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Status Report on Coral and Sponge Conservation in Canada

2009

Canada

Photo Credit: Fisheries and Oceans Canada
(L-R) *Mycale spp., Paragorgia arborea, Primnoa resedaeformis*

2009

STATUS REPORT ON CORAL AND SPONGE CONSERVATION IN CANADA

by

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ABSTRACT

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Corals (Class Anthozoa) exist primarily as colonial marine polyps that secrete a calcareous skeleton. Sponges (Phylum Porifera) are simple marine, sessile animals having a porous structure and a tough, often siliceous or calcareous, skeleton. In Canada, cold-water corals (also known as deep water corals) and sponges are found in the Pacific Ocean, Atlantic Ocean and the eastern Arctic Ocean. Corals and sponges are vulnerable to a number of activities, most notably fishing. As a result, international attention has been focused on their conservation and protection. In Canada, Fisheries and Oceans Canada (DFO) is the lead federal department responsible for research and conservation of these species. Although there is no national strategy for coral and sponge conservation, three DFO regions have, or are in the process of, developing conservation strategies or plans. Conservation measures, mostly in the form of closed fishing areas, have been established by DFO and the fishing industry to address site-specific conservation concerns. DFO is in the process of implementing a new Sustainable Fisheries Framework which includes an approach to address fishing impacts on benthic ecosystems, starting with corals and sponges.

RÉSUMÉ

Campbell, J.S. and Simms, J.M. 2009. Status Report on Coral and Sponge Conservation in Canada. Fisheries and Oceans Canada: vii + 87 p.

Les coraux (de la classe des Anthozoaires) existent principalement sous la forme de polypes marins coloniaux qui secrètent un squelette calcaire. Les éponges (de l'embranchement des Porifères) sont de simples animaux marins sessiles qui ont une structure poreuse et un squelette robuste, constitué souvent de silice ou de calcaire. Au Canada, on trouve des coraux d'eau froide (aussi appelés coraux d'eau profonde) et des éponges dans les océans Pacifique et Atlantique ainsi que dans l'est de l'océan Arctique. Les coraux et les éponges sont vulnérables à diverses activités, notamment la pêche. D'où l'intérêt que suscite dans le monde entier leur conservation et leur protection. Au Canada, Pêches et Océans Canada (le MPO) est le principal ministère fédéral responsable de l'étude et de la conservation de ces espèces. Bien qu'il n'y ait pas de stratégie nationale de conservation des coraux et des éponges, trois Régions du MPO ont élaboré ou sont sur le point d'élaborer des stratégies ou plans de conservation dans ce domaine. Le MPO et l'industrie ont pris des mesures de conservation, essentiellement des fermetures de zones à la pêche, pour faire face à des problèmes de conservation propres à certains endroits. Le MPO est en voie de mettre en œuvre un nouveau Cadre pour des pêches durables qui prend en compte les incidences de la pêche sur les écosystèmes benthiques, à commencer par les coraux et les éponges.

1.0 INTRODUCTION

In 2007, the Government of Canada announced funding for a series of initiatives related to improving the health of Canada's oceans. Among these initiatives was the establishment of four Centres of Expertise (CoE). The CoE in Cold-Water Corals and Sponge Reefs, established in 2008, is located at Fisheries and Oceans Canada's (DFO) Northwest Atlantic Fisheries Centre in St. John's, Newfoundland and Labrador. The objective of the centre is to help coordinate the Government of Canada's approach to coral and sponge conservation. In addition, the centre will:

- provide strategic advice to senior management;
- support regional, national, and international efforts for coral and sponge conservation;
- develop tools and approaches to improve coral and sponge conservation in Canada.

This publication, which is a key deliverable of the CoE, is intended to provide a broad, concise overview of Canada's science, policy, and legislation pertaining to coral and sponge conservation. The report is not intended to be a detailed science review but rather a reference document for this conservation issue. The species information presented in this report is not a final assessment of corals and sponges in Canada, however a number of detailed regional and national assessments of coral and sponge species have been published (Gilkinson and Edinger 2009; Cogswell et al. 2009). This report, in conjunction with other activities of the centre, will provide a reference for future activities, such as national workshops.

The report consists of twelve sections, including this introduction. The main body of the report contains six sections, the first of which provides an overview of the biology, distribution and ecosystem function of corals and sponges in Canada; and the second section summarizes the various hazards to these species. The next section outlines international initiatives related to the conservation of corals and sponges. The following two sections provide a context for legislative and policy frameworks in Canada. The final section describes science, research, and conservation initiatives based on the six DFO administrative regions. The remaining sections contain conclusions, acknowledgements, references, tables, figures, and appendices, which list the various species known in Canada as well as current and proposed Canadian scientific research activities.

2.0 OVERVIEW OF CORALS AND SPONGES IN CANADA

2.1 BIOLOGY

Corals

The term “coral” is generally used to describe a group of organisms having marine polyps that produce calcium carbonate secretions that form hard parts or skeletons. Cold-water corals are distinguished from warm-water corals as they lack symbiotic algae and therefore do not require sunlight to grow. The biology and ecosystem function of cold-water corals (also referred to as deep-water corals) in the marine waters of Canada have not, to this point, been greatly studied. Cold-water corals include both reef-building and non-reef-building types. Only a few stony coral species (Order Scleractinia) form deep-water structures or reefs (approximately 6 – 14 species), while other species can occur as individual small colonies. These coral taxa, such as gorgonians (i.e. sea fans and sea whips), pennatulaceans (i.e. sea pens), and black corals often have complex branching morphologies and may form dense groves or thickets. The taxonomy of the known Canadian cold-water coral groups (Hourigan et al. 2007) is shown in Table 1.

Biological information has been collected in the northeast Atlantic from coral reefs of Lophelia pertusa, a deep-water structure-forming stony coral. This species has been discovered off Canada’s Atlantic and Pacific coasts. In Norwegian fiords, Lophelia pertusa has been found in waters as shallow as 39 m while other coral groups have been observed at depths below 200 m. This would indicate that hydrographic conditions and the geomorphology of the seabed combined with temperature, salinity, and nutrient supply are more important than depth when influencing the distribution and growth of corals (Roberts et al. 2006).

Coral habitats can range from the inter-tidal zone to depths of ~2.5 Km. Corals are usually established after the settlement of coral larvae on a hard substratum. As the coral grows, older polyps die and the skeleton becomes vulnerable to bioeroders and mechanical breakage. These processes create a reef framework that traps mobile sediment. Provided that coral growth keeps pace with sediment infill, localized mound or reef formation is initiated. Corals are frequently reported from sites with locally accelerated currents, or from areas of the continental slope where internal tidal waves enhance seabed food supply. Sedimentary trap studies show that phytoplankton material, fecal pellets, detrius, and zooplankton are the most substantial sources of particulate carbon available to coral communities in the Northeast Atlantic. It is likely that detrital and re-suspended materials are important food sources for corals in deep waters (Roberts et al. 2006).

With respect to growth rates and longevity, studies of some gorgonian (i.e. sea fans) corals suggest a growth rate of 5-26 mm/yr with lifespans of 100 to 200 years for mature colonies while some Lophelia (spp) reefs have structures which are estimated to be over

8,000 years old (Roberts et al. 2006). Sherwood and Edinger 2009 estimated growth rates off Newfoundland and Labrador at approximately less than two centimetres per year vertically. Recent radiocarbon age studies of some corals collected off Newfoundland and Labrador showed that lifespans ranged from 40 years for one live-collected coral and up to 270 years for another subfossil specimen (Sherwood and Edinger 2009).

Little is known about the reproduction of cold-water corals, but some of those studied have separate sexes, releasing their gametes into the water column for external fertilization (Sun et al. 2009). In the northeast Atlantic, this is the case for *Lophelia pertusa* as this species produces gametes following the fall of particulate matter derived from phytoplankton. This usually occurs in the autumn and this species is then likely to spawn before the following spring (Roberts et al. 2006). In the northwest Atlantic, Nephtheid soft coral fertilization was found to be internal with the peak-breeding season being between November and February (Sun et al. 2009). Asexual reproduction in other coral species can occur by division of an existing polyp or by fragmentation, whereby pieces of a parent colony break off and form new colonies.

Sponges

Sponges are primitive aquatic animals that lack organs but have specialized cells and a collangenous matrix. Their bodies are organized around a simple or complex water system, making them highly effective filter feeders (ICES 2009). There are over 300 species of marine sponges known in or in close proximity to the waters of British Columbia (Gardner 2006). Nearly a third of them are unnamed. Seven species of glass sponge have been discovered off British Columbia but only three of them are abundant and form the framework of the unique glass sponge reefs. On Canada's Atlantic coast, at least 34 species of sponge have been identified, although it is expected that this list will be substantially expanded in future years. Recently, 25 species have been identified as habitat-forming and a full list of these species and their distributions are currently being documented (ICES 2009).

Sponge habitats can range from the inter-tidal zone to deeper than eight kilometres (ICES 2009). Adult sponges are largely sessile and live in an attached position where a firm substrate is provided, such as rocky ocean bottom.

Sponges undergo both sexual and asexual forms of reproduction. Asexual reproduction occurs in internal/external budding or fragmentation (ICES 2009). In sexual reproduction, sperm is dispersed by water currents and enters neighbouring sponges. Most sponges are hermaphroditic and produce eggs and sperm at complimentary times, the young embryo develops internally (known as brooding), eventually releasing larvae that settle and metamorphose quickly (ICES 2009).

All glass sponges found to date reproduce sexually, producing gametes through a process known as brooding (the embryo developing inside the sponge) (Leys and Ereskovsky 2006). Growth rate studies of hexactinellid (i.e. glass) sponges indicate a

mean growth rate of up to two centimetres per year with the age of an average-sized sponge being 35 years (Leys and Lauzon 1998). Large glass sponges have been estimated to be 220 or more years old.

2.2 DISTRIBUTION

Corals

Worldwide distribution of cold-water corals has been known since the nineteenth century as a result of incidental catches taken from fisheries using bottom-contacting gear and historical exploratory scientific/fisheries cruises. Until 1992, data on the distribution of corals in the marine waters of Canada was limited. Information on coral distribution has been enhanced significantly in the last decade by scientific surveys, fisheries observer programs, fishermen's traditional ecological knowledge, and *in-situ* observations using deep-water video and camera equipment.

In the northwest Atlantic corals appear to be distributed along the continental shelf edge and slope at depths greater than 200m mainly at the end of channels between fishing banks and in submarine canyons. These bathymetric features are considered good habitat for corals because they contain hard substrates mostly of glacial origin. These areas may also be associated with strong, relatively warm currents that increase nutrient-load and expose preferred hard substrates for larval settlement. Hard substrates are believed to be important for larval settlement, especially for larger gorgonian corals, some of which attach to cobbles, boulders, or bedrock (Wareham and Edinger 2007a). Corals are found from Baffin Bay south to the eastern Canadian continental shelf (Figure 1) (Gilkinson and Edinger 2009; Wareham and Edinger 2007a; Edinger et al 2007).

Areas of coral concentrations have also been located off southwestern Nova Scotia, southeast of Cape Breton Island and near Sable Island (Figure 2). To the North, the abundance of corals extends from the southwest edge of the Grand Banks, along the outer edge of the Banks, along the Flemish Pass and around the Flemish Cap. So far, species of gorgonian coral (i.e. *Keratoisis ornata*) and soft coral (i.e. *Gersemia rubiformis*) have been identified in the Gulf of St. Lawrence. It is anticipated that other corals will be found in the numerous deep troughs in the northern area of the Gulf (Gass and Willison 2005).

Recent mapping efforts in British Columbia (BC) show that corals are found on the continental shelf and slope (particularly on the flanks of banks) between depths of 100 to 500 m (Figure 3). Most of the records are taken from groundfish trawl fishery observations, so descriptions of the distribution of corals may be influenced by the location of fishing activities in the area (DFO 2006a). Corals also occur in depths greater then 500 m, however surveys below these depths have not occurred to verify specific distributions in BC.

Sponges

Information on the distribution of sponges in Atlantic Canada is limited. The data has been collected mostly by fishery observers on-board commercial fishing vessels. DFO regional multispecies trawl surveys are now collecting sponges which will assist in improving sponge distributional records in Atlantic Canada. Catches of sponges have been recorded on the Scotian Shelf, in the Gulf of St. Lawrence (Figure 4), and in deeper waters along the Grand Banks, Flemish Cap, and Labrador Shelf. With the progression of commercial fisheries into deeper waters since the 1992 groundfish moratorium, large sponge catches have been recorded at depths between 800 and 1400 m throughout the Northwest Atlantic. Sponges have been recorded from the Gulf of St. Lawrence and specific distributional records for some of the 34 species are available (Fuller 2004).

In the Pacific, the waters off British Columbia (BC) have the only known glass sponge reefs in Canada and one of the few glass sponge reef systems in the world. The discovery of these glass sponge reefs in 1987 has resulted in considerable scientific and public interest. The three main sponge species that are present in the reefs are found in different habitats through coastal BC where both hard substrate and adequate water currents exists, such as on fiord walls (Conway et al 2005).

An analysis of the by-catch of corals and sponges in BC's groundfish trawl fishery showed that there were at least 12 areas of highly concentrated coral/sponge species concentration on the continental shelf and slope, namely West of Vancouver Island, in Queen Charlotte Sound and around Haida Gwaii (Queen Charlotte Islands) (Figure 15) (DFO 2006b).

2.3 ECOSYSTEM FUNCTION

Corals may form one of the most complex habitats in the deep ocean, providing niches for many species (Roberts et al. 2006). They create biogenic habitat (habitat produced by life processes), forming complex, three-dimensional structures with spaces and gaps that provide habitat for marine life. Over 1300 marine species have been found living on *L. pertusa* reefs in the northeast Atlantic. In an Atlantic Canada study, the associated fauna of gorgonian corals collected from the continental shelf and slope (300-600 m depth) amounted to 114 associated species and over 3900 specimens. The study indicated that associated species richness and abundance was correlated with coral morphology and that crustaceans dominated the local fauna (Buhl-Mortensen and Mortensen 2005). Corals may provide a framework for biological diversity and may influence directly or indirectly the local occurrence or abundance of fish species.

A study to describe patterns of association between corals and commercial and non-commercial fish and invertebrate species off northeast Newfoundland indicated that coral biomass and fish biodiversity were closely correlated (Edinger et al. 2007). This association could reflect biological interactions or overlapping habitat preferences. Off the Pacific coast, coral ecosystems and their habitats are used by many diverse species thus

contributing to demersal and benthic marine food webs (Conway et al. 2007; Cook et al. 2008).

Organisms commonly associated with sponge grounds include several species of marine worms and bryozoans (tiny colonial animals that generally build stony structures of calcium carbonate) which often encrust dead sponge skeletons. In 2009, cuttlefish eggs at various developing stages were found within sponge collected in the Northwest Atlantic Ocean during the 2008 summer Northern Shrimp Survey by-catch species collection (S. Fuller Personal Communications, 2009). Several species of rockfish (*Sebastes* sp.) have been identified as users of sponge habitat, taking advantage of openings and niches between the sponges. Mature and juvenile rockfish have been observed around these sponge grounds, suggesting that the sponges are being used as a nursery area. Rockfish catches by the deep-shelf trawl fishery are positively correlated with large sponge bycatch. Species of crab, shrimp, prawns, and other euphausids are locally abundant around these sponge grounds as well. Sea stars and sea urchins commonly appear where sponges are dying or are obviously in poor condition (DFO 2008a).

The glass sponge reefs, which are found off the west coast, are one of only two known glass sponge reef systems in the world. They have existed since the end of the last glaciation which occurred approximately 9000 years ago (Conway et al. 2005). The reefs have formed large complexes (many kms wide) which provide a stable but fragile ecosystem. The reefs are constructed through several stages of frame building via baffling and trapping of suspended sediments (Conway et al. 2005). The glass sponges or *Hexactinellids* are porous animals characterized by a rigid framework made of silica spicules. These sponges are filter feeders obtaining nutrition from direct absorption of dissolved substances and to a lesser extent from particulate materials.

There is evidence to suggest that corals and sponges can provide significant deep-sea habitat, enhance species richness and support biodiversity (Kramp et al. 1932; Hecker and Blechschmidt 1979; Etnoyer and Warrenchuck 2007; Molodtsova and Budaeva 2007). Benthic habitat-forming organisms like corals and sponges can provide marine fishes and invertebrates (Gardner 2006; ICES 2009) with:

- protection from strong currents;
- refuge from predators;
- nurseries for larval and juvenile life stages;
- feeding areas;
- spawning areas;
- resting areas;
- breeding areas.

Therefore, because corals and sponges are formed below the photic zone, they are among the few habitat-forming features on the sea floor (Gardner 2006; ICES 2009).

3.0 IMPACTS TO CORALS AND SPONGES

3.1 OVERVIEW

Corals and sponges can be adversely affected by a broad range of impacts, many of which are associated, either directly or indirectly, with human activities. Fishing, petroleum, mineral exploration and production, and submarine cable/pipeline installation are the principal global sources of direct physical destruction or damage. There are also a variety of region-specific hazards reflecting local activities and practices. Additionally, invasive species, climate change and ocean acidification are emerging as significant impacts.

Slow growth rates, longevity, variable reproductive strategies, and habitat-limiting factors make corals and sponges particularly vulnerable to direct physical impacts as well as indirect disturbances such as environmental changes. Disturbances from chemical and environmental toxins or sedimentation have chronic and acute impacts. Risk can vary on a species by species basis due to characteristics such as skeletal structure.

3.2 COMMERCIAL/INDUSTRIAL OPERATIONS

3.2.1 Fishing

Fishing activity has the potential to either remove or damage corals and sponges when these organisms are impacted by fishing gear. Through the centuries there have been reports of corals and sponges being brought to the surface by fishing gear and many of the museum samples have been gathered through this process (Breeze 1997).

There has been very limited research into the effects of commercial fishing operations on corals and sponges in Canadian waters. However, international studies have shown that corals, and by inference, sponges and sponge reefs, can be damaged by a variety of bottom fishing gear (Friewald et al. 2004; Mortensen et al 2005; Edinger et al 2007;Lumsden et al. 2007; Fuller et al. 2008a; Fuller et al. 2008b). The majority of studies have focused on mobile gear and there have been comparably fewer studies on fixed gear (DFO 2008a). Studies have shown that mobile gear has a greater impact than fixed gear. The impacts on benthic habitats were correlated with the degree of bottom contact and sediment penetration of the gear. Bottom trawling is the largest impact on coral and sponge habitat because the area of seafloor contacted per haul is relatively large, the forces on the seafloor from the trawl gear are substantial and the spatial distribution of bottom trawling is extensive (DFO 2006f; Fuller et al. 2008b). Recent studies have identified that the first pass with a trawler dredge is more detrimental than subsequent passes (DFO 2006f). Although recent modifications such as grates in the trawl have reduced by-catch in fisheries, this same technology may limit the number of corals caught but not actually impacted.

Fixed gear such as bottom-set gillnets, bottom-set longlines, pots, traps, and vertical hook and line fishing all impact the benthos to some degree (Chuenpagdee et al. 2003;

Friewald et al. 2004; DFO 2006g; Lumsden et al. 2007; Fuller et al. 2008a). Fixed gear may target areas where trawling is difficult (i.e. canyons) which in turn may be where corals are concentrated. Fuller et al 2008a is a recent analysis of the fishing gear impacts on benthic species including corals and sponges.

3.2.2 Offshore Petroleum

Activities associated with the exploration for, and the development and production of, offshore petroleum resources have the potential to affect corals and sponges. Physical damage or dislodgement of organisms and hard substrate, and/or crushing of corals and sponges can result from: anchoring and/or mooring of floating vessels; seabed placement of drilling units and production facilities; and production pipelines (DFO 2008a). These activities also have the potential to disturb sediments, which may increase turbidity that can negatively affect both corals and sponges. During drilling operations the rock cuttings produced as the well is drilled are usually discharged from the drilling unit and fall to the seabed which may affect corals and sponges if they are present (Lumsden et al. 2007). During drilling operations there is a risk of the uncontrolled release of oil and/or natural gas into the marine environment. A similar risk also exists during production and transport operations. The effect of this on corals and sponges is difficult to quantify due to the many variables associated with such a release.

3.2.3 Subsea Cables

Subsea telecommunications and electrical cables are relatively common on Canada's Pacific and Atlantic coasts. Some of the cables are simply laid on the seabed while portions of others are buried. Cable burial and repair processes have the potential to damage the benthos (Friewald et al. 2004). In addition to the risk of direct damage or destruction of benthic habitats and fauna there is also the potential for suffocation via increased sedimentation associated with these activities.

3.2.4 Subsea Mining

Subsea mining holds significant potential to directly damage corals and sponges. Manganese nodules and crusts in the deep ocean are a potential source of highly concentrated heavy metals such as nickel, cobalt, and copper. As with subsea cables, subsea mining has the potential to damage corals and sponges both through sedimentation as well as by direct damage or destruction (DFO 2008a).

3.2.5 Land-source discharges

Materials, chemicals, and toxins which can reach the marine environment originate in sewage which has been partially treated or untreated; farm runoff; or residential runoff. Many of these are initially discharged into freshwater, although some are discharged directly into coastal waters. However, there is little scientific information about what, if any, effects these materials have on corals or sponges (Friewald et al. 2004). These discharges may be impacting sponges, some of which are present in near-shore coastal areas, particularly on the Pacific Coast.

3.2.6 Marine log handling facilities

On the Pacific coast, timber handling and transportation can generate significant debris fields. As this material sinks and is redistributed by currents it can bury benthic fauna and physically abrade the bottom. In deep cold water, decomposition of organic wood material is slowed and significant bacterial matting can occur which reduces dissolved O_2 quality. In 2003, guidelines were developed to protect highly productive intertidal and shallow subtidal areas. These guidelines directed operations into "*steep and deep*" areas which may increase risks for corals and sponges (G3 Consulting Ltd. 2003; DFO 2008a).

3.2.7 Net pen aquaculture operations

Also on the Pacific coast, concerns have been raised about the potential for organic (e.g. food, feces) deposition under finfish net pens to alter substrate composition and quality and reduce water quality. In addition, anchoring systems for net pens can disturb the substrate and any sessile benthic fauna while large arrays of net pens can alter local currents and shade the water column reducing sunlight penetration (DFO 2008a). Concerns have also been raised about the potential impact of aquaculture operations on corals and sponges off the south coast of Newfoundland.

3.3 ENVIRONMENTAL CHANGES

3.3.1 Climate Change

Human-induced global climate change has profound implications for marine ecosystems. Climate-induced changes to oceans will include rising sea levels, changes to upwelling and ocean circulation regimes, water column stratification changes (particular relevance to many coral and sponge species), ocean acidification, and warmer ocean temperatures.

3.3.2 Ocean Acidification

The global oceans represent earth's greatest natural carbon sink, holding more than 88% of all CO_2 on the planet and cycling a significant portion of human CO_2 emissions every year. The potential impacts of climate change on corals are not well understood but over the next few decades ocean uptake of CO_2 and its acidifying reaction with seawater is expected to substantially decrease oceanic pH and the availability of carbonate ions (needed for calcification). Experimental evidence suggests that the reduced level of calcium carbonate saturation will result in corals having difficulty building and maintaining their external calcium carbonate skeletons (Orr et al 2005). This, in turn, will make the species more vulnerable to subsequent impacts.

3.3.3 Temperature Change

Coldwater corals may also be impacted in several important ways by ocean warming. Corals rely on zooplankton as their primary food source but warmed water may reduce the availability of phytoplankton and zooplankton due to increased grazing from higher tropic levels. Increased ocean temperatures may also lead to a change in the depths

where carbonate is available for corals to use. Due to their slow growth and longevity it is not anticipated that corals will be capable of adapting to the predicted rapidly changing conditions (DFO 2008a).

3.3.4 Hypoxia / Anoxia

The global oceans have pockets called “dead zones” which are areas experiencing sustained anoxic/hypoxic (no/low oxygen) conditions. These pockets are increasing in size and frequency as ocean temperature and acidification increase. Current research in the Pacific has indicated that sponges are very tolerable to hypoxic but not anoxic conditions (Whitney et al. 2005).

3.4 OTHER

3.4.1 Invasive Species

Invasive species are non-indigenous species whose introductions may cause environmental harm. The introduction of these species into receiving waters where they can thrive has long been recognized as a significant potential disturbance to native ecosystems. *Carijoa riisei*, an octocoral native to the Western Atlantic, was discovered in 2001 overgrowing black corals in Hawaii. In areas where *C. riiesei* had become established, up to 90% of the native black coral populations were killed or completely overgrown by the invader (Kahng, et al. 2005). There are no reports of similar situations in Canadian waters; however the issue has not been the subject of significant scientific attention.

3.4.2 Commercial Harvest

In some parts of the world, commercial harvesting of warm-water corals presents a risk to their conservation. However, selective harvesting, when practiced under an effectively enforced management plan, can be done sustainably with minimal impact on the reef (Coral Reef Alliance 2005). Some of the coral types harvested for trade in other parts of the world are found in Canada’s Atlantic coastal waters. However, there is currently no commercial harvest of corals in Canada.

4.0 INTERNATIONAL CONTEXT

4.1 OVERVIEW

The responsibilities of countries to contribute and cooperate in the protection of the marine environment and its biodiversity are defined in international conventions and agreements such as the Convention on Biological Diversity, resolutions of the United Nations General Assembly, United Nations Convention on the Law of the Sea and the United Nations Fish Stocks Agreement. Under this international and global framework, regional and national fisheries management organizations are committed to adjust their management toward an ecosystem-based approach and implement area-based fishing restrictions aimed at the protection of deep-sea fish stocks and their vulnerable habitats. This section will outline agreements and conventions that are related to coral and sponge conservation. These agreements have also been a catalyst for other management actions in both domestic and international waters.

4.2 CONVENTION ON BIOLOGICAL DIVERSITY

The Convention on Biological Diversity (CBD) is an international treaty that was adopted in Rio de Janeiro in June 1992 (Convention on Biological Diversity 2004). The Convention has been ratified by 190 states and the European Union, and Canada has been party to the Convention since December 1992. The Convention has three main objectives:

- conservation of biological diversity;
- sustainable use of its components;
- fair and equitable sharing of benefits arising from genetic resources.

The convention recognized, for the first time in international law, that the conservation of biological diversity is "*a common concern of humankind*". The agreement covers all ecosystems, species, genetic resources, and the long-term maintenance of biological diversity. The Convention is legally binding; countries ('Parties') that join are obliged to implement its provisions.

The Convention also offers decision-makers guidance based on the precautionary principle. Where there is the potential of significant reduction or loss of biological diversity lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such an impact.

In the Convention, marine and coastal living resources are part of a program on marine and coastal biological diversity. The overall goal of this program element is to achieve conservation and long-term sustainable use of marine and coastal resources. Deep seabed biodiversity and corals are two focal areas of this program element. The Parties to the CBD expressed their concerns about the increased risks to biodiversity both in territorial waters and in marine waters outside the limits of national jurisdiction. It was underlined that there is an urgent need to improve conservation and sustainable use of biodiversity through the establishment of marine protected areas consistent with

international law and based on scientific information. In this regard, seamounts, hydrothermal vents, cold-water corals, and other vulnerable ecosystems were specifically identified.

In 2008, under the CBD, scientific criteria were adopted for identifying ecologically and biologically significant deep-sea areas in need of protection (Convention on Biological Diversity 2008). These criteria included species with structures providing biogenic habitats, such as cold-water corals and sponges, as examples of species that contribute to comparatively higher biodiversity, and that are vulnerable, fragile, sensitive, or slow to recover.

4.3 UNITED NATIONS GENERAL ASSEMBLY SUSTAINABLE FISHERIES RESOLUTIONS

In February 2004, over 1000 scientists from 69 countries released a statement expressing concern "*…that human activities, particularly bottom trawling, are causing unprecedented damage to the deep-sea coral and sponge communities and continental plateaus and slopes, on seamounts and mid-ocean ridges*" (MCBI 2004). The statement called on governments and the United Nations to establish a moratorium on high seas bottom trawling.

A report published in July 2004, supported by the United Nations Environment Programme (UNEP) Coral Reef Unit, the World Wildlife Fund (WWF), and the Governments of Ireland, Norway and the United Kingdom, expressed concern for the protection of cold-water corals and emphasized their worldwide vulnerability (UNEP-WCMC 2004). The report was written by five international coral reef experts, contained 24 recommendations for action, and covered many aspects of cold-water coral protection (Freiwald et al. 2004).

With the growing international concern, Resolution 59/25 was tabled and adopted at the 59th session of the United Nations General Assembly (UNGA) held in 2004. This resolution pertains to Sustainable Fisheries and the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea (1982) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

Under *Responsible Fisheries in the Marine Ecosystem* section, the following requests pertain to cold-water corals and their protection:

"Calls upon States, either by themselves or through regional fisheries management organizations or arrangements,… to take action urgently, and consider on a case-by-case basis and on a scientific basis, including the application of the precautionary approach, the interim prohibition of destructive fishing practices, including bottom trawling that has adverse impacts on vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals located beyond national jurisdiction, until such time as appropriate conservation and management measures have been adopted in accordance with international law".

It was agreed that there would be a review within two years on action taken in response to the above requests with a view to develop further recommendations where necessary.

At the 61st session in 2006, the Sustainable Fisheries Resolution A/RES 61/105 was adopted. In this resolution, the UNGA again called upon States to take immediate action to sustainably manage fish stocks and protect vulnerable marine ecosystems (VMEs), including seamounts, hydrothermal vents and cold-water corals, from destructive fishing practices. UNGA reaffirmed the importance of its previous resolution 59/25 concerning the impacts of fishing on VMEs. Under paragraph 83 of A/RES 61/105, regional fisheries management organizations were requested to adopt and implement, not later than 31 December 2008, the following measures, in accordance with the precautionary approach, ecosystem approaches and international law:

- to assess, on the basis of the best available scientific information, whether individual bottom trawling activities have significant adverse impacts on VMEs;
- to identify VMEs and determine whether bottom fishing activities would cause significant adverse impacts on these ecosystems;
- to close areas where VMEs, including seamounts, hydrothermal vents, and cold-water corals, are known to occur, to bottom fishing and to ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts;
- to require members of the regional fisheries management organizations to require vessels flying their flag, to cease bottom fishing activities in areas where, in the course of fishing operations, VMEs are encountered and to report the encounter.

At the 63rd (2008) session of UNGA, under Agenda item 49(f), Sustainable Development: CBD, the UNGA, once again, expressed concern about the continued loss of biological diversity even in the face of commitments made at the World Summit on Sustainable Development whereby States were to implement national biodiversity strategies and action plans by 2010. Also by that date, Member States were urged to fulfil their commitments to significantly reduce the rate of loss of biodiversity loss.

4.4 FISHERIES AND AGRICULTURE ORGANIZATION (FAO)

In 1995, more than 170 members of the Food and Agriculture Organization (FAO) of the United Nations adopted the Code of Conduct for Responsible Fisheries through the Rome Declaration on Responsible Fisheries (FAO 1995). These nations committed to end destructive fisheries practices and protect vulnerable habitat. However, no time lines were set and the Code was voluntary in nature and did not create legally binding obligations upon States.

The Code of Conduct consists of a collection of principles, goals, and elements for action and was developed by members of FAO, inter-governmental organizations, the fishing industry and non-governmental organizations. It took two years to prepare and represents a global consensus on a wide range of fisheries and aquaculture issues.

Governments, in cooperation with their industries and fishing communities, have the responsibility to implement the Code.

International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO 2007) were developed at the request of the FAO Committee on Fisheries at its 27th session (March 2007) in order to assist States and regional fisheries management organizations in sustainably managing deep-sea fisheries and in implementing the UNGA Resolution 61/105 with respect to the protection of VMEs. FAO members at a Technical Consultation in Rome adopted the Guidelines in August 2008. The role of the Guidelines is to provide tools with guidance on their application to facilitate and encourage efforts of regional fisheries management organizations and States towards sustainable use of marine living resources, the prevention of significant adverse impacts to VMEs and the protection of marine diversity. The Guidelines are designed to limit the impact of fishing on fragile deep-sea fish species and habitats, including cold-water corals. Regional fisheries management organizations are utilizing these guidelines as they undertake efforts to implement management measures to fulfil the UNGA Resolution 61/105 mandate.

4.5 NORTHWEST ATLANTIC FISHERIES ORGANIZATION

The Northwest Atlantic Fisheries Organisation (NAFO) was established in 1979 with the objective of contributing to the utilisation, management, and conservation of the fishery resources within the northwest Atlantic Convention Area. NAFO members include Canada, Cuba, Denmark, European Union, France, Iceland, Japan, Republic of Korea, Norway, Russian Federation, Ukraine, and the USA. NAFO is structured such that a Fisheries Commission, Scientific Council, General Council, and Secretariat serve to manage, conserve, and advise upon status of fish resources. The NAFO Convention Area encompasses a very large portion of the Atlantic Ocean and includes the 200-mile zones of Coastal States jurisdiction (USA, Canada, St. Pierre and Miquelon and Greenland). Management by NAFO, however, applies only to the areas straddling and outside the EEZs (Exclusive Economic Zones).

In response to the 2004 request by UNGA for states and regional fisheries organizations to address significant adverse impacts of fishing on VMEs, NAFO implemented precautionary closures of four seamount areas (Orphan Knoll, Newfoundland Seamounts, Corner Seamounts, New England Seamounts) (Figure 6) from high seas bottom trawling for a four-year period (2007 to 2010) (NAFO 2006). The measures were taken to implement precautionary and ecosystem-based approaches for the protection of seamounts. Since January 1, 2008, 20% of the fishable area of each seamount has remained open to small scale and restricted exploratory fisheries to gather data for NAFO scientists. These seamount mitigative measures were extended, as of January 1, 2009, to include the Fogo Seamounts off Newfoundland (NAFO 2008a).

In 2007 NAFO implemented a Coral Protection Zone which is approximately 14,000 Km^2 and is located in NAFO Division 3O (Figure 7). This zone is now closed to all bottom contact fishing gear and will be reviewed in 2012 by Fisheries Commission based on

advice from Scientific Council. At that time a decision will be made on future management measures (NAFO 2009b). Gilkinson et al 2009 noted that the configuration of the zone does not protect important habitat for the longest lived gorgonian coral. These corals are found at depths less than 800 m which is the current landward boundary of the Coral Protection Zone.

At an inter-sessional meeting in May 2008, NAFO members agreed to put in place strict conditions that are required before the opening of any new bottom fisheries in the NAFO Regulatory Area. New bottom fishing areas refers to all other areas within the Regulatory Area which are not defined as existing bottom fishing areas, including waters deeper than 2000m. In particular, a mitigation plan will be required which must include measures to prevent significant adverse impacts to VMEs which may be encountered during the fishery. If species such as corals and sponges are encountered the vessel must quantify their catch. If observers are available, they must identify the corals and sponges and other organisms to the lowest taxonomic level possible (NAFO 2008a).

At the NAFO Annual Meeting in September of 2008, it was anticipated that NAFO might close six deep sea areas identified by scientists as containing high concentrations of corals and other vulnerable species. However, NAFO indicated that additional information would be required including greater definition and location of concentrations of sensitive and vulnerable species, resilience of species to perturbation, species recovery expectations, and distributional extent. NAFO did adopt an interim encounter protocol that requires fishing vessels to move two nautical miles from an area if they catch more than 100 kilograms of coral or 1000 kilograms of sponges (NAFO 2008a). However it is important to note that these thresholds have never been observed in catch data between 2007-2009 (NAFO 2009b). The NAFO Working Group of Fishery Managers and Scientists has recommended that the issue of coral thresholds should be reviewed. This review should consider additional information from Scientific Council as well as experience beyond NAFO (NAFO 2009b).

At the request of the NAFO Fisheries Commission, scientists at their October 2008 meeting identified seven candidate VMEs in the NAFO regulatory area where significant by-catches of corals and sponges have occurred in the commercial fishery. Four areas in the vicinity of the Flemish Cap emerged as key locations where significant concentrations of corals occur. Buffer zones were delineated for added protection for these coral concentrations. In June 2009, the NAFO published an identification key for known Atlantic cold-water coral species (NAFO 2009a). This identification key will not be a comprehensive list but will highlight important habitat and/or rare coral species.

In addition to the corals work, NAFO Scientific Council has been gathering information on sponges from the NAFO Convention Area and has identified more than 300 species of sponges, ranging from thin and encrusting, to branching and to mound-forming (NAFO 2008a). Species belonging to all three sponge classes *Calcarea*, *Demospongae* and *Hexactinalledae* have been identified from the area. Large sponge by-catches were recorded in a relatively low number of trips (< 5%) in both surveys and observer data.

However, large catches of sponges, up to 6000 kg have been recorded on the Scotian Shelf and in deeper waters along the Grand Banks, Flemish Cap and Labrador Shelf. With the progression of fisheries into deeper waters, large sponge catches have been recorded between 800 and 1400 meters throughout the Northwest Atlantic (NAFO 2008a).

The presence of sponges has not been systematically recorded by fisheries observers in the NAFO Convention Area. However, records do exist, particularly when an observer has witnessed a large catch of sponges. There is currently no protection afforded to sponge concentrations in the northwest Atlantic and eastern Arctic, however, some sponge species may be protected in areas where there are coral conservation closures in the Area. In 2008, Fisheries Commission requested advice from Scientific Council on sponge concentrations so that mitigative measures can eventually be implemented to protect sponges in VMEs. Fisheries Commission will assess this advice and consider conservation measures to protect sponges at the September 2009 NAFO General Meeting.

4.6 INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

The International Council for the Exploration of the Sea (ICES) is an organization that coordinates and promotes marine research in the North Atlantic. This includes adjacent seas such as the Baltic and North Seas. The Council acts as a meeting point for a community of more than 1600 marine scientists from 20 countries around the North Atlantic who gather information pertaining to the marine ecosystem. As well as filling gaps in existing knowledge, this information is also developed into scientific advice which is then used by the 20 member countries (which fund and support ICES) to help them manage the North Atlantic Ocean and adjacent seas.

Prior to 2007, the ICES Working Group on Deep Water Ecology (WGDEC) had been providing advice on scientific questions predominately relating to deep-water areas of the northeast Atlantic. With the dissolution of WGDEC in 2007 and the formation of the joint group, the ICES-NAFO Joint Working Group on Deep Water Ecology (WGDEC), it became possible to place more emphasis on deep-water ecology research in the Northwest Atlantic.

At its March 2008 meeting (ICES 2008), the joint WGDEC was able to:

- make progress with descriptions of the distributions of structure-forming sponges and soft corals in the North Atlantic and develop maps;
- continue with building a (meta) database of scientific/cruise results with benthic habitat information in the North Atlantic and develop maps;
- review the "*Guidelines for the Management of Deep-sea Fisheries on the High Seas*" being considered by FAO and its subsidiary, the Committee on Fisheries in 2008, and develop possible guidelines that could be implemented by ICES and NAFO; and

- examine vessel monitoring systems data with the objective of examining patterns of fishing in deep-water areas such as around seamounts and the continental slope to determine where intensive fishing is occurring and evaluating the likelihood of sensitive habitats in those areas.

The Working Group met in March 2009, and published new information on the distribution of sponge grounds in the North Atlantic (ICES 2009).

4.7 CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) sets controls on the movement of animal and plant species that are, or may be vulnerable due to excessive commercial exploitation. Canada was a founding member of CITES when the agreement came into force in 1975. Environment Canada is the lead agency responsible for implementing CITES on behalf of the Government of Canada.

Marine reef species listed under CITES include 2000 species of corals, clams, whelks, and sea turtles. The coral listings are made up of predominately tropical corals which have been harvested for a variety of purposes, including construction materials, souvenirs, and jewellery, as well as for marine aquaria.

There are two levels of CITES protection for corals:

- Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances;
- Appendix II includes species that may be impacted if trade is not controlled.

Species in Appendix II are to be regulated through the use of export permits. Countries must not only assess and monitor the exports, but also manage the resource so that the collection and trade is not a detriment to its role in the ecosystem. All coral species listed are covered by CITES Appendix II.

Some of the coral species listed (i.e. *Scleractinians and Antipatharians*) have been found in deeper and colder water environments. A total of about 492 coral species are identified and have been classified into the following Anthozoan Orders:

- *Scleractinia* (stony corals, white corals, cluster corals, bird nest corals, cauliflower corals). To date, about 15 species of this Order have been found in Canadian waters;
- *Helioporacea* (blue corals);
- *Stolonifera* (organ pipe corals);
- *Antipatharia* (black corals). To date, about eight species of this Order have been found in Canadian waters.

5.0 LEGISLATIVE CONTEXT FOR CONSERVATION

5.1 OVERVIEW

The authorities and responsibilities of the Department of Fisheries and Oceans, as with other departments and agencies of the Government of Canada, are set out in a variety of acts of the Canadian Parliament. *The Department of Fisheries and Oceans Act* sets out the powers, duties, and functions of the Minister of Fisheries and Oceans while it is the implementation of the *Fisheries Act* and the *Oceans Ac*t that are particularly applicable to the management and conservation of corals and sponges. Additionally there are several pieces of legislation for which DFO shares implementation responsibility with a number of federal departments and agencies. The *Canadian Environmental Assessment Act* and the *Species at Risk Act* are two of these which are also of interest for the management and conservation of corals and sponges.

5.2 DEPARTMENT OF FISHERIES AND OCEANS ACT

Section 4.1 of the *Department of Fisheries and Oceans Act* (DOJ 1985a) states that *"The powers, duties and functions of the Minister extend to and include all matters over which Parliament has jurisdiction, not by law assigned to any other department, board or agency of the Government of Canada, relating to*

*(*a*) sea coast and inland fisheries;*

*(*b*) fishing and recreational harbours;*

*(*c*) hydrography and marine sciences;*

*(*d*) the coordination of the policies and programs of the Government of Canada respecting oceans."*

The Act establishes the scope of the Minister's responsibilities and provides the legislative foundation for DFO's interest in matters related to corals and sponges.

5.3 FISHERIES ACT

This A*ct* provides the Minister of Fisheries and Oceans Canada with the authority to manage freshwater and marine fisheries. The Act includes licensing, and enforcement provisions for closing areas to fishing as well as provisions to conserve and protect fish habitat. There are two types of habitat provisions in the *Fisheries Act*: habitat protection and pollution prevention. A key habitat protection provision is subsection 35(1). This section prohibits the harmful alteration, disruption or destruction (HADD) of fish habitat without an authorization from the Minister or by regulation.

Section 36 of the Act is the key pollution prevention provision. It prohibits the deposit of deleterious substances into waters frequented by fish unless authorized by regulation or

by federal laws. The administration of section 36 has been assigned to the Minister of Environment.

The habitat protection provisions of the *Fisheries Act* apply to all projects and development activities, including non-fishing activities such as oil and gas, aquaculture operations, etc, which occur in or near water and have the potential to result in the harmful alteration, disruption, or destruction of fish habitat through chemical, biological, or physical means. Under the *Act* corals and sponges are defined as “fish” and “fish habitat”. The Act defines “fish” to include “parts of fish, shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans, and marine animals”. The *Fisheries Act* defines ‘fish habitat’ as “Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes"(*Fisheries Act*, sec 34(l)). DFO manages fisheries in accordance with the roles and responsibilities outlined in the *Fisheries Act*. The *Act* has been used to implement conservation measures. For example the Northeast Channel Coral Conservation Area, the Lophelia Coral Conservation Area, and the Gully Marine Protected Area (MPA) all have licence conditions, based on the *Fisheries* Act, to restrict bottom fishing.

5.4 OCEANS ACT

The *Ocean’s Act* (DOJ 1996), enacted in 1997, outlines Canada's duties and responsibilities in its oceans territory and introduces a new oceans management approach which promotes sustainable development. Under the *Act*, the Minister of Fisheries and Oceans is authorized to lead and facilitate the development and implementation of a national strategy for the management of estuarine, coastal, and marine ecosystems in Canadian waters.

The *Oceans Act* has the provision to establish Marine Protected Areas (MPAs) which may be designated for one or more of the following reasons:

“(a) the conservation and protection of commercial and non-commercial fishery resources, including marine mammals, and their habitats;

(b) the conservation and protection of endangered or threatened marine species, and their habitats;

(c) the conservation and protection of unique habitats;

(d) the conservation and protection of marine areas of high biodiversity or biological productivity; and

(e) the conservation and protection of any other marine resource or habitat as is necessary to fulfil the mandate of the Minister.”

Of the seven MPAs currently designated in Canada; two MPAs, the Gully on the Eastern Scotian Shelf and the Bowie Seamount in the Northeast Pacific, contain cold water

corals. Sponges are also present at the Bowie Seamount and Gully MPAs. For more information see regional overviews for Maritimes and Pacific Regions, (Sections 7.2.2 and 7.2.6 respectively) in this report. The 2007 federal budget provided funding for the establishment of an additional six MPAs. It is anticipated that some of these will include measures to protect corals and sponges.

5.5 CANADIAN ENVIRONMENTAL ASSESSMENT ACT

The *Canadian Environmental Assessment Act* (DOJ 1992) requires federal departments, agencies, and crown corporations, including DFO to conduct environmental assessments for prescribed projects in Canada. The *Act* is administered by the Canadian Environmental Assessment Agency (CEAA), an independent agency that reports directly to the federal Environment Minister.

The Law List Regulations help define the scope of the *Act* by identifying those federal statutory and regulatory approvals that will trigger an environmental assessment (EA). Under the *Act*, an EA is required before a federal authority takes an action, such as: being the proponent; providing funding, providing land, or issuing a license, permit, or other regulatory authorization. Certain classes of projects may be excluded from having to undergo an EA pursuant to the *Act*. These projects are either identified in a specific Exclusion List or they fall into the category of a national emergency.

The Law List prescribes the following sections of the federal *Fisheries Act* for which an exercise of powers, duties or functions of the Minister of Fisheries and Oceans is required: subsection 22 (1); subsection 22 (2); subsection 22 (3); section 32; subsection 35 (2); and subsection 37 (2). Of these six, it is Section 35 which may pertain to corals and sponges.

DFO (Habitat Management) has responsibility for conducting an EA under the *Canadian Environmental Assessment Act* prior to regulatory decisions being made by DFO under laws administered by the Department. The most common CEAA regulatory trigger for DFO is the issuance of authorizations of a HADD under section 35 of the *Fisheries Act*.

5.6 SPECIES AT RISK ACT

The *Species at Risk Act* (SARA) (DOJ 2002a) provides Environment Canada, Fisheries and Oceans Canada, and Parks Canada Agency with the authority to protect nationally listed wildlife at risk from becoming extinct or lost from the wild, provides for the recovery of extirpated, endangered, and threatened species and encourages the management of species of special concern to prevent them from becoming endangered or threatened. The *Act*, which became law in 2003, also creates prohibitions to protect listed threatened and endangered species, their residences, and their critical habitat.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent advisory body which assesses the risk of extinction for wildlife species and provides these assessments to government and the public. Species can be classified as be extirpated, endangered, threatened, or of special concern.

If COSEWIC determines that a species is at risk, then the federal Cabinet must determine whether to list that species under the *Act.* Once a species is listed under the *Species at Risk Act*, it becomes illegal to kill, harass, capture or harm. Critical habitats are also protected from destruction. The Act also requires that recovery strategies, action plans or management plans be developed for all listed species. Recovery strategies/action plans for extirpated and endangered, management plans are for species of special concern.

To date no coral or sponge species have been assessed or listed under SARA. However DFO is contributing to a General Status Report which will include all coral and sponge species in Canada. The Status Report will assess population trends of species and is scheduled for publication in 2010 (Appendix 2).

5.7 CANADA NATIONAL MARINE CONSERVATION AREAS ACT

Under the *Canada National Marine Conservation Areas Act* (DOJ 2002b), Parks Canada is responsible for the establishment and management of a national system of representative marine protected areas -- called national marine conservation areas (NMCAs) -- based on a 29 marine region framework. Five of these regions are in the Pacific Ocean, 9 in the Arctic Ocean, 10 in the Atlantic Ocean and 5 in the Great Lakes.

NMCAs are marine areas managed for ecologically sustainable use and contain zones of high protection. They include the seabed, the water column above it wetlands, estuaries, islands, and other coastal lands. Species such as corals and sponges would be considered in the management measures of an NMCA. Activities such as ocean dumping, undersea mining, and oil and gas exploration and development are prohibited in all NMCAs. Traditional fishing activities are permitted, but managed within a goal of ecosystem conservation.

Three NMCAs have been established:

- Fathom Five National Marine Park in Ontario;
- Saguenay–St. Lawrence Marine Park in Quebec;
- Lake Superior National Marine Conservation Area in Ontario.

Four other potential NMCA sites have been proposed: Gwaii Haanas and the Southern Strait of Georgia in British Columbia, the Îles de la Madeleine in Quebec and Lancaster Sound in Nunavut. All of these proposed NMCAs are known to contain some corals and sponges (Section 7.4).

6.0 DFO NATIONAL CONTEXT

6.1 OVERVIEW

In addition to the legislative framework of laws and regulations, there are also policies and programs within the Government of Canada that are relevant to coral and sponge conservation. Among these are *Canada's Oceans Strategy*, the *Oceans Action Plan* and the *Health of the Oceans* initiative.

6.2 CANADA'S OCEANS STRATEGY

In 2002, *Canada's Oceans Strategy* (DFO 2002a) was released which outlined the federal government's vision and direction for modern oceans governance. The overarching goal of the strategy is to ensure healthy, safe, and prosperous oceans for the benefit of current and future generations of Canadians. The *Strategy* is based on three principles; sustainable development, integrated management, and the precautionary approach. Application of these principles is premised on a sound basis of scientific and traditional knowledge.

6.3 OCEANS ACTION PLAN

The *Oceans Action Plan* (DFO 2005c) is the blueprint for the implementation of *Canada's Oceans Strategy*. The OAP is divided into the following four pillars.

- *"International Leadership, Sovereignty and Security - Assert sovereignty, including continued monitoring and management of Canada's Arctic waters and resources; address overfishing and security issues; and apply Canadian jurisdiction within an effective international oceans governance framework (e.g., by addressing high seas biodiversity, deficiencies in high seas regimes and implementing existing commitments);*
- *Integrated Oceans Management - Promote relations with stakeholders that will address conflicts and benefit communities in key oceans areas, based on the principles of ecosystem-based management and the precautionary approach (e.g., by implementing Integrated Management plans);*
- *Health of the Oceans - Provide the backbone of marine conservation and sustainability by protecting critical marine environments, preventing pollution and maintaining adequate aquatic animal health (e.g., by designating key Marine Protected Areas and national protection measures);*
- *Oceans Science and Technology - Build an environment that promotes growth in leading ocean technologies and mapping priority areas, using science in support of ecosystem-based management (e.g., opportunities for Canadian marine technology firms to develop and apply new technologies)."*

All four pillars are relevant, to varying degrees, to coral and sponge conservation. The OAP stated that *"all indicators point to the reality that the health and quality of the marine environment are at risk or declining"* and identified the need for a *"greater commitment to:*

- *stronger ecosystem-based science to look at the interactions among the diverse parts that make up the natural world, as well as scientific advice to turn information and research results into definitive action;*
- *deployment of modern technology to support oceans understanding and awareness, and monitoring and management regionally and nationally;*
- *integrated planning amongst oceans users based on clear, well-understood and shared ecosystem objectives;*
- *effective regulatory measures to protect the oceans resources against over-harvest, as well as environmental degradation;*
- *protection measures, especially the designation of marine protected areas, in the ocean to protect the most important, productive, and biologically diverse areas and vulnerable species."*

6.4 HEALTH OF THE OCEANS

In 2007, the Government of Canada announced funding for a series of initiatives related to improving the health of Canada's oceans (DFO, 2007d). Most, if not all, of the initiatives for which DFO received funding have some relevance to coral and sponge conservation:

- New Oceans Centres of Expertise (Coastal Management, Cold-Water Corals and Sponge Reefs, State of the Oceans Reporting, and Traditional Ecological Knowledge);
- Federal Marine Protected Area Strategy Implementation (co-funded between Fisheries and Oceans Canada, Parks Canada and Environment Canada);
- Development of Federal-Provincial-Territorial marine protected area network;
- Marine Protected Areas Establishment (DFO, Parks Canada and Environment Canada);
- Ecosystem Science Support and Advice on Health of the Oceans;
- Collaboration with the World Wildlife Fund;
- Arctic Council- Ecosystem Projects.

Of particular importance was the establishment of a Centre of Expertise for Cold-Water Corals and Sponge Reefs at the Northwest Atlantic Fisheries Centre in St. John's, NL. As noted in the introduction this centre has a mandate to coordinate the Government of Canada's approach to coral and sponge conservation.

The Health of the Oceans initiative also included funding for six new Marine Protected Areas under the *Oceans Act*. It is anticipated that some of these new areas will provide protection to corals and sponges.

6.5 SUSTAINABLE FISHERIES FRAMEWORK

In April 2009, DFO released the Sustainable Fisheries Framework (SFF) for the management of fisheries resources. The objective of this new framework is "*..... to ensure that Canada's fisheries are environmentally sustainable, while supporting economic prosperity. This means maintaining a balance between healthy fish stocks and marine environments, while allowing for prosperous fisheries; a balance known as 'sustainable development'*". The SFF was developed for three key reasons:

- the growing number of requests to certify and to demonstrate that Canada's fish products are harvested sustainably in order to maintain existing markets for Canadian seafood products, or expand upon them;
- the evolving domestic legislation and policy framework of the government of Canada which require a more comprehensive Ecosystem Approach to the management of fishery resources;
- to meet the international agreements and protocols which Canada has become a signatory to over the last ten to fifteen years.

The SFF comprises four main elements: conservation and sustainable use policies; economic policies; governance policies and principles; and planning and monitoring tools. Of particular relevance to this report is the conservation and sustainable element which includes a policy for managing impacts of fishing on sensitive benthic areas (DFO 2009b).

6.6 POLICY FOR MANAGING THE IMPACTS OF FISHING ON SENSITIVE BENTHIC AREAS

The Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009b) recognizes that benthic ecosystems are essential components of ocean ecosystems. They provide habitat, support species and contribute to biodiversity. As such, DFO has acknowledged that they have to be considered in managing fisheries. This policy also reflects Canada's international commitments (see section 4.0) as well as the legal and policy frameworks designed to deliver the management of Canada fisheries and ocean's resources (see section 5.0) including the *Fisheries Act* and the *Oceans Act*. The policy outlines a systematic, transparent, and consistent approach to addressing benthic impacts from Canadian fisheries. This policy will be implemented by the Fisheries and Aquaculture Management Sector (the regulator of commercial, recreational, and

Aboriginal marine fishing activities in Canada). The policy outlines separate processes for historically fished and frontier areas:

- a historically fished area is a marine ecosystem where there is a history of fishing (includes current fishing activity);

- a frontier area is a marine ecosystem area in deep water (deeper then 2000m) or in the Arctic where there is no history of fishing and little if any information is available concerning the benthic features (habitat, communities and species) and the impacts of fishing on these features.

This policy incorporates the precautionary and ecosystem-based approaches and follows the following five steps, which are to be applied consistently to both frontier and historically fished areas:

1. Assemble and map existing data and information that would help determine the extent and location of benthic habitat types, features, communities and species; including whether the benthic features (communities, species and habitat) situated in areas where fishing activities are occurring or being proposed are important from an ecological and biological perspective;

2. Assemble and map existing information and data on the fishing activity;

3. Based on all available information, and using the Ecological Risk Analysis Framework (ERAF), assess the risk that the activity is likely to cause harm to the benthic habitat, communities and species, and particularly if such harm is likely to be serious or irreversible;

4. Determine whether management measures are needed, and implement such management measures;

5. Monitor and evaluate the effectiveness of the management measure and determine whether changes are required to the management measures following this evaluation.

The formal implementation of the policy is expected in 2010, following the completion of the ERAF. The ERAF will be used to identify any risk levels that fisheries may pose to an ecosystem component so that appropriate action may be taken. The first step will be developing a risk analysis framework for fishing impacts on corals and sponges (DFO 2009b).

7.0 SCIENCE, RESEARCH, AND CONSERVATION

7.1 OVERVIEW

This section will summarize science, research, and conservation efforts related to corals and sponges within Canada. Activities within Natural Resources Canada and Parks Canada are also included in this section. Efforts by the fishing industry and environmental non-governmental organizations are also included. Finally, an outline of research interests in participating universities is included.

7.2 FISHERIES AND OCEANS CANADA

7.2.1 Newfoundland and Labrador Region

Science and Research

Using dedicated funding from the Northern Cod Science Program, a research program to address the environmental impacts of Mobile Bottom Fishing Gears (MBFG) was initiated in 1990 in DFO's Newfoundland and Labrador (NL) Region. This research was a collaborative initiative involving DFO Maritimes Region (Bedford Institute of Oceanography-BIO) and DFO NL Region (Northwest Atlantic Fisheries Centre-NAFC). Between 1990-2005, the research group conducted three field experiments, each three years in duration; two on the Scotian Shelf and one on the northeast Grand Bank (Figure 9).

Directed research into the impacts of MBFG in the NL Region has been carried out (DFO 2006c). These projects include:

- impacts of shrimp trawling on snow crabs;
- delineating historical spatial and temporal patterns of commercial trawling activity;
- simulated trawl door scouring experiments;
- impacts of scallop dredging;
- sensitive areas and habitats: geographic distribution and diversity of cold water corals.

With respect to corals in the NL Region, there have not been any studies on the direct impacts of bottom fishing in Canada. However it is understood that recent information obtained on coral spatial distribution, abundance, and diversity can be used to assess bottom-tending gear impacts (Gordon Jr. et al. 2002, Edinger et al. 2007, Gilkinson and Edinger 2009).

The actual study of corals in the NL Region is directly linked to, and is pre-dated by, research in the Maritimes Region. Early stages of DFO coral research in eastern Canada can be divided into two phases:

- Phase 1 (1997-2000) consisted of largely opportunistic coral collections and video surveys during research cruises funded through other projects. Coral by-catch data was also collected during routine multi-species surveys.
- Phase 2 (2001-2003) was initiated following the First International Symposium on Deep-Sea Corals held in Halifax in 2000 (Willison et al. 2001) after which funding was received from the DFO National Environmental Sciences Strategic Research Fund for a three-year period. Research was expanded to include a dedicated remotely operated vehicle cruise in 2001.

In this program most of the on-site observations were made using the BIO-designed Campod (an instrumented tripod equipped with video and still cameras) on board the research vessel, *CCGS Hudson.* It is important to note that Campod was restricted in studying corals and sponges up to a depth of 500 m due to the length of the cable. In 2006, the cable was extended giving the maximum depth of 750 m.

Beginning in 2001, coral samples and data collected during research surveys in the NL Region were archived in Maritimes Region. With support from Memorial University, a fully operational coral collection protocol was put in place for the research surveys and the Fisheries Observer Program (FOP). This launched a long-term NL Region coral research program (Wareham and Edinger 2007a).

The DFO multi-species stock assessment surveys cover areas off central and southern Labrador as well as waters off the northeast and south coasts of Newfoundland. The Northern Shrimp Stock Assessment Survey, co-sponsored by the Northern Shrimp Research Foundation and DFO, extends from southeast Baffin Island to northern Labrador. Observations from the FOP cover a broader area, extending from Baffin Basin southward to the Grand Banks and out to Flemish Cap.

Prior to 2005, the focus of the research was the systematic mapping of coral by-catch (by trawls) which greatly expanded the knowledge of coral distributions and diversity in the NL Region. By that year 30 coral species (Appendix 1) had been recorded which were primarily found along the continental edge and slope with most species found deeper than 200 m (particularly near submarine canyons or saddles where the shelf has been incised). To that date, co-operative efforts had identified two broad coral species richness “hotspots”, one being on the southwest edge of the Grand Bank (16 species) and another area on the Labrador Slope between Hamilton Bank and Belle Island Bank (14 species). FOP indicated an extremely high abundance and moderate diversity of corals off southeast Baffin Island, Davis Strait, Hatton Basin, Saglek Bank, Tobin’s Point, Orphan Knoll, and around the Flemish Cap (Figure 9). Most of these areas have been suggested in previous research based on the research trawl survey results and the local ecological knowledge of commercial fishermen (Wareham and Edinger 2007a).

The research program was substantially expanded in 2005 when three years of funding were obtained through DFO’s International Governance Program. Cooperative studies, led by Memorial University researchers, were initiated on coral distribution; abundance

and diversity; inter-relationships between corals and fish; trophic relationships; condition of corals; growth rates/longevity; oceanographic conditions; taphonomy (post mortem decay of corals) and reproduction/recruitment (see Section 7.7.2). Results of the project so far have significantly expanded the knowledge of coral distributions in the NL and eastern Arctic regions and have identified key areas for coral protection. The funding also permitted a deep-sea cruise in 2007 to study, *in-situ*, benthic habitats and communities of the continental slope (SW Grand Banks, The Gully and Stone Fence Areas) using the Remotely Operated Platform (vehicle) for Ocean Science (ROPOS) to collect high resolution video and still photos. The project led to the documentation and mapping of 36 coral species (Appendix 1) although it is understood that not all areas have been adequately surveyed. This is especially evident in the data-poor areas further north (Gilkinson and Edinger 2009).

All coral and sponge distributional information collected from DFO regional surveys and the Fisheries Observer Program (FOP) are provided to NAFO Scientific Council to assist the council in making recommendations concerning the expansion of measures to protect corals and sponges on the continental shelf and the slope off of Newfoundland and Labrador and in the eastern Arctic (NAFO 2008b). The ICES 2009 coral identification key was created to address issue of variability in observer data. The data can be inconsistent from observer to observer and region to region (NAFO 2009).

Conservation:

Currently, there are very few conservation measures in place to protect corals or sponges in the NL Region. However, the Region has committed to develop a conservation strategy for corals and sponges by 2012. Under the auspices of NAFO, a Coral Protection Zone has been established in NAFO Division 3O, which is approximately 14,000 Km^2. This zone is now closed to all fishing activity involving bottom contact gear and was previously described in Section 4.5 (Figure 7). The closure encompasses a large component of the NL Region.

The Groundfish Allocation Enterprise Council/Canadian Association of Seafood Producers has voluntarily established a 12,500 Km^2 Coral Protection Zone in the northern Labrador Sea (Figure 10). This initiative will be described in more detail in Section 7.5.

Unlike corals, the science and conservation of sponges has received little attention. However, in 2008, funding was approved to develop a preliminary sponge sampling protocol for the multispecies trawl surveys. Sponges that were collected during the 2008 survey are now being identified and catalogued. It is anticipated that more comprehensive collection protocols will be available in 2009 for both the surveys and for the FOP.

7.2.2 Maritimes Region

Science and Research

As indicated above, a collaborative research program between the Maritimes and NL

Regions was established in 1990 to study the potential impacts of mobile fishing gear on benthic marine ecosystems. The long-term objectives were to:

- develop new instrumentation for viewing and sampling marine benthic habitat and communities;
- obtain quantitative information on the impacts of mobile fishing gear on marine benthic habitat and communities;
- collect quantitative information on the recovery rate of benthic habitat and communities after disturbance by mobile fishing gear.

Funding over the years was provided from numerous sources including DFO's Northern Cod Science Program, the Atlantic Fisheries Adjustment Program, the Green Plan Sustainable Fisheries Program, the Environmental Science Strategic Research Fund, and the fishing industry.

Results of the various experiments in the program illustrated that impacts of bottom-contacting mobile fishing gear are extremely variable and depend upon many factors including the kind of gear, how it is used, recovery period, the kind of physical habitat, and the species composition of the benthic community. Lab experiments indicated that soft corals attached to cobbles were not adversely affected by physical disturbance. However, the observations made on other corals indicated their high vulnerability to fishing gear impacts. Benthic organisms most susceptible to the fishing gear studied were mostly large epibenthic forms living at the sediment-water interface. It was suggested that large attached epifauna (i.e. corals and sponges), which are easily disturbed, have slow growth rates and would require approximately a century to recover (DFO 2006d).

With respect to coral research in Maritimes Region, government and university scientists have been active in this area since 1997 when DFO in collaboration with universities, environmental non-governmental organizations, and industry partners began collecting information on corals. In 1997, the Ecology Action Centre in Halifax received funding to identify and map the records of deep-sea coral species on the Scotian Shelf. Information was collected through interviews with fishermen, museum collections, discussion with other researchers in the field as well as the relevant scientific literature (Breeze et al. 1997). In 2000, the Region hosted the First International Symposium on Deep-sea Corals where scientists gathered to discuss advances in coral research (Willison et al. 2001). That same year, DFO initiated a full coral research program largely funded by the Environmental Studies Research Fund (ESRF). This funding was provided from special levies on the oil and gas industry and administered by the National Energy Board of Canada (Mortensen et al. 2006).

Prior to the ESRF coral study, most of the available data was anecdotal in nature and based primarily on fishing bycatch information. It was found that four major groups of cold-water corals occur:

- Alcyonacea (soft corals);

- Gorgonacea (horny corals);
- Scleractinia (stony corals);
- Antipatharia (black corals).

During the ESRF project, data, samples, and distributional information were obtained from research surveys, FOP, interviews with fishers, and four dedicated coral research surveys using DFO research vessels. These survey trips visited the Northeast Channel, Scotian Slope, the Gully, the Laurentian Channel and the southern edge of the Grand Banks. The surveys relied on video and photographs to document the distribution, abundance, and condition of corals in these waters, their preferred habitats and some of their associated species.

As mentioned in the previous section, DFO scientists from BIO collaborated with those at NAFC and Memorial University to explore the fauna in the deep waters in selected areas of Canada's continental slope. The 2007 program involved the deployment of ROPOS from the Canadian Coast Guard Ship (CCGS) Hudson in several areas of operation in the Region: the Gully MPA, the Stone Fence Lophelia Coral Conservation Area, and at the southwest edge of the Grand Banks at Haddock Channel, Halibut Channel and the Desbarres Canyon (Figure 11). More than 3,000 high-resolution digital images, 10,000 high quality screen-shots and many hours of high-resolution colour video coupled with positional data were obtained. Data were collected to depths of 2500 m at both the Gully and Stone Fence and to 2000 m on the southwest Grand Banks.

Information on the sponges found in the marine waters of Maritimes Region is limited, as their presence in fishing gear was previously not systematically recorded. More recently, sponge specimens have been retained from bycatch from multispecies research surveys and the FOP (Figure 4).

Conservation:

Since 2002, DFO Maritimes Region has had conservation measures in place to protect key coral habitats. A Coral Conservation Plan was released in 2006 (DFO 2006e) to address several needs:

- to document previous efforts to conserve corals;
- to put forward a more comprehensive approach on coral conservation;
- to identify issues where additional work was needed;
- to build collaborative arrangements among a variety of groups to address coral conservation.

The Plan (2006-2010) is a component of the Eastern Scotian Shelf Integrated Management Initiative (ESSIM), a collaborative planning initiative in the Region (DFO 2005a). In addition to identifying strategies and actions, the plan also puts forth a site

evaluation process for considering appropriate management measures for areas with corals.

Conservation and management objectives for the Coral Conservation Plan are as follows:

- conserve the health and integrity of coral communities by minimizing impacts of human activities on coral communities and protecting and/or restoring important coral habitats;
- integrate coral conservation requirements into existing management processes and build capacity to address management needs;
- implement a flexible and adaptive approach to management and decision-making based on the best available information related to coral conservation;
- consider and evaluate resource use activities when carrying out coral conservation planning and management;
- provide information to the public on corals and coral conservation measures; and
- collaborate with the international community on cold-water coral issues.

The Maritimes Region has conservation measures in the following areas (Breeze and Fenton, 2007) (Figure 11):

- The Northeast Channel Coral Conservation Area is 424 Km^2 portion of the Northeast Channel off southwestern Nova Scotia. This area had been the focus of coral conservation efforts in the Region since the late 1990s. In June 2002, the Conservation Area was established to protect the high densities of intact octocorals, mainly bubblegum and seacorn coral. The area selected was based on analysis from 2000 and 2001 visual surveys by DFO and Dalhousie University. The conservation area is divided into two zones. About 90% of the area is restricted to all bottom fisheries, while 10% is open only to longline fishing gear (DFO 2002a).
- The Lophelia Coral Conservation Area, established in 2004, is a 15 Km^2 zone located at the eastern end of the Laurentian Channel known as the Stone Fence. In September 2003, mounds of reef-building hexacoral, *Lophelia pertusa* (i.e. spider hazards), were observed. This area was the only known location with living *Lophelia pertusa* colonies on Canada's Atlantic coast until another area was discovered in The Gully MPA (Cogswell et al. 2009). The coral structures and nearby seabed had signs of extensive damage from fishing gear. It is anticipated that the closure will protect the reef complex from further damage and allow for gradual recovery (DFO 2004a).
- The Gully MPA was designated in May 2004 under Canada's *Oceans Act* and comprises an area of 2364 Km^2. One of the objectives of the MPA is to protect the rich diversity of marine habitats and species found there, including many different species of corals. The MPA contains three management zones with varying levels of

protection based on the conservation objectives and the ecological vulnerability of each zone. Zone 1, comprising the deepest parts of the canyon, is preserved in a near-natural state with full ecosystem protection. Zone 2 imposes strict protection for the canyon head and sides, feeder canyons, and the continental slope. Zone 3, which is the least protected, is made up of the adjacent sand banks, which are prone to regular natural disturbance (DFO 2004b).

An important deliverable of the Coral Conservation Plan was the development of a Maritimes Region Deep-Sea corals Outreach and Education Strategy (Martin 2007). The Strategy (2006-2010) identifies key messages and priority outreach and education initiatives for target audiences. The Region developed a corals educational kit which was designed for high schools in Nova Scotia. In 2009, the Maritimes Region released a DVD entitled "*Oasis of the Deep: Cold Water Corals of Atlantic Canada*". The DVD describes the different types of corals found in Atlantic Canada and includes videos and photographs taken during recent scientific surveys (DFO 2008c).

7.2.3 Gulf Region

To date very little information is available on the distribution and species abundance of corals in the waters of the southern Gulf of St. Lawrence. With respect to sponges in the Region, a detailed species list with graphical descriptions was prepared from collections taken in the late 1800s (Lambe 1896). The ICES-NAFO Working Group on Deep-Sea Ecology (WGDEC) has recently compiled the historical sponge taxonomic information along with collections made during the annual research trawl survey of 2003. In total, there are 34 species of sponge recorded, 12 of which were identified following the survey (Fuller 2004). Currently, there are no conservation measures in the Gulf Region to protect corals or sponges.

7.2.4 Quebec Region

To date very little information is available on the distribution and species abundance of coral in the Quebec Region. However, it anticipated that the numerous deep troughs found in this region provide suitable habitat for some species. Although there is no science program in place which specifically targets coral and sponges, specimens are being collected as a by-catch to assess benthos in the research trawl survey area. Future research includes interviews with local fisherman, and a review of DFO scientific survey data to identify the distribution of corals and sponges off western Newfoundland and the north shore of Quebec by a Master's of Science student from Memorial University. In the northern Gulf of St. Lawrence, a marine ecosystem overview and assessment report, prepared by scientists from DFO, indicated the presence of sponges, corals, and anemones (Dufour and Ouellet 2007). Currently, there are no conservation measures in the Quebec Region to protect corals and sponges.

7.2.5 Central and Arctic Region

Science and Research

To date the distribution, abundance, and diversity of corals and sponges in the Central and Arctic (C&A) Region have not been extensively studied. DFO led scientific surveys on the Beaufort Sea Shelf in the Western Arctic were conducted between 1984 and 1988 and started again on an annual basis in 2001. No corals or sponges have been observed in the benthic material collected. The Beaufort Sea Shelf experiences a great degree of ice scour and is composed largely of a mud/sand substrate due to the significant influence of the Mackenzie River plume. Neither condition is conducive to coral or sponge attachment. The shelf break and deep waters of the Beaufort Sea and the waters of the Arctic Archipelago remain unexplored.

In the eastern Arctic many different species of corals and sponges have been observed in the Labrador Sea, Davis Strait, and Baffin Bay (Fig. 1). C&A Region collected coral samples during its multi-species trawl surveys in NAFO Division 0A in 1999, 2001, 2004 and 2006. Both corals and sponges were collected on multi-species surveys in Hudson Strait in 2007 and Division 0A in 2008. The FOP has also recorded corals and sponges from these northern areas. An area of apparent ecological significance is the southeast corner of NAFO Division 0A. Likely due to a combination of ocean currents (meeting of southern Atlantic and northern Arctic currents) and bathymetry (shelf break), this area supports concentrations of corals (including Gorgonian and Antipatharian species) as well as Greenland halibut and narwhals. Corals and sponges will continue to be collected during the upcoming fall 2009 survey in Hudson Strait as per the NL Region's collection protocol. C&A Region does not have a specific coral or sponge research program but works closely with NL Region so that species collected are identified, data is archived, and information reported.

Conservation

In 1998 DFO, with support from the Nunavut Wildlife Management Board (NWMB), restricted fishing effort for Greenland Halibut (Turbot) in NAFO Division OA; to minimize impacts on the winter food source and over-wintering habitat for narwhals. The boundaries for this area were defined based on the best knowledge available at the time (Fig. 12). Corals were first located along the steep shelf break (depths > 500m) in this same area during DFO multi-species trawl surveys conducted in 1999 and 2001. In 2006, given the known negative impacts to corals by fishing gear, DFO proposed a full closure to Greenland Halibut fishing in the restricted area. This proposal was supported by the NWMB, community organizations, and the majority of stakeholders. The full closure was incorporated into the Greenland Halibut Fishery Management Plan (2006-2008) and implemented for the 2008 fishing season (DFO 2007a). Restrictions have not been placed on shrimp fishing vessels in the area because they fish in shallow waters (<400

m). New information available on coral distribution and narwhal movements indicates the southeast corner of NAFO Division 0A contains sensitive habitat and species within and beyond the closed area.

7.2.6 Pacific Region

Science and Research

The Pacific Region contains both corals and sponges, with the hexactinellids or glass sponge reefs having received the most attention. Corals have received less focus to date although substantive effort has been made in recent years in mapping distributions, taxonomy, fisheries impacts, and zoogeography.

Currently, 80 species of corals have been documented in the Pacific Region but other species may also occur in these waters, as 50 additional corals have been found from southeast Alaska, around Gulf of Alaska seamounts and off the states of Washington and Oregon (DFO 2008a, Jameison, et al 2007, ICES 2009). To date, corals found in this region have been located on the continental shelf and slope, particularly on the flanks of the banks and are therefore vulnerable to bottom trawling activities. Most of the corals in the northeast Pacific are Gorgonian (i.e. octocorals), or horny corals which attach to rocks and have a branching tree-like appearance. They are most common between 100 and 300 m depth. These species can form large colonies or forests and are considered to be the “backbone” of the coral ecosystem in the Pacific Region (Conway et al. 2005; Conway et al. 2007; Cook et al. 2008). Colonies can be up to 3 m high, 7 m wide and individuals may live for over 500 years. The octocoral group, which consists primarily of three Families, has habitat-forming characteristics that are an important contribution to deep-water benthic communities. These are:

- *Primnoidae* (i.e. red tree coral) at depths between 100-500 m;
- *Paragorgiidae* (i.e. bubble gum tree coral) at depths between 0-800 m;
- *Isididae* (i.e. bamboo coral) at depths between 600-1200 m.

Included in the octocoral group are the gorgonian sea pens and sea whips (i.e. *Pennatulacidae*), which can be quite abundant in areas of softer substrate. A portion of their bodies is buried in the substrate which provides stability for the animal in stronger currents.

The reef-building hexacoral, *Lophelia pertusa*, has not yet been found in abundance but it does exist in Juan de Fuca Canyon, Alberni Inlet, and Strait of Georgia (Figure 13). This is a highly branched massive coral that occurs on flat substrates and its reefs can exceed two metres in height and extend over large areas (DFO 2006b).

Although the marine waters of the Pacific Region contain at least 250 species of sponges only seven of these are the habitat-forming glass sponges (ICES 2009). Research on the

ecological significance of glass sponges is limited, although the distribution of their sponge reefs or bioherms has been better documented. The *hexactinellids* (i.e. glass sponges) are slow-growing, long-lived, and are globally unique. Sponge bioherms are actually communities of several different sponge species but in the Pacific Region, three reef-building species predominate. The bioherms can increase in size over the course of centuries to exceed 19 m in height with steep slopes on the flanks and can have live sponges up to 1.5 m high.

Four glass sponge reef complexes were discovered in 1987 by the Geological Survey of Canada during geophysical surveys of the seafloor troughs of Queen Charlotte Sound and Hecate Strait (NRCan 2008). The reef-building sponge species were also found outside of the reefs. At least five large sponge species occur at depths of 15-35 m in a number of fiords in the Strait of Georgia. It has been noted that glass sponges can be significant components of coral forests.

In the summer of 2008, DFO and Canadian Healthy Oceans Network funded a scientific cruise to collect corals and sponges in the Dixon Entrance area (between Queen Charlotte Islands and southeast Alaska). The same cruise also went to Olympic Coast National Marine Sanctuary, near the Washington State/British Columbia border. This component of the cruise was funded by the United States (Edinger et al, 2008).

Conservation

Beginning in 1996, 100% observer coverage became mandatory in the Pacific Region's bottom trawl fishery. Coral and sponge by-catches have been recorded since that time, but as non-commercial species they were not reported in much taxonomic detail, and the training in the FOP was minimal. This situation has improved since 2003. A total of 295 tonnes of coral and sponge were observed as by-catch in the Region's trawl fishery from 1996 to 2002. These observations are likely under-reported and it is possible that many of the damaged coral and sponge fragments remain on the sea floor. Density analysis of the by-catch weights $(Kg/Km^2)^{0.5}$ from 1996-2002 indicated twelve areas of both high coral/sponge species concentration, representing about 7.5% of B.C.'s continental shelf and slope (Ardron et al 2007; DFO 2006b).

To date, the Pacific Region has not implemented conservation measures specifically for corals. There are, however fishery closures for the three main glass sponge reef assemblages in the Hecate Strait (Figure 14). Starting in 2000, the trawl fleet voluntarily avoided fishing in these four key sponge reef areas. However, video evidence indicated that the voluntary closures were not effective, which led to mandatory groundfish trawling closures under the *Fisheries Act* in July 2002 (DFO 2002b). This was put in place by DFO with the support of the Canadian Groundfish Research and Conservation Society and the Groundfish Trawl Advisory Committee. More damage occurred after 2002 and surveys by Natural Resources Canada using video and multibeam survey equipment revised the understanding of the size and shape of the sponge reefs (DFO 2007b). The fishing industry supported further changes to the boundaries of the groundfish trawl closures in 2006. With these changes the total area of closure now amounts to 1,661

Km². Figure 14 is a map of the three current closures which protect four sponge reefs from bottom trawling (DFO 2008d). The three hexactinellid sponge reef areas protected are:

- reef A1 and A2 located on McHarg Bank off Banks Island in Hecate Strait;
- reef B located in Mitchell's Trough north off Aristazabal Island in Hecate Strait;
- reef C located in Mitchell's Trough south in Hecate Strait;
- reef D located in Goose Trough off Hunter Island in Queen Charlotte Sound.

In April 2008, the Bowie Seamount located 180 Km west of Haida Gwaii (Queen Charlotte Islands), was designated as a MPA under the *Oceans Act*. This seamount has a total area of approximately 6,300 Km2 and is part of a diverse biological ecosystem. The area adjacent to the seamount has an abundance of phytoplankton and zooplankton which support microscopic plants and animals at the base of the food web and the marine community as a whole. High densities of crab, sea stars, sea anemones, sponges, and corals are present on and around the seamount (DFO 2008b).

Pacific Region is in the process of finalizing a Coral and Sponge Conservation Strategy which will serve as a guide for staff to address coral and sponge conservation in the management of activities that may impact these species. DFO has been working with Canadian Parks and Wilderness Society (CPAWS) on the development of the strategy. The draft strategy outlines a set of conservation, management, and research objectives, along with a framework for strategies and actions to achieve the objectives. An implementation plan and process have also been outlined (DFO 2008a). In November 2008, DFO and CPAWS hosted a stakeholder workshop to review the draft strategy (Gardner 2009). The Pacific Region is currently working on a second draft and it is anticipated the strategy will be completed in 2010.

7.3 NATURAL RESOURCES CANADA (NRCAN)

Natural Resources Canada's interest in coral and sponge research stems from their mandate to understand the seabed geology and biology and the factors that influence the present distribution of geological and biological elements of continental shelf systems. NRCan's objective concerning sponge grounds is "*…to understand the modern geological, oceanographic and biological environment of sponge reefs as they exist on our continental shelf.*"

During a seafloor mapping exercise in British Columbia's Hecate Strait, Geological Survey of Canada (GSC) scientists from NRCan observed (using sonar imaging) a series of permeable mounds over large areas of the ocean floor. Similar acoustic anomalies were observed again in 1986 during a survey in Queen Charlotte Sound. Four sponge reef complexes at water depths of 165-240 m were discovered in 1987-1988 in three seafloor troughs of Queen Charlotte Sound and Hecate Strait (Conway et al. 2005). The northernmost reef was located 16 Km offshore from Banks Island and the southern most was 80 Km north of Vancouver Island. Since that time, substantial advances have been

made using multibeam swath bathymetry, side scan sonar, submersible and remotely operated vehicles to map distributions and provide new insights into the structure of the sponge reefs. Bathymetry and backscatter maps show the distribution and form of reefs in two large complexes in the Queen Charlotte Basin covering hundreds of square kilometres and three smaller reef complexes in the Georgia Basin. Coring of glass sponge bioherms and radiocarbon dating of carbonate shells indicate that the reefs have been growing for the past 10,000 years.

Scientists from the GSC's Pacific Geosciences Centre, in collaboration with researchers at the University of Stuttgart (in Germany), have initiated a multidisciplinary project to understand the modern geological, oceanographic and biological environment of sponge reefs as they exist on our continental shelf (Sponge Reef Project 2008). Specific objectives include:

- mapping the distribution of sponge reefs and understanding the geological and physical processes of formation to provide guidance and support to ocean management related decisions with respect to fisheries and potential oil and gas development;
- determining the critical physical and chemical oceanographic influences on sponge reef development, and determine the mechanisms of sponge reef growth, both biotic and abiotic;
- providing a geological and geophysical framework for an understanding of the biologic system that the reefs represent, and contribute to the overall understanding of the sponge reef ecosystem.

Over the period 2002-2006, GSC scientists:

- undertook multibeam surveys of Hecate Strait and Queen Charlotte Basin sponge reef complexes and produced final multi-beam maps for the four sponge reef complexes;
- mapped and delineated benthic habitats by integrating seabed video tracts with geophysical habitat coverage in cooperation with DFO scientists;
- prepared maps of the areal extent of sponge reefs using geophysical data and multibeam coverage;
- deployed current metres and sediment traps as components of oceanographic moorings on sponge reefs;
- actively participated in public workshops with DFO to disseminate the results of the collaborative understanding of sponge reefs as critical habitat for fisheries managers and appropriate non-governmental organizations;
- compiled a description of biological attributes of the sponge reefs and integrated these with the geological understanding of reef distribution and development.

In October 2008, the Canadian Parks and Wilderness Society (CPAWS), University of Alberta, and NRCan hosted a Glass Sponge Reef Symposium at the Institute of Ocean Sciences in Sidney, BC. The goal of the symposium was to present recent scientific work on sponge reefs with the objective of determining new directions for sponge reef research, and to examine ways to advance conservation and management of these sensitive seafloor areas.

In the Northwest Atlantic, NRCan has been investigating the linkage between petroleum seepages to specific concentrations of corals and sponges in Canadian waters (C. Jauer, Personal Communication 2009). The concept stems from research in Norway on benthic communities of deep water corals in areas of seeping petroleum fluids.

7.4 PARKS CANADA

Parks Canada is progressing towards the establishment of four new National Marine Conservation Areas (NMCAs) across the country. Two of these, Lancaster Sound in the Arctic and Iles de la Madeleine in the southern Gulf of St. Lawrence, have yet to be studied for the presence of corals and sponges. The remaining two proposed NMCAs are in the marine waters off British Columbia. The proposed Gwaii Haanas National Marine Conservation Area Reserve is located at the southern end of the Haida Gwaii/Queen Charlotte Islands and will represent both the Hecate Strait and Queen Charlotte Shelf regions (Parks Canada 2008). The area will extend about ten kilometres offshore and encompass approximately 3,400 Km^2 of the Hecate Strait and Queen Charlotte Shelf marine regions. The continental shelf is very narrow on the outside of the Queen Charlotte Islands and the outer limit of the NMCA boundary could extend offshore to depths of more than 1000 m, where corals commonly occur. There are also a few deep areas within the proposed NMCA on the east side of the islands which may have corals and sponges (DFO 2006a) (Figure 16).

Parks Canada, working cooperatively with various groups and agencies, is also evaluating the feasibility of establishing the Southern Strait of Georgia National Marine Conservation Area (Parks Canada 2007). The area encompasses about 900 Km^2 and extends from along the east side of Vancouver Island. The feasibility study, to be completed in 2009, is exploring how to zone the marine areas for different levels of protection. Management strategies will be developed for protecting species at risk and special habitats, such as the glass sponges of Saanich Inlet (Parks Canada 2007).

7.5 FISHING INDUSTRY

The fish processing industry in Canada is represented by the Fisheries Council of Canada (FCC) which has been active in dealing with fisheries management, environmental, and ocean use issues. The FCC is a non-profit trade association representing companies engaged in the growing, harvesting, processing, and marketing of fish and seafood. It is an organization of fisheries and seafood associations and enterprises that support shared, fundamental principles. FCC membership includes

Canadian Association of Prawn Producers, Groundfish Enterprise Allocation Council and the Northern Coalition who have been active in addressing concerns regarding fishing impacts on sensitive areas including corals and sponges. The growing conservation awareness of the fishing industry has resulted in cooperative efforts to improve harvesting technologies in Canada. In particular, the industry has implemented measures to reduce by-catch of non-target species. Initially these efforts focused on juvenile and non-target fish species but more recently attempts have been made to reduce impacts on the marine environment (i.e. corals and sponges).

In May 2007, Canada's offshore shrimp and groundfish trawling industry was comprised of the Canadian Association of Prawn Producers (CAPP), the Groundfish Enterprise Allocation Council (GEAC) and the Northern Coalition (NC) voluntarily closed fishing to protect coral concentrations in the northern Labrador Sea (Figure 10). The fishing organizations established a 12,500 Km^2 Coral Protection Zone to protect mainly gorgonian corals (Fisheries Council of Canada, 2007). Gilkinson et al 2009 have stated that the current configuration of the closed area is inadequate in size and location to protect areas that contain high areas of coral by-catch.

Other measures taken to conserve corals include:

- incorporation of a coral monitoring program into research surveys conducted by industry;
- fishing captains work cooperatively with independent at-sea observers to collect data on encounters with corals;
- fishing captains cease fishing and retrieve gear if they believe they are in an area where large tree-like corals may exist, even outside the Coral Protection Zone;
- fishing captains are not to fish in coral protection zones already established by DFO.

The annual northern shrimp research survey, conducted by the industry off northern Labrador, is a collaborative effort with DFO Science in NL Region. The survey extends for six weeks and the results are used for Northern shrimp stock assessment purposes. All corals and sponges and distributional data which are collected in the survey are returned to DFO for processing.

In 2008, the Canadian Northern prawn fishery was the first fishery in Canada to attain the Marine Stewardship Council (MSC) certification for sustainable fishing (MSC 2008). The MSC is an international non-profit organization established to certify that fisheries are sustainable. The certification is based on the FAO Code of Conduct for Responsible Fisheries and other international conservation agreements. Fisheries that are certified must be able to demonstrate that their operations be managed to maintain the structure, productivity, function, and diversity of the ecosystem on which the fishery depends. The MSC operational criteria (MSC 2002) which must be followed in the fishery include:

- making use of fishing gear and practices designed to avoid the capture of non-target species;
- implementing appropriate fishing methods to minimise adverse impacts on habitat, especially in critical or sensitive zones;
- minimising operational waste;
- conducting the fishery in compliance with the fishery management system;
- assisting and cooperating with management authorities in the collection of catch, discard, and other information of importance to the effective management of the resource.

7.6 ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS

7.6.1 World Wildlife Fund (WWF)

Internationally, the World Wildlife Fund (WWF) has raised concern regarding the impacts on cold-water corals found in the world's oceans. As corals are slow-growing, long-lived, and vulnerable to impacts by fishing, the WWF is concerned that the reefs and their ecosystems would be destroyed before they are mapped and scientifically studied. WWF has been advocating for networks of marine protected areas to be established around the world to protect cold-water coral reefs.

WWF-Canada has been working on the protection of cold-water corals since 2002, when they convened a multi-stakeholder workshop in January to assess cold-water coral conservation. As a direct result of this workshop, a WWF report entitled "*Conservation of Deep-Sea Corals in Atlantic Canada*" was released (Gass 2003). This report outlined a draft conservation strategy and next steps for cold-water coral conservation, including the need for the establishment of a multi-stakeholder group to strengthen deep-sea coral research collaborations and conservation in Atlantic Canada. WWF hosted a second workshop in January 2003, which helped finalize the formation of the Atlantic Canada Coral Initiative (ACCI). ACCI is an open participatory organization for people interested in deep-sea corals in Atlantic Canada (Atlantic Canada Coral Initiative 2003).

During the 2007 NAFO Scientific Council meeting, WWF Canada presented a report entitled *Coldwater corals off Newfoundland and Labrador: Distribution and fisheries impacts* (Edinger et al. 2007). The presentation to NAFO demonstrated the impact on corals of by-catch fisheries in the northwest Atlantic area and identified the need for protection of critical coral habitat (WWF 2007). WWF-Canada is also a member of the Working Group on Fishery Managers and Scientist on VMEs.

A Collaborative Agreement was signed between WWF-Canada and Fisheries and Oceans Canada in October 2008 (replacing an earlier agreement signed in 2006) to achieve shared objectives for the conservation, protection, and sustainable development of Canada's oceans (DFO 2007c). The agreement specifically identifies collaborative research and management efforts related to coral and sponge conservation.

7.6.2 The Canadian Parks and Wilderness Society (CPAWS)

The Canadian Parks and Wilderness Society (CPAWS) is a national organization which has focused on wilderness protection. With respect to the oceans and freshwater, their goals are to:

- establish a network of marine protected areas in Canada's waters, especially National Marine Conservation Areas (NMCAs);
- conserve special marine features, like the Hecate Strait glass sponge reefs, cold water corals, and the Bay of Fundy horse mussel reefs;
- encourage sustainable use of marine and coastal resources.

CPAWS has 13 chapters across Canada. The BC chapter has been very active in campaigning for permanent legislated protection for the sponge reefs of Hecate Strait. It also has partnered with DFO in developing the Coral and Sponge Conservation Strategy for the Pacific Region. In October 2008, the BC Chapter was one of the sponsors of a Glass Sponge Reef Symposium (CPAWS 2008).

7.6.3 Living Oceans Society

Living Oceans Society (LOS) focuses exclusively on marine conservation issues. It is based in Sointula, a small fishing village on the Central Coast of BC. LOS advocates for managing oceans for the common good, following science-based policies that take into account entire ecosystems.

LOS has recommended DFO expand its areas of protection for corals and sponges in BC waters. A report published in 2005 by the Society entitled "*Protecting British Columbia's Corals and Sponges*" indicated that the greatest hazard to the survival of coral and sponges in BC is bottom trawling (Living Oceans Society 2005). Based on the analysis of observer data from the fishery, LOS made nine recommendations, including the closure of 12 Coral-Sponge Protection Areas in Hecate Strait and on the continental slope off the west coast of Vancouver Island (Ardron 2005, Figure 15).

In June 2009, LOS hosted a news conference in Vancouver to announce the launch of a deep-sea expedition to obtain footage of coral and sponge grounds in the Hecate Strait. The *Finding Coral* expedition was specifically designed to study deep water corals and document hazards to their well being (Living Oceans Society http://www.findingcoral.com/).

7.6.4 David Suzuki Foundation

The David Suzuki Foundation, in its Oceans and Sustainable Fishing Program, focuses on conserving, protecting, and restoring the health and diversity of marine and freshwater ecosystems. The Foundation works to ensure that the oceans are well managed and that marine ecosystems maintain their diversity and abundance.

In the 2008 report entitled "*State of the Ocean in the Pacific North Coast Integrated Management Area (PNCIMA)"* which was published on behalf of the David Suzuki Foundation (David Suzuki Foundation 2008), concern was expressed about commercial activities, which impact the survival of glass sponge reefs and corals in the PNCIMA (Hall 2008). It was acknowledged that in 2002, DFO restricted bottom trawling in some regions of the PNCIMA to protect glass sponge reefs. Though the boundaries were readjusted in 2006, concern still exists that the buffer zones around the reefs may need to be extended. The report suggests that comprehensive ecosystem-based management should be applied to ensure that sponge reef and coral systems are not destroyed or lost before they are scientifically described and understood.

7.6.5 The Sierra Club

The Sierra Club has been active in Canada since 1969, working to influence public policy and environmental awareness. It has local chapters and working groups in every region of the country. Sierra Club BC was formed in 1969 when a campaign was launched to protect forests and wilderness areas. More recently, the organization has been especially active in advocating on marine conservation issues.

The Sierra Club BC chapter joined with LOS and the David Suzuki Foundation in 2008 to urge the federal government to more vigorously protect Canada's oceans. Of particular concern, was the lack of progress being made in the formal establishment of PNCIMA; where, long-term protection and sustainable use of resources would be assured. This area contains glass sponge reefs and corals which are susceptible to active bottom trawling.

7.6.6 Georgia Strait Alliance

Since 1990**,** Georgia Strait Alliance has been the only citizen's group focused on protecting the marine environment in and around the whole Strait of Georgia. The Alliance is a non-profit, charitable organization working to:

- protect marine life and its habitat;
- restore our region's water and air quality;
- promote sustainable communities;
- foster stewardship of the marine environment.

Sponge reefs have been discovered in the Strait of Georgia and the Alliance has been asking the federal government for permanent protection of the reefs and the restricting of bottom trawling on or in the area of the reefs. The Georgia Strait Alliance is a strong supporter of the southern Strait of Georgia NMCA initiative (Parks Canada 2007) and a network of marine protected areas along the BC coast.

7.6.7 Canadian Ocean Habitat Protection Society

In 1996, the Canadian Ocean Habitat Protection Society, a group comprised of mostly Nova Scotian fisherman, raised public awareness of coral conservation (Cogswell et al.

2009). The COHP has worked closely with Dalhousie University and the other environmental organizations to promote awareness of corals off Nova Scotia, as well as the impacts that fishing gear have had on these species. The Society has pressured DFO to protect areas from damage from fishing gear.

7.6.8 Ecology Action Centre

In 1997, the Ecology Action Centre (EAC) was the first group in Canada to attempt to assess the distribution of deep sea corals off Nova Scotia (Cogswell et al. 2009). This was a landmark publication using museum records and Local Environmental Knowledge from fisherman to map coral distributions on the Scotian Shelf. This publication has brought deep-sea corals back into the public and scientific communities, and has helped to focus deep-sea research in the Maritimes (Cogswell et al. 2009).

The EAC works closely with social and natural scientists to address marine and coastal issues in Nova Scotia. The Marine Issues Committee of the EAC works to ensure the conservation, protection, and restoration of the marine ecosystem, as well as maintaining sustainable fisheries for coastal communities, on a local, national, and international scale. Their objectives are in support of:

- fisheries management decisions which support fishing practices that minimize habitat damage and by-catch. EAC conduct's research and raises awareness on destructive fishing practices while promoting alternatives, including gear substitutions, modifications, and area closures;
- fisheries law, policy, and management decisions, both nationally and internationally, that are responsive to scientific input and provide for public involvement, with the primary objective of protecting and restoring the marine ecosystem;
- a functioning zoning system off Nova Scotia that protects critical habitat areas from the fishing practices that damage them as well as extensive marine planning that properly engages all stakeholders.

7.7 ACADEMIA

7.7.1 Overview

This section briefly outlines some of the research and scientific work at universities across Canada. As the cost of reaching coral and sponge study sites can be quite substantive, most of the academic programs are integrated with DFO and NRCan science programs and they are able to use government scientific surveys on Canadian Coast Guard vessels.

7.7.2 Memorial University of Newfoundland (MUN)

Researchers at MUN (Biology, Geography, and the Ocean Science Centre) have been conducting coral-related research in the following areas:

- coral reefs and environmental impacts on them;
- the paleoecology of fossil coral reefs;
- the biogeography and conservation of cold-water coral reefs;
- impact of mining on reefs and other marine environments;
- marine protected area design (corals focus);
- marine conservation and distributional mapping of corals;
- reproduction and the reproductive patterns of corals;
- microscopic structure of corals;
- spawning and larval behaviour/settlement and juvenile growth in soft corals;
- stable isotope analysis of corals;
- growth rates and longevity and biogeochemistry of corals;
- marine community ecology and biodiversity;
- deep-sea and coral ecology;
- disturbance and anthropogenic impacts on marine communities;
- coral diversity structure relative to habitat type.

7.7.3 Dalhousie University

Coral and sponge specialists at Dalhousie University (Oceanography, Earth Sciences, Bio-Medicine, and Biology) have been working in the following areas:

- ecology of deep-water coral ecosystems;
- larval production, dispersal, and recruitment of invertebrates in deep-sea habitats;
- benthos structure associated with deep-sea corals.

7.7.4 McMaster University

Current research on corals at McMaster University (Earth Sciences) includes:

- stable isotopes in coral reef organisms as pollution indicators;
- climate change encoded in corals.

7.7.5 University of Alberta

Sponge expertise in the Department of Biological Sciences at University of Alberta is studying:

- evolutionary and developmental biology in sponges;
- embryonic and physiological processes in living sponges;
- developmental mechanisms in basal metazoans;
- mechanisms of cell to cell communication in sponges.

7.7.6 University of Victoria

Sponge related research at the University of Victoria (School of Earth and Ocean Sciences) has concentrated on:

- hexactinellid sponges and their associated biota taxonomy;
- biota associated with different bottom types, including gorgonian coral and sponge habitat
- biology and ecology of sponge reefs.

7.7.7 University of Stuttgart (Germany)

Working cooperatively with NRCan and DFO, researchers at the University of Stuttgart have been focusing on:

- paleoecology and taxonomy of sponge reefs including the accompanying fauna;
- biology and ecology of hexactinellid sponges;
- biology and ecology of the glass sponge reefs off British Columbia to better understand their fossil record.

7.7.8 Universidade de Vigo (Spain)

Working cooperatively with the Bedford Institute of Oceanography, DFO researchers at the Universidade de Vigo, Instituto Español de Oceanografía (IEO), Instituto das Pescas da Investigação e do Mar (IPIMAR) and British Geological Survey (BGS) have been focusing on:

- ecology, geomorphology and sedimentology of benthic areas in sensitive high-sea regions;
- taxonomy and abundance of corals and sponges;
- incorporating an ecosystem-based approach to developing a vulnerable marine ecosystems risk framework to fisheries management.

8.0 CONCLUSIONS

Corals and sponges are distributed throughout the marine waters of Canada's Atlantic, Pacific, and the eastern Arctic Oceans. Unique glass sponge reefs are found in the Pacific waters of British Columbia. Little was known about corals and sponges until recently, when collections and observations commenced using scientific surveys, observer programs, fishermen's knowledge, and deep-water video and camera technology.

Corals and sponges are vulnerable to a number of activities, most notably fishing activities. As a result they have become a focal point for international commitments to protect them. Calls for conservation have out-paced science's ability to answer key questions regarding basic biology, distribution, and function within temporal ecosystems. In Canada, DFO is the lead department responsible for research and conservation of these species. There is a range of legislative tools available to protect corals and sponges. Although no national strategy exists, three DFO regions have, or are in the process of, developing conservation strategies or plans. In addition, DFO's Sustainable Fisheries Framework is developing an approach to address fishing impacts on sensitive benthic ecosystems, starting with corals and sponges.

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Bowie Seamount Marine Protected Area: www.pac.dfo-mpo.gc.ca/oceans/mpa/bowie/default_e.htm

Canada Department of Justice: http://laws.justice.gc.ca/en/

Canada National Marine Conservation Areas Act: www.laws.justice.gc.ca/en/C-7.3/index.html

Canada's Oceans Strategy: www.dfo-mpo.gc.ca/oceans-habitat/oceans/ri-rs/cos-soc/page02_e.asp

Canadian Environmental Assessment Agency**:** www.ceaa.gc.ca/default.asp?lang=En&n=D75FB358-1

Canadian Environmental Protection Act**:** www.laws.justice.gc.ca/en/showtdm/cs/C-15.2

Canadian Healthy Oceans Network: http://www.marinebiodiversity.ca/CHONe

Canadian Parks and Wilderness Society: www.cpaws.org/

Committee on the Status of Endangered Wildlife in Canada: www.cosewic.gc.ca/eng/sct5/index_e.cfm

Convention on Biological Diversity: www.cbd.int/

Convention on International Trade in Endangered Species of Wild Flora and Fauna - International: www.cites.org/

Convention on International Trade in Endangered Species of Wild Flora and Fauna – Canada: www.cites.ca/

David Suzuki Foundation: http://www.davidsuzuki.org/

Deep-Sea Corals in Atlantic Canada: http://www.marinebiodiversity.ca/CoralWebsite/Homepagecorals.htm

Department of Fisheries and Oceans Act: www.laws.justice.gc.ca/en/showtdm/cs/F-15

DFO 2005 – 2010 Strategic Plan: www.dfo-mpo.gc.ca/dfo-mpo/plan-eng.htm

DFO Marine Protected Areas: www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/index-eng.htm

DFO Maritimes Region Coral Conservation Measures: www.mar.dfo-mpo.gc.ca/oceans/e/ocmd/coral/coral-measures-e.html

DFO Maritimes Region Coral Conservation Plan: http://www.mar.dfo-mpo.gc.ca/oceans/e/ocmd/coral/coral-plan-e.html

Ecology Action Centre: www.ecologyaction.ca/

Fisheries Act: www.laws.justice.gc.ca/en/showtdm/cs/F-14

Fisheries and Oceans Canada: www.dfo-mpo.gc.ca/index-eng.htm

Fisheries Council of Canada: www.fisheriescouncil.ca/

Georgia Strait Alliance: www.georgiastrait.org/

Gwaii Haanas National Marine Conservation Area: www.pc.gc.ca/pn-np/bc/gwaiihaanas/natcul/index_e.asp

Health of the Oceans Funding: www.dfo-mpo.gc.ca/oceans/management-gestion/healthyoceans-santedesoceans/who-qui-eng.htm

Industry Coral Protection Zone in MPA News: http://depts.washington.edu/mpanews/MPA87.htm - voluntary

International Council for the Exploration of the Sea (ICES): www.ices.dk/indexfla.asp

Living Oceans Society: http://www.livingoceans.org/default.aspx and http://www.findingcoral.com/

Marine Stewardship Council: www.msc.org/

Maxent software for species habitat modeling: http://www.cs.princeton.edu/~schapire/maxent/

National Oceanographic and Atmospheric Administration's Coral Reef Conservation Program: http://coralreef.noaa.gov/

Natural Resources Canada Geological Survey of Canada: http://gsc.nrcan.gc.ca/index_e.php

Northwest Atlantic Fisheries Organization (NAFO) Report of the Fisheries Commission September 2008: www.nafo.int/fisheries/frames/reports.html

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Oceans Act: www.laws.justice.gc.ca/en/showtdm/cs/O-2.4

Oceans Action Plan: www.dfo-mpo.gc.ca/oceans-habitat/oceans/oap-pao/index_e.asp

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Queen Charlotte Basin Ocean Management: http://ess.nrcan.gc.ca/2002_2006/gom/queen/workplan_e.php/

Sierra Club of British Columbia: www.sierraclub.bc.ca/

Southern Strait of Georgia National Marine Conservation Area: www.pc.gc.ca/progs/amnc-nmca/cnamnc-cnnmca/dgs-ssg/page3_e.asp

Species at Risk Act: www.laws.justice.gc.ca/en/showtdm/cs/S-15.3

Species at Risk Public Registry: www.sararegistry.gc.ca/default_e.cfm

Sponge Reef Project: www.porifera.org/a/cif1.htm

Sponge Reefs on the Continental Shelf: http://gsc.nrcan.gc.ca/marine/sponge/index_e.php

Sustainable Fisheries Framework: www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/overview-cadre-eng.htm

The Gully Marine Protected Area: www.mar.dfo-mpo.gc.ca/oceans/e/essim/gully/essim-gully-e.html

United Nations Environment Programme (UNEP), World Conservation Monitoring Centre: www.unep-wcmc.org

United Nations Food and Agricultural Organization (FAO) - Code of Conduct for Responsible Fisheries: www.fao.org/fishery/ccrf/en

United Nations Food and Agricultural Organization (FAO): www.fao.org/fishery/en

United Nations General Assembly Resolutions: www.un.org/Depts/los/general_assembly/general_assembly_resolutions.htm

World Wildlife Fund: www.worldwildlife.org/

World Wildlife Fund-Canada: http://wwf.ca/

11.0 TABLE

Table 1. Taxonomy of major coral groups (from Hourigan et al. 2007).

PHYLUM CNIDARIA

Class Anthozoa – corals, sea anemones, sea pens

- Subclass Hexacorallia (Zoantharia) – sea anemones, stony & black corals
  - Order Scleractinia – stony corals
  - Order Zoanthidea – zoanthids
  - Order Antipatharia – black corals
- Subclass Octocorallia (Alcyonaria) – octocorals
  - Order Alcyonacea – true soft corals, stoloniferans
  - Order Gorgonacea – sea fans, sea whips
  - Order Pennatulacea – sea pens
  - Order Helioporacea – Lithotelestids & blue corals

Class Hydrozoa – hydroids and hydromedusae

- Order Anthoathecatae – stylasterid (lace) corals & fire corals

Class Cubozoa – does not contain corals

Class Scyphozoa – does not contain corals

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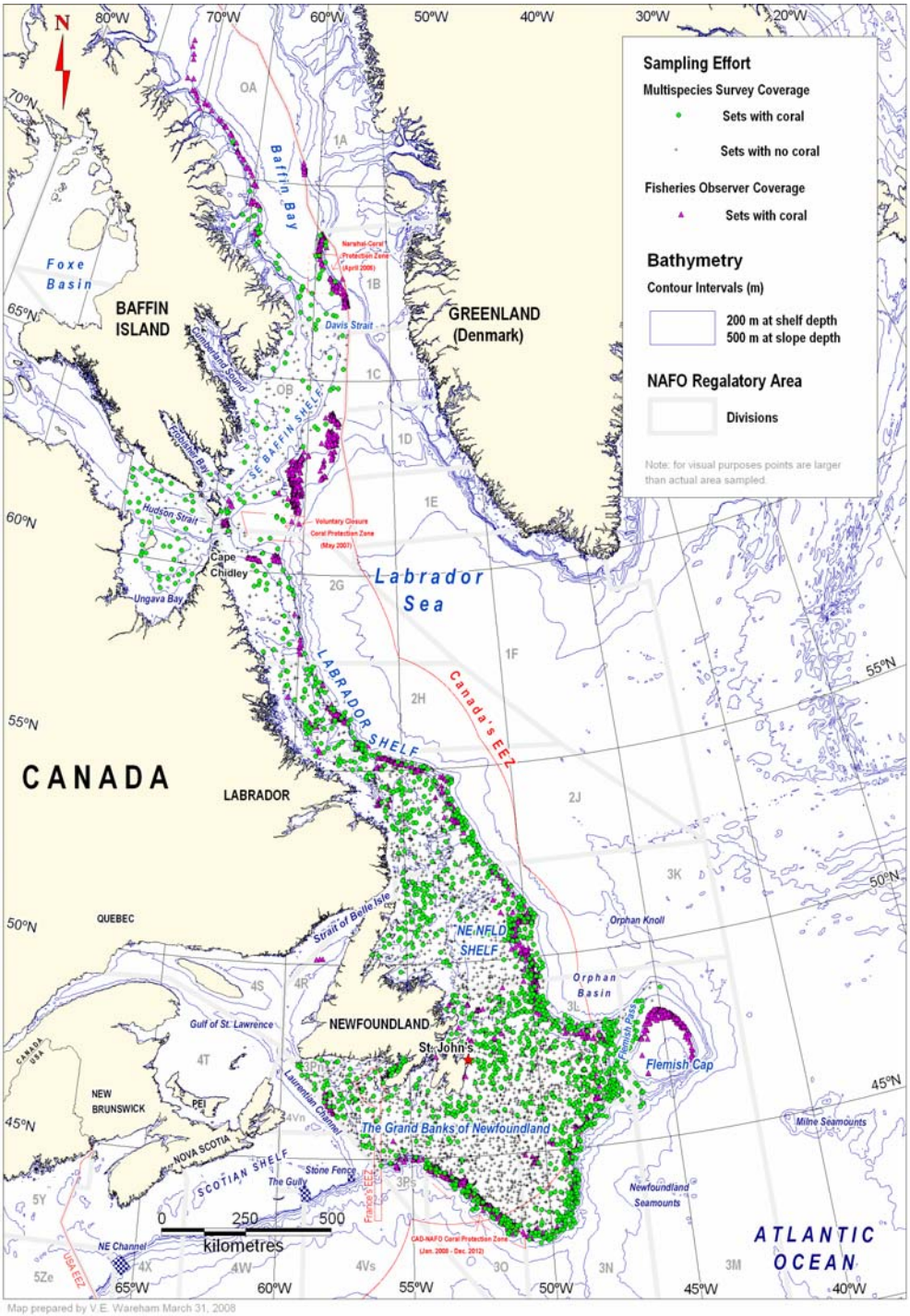

Figure 1. Distribution of cold-water corals off Newfoundland and Labrador and in eastern Arctic waters (adapted from Gilkinson and Edinger 2009).

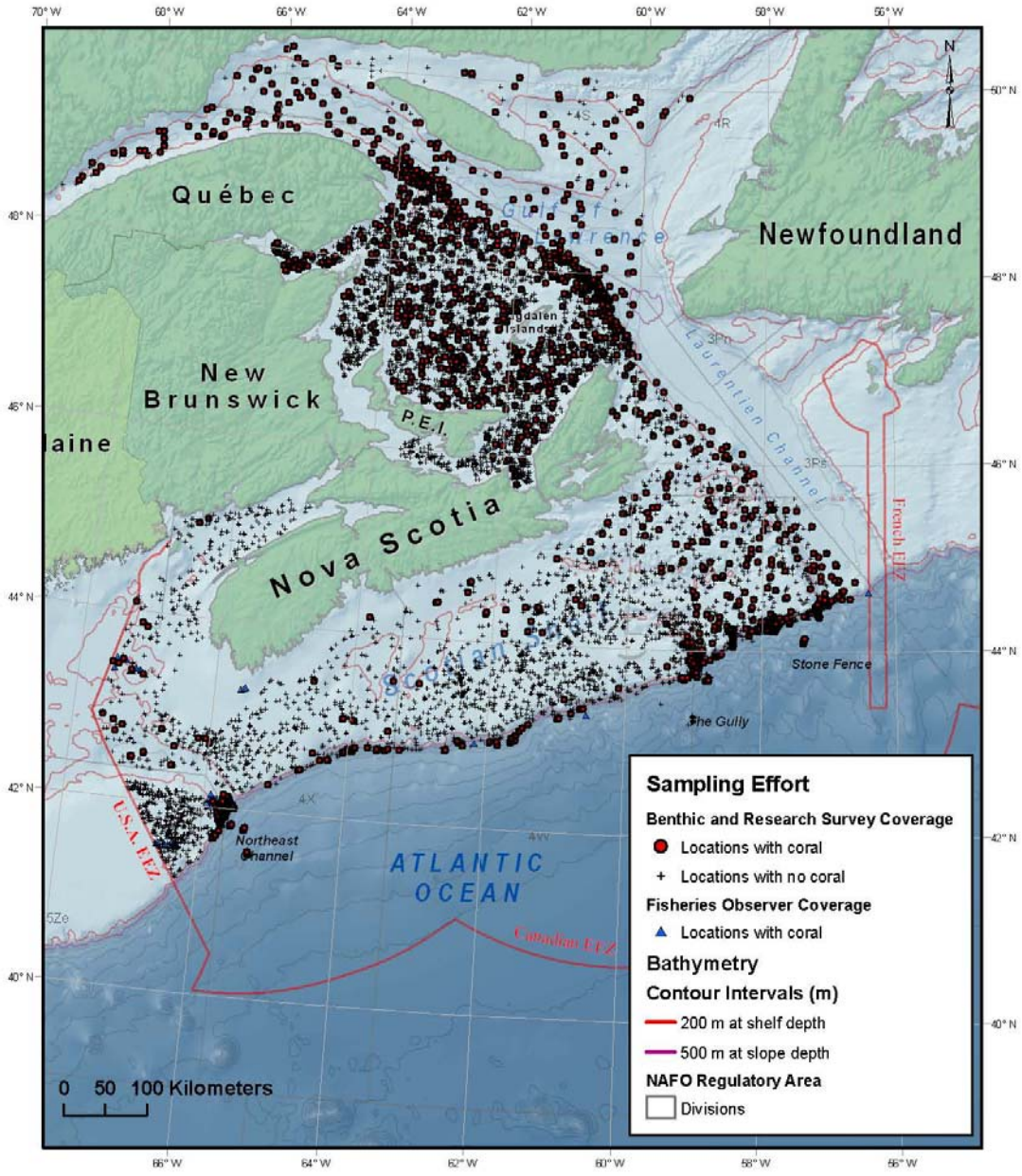

Figure 2. Distribution of cold-water corals on the Scotian Shelf and in the Gulf of St. Lawrence.

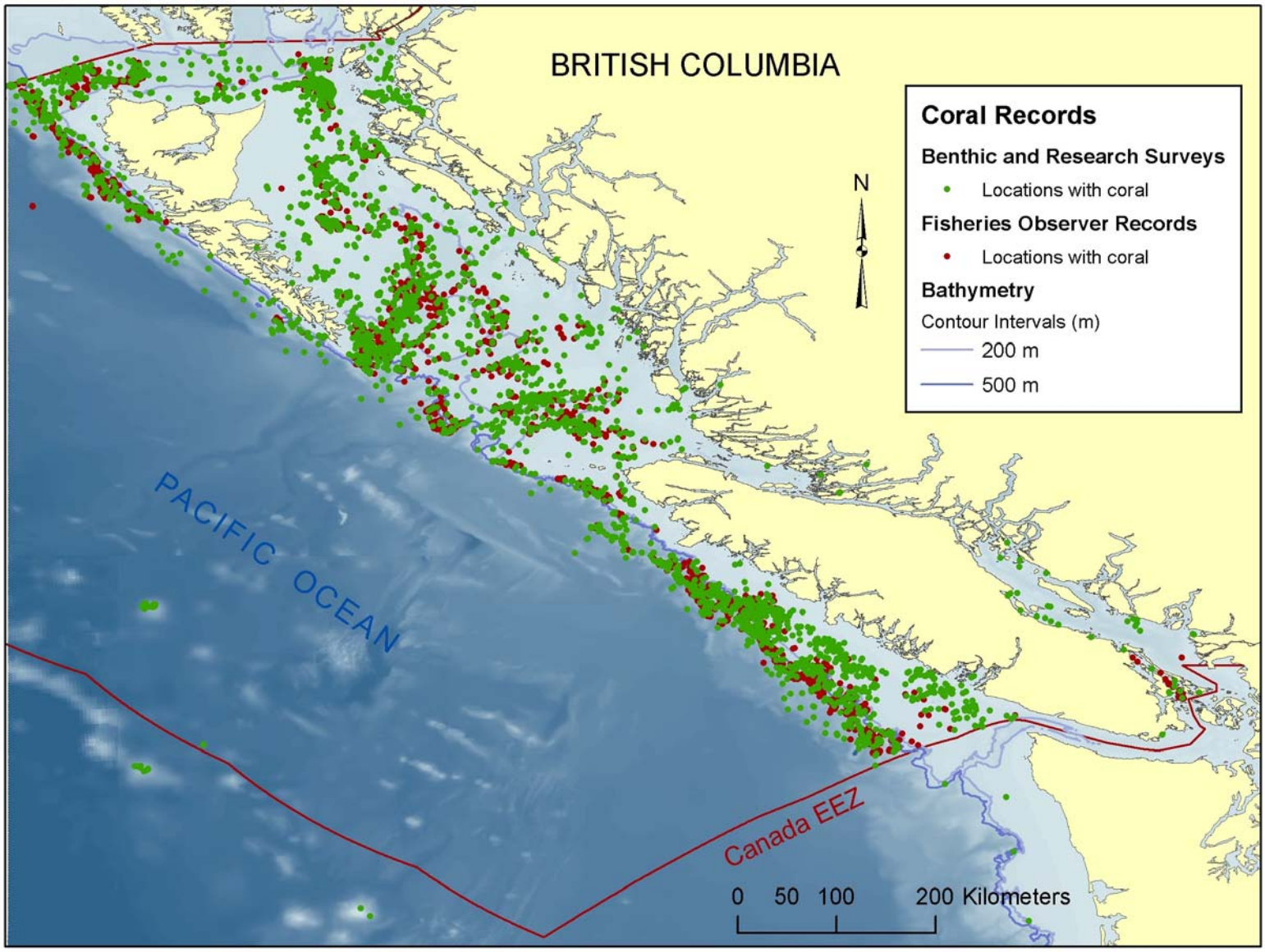

Figure 3. Distribution of coral data from groundfish, tanner crab, and shrimp research databases. Data from the commercial groundfish trawl and longline fisheries are also included.

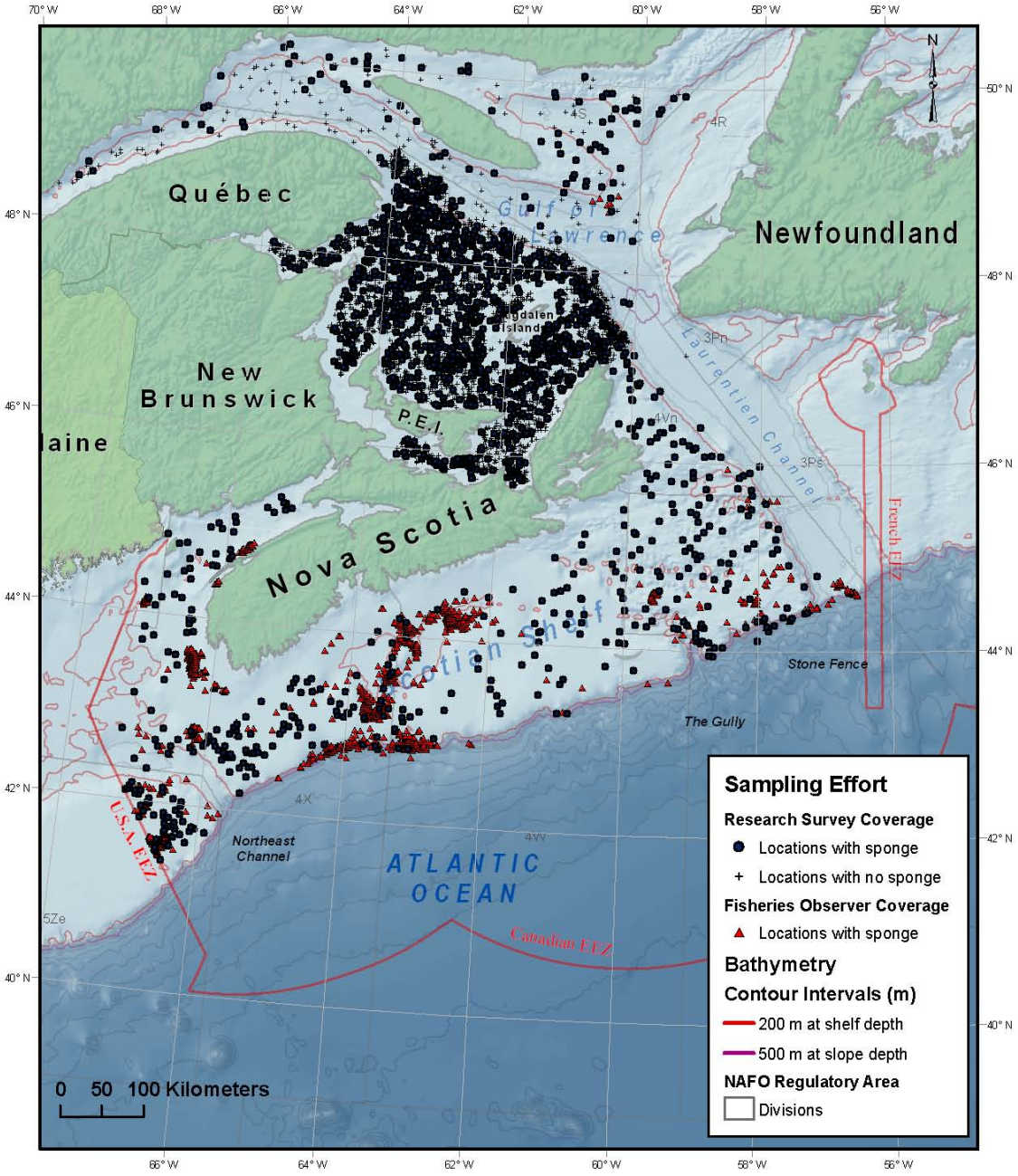

Figure 4 Distribution of sponges on the Scotian Shelf.

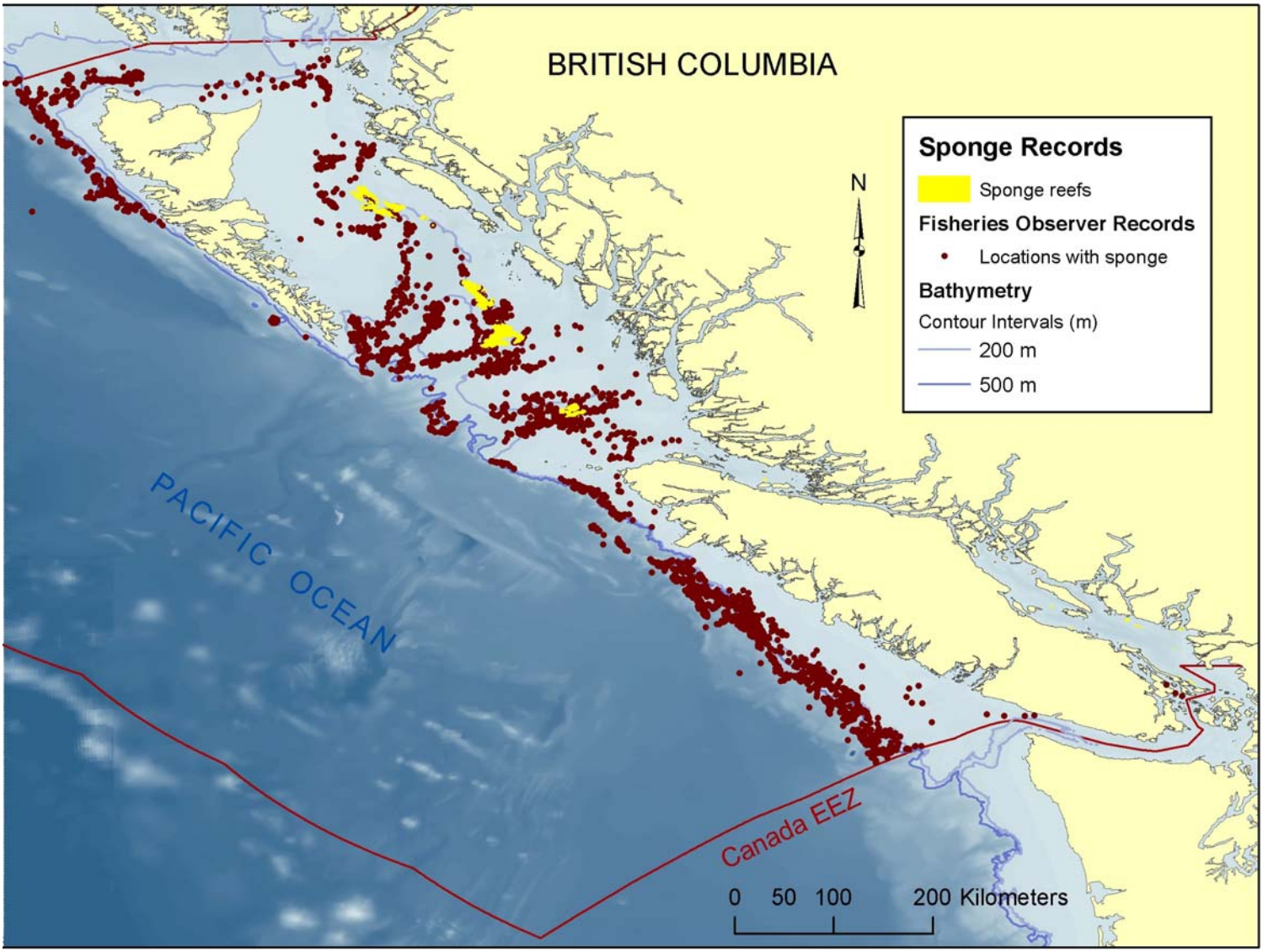

Figure 5. Distribution of sponges from the commercial groundfish trawl and longline fisheries. Sponge reefs are also identified.

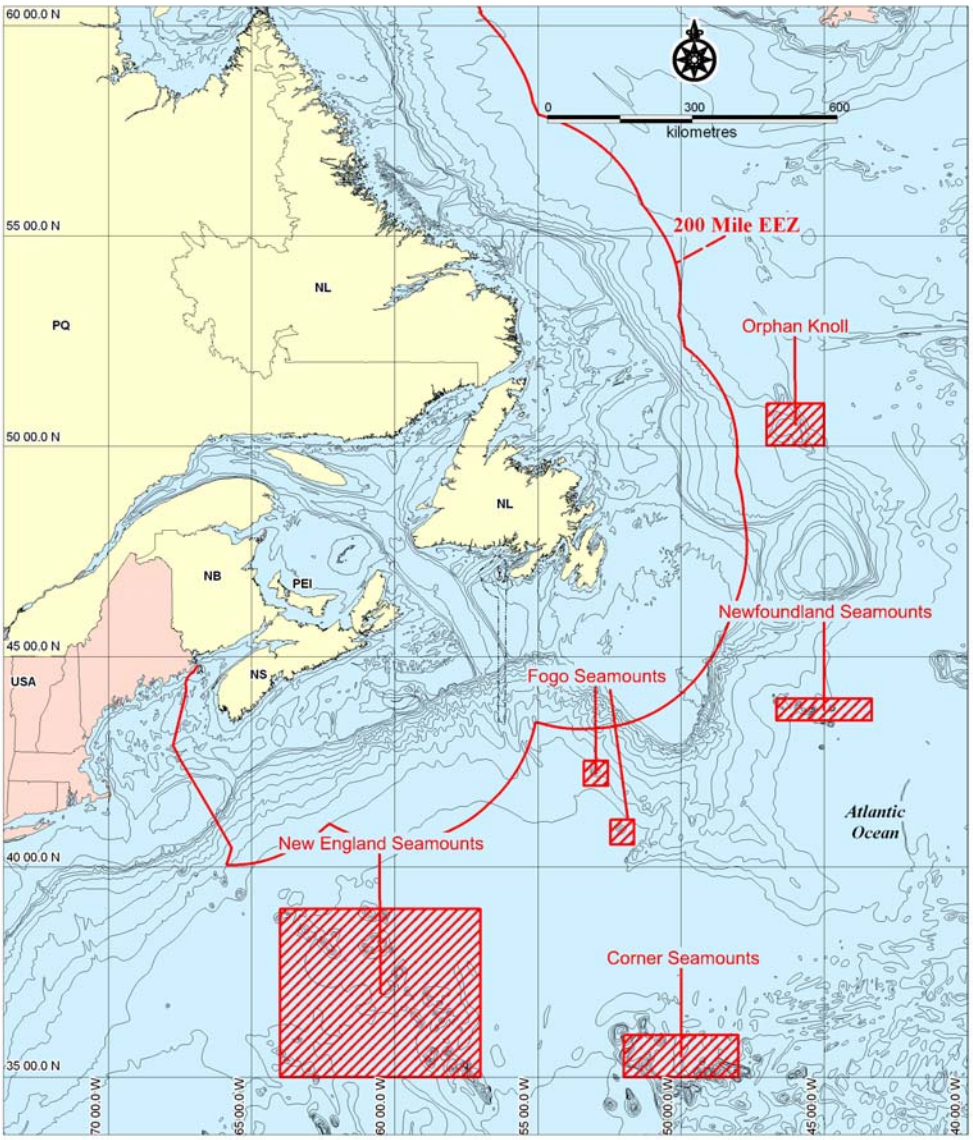

Figure 6. Five seamount areas closed by NAFO to bottom trawling (Orphan Knoll, Newfoundland Seamounts, Corner Seamounts, New England Seamounts, Fogo Seamounts).

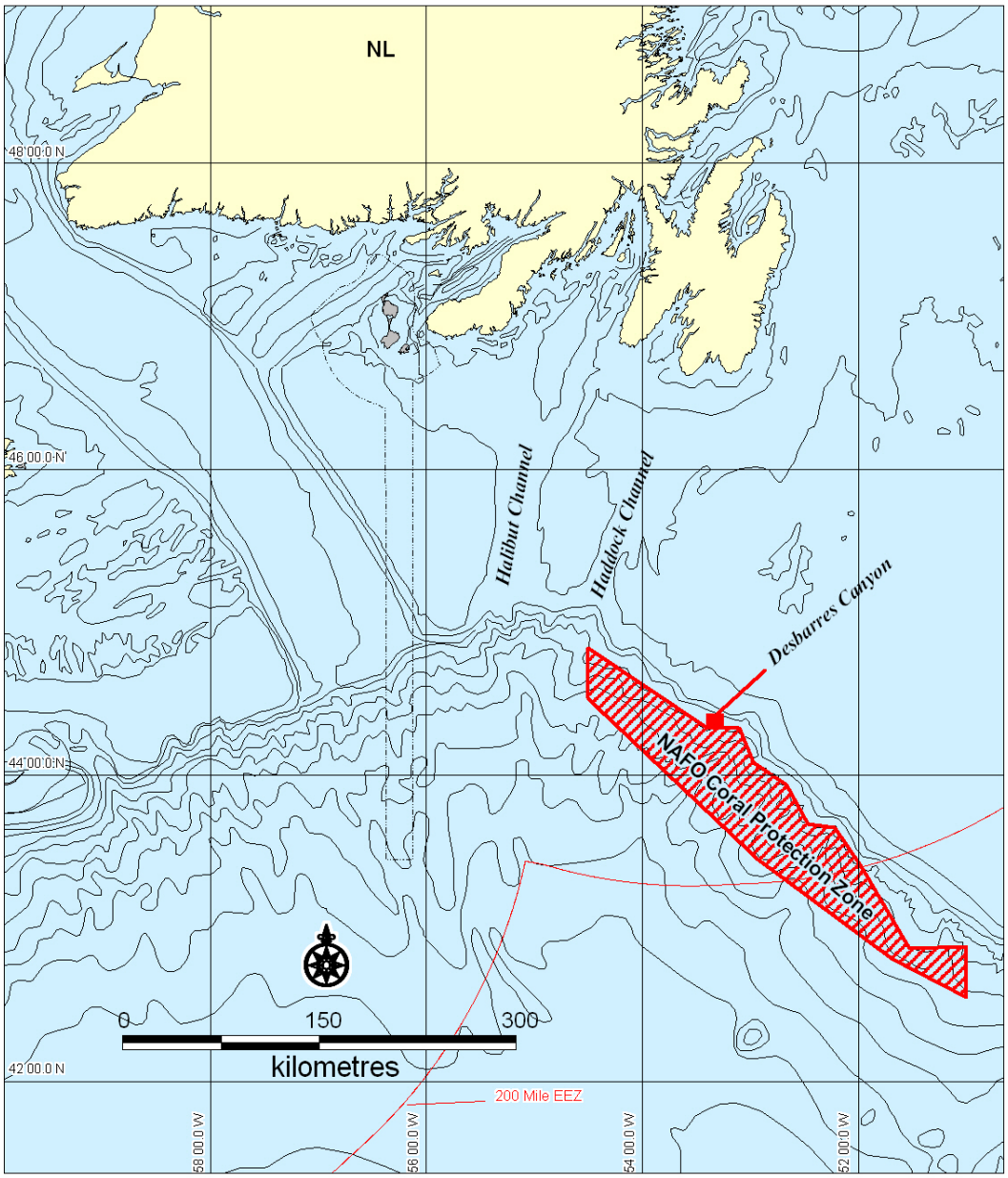

Figure 7. Canada-NAFO Division 3O Coral Protection Zone on the southwest edge of the Grand Banks.

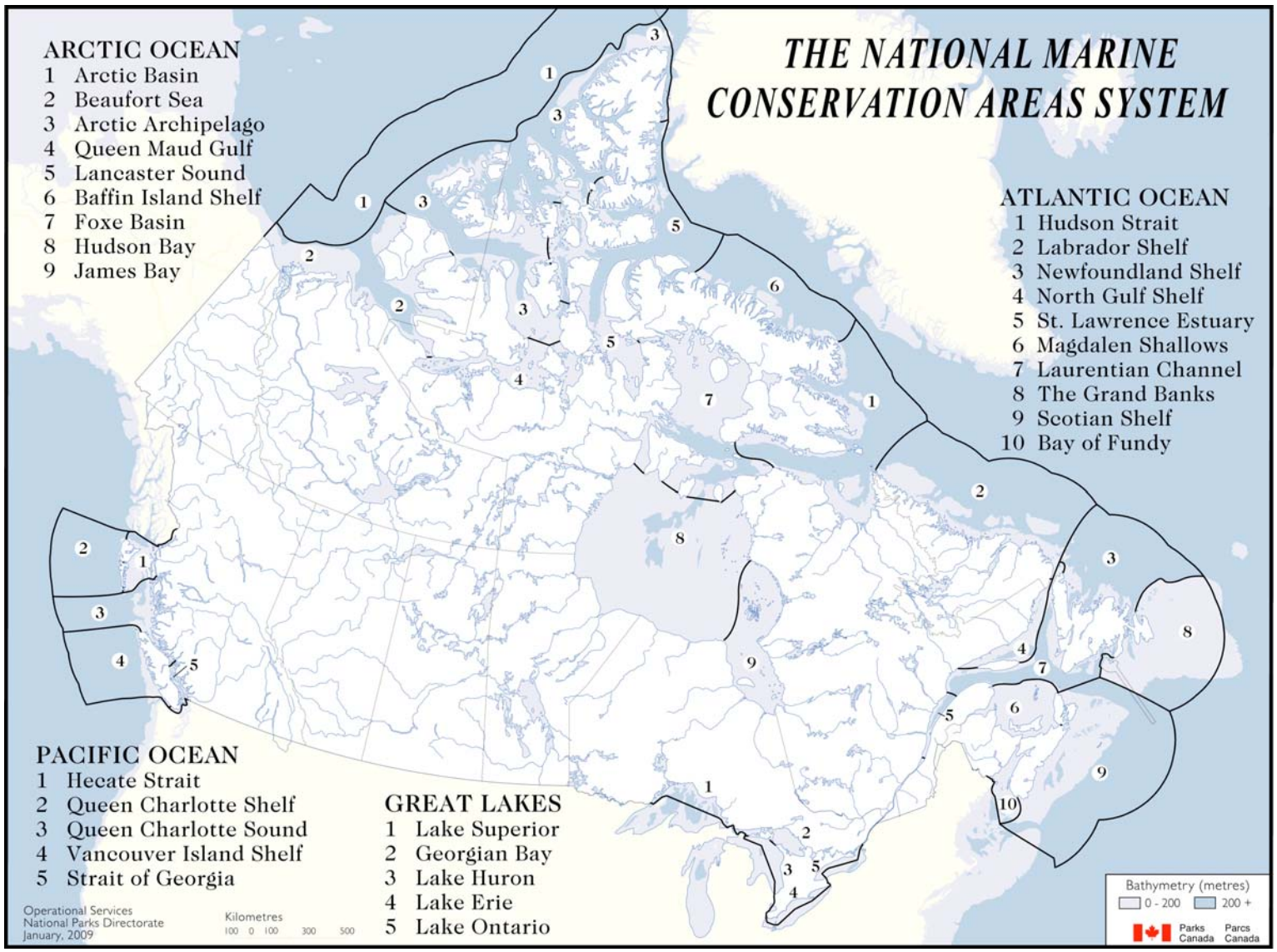

Figure 8. Marine Regions for Parks Canada's National Marine Conservation Areas Program.

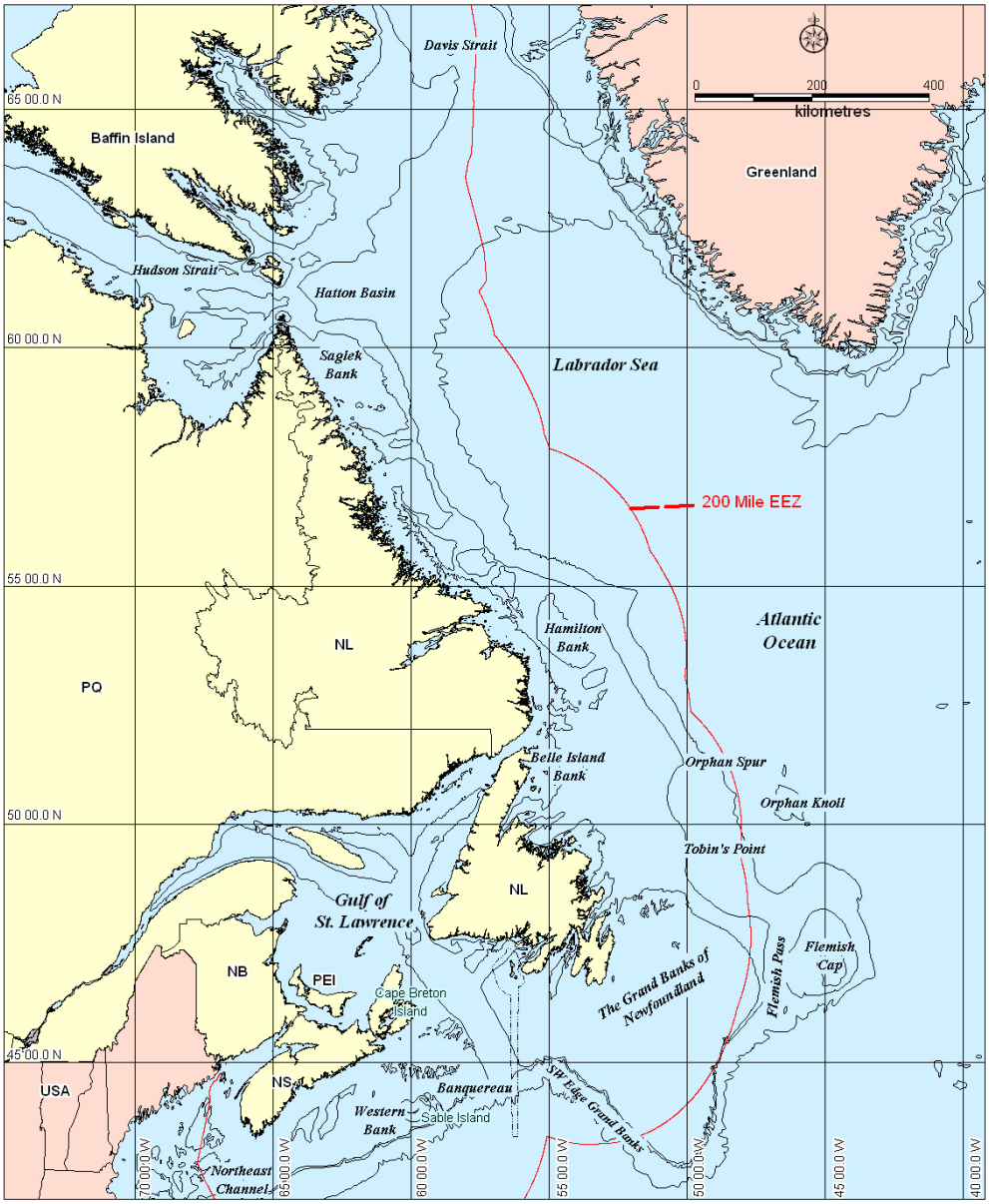

Figure 9. Map indicating locations identified in this report pertaining to Atlantic Canada and the eastern Arctic.

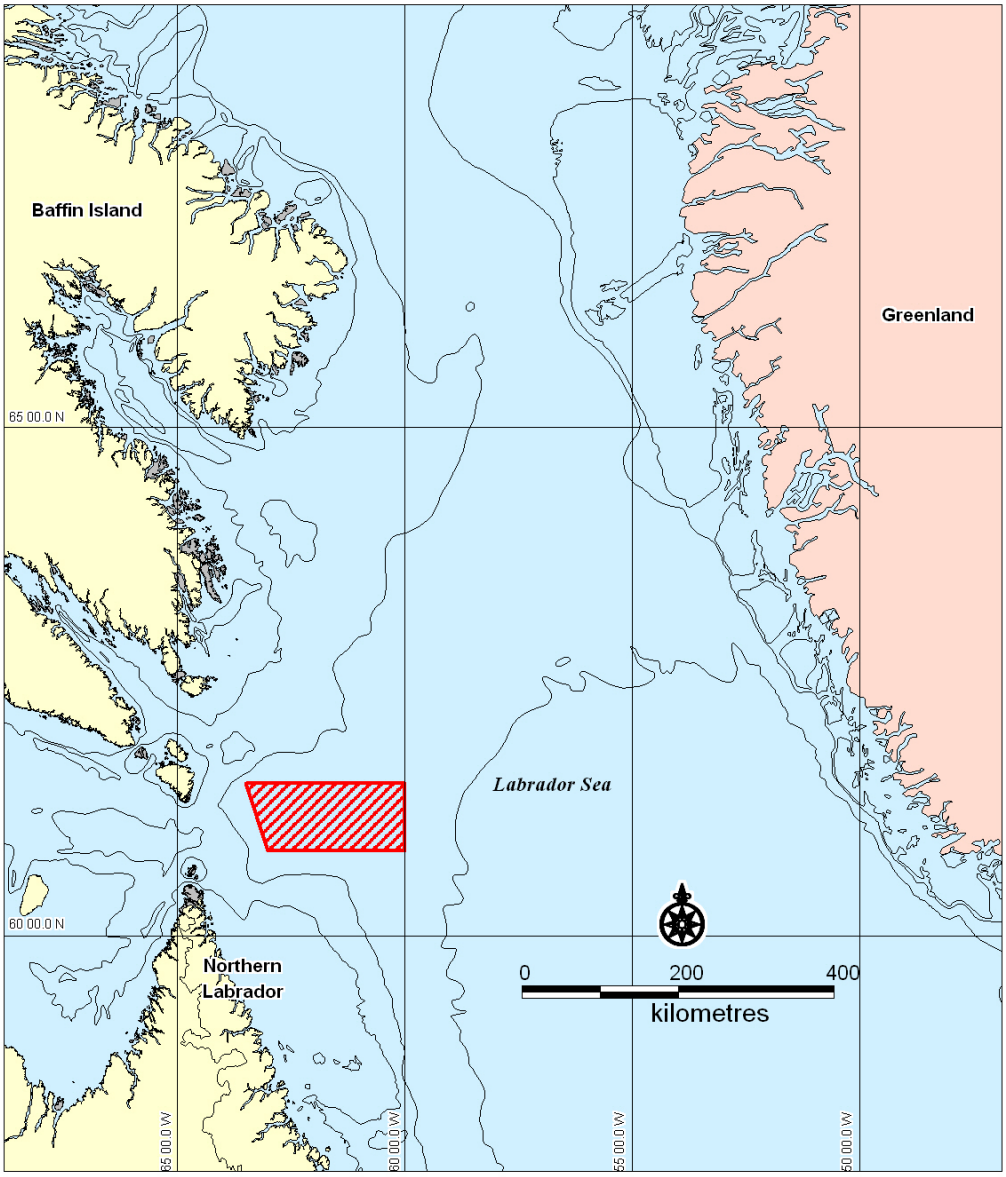

Figure 10. Fishing industry Coral Protection Zone in the northern Labrador Sea.

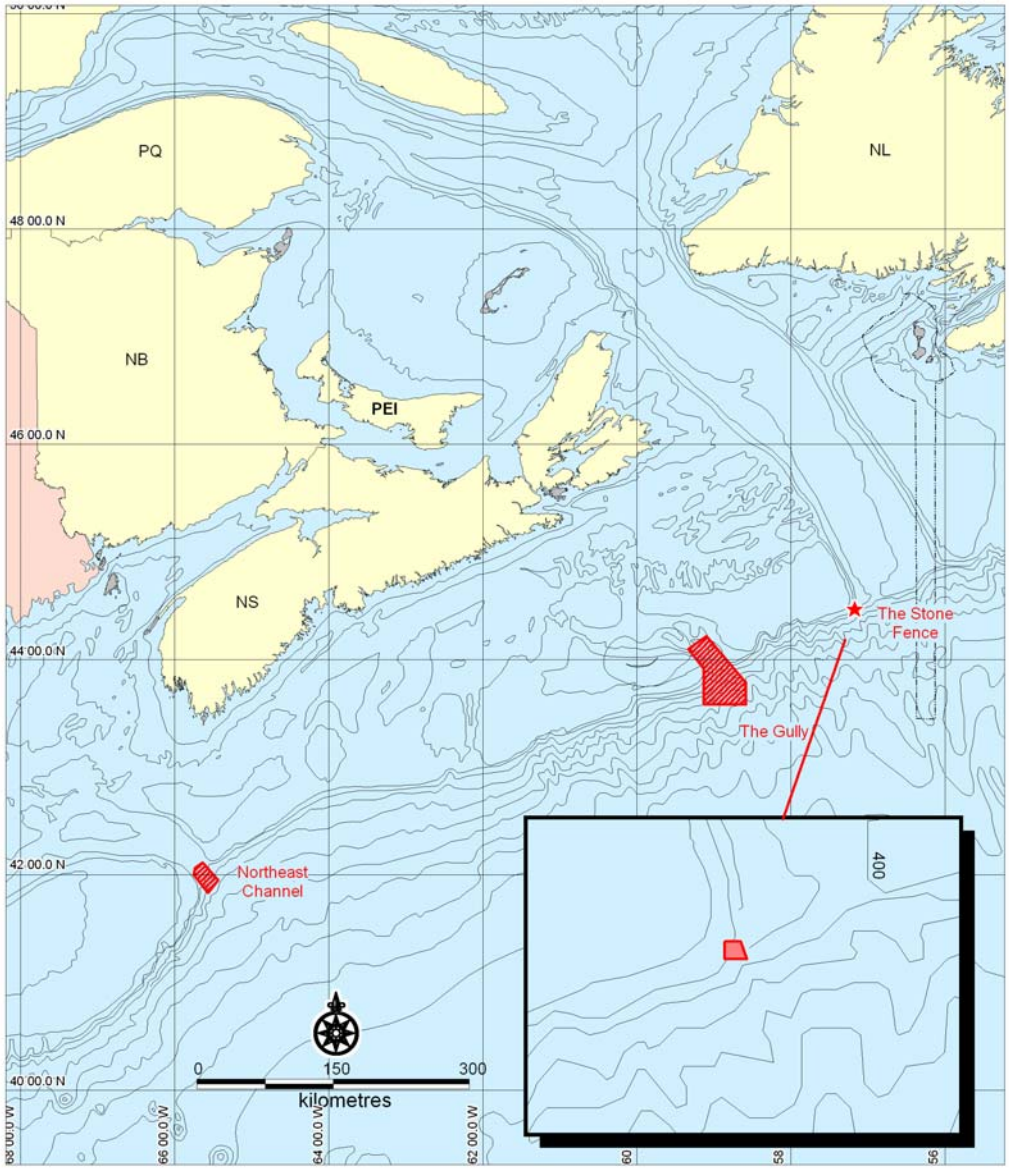

Figure 11 Maritimes Region Coral Conservation Areas (Northeast Channel, Stone Fence and the Gully MPA). Enlarged area shows the Lophelia Coral Conservation Area.

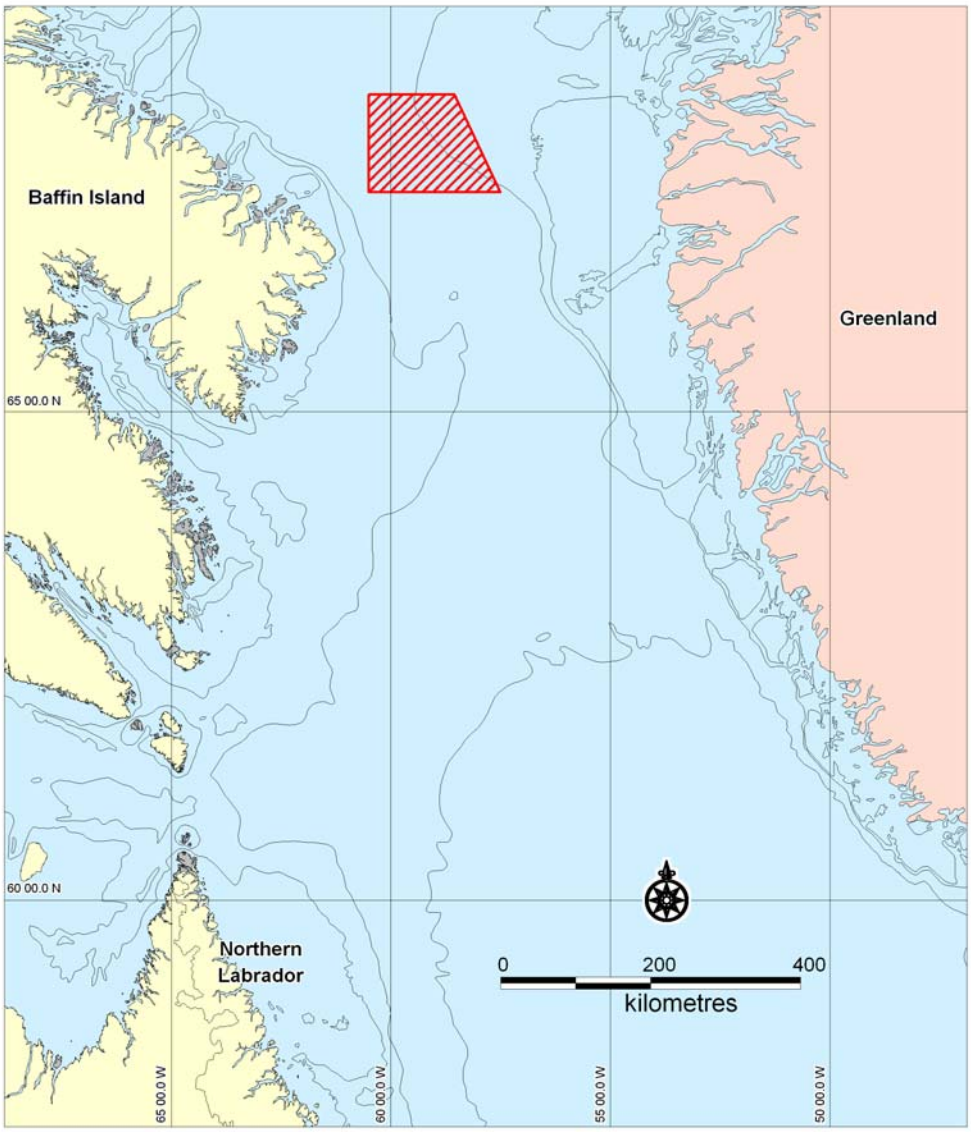

Figure 12 Narwhal-Coral Closed Area in the Davis Strait (NAFO 0A).

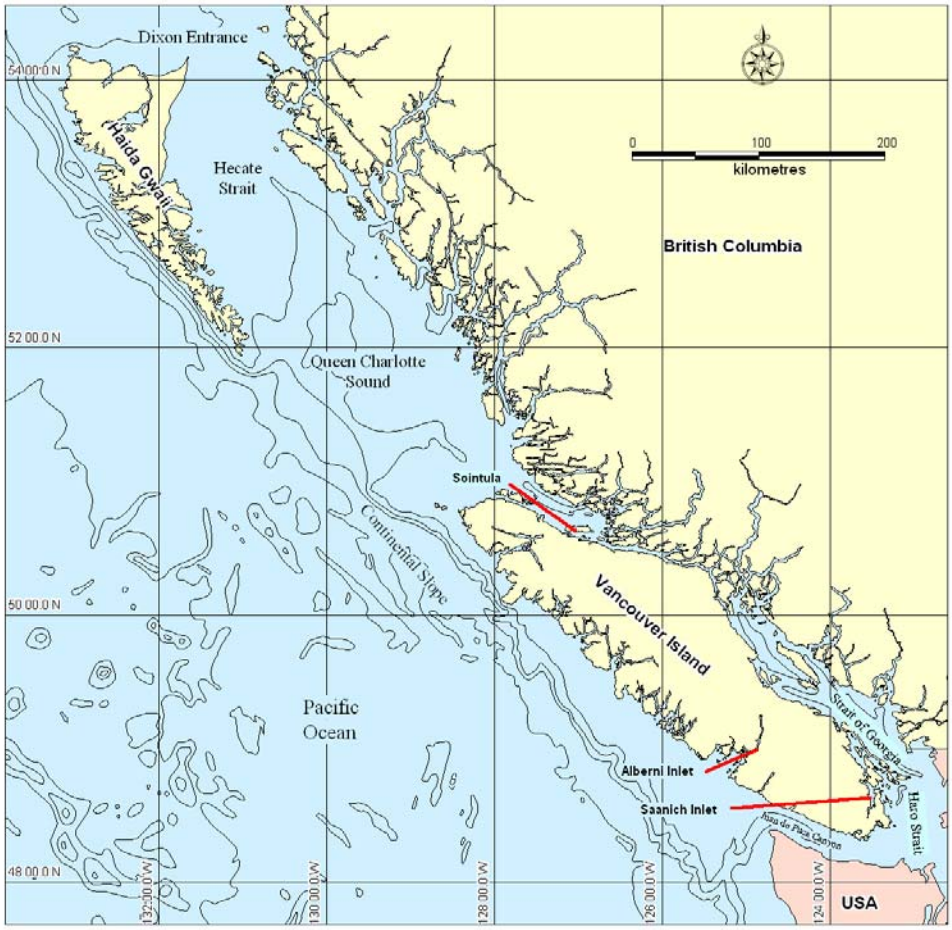

Figure 13 Map indicating locations in Pacific Region identified in this report.

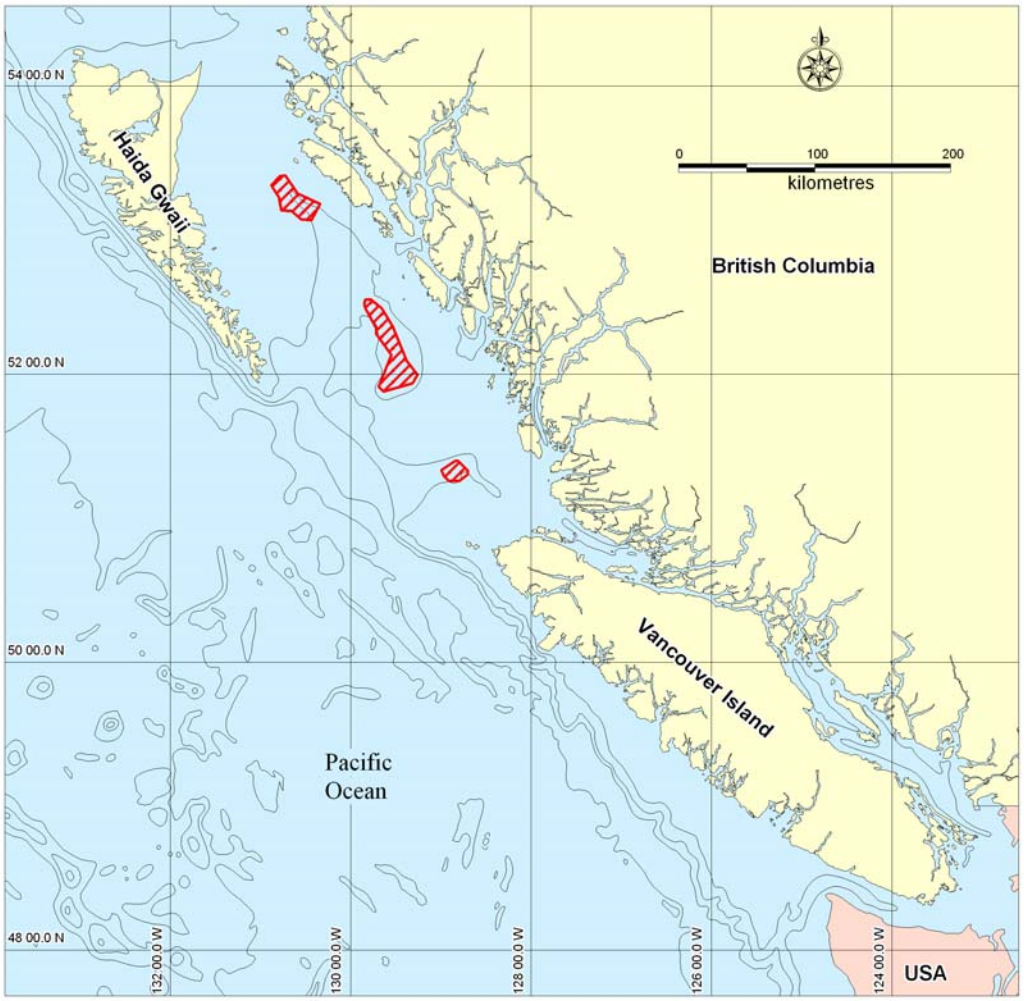

Figure 14 Sponge Reef areas closed to bottom trawling.

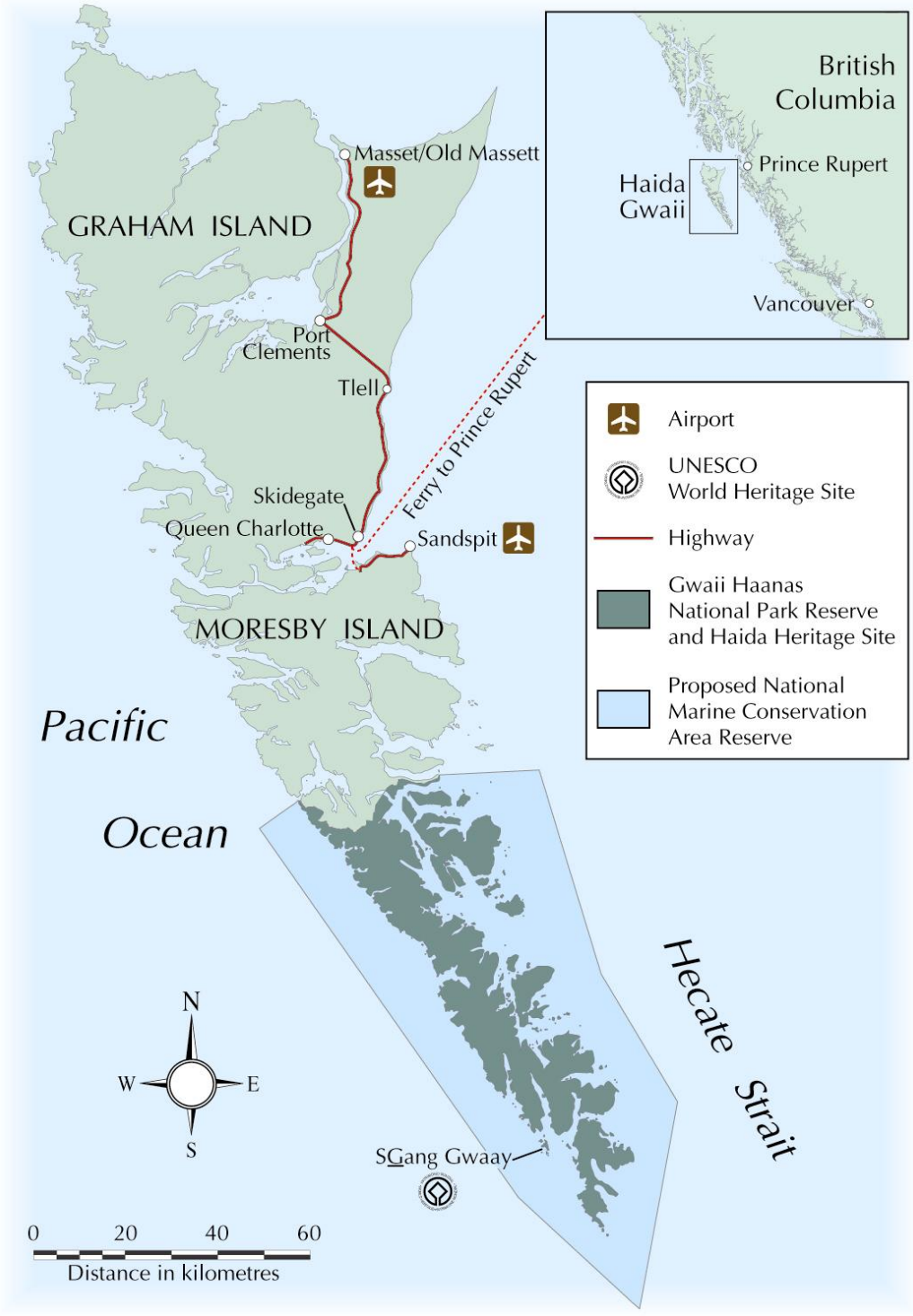

Figure 15 Proposed Gwaii Haanas National Marine Conservation Reserve

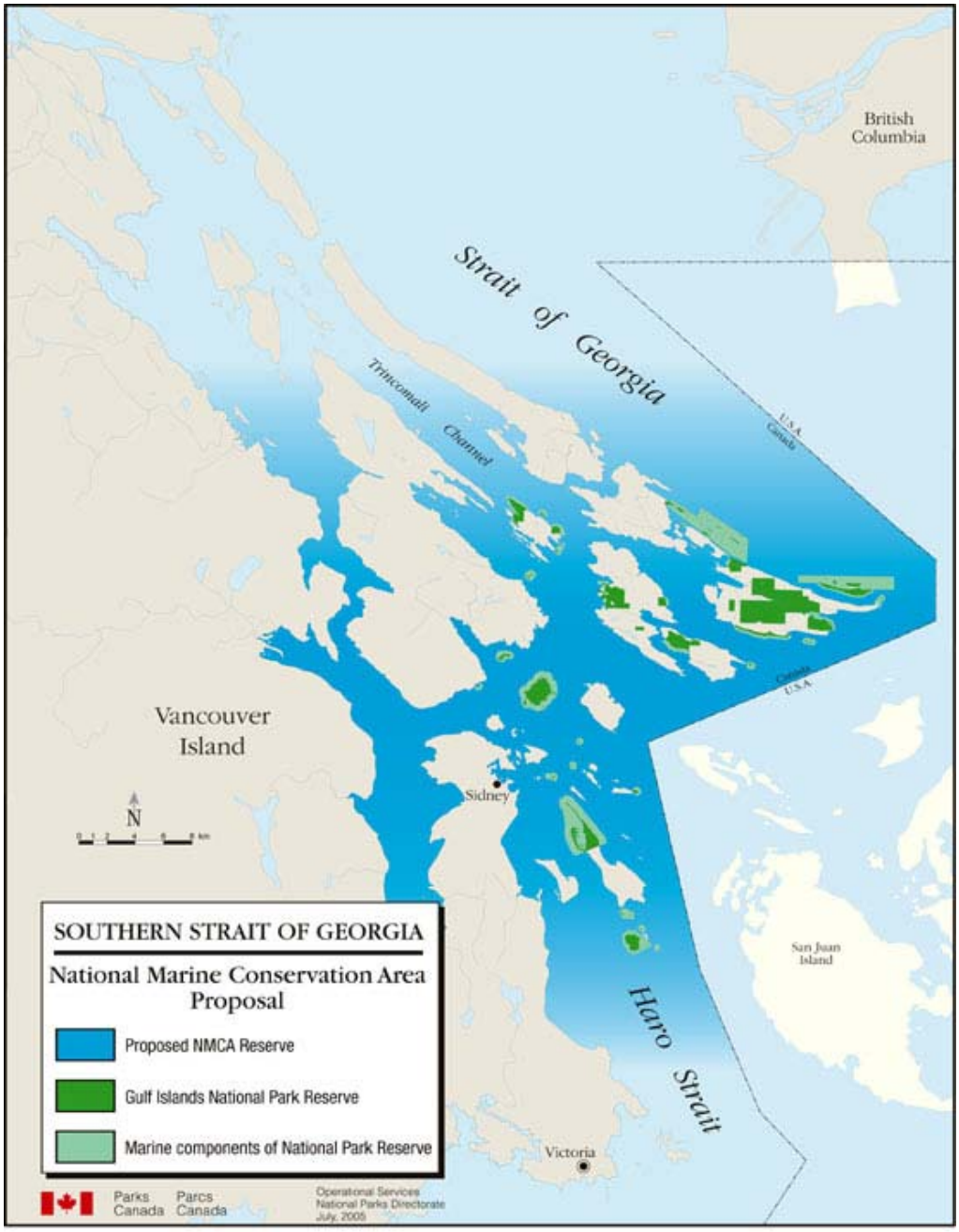

Figure 16 Proposed Strait of Georgia National Marine Conservation Area.

APPENDIX 1: LIST OF SPECIES OF COLD-WATER CORALS AND SPONGES CURRENTLY KNOWN IN CANADA

NEWFOUNDLAND/LABRADOR AND EASTERN ARCTIC CORALS (FROM WAREHAM AND EDINGER 2007 AND GILKINSON AND EDINGER 2009 *)

Order Alcyonacea (Soft Corals and Gorgonians)

Family Nephtheidae

Capnella florida

Gersemia rubiformis

Nephtheids

Family Alcyoniidae

Anthomastus grandiflorus

Family Primnoidae

Primnoa resedaeformis

Family Paragorgiidae

Paragorgia arborea

Family Anthothelidae

Anthothela grandiflora

Family Isididae

Keratoisis ornata

Acanella arbuscula

Family Acanthogorgiidae

Acanthogorgia armata

Family Chrysogorgiidae

Radicipes gracilis

*Chrysogorgia agassizii**

Family Plexauridae

Paramuricea grandis

Paramuricea placomus

Order Antipatharia (Black or Horny corals)

Family Schizopathidae

Stauropathes arctica

Bathypathes sp.

Order Scleractinia (Stoney and Cup Corals)

Family Flabellidae

Flabellum alabastrum

*Flabellum macandrewi**

Dasmosmilia lymani

Family Caryophlliidae

Desmophyllum dianthus

Vaughanella margaritata

*Javania cailleti**

Order Pennatulacea (Sea Pens and Sea Whips)

Family Virgulariidae

Halipteris finmarchia

Family Pennatulidae

Pennatula grandis

Pennatula phosphorea

Pennatula aculeata

Family Funiculinidae

Funiculina quadrangularis

Family Umbellulidae

Umbellula lindahli

*Umbellula encrinus**

Family Protoptilidae

Distichoptilum gracile

*Protoptilum carpenteri**

Family Anthoptilidae

Anthoptilum grandiflorum

Family Kophobelemnidae

Kophobelemnon stelliferum

Sea pen spp.

Sea pen sp. 4,12

MARITIMES CORALS (MORTENSEN ET AL. 2006, COGSWELL ET AL. 2009)**

Order Alcyonacea (Soft Corals)

Family Alcyoniidae

Anthomastus grandiflorus

Family Nephtheidae

Duva florida

Drifa glomerata

Eunephthya cf. fruticosa

Gersemia rubiformis

Order Gorgonacea (Horny Corals)

Family Anthothelidae

Anthothela grandiflora

Family Paragorgiidae

Paragorgia arborea

*Paragorgia johnsoni***

Family Acanthogorgiidae

Acanthogorgia armata

Family Chrysogoroiidae

*Chrysogorgia agassizii***

Radicipes cf. challengeri

Radicipes gracilis

Family Clavulariidae

Trachythela rudis

Family Isidiidae

Acanella arbuscula

*Acanella nomari***

Keratoisis ornata

Family Plexauridae

Paramuricea placomus

Paramuricea grandis

Family Primnoidae

Primnoa resedaeformis

Family Xeniidae

Anthelia borealis

Order Anthipatharia (Black Corals)

Family Antipathidae

Cf. Bathypathes sp.

*Stichopathes spp.***

Family Schizopathidae**

Stauropathes arctica

Order Scleractinia (Stony Corals)

Family Caryophylliidae

*Desmophyllum spp.***

Lophelia pertusa

Family Flabelliidae

Flabellum alabastrum

Flabellum angulare

Flabellum macandrewi

Javinia cailleti

Order Pennatulacea (Sea Pens and Sea Whips)**

Family Virgulariidae

Halipteris finmarchia.

Family Pennatulidae

Pennatula aculeata

Pennatula borealis

Family Umbellulidae

Umbellula spp.

Family Kophobelemnidae

Kophobelemnon stelliferum

Family Anthoptilidae

Anthoptilum grandiflorum

Anthoptilum murrayi

Pennatulacea (Sea Pens)

sp. 1,2,10,11

PACIFIC CORALS (FROM DFO 2006A)

Order Alcyonacea (Soft Corals)

Family Acanthogorgiidae

Calcigorgia spiculifera

Calcigorgia kinoshitae

Family Alcyoniidae

Alcyonium sp.

Anthomastus cf. grandiflora

Anthomastus ritteri

Anthomastus sp.

Family Clavulariidae

Clavularia sp.

Family Isididae

Isidella sp.

Keratoisis sp.

Lepidisis sp.

Family Nephtheidae

Eunephthea rubiformis

Eunephthea sp.

Order Pennatulacea (Sea Pens)

Family Anthoptilidae

Anthoptilum grandiflorum

Anthoptilum cf murrayi

Family Funiculinidae

Funiculina parkeri

Family Halipteridae

Halipteris cf californica

Family Kophobelemnidae

Kophobelemnon hisipidum

Kophobelemnon affine

Family Pennatulidae

Pennatula phosphorea

Ptilosarcus gurneyi

Ptilosarcus sp.

Family Paragorgiidae (Bubblegum Trees)

Paragorgia arborea (syn. pacifica)

Paragorgia yutlinux sp. nov

Paragorgia stephencairnsi sp. nov

Family Plexauridae

Swiftia (Psammogorgia) spauldingi

Swiftia pacifica

Swiftia simplex

Swiftia torreyi

Family Primnoidae

Primnoa pacifica var. willeyi

Family Protoptilidae

Distichoptilum cf rigidum

Protoptilum sp. A

Family Stachyptilidae

Stachyptilum superbum

Family Umbellulidae

Umbellula lindahli

Family Virgulariidae

Acanthoptilum gracile

Balticina californica

Balticina septentrionalis

Stylaulta elongata

Virgularia sp.

Virgularia cystiferum

Order Scleractinia (Stony Corals)

Family Caryophylliidae

Caryophyllia alaskensis

Caryophyllia arnoldi

Labryinthocyathus quaylei

Desmophyllum dianthus (syn. cristagalli)

Lophelia pertusa

Paracyathus caltha

Paracyathus stearnsi

Family Dendrophylliidae

Balanophyllia elegans

Family Fungiacyathidae

Javania cailleti

Order Antipatharia (Black Corals)

Family Antipathidae

Antipathes sp.

Family Cladopathidae

Chrysopathes speciosa

Family Schizopathidae

Bathypathes patula

Dendrobathypathes boutillieri

Lillipathes wingi

Umbellapathes sp.

Order Filifera (Hydrocorals)

Family Stylasteridae

Errinopora poutalesii

Stylantheca porphyra

Stylantheca pterograpta

Stylaster norvigicus

Stylaster porphyra

Stylaster venustus

PACIFIC COAST GLASS SPONGES (HEXACTINELLIDA)

Order Hexactinosida

Family Aphrocallistidae

Heterochone calyx (Finger Goblet or Chalice Sponge)

Aphrocallistes vastus (Cloud Sponge)

Family Farreidae

Farrea occa

Order Lyssacinosa

Family Rosselidae

Rabdocalyptus dawsoni (Boot Sponge)

Acanthascus platei

Acanthascus cactus

Staurocalyptus dowlingi

SOUTHERN GULF OF ST. LAWRENCE SPONGES (FROM FULLER 2004)

Order Clathrinida

Family Leucosoleniida

Clathrina cancellata

Grantia canadensis

Order Spirophorida

Family Tetillidae

Tetilla cranium

Order Hadromerida

Family Clionaidae

Cliona celata

Family Polymastiidae

Polymastia robusta

Polymastia mammillaris

Polymastia infrapilosa

Trichostemma hemisphaericum

Order Poecilosclerida

Family Microcionidae

Clathria delicata sp. nov

Family Acarnidae

Iophon chelifer

Iophon sp.

Family Myxillidae

Myxilla incrustans

Family Sycettidae

Leuconia aspera

Sycon protectum sp. nov

Tentorium semisuberites

Weberella bursa

Family Stylocordylidae

Stylocordyla borealis

Family Suberitidae

Suberites ficus

Suberites hispidus

Family Mycalidae

Mycale lingua

Esperella modesta

Family Desmacellidae

Biemna cf. variantia

Hemigellius arcoferus

Gellius flagellifer

APPENDIX 2: LIST OF CURRENT OR PROPOSED SCIENTIFIC RESEARCH ACTIVITIES FOR CORALS AND SPONGES IN CANADIAN WATERS

1. DFO regional multispecies stock assessment surveys will continue to collect specimens of corals and sponges following collection protocols in the NL and Pacific Regions. In Maritimes Region, corals and sponges are collected and retained in most of their research surveys. Annual ecosystem trawl surveys have non-standardized collection protocols for corals in place, with less emphasis on sponges. The Central and Arctic Region trawl survey is expected to proceed with its multispecies survey in the Hudson Strait in October 2009 where coral and sponge specimens will be collected and then sent to DFO NL Region for processing. Although Quebec Region does not have a specific coral/sponge research program, it does collect and process benthos as a by-catch during the multidisciplinary survey of groundfish stocks in the northern Gulf of St. Lawrence. This research is conducted in collaboration with Dr. Philippe Archambault at the University of Quebec at Rimouski.

2. The annual Industry/DFO Northern Shrimp Survey in NAFO Divisions 2G and 0B is expected to commence in mid July 2009 and extend over a six-week period. Corals and sponges will be collected in combination with their geospatial locations. All specimens and data will be returned to the Northwest Atlantic Fisheries Centre for processing.

3. Observers on board commercial fishing vessels, as part of DFO regional Fisheries Observer Programs, will continue to collect sponge and coral specimens and record locations of encounters with them in 2009.

4. In 2009, the Universidade de Vigo (Spain), Instituto Español de Oceanografía (IEO) (Spain) and BIO/DFO are conducting a survey with the Spanish research vessel Miguel Oliver. The main research objective of the cruise is to map potential Vulnerable Marine Ecosystems which may exist in the NAFO Regulatory Area at depths shallower than 2000 m.

5. BIO/DFO also has four marine species survey cruises in the summer of 2009. The overall objective of these cruises will be to collect detailed information on the coral and sponge grounds in the NRA, Flemish Cap, Flemish Pass and the Southwest Grand Banks.

6. A DFO led survey in partnership with Memorial University will be initiated in 2010 using the CCGS Hudson for 21 days to study deep-sea corals and sponges in three areas in international waters along the continental margin of Newfoundland. Surveys will be conducted at Orphan Knoll, along the edges of the Orphan Basin and along the slopes of Flemish Pass which is the deep-water channel separating the Flemish Cap from the Grand Banks. The research will document the geological features that support coral habitat, coral density, paleo-oceanographic records in coral skeletons, fish and invertebrate biodiversity associated with corals and sponges, fish utilization of deep-sea

coral habitat, genetic connectivity among coral populations, and near bottom turbulence (boundary layer) induced by large gorgonian corals. The remotely operated vehicle, ROPOS (Remotely Operated Platform for Ocean Science), will be used to conduct in-situ mapping surveys and produce video footage of deep-sea corals and the geological features supporting their habitat.

7. Trans-Atlantic Coral Ecosystem Study (TRACES) is a scientific programme to investigate cold-water coral communities found along the continental shelf break and slope, and in association with canyons and seamounts in the North Atlantic Ocean. The success of TRACES relies on scientific cooperation between Canada, the European Union and the United States. Through TRACES, coral science experts, including those from Canada, are developing the first coherent plan to study coral ecosystems across an ocean basin and laying the foundations for the international research programme to begin in 2010. A science plan was to be completed by the end of 2008 and the first TRACES projects are to apply for research funds in 2009. Benefits of the Study are:

- better understanding of North Atlantic climate history and ecology using cold-water coral records;
- better understanding of genetic and biodiversity links among coral ecosystems used to develop long-term conservation management policies;
- develop expertise and international partnerships between Canada, E.C. and the US;
- raise public understanding and awareness of cold-water corals and their associated marine environment.

8. An MSc student, at Memorial University is planning to document the distribution of cold-water corals in the northern Gulf of St. Lawrence using data from DFO Science multispecies trawl surveys and the Fishery Observer Program in the Gulf. Additionally, he will be using the local ecological knowledge of area fisherman to map coral concentrations to determine their distribution and diversity.

9. DFO's International Governance Strategy (IGS) provides incremental funding to new activities in key research areas to support pressing international priorities and commitments. IGS funded research provides leverage science for international policy debates and contributes to international scientific cooperation that informs Regional Fisheries Management Organisations (RFMO) decision-making. In 2009, IGS funded research at the Northwest Atlantic Fisheries Centre to publish State of Knowledge reports for the Hudson Strait 'hotspot' and the entire Maritimes Region. These reports will show the distributions of coral and sponge grounds relative to fishing and industrial pressures in pre-determined biodiversity hotspots in the Maritimes and Northwest Atlantic.

DFO Science NL Region has IGS funding to study the taxonomy and distribution of sponges along the eastern seaboard of Canada until 2012. This project falls within the IGS category “Protecting High Seas Marine Habitat and Communities”. Important project components include the development of in-house taxonomic expertise and the training of DFO staff and fisheries observers in sponge collection and handling protocols in both Maritimes and NL Regions.

Pacific Region has received IGS funding to develop and validate rapid and cost-effective species distribution models for identifying the habitat of ecologically and biological sensitive species, which require enhanced protection. This project will involve amassing a database of all known coral and sponge locations in BC. The final models will be used to help identify coral and sponge habitat in national and international waters.

The Pacific Region is also currently using species distribution models (Maxent) to predict the distribution of coral and sponges based on known occurrence records and background environmental variables. Using this method only requires presence information and has demonstrated accurate predictive performance on a wide range of species in very diverse regions around the world. Maxent’s predictive capability will be validated on a couple of research cruises in the spring of 2009.

Sponge samples collected during the 2008 NL Region survey are being photographed and identified so that a species guide can be prepared for the Region. This guide will contain specimen photos, spicule descriptions, and depth distributions. A graduate student from Memorial University, as part of her thesis, is preparing distributional maps showing sponge complexes and deepwater sponge concentrations from the Arctic to the Bay of Fundy.

10. Living Oceans Society conducted a Deep Sea Coral Research Expedition in BC waters for 17 days in June 2009. Objectives of the expedition are to:

- document the abundance and species of corals in the areas surveyed;
- document where deep-sea corals are located and use the results to further develop models where deep-sea corals could be found;
- identify fish and invertebrates associated with coral ecosystems;
- document any damage to the coral assemblages and, where possible, identify the cause of the damage.

Coral areas will be explored with submersibles using transects of predetermined lengths utilizing digital video and still-cameras as data recorders. Voucher specimens will be collected to verify identifications and genetic reference. Small, baited traps will be placed

near selected habitats to collect small invertebrates and fishes. Rotary time-lapse cameras will be deployed for population assessment of nektonic fish and invertebrates. Multibeam mappings, physical oceanographic, and water quality data will be collected to characterize the hydrography of each site and sea floor samples will be collected for habitat characterization.

11. In May 2008, DFO Science created the Centre of Expertise for Aquatic Habitat Research (CAHR) which is one of 12 DFO Science virtual Centres of Expertise. The CAHR Secretariat is located at Northwest Atlantic Fisheries Centre in St. John's. CAHR is described as follows:

- CAHR's primary role is research and development of new knowledge on population-habitat linkages by fostering collaborations, facilitating research and investigating effect of human and natural changes on habitat services;

- CAHR forms part of DFO's Science Renewal initiative to move from project-based to program-based research;

- CAHR is a two-way information exchange mechanism by conveying management and multi-regional needs to scientists and contributes to formation of aquatic habitat research priorities;

- CAHR is a virtual network for aquatic habitat research.

12. Environment Canada is in the process of preparing a General Status of Species in Canada to be published in 2010. The Wild Species series was created under the auspices of the Accord for the Protection of Species at Risk. The Accord was established in 1996 by provincial, territorial, and federal ministers responsible for wildlife with a goal of preventing species in Canada from becoming extinct or extirpated because of human impact. The intent of the Wild Species series is to answer the fundamental questions about wild species in Canada (i.e. which species occur in Canada?). The status report represents the results of general status assessments for a broad cross-section of Canadian species and is also a requirement of the *Species at Risk Act*. General status assessments are made by integrating the best available information on population size, distribution, hazards and trends to generate an expert evaluation of the status of each species. DFO Science staff will be assessing 1600 marine/freshwater species which will include coral and sponge species found in Canada.

13. Canadian Healthy Oceans Network (CHONe) is a strategic partnership between university researchers and government, predominantly DFO scientists. CHONe is a Natural Sciences & Engineering Research Council of Canada (NSERC) Strategic

Network that has been funded for 5 years, beginning in 2008. The Network develops scientific guidelines for conservation and sustainable use of Canadian marine biodiversity resources. The three broad research themes of CHONe are:

- marine biodiversity;
- ecosystem function;
- population connectivity.

CHONe will deliver products to test conservation approaches and assumptions, and provide a suite of tools that can be used in new applications to ensure that future policy and management decisions are developed using the best science possible to obtain the desired outcomes for all stakeholders.