle remains entangled at release.
[2] Per veterinary recommendation hooks would not be removed if the insertion point of the hook is not visible when viewed through the open mouth.
[3] Assumes that a resuscitated turtle will always have the line cut to a length less than half the length of the carapace, even if the hook remains.

Table 45. Date on Leatherback Turtle capture type and release condition observed in large pelagic longline fishery during 2001 – 2011; note that release condition of 6 individuals could not be determined and was assumed to be dead.

	Release Condition		
Maritimes Observer Capture Type	**Alive**	**Dead**	**Total**
Flipper/Body Hooked, Line Cut	13		13
Flipper/Body Hooked, Removed	6		6
Gear Entangled, Line Cut	19		19
Gear Entangled, Removed	41		41
Mouth Hooked, Line Cut	36		36
Mouth Hooked, Removed	2		2
Unable to Determine	15	6	21
Total	132	6	138

Table 46. Estimate of Leatherback Turtle post capture mortality based upon Maritimes observer and NMFS capture type / release condition criteria applied to large pelagic longline fishery observations during 2006 – 2010.

			Release Condition				
Maritimes Observer Capture Type	**NOAA Injury Category**	**NOAA Release Condition**	**Alive**	**Dead**	**Total**	**%**	**PCM**
Flipper/Body Hooked, Line Cut	Hooked externally with or without entanglement	Released with hook	3		3	30.0%	0.9
Flipper/Body Hooked, Removed	Hooked externally with or without entanglement	Released with all gear removed	1		1	10.0%	0.1
Gear Entangled, Line Cut	Entangled only, no hook involved	Released Entangled	10		10	60.0%	6
Gear Entangled, Removed	Entangled only, no hook involved	Fully Disentangled	9		9	2.0%	0.18
Mouth Hooked, Line Cut	Hooked in esophagus with or without entanglement	Released with hook	7		7	70.0%	4.9
Mouth Hooked, Removed	Hooked in esophagus with or without entanglement	Released with hook	1		1	85.0%	0.85
Unable to Determine			4	1	5	95.0%	3.8
		Total	35	1	36		16.73
						Total Dead	17.73
						%	49.3%

Table 47. Seasonal occurrence of seismic surveys conducted in the CNSOPB mandate area since 1996; note that detailed information for surveys conducted prior to 1996 was not available (data provided by CNSOPB).

Year	Line length (km - 2D)	Total area (km^2 - 3D)	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1996		547												
1997														
1998	11590													
		1440												
	475													
	187													
	?													
	120													
1999	36570													
	31000													
	21444													
		1302												
		263												
		1302												
		4164												
2000	2674													
		3043												
		158												
		4788												
		3400												
	2012													
2001	10686													
		1334												
		1100												
		2934												
	1875													
		1235												
	400													
	?													
2002	?													
		450												
	2583													
2003	1920	739												
		1767												
	9989													
		2259												
	3357													
	506													
2004		353												
	?													
2005	920													

Table 48. Seasonal occurrence of seismic surveys conducted in the CNLOPB mandate area since 1990; note that only the completion month of each survey was available (data provided by CNLOPB).

Year	Survey	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1990	2D					1748	165			112	2025
	3D					14489					14489
1991	2D					2509	1911				4420
	3D							21296			21296
1992	2D			294		233					527
	3D										
1993	2D										
	3D										
1994	2D							210			210
	3D										
1995	2D		40			727	503				1270
	3D						62942				62942
1996	2D						1122		141		1263
	3D										
1997	2D			118							118
	3D			47214	27230						74444
1998	2D			214	5691	3097		11825			20827
	3D					48150					48150
1999	2D					845		3309			4154
	3D							153541			153541
2000	2D	872						77			949
	3D				96495	116841					213336
2001	2D			144	70	3495	355				4064
	3D					17047	109435				126482
2002	2D			783					597		1380
	3D										
2003	2D										
	3D										
2004	2D										
	3D						101382				101382

Table 49. Mean of the size of plastics by latitude between 1991–1995 and 2004–2007; standard error indicated in parentheses (adapted from Moret-Ferguson et al., 2010).

Latitude (°)	Size (mm)	
	1990s n = 392	2000s n = 354
40	30.64 (8.86)	13.04 (3.75)
35	9.72 (2.23)	3.83 (0.48)
30	5.98 (0.46)	5.17 (0.42)
25	8.01 (2.67)	3.33 (0.55)
20	6.23 (2.47)	2.74 (0.71)
15	4.76 (1.63)	4.15 (0.97)

Table 50. Categories used by Great Canadian Shoreline Cleanup (CSC) program to classify debris items; note that some non-plastic items may contain some plastic.

	Non-plastic	Plastic
Shoreline & Recreational Activities	Bags (Paper)	Bags (Plastic)
	Beverage Bottles (glass)	Balloons
	Beverage Cans	Beverage Bottles (plastic) 2 liter or less
	Caps/Lids	Six-Pack Holders
	Clothing/Shoes	
	Cups, plates, etc	
	Food Wrappers	
	Pull Tabs	
	Shotgun Shells	
	Straws/Stirrers	
	Toys	
Ocean/Waterway Activities	Bait Containers	Fishing Lures/Light Sticks
	Bleach/Cleaner	Plastic Sheeting
	Buoys/Floats	Strapping Bands
	Crab/Lobster/Fish Traps	
	Crates	
	Fishing Line	
	Fishing Nets	
	Light Bulbs	
	Oil/Lube Bottles	
	Pallets	
	Rope	
Smoking-Related Activities	Cigarettes/Cigarette Filters	Tobacco Packaging
	Cigarette Lighters	
	Cigar Tips	
Dumping Activities	Appliances	
	Batteries	
	Building Materials	
	Car/Car Parts	
	55-Gallon Drums	
	Tires	
Medical/Personal Hygiene	Diapers	Condoms
		Syringes
		Tampons

Table 51. Total number of debris items, percent plastic and origin of plastic items reported by CSC program in Atlantic Canada during 2008 – 2011.

	Total Debris	Plastics	Shoreline	Ocean	Smoking	Dumping	Medical
2008	53508	14.3%	43.8%	32.1%	10.1%	0.0%	14.0%
2009	57133	20.7%	65.7%	12.2%	7.9%	0.0%	14.3%
2010	40242	19.7%	62.8%	18.3%	8.8%	0.0%	10.1%
2011	51846	20.2%	63.1%	13.6%	9.1%	0.0%	14.2%
	Average	18.7%	58.8%	19.1%	8.9%	0.0%	13.1%

Table 52. Synopsis of fishery threats to Leatherback Turtles of Atlantic Canada; scale of threat is no. trips during 2006 -2010 both total and in Leatherback areas of concentration (no. & % of total); evidence of encounter is no/year, adjusted for observer coverage and unadjusted for reporting rate for other data; threat trend is based on no. trips during 2006 -2010; shading splits table into threats which have good (dark), some (light) and no (none) evidence of encounter.

Threat	Scale of Threat (No trips)			Evidence of Encounter				Threat Trend
				Observer		SARA Logs	Nfld Network	(2006 -2010)
	Total	Forage	%	Coverage (%)	No/Year (adjusted)	No/Year (unadjusted)	No/Year (unadjusted)	
Large Pelagic longline	2,253	578	25.7%	5 - 30%	60 - 90	25 (M)	1.9	Decline
Snow Crab trap	63,864	16,773	26.3%	2 - 18%	5.5 (M)	0	0.06	Stable
Whelk pot	8,136	1,601	19.7%	<1%	0	1.4 (G)	0.14	Stable
Groundfish gillnet	120,190	27,922	23.2%	0.4 - 20.8%	0	0.4 (Nfld)	0.94	Decline
Groundfish longline	35,658	4,649	13.0%	1.2 - 31.5%	0	0.43 (Q)	0.29	Stable
Herring gillnet	42,759	10,332	24.2%	<1%	0	0.25 (G)	0.11	Stable
Lobster trap	523,776	192,523	36.8%	0 - 6%	0	0.2 (M), 0.25 (G)	0	Stable
Halibut longline	9,985	2,224	22.3%	11.7%	0	0	0	Stable
Turbot gillnet	9,639	3	0.0%	3.2 - 54.5%	0	0	0	Decline

Table 53. Synopsis of non-fishery threats to Leatherback Turtles of Atlantic Canada; forage in Scale of Threat is degree to which threat encounters Leatherback areas of concentration; threat trend is based on activity trend discussed in text.

Threat	Scale of Threat		Evidence of Encounter	Threat Trend
	Spatial Scale	Forage		
Maritime Transport	Coastwide	?	Limited	Increase?
Marine Debris	Coastwide	?	Limited	Stable
Seismic Survey	Coastwide	Low	Limited	Decline

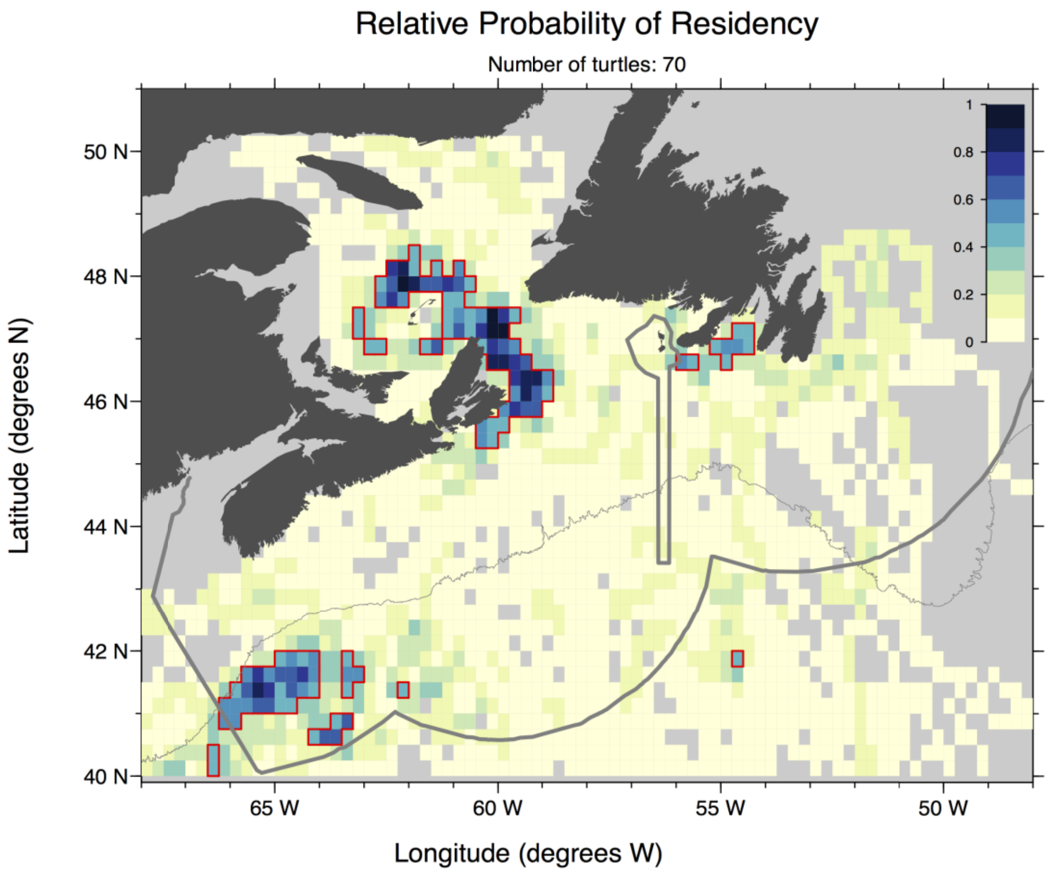


Figure 1. Areas of important habitat for leatherback turtles in Canadian waters, as indicated by satellite telemetry. Scale represents aggregated residency probability. Red polygons denote areas where aggregated residency probabilities ≥0.4 for all satellite tracked turtles. Thick grey line indicates Atlantic Canadian Exclusive Economic Zone boundary; thin grey line indicates 1000 m isobath. Source: M.C. James and I.A. Jonsen, unpublished data; as presented in DFO 2012. Not to be cited outside the context of this zonal advisory process.

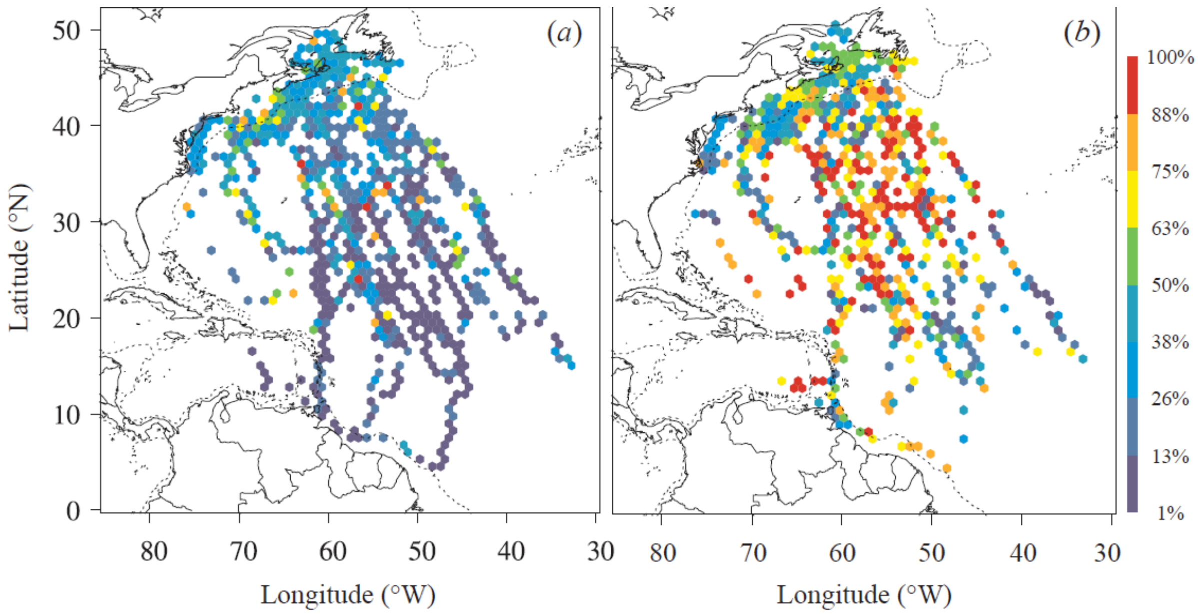


Figure 2. Median surface times of Leatherback Turtles (<2 m: n = 12 turtles; <3 m: n = 3 turtles) during (a) the night period and (b) the day period within hexagonal area bins (width: 0.917° longitude; largest height: 1.001° latitude) (from James et al. 2006b; © Canadian Science Publishing or its licensors).

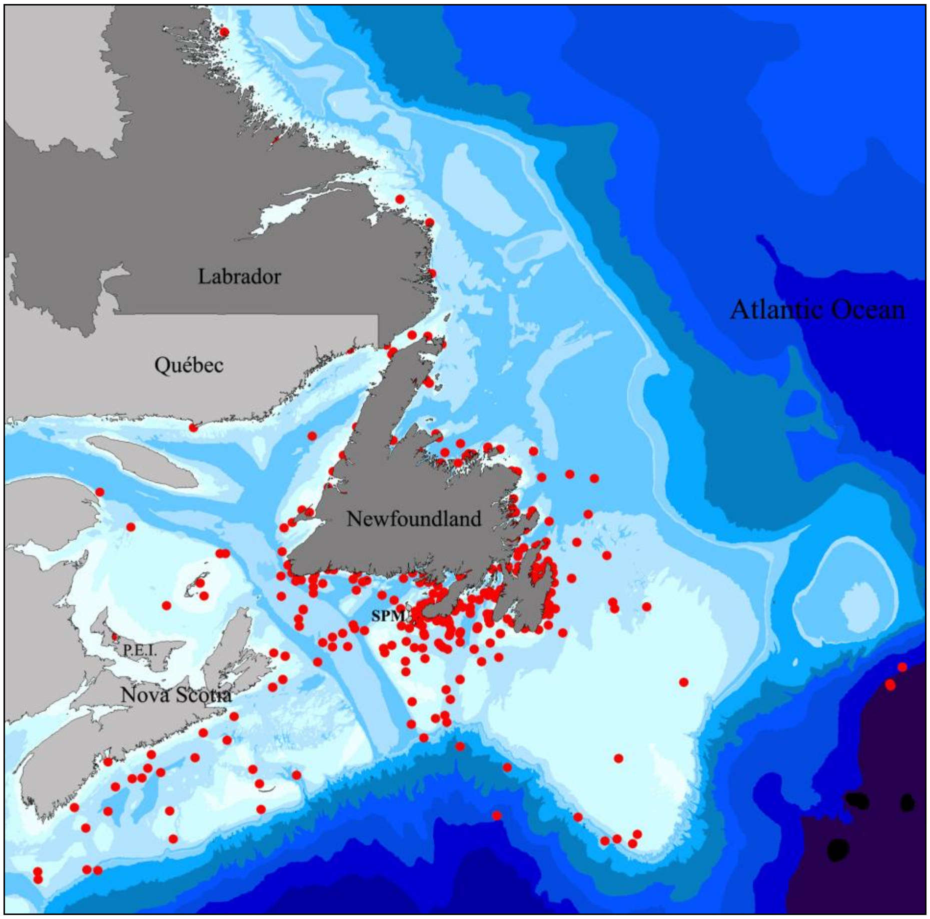


Figure 3. Leatherback observations from the Newfoundland sightings – survey and opportunistic platforms (from J. Lawson, pers. comm.).

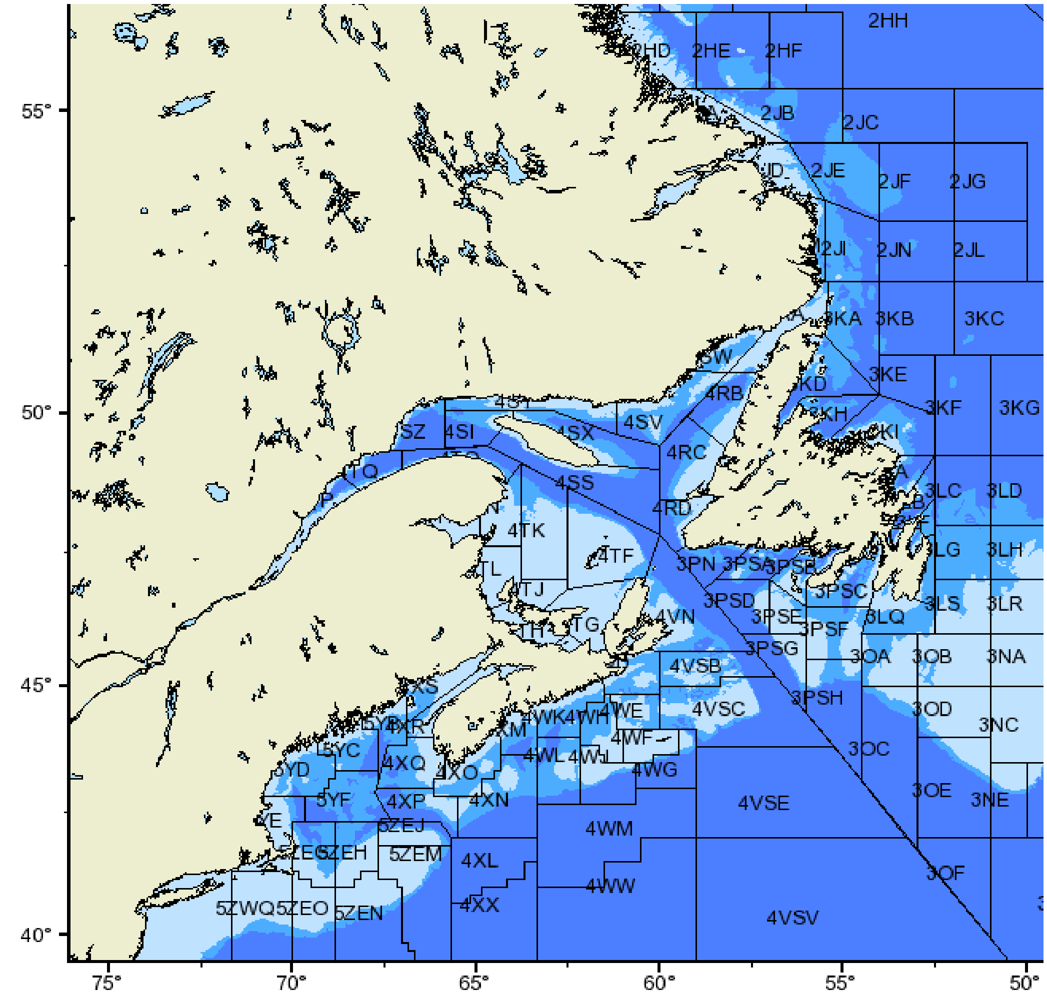


Figure 4. NAFO divisions and DFO Statistical Unit Areas off Canada's Atlantic Coast.

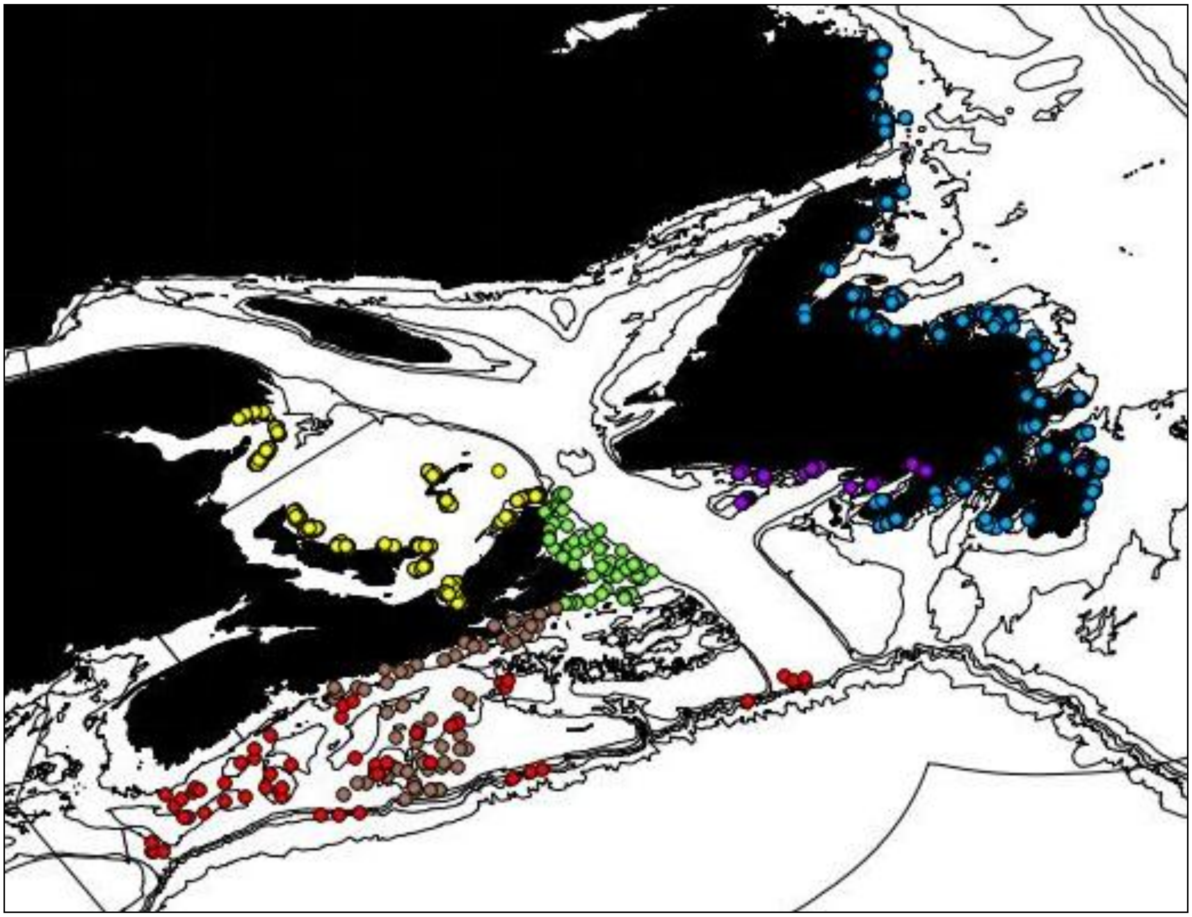


Figure 5. Distribution of sets in 2010 fixed gear sentinel surveys off Canada's east Coast; dot colour of each survey – Halibut (red), 4Vn (green), 4VsW (brown), Gulf longline (yellow), Newfoundland longline (light purple), Newfoundland gillnet (blue).

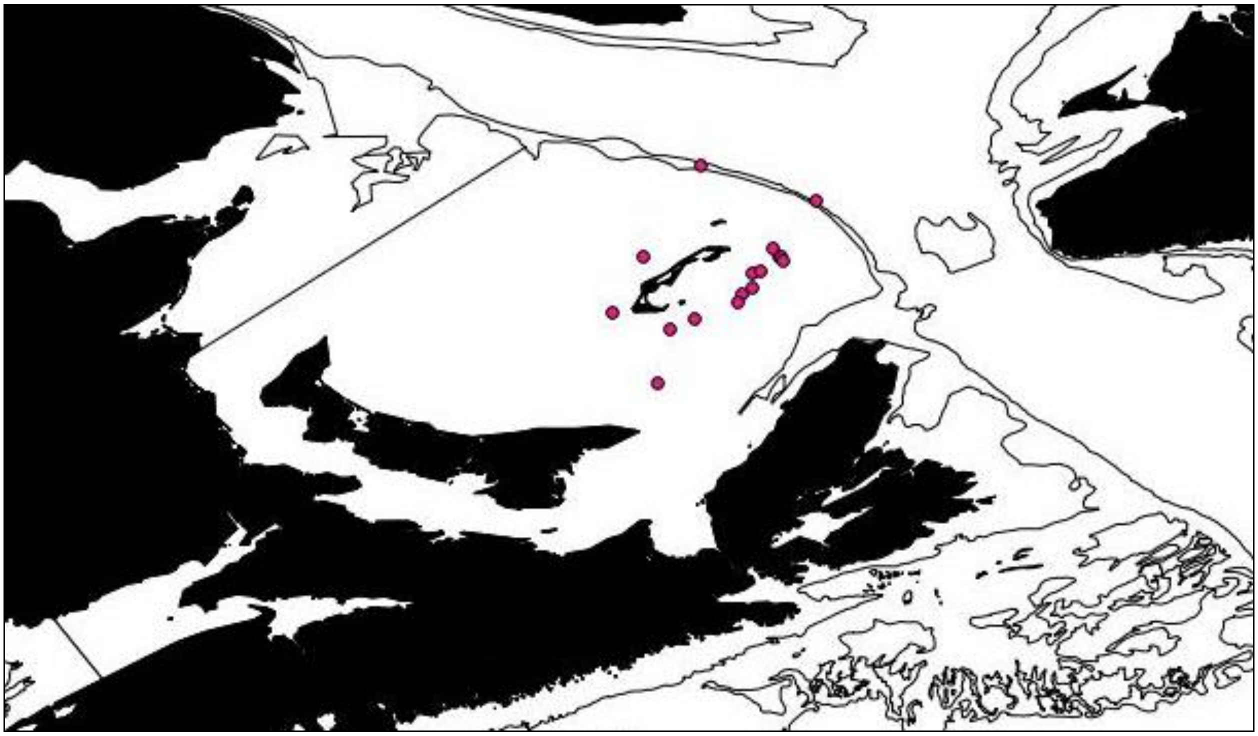


Figure 6. Leatherback Turtle encounters reported in SARA logbooks from DFO Quebec Region.

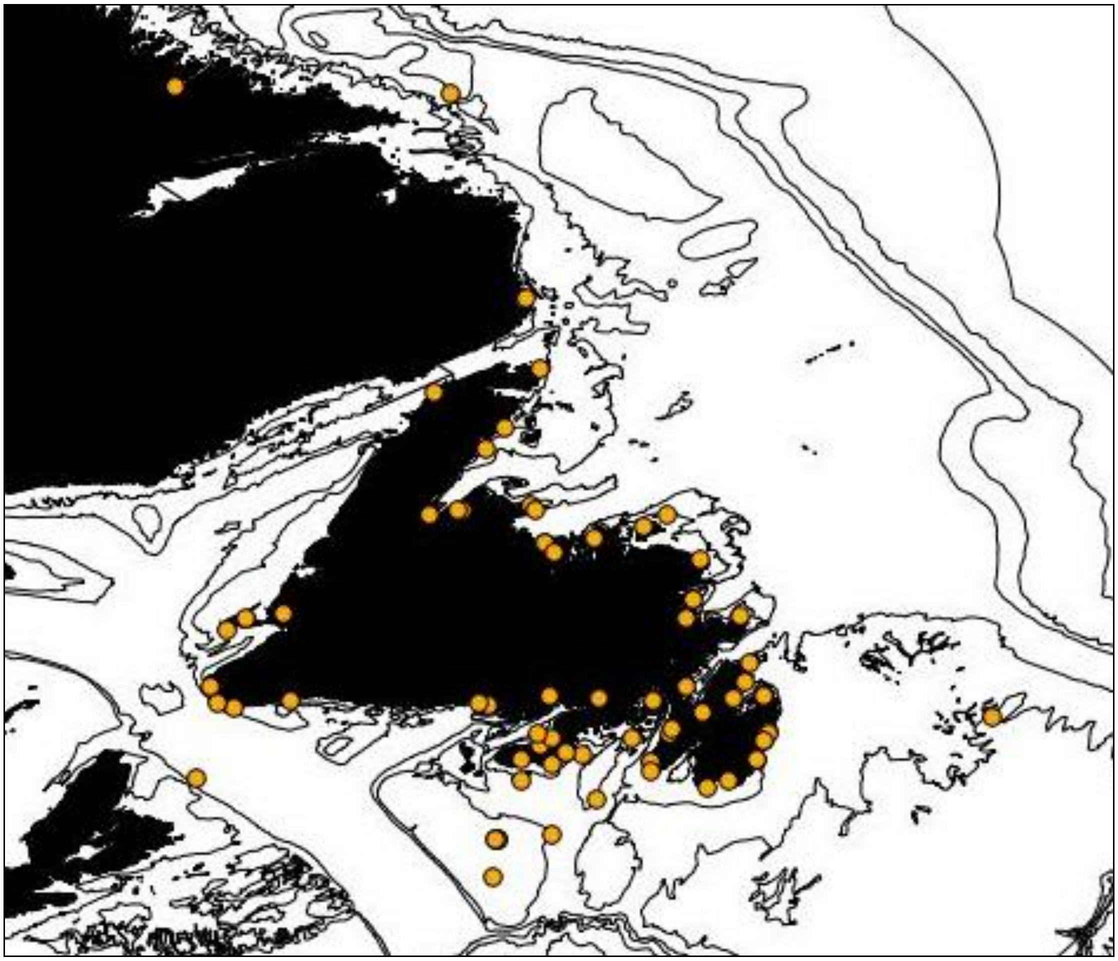


Figure 7. Distribution of Leatherback observations encountered in fishing gear around Newfoundland as reported by Whale Release and Strandings Network (data from W. Ledwell and J. Lawson).

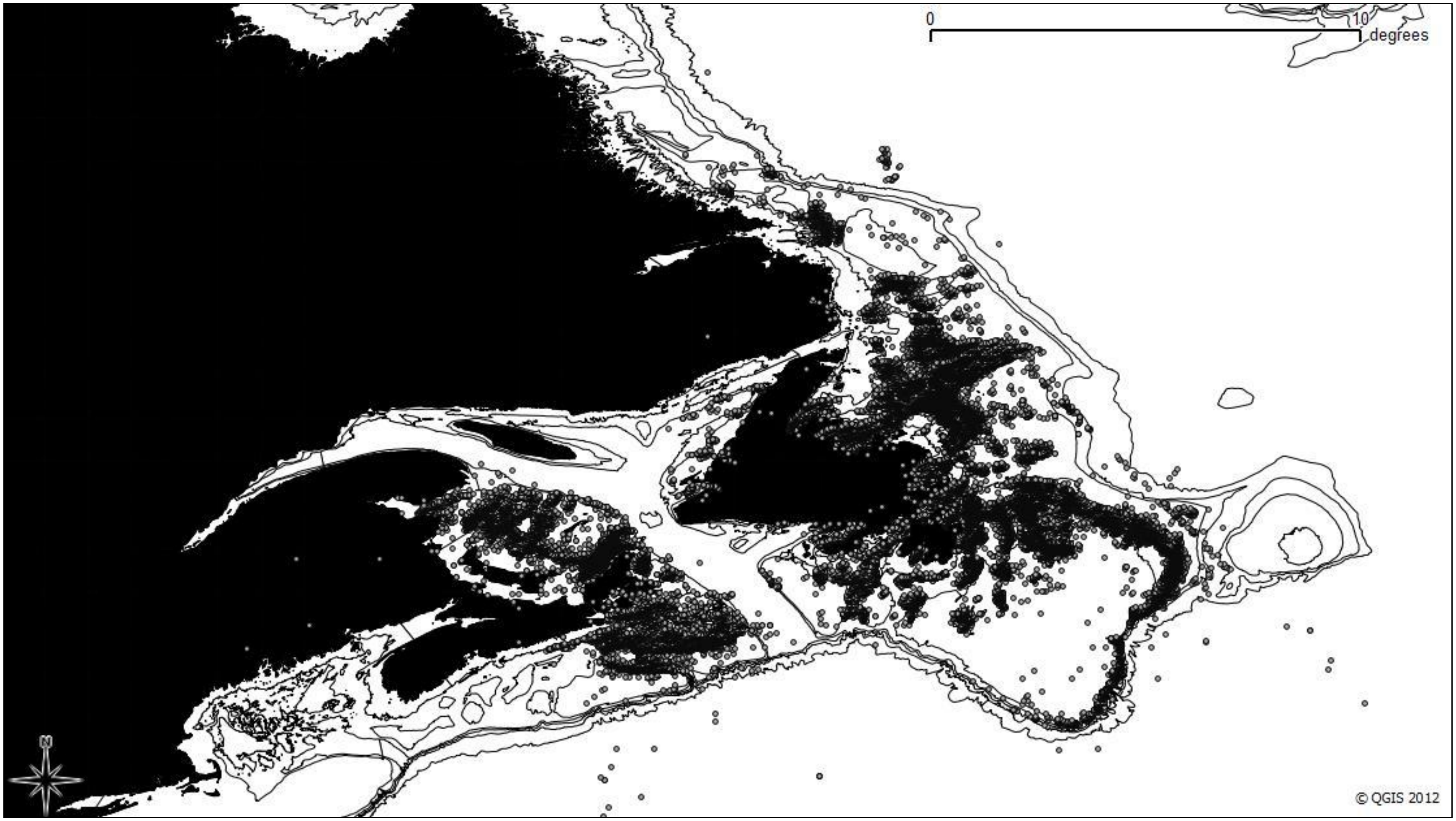


Figure 8. Locations of summer – fall 2006 – 2010 Snow Crab trap fishery, as reported in ZIFF.

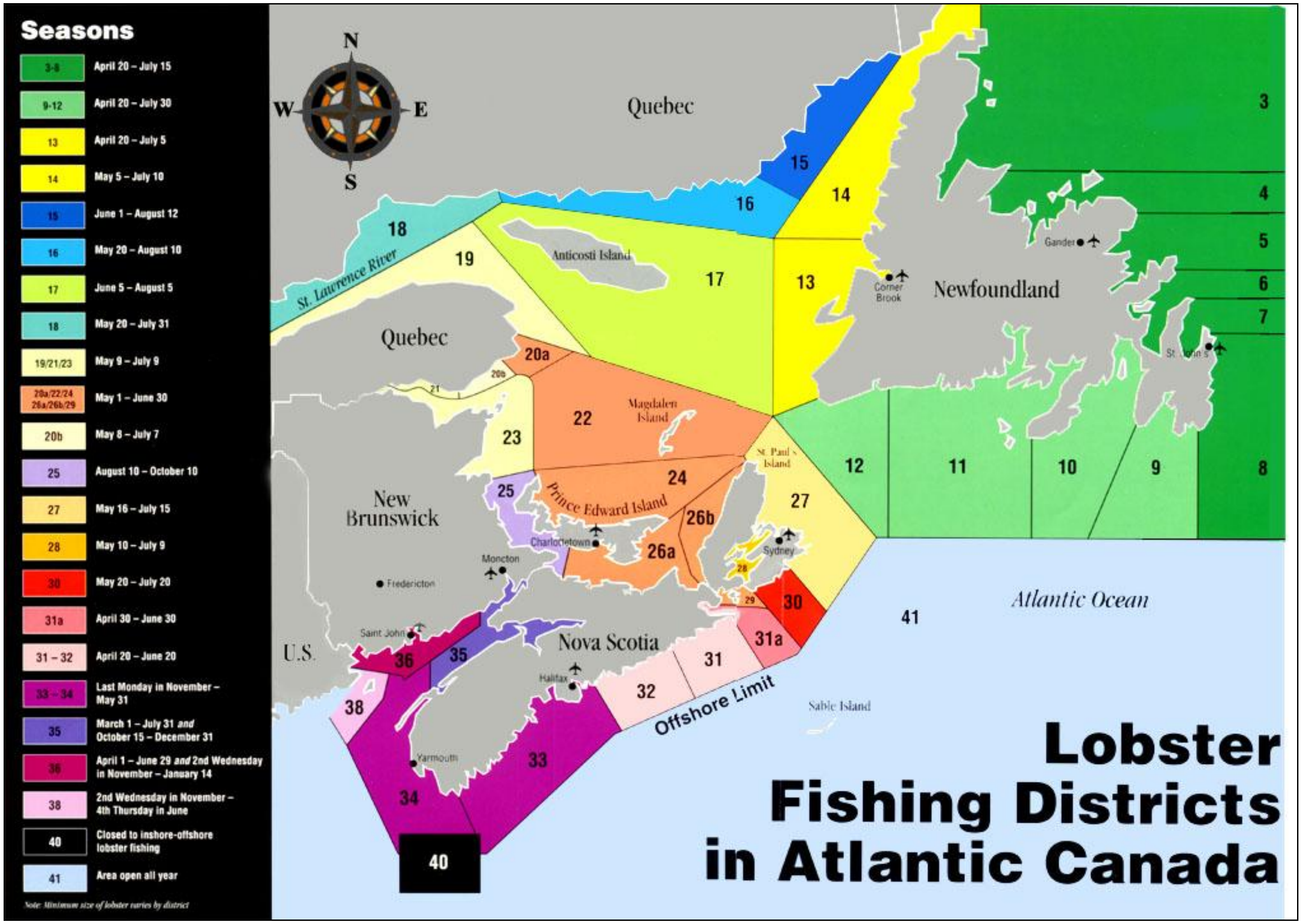


Figure 9. Lobster management seasons in Atlantic Canada (from http://www.gov.ns.ca/fish/marine/map/lobarea.shtml#map).

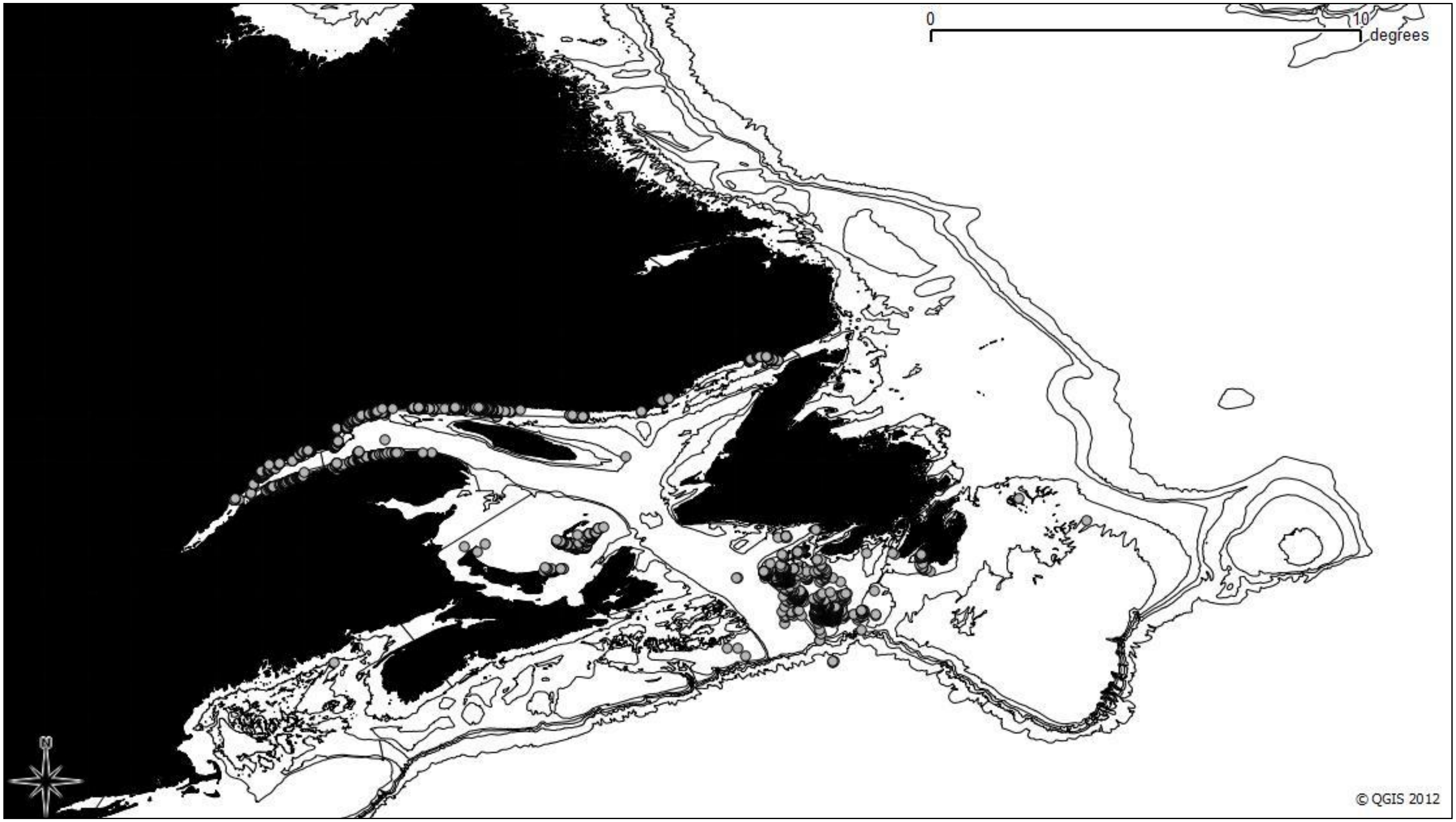


Figure 10. Locations of the summer – fall 2006 - 2010 Whelk pot fishery, as reported in ZIFF.

Figure 11. Locations of the summer – fall 2006 - 2010 large pelagic longline fishery, as reported in ZIFF.

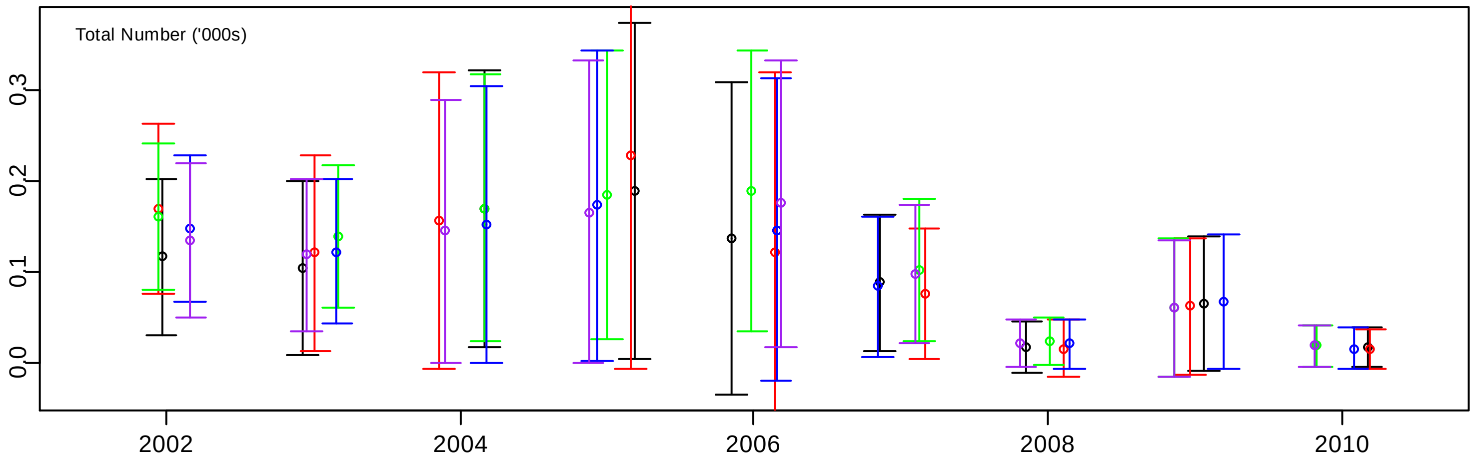


Figure 12. Estimate of total Leatherback bycatch numbers based on total weight of a trip's catch, weight of Swordfish kept (target), number of hooks, number of sets and number of sea days) with 95% confidence interval (from Hanke et al. 2012).

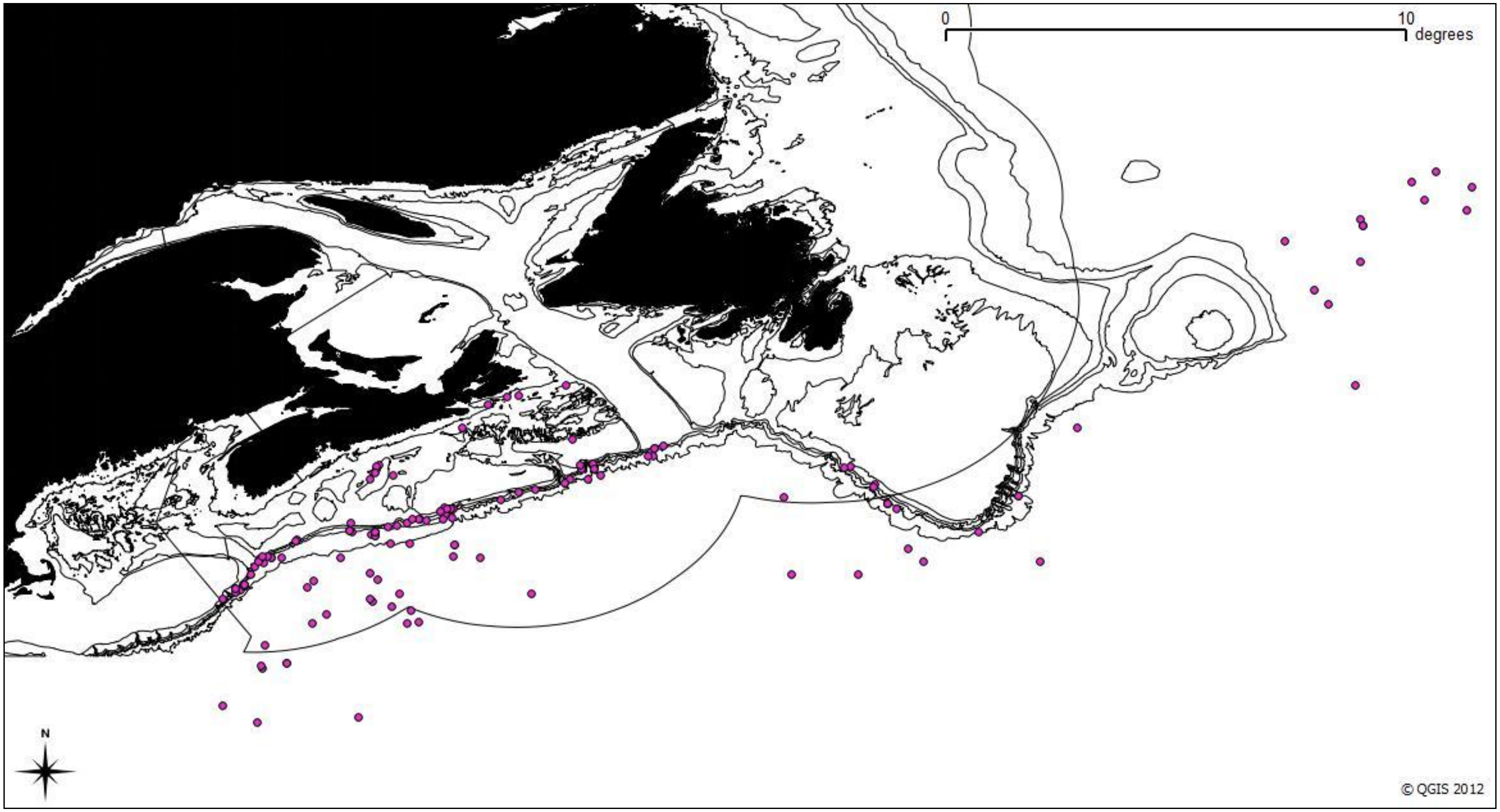


Figure 13. Spatial distribution of 138 Leatherback Turtles observed in large pelagic longline fishery during 2001 – 2011; note group of observations east of Flemish Cap that were recorded during 2001 – 2003.

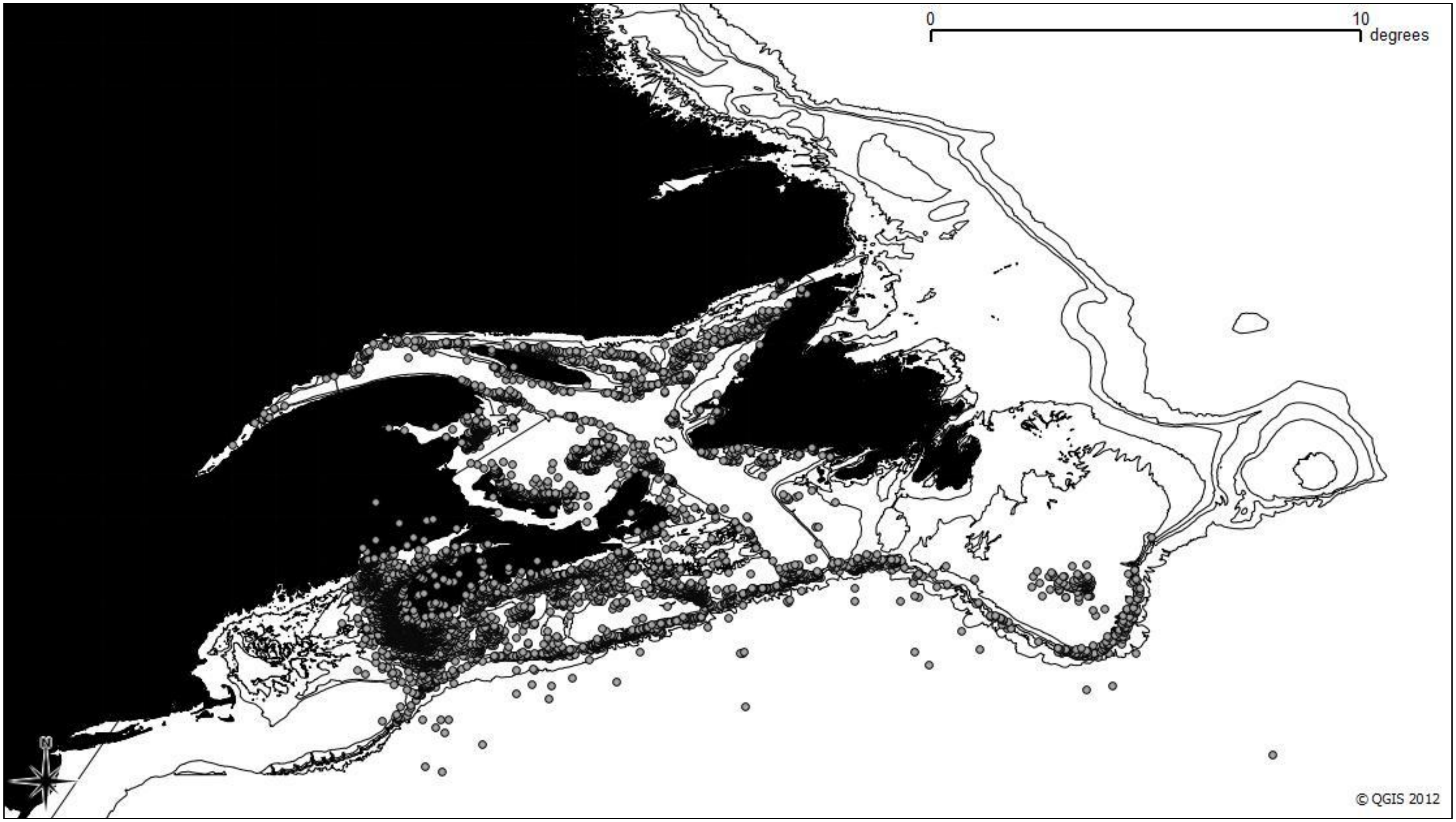


Figure 14. Locations of summer – fall, 2006 – 2010, Atlantic Halibut fishery, as reported in ZIFF.

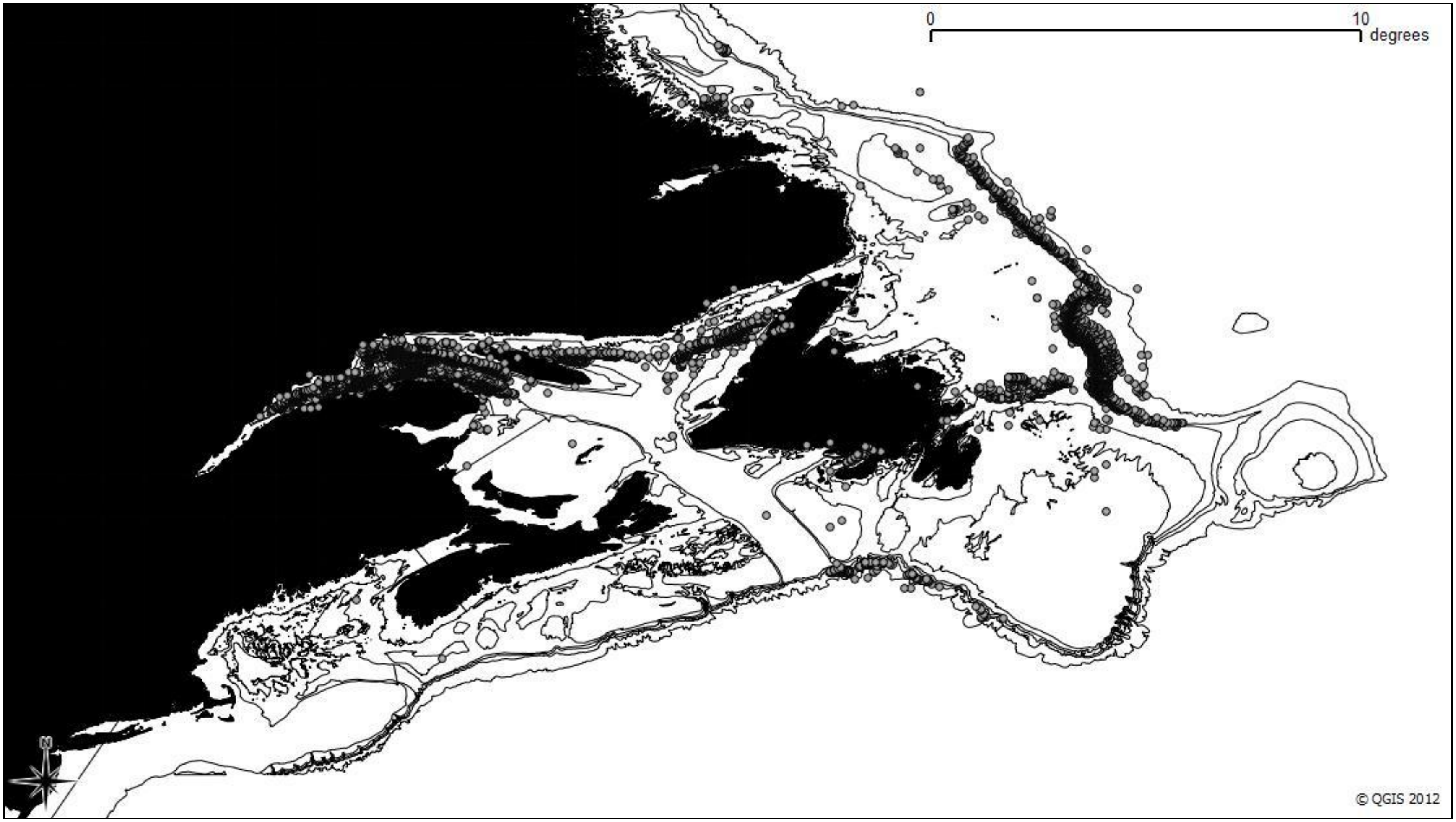


Figure 15. Locations of summer – fall, 2006 – 2010, Turbot gillnet fishery, as reported in ZIFF.

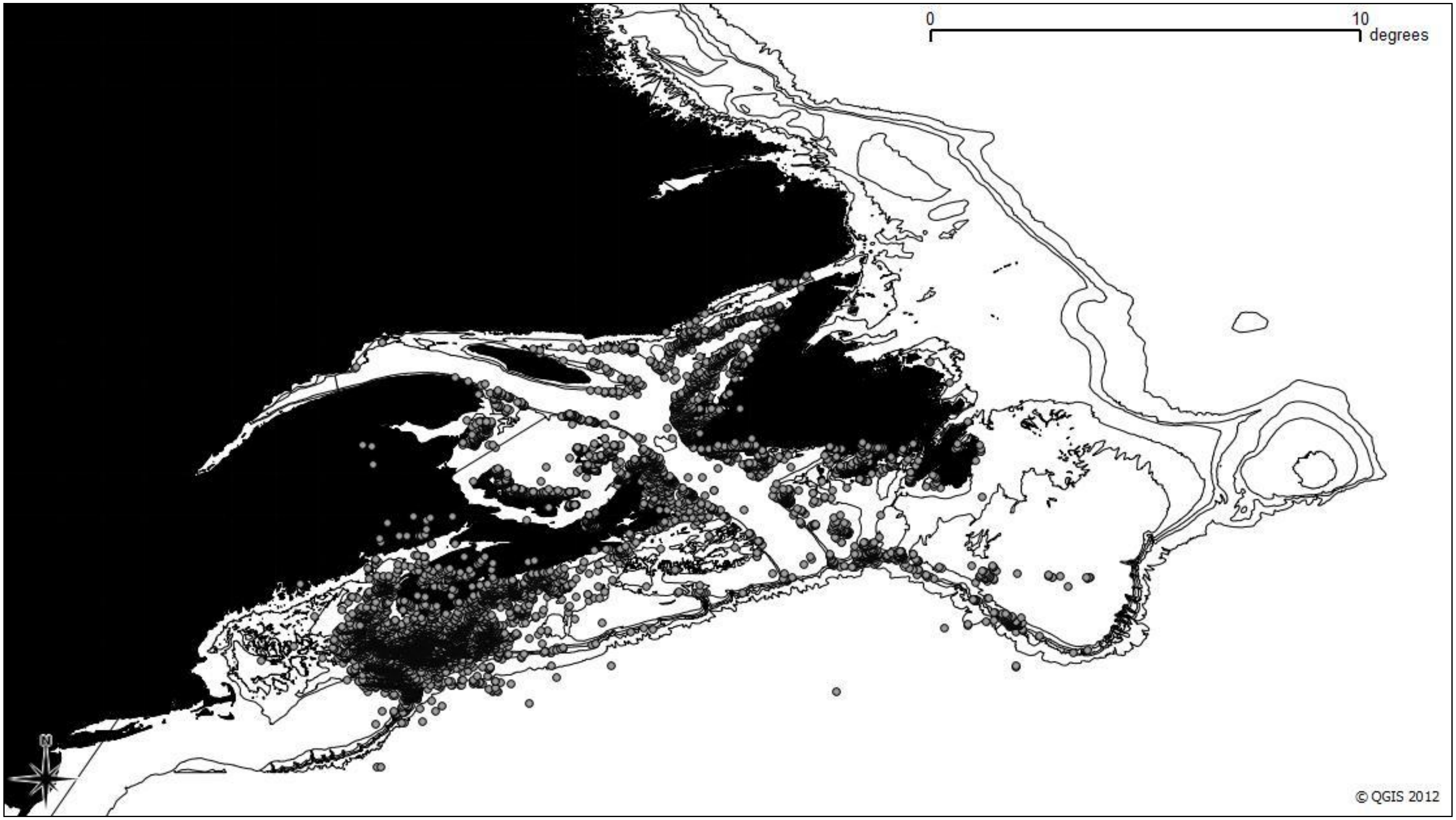


Figure 16. Locations of summer – fall, 2006 – 2010, groundfish longline fishery, as reported in ZIFF.

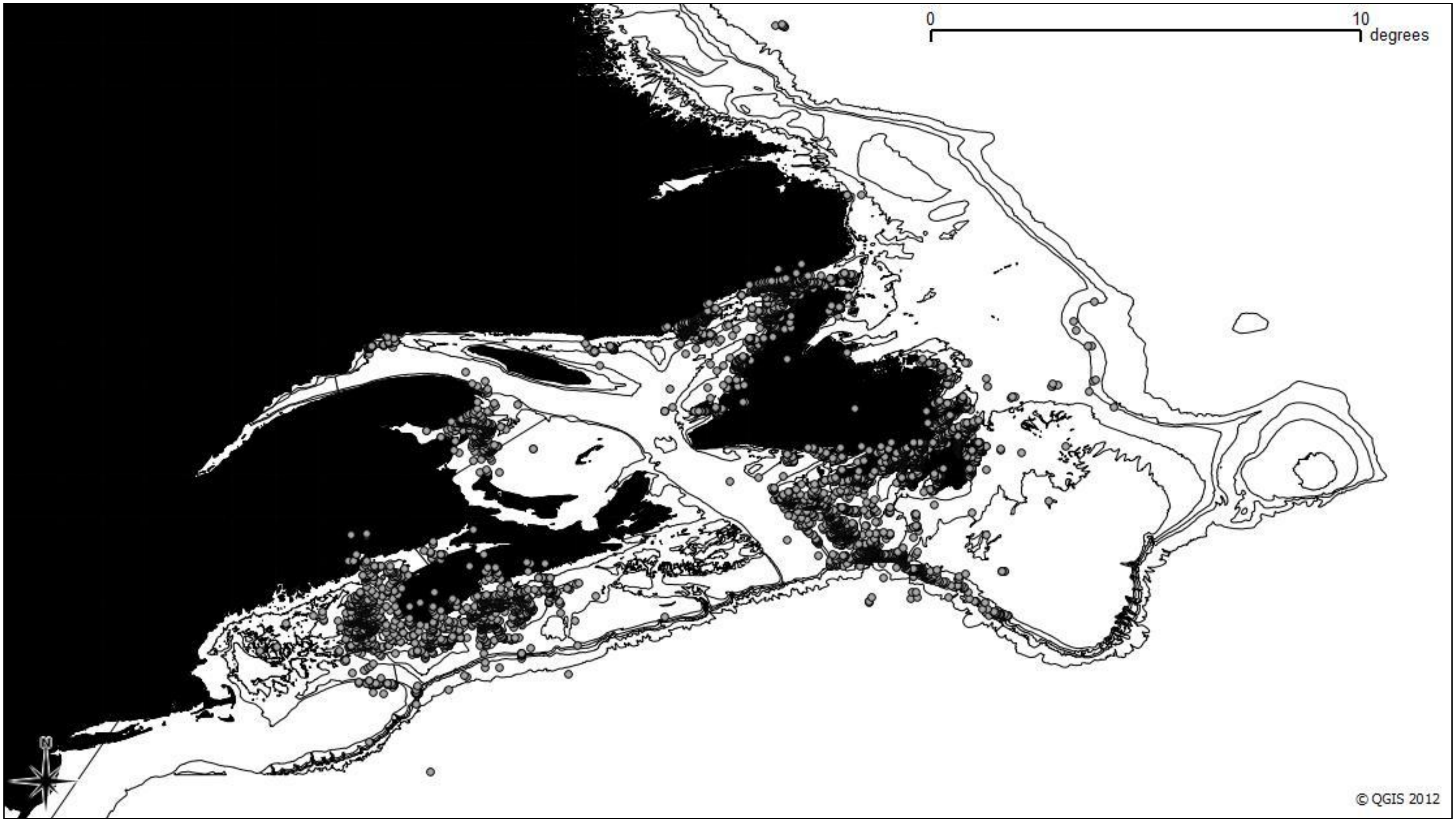


Figure 17. Locations of summer – fall, 2006 – 2010, groundfish gillnet fishery, as reported in ZIFF.

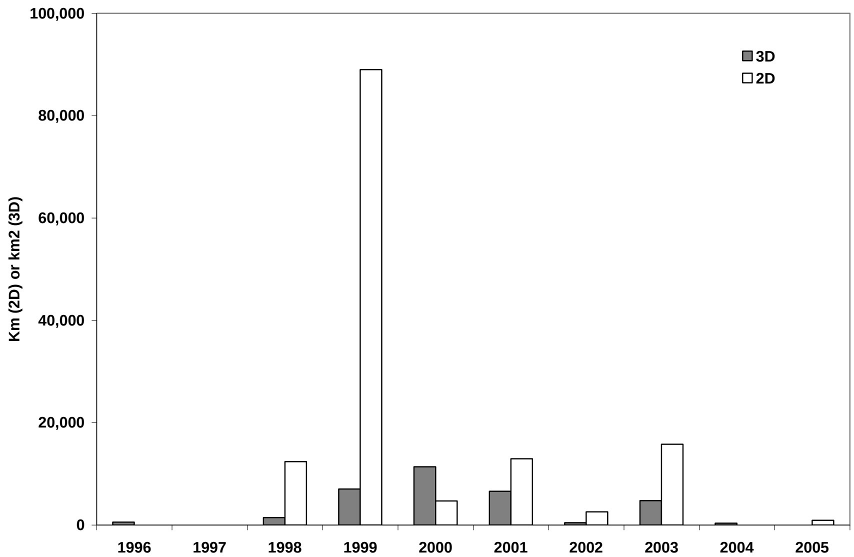


Figure 18. Annual intensity of 2D and 3D seismic surveys conducted in the CNSOPB mandate area since 1996; note that 2D surveys are measured according to the lengths (km) of transects while 3D surveys are measured according to the area (km²) covered (data provided by CNSOPB).

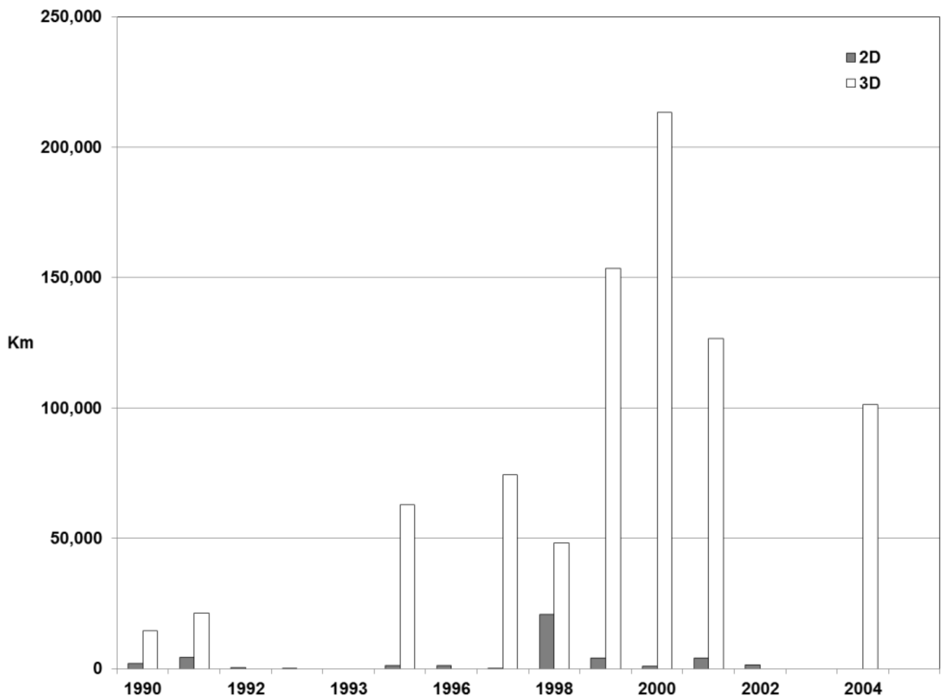
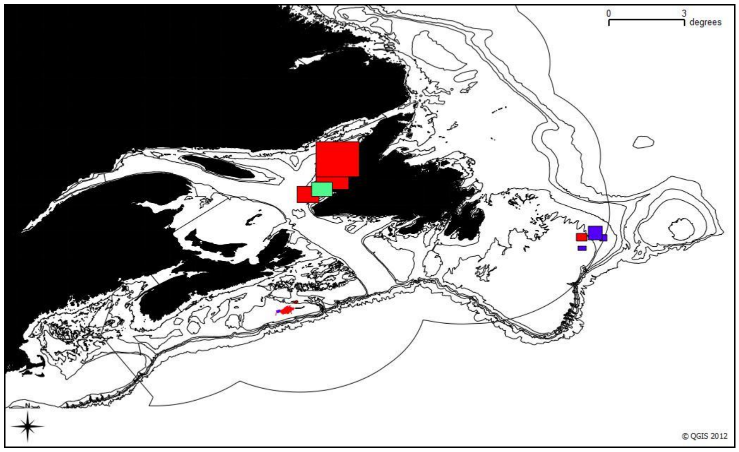
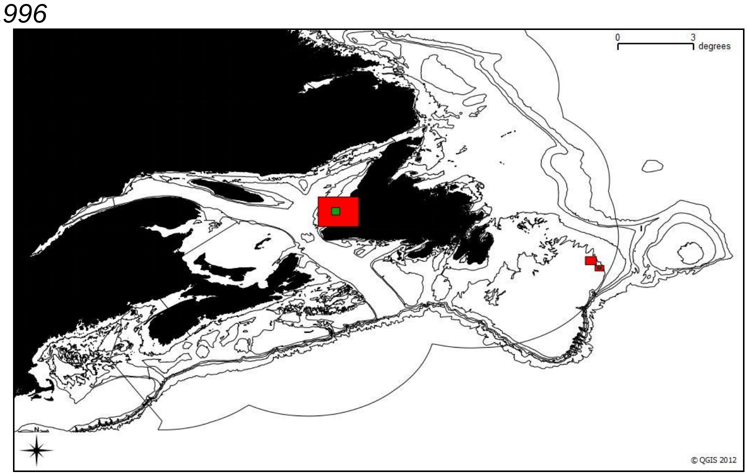


Figure 19. Annual intensity of 2D and 3D seismic surveys conducted in the CNLOPB mandate area since 1990; note that 2D and 3D surveys are measured according to the lengths (km) of transects (data provided by CNLOPB).

a) 1990 - 1992



b) 1994 – 1996



c) 1997 – 1999

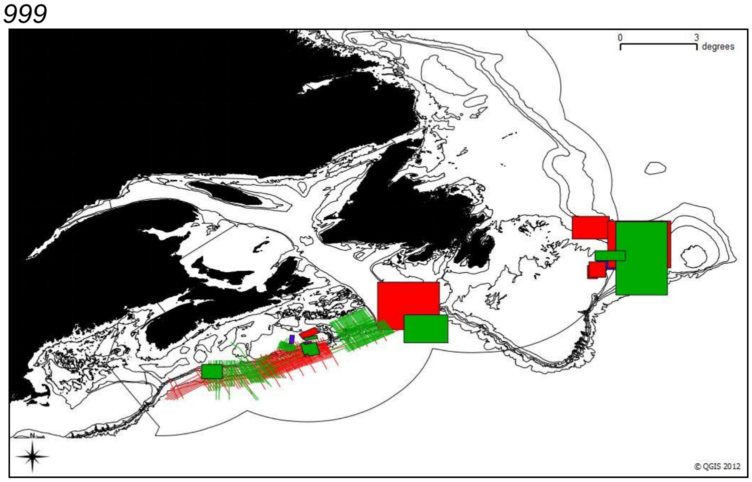
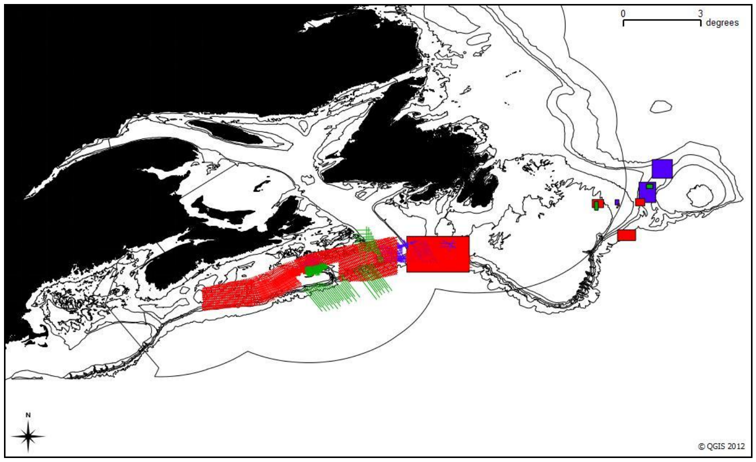


Figure 20. Spatial distribution of CNSOPB and CNLOPB-sponsored 2D and 3D seismic surveys during 1990 – 2005; on each panel, blue, red and green indicate the first, middle and last years presented; for the CNLOPB surveys, only the bounding latitudes and longitudes of the survey area were available which necessitated presentation of these areas as boxes (data provided by CNSOPB and CNLOPB).

d) 2000 – 2002



e) 2003 – 2005

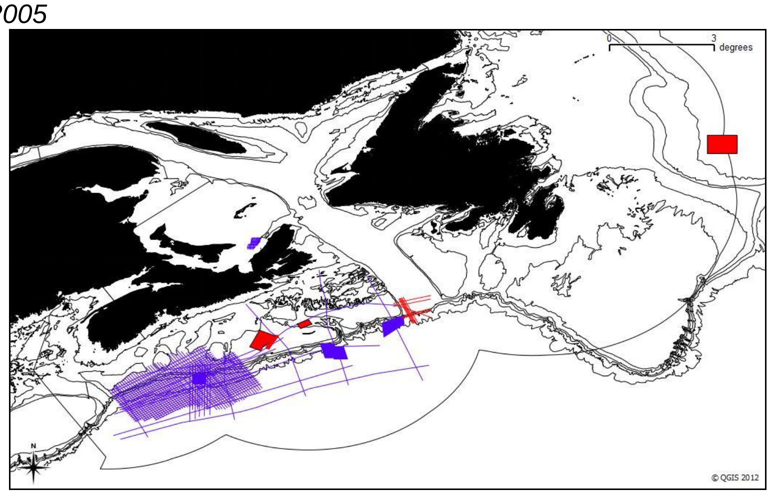


Figure 20 (continued). Spatial distribution of CNSOPB and CNLOPB-sponsored 2D and 3D seismic surveys during 1990 – 2005; on each panel, blue, red and green indicate the first, middle and last years presented; for the CNLOPB surveys, only the bounding latitudes and longitudes of the survey area were available which necessitated presentation of these areas as boxes (data provided by CNSOPB and CNLOPB).

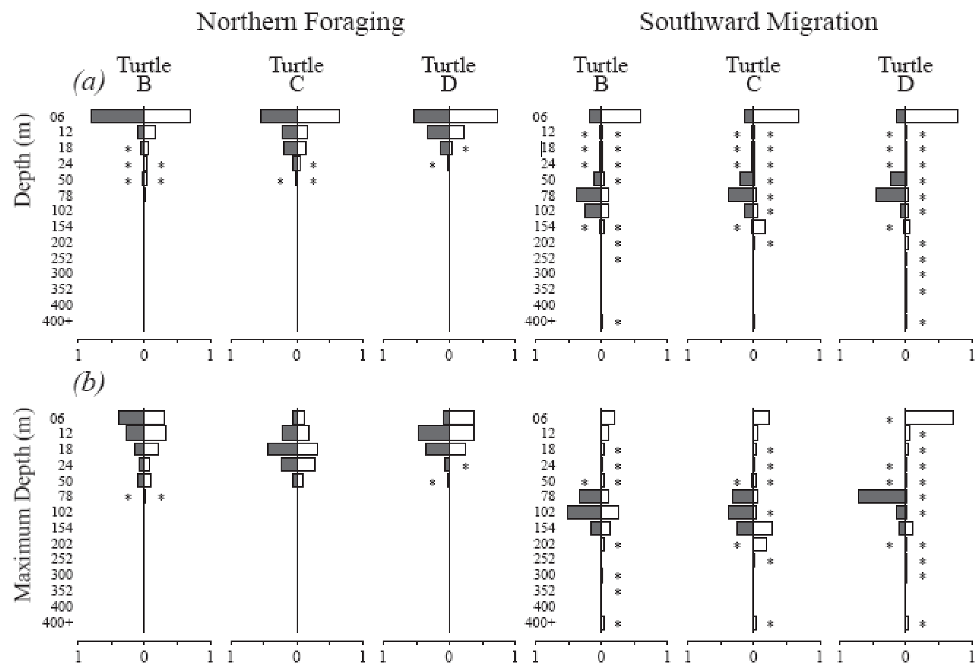


Figure 21. Back-to-back histograms of measures of diving behaviour during night (solid bars: 2100 – 0300) and day (open bars: 0900 – 1500) for three Leatherback Turtles: B (subadult, CCL = 134.0 cm), C (mature female, CCL = 155.0 cm) and D (mature male, CCL = 168.5 cm); asterisks indicate bars with values between 0.005 and 0.05; a) proportion of time (6 h period) spent in depth range and b) proportion of dives whose maximum depth fell in depth range (reproduced from James et al. 2006b; © Canadian Science Publishing or its licensors).

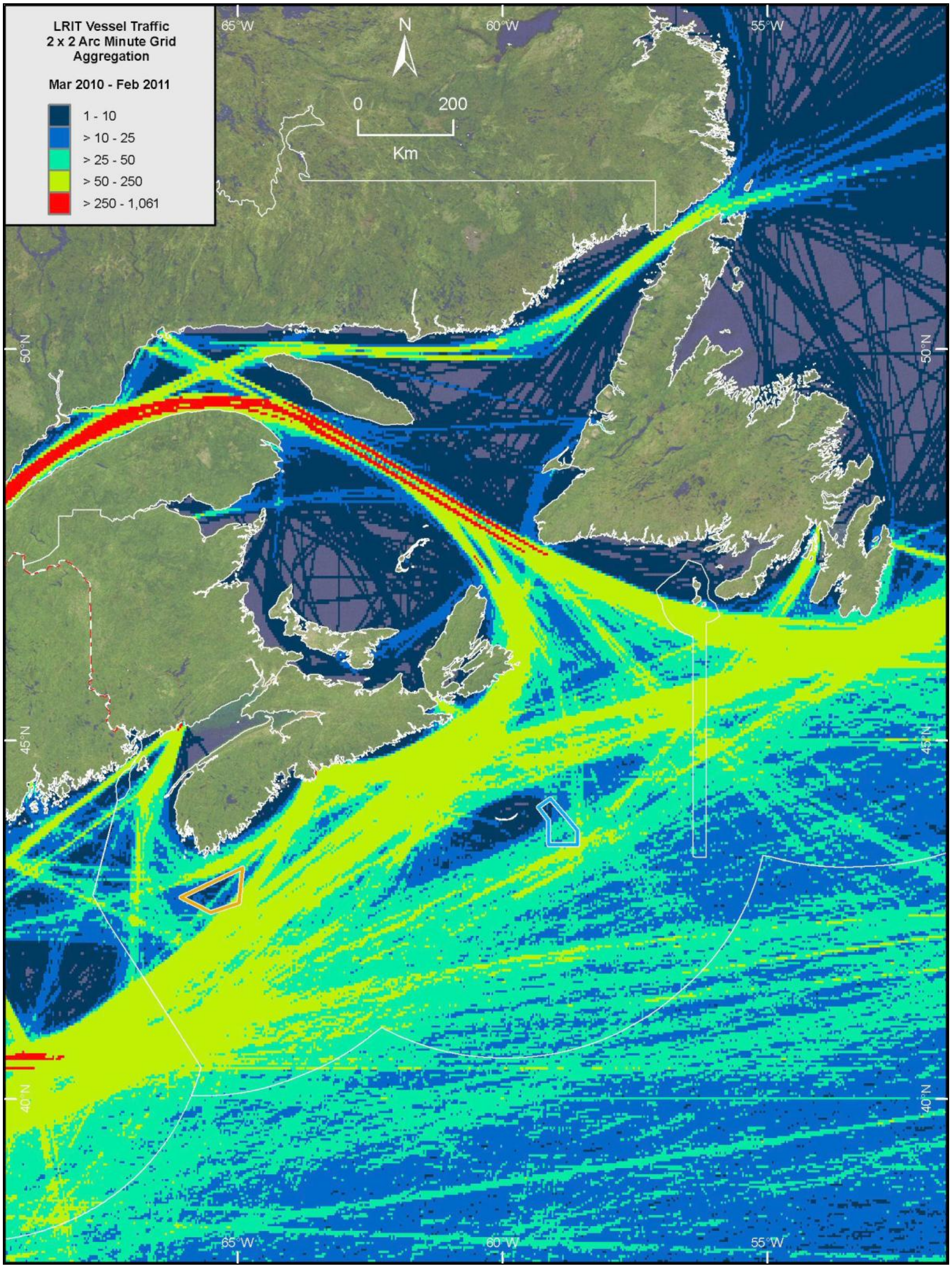


Figure 22. Twelve-month (March 2010–February 2011) composite raster of vessel track counts per 2 x 2 minute grid cell (Atlantic region view) based on Long Range Identification and Tracking (LRIT) system data. Blue polygon: Gully MPA boundary; Orange polygon: Roseway Basin Area to be avoided (from Koropatnick et al. 2012).

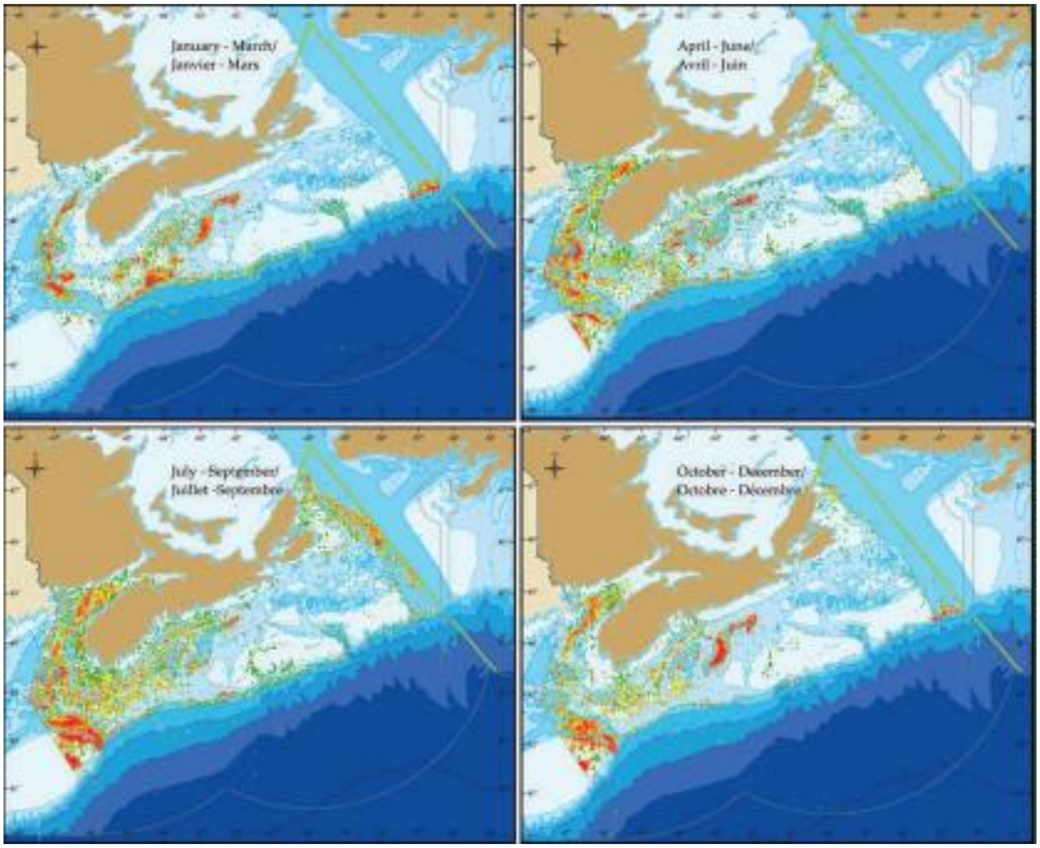


Figure 23. Seasonal distribution of 1999 – 2003 groundfish landings from Scotian Shelf fisheries (from Breeze and Horsman 2005).

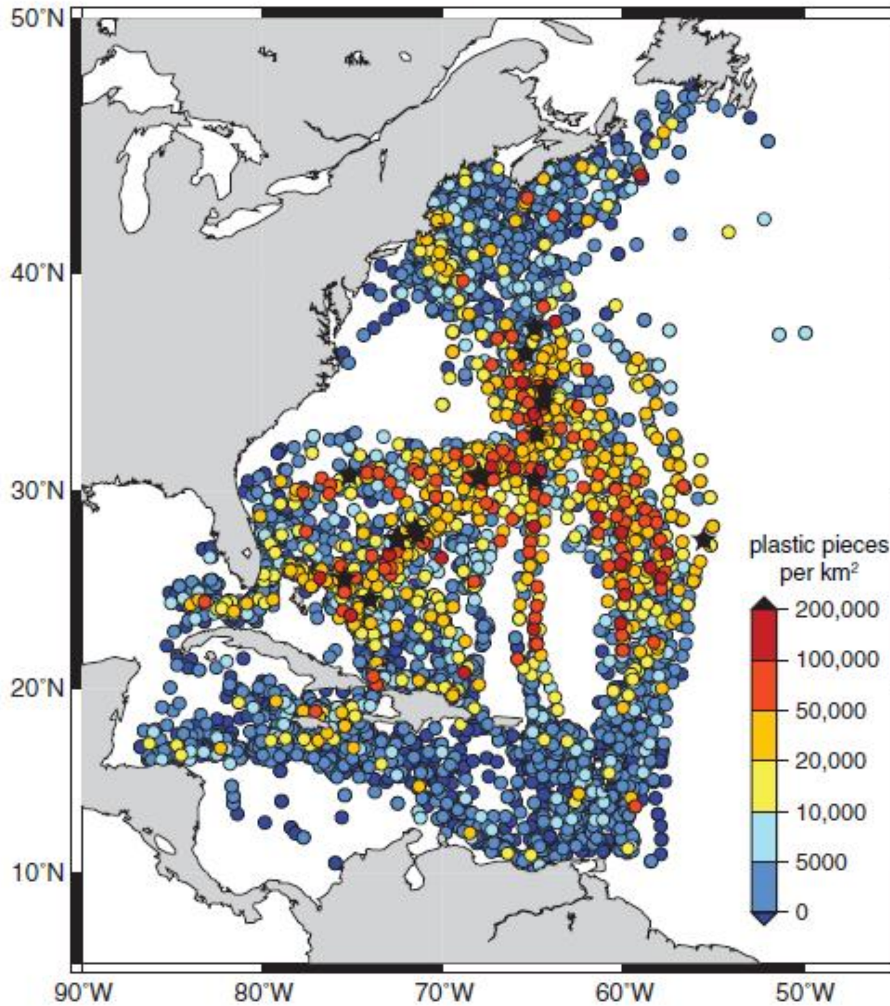


Figure 24. Distribution of plastic marine debris collected in 6136 surface plankton net tows on annually repeated cruise tracks from 1986 to 2008 in the western North Atlantic Ocean and Caribbean Sea; symbols indicate location of each net tow; color indicates measured plastic concentration in pieces km^2; black stars indicate tows with measured concentration greater than 200,000 pieces km^2; symbols are layered from low to high concentration (reproduced from Law et al. 2010; reprinted with permission from the American Association for the Advancement of Science (AAAS)).

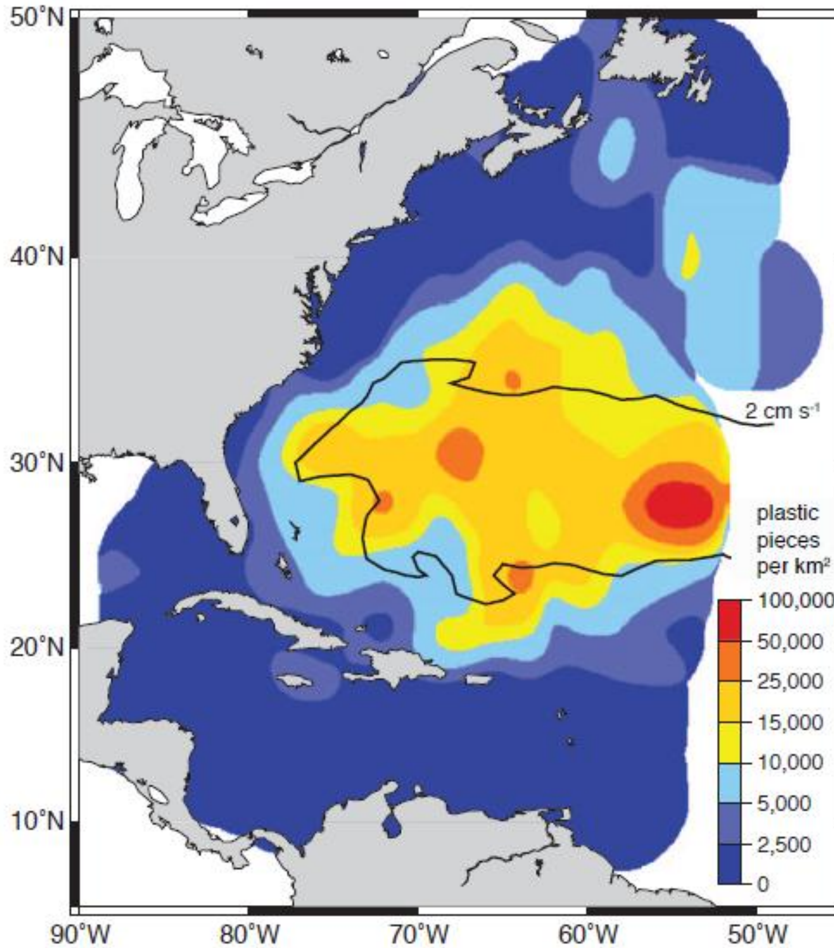


Figure 25. Average plastic concentration (color shading, units of pieces km^2) computed in 0.5° bins and smoothed with a 700-km width Gaussian filter; black line indicates the 2 cm s^{-1} contour of the ten-year (1993 to 2002) mean surface circulation computed using data from drifters, satellite altimetry, hydrographic profiles, and reanalysis winds, and assuming a surface horizontal momentum balance; highest plastic concentration is encompassed by the velocity contour, which is indicative of the subtropical convergence (reproduced from Law et al. 2010; reprinted with permission from AAAS).

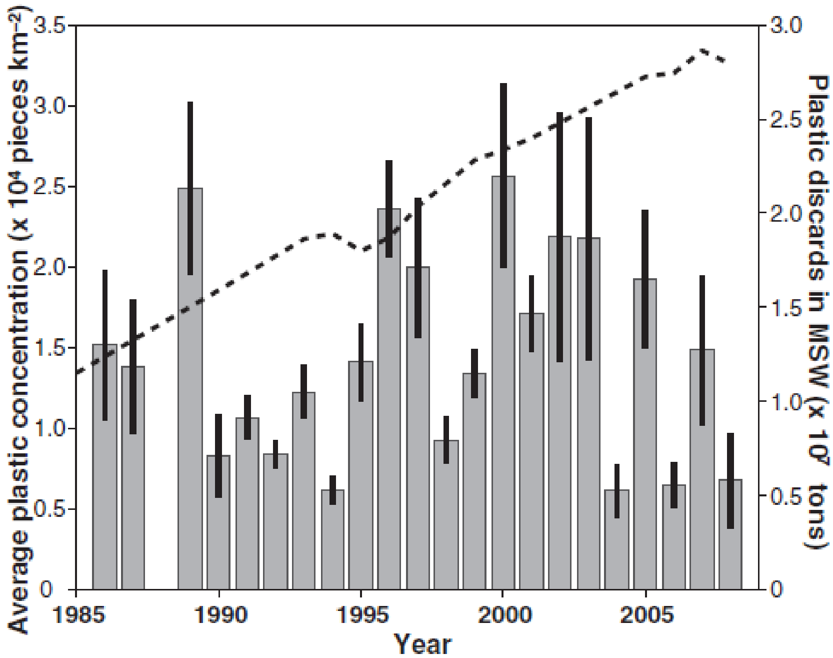


Figure 26. Annually averaged plastic concentration in region of highest accumulation (22° to 38°N, 54° to 79°W) during 1986 - 2008, with standard error bars; dashed line indicates concurrent time series of plastic discarded in U.S. municipal solid waste stream (reproduced from Law et al. 2010; reprinted with permission from AAAS).

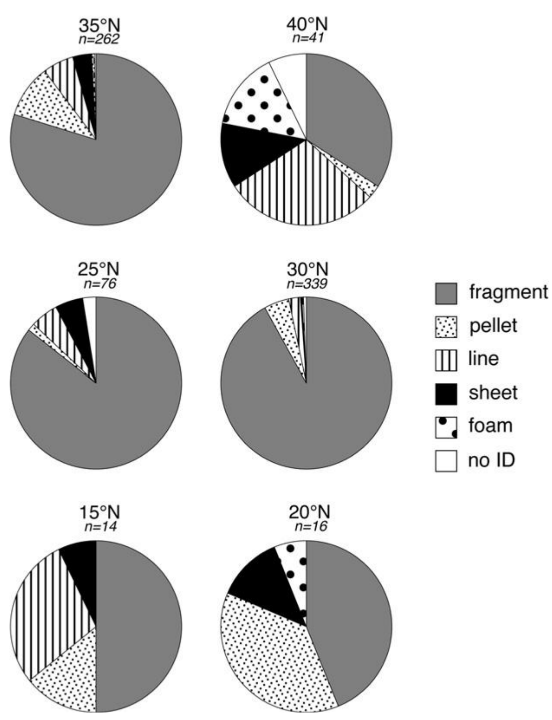


Figure 27. Proportion of six principal plastic forms at every fifth parallel; industrial resin pellets made up 38% of particles at 20°N, marine-related line composed 29% of particle forms at 15°N and 40°N, latitudes at which the fishing industry is more active (reproduced from Moret-Ferguson et al. 2010; reprinted with permission from Elsevier).

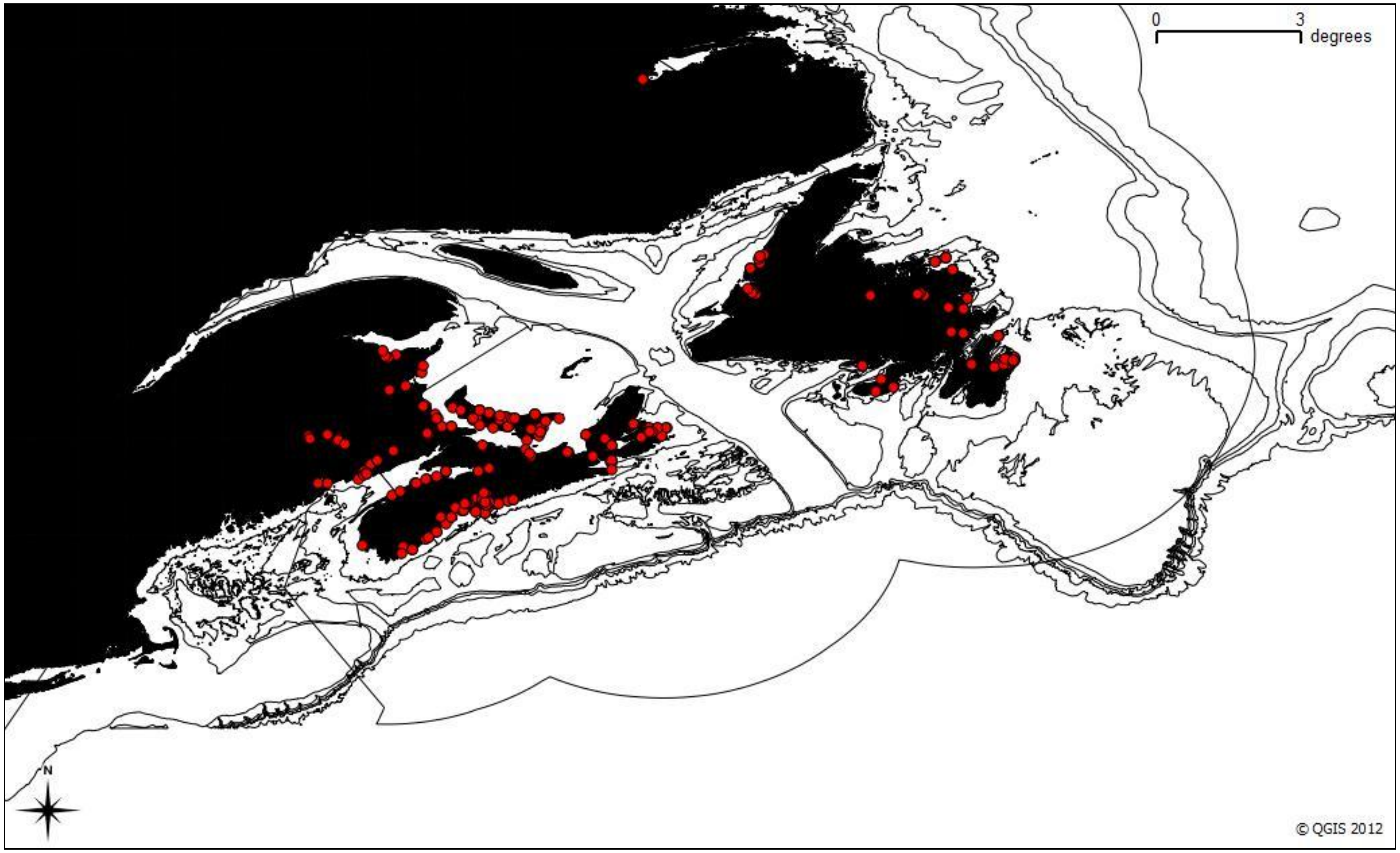


Figure 28. Reporting locations of marine debris in 2008 – 2011 Great Canadian Shoreline Cleanup (CSC) program dataset.

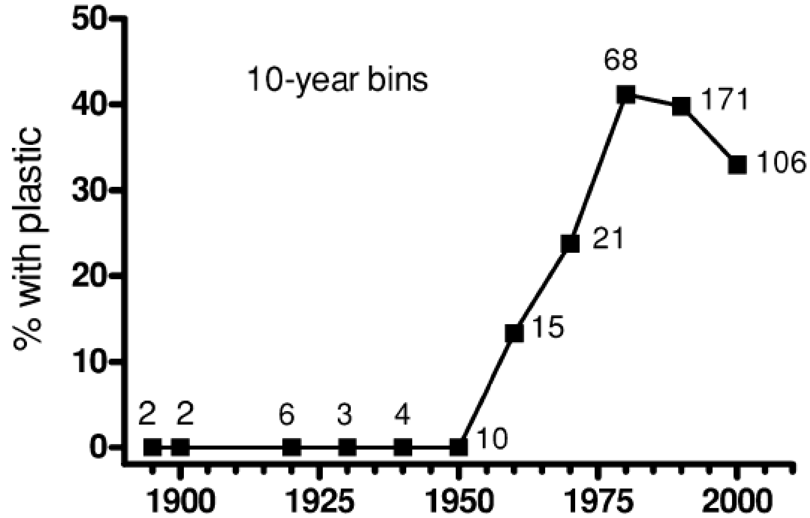


Figure 29. Percent of autopsies in which plastic was found in the GI tract; N values beside points are numbers of turtles examined; data plotted in 5-year bins, starting at the dates shown on the x-axis, except for the first point, which is for all cases prior to 1900 (reproduced from Mrosovsky et al. 2009; reprinted with permission from Elsevier).

APPENDIX A. DATA TABLES ASSOCIATED WITH FISHERY THREATS TO LEATHERBACK TURTLES IN ATLANTIC CANADA

Table A1. Database codes used to define fixed gear fisheries considered in this report; note that NAFO does not archive large pelagic species landings which is maintained by ICCAT.

Fishery		Snow Crab Trap	Lobster Trap	Whelk Pot	Herring Gillnet	Pelagic Longline	Halibut Longline	Turbot Gillnet	Groundfish Longline	Groundfish Gillnet
ZIFF	**Gear**	Pot (62)	Pot (62)	Pot (62)	Gillnet (41-43)	Longline (51)	Longline (51)	Gillnet (41)	Longline (51)	Gillnet (41-43)
	Main Species Caught	Snow Crab (705)	Lobster (700)	Whelk (615)	Herring (200)	Large Pelagics (251 - 254, 256)	Halibut (130)	Turbot (144)	Cod, Haddock, Pollock, White Hake (100,110,170,171)	Cod, Haddock, Pollock, White Hake (100,110,170,171)
	Species	Snow Crab (705)	Lobster (700)	Whelk (615)	Herring (200)	All Species selected by Main Species Caught	Halibut (130)	Turbot (144)	All Species selected by Main Species Caught	All Species selected by Main Species Caught
Maritimes Observer	**Gear**	Covered pots (62)	Covered pots (62)	Covered pots (62)	NA	Longline (50 – 52)	Set Lines (51)	Set Gillnet (41)	Set Lines (51)	Set Gillnet (41)
	Trip Type	Crab	Lobster (2550)	Whelk (4211)		Swordfish (72) Tuna, Swordfish (73)	Halibut (30)	Turbot (31)	Cod, Haddock, Pollock & White Hake (7001, 12)	Cod, Haddock, Pollock & White Hake (7001, 12)
	Common	Snow Crab (2526)	Lobster (2550)	Whelk (4211)		Large Pelagics (71-73; 190-192)	Halibut (30)	Turbot (31)	All groundfish species selected by trip type	All groundfish species selected by trip type
Gulf/ Quebec Observer	**Gear**	Pots (FPO)	Covered pots (62)	Pots (FPO)	NA	Hooks & Lines (LX)	Longline (LLS)	Gillnet (GNS)	Longline (LX)	Gillnet (GNS)
	Trip Type	Snow Crab (2526)	Lobster (2550)	Whelk (4210)		Large Pelagics (71-73; 190-192)	Halibut (30)	Turbot (31)	Cod (10)	Cod (10)
	Common	Snow Crab (2526)	Lobster (2550)	Whelk (4210)		Large Pelagics (71-73; 190-192)	Halibut (30)	Turbot (31)	All groundfish species selected by trip type	All groundfish species selected by trip type
Newfoundland Observer	**Gear**	Pots (64)	Pots (64)	Pots (64)	Gillnet (5)	Longline (7)	Longline (7)	Gillnet (5)	Longline (7)	Gillnet (5)
	Directed Species	Snow Crab (8213)	Lobster (8154)	Whelk (3515)	Herring (0150)	Large Pelagics (563-582)	Halibut (0893)	Turbot (0892)	Cod (438), Haddock (441), Pollock (443), White Hake (447)	Cod (438), Haddock (441), Pollock (443), White Hake (447)
	Species	Snow Crab (8213)	Lobster (8154)	Whelk (3515)	Herring (0150)	Large Pelagics (563-582)	Halibut (0893)	Turbot (0892)	All species selected by directed species	All species selected by directed species

Table A2. Landings (t) and number of trips of the summer – fall Snow Crab trap fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

	Landings, t					
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
2Ha			10			10
2Hd	118		61	19		198
2He	32	191	50	71	70	413
2Hf	3	2	3	2		9
2Hh				66	26	91
2Ja	37	4	45		73	158
2Jb	296	413	444	430	504	2,087
2Jc	1		13	0	0	15
2Jd	11			1	20	32
2Je	29	133	208	329	290	989
2Jf	74	91	3	16	2	186
2Jg					2	2
2Ji	198	567	460	610	280	2,115
2Jm	213	343	337	98	72	1,063
2Jn	321	725	497	751	166	2,461
3Ka	80	230	288	629	442	1,670
3Kb	62	853	908	4,169	1,981	7,973
3Kc		129	7	559	156	852
3Kd	111	434	453	439	321	1,757
3Ke	90	1,770	1,400	3,864	764	7,888
3Kf	55	207	146	570	337	1,315
3Kg	2	47	32	69	54	204
3Kh	259	1,195	998	629	452	3,532
3Ki	113	2,089	972	2,147	818	6,139
3La	277	1,102	479	453	646	2,957
3Lb	279	872	698	160	479	2,489
3Lc	936	1,284	1,378	1,042	1,870	6,511
3Ld	692	588	1,056	594	988	3,917
3Le	1	20	20	6	3	49
3Lf	532	581	770	362	500	2,746
3Lg	1,903	1,672	2,509	1,568	2,298	9,949
3Lh	2,024	1,895	2,401	1,283	1,457	9,060
3Li	775	712	1,665	1,292	2,038	6,482
3Lj	876	897	1,216	644	985	4,618
3Lq	933	577	889	1,023	1,454	4,875
3Lr	757	524	545	191	169	2,186
3Ls	1,078	1,396	1,890	714	908	5,987
3Lt	1,592	1,648	1,337	564	1,080	6,220
3MC			3			3
3MD			11			11
3Mm			9		1	10
3Na			5	6	5	16
3Nb	1,017	831	825	333	682	3,688
3Nc	3	16	1	21	29	71
3Nd	573	619	501	296	304	2,293
3Ne	162	0	51	53	146	412
3Nf		355	274	76	265	970
3Oa	510	348	628	294	633	2,413
3Ob	74	99	137	999	1,340	2,650
3Od	0				1	1
3Oe	49		6			55
3Pn	0		0			1
3Psa			2	0	4	7
3Psb		2	0	9	72	84
3Psc	71	151	225	135	442	1,024
3Psd		3	6	10	67	86
3Pse	6	24	24	11	85	151
3Psf	124	357	289	187	995	1,952
3Psg		1	4			5
3Psh	26	41	121	58	215	461
4Ra	19	2	16	5	6	48
4Rb	22	57	15	4	3	100
4Rc	16	94	44	23	21	198
4Rd	8	6	19	34	22	90
4Sv		3				3
4Tf	762	1,168	2,229	1,388	218	5,765
4Tg	2,169	3,146	3,074	2,619	1,254	12,261
4Th	1	11	9	32	0	54
4Ti				14		14
4Tj	78	378	631	341	77	1,505
4Tk	918	1,650	3,744	1,997	0	8,309
4Tl	85	131	238	266	9	728
4Tm	61	20	125	385		591
4Tn	219	556	1,079	972	10	2,836
4Vn	666	342	341	267	207	1,823
4Vsb	452	415	767	644	851	3,129
4Vsc	2,026	2,446	3,590	4,782	4,946	17,789
4Vse		7	1		0	8
4Vsu	27	22	61	49	80	239
4Vsv		16				16
4WD	344	463	1,504	1,660	794	4,765
4We	1,045	1,087	1,850	2,678	2,737	9,397
4Wf	257	312	142	191	148	1,051
4Wg	128	2	1	63	86	279
4Wh	9	3	5	6	2	25
4Wj	1					1
4Wk	20	54	41	41	6	162
4WM	1		14			15
4Wu	8		63	47	48	166
4Ww		13	10			23
5Yd					3	3
Total	26,718	38,442	46,924	46,359	38,523	196,965
				Concentration areas		38,188
					%	19.4%

	Trips					
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
2Ha			1			1
2Hd	12		7	6		25
2He	5	20	11	14	14	64
2Hf	1	2	1	1		5
2Hh				10	5	15
2Ja	7	1	5		12	25
2Jb	32	44	52	53	51	232
2Jc	1		2	1	1	5
2Jd	2			1	5	8
2Je	7	22	30	72	65	196
2Jf	10	11	2	8	3	34
2Jg					1	1
2Ji	25	63	46	166	167	467
2Jm	133	178	134	45	34	524
2Jn	65	99	73	88	33	358
3Ka	57	124	79	215	275	750
3Kb	12	98	96	439	345	990
3Kc		17	1	71	28	117
3Kd	78	325	238	246	407	1,294
3Ke	29	238	187	550	210	1,214
3Kf	11	29	20	88	71	219
3Kg	1	11	7	43	29	91
3Kh	610	1,024	703	781	850	3,968
3Ki	122	993	509	1,425	938	3,987
3La	260	678	363	358	726	2,385
3Lb	447	1,197	959	193	530	3,326
3Lc	233	306	314	295	329	1,477
3Ld	124	129	190	100	107	650
3Le	1	3	7	4	2	17
3Lf	669	585	672	393	451	2,770
3Lg	518	459	624	671	754	3,026
3Lh	296	292	340	176	179	1,283
3Li	93	87	192	138	205	715
3Lj	655	656	633	373	621	2,938
3Lq	301	155	236	260	338	1,290
3Lr	136	96	103	45	33	413
3Ls	217	253	314	139	183	1,106
3Lt	173	236	215	97	152	873
3MC			1			1
3MD			2			2
3Mm			2		1	3
3Na			1	1	1	3
3Nb	127	138	148	53	108	574
3Nc	1	1	1	4	7	14
3Nd	53	65	54	32	37	241
3Ne	10	1	5	4	11	31
3Nf		18	17	7	16	58
3Oa	78	51	81	49	95	354
3Ob	15	13	15	167	220	430
3Od	1				1	2
3Oe	8		1			9
3Pn	3		1			4
3Psa			1	1	9	11
3Psb		2	4	23	192	221
3Psc	195	293	297	115	305	1,205
3Psd		2	3	3	18	26
3Pse	5	20	17	9	41	92
3Psf	54	112	78	52	210	506
3Psg		1	3			4
3Psh	12	15	36	17	61	141
4Ra	23	2	14	4	7	50
4Rb	72	256	78	21	11	438
4Rc	44	263	192	92	92	683
4Rd	34	33	62	122	75	326
4Sv		3				3
4Tf	347	623	794	610	107	2,481
4Tg	1,558	2,483	2,092	1,794	558	8,485
4Th	1	6	5	9	2	23
4Ti				4		4
4Tj	17	73	119	61	13	283
4Tk	189	298	630	406	1	1,524
4Tl	46	54	84	133	3	320
4Tm	28	9	51	118		206
4Tn	89	182	364	351	4	990
4Vn	511	343	198	109	66	1,227
4Vsb	117	97	199	171	165	749
4Vsc	327	339	508	607	522	2,303
4Vse		1	1		1	3
4Vsu	4	8	10	8	12	42
4Vsv		4				4
4Wd	148	145	352	388	172	1,205
4We	215	176	293	407	321	1,412
4Wf	36	43	22	32	27	160
4Wg	11	2	1	10	11	35
4Wh	4	1	2	1	1	9
4Wj	1					1
4Wk	10	18	14	13	2	57
4Wm	2		4			6
4Wu	2		10	11	7	30
4Ww		4	3			7
5Yd					1	1
Total	9,741	14,629	14,237	13,584	11,673	63,864
				Concentration areas		16,773
					%	26.3%

Table A3. Landings (t) and number of trips of the summer – fall Lobster trap fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

	Landings, t					
Unit Area	2006	2007	2008	2009	2010	Total
3Kd	0	1			0	1
3Kh	40	53	15	35	23	166
3Ki	60	56	50	36	40	241
3La	50	53	56	48	54	261
3Lb	11	15	15	15	16	73
3Lf	6	4	5	5	6	26
3Lj	1	0	0	0	0	1
3Lq	1	0	0	0	0	2
3Pn	23	59	89	69	62	302
3Psa	30	34	43	45	40	192
3Psb	144	182	189	136	139	789
3Psc	38	26	28	37	31	161
4Ra	50	124	111	92	51	428
4Rb	41	84	76	60	40	301
4Rc	81	114	102	75	48	421
4Rd	47	78	84	85	44	338
4S			1			1
4Ss	69	77	70	95	101	412
4Sv	6	14	8	10	11	50
4Sw	6	10	11	12	12	50
4Sx	17	17	21	25	29	109
4Sy	1	1	2	2	3	8
4Sz	0					0
4Tf	1,111	1,268	1,047	1,009	1,212	5,646
4Tg	1,903	2,195	2,726	2,293	1,878	10,994
4Th	929	1,305	1,345	1,619	1,544	6,741
4Tj	472	616	581	557	368	2,594
4Tl	2,923	3,760	3,793	4,146	4,378	19,001
4Tm	203	250	205	237	219	1,114
4Tn	524	631	479	540	526	2,699
4To	17	10	9	14	10	60
4Tq		0				0
4Vn	985	1,071	1,803	1,253	1,410	6,522
4Vse				0		0
4Wd	773	982	1,420	1,194	988	5,358
4Wk	211	351	334	357	245	1,498
4Xl	1				2	3
4Xm	20	24	21	21	30	117
4Xn	75	77	110	41	87	389
4Xo	37	32	30	22	42	163
4Xp	66	56	70	43	88	324
4Xq	17	18	13	22	81	150
4Xr	759	768	933	956	1,182	4,598
4Xs	794	673	1,190	1,159	1,173	4,989
4Xu		0			1	1
5Yb	55	36	50	72	136	348
5Yf				0		0
5ZEj	11	24	2	6	19	62
5ZEm	37	36	30	24	45	172
5ZEu					0	0
NK				3		3
Total	12,644	15,187	17,167	16,470	16,413	77,881
				Concentration Area		28,969
					%	37.2%

	Trips					
Unit Area	2006	2007	2008	2009	2010	Total
3Kd	2	7			3	12
3Kh	686	920	315	562	472	2,955
3Ki	929	802	555	487	483	3,256
3La	413	451	369	372	410	2,015
3Lb	138	189	134	109	126	696
3Lf	60	53	33	36	43	225
3Lj	9	2	3	3	3	20
3Lq	7	3	3	2	2	17
3Pn	188	338	414	383	366	1,689
3Psa	156	173	336	306	273	1,244
3Psb	728	1,460	1,046	789	816	4,839
3Psc	284	266	225	193	153	1,121
4Ra	529	1,055	700	663	522	3,469
4Rb	1,357	1,881	1,673	1,346	1,099	7,356
4Rc	910	1,328	1,208	1,165	844	5,455
4Rd	844	1,083	871	1,192	898	4,888
4S			4			4
4Ss	64	66	54	51	55	290
4Sv	81	127	120	116	140	584
4Sw	60	152	138	239	153	742
4Sx	22	19	16	16	17	90
4Sy	11	5	17	11	22	66
4Sz	1					1
4Tf	2,621	2,785	2,498	2,359	2,518	12,781
4Tg	18,454	20,644	20,245	18,798	17,614	95,755
4Th	12,864	14,065	13,263	12,442	12,396	65,030
4Tj	3,600	4,179	3,779	3,713	2,322	17,593
4Tl	28,112	30,029	28,855	26,865	26,407	140,268
4Tm	2,110	2,303	1,709	2,639	1,421	10,182
4Tn	3,381	3,464	3,365	4,511	3,216	17,937
4To	47	39	40	41	32	199
4Tq		1				1
4Vn	10,965	10,962	14,886	12,963	13,276	63,052
4Vse				1		1
4Wd	3,749	3,489	4,238	3,818	3,983	19,277
4Wk	2,197	2,717	2,575	2,614	2,262	12,365
4Xl	3				3	6
4Xm	44	53	66	58	50	271
4Xn	20	19	32	13	14	98
4Xo	40	46	44	29	53	212
4Xp	26	30	33	19	22	130
4Xq	31	27	29	31	72	190
4Xr	1,973	2,056	2,250	2,375	2,380	11,034
4Xs	2,779	2,420	3,514	3,396	3,201	15,310
4Xu		1			2	3
5Yb	144	216	117	227	236	940
5Yf				2		2
5ZEj	6	7	3	4	7	27
5ZEm	10	11	15	7	11	54
5ZEu					1	1
NK				23		23
Total	100,655	109,943	109,790	104,989	98,399	523,776
				Concentration Area		192,523
					%	36.8%

Table A4. Landings (t) and number of trips of the summer – fall Whelk pot fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

	Landings, t					
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
2Ja	4					4
2Jd	16	11	15	21	20	84
2Jm	192	125	140	128	122	707
3Ka	5	9	2		20	36
3Kd	0	2	1			4
3La	9	0			0	9
3Lb				0	7	7
3Lc	0					0
3Lf	52	24	14	25	9	124
3Lh	0					0
3Lj	7					7
3Lq	77	66	57	102	89	391
3Psa			17	4	17	38
3Psb	284	292	122	53	2	753
3Psc	439	217	599	264	49	1,568
3Psd	29	77	191	175	16	487
3Pse	1,534	1,064	1,584	983	1,367	6,533
3Psf	454	442	659	655	783	2,992
3Psg	893	1,444	1,168	1,253	1,626	6,383
3Psh	13	66	1,342	1,107	1,361	3,890
4Ra	21	8	12	11	10	62
4Rb			0			0
4Sv			1	0		2
4Sw			23	10		32
4Sy			310	587		897
4Sz			50	35		86
4T			1			1
4Tf	3		346	23		372
4Tg	7				0	7
4Tl	1			0		1
4To			17	16		33
4Tp	0		60	150		210
4Tq			34	36		70
4Tu				2		2
4VN			0			0
4VSB			0			0
4Vsc				0		0
Total	4,041	3,848	6,766	5,638	5,499	25,792
				Concentration Area		11,472
					%	44.5%

	Trips					
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
2Ja	12					12
2Jd	49	24	31	39	51	194
2Jm	515	336	377	341	317	1,886
3Ka	12	19	3		30	64
3Kd	1	4	2			7
3La	15	1			1	17
3Lb				2	34	36
3Lc	1					1
3Lf	214	117	67	90	22	510
3Lh	1					1
3Lj	15					15
3Lq	44	11	28	23	27	133
3Psa			3	1	2	6
3Psb	58	49	17	8	1	133
3Psc	59	43	82	32	6	222
3Psd	4	11	23	18	3	59
3Pse	193	133	201	116	140	783
3Psf	85	70	69	69	77	370
3Psg	128	146	101	105	166	646
3Psh	3	15	127	91	115	351
4Ra	57	23	45	23	11	159
4Rb			1			1
4Sv			13	4		17
4Sw			105	49		154
4Sy			514	767		1,281
4Sz			145	112		257
4T			2			2
4Tf	3		188	18		209
4Tg	10				6	16
4Tl	1			2		3
4To			90	104		194
4Tp	1		117	155		273
4Tq			58	50		108
4Tu				11		11
4VN			1			1
4VSB			1			1
4Vsc				3		3
Total	1,481	1,002	2,411	2,233	1,009	8,136
				Concentration Area		1,601
					%	19.7%

Table A5. Landings (t) and number of trips of the Herring gillnet fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

		Landings, t				
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3La	7	13		21	0	41
3Lb	14	27	28	16	1	85
3Lj	0					0
3Mm					4	4
3O					1	1
3Pn	79	10	8	12	9	119
3Psc			0			0
4Ra	359	43		0	451	853
4Rb	68	22	1		69	160
4Rc					3	3
4Rd		0				0
4Su		27				27
4Sv	8	16	4	23	6	57
4Sw	22	1	41	92	77	233
4Sy			0			0
4Sz	6	25	4	1	0	36
4Tf	20	34	68	115	185	421
4Tg	9,140	7,966	6,913	8,580	9,177	41,775
4Th	9,124	8,720	5,339	8,421	7,994	39,597
4Tj	137	87	14	49	46	332
4Tl	8,709	7,279	7,929	8,753	9,507	42,177
4Tm	1,085	1,331	739	334	280	3,769
4Tn	20,615	18,241	18,029	16,077	15,520	88,482
4To	0	9	4		5	19
4Tq	5	7	9		5	27
4Tu	9			3,016	5	3,030
4Vn	83	6	11	3	1	103
4Vsc				9		9
4We		1				1
4WH			3			3
4Wk	3,278	3,351	2,050	5,144	2,073	15,897
4Wl		21	4	5	3	33
4WM			9			9
4Wu	58	267	236	870	338	1,769
4Xl				10	8	18
4Xm	61	275	20	67	58	481
4Xn		52	10	45	25	132
4Xo	2,585	995	955	3,475	2,766	10,777
4Xq	589	1,238	13	4	115	1,960
4Xr	67	95	7	101	98	368
4Xs			3	6	27	36
4Xu	583	209	118	207	255	1,373
4Xx					3	3
5Yb				1		1
Total	56,712	50,370	42,566	55,458	49,115	254,222
				Concentration Area		53,579
					%	21.1%

			Trips			
Unit Area	**2,006**	**2,007**	**2,008**	**2,009**	**2,010**	**Total**
3La	14	9		17	1	41
3Lb	61	47	10	20	10	148
3Lj	1					1
3Mm					1	1
3O					1	1
3Pn	121	37	7	16	2	183
3Psc			1			1
4Ra	241	25		1	244	511
4Rb	9	14	1		39	63
4Rc					4	4
4Rd		1				1
4Su		6				6
4Sv	12	44	14	28	10	108
4Sw	68	5	13	30	13	129
4Sy			1			1
4Sz	18	51	14	5	10	98
4Tf	9	2	15	17	61	104
4Tg	2,428	1,569	1,118	1,421	1,815	8,351
4Th	1,507	1,490	1,040	1,528	1,399	6,964
4Tj	38	15	8	35	33	129
4Tl	1,101	914	974	1,081	1,305	5,375
4Tm	206	256	123	79	76	740
4Tn	2,587	2,781	2,773	2,299	3,341	13,781
4To	1	20	12		13	46
4Tq	39	93	140		18	290
4Tu	1			611	2	614
4Vn	19	25	31	32	24	131
4Vsc				1		1
4We		1				1
4WH			1			1
4Wk	470	473	290	633	370	2,236
4Wl		1	1	1	2	5
4WM			1			1
4Wu	9	43	32	115	55	254
4Xl				2	1	3
4Xm	64	80	51	54	26	275
4Xn		7	2	5	6	20
4Xo	343	139	156	445	382	1,465
4Xq	59	176	5	4	28	272
4Xr	30	29	5	15	23	102
4Xs			1	4	4	9
4Xu	95	52	41	41	61	290
4Xx					1	1
5Yb				1		1
Total	9,551	8,405	6,881	8,541	9,381	42,759
				Concentration Area		10,332
					%	24.2%

Table A6. Landings (t) and number of trips of the large pelagic longline fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

		Landings, t				
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3Lr					0	0
3Mb		12				12
3Mm	0				0	1
3Nc	1					1
3ND			24			24
3Ne		1	14	3		18
3Nf	0		1			2
3Nn	2	0				2
3Nu		1				1
3Oc	55	47	46	11	2	162
3Od	28	44	32	16	4	124
3Oe	169	182	50	151	4	557
3Of	2	5				7
3Pse	0					0
3Psf					0	0
3Psg	0	9				9
4Vsc	45	176	220	215	97	753
4Vse	25	13	6	32	15	91
4Vsu	0	0	15	1		16
4Vsv	7	36	20	11	3	77
4Wf	2	0		1	2	6
4Wg	48	87	105	32	78	350
4Wh	69	24	0	0	21	115
4Wj	121	53	61	12	26	272
4Wk	74	84	4	80	185	426
4Wl	135	166	71	13	342	728
4Wm	117	101	91	64	27	401
4Wu	10	11	2	4	6	33
4Ww	136	153	61	15	10	375
4Xl	110	54	45	24	42	274
4Xm	3	2		6		12
4Xn	264	88	194	295	137	978
4Xo	0	1	6	1	1	10
4Xp	8	17	24	5	8	63
4Xr	1	2		2		5
4Xs				0		0
4Xu	11	0	3	0	14	29
4Xx	184	203	149	88	136	760
5Yc		5				5
5ZEj	25	23	30	32	23	132
5ZEm	150	68	216	187	364	985
5ZEo					2	2
5ZEu	17	2	2	4	1	26
6D		14	0	0		14
6E		2		0		2
ICCAT 3	0	4	1		2	8
Total	1,822	1,690	1,493	1,308	1,553	7,867
				Concentration Area		2,047
					%	26.0%

		Trips				
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3Lr					1	1
3Mb		1				1
3Mm	1				1	2
3Nc	1					1
3ND			1			1
3Ne		2	1	3		6
3Nf	1		2			3
3Nn	1	1				2
3Nu		1				1
3Oc	10	9	5	5	2	31
3Od	8	8	7	5	2	30
3Oe	14	13	8	15	4	54
3Of	2	1				3
3Pse	1					1
3Psf					1	1
3Psg	1	1				2
4Vsc	11	22	21	23	11	88
4Vse	13	11	5	10	4	43
4Vsu	1	1	1	3		6
4Vsv	3	9	8	5	1	26
4Wf	1	1		1	2	5
4Wg	17	19	18	13	16	83
4Wh	20	7	1	2	10	40
4Wj	30	26	25	7	12	100
4Wk	42	39	10	24	39	154
4Wl	49	41	26	13	41	170
4Wm	43	51	41	32	13	180
4Wu	7	6	4	9	7	33
4Ww	47	41	36	9	6	139
4Xl	41	33	20	23	37	154
4Xm	3	3		1		7
4Xn	62	32	49	46	42	231
4Xo	1	2	2	2	2	9
4Xp	14	19	21	15	14	83
4Xr	2	3		1		6
4Xs				1		1
4Xu	6	3	6	2	8	25
4Xx	55	57	44	26	33	215
5Yc		2				2
5ZEj	13	14	19	26	17	89
5ZEm	35	25	35	35	56	186
5ZEo					2	2
5ZEu	4	2	5	4	4	19
6D		5	1	1		7
6E		2		1		3
ICCAT 3	1	2	2		2	7
Total	561	515	424	363	390	2,253
				Concentration Area		578
					%	25.7%

Table A7. Landings (t) and number of trips of the summer – fall Halibut longline fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

		Landings, t				
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3Kd	2					2
3Mm		0				0
3Na				6		6
3NB			0			0
3Nc	27	54	2	2	45	130
3Nd	1	11	11	6	8	35
3Ne		44	10	7	19	80
3Nf		22	8	8	8	46
3Oa				11		11
3Oc	6	2	40	3	1	50
3Od	1	3	1	0	7	10
3Oe	3	2	0	1	5	12
3Pn	4	8	9	13	21	55
3Psa	2	9	8	7	10	36
3Psb	0	1	2	1	1	4
3Psd	0		0	0		1
3Pse	0				0	0
3Psg	1			1	6	8
3Psh	73	38	37	61	39	247
4Ra	5	9	32	47	28	122
4Rb	35	49	45	105	75	309
4Rc	21	11	31	36	28	128
4Rd	34	12	18	17	23	104
4Ru	5	15	8		4	32
4Si	3	1	0	5	6	16
4Ss	8	31	12	6		57
4Sv	15	24	12	37	21	109
4Sw		0	0	0	5	5
4Sx	22	53	61	48	45	229
4Sy	3	8	7		0	18
4Sz	2	1	3	2	0	9
4Tf	20	31	55	62	54	222
4Tg	5	5	4	7	12	33
4Th		0		0		0
4Tj	2	1	2	9	14	29
4Tk	10	1	5	10	6	32
4Tl	1	1	2	2	10	16
4Tm	0		1	1		1
4Tn	59	56	50	53	91	309
4To		1	0			2
4Tp	0	1	0		1	2
4Tq		1	0			1
4Tu		1	7	1	3	11
4Vn	12	17	22	18	19	87
4Vsb	1	0	2	5	0	8
4Vsc	53	53	47	37	64	254
4Vse		1	3	0		3
4Vsu	1	1	1	1	1	4
4Vsv		0				0
4Wd	7	3	4	1	3	17
4We	4	2	17	4	2	29
4Wf	2	1	2	1	0	6
4Wg	14	21	20	23	35	115
4Wh	0	4	5	4	5	19
4Wj	22	30	28	22	31	133
4Wk	16	16	26	24	20	103
4Wl	11	16	14	26	18	84
4Wm	1	0		0	0	2
4Wu	1	3	1	1	2	8
4Xl	1	3			1	4
4Xm	4	3	4	6	8	25
4Xn	16	37	27	19	40	138
4Xo	68	63	80	104	88	402
4Xp	49	15	7	20	18	108
4Xq	61	39	50	66	55	270
4Xr	14	14	10	11	11	60
4Xs	8	10	6	9	6	39
4Xu	20	18	24	24	18	104
4Xx	0		0	1		1
5Yb	0	1	1	5	2	10
5ZEj		10	4			13
5ZEm		1	13	0	0	14
5ZEu		1				1
Total	753	889	904	1,006	1,041	4,592
				Concentration Area		842
					%	18.3%

		Trips				
Unit Area	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
3Kd	1					1
3Mm		1				1
3Na				1		1
3NB			1			1
3Nc	3	7	3	2	7	22
3Nd	1	3	2	2	3	11
3Ne		4	3	3	3	13
3Nf		3	2	4	3	12
3Oa				1		1
3Oc	2	2	3	3	2	12
3Od	1	2	2	1	2	8
3Oe	2	3	1	2	2	10
3Pn	32	57	50	49	90	278
3Psa	25	91	50	65	49	280
3Psb	8	18	21	6	8	61
3Psd	1		1	1		3
3Pse	1				2	3
3Psg	2			3	3	8
3Psh	7	5	4	9	9	34
4Ra	37	78	185	204	107	611
4Rb	111	120	105	172	106	614
4Rc	95	53	125	89	55	417
4Rd	62	78	57	77	65	339
4Ru	1	2	2		1	6
4Si	9	3	3	5	7	27
4Ss	5	6	4	4		19
4Sv	9	8	4	9	12	42
4Sw		2	1	3	83	89
4Sx	14	13	26	20	22	95
4Sy	4	1	3		1	9
4Sz	13	7	9	5	1	35
4Tf	52	87	82	92	192	505
4Tg	38	29	31	26	55	179
4Th		1		1		2
4Tj	12	15	10	18	60	115
4Tk	5	3	4	11	6	29
4Tl	4	3	9	10	22	48
4Tm	2		4	5		11
4Tn	61	54	77	83	78	353
4To		5	3			8
4Tp	3	4	2		2	11
4Tq		2	2			4
4Tu		1	3	1	2	7
4Vn	35	23	25	28	25	136
4Vsb	2	1	4	10	1	18
4Vsc	29	34	24	26	52	165
4Vse		1	1	1		3
4Vsu	1	1	2	4	4	12
4Vsv		1				1
4Wd	21	16	19	9	18	83
4We	7	8	17	9	10	51
4Wf	3	1	4	4	2	14
4Wg	18	24	29	23	37	131
4Wh	4	13	15	12	14	58
4Wj	22	30	28	30	34	144
4Wk	63	66	79	101	92	401
4Wl	16	25	28	41	32	142
4Wm	3	1		2	2	8
4Wu	6	4	2	4	7	23
4Xl	2	3			3	8
4Xm	24	19	20	29	36	128
4Xn	22	48	43	29	45	187
4Xo	225	269	228	222	163	1,107
4Xp	30	38	23	28	22	141
4Xq	222	218	209	148	144	941
4Xr	156	177	126	116	82	657
4Xs	99	116	72	75	35	397
4Xu	119	183	191	63	56	612
4Xx	1		1	1		3
5Yb	5	12	12	21	16	66
5ZEj		2	3			5
5ZEm		1	4	1	1	7
5ZEu		1				1
Total	1,758	2,107	2,103	2,024	1,993	9,985
				Concentration Area		2,224
					%	22.3%

Table A8. Landings (t) and number of trips of the summer – fall Turbot gillnet fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

Unit Area	2006	2007	2008	2009	2010	Total
0B	1,590	1,373	1,012	1,102	1,438	6,516
2Ga				27		27
2Gg		3		27	31	61
2Ha				14	3	17
2Hb	48					48
2Hd	24	8	13	17	1	64
2He	289	125	145	66	20	645
2Hf	5			1		6
2Hh	0					0
2Ja	6			8		14
2Jb			6			6
2Jc		63			20	83
2Jd				2		2
2Je			5		31	35
2Jf	89	224	101	97	335	847
2Jg	2				9	10
2Ji	12				19	31
2Jl	109	307	98	228	295	1,037
2Jm			27	21	19	67
2Jn		38	26	41	49	155
3Kc	234	140	91	115	374	954
3Kd					1	1
3Kg	829	1,188	1,251	1,645	913	5,826
3Kh	0					0
3La	183	53	10	0		246
3Lb	174	73	32	0		279
3Lc	768	382	74		2	1,227
3Ld	241	464	474	889	948	3,015
3Le	36	5		36	39	117
3Lf	2	3	7			12
3Lg	15	13	37	38	108	211
3Lh			4		2	6
3Lj	3					3
3Lr				4		4
3Oc		88				88
3Oe	23				0	23
3Psa		0		3		3
3Psb	2	33	10	54	70	169
3Psc	0		2			2
3Psd					0	0
3Psf			1			1
3Psg			11	9	4	24
3Psh	51		37	57	42	186
4Ra	98	64	27	52	41	281
4Rb	634	762	536	1,157	1,088	4,176
4Rc		57	131	60	20	267
4Rd					3	3
4Si	849	596	415	426	314	2,601
4Ss	2	284	184	132	131	732
4Su		0				0
4Sv	58	151	263	149	279	901
4Sw		3	3			6
4Sx	219	125	100	475	563	1,482
4Sy	6	0	46	33	8	95
4Sz	397	366	224	239	243	1,468
4Tk	26		36	21	14	96
4Tl					1	1
4Tn	89	19	84	16	36	244
4To	427	348	549	503	492	2,320
4Tp	103	18	90	31	50	291
4Tq	224	192	175	202	118	911
Total	7,866	7,567	6,336	7,998	8,174	37,942
			Concentration Area			3
					%	0.0%

Unit Area	2006	2007	2008	2009	2010	Total
0B	28	27	18	14	21	108
2Ga				5		5
2Gg		1		3	7	11
2Ha				2	1	3
2Hb	3					3
2Hd	3	3	2	3	1	12
2He	25	17	9	9	3	63
2Hf	1			1		2
2Hh	1					1
2Ja	1			4		5
2Jb			1			1
2Jc		1			2	3
2Jd				1		1
2Je			2		2	4
2Jf	10	9	6	2	24	51
2Jg	1				2	3
2Ji	1				1	2
2Jl	15	17	9	12	22	75
2Jm			2	7	8	17
2Jn		2	3	4	8	17
3Kc	18	13	7	11	27	76
3Kd					1	1
3Kg	99	79	63	69	114	424
3Kh	1					1
3La	48	20	5	2		75
3Lb	31	22	7	1		61
3Lc	98	58	6		2	164
3Ld	25	32	27	57	68	209
3Le	6	1		3	4	14
3Lf	1	2	2			5
3Lg	2	8	4	5	7	26
3Lh			1		1	2
3Lj	1					1
3Lr				2		2
3Oc		10				10
3Oe	5				1	6
3Psa		1		2		3
3Psb	22	109	29	102	133	395
3Psc	1		1			2
3Psd					1	1
3Psf			1			1
3Psg			5	6	3	14
3Psh	10		7	9	7	33
4Ra	61	47	30	21	26	185
4Rb	240	345	298	255	256	1,394
4Rc		11	32	17	8	68
4Rd					2	2
4Si	291	181	168	168	136	944
4Ss	2	67	39	33	40	181
4Su		1				1
4Sv	11	72	134	46	51	314
4Sw		1	2			3
4Sx	27	23	13	40	80	183
4Sy	6	1	21	7	6	41
4Sz	317	275	195	171	201	1,159
4Tk	18		9	9	6	42
4Tl					1	1
4Tn	70	8	57	9	22	166
4To	500	270	302	374	314	1,760
4Tp	144	17	90	41	54	346
4Tq	326	155	118	201	136	936
Total	2,470	1,906	1,725	1,728	1,810	9,639
			Concentration Area			3
					%	0.0%

Table A9. Landings (t) and number of trips of the summer – fall Groundfish longline fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

	Landings, t					
Unit Area	2006	2007	2008	2009	2010	Total
2Jm		2	2	3	1	8
3Ka	0	2	1	0	0	4
3Kd	2	2	2	2	0	8
3Kh	12	4	4	6	3	30
3Ki	2	7	11	12	9	41
3La	13	3	6	9	7	39
3Lb	6	2	8	6	8	30
3Lf	3	3	6	11	7	31
3Lj	30	3	4	7	3	47
3Lq	2	2	2			5
3Nc	8	6		0		15
3Ne				0	2	2
3Oa	30	48	37			115
3Oc	9	24	11		1	45
3Od	4	88	174	22	1	289
3Oe	99	224	381	249	88	1,042
3Pn	773	812	1,011	919	596	4,111
3Psa	888	707	548	314	274	2,731
3Psb	429	329	452	248	123	1,581
3Psc	92	74	129	61	48	404
3Psd	30	43	246	70	7	398
3Pse		10	10	9	2	31
3Psf	14	51	45	18	18	145
3Psg	12	51	31	1	30	125
3Psh	83	210	197	21	115	626
3Psu	20	24	51			94
4Ra	25	82	46	63	69	286
4Rb	227	334	435	261	241	1,497
4Rc	240	556	500	296	181	1,772
4Rd	725	636	584	337	159	2,441
4Ss	6		13	19	16	54
4Sv	24	23	77	120	209	453
4Sw	3	1	8	3	1	16
4Sx	6	6	20	10	3	45
4Sy			2		3	5
4Sz			0	0		0
4Tf	341	211	174	45	24	795
4Tg	28	17	6	4	3	57
4Th	0					0
4Tj	18	10	4	5	6	43
4Tk	10	1	28	2	5	46
4Tl	14	2	1	0		18
4Tm	1					1
4Tn	34	29	53	6	7	128
4To	0	0	0		0	0
4Tu	4	9	6	5		23
4Vn	293	52	7	35	25	413
4Vsb	1	1	0	5		6
4Vsc		6	3	2	5	16
4Vsu		0	0	0	0	0
4Vsv					0	0
4Wd	1	0	1	1	0	3
4We		0		0		0
4WG			5			5
4Wh		0	5		0	6
4Wj	4		0		0	4
4Wk	48	34	35	10	19	147
4Wl	4	5	6	6	18	39
4Wm	1				0	1
4Wu	0	2	6	1	0	9
4Xl	4		6	5	1	17
4Xm	165	86	129	104	58	543
4Xn	503	675	841	401	417	2,836
4Xo	848	860	904	800	675	4,088
4Xp	972	994	927	1,050	1,098	5,041
4Xq	264	312	358	254	258	1,446
4Xr	95	75	53	57	42	323
4Xs	16	7	1	14	5	45
4Xu	342	194	339	189	208	1,271
5Yb		12				12
5Yc	3			0		4
5Yd	3					3
5Yf	2			5	2	9
5ZEj	2,458	2,449	2,828	2,442	2,298	12,475
5ZEm	25	87	64	248	367	790
5ZEu	127	98	116	104	199	644
6D				2		2
Total	10,446	10,595	11,964	8,900	7,967	49,872
			Concentration Area			7,285
					%	14.6%

	Trips					
Unit Area	2006	2007	2008	2009	2010	Total
2Jm		8	16	14	7	45
3Ka	3	18	15	6	4	46
3Kd	15	15	8	13	4	55
3Kh	73	34	27	53	29	216
3Ki	9	32	32	45	32	150
3La	58	17	20	32	20	147
3Lb	19	8	38	22	22	109
3Lf	20	14	45	56	37	172
3Lj	250	17	32	42	22	363
3Lq	5	10	3			18
3Nc	1	2		1		4
3Ne				1	1	2
3Oa	2	4	6			12
3Oc	2	3	1		1	7
3Od	2	5	5	1	1	14
3Oe	3	8	8	4	3	26
3Pn	766	1,166	1,359	1,530	951	5,772
3Psa	1,472	1,401	1,156	977	905	5,911
3Psb	903	630	1,016	738	411	3,698
3Psc	213	176	224	155	124	892
3Psd	7	11	38	14	2	72
3Pse		3	5	5	1	14
3Psf	1	8	8	3	6	26
3Psg	4	6	7	2	7	26
3Psh	5	13	16	3	7	44
3Psu	2	3	11			16
4Ra	31	131	126	169	143	600
4Rb	464	507	560	499	386	2,416
4Rc	343	733	767	964	526	3,333
4Rd	345	382	549	460	277	2,013
4Ss	1		6	4	6	17
4Sv	20	20	18	16	27	101
4Sw	21	9	46	16	14	106
4Sx	3	1	8	6	3	21
4Sy			1		1	2
4Sz			1	1		2
4Tf	246	188	148	71	57	710
4Tg	82	71	46	40	37	276
4Th	1					1
4Tj	30	29	12	16	33	120
4Tk	2	1	9	2	2	16
4Tl	14	11	3	2		30
4Tm	5					5
4Tn	53	47	58	30	29	217
4To	1	1	1		1	4
4Tu	4	7	4	3		18
4Vn	172	51	25	60	33	341
4Vsb	1	2	1	4		8
4Vsc		2	4	2	4	12
4Vsu		1	1	4	1	7
4Vsv					1	1
4Wd	20	7	14	10	4	55
4We		1		1		2
4WG			2			2
4Wh		1	3		3	7
4Wj	2		1		1	4
4Wk	60	39	52	27	32	210
4Wl	3	5	7	6	17	38
4Wm	2				1	3
4Wu	1	3	4	7	1	16
4Xl	2		2	2	1	7
4Xm	155	91	103	96	63	508
4Xn	183	255	260	130	131	959
4Xo	406	431	399	279	223	1,738
4Xp	235	223	222	191	202	1,073
4Xq	67	85	91	60	55	358
4Xr	92	85	31	86	37	331
4Xs	15	12	3	12	11	53
4Xu	216	152	188	69	78	703
5Yb		4				4
5Yc	1			1		2
5Yd	1					1
5Yf	1			1	2	4
5ZEj	283	298	226	208	171	1,186
5ZEm	3	16	7	24	30	80
5ZEu	22	17	10	12	18	79
6D				1		1
Total	7,444	7,531	8,115	7,309	5,259	35,658
			Concentration Area			4,649
					%	13.0%

Table A10. Landings (t) and number of trips of the summer – fall Groundfish gillnet fishery, by unit area and year, as reported in ZIFF; shaded rows indicate landings and trips reported from DFO unit areas of Leatherback areas of concentration.

			Landings, t			
Unit Area	2006	2007	2008	2009	2010	Total
2Ja	1		0			1
2Jd				1	3	4
2Ji			0			0
2Jm	26	14	36	20	22	118
3Ka	26	20	32	7	16	100
3Kb	1	4	3	2		11
3Kc	0					0
3Kd	53	53	115	47	57	325
3Kg		8		0	2	10
3Kh	198	217	341	158	224	1,138
3Ki	515	437	600	504	447	2,503
3La	241	267	389	443	442	1,782
3Lb	319	323	420	432	388	1,882
3Lc		11		9		20
3Ld			6	5	9	20
3Le		1				1
3Lf	178	183	260	320	255	1,197
3Lg	0	0	1		0	2
3Lh	0					0
3Lj	141	133	157	115	114	659
3Lq	9	15	11	3	6	45
3Ls			2			2
3Oa	110	139	28	1	24	302
3Ob			2			2
3Oc	412	130	54	61	96	754
3Od	3	4	24		4	36
3Oe	6		42	1		50
3Pn	1	3	1	4	2	11
3Psa	445	559	446	281	193	1,924
3Psb	840	753	616	377	383	2,969
3Psc	2,689	3,126	2,913	1,496	1,906	12,131
3Psd	530	282	210	70	1	1,092
3Pse	267	354	403	174	79	1,277
3Psf	687	859	339	468	567	2,920
3Psg	197	315	45	48	68	673
3Psh	1,312	1,778	916	459	499	4,964
3Psu	19	6				24
4R			0			0
4Ra	1,141	1,448	1,558	790	891	5,828
4Rb	418	582	516	540	328	2,385
4Rc	136	149	145	98	72	601
4Rd	81	87	87	24	11	291
4Ru	192	368				561
4S			0			0
4Si					1	1
4Su	2	9				11
4Sv	272	123	121	71	83	671
4Sw	417	646	594	341	333	2,331
4Sy	22	5	14	7	11	58
4Sz	2	5	1	1	4	13
4T			0			0
4Tg	0					0
4Th	0					0
4Tk	2					2
4Tl	29	14	17			59
4Tm	1	3	0			4
4Tn	244	75	123	3	3	448
4To	1	0	0			1
4Tu	4	10				14
4Vsu		2				2
4Wf		11				11
4Wh	2				1	3
4Wj		1			0	1
4Wk	79	104	112	71	29	395
4Wl	74	49	53	66	30	272
4Wm					1	1
4Wu		11	7	19	2	40
4Xm	78	122	113	130	42	486
4Xn	55	120	148	159	112	594
4Xo	121	174	194	198	181	869
4Xp	23	47	87	73	29	259
4Xq	696	766	496	540	854	3,353
4Xr	58	41	23	23	23	169
4Xs	72	30	4	36	27	169
4Xu	56	54	62	260	133	565
4Xx					2	2
5Yb	139	59	78	62	9	348
5Yc	6		20		4	30
5Yd					5	5
5Yf					4	4
5ZEj	102	179	263	372	409	1,325
5ZEm				3	2	6
5ZEu				16	6	22
Total	13,752	15,290	13,254	9,413	9,452	61,160
			Concentration Area			17,701
					%	28.9%

			Trips			
Unit Area	2006	2007	2008	2009	2010	Total
2Ja	9		1			10
2Jd				1	2	3
2Ji			1			1
2Jm	122	49	116	76	134	497
3Ka	161	101	122	62	140	586
3Kb	8	24	13	21		66
3Kc	1					1
3Kd	334	313	494	375	434	1,950
3Kg		3		1	4	8
3Kh	1,373	1,416	1,745	1,214	1,476	7,224
3Ki	1,986	1,337	1,477	1,624	1,646	8,070
3La	1,064	904	1,062	971	1,055	5,056
3Lb	1,229	926	1,106	977	899	5,137
3Lc		2		4		6
3Ld			2	2	4	8
3Le		4				4
3Lf	930	859	902	977	991	4,659
3Lg	1	1	7		2	11
3Lh	1					1
3Lj	815	771	810	633	668	3,697
3Lq	38	67	35	29	25	194
3Ls			1			1
3Oa	22	30	12	2	6	72
3Ob			1			1
3Oc	119	59	21	23	26	248
3Od	2	1	6		3	12
3Oe	3		25	3		31
3Pn	4	13	7	28	9	61
3Psa	1,550	1,537	1,500	1,065	882	6,534
3Psb	2,314	2,058	1,794	1,374	1,207	8,747
3Psc	5,929	5,915	5,669	3,985	3,923	25,421
3Psd	138	105	62	21	2	328
3Pse	84	119	167	73	28	471
3Psf	176	282	120	135	121	834
3Psg	73	87	20	24	24	228
3Psh	337	450	241	156	137	1,321
3Psu	3	1				4
4R			2			2
4Ra	1,851	2,647	3,842	2,593	2,392	13,325
4Rb	1,047	1,849	1,813	2,291	1,495	8,495
4Rc	402	469	623	604	492	2,590
4Rd	188	269	321	168	96	1,042
4Ru	362	801				1,163
4S			1			1
4Si					1	1
4Su	2	14				16
4Sv	489	362	288	210	265	1,614
4Sw	765	1,157	1,715	1,106	1,005	5,748
4Sy	38	7	17	18	24	104
4Sz	12	23	10	11	21	77
4T			1			1
4Tg	2					2
4Th	1					1
4Tk	4					4
4Tl	45	22	24			91
4Tm	5	7	3			15
4Tn	511	224	200	2	2	939
4To	3	1	3			7
4Tu	12	35				47
4Vsu		1				1
4Wf		1				1
4Wh	3				1	4
4Wj		1			1	2
4Wk	53	54	36	40	25	208
4Wl	11	22	15	23	11	82
4Wm					1	1
4Wu		5	2	4	1	12
4Xm	130	165	175	154	55	679
4Xn	33	77	80	96	87	373
4Xo	77	135	118	95	86	511
4Xp	7	11	8	14	10	50
4Xq	217	206	102	105	219	849
4Xr	38	11	7	6	10	72
4Xs	55	15	4	8	8	90
4Xu	57	41	31	61	48	238
4Xx					1	1
5Yb	54	20	11	7	8	100
5Yc	2		3		1	6
5Yd					1	1
5Yf					1	1
5ZEj	10	14	34	26	31	115
5ZEm				1	1	2
5ZEu				2	1	3
Total	25,312	26,100	27,028	21,501	20,249	120,190
			Concentration Area			27,922
					%	23.2%

APPENDIX B. ACRONYMS USED IN REPORT

Abbreviation	Name
AAAS	American Association for the Advancement of Science
CCL	Curved Carapace Length
CNLOPB	Canada-Newfoundland Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSC	Great Canadian Shoreline Cleanup (CSC) program
CSTN	Canadian Sea Turtle Network
DFO	Fisheries and Oceans Canada
EEZ	Canadian Exclusive Economic Zone
FSRS	Fishermen and Scientists Research Society
ICCAT	International Commission for the Conservation of Atlantic Tunas
MARFIS	DFO Maritimes Fisheries database
NAFO	Northwest Atlantic Fisheries Organization
NMFS	US National Marine Fisheries Service
NOAA	US National Oceanic and Atmospheric Administration
PCM	Post Capture Mortality
SARA	Canadian *Species at Risk Act*
SEA	Sea Education Association
VTS	Vessel Traffic Service
ZIFF	Zonal Interchange Fisheries File