Fisheries and Oceans Canada
Pêches et Océans Canada

Coral & Sponge Conservation Strategy

for Eastern Canada 2015

Canada

All photos were taken by the Canadian Scientific Submersible Facility and DFO during recent research cruises using the Remotely Operated Vehicle for Ocean Sciences (ROPOS)

Fisheries and Oceans Canada
Pêches et Océans Canada

Coral & Sponge Conservation Strategy

for Eastern Canada 2015

Canada

Executive Summary

Cold water corals and sponges can be found throughout the waters off eastern Canada, in a range of depths, substrate types, and currents. Whether in a group or as an individual, these animals may provide structural habitat for other marine creatures by providing a place to rest, feed, spawn, and avoid predators. In deep, dark waters, coral and sponge communities may present the only habitat forming features on the seafloor. Corals and sponges are sessile, and generally long-lived and slow growing, making them particularly vulnerable to human activities both directly (e.g., bottom contact fishing gear, subsea pipeline installation) and indirectly (e.g., climate change, ocean acidification).

The advent of cutting edge technologies such as remotely operated and autonomous underwater vehicles has allowed the exploration of coral and sponge communities previously out of reach. Although recent research has significantly contributed to our understanding and appreciation of corals and sponges, there is still a great deal to learn about the distribution, diversity, reproduction, and resilience of these animals.

The conservation and protection of corals and sponges is important to Canadians. Many of the marine animals that have a functional relationship with corals and sponges are of commercial importance to Canadians, making their conservation and protection a key factor in sustainable fisheries management. Coral and sponge communities play a vital ecological role in maintaining diverse and healthy aquatic ecosystems, contributing to species richness and biodiversity. Given our limited knowledge of coral and sponge biology and potential for harmful human induced impacts, it follows that a heightened level of conservation and protection is required.

The Coral and Sponge Conservation Strategy for Eastern Canada has been developed to outline the current state of knowledge of corals and sponges, to provide the international and national context for coral conservation, and to outline new and existing research and conservation efforts in eastern Canadian waters. The Strategy provides a comprehensive approach to coral and sponge conservation through increased coordination and collaboration of management and research efforts. The Strategy identifies conservation, management, and research objectives common to all five Fisheries and Oceans Canada management regions in eastern Canada (Central and Arctic, Quebec, Gulf, Maritimes, and Newfoundland and Labrador) consistent with existing legislation and policy through a shared focus on ecosystem-based management.

The goal of the Coral and Sponge Conservation Strategy for Eastern Canada is to facilitate the conservation and protection of cold water coral and sponge species, communities, and their habitats in the Atlantic and Arctic Oceans of eastern Canada. Protection of these benthic species will be achieved through collaboration and integrated ocean management, providing sustainable economic and ecological value to all Canadians.

Acronyms

AIS – Aquatic Invasive Species

AOI – Area of Interest

C&A – Central and Arctic Region

CEAA – *Canadian Environmental Assessment Act*

CHONe – Canadian Healthy Oceans Network

CHP – Conservation Harvesting Plan

C-NLOPB – Canada – Newfoundland and Labrador Offshore Petroleum Board

C-NSOPB- Canada- Newfoundland and Labrador Offshore Petroleum Board

CO_2 – Carbon Dioxide

CSAS – Canadian Science Advisory Secretariat

DFO – Fisheries and Oceans Canada

EA – Environmental Assessment

EBSA – Ecologically and Biologically Significant Area

EFM – Ecosystems Fisheries Management

EC – Environment Canada

EEZ – Exclusive Economic Zone

ENGO – Environmental Non-Government Organization

ERAF – Ecological Risk Analysis Framework

ESSIM – Eastern Scotian Shelf Integrated Management

FCC – Fisheries Council of Canada

FGR – Fishery (General) Regulations

FOP – Fisheries Observer Program

FPP – Fisheries Protection Program

GEAC – Groundfish Enterprise Allocation Council

GIS – Geographic Information System

GOSLIM – Gulf of St. Lawrence Integrated Management

HOTO – Health of the Oceans

ICES – International Council for the Exploration of the Sea

IFMP – Integrated Fishery Management Plan

IFOGS - International Fisheries and Oceans Governance Strategy

IGS - International Governance Strategy

IM – Integrated Management

LOMA – Large Ocean Management Area

MPA – Marine Protected Area

MSC – Marine Stewardship Council

NAFO – Northwest Atlantic Fisheries Organization

NL – Newfoundland and Labrador Region

NMCA – National Marine Conservation Area

NPC – Nunavut Planning Commission

NRA – NAFO Regulatory Area

PB/GB LOMA – Placentia Bay/Grand Banks Large Ocean Management Area

PC – Parks Canada

RMF – Risk Management Framework

RFMO – Regional Fisheries Management Organization

ROPOS – Remotely Operated Platform for Ocean Science

ROV – Remotely Operated Vehicle

SARA – *Species at Risk Act*

SPERA – Strategic Program for Ecosystem-Based Research and Advice

TEK – Traditional Ecological Knowledge

TRACES – Trans-Atlantic Coral Ecosystem Study UNGA – United Nations General Assembly

VME – Vulnerable Marine Ecosystem

Table of Contents

Introduction

Corals and sponges are traditionally thought of as species of shallow, tropical waters, but that is changing. While the existence of cold water corals and sponges has been acknowledged for many years, primarily because of by-catch in fishing gear, the location, extent, diversity, and ecological role of these animals remained largely a mystery. In recent years, the advent of new technology, such as remotely operated vehicles and high definition cameras, has shed light on areas of the ocean floor previously unexplored. Like their tropical relatives, cold water corals and sponges increase the structural complexity of the sea floor, creating habitat for fish and invertebrates in what may otherwise be a cold, dark, barren area of the ocean. This habitat provides protection from currents and predators, nurseries for young fish, and feeding, breeding, and spawning areas for numerous fish and invertebrate species.

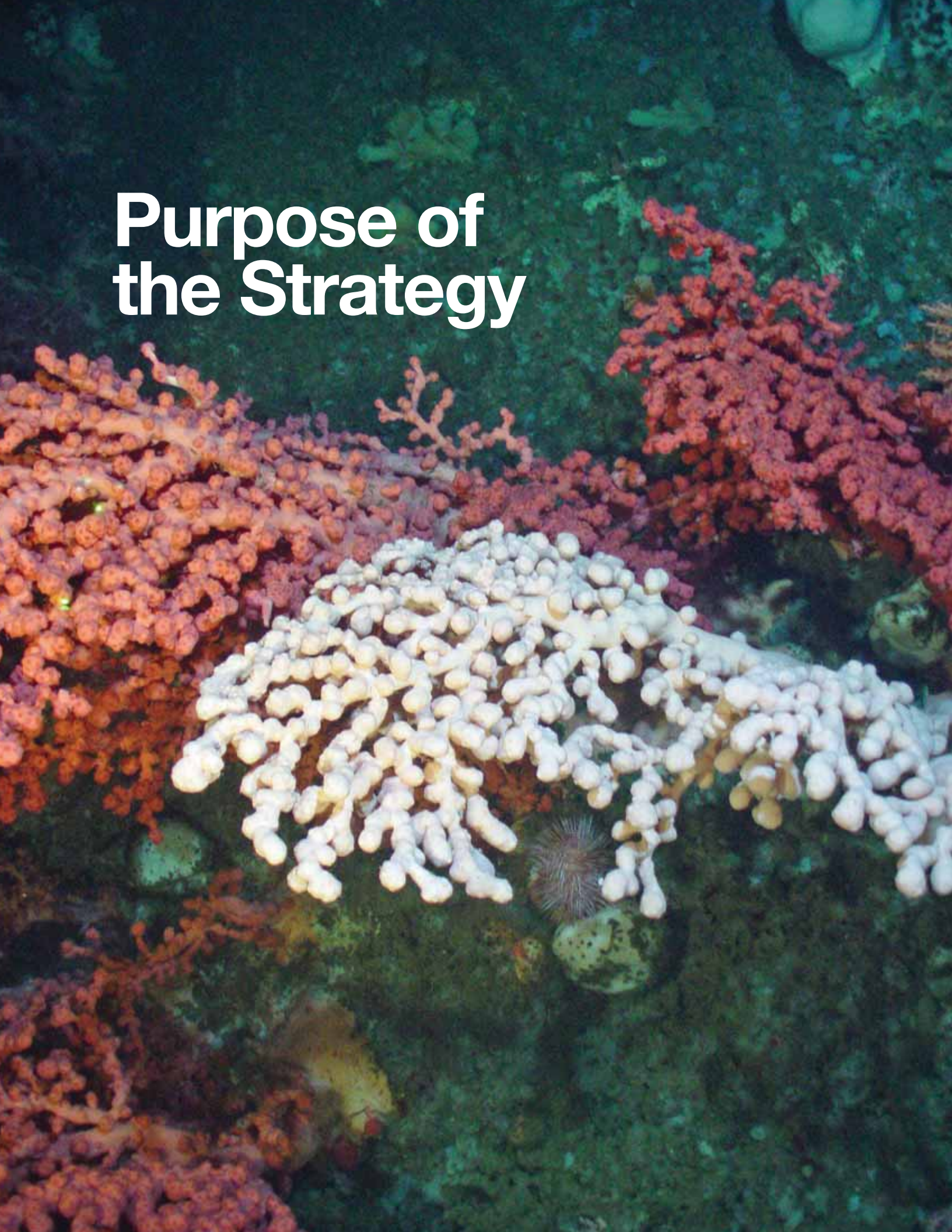
Globally, cold water corals and sponges are found from the Antarctic in the southern hemisphere to the Arctic in the north. In eastern Canadian waters, cold water corals and sponges can be found from the intertidal zone to thousands of meters below the sea surface in the midnight zone (the deepest layer of the ocean that receives no sunlight). These coral and sponge communities play a vital role in maintaining healthy aquatic ecosystems, and support fish and invertebrates that are of social and economic importance to Canadians. Thus there is a need for the management of human activities that support the protection and conservation of these animals. Ecosystem-based management is the management of human activities to ensure that marine ecosystems, their structure, function and overall environmental quality are not compromised, and is the approach of Fisheries and Oceans Canada (DFO) to conserving and protecting the health of Canada's marine environment.

In Canada, Parliament has set out an agenda for sustainable development of our oceans based on a balanced approach to development and conservation of ocean resources through integrated oceans management. DFO is the lead federal department responsible for research and conservation of coral and sponge species. The national legislative context is provided in the *Oceans Act* and *Fisheries Act*, with further guidance provided in policies such as Canada's Oceans Strategy (DFO 2002) and the Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009a).

There are five DFO management regions located in eastern Canada: Central and Arctic, Quebec, Gulf, Maritimes, and Newfoundland and Labrador. The Coral and Sponge Conservation Strategy for Eastern Canada has been developed to define the current state of knowledge of corals and sponges, to provide the international and national context for coral conservation, and to outline existing research and conservation efforts in eastern Canadian waters. In general, the Strategy provides a comprehensive approach to coral and sponge conservation through increased coordination and collaboration of management and research efforts.

Notably, the development of this Strategy has benefitted from existing Canadian strategies including the *Maritimes Coral Conservation Plan* (DFO 2006a) and the *Pacific Region Cold-Water Coral and Sponge Conservation Strategy* (DFO 2010a), as well as the United States National Oceanic and Atmospheric Administration *Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation* (NOAA 2010). In addition, the Government of Canada funded the National Centre of Expertise in Cold Water Coral and Sponge Reefs (2007-2012) through its Health of the Oceans Initiative (HOTO). This Centre was instrumental in the coordination and development of this Strategy.

Purpose of the Strategy



The goal of the Coral and Sponge Conservation Strategy for Eastern Canada is to facilitate the conservation and protection of cold water coral and sponge species, communities, and their habitats in the Atlantic (including the Gulf of St. Lawrence) and Arctic Oceans of eastern Canada. Protection of these benthic species which are integral components of a healthy ecosystem will be achieved through collaboration and integrated ocean management, providing sustainable economic and ecological value to all Canadians. The Strategy will undergo a formal review every five years.

The Strategy identifies conservation, management, and research objectives with the supporting targets and actions common to all five eastern DFO regions, while highlighting alignment with existing legislation and policy through a shared focus on ecosystem-based management. The Strategy will benefit both managers and clients in fostering transparency and accountability. It is important to note that the Strategy is not a management plan.

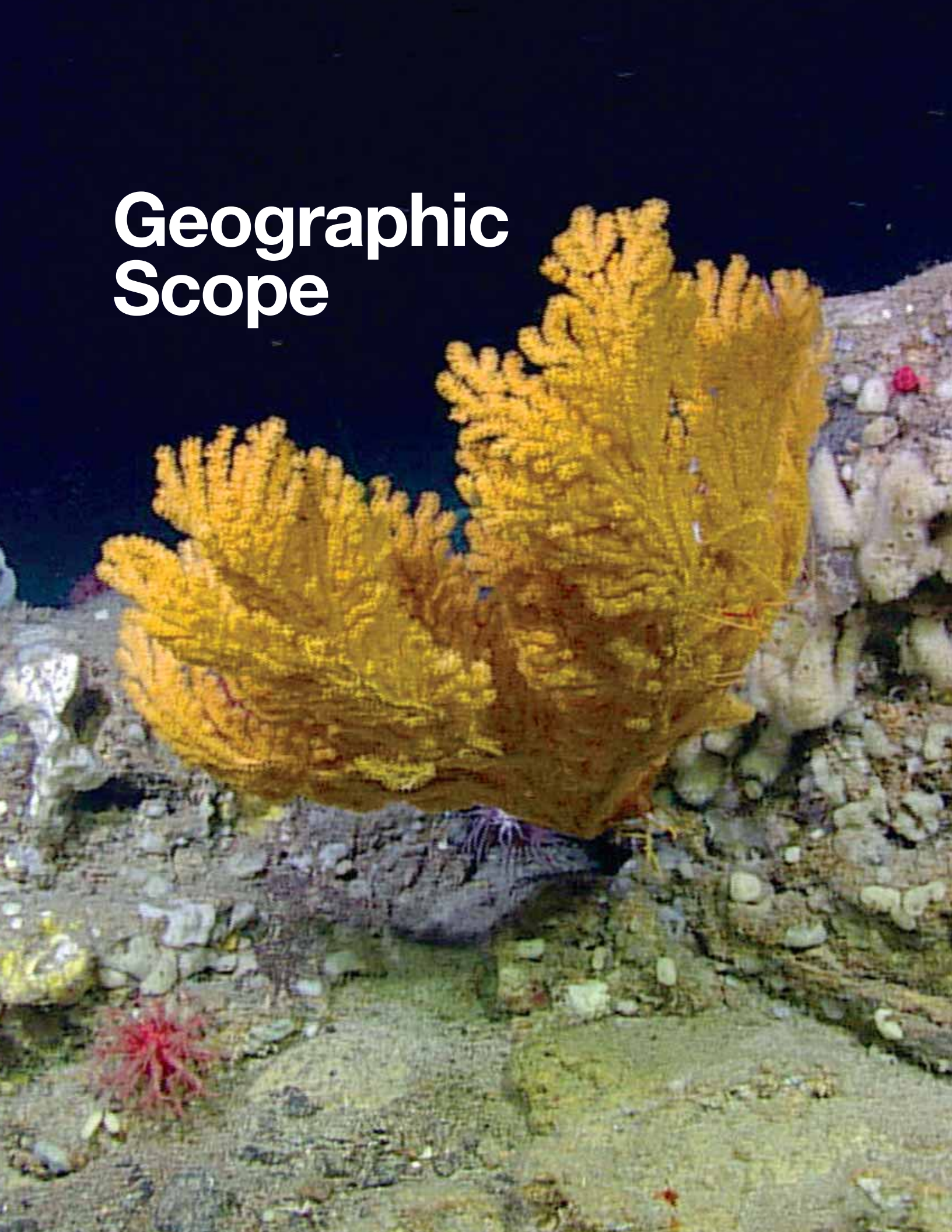
Why Protect Corals and Sponges?

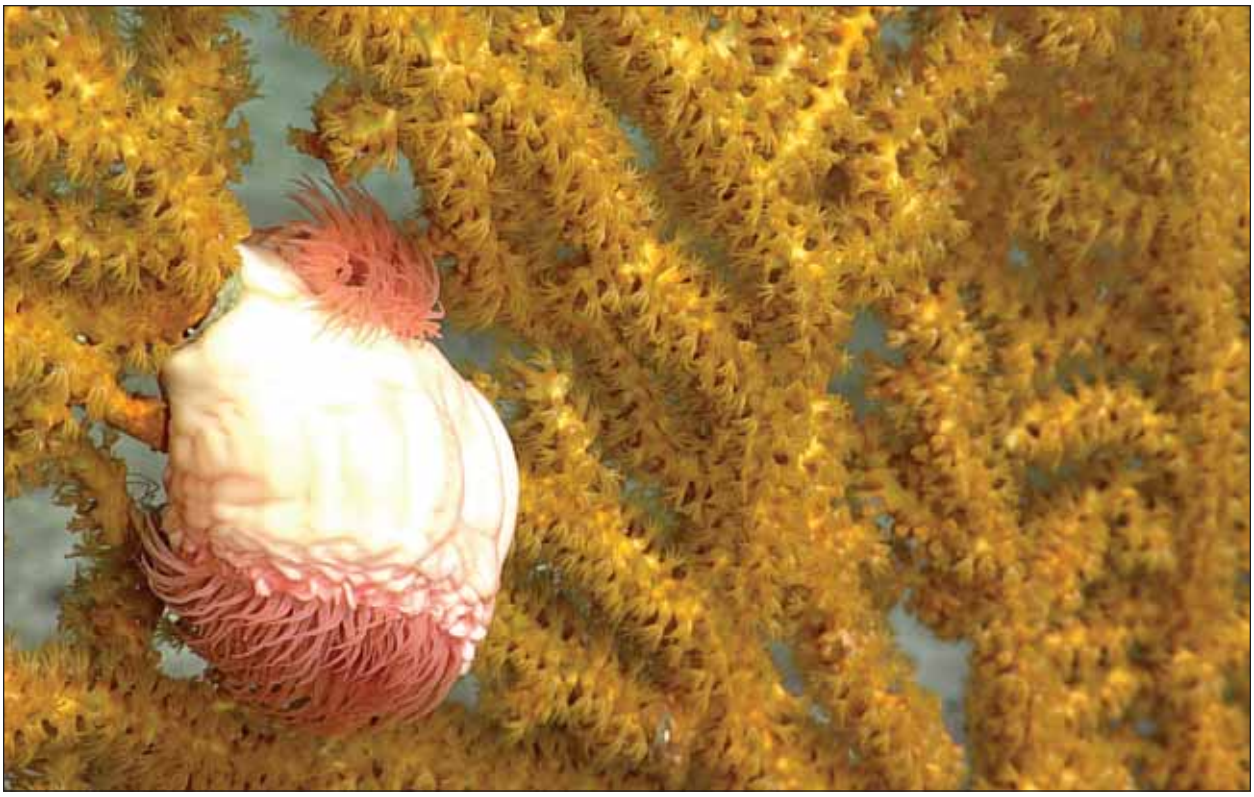
Cold water corals and sponges are a biologically diverse group of species which can occupy a variety of substrate types, current speeds, and depth ranges. Either as individuals or in groups, these species may form structural habitats that provide an important functional role for numerous forms of marine life (Hogg *et al.* 2010). They act as nurseries, refugia, and spawning and breeding grounds for many aquatic species (DFO 2010b; Baillon *et al*. 2012; Baker *et al*. 2012a; Baker *et al.* 2012b).

Due to their sessile, long-lived nature, corals and sponges are particularly vulnerable to physical damage, sediment smothering, toxicity, and potential climate change effects. Examples of human activity that may pose a threat include bottom contact fishing, submarine cable installation, and oil and gas exploration and development. In implementing the Strategy it is important to note that vulnerability of corals and sponges varies by species and some human activities cause greater impacts than others (DFO 2006b; DFO 2010c). From a broader ecosystem perspective there is still much to learn about the role of corals and sponges as they relate to biodiversity and ecosystem management, making conservation and research objectives key components of coral and sponge management.

With increasing interest in third-party certification of sustainable fisheries, conservation and protection of corals and sponges is also an important market factor for eastern Canada fisheries. Several fisheries within the geographic scope of the Strategy have or are currently undergoing certification under such programs as the Marine Stewardship Council (MSC 2010) or assessed through eco-guides such as SeaChoice or the Monterey Bay Aquarium. One of the criterion evaluated during the assessment process for sustainable fisheries is the environmental impact of the fishery and its associated management tool. The Strategy will help support and clarify processes being used in relation to coral and sponges.

Geographic Scope



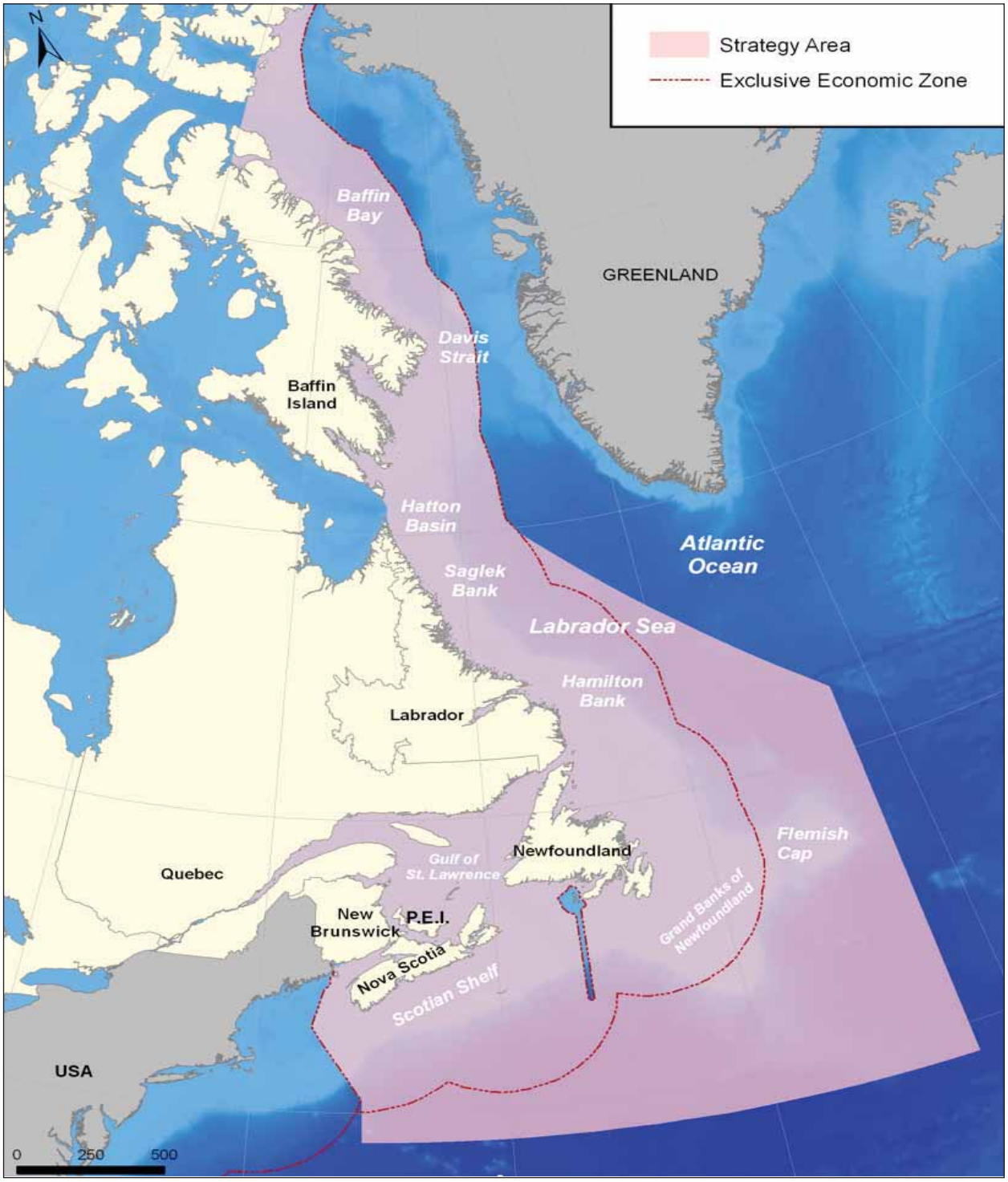


The Coral and Sponge Conservation Strategy for Eastern Canada covers the coral and sponge species, communities, and habitats in the Atlantic and Arctic Oceans of eastern Canada. The geographic scope of this Strategy includes corals and sponges occurring from the eastern Arctic Ocean, south to the Scotian Shelf, and east to the Grand Banks. The geographic scope includes the Gulf of St. Lawrence and extends out to the 200 mile limit (Canada's Economic Exclusion Zone or EEZ), and includes all of Northwest Atlantic Fisheries Organization (NAFO) areas 2, 3, and 4 outside the EEZ (Figure 1).

Though fishing activities outside the EEZ are managed by NAFO, these NAFO areas have been included in the Strategy because parts of the continental shelf extend past the EEZ, and Canada has jurisdiction over the continental shelf for sedentary species, such as corals. Canada has been leading the efforts at NAFO to identify vulnerable marine ecosystems in the NAFO Regulatory Area (NRA) and taking action to protect them. NAFO has several closures within this area which protect sensitive benthic habitat, including corals and sponges. DFO's Policy to *Manage the Impacts of Fishing on Sensitive Benthic Areas* (DFO 2009a) applies to fishing activity managed by the Government of Canada inside and outside the EEZ. In addition, Canada collaborates closely with NAFO in scientific research related to coral and sponges.

Through this Strategy, DFO regions will work individually and, where appropriate, cooperatively with NAFO to develop conservation approaches that take into account the importance of scientific research and the ecosystem-based management approach. One strategy is better aligned with an ecosystem approach as compared to several strategies governed by administrative boundaries.

Figure 1: Geographic Scope of the Coral and Sponge Conservation Strategy for Eastern Canada



International Context

Canada is signatory to a number of binding and non-binding commitments related to coral and sponge conservation. The protection of deep-sea fish stocks and vulnerable habitats in which they live is a fundamental consideration towards implementing successful conservation efforts. Due to the importance of corals and sponges in the benthic ecosystem, a number of these agreements focus on coral and sponge conservation, forming a catalyst for management actions. Table 1 outlines some of the international commitments Canada has taken part in, and provides a description of some of the ways in which these commitments link to coral and sponge or benthic conservation.

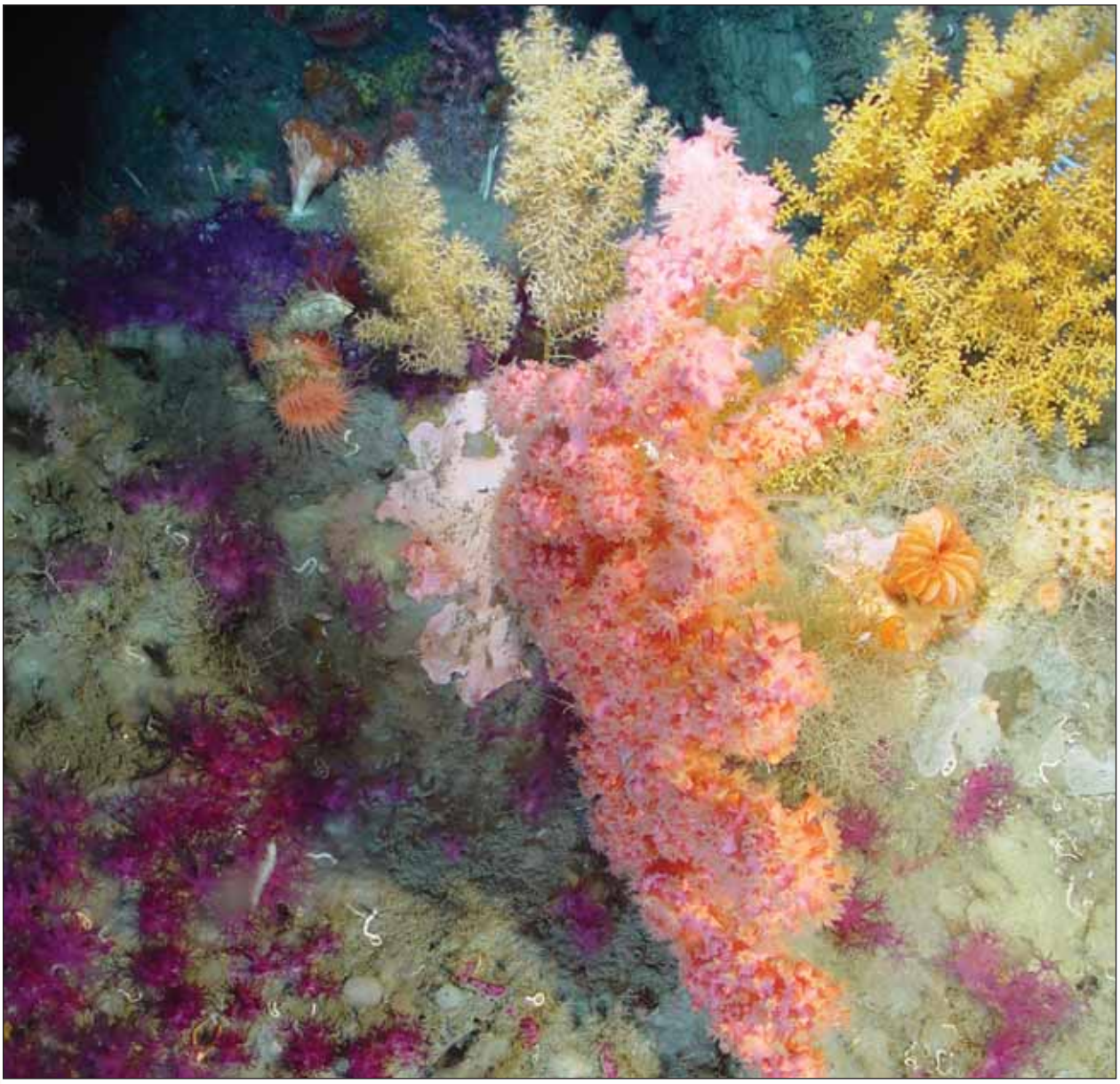


Table 1: International Commitments

Commitment	Description
United Nations Convention on Biological Diversity	The Convention has three principle objectives - conservation of biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources. Decision making is guided by the precautionary principle and as such it has been underlined that there is an urgent need to improve conservation and sustainable use of biologically diverse habitats through the establishment of a network of marine protected areas. (UN 1992).
World Summit on Sustainable Development (Johannesburg Summit)	States agreed to "maintain the productivity and biodiversity of important and vulnerable marine and coastal areas…" which included a commitment to establish representative networks of marine protected areas by 2012 (WSSD 2002).
United Nations Resolution on Sustainable Fisheries	In 2006, the Sustainable Resolution A/RES 61/105 was adopted by the United Nations General Assembly (UNGA). This Resolution provides guidance on the protection of Vulnerable Marine Ecosystems (VMEs) from significant adverse impacts of bottom fishing activities in the high seas. It calls on States to work individually and cooperatively through Regional Fisheries Management Organizations (RFMOs) to develop deep-sea fisheries strategies that take into account the precautionary approach and ecosystem-based management (UN 2006). Paragraph 83 called on RFMOs to adopt measures to assess whether individual bottom activities have an adverse impact on VMEs, to identify VMEs and to determine whether bottom fishing activities would cause significant adverse impacts on these ecosystems, to close areas where VMEs are known to occur to bottom fishing until conservation measures are put in place to prevent significant adverse impacts, and to require member flagged vessels to cease bottom fishing where VMEs are encountered and to report the encounter. In 2009, UNGA adopted resolution A/RES 64/72 reaffirming commitments in 61/105 and identifying further actions for the identification and protection of VMEs.
United Nations Food and Agriculture Organization (FAO) Technical Consultation on the International Guidelines for the Management of Deep-sea Fisheries in the High Seas	In 2009 member states adopted *International Guidelines for the Management of Deep Sea Fisheries in the High Seas* to assist member states with sustainable management of deep-sea fisheries. These guidelines are designed to limit the impacts of deep-sea fishing on fragile deep-sea fish species and habitats, including certain cold water corals and some types of sponge dominated communities (FAO 2009).

Canadian Context

The Government of Canada is committed to conserving and protecting our oceans to preserve healthy and productive ecosystems for the benefit of current and future generations. As such, there are numerous pieces of legislation that apply to the conservation and protection of corals and sponges. Within the Government of Canada, DFO is the lead federal department responsible for research and conservation of coral and sponge species. The national legislative and policy context for the Strategy can be found in the *Oceans Act* and the *Fisheries Act*, as well as the Department's mandate and mission. These Acts set out the powers, duties, and functions of the Minister of DFO that are applicable to the conservation and protection of corals and sponges. There are additional government policies that will influence implementation of the Strategy, such as the Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009a). Other operational guidance provides further clarity and direction in implementing these legislated responsibilities.

Additional pieces of federal legislation, such as the *Species at Risk Act, the Canadian Environmental Assessment Act* and the *Canada National Marine Conservation Area Act*, may also relate to coral and sponge conservation. Unlike the *Fisheries Act* and *Oceans* Act though, responsibilities for these Acts are shared with other departments and agencies. Table 2 outlines national legislation and provides a description of some of the ways in which these commitments link to coral and sponge or benthic conservation.

Within DFO, various programs have responsibilities with respect to corals and sponges, directed by the legislation outlined below. In each of the DFO regions, Oceans, Science, and Fisheries Management work together on complementary programs which further the understanding, conservation, and management of corals and sponges in eastern Canada. While these programs have varying mandates, a major commonality is the principle that conservation, based on an ecosystem approach, is of fundamental importance to maintaining biological diversity and productivity in the marine environment.

Ecosystem-based management is the management of human activities to ensure that marine ecosystems, their structure, function and overall environmental quality are not compromised. This principle aligns Oceans, Science, and Fisheries Management together in the Coral and Sponge Conservation Strategy for Eastern Canada.

Oceans

In 1997, Canada became the first country in the world to adopt comprehensive legislation for oceans management. By passing its *Oceans Act*, Canada made a legal commitment to conserve, protect and develop the oceans in a sustainable manner. Canada's *Oceans Act* is founded on three principles of sustainable development, integrated management, and the precautionary approach.

In 2002, Canada released its Oceans Strategy (DFO 2002) outlining the government's vision and direction for modern oceans governance. The overarching goal of the strategy is ensuring healthy, safe and prosperous oceans for the benefit of current and future generations of Canadians. On behalf of the federal government, the Minister of Fisheries and Oceans is called upon to fundamentally change the way we use and manage our oceans by providing policy direction for integrated oceans management; calling for coordination of policies and programs within and across governments; and advocating an ecosystem approach to ocean resource management and environmental assessment.

Ecosystem-based management is an integrated or holistic approach to making decisions about ocean-based development and conservation activities. It means considering the environmental impact of an activity on the whole ecosystem, not simply the specific resource targeted. It also means taking into account the cumulative impact of all human activities on the ecosystem within that area. This is different from past management approaches that focused on a single species or single economic activity.

Table 2: Legislation

Legislation	Description
Fisheries Act	The *Fisheries Act*, enables DFO to manage threats to fish that are part of or support commercial, recreational or Aboriginal fisheries with the goal of ensuring their productivity and ongoing sustainability. The prohibition, as per subsection 35(1), is supported by definitions of commercial, recreational and Aboriginal fisheries in the Act, as well as a definition of "serious harm to fish", which is the death of fish or any permanent alteration to, or destruction of, fish habitat (DOJ 1985).
Oceans Act	The *Oceans Act* outlines Canada's duties and responsibilities in its ocean territory and promotes sustainable development as a management approach. Several principles are outlined in the preamble of the Act including sustainable development, the ecosystem approach, precautionary approach and integrated management. The Act calls for DFO to lead a national system of Marine Protected Areas (MPAs) on behalf of the Government of Canada. It also includes a list of criteria for the establishment of MPAs (i.e. the conservation and protection of unique habitats and marine areas of biodiversity) (DOJ 1996).
Canadian Environmental Assessment Act	The *Canadian Environmental Assessment Act* requires federal departments or agencies, including DFO, to participate in environmental assessments for prescribed projects in Canada (DOJ 2012).
Species at Risk Act	The *Species at Risk Act (SARA)* provides Environment Canada (EC), Parks Canada (PC), and DFO with the authority to protect nationally listed species at risk (DOJ 2002a).
Canada National Marine Conservation Areas Act	The *Canada National Marine Conservation Areas Act* provides for the establishment of National Marine Conservation Areas to protect and conserve representative marine areas (DOJ 2002b). NMCAs will be an important component of Canada's network of MPAs. PC is the lead federal department for the establishment of National Marine Conservation Areas (NMCA), however, DFO leads MPA Network development and has an important role regarding fishery related matters within NMCAs.

Fisheries Management

Building on existing fisheries management practices, Canada's Sustainable Fisheries Framework (DFO 2009b) forms a foundation for implementing an ecosystem approach in the management of its fisheries. This includes using new policies and tools to implement the precautionary approach to fisheries management decision making, and manage the impacts of these fisheries on sensitive benthic areas, by-catch and forage species. This sector is responsible for a variety of fishing closed areas that have primary benefits for corals and sponges.

Of particular importance is the Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009a). The purpose of this policy is to help DFO manage fisheries to mitigate impacts of fishing on sensitive benthic areas or avoid impacts of fishing that are likely to cause serious or irreversible harm to sensitive marine habitat, communities, and species. Furthermore, an Ecological Risk Assessment Framework (ERAF) specific to cold water corals and sponges outlines a process for identifying the level of ecological risk of fishing activity and its impacts on sensitive benthic areas in the marine environment (DFO 2013).

Science

Aquatic ecosystems are increasingly affected by human activities. Limiting possible damage and making human activities more sustainable is the complex task of policymakers and managers who, in turn, rely on scientists for advice on which to base their decisions. Ecosystem science is the foundation for the science needed to support the integrated ocean management of diverse human activities, such as fishing, aquaculture, transportation, and oil and gas exploration that are regularly undertaken in the same area.

At its first meeting in October 2005, the Science Management Board confirmed that the highest priority for DFO Science is providing scientific support for ecosystem-based management. In response, the *Ecosystem Science Framework in Support of Integrated Management* (DFO 2007) was developed to realign its focus to ensure the long-term stability of the monitoring and data management programs, and to maximize flexibility in the area of research and the provision of products, services, and, particularly, scientific advice to respond to changing needs.

The Strategic Program for Ecosystem-Based Research and Advice (SPERA) supports those objectives with research projects and scientific tool development which support national priorities for managing ecosystems in Canada's domestic waters. Projects address key issues, such as scientific guidance on the avoidance of benthic impacts; science support for mitigating by-catch and tools to help manage biological diversity in Canadian waters. There are three types of SPERA funded projects: assessing ecosystem impacts of human activities; assessing and reporting on ecosystems; and tools for implementing the ecosystem approach.

The International Governance Strategy (IGS) Science program, formerly known as the International Fisheries and Oceans Governance Strategy (IFOGS), is a component of a larger multisectoral program which has the objectives to ensure 1) sustainable fisheries and 2) robust marine environmental and ecosystem sustainability. Under the funding theme 'Science in Support of Protecting High Seas Marine Habitat and Communities' this program has provided substantial ongoing support since 2005 for research on corals and sponges throughout the geographic region covered by the present strategy.

Integrated Management

Integrated Management (IM) initiatives align with existing policies outlined by DFO's Oceans, Fisheries Management, and Science programs. Parliament has set out an agenda for sustainable

development of our oceans based on a balanced approach to development and conservation of oceans resources through integrated management. Canada's *Oceans Act* and Oceans Strategy assign a number of responsibilities to the Minister of Fisheries and Oceans.

In 2005, Canada adopted its Oceans Action Plan (DFO 2005), a government-wide commitment to our oceans. One of the core commitments of Canada's Oceans Action Plan is to IM. As a means to achieve IM, Canada has defined 13 bioregions which serve as the ecological reference base for ecosystem-based oceans management decisions (DFO 2009c, GOC 2011). These bioregions comprise the spatial planning framework for Canada's national network of Marine Protected Areas (MPAs), of which coral and sponge areas will be an important component. Federally, the 1997 *Oceans Act* assigns responsibility to the Minister of Fisheries and Oceans to lead and coordinate development and implementation of a national system (or network) of MPAs on behalf of the Government of Canada, within the context of integrated management of estuarine, coastal and marine environments. DFO, PC, and EC are working collaboratively on the national MPA network. Four of these bioregions (plus the NAFO areas 2, 3, and 4) make up the geographic scope of this Strategy (Figure 2): the Eastern Arctic, the Newfoundland-Labrador Shelves, the Scotian Shelf and the Gulf of St. Lawrence bioregions. Coral and sponge conservation will be a main focus in the identification of areas for the network (GOC 2011).

Within Canada's bioregions, IM processes were piloted in five large ocean management areas (LOMAs). Three of these LOMAs fall within the scope of the Strategy (Figure 2): Gulf of St. Lawrence, Eastern Scotian Shelf Integrated Management (ESSIM), and Placentia Bay/Grand Banks (PB/GB). Important work conducted within these LOMAs will form the basis for oceans management planning, MPA Network development, and coral and sponge conservation at the bioregional level.

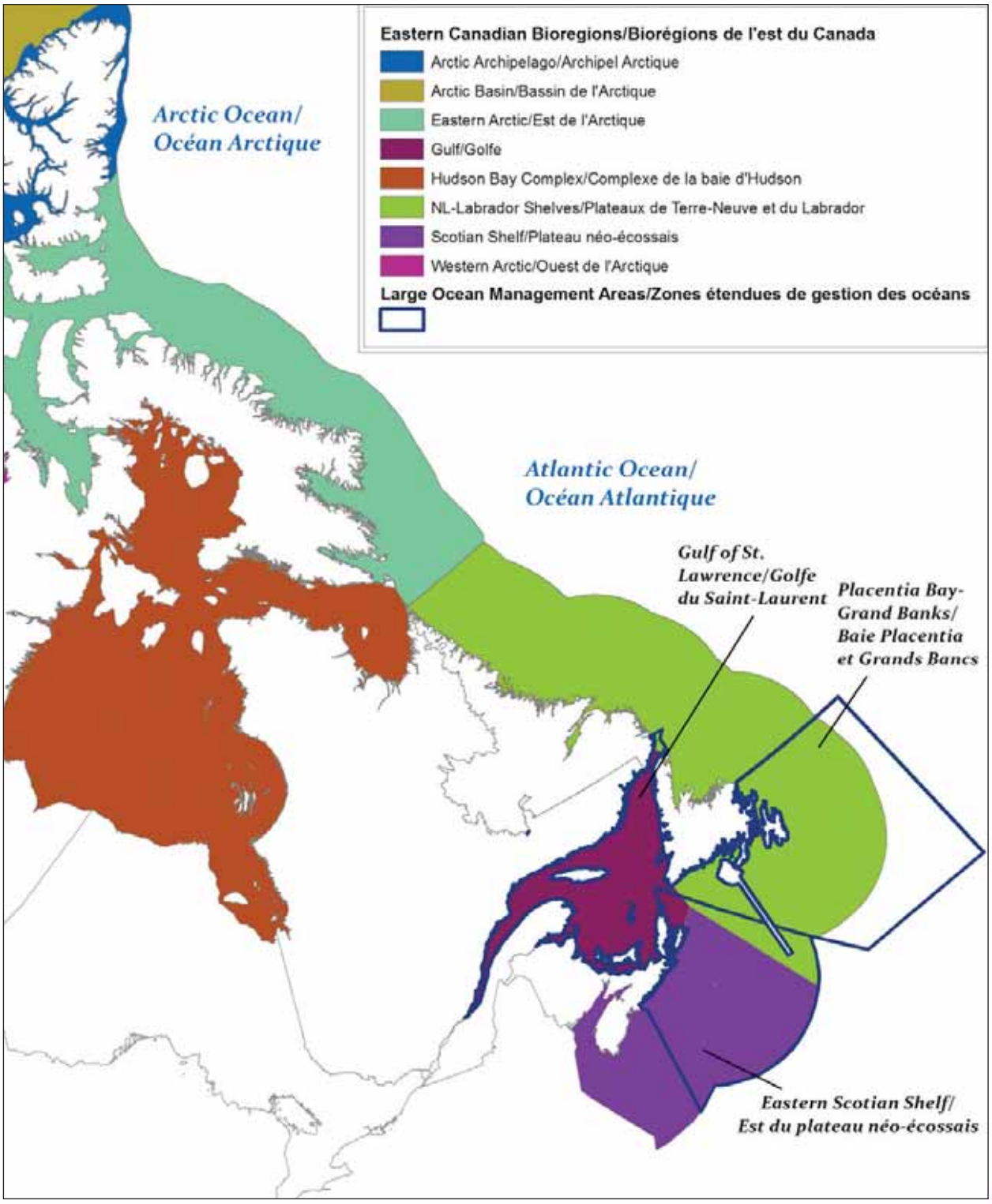
A strategic framework has been released for each LOMA for a variety of stakeholder-based priorities, which include corals and sponges. In addition, the Maritimes Region Coral Conservation Plan (DFO 2006a) was completed in support of the plan objectives for the Scotian Shelf.

Scientific overviews and assessments were completed for each LOMA to serve as the basis for objective setting exercises with affected and interested stakeholders. A key part of the scientific review involved the identification of ecologically and bio-logically significant areas (EBSAs), and this work continues at the bioregional scale.

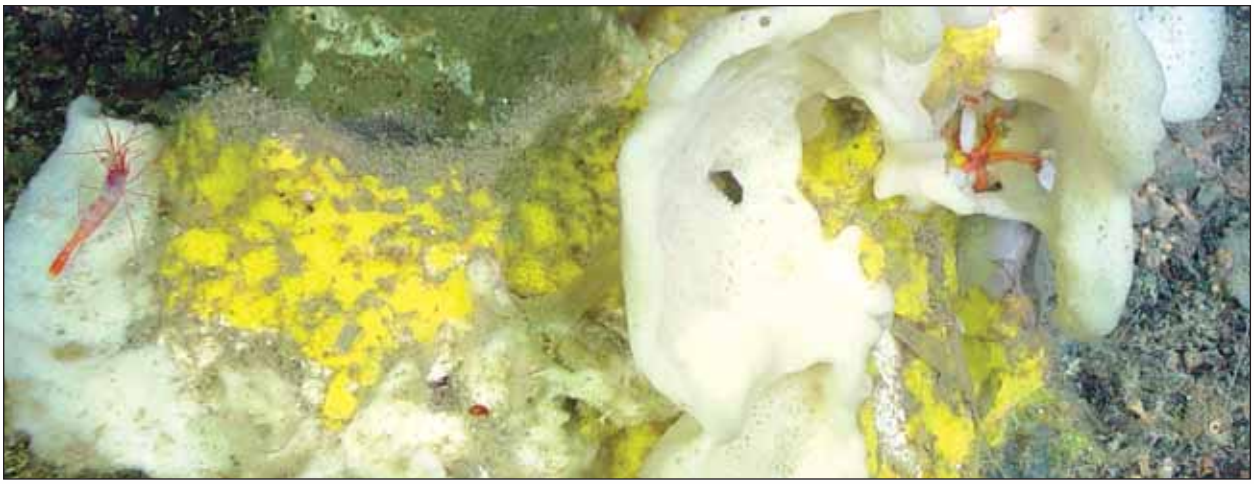
EBSAs which are areas of particularly high ecological or biological significance that should receive a greater-than-usual degree of risk aversion in man-agement have been identified in an effort to identify conservation priorities and facilitate action planning. In many cases, EBSAs inform the Area of Interest (AOI) process that identifies potential sites for MPA designation. Examples of current AOI processes include Laurentian Channel in Newfoundland andLabrador DFO Region, and St. Anns Bank in the Maritimes DFO Region. Certain coral and sponge concentrations clearly qualify as EBSAs due to the structure providing role they play in benthic ecosystems and their vulnerability to disturbance (Freiwald *et al.* 2004; Roberts *et al.* 2009). The southeast corner of NAFO Division 0A has been identified as the Southern Baffin Bay EBSA (DFO 2011) which supports concentrations of corals (including gorgonian and antipatharian species).

The IM planning units described above are one of the ways in which Canada's commitments, policies, and legislation are implemented at the regional level. By collaborating with stakeholder committees, the Government of Canada is helping to coordinate oceans and coastal management decisions among government agencies which will ensure healthy coral and sponge ecosystems are maintained through responsible economic development.

Figure 2: Eastern Canada's Bioregions and Large Ocean Management Areas



Status of Coral and Sponge Conservation in Eastern Canada



In Canada, DFO is the lead department responsible for research and conservation of coral and sponge species, but these species have also become a focal point for international conservation. In some cases, conservation measures have been put in place to protect these important coral and sponge areas where they have been identified in eastern Canada. Existing coral and sponge conservation areas are described below, ranging from international NAFO closures, federal government closed areas, and voluntary industry-driven closures.

NAFO Closures

In 2006, the United Nations General Assembly (UNGA) passed the Sustainable Fisheries Resolution 61/105, calling on states and Regional Fisheries Management Organizations (RFMOs) to take action to protect VMEs in the high seas (UN 2006). In response, NAFO has enacted several measures to protect corals and sponges which include coral and sponge closures, as well as seamount closures (Table 3). Deep-sea corals and their associated fauna can be considered straddling resources as their distributions extend both inside and outside Canada's 200 mile limit.

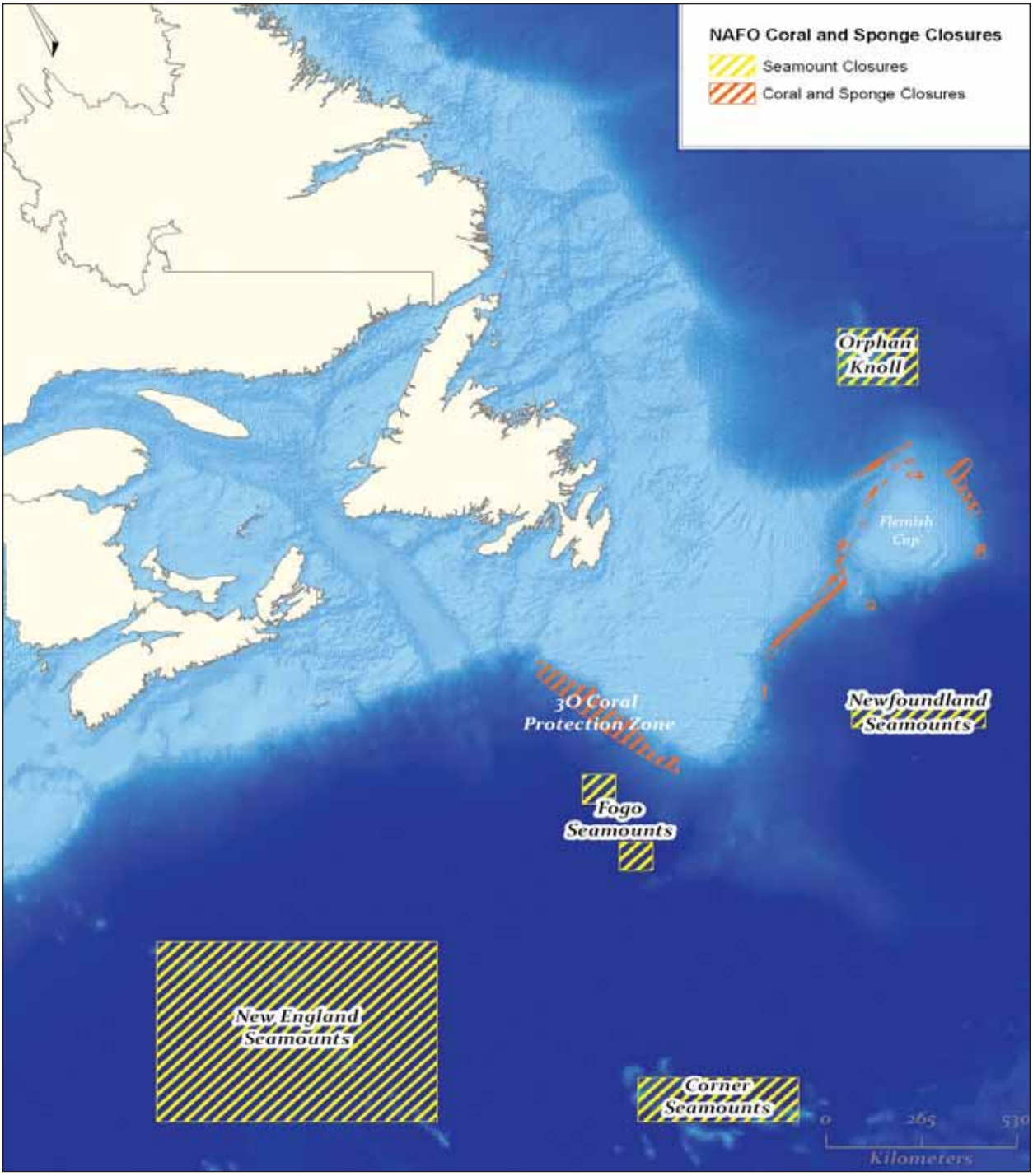
- In 2007 a Coral Protection Zone in Division 3O was closed to all bottom contact fishing gear. An additional 11 significant coral and sponge zones were closed in 2010 and one in 2013 around the Flemish Cap (NAFO 2011a, NAFO 2013). These closures were reassessed in 2014 and based on new data, the boundaries of several closures were adjusted. (Table 3, Figure 3).
- In 2007, NAFO closed four seamount areas (two outside the EEZ) and restricted bottom impacting gear. In 2009, NAFO added the Fogo Seamounts to the list of closures (Table 3, Figure 3) (NAFO 2011a).
- NAFO implemented an encounter protocol for existing fisheries in the NRA to reduce impacts on corals and sponges, whereby by-catch above a threshold means a vessel master must notify the NAFO Secretariat, immediately cease fishing, and move away at least 2 nautical miles. These measures apply to foreign and Canadian vessels operating in the NRA, and Canadian vessels operating in NAFO Division 3O inside the EEZ. NAFO also adopted a map of existing bottom fishing areas known as a "footprint" in 2011. Fishing for groundfish outside the footprint is considered exploratory, therefore the impacts on VMEs have to be considered, and the exploratory fisheries protocol must be followed (NAFO 2011b).

Table 3: NAFO closures

Management Measures	Location	Feature	Area (km²)
Closed to All Bottom Impacting Gear	Coral Protection Zone in Division 3O	Coral and Sponge	14,040
Closed to All Bottom Impacting Gear	Adjacent to Flemish Cap	Coral and Sponge	10,488
Restrictions on Bottom Impacting Gear	Orphan Knoll	Isolated topographic high	15,780
Restrictions on Bottom Impacting Gear	Newfoundland Seamounts	Seamount	15,410
Restrictions on Bottom Impacting Gear	Fogo Seamounts	Seamount	9,141
Restrictions on Bottom Impacting Gear	*New England Seamounts	Seamount	276,035
Restrictions on Bottom Impacting Gear	*Corner Seamounts	Seamount	40,241

*New England Seamounts and Corner Seamounts are within NAFO Regulatory Area but not within the scope of this Strategy.

Figure 3: NAFO coral and sponge closures*



*New England Seamounts and Corner Seamounts are within NAFO Regulatory Area but not within the scope of this Strategy.

DFO Closures

Management tools available to DFO to conserve and protect sensitive benthic areas, including coral and sponge communities, vary from fisheries gear / effort / temporal restrictions and fisheries closures, to MPAs (Table 4, Figures 4 and 5).

- Important coral conservation measures in the Scotian Shelf bioregion include the establishment of the Northeast Channel Coral Conservation Area (2002) and the Lophelia Coral Conservation Area (2003) under the *Fisheries Act*, and the designation of the Gully Marine Protected Area (2004) under the *Oceans Act*.

- In June 2013, the Minister of Fisheries and Oceans Canada announced further conservation measures for two sensitive areas of the Scotian Shelf. The Emerald Basin Vazella Closure and the Sambro Bank Vazella Closure were created to protect them from bottom-contact fishing, protecting a rare sponge, Vazella pourtalesi. The Emerald Basin Vazella Closure was initiated as a voluntary closure by the Groundfish Enterprise Allocation Council (GEAC). With some boundary modifications, this area evolved into a DFO closure.

- DFO has established coral and sponge conservation measures in Davis Strait. A partial closure to Greenland Halibut fishing was established in 1998, to protect a primary food source for Narwhal which aggregate in the area during the winter. Subsequently this area was found to contain coral concentrations including large aggregations of gorgonian corals, rare black corals, and antipatharian species and a full closure to Greenland Halibut fishing was implemented in 2008.

Table 4: DFO closed areas related to coral and sponge conservation

Management Measures	Location	Area (km^2)
Restrictions to Bottom Impacting Gear	Northeast Channel Coral Conservation Area	424
Restrictions to Bottom Impacting Gear	Lophelia Coral Conservation Area (The Stone Fence)	15
Restrictions to Bottom Impacting Gear	Gully Marine Protected Area	2,364
Restrictions to Bottom Impacting Gear	The Emerald Basin Vazella Closure	197
Restrictions to Bottom Impacting Gear	Sambro Bank Vazella Closure	62
Restrictions to Bottom Impacting Gear - Greenland Halibut Fishery	Division 0A Narwhal Overwintering and Coldwater Coral Zone	11,634

Figure 4: Fisheries and Oceans Canada closed areas (Newfoundland and Labrador, Maritimes, Gulf and Quebec)

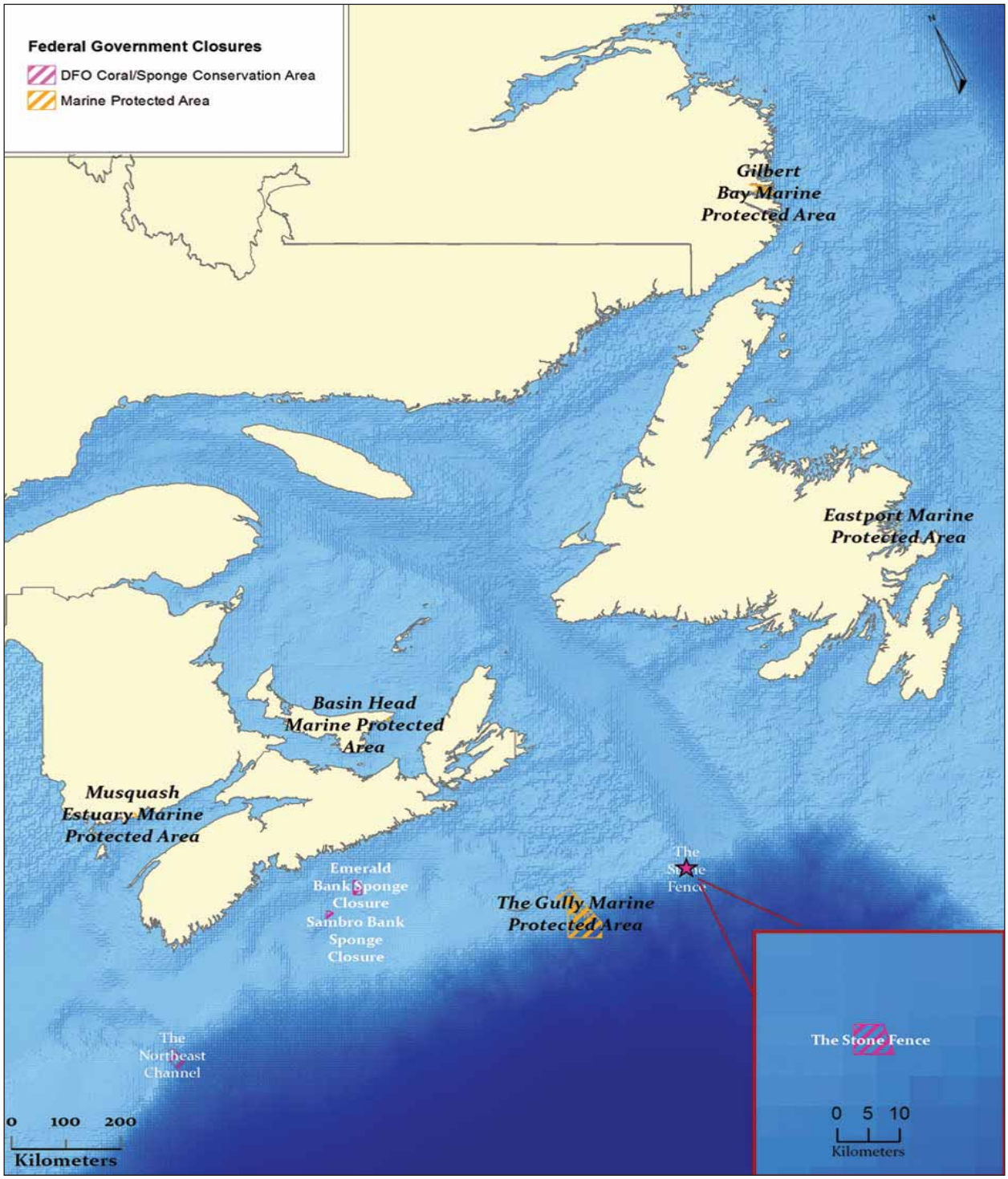
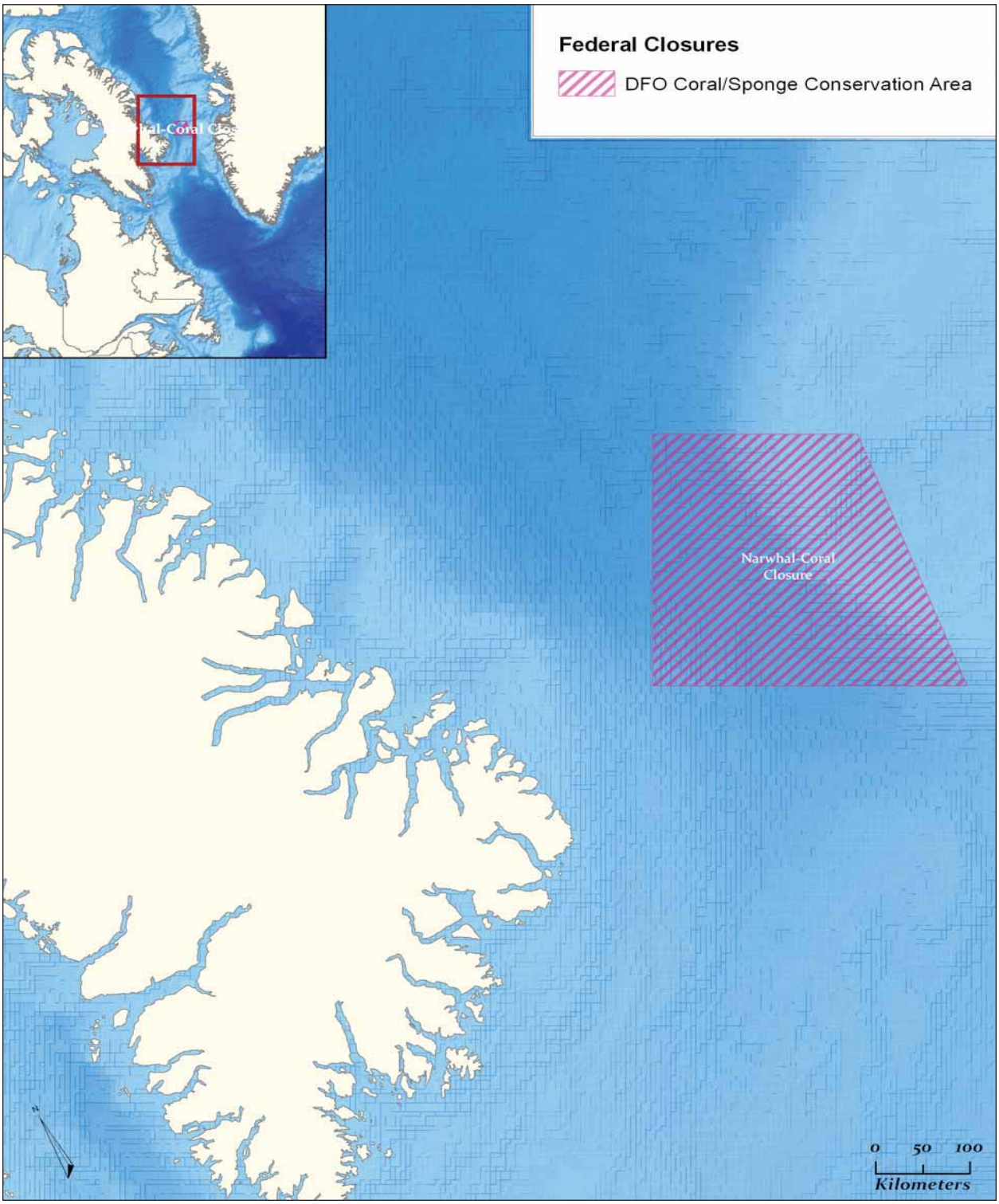


Figure 5: Fisheries and Oceans Canada closed areas (Central and Arctic)



Industry-driven Closures

The Fisheries Council of Canada (FCC) is a non-profit trade association representing companies engaged in the growing, harvesting, processing, and marketing of fish and seafood. FCC membership includes the Canadian Association of Prawn Producers, GEAC 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 and practices in Canada (Campbell and Simms 2009).

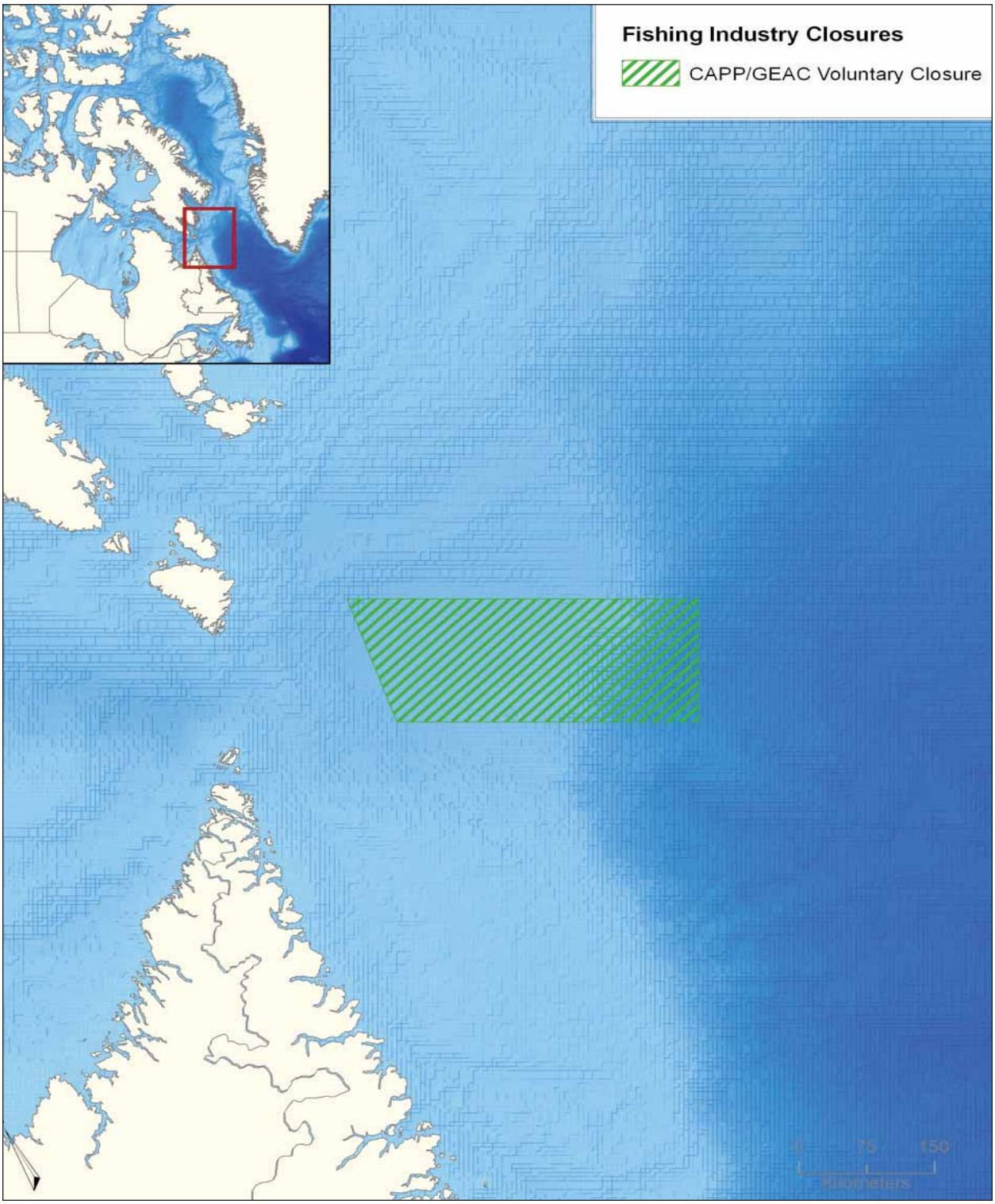
Industry created a voluntary closure (12,500km^2) enacted by the Canadian Association of Prawn Producers, GEAC, and the Northern Coalition to protect coral concentrations in an area of the Northern Labrador Sea referred to as Hatton Basin (Figure 6).

Other National Proposed Closures

Within the Government of Canada, there are other national programs and marine conservation tools which have the potential to contribute to the conservation of coral and sponge communities. DFO, PC and EC each have specific but complementary mandates for protecting oceans and their living resources, and establishing MPAs. For example, in 2005 the Ministers of these federal agencies released Canada's Federal Marine Protected Areas Strategy, which outlines how their respective MPA programs—PC's NMCAs, EC's National Wildlife Areas and Migratory Bird Sanctuaries—can collectively contribute to a network. The Coral and Sponge Conservation Strategy for Eastern Canada will encourage federal agencies to have a more comprehensive approach to coral and sponge conservation through increased coordination of management and research efforts.

Designation of the following areas is under active investigation (Table 5):

Figure 6: Industry-driven closure for coral and sponges



- In June 2010 the Laurentian Channel was announced as an Area of Interest (AOI) (Figure 7) in the NL DFO Region, with MPA designation expected in 2015. Significant concentrations of sea pens have been identified as a conservation priority and management measures will be drafted to ensure human activities do not impact these species (DFO 2010b).

- St. Anns Bank is within the Scotian Shelf Bioregion and was chosen in part for the presence of vulnerable benthic habitats and species, such as corals and sponges (Figure 7).

- In 2011, PC and the government of Quebec announced an agreement to conduct a feasibility study on the creation of a marine protected area in the Îles-de-la-Madeleine area to expand marine and coastal area conservation and continue efforts to safeguard biological diversity.

- In 2009 PC, the Government of Nunavut and the Qikiqtani Inuit Association announced an agreement to conduct a feasibility study for a proposed NMCA in Lancaster Sound to represent the Lancaster Sound marine region and protect the area's rich natural heritage (Figure 8).

Table 5: Proposed protected areas and potential management measures contributing to coral and sponge conservation

Organization	Location	Area (km^2)	Potential Management Measures
DFO	Laurentian Channel	~12,000	Zones proposed with no oil and gas activity and no commercial fishing.
DFO	St. Anns Bank	~5,100	Zones proposed with no oil and gas activity and no commercial fishing.
Gov of Quebec, PC	Iles-de-la-Madeleine	~17,000	Restrictions to ocean dumping, undersea mining, oil and gas exploration and development, commercial fisheries.
PC	Lancaster Sound	~44,000	Prohibitions on undersea mining, oil and gas exploration and development and ocean dumping. Restrictions to commercial fisheries.

Figure 7: Proposed MPAs in Atlantic Canada (exact boundaries to be determined)

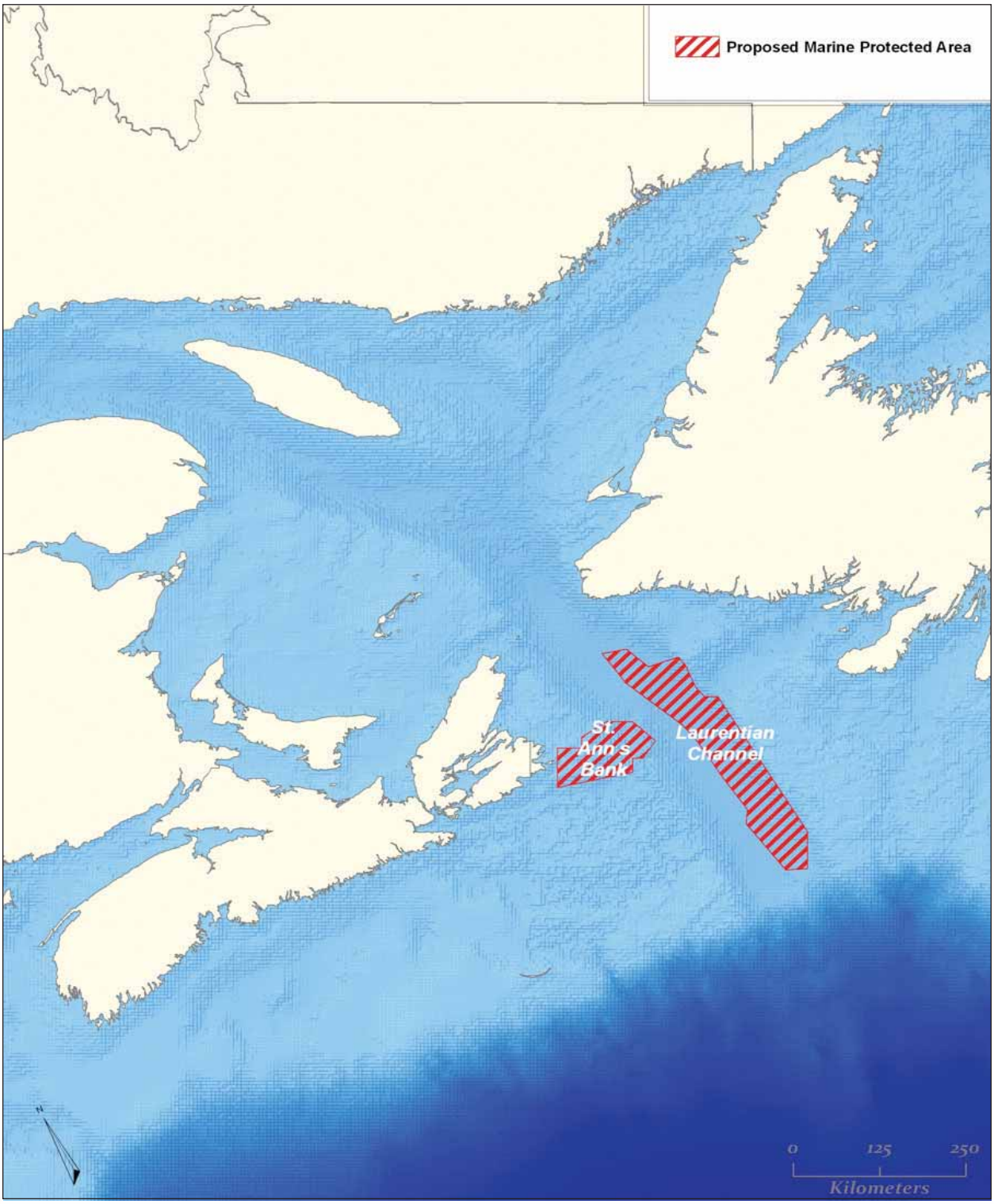
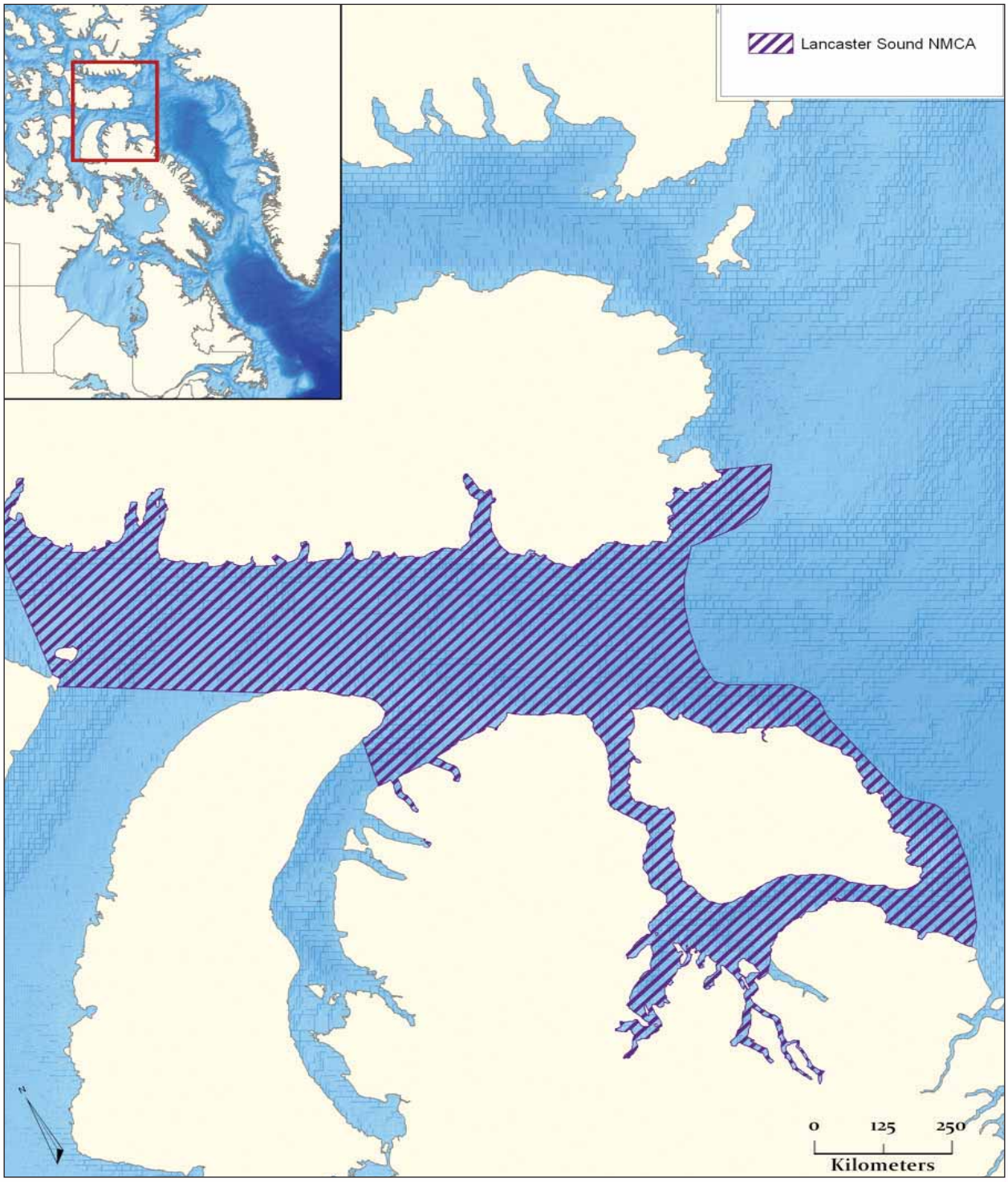
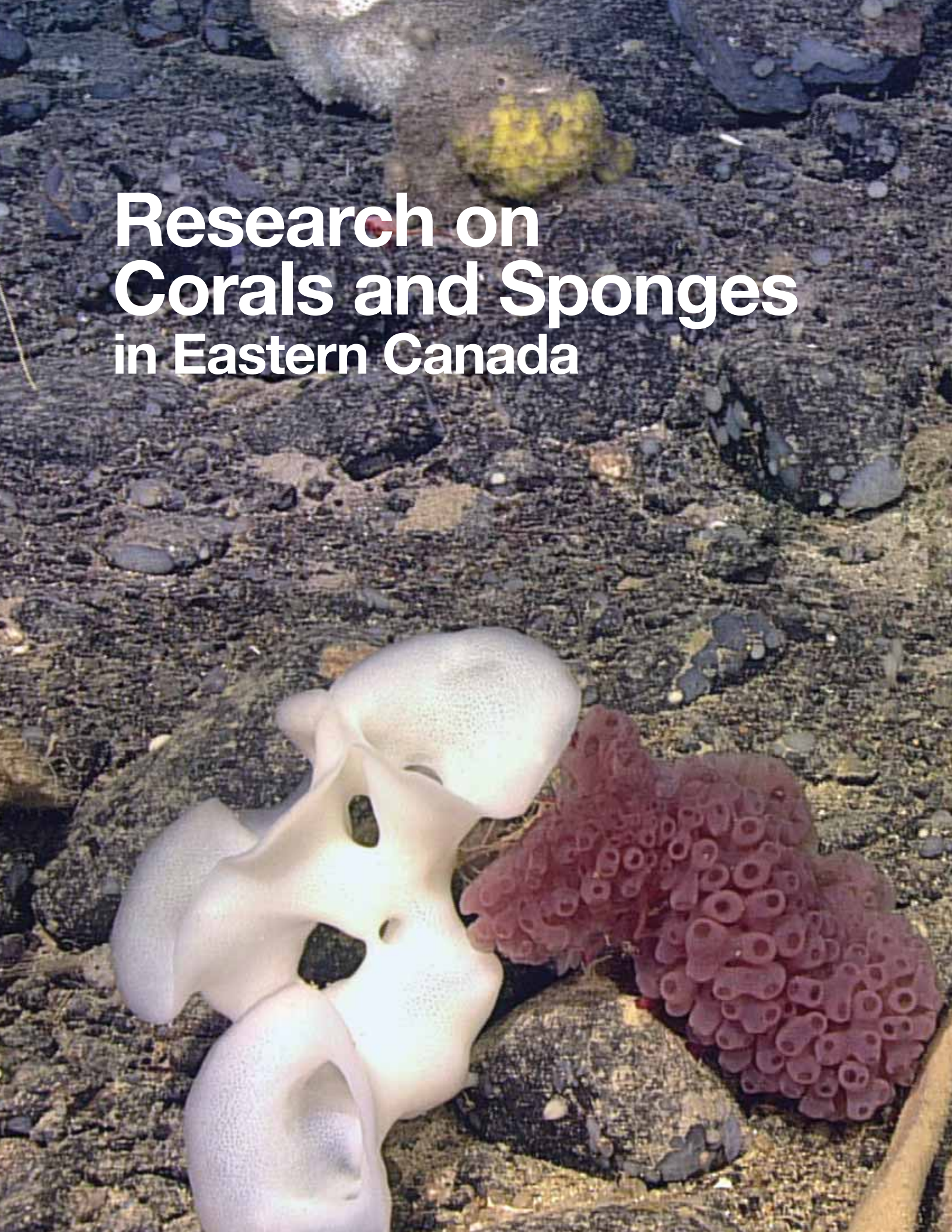


Figure 8: Proposed National Marine Conservation Area (NMCA) in Lancaster Sound



Research on Corals and Sponges in Eastern Canada



DFO recognizes that a strong scientific research program is required to make sound management decisions in order to ensure sustainability of ocean resources, especially for sensitive habitat represented by coral and sponge communities. Understanding these unique species and their inter-relationships with other species in deep-sea ecosystems is crucial in order for DFO to meet conservation objectives under the *Fisheries Act*, *Oceans Act*, and the *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas*.

In order to properly manage these important and sensitive species and their habitats, detailed knowledge of their biology, distributions (particularly concentrations), biodiversity and ecological relationships with other species, including fish, is urgently needed. Since 2000, several dozen scientific publications have been produced on the biology and ecology of corals and sponges in eastern Canada. Core research focuses on the distribution, diversity and abundance of corals and sponges from fisheries and survey trawl by-catch in eastern Canada (Wareham and Edinger 2007; Wareham 2010; Baillon *et al*. 2012, inter alia). More in-depth studies on distribution patterns of corals in relation to physical and biological features have been undertaken in eastern Canada using remotely operated vehicles (Mortensen and Buhl-Mortensen; 2004; Edinger *et al*. 2011; Baker *et al*. 2012a,b). While much remains to be investigated on the physiology, biochemistry and life history traits of corals and sponges, nonetheless, through studies of by-catch and dedicated research cruises in eastern Canada, significant advances have been made in our understanding of coral longevities and growth rates (Sherwood and Edinger 2009), trophic relationships (Sherwood *et al*. 2008) and reproductive strategies (Sun *et al*. 2010; Mercier *et al*. 2011; Mercier and Hamel 2011; Lacharité and Metaxas 2013; Baillon *et al*. 2014). Ongoing laboratory research priorities include biochemical, geochemical and reproductive studies. In terms of furthering our understanding of preferred habitat for corals and sponges, recent research focuses on interpolating concentrations of corals and sponges over wide geographic areas (Kenchington *et al*. 2010; Wareham *et al*. 2010) and predictive modeling (Knudby *et al*. 2013a,b,c).

Data on corals and sponges is generally collected opportunistically from the following primary sources: (1) annual DFO multispecies research vessel surveys conducted by Science Branch and (2) fisheries observer data, collected onboard commercial fishing vessels operating within Canadian waters and in the NAFO Convention Area (3) and the Northern Shrimp Survey (DFO and Industry collaboration).

While these sources of information have been invaluable, most rely on trawls which routinely sample on relatively level sea beds leading to a bias in favor of certain types of sea floors. Fisheries Observer Program (FOP) data collected from commercial vessels are biased towards 'good fishing grounds'. In short, research data can be biased towards 'trawlable' bottom types, whereas FOP data can be biased towards 'fishing effort'. Alternative, non-intrusive data collection techniques (i.e. those used in the 2007 SW Newfoundland slope and 2010 Flemish Cap and Orphan Knoll ROPOS cruises) are often required for corals and sponges, including multibeam sonar, video footage and drop cameras, acoustic sub-bottom profiling, and dedicated remotely operated vehicle (ROV) deployment. Objectives for this type of research include characterization of the geological basis of coral habitat, quantification of coral/sponge diversity and abundance and coral-associated biodiversity, distribution, and comparison of coral diversity and abundance between fished and unfished areas.

While current ecosystem science research within DFO is supported through SPERA for research projects and scientific tool development, collaboration with other regions, nations, universities, and industry has become an effective means of obtaining and sharing information. For example, data collected using the FOP as well as distributional information collected from DFO surveys are made available to

the NAFO Scientific Council and NL and C&A DFO regions to assist in providing advice on measures to protect corals and sponges (Campbell and Simms, 2009). DFO has also undertaken dedicated research cruises in collaboration with international, and academic partners (i.e. Dalhousie University, Memorial University, World Wildlife Fund, Smithsonian and Peabody Museums) that have yielded many publications on coral and sponge populations in eastern Canada (Gilkinson and Edinger 2009) (see Appendix E for additional publications). In 2009, a Geographic Information Systems (GIS) database on corals and sponges for the NRA and Canadian east coast was created. Also, identification guides for corals and sponges were distributed to address issues of inconsistency between observers in the regions (Kenchington *et al*. 2009; Best *et al*. 2010). Local Traditional Ecological Knowledge (TEK) is also a source of information (Gass and Willison 2005; Colpron *et al*. 2010). As previously discussed under Science Sector, results of IGS and IFOGS funded projects have significantly expanded our knowledge of coral and sponge distributions in the eastern Canadian and Arctic regions and have identified key areas for coral and sponge protection. Other sources of funding for coral research in Atlantic Canada include the Environmental Studies Research Funds.

The Canadian Healthy Oceans Network, or CHONe, is a Natural Sciences and Engineering Research Council of Canada strategic network focused on biodiversity science for the sustainability of Canada's three oceans. CHONe pursues research through a wide range of strategies that include extensive field research, image analysis tools, and laboratory experiments which support many research projects related to corals and sponges. Increasingly, international research collaboration is being recognized as an important tool to share resources (e.g. funding, shiptime) and exchange information at basin scales. The TRACES (Trans-Atlantic Coral Ecosystem Study) initiative is an example of cooperation between Canada, the European Union, and US scientists (Gilkinson and Edinger 2009). Increased knowledge of the NAFO areas can be gained through greater scientific collaboration with European Union fisheries research surveys and European Union fisheries observers. Ultimately, however, an ROV cruise for in situ observations of corals and sponges may be required to explore some of these deep-sea areas.

Continued research, especially using non-invasive techniques, is required to understand the diversity of coral and sponge communities found in eastern Canadian waters, and to provide adequate management advice. Recently, collaboration with federal partners, international organizations, academia, and industry has become more common. Data sharing takes place amongst DFO regions, NAFO, and other partners, and as the scientific community continues to advance research on these species, more cooperation is expected. Many data gaps still exist and the Coral and Sponge Conservation Strategy for Eastern Canada will promote information sharing, science surveys, and research collaboration to advance our understanding, thereby increasing our ability to protect and conserve these unique species.

Objectives

The Coral and Sponge Conservation Strategy for Eastern Canada focuses on three primary objectives: conservation, management, and research (Table 6). Conservation and management objectives are closely related and are linked for the purpose of the Strategy.

The objectives and associated regional targets and actions that follow are part of a broader Departmental mission to provide Canadians with economically prosperous maritime sectors and fisheries, safe and secure waters, and sustainable aquatic ecosystems. These objectives, which are consistent with those found in both the Maritime Region's *Coral Conservation Plan* and the *Pacific Region's Cold-water Coral and Sponge Conservation Strategy*, are the foundation that will guide future direction concerning corals and sponges. In this Strategy, the conservation objective provides the basis for management and research objectives. Together, these objectives guide the targets and actions to be implemented by DFO regional authorities (Table 7 and 8).

Table 6: Objectives of the Coral and Sponge Conservation Strategy for Eastern Canada

Strategy Objectives	
Conservation Objective	To conserve the health, composition, and function of coral and sponge species, communities, and their habitat in support of healthy ecosystems.
Management Objective	To manage human activities with impacts on coral and sponge communities efficiently and effectively in support of healthy ecosystems and sustained economic benefits, within a risk assessment framework.
Research Objective	To support decision making through the provision of scientifically based peer-reviewed advice on the location of corals and sponges, human caused impacts on these species, the health and integrity of corals and sponges, and their contributions to the conservation of healthy ecosystems.

Targets and Actions

Specific targets and actions have been developed to outline how DFO will achieve the objectives of this Strategy. Table 7 outlines targets and associated actions in relation to conservation, and management priorities, while targets and actions related to research priorities are outlined in Table 8. Each DFO region will further define each action in a regional context, provide detailed timelines and identify lead sectors to ensure a consistent approach to addressing the Strategic Objectives, while allowing the flexibility to respond to regional differences.

Table 7 Targets (T) and Actions (A) in support of conservation and management objectives

T1. Define and Identify Important Coral and Sponge Areas	
Action	**Purpose**
A 1.1 Refine and focus on 'significant' coral and sponge species.	To increase knowledge
A 1.2 Compile and map existing data on the distribution and relative abundance of coral and sponge species, and update as new data becomes available.	To increase knowledge
A 1.3 Identify and delineate significant coral and sponge concentrations using advice from Canadian Science Advisory Secretariat (CSAS), predictive models, and other appropriate sources.	To increase knowledge
A 1.4 Identify and delineate coastal sponge aggregations and study their distribution and ecological function.	To increase knowledge
T2. Identify Threats and Stressors to Corals and Sponges	
Action	**Purpose**
A 2.1 Define human caused 'threats' and 'stressors' to corals and sponges using advice from CSAS reports and other appropriate sources.	To inform decision making
A 2.2 Assemble and map existing information on human activities that may affect corals and sponges in eastern Canadian waters.	To inform decision making
T3. Assess Risks to Coral and Sponge Areas and Determine whether Management Measures are Needed	
Action	**Purpose**
A 3.1 Consistent with the Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas, assess the fishing-related risk of harm to corals and sponges. **A 3.1.1** Delineate historically fished and frontier areas within the scope of the Strategy.	To inform decision making

A 3.1.2 Apply the ERAF to determine the risk of serious or irreversible harm to corals and sponges within historically fished areas. **A 3.2** Assess threats to sponges and corals resulting from proposed developments and activities, and depending on the level of risk, recommend mitigations to reduce impacts to an acceptable level, issue an Authorization under the *Fisheries Act*, or refuse to authorize the project.	To inform decision making
T4. Protect Important Coral and Sponge Areas through Implementation of New or Existing Management Measures	
Action	**Purpose**
A 4.1 Apply the appropriate management options to address risks identified in A 3.1 and A 3.2 including provisional measures where warranted.	To inform decision making
A 4.2 Where appropriate, incorporate management measures into Integrated Fisheries Management Plans (IFMPs), Conservation Harvesting Plans and license conditions, including fishery closures.	To inform decision making
A 4.3 Advise industry proponents (e.g. oil and gas) and regulatory authorities through environmental review processes on the presence, potential impacts, and proposed mitigations for corals and sponges.	To inform decision making
A 4.4 Develop encounter protocols consistent with the Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas and the New and Emerging Fisheries Policy, with a focus on frontier areas.	To develop Policy
A 4.5 Consider coral and sponge conservation when developing operational objectives and management actions within IM initiatives, MPA network development, and SARA recovery plans.	To inform decision making
A 4.6 Assess impacts on corals and sponges as part of activity approval processes within existing *Oceans Act* MPAs and as part of exceptions and prohibitions during new *Oceans Act* MPA designation processes.	To inform decision making
T5. Monitor and Evaluate the Effectiveness of the Management Measures	
Action	**Purpose**
A 5.1 Continue reporting requirements for coral and sponge by-catch.	To inform decision making
A 5.2 Develop and implement pre- and post-impact monitoring standards based on sound science advice.	To increase knowledge
A 5.3 Regularly evaluate the effectiveness of existing habitat protection and mitigation measures, including fishery compliance, IFMPs and closed areas, in protecting corals and sponges.	To inform decision making

A 5.4 Analyze trends in coral and sponge occurrence recorded from DFO Science surveys.	To increase knowledge
T6. Foster Public Involvement and Participation in Conservation and Management of Corals and Sponges	
Action	**Purpose**
A 6.1 Use new and existing DFO communications and outreach tools and opportunities to increase awareness of coral and sponge conservation and encourage public involvement (Diving into the Deep: Coral and Sponge Conservation in Canada, Oasis of the Deep and other appropriate DVDs, posters, displays, etc.).	To raise awareness
A 6.2 Provide regional updates on management measures and monitoring results in relation to regional coral and sponge conservation to stakeholders as appropriate.	To raise awareness
A 6.3 Facilitate information sharing and collaborative planning with other government agencies, Aboriginal organizations and stakeholders on coral and sponge conservation (using existing processes such as oceans governance and MPA advisory committees, and the committees established in the context of federal-provincial agreements.).	To raise awareness
A 6.4 Foster shared stewardship and collaboration with relevant government agencies, Aboriginal organizations, industry and other stakeholders regarding the conservation of corals and sponges.	To raise awareness

Table 8 Targets (T) and Actions (A) in support of research objectives

T1. Enhance Ongoing Benthic Habitat Research Activities in relation to Corals and Sponges	
Action	**Purpose**
A1.1 Identify and prioritize research needs and conduct research where data is insufficient.	To increase knowledge
A1.2 Research, develop, and implement methods to detect and assess coral and sponge species and communities (i.e. predictive models, field studies, development of metrics, bathymetric and multibeam bottom classification studies, oceanographic variability measurement and modeling, and habitat characterization).	To increase knowledge
A1.3 Minimize the risk of damage to corals and sponges from research activities such as trawl surveys	To increase knowledge

A1.4 Develop and refine protocols and tools to standardize quality and nature of collected data (i.e. observer taxonomic guides, standard data collection, storage, access protocols, metadata standards, DFO Survey).	To increase knowledge
A1.5 Compile, analyze, and assess data from DFO Science surveys, bottom classification studies, oceanographic studies and other emerging sources in support of coral and sponge conservation and management objectives.	To increase knowledge
A1.6 Conduct research on the role(s) coral and sponge species play in the broader ecosystem and their importance to species targeted by recreational, commercial and Aboriginal fisheries.	To increase knowledge
A1.7 Research the impacts that human activities have on coral and sponge communities.	To increase knowledge
A1.8 Continue reporting requirements for coral and sponge by-catch through the At-sea Observer Program.	To increase knowledge
A1.9 Pursue opportunities to increase funding for benthic habitat research.	To increase knowledge
T2. Monitor and Evaluate the Health of Corals and Sponges	
Action	**Purpose**
A2.1 Develop indicators for coral and sponge health and recovery.	To increase knowledge
A2.2 Determine ecosystem indicators that measure the extent and nature of human impacts on coral and sponge habitats.	To increase knowledge
A2.3 Monitor health of corals and sponges within fisheries closures and MPAs, including recovery from human impacts.	To increase knowledge
T3. Provide Opportunities for Information Sharing and Research Collaboration	
Action	**Purpose**
A3.1 Promote and conduct collaborative research and enhance existing scientific surveys in support of current conservation measures and strategies [e.g. science surveys and other surveys conducted by academia, international collaborators, and environmental non-government organizations (ENGOs)].	To inform decision making
A3.2 Seek opportunities for information sharing and research collaboration with international and federal-provincial working groups.	To inform decision making
A3.3 Seek partnerships with industry to conduct research, develop research tools (e.g. ROV) and facilitate data sharing.	To inform decision making

A3.4 Develop a data mapping application for other departments, co-management organizations and agencies to use in management decision-making.	To inform decision making
T4. Evaluate the potential Impacts of Conservation Measures on Human Activities	
Action	**Purpose**
A4.1 Evaluate the potential socioeconomic impact of any new conservation measures through the ERAF process, industry consultations, and/or socioeconomic overview.	To inform decision making

Development and Implementation

Implementation

While the implementation of region specific targets and actions will be led within each respective DFO region, there will be collaboration among the regions where appropriate. The five DFO regions within eastern Canada will work together to promote consistency in the implementation of legislation and policy to conserve and protect corals and sponges, and find efficiencies in research efforts and data sharing.

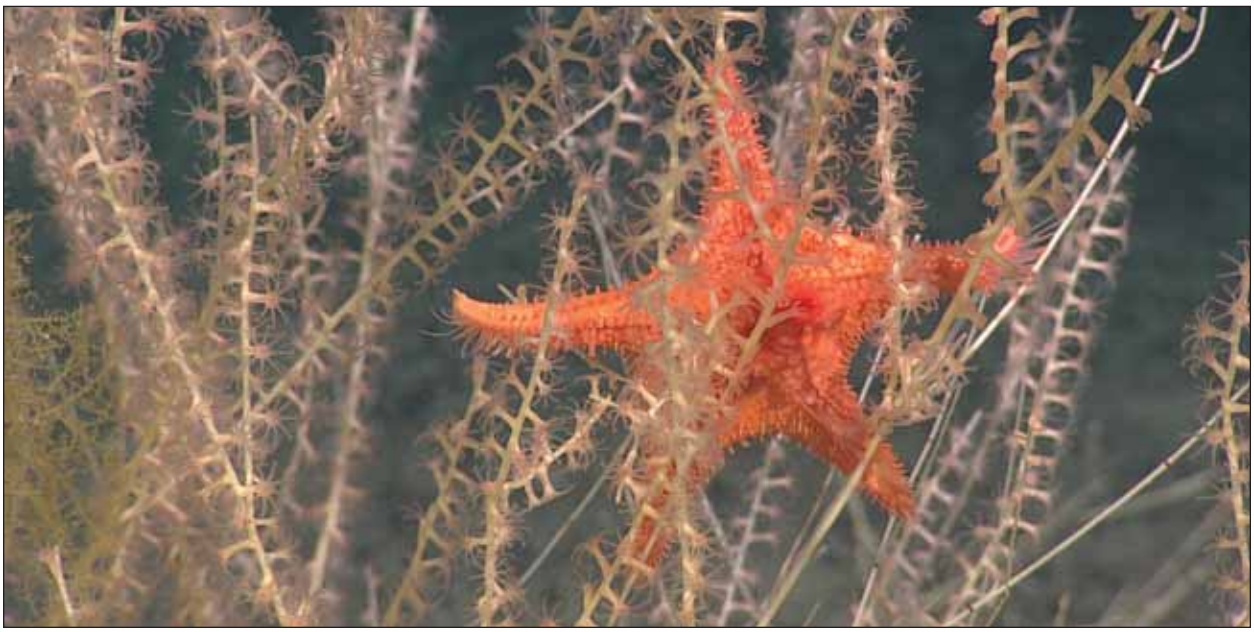
Some of the actions listed in the Strategy are within the scope of work already planned or underway within the Department and can therefore be managed within existing resources. Where gaps exist, particularly with respect to research and monitoring, the Strategy will inform future strategic planning and funding allocation.

The fishing industry, international partners, ENGOs, and academics have played an important role in achieving the coral and sponge conservation measures currently in place. It is hoped that these groups will continue to collaborate and provide information and advice to regulators. For other groups, such as the oil and gas industry, the Strategy identifies opportunities to collaborate on research, as well as conservation issues.

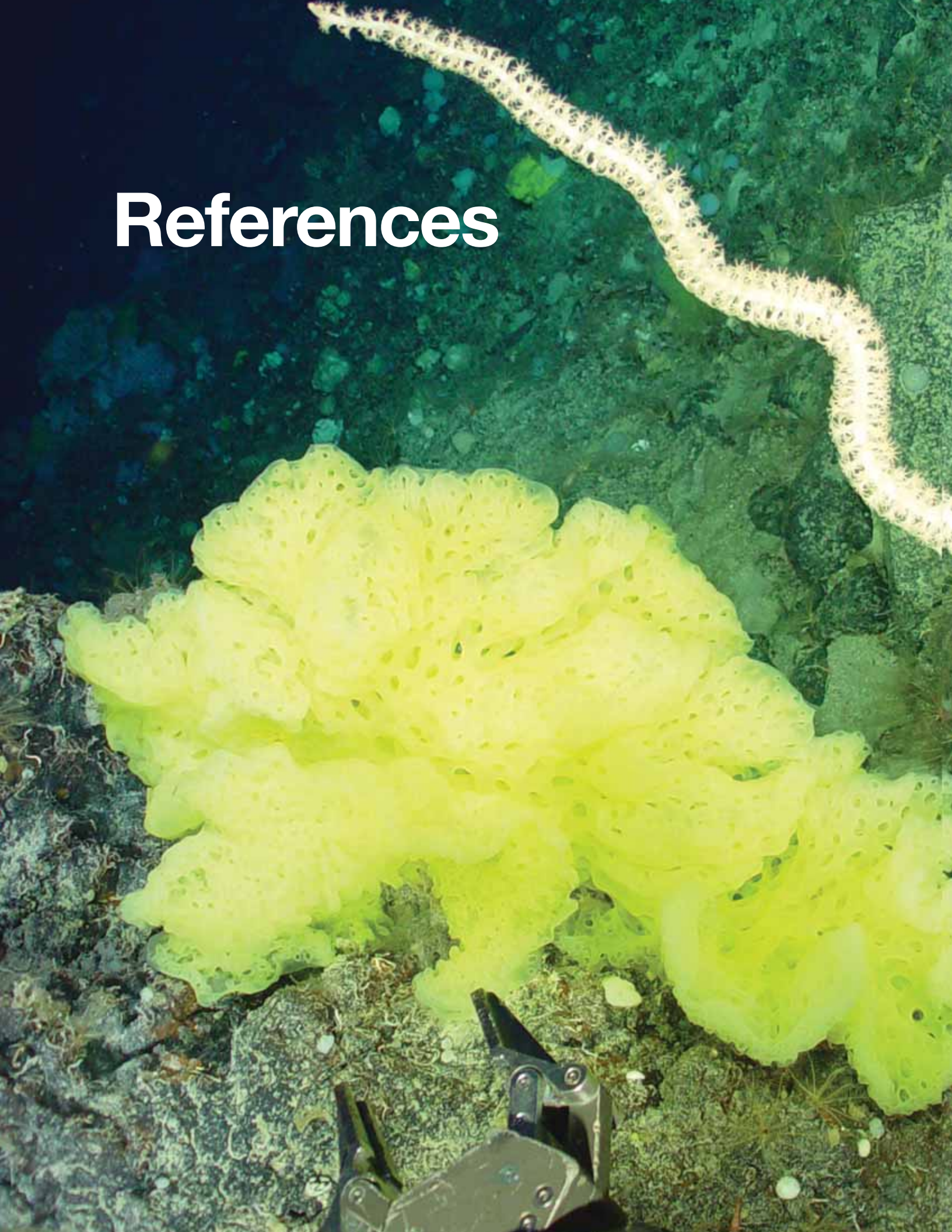
The conservation and protection of corals and sponges may have implications for fishing, oil and gas, and other human activities. The Department will provide opportunities for stakeholders potentially impacted by the implementation of the Strategy to be consulted before any management measures are taken. A Strategy for the conservation and protection of corals and sponges provides transparency, stability, and predictability in the Department's management response.

Review

Each DFO region will report annually on the status of Targets and Actions identified within the Strategy, an exercise that will be coordinated by the Newfoundland and Labrador Region. The Strategy will undergo a review every five years.



References



References

Baillon, S., Hamel, J.F., Wareham, V.E., and Mercier, A. 2012. Deep cold-water corals as nurseries for fish larvae. Frontiers in Ecology and the Environment. doi:10.1890/120022.

Baillon, S., Hamel, J.F., Wareham, V.E., Mercier, A. 2014 Seasonality in reproduction of the deep-water pennatulacean coral Anthoptilum grandiflorum Marine Biology 161.1:29-43.

Baker, K.D., Haedrich, R.L., Snelgrove, P.V.R., Wareham, V.E., Edinger, E.N., and Gilkinson, K.D. 2012a. Small-scale patterns of deep-sea fish distributions and assemblages of the Grand Banks, Newfoundland continental slope. Deep-Sea Research, 65: 171-188.

Baker, K.D., Wareham, V.E., Snelgrove, P.V.R., Haedrich, R.L., Fifield, D.A., Edinger, E.N., and Gilkinson, K.D. 2012b. Distributional patterns of deep-sea coral assemblages in three submarine canyons off Newfoundland, Canada. Marine Ecology Progress Series, 445: 235 -249

Best, M., E. Kenchington, K . MacIsaac, V. E. Wareham, S. D. Fuller, and Thompson A. B. 2010. NAFO Scientific Council Studies, 2010, 43.doi:10.2960/Sv43.m l.

Campbell, J.S. and Simms, J.M. 2009. Status report on coral and sponge conservation in Canada. Fisheries and Oceans Canada. vii + 87.

Colpron, E., E. Edinger, and Neis B. 2010. Mapping the distribution of deep-sea corals in the Northern Gulf o St. Lawrence using both scientific and local ecological knowledge. Canadian Science Advisory Secretariat Research Document 2010/047.

DFO. 2002. Canada's Ocean Strategy. (Accessed at: www.dfo-mpo.gc.ca/oceans/publications/cosframework/im-gi-eng.pdf).

DFO. 2005. Canada's Oceans Action Plan. (Accessed at: www.dfo-mpo.gc.ca/oceans/publications/oap-pao/index-eng.asp).

DFO. 2006a. Coral Conservation Plan: Maritimes Region (2006-2010). Oceans and Coastal Management Report 2006-01.

DFO. 2006b. Impacts of trawl gears and scallop dredges on benthic habitats, populations and communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/025.

DFO. 2007. Ecosystem Science Framework in Support of Integrated Management. (Accessed by: http://www.dfo-mpo.gc.ca/science/publications/ecosystem/index-eng.htm).

DFO. 2009a. Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas. (Accessed at: http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/benthi-eng.htm).

DFO. 2009b. Sustainable Fisheries Framework. (Accessed at: http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/overview-cadre-eng.htm).

DFO. 2009c. Development of a Framework and Principles for the Biogeographic Classification of Canadian Marine Areas. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/056.

DFO. 2010a. Pacific Region Cold-Water Coral and Sponge Conservation Strategy 2010-2015.

DFO. 2010b. Occurrence, sensitivity to fishing, and ecological function of corals, sponges, and hydrothermal vents in Canadian waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/041.

DFO. 2010c. Potential impacts of fishing gears (excluding mobile bottom-contacting gear(s) on marine habitats and communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/003.

DFO. 2011. Identification of Ecologically and Biologically Significant Areas (EBSA) in the Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/055.

DFO. 2013. Ecological Risk Assessment Framework (ERAF) for Coldwater Corals and Sponge Dominated Communities. (Accessed at http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/risk-ecolo-risque-eng.htm).

DOJ. 1985. Fisheries Act (R.S.C., 1985, c. F-14). (Accessed at: http://laws-lois.justice.gc.ca/eng/acts/F-14/page-10.html#s-35).

DOJ. 1996. Oceans Act (S.C. 1996, c. 31). (Assessed at: http://laws-lois.justice.gc.ca/eng/acts/O-2.4/page-1.html) .

DOJ. 2002a. Species at Risk Act (S.C. 2002, c. 29). (Accessed at: http://laws-lois.justice.gc.ca/eng/acts/S-15.3/page-2.html#docCont).

DOJ. 2002b. Canada National Marine Conservation Areas Act (Accessed at: http://laws-lois.justice.gc.ca/eng/acts/C-7.3/).

DOJ. 2012. Canadian Environmental Assessment Act, 2012 (S.C. 2012 c.19, s. 52 (Accessed at: http://laws-lois.justice.gc.ca/eng/actsc-15.21/page-7.html#docCont).

Edinger, E.N., Sherwood, O.A., Piper, D.J.W., Wareham, V.E., Baker, K.D., Gilkinson, K.D., and Scott, D.B. 2011. Geological features supporting deep-sea coral habitat in Atlantic Canada. Continental Shelf Research 31: 69-84.

FAO. 2009. International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome/Roma, 73p.

Freiwald, A., Fosså, J., Grehan, A., Koslow, T., and Roberts, J. 2004. Cold-water coral reefs, out of sight – no longer out of mind. United Nations Environment Programme (UNEOP-WCMC). Cambridge, UK. 88p.

Gass, S.E. and Willison, J.H.M. 2005. An assessment of the distribution of deep-sea corals in Atlantic Canada by using both scientific and local forms of knowledge. In Cold-water corals and ecosystems. Edited by A. Freiwald and J.M. Roberts. Springer-Verlag Berlin Heidelberg. 223-245.

Gilkinson, K. and Edinger, E. (eds.). 2009. The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. Can. Tech. Rep. Fish. Aquat. Sci. 2830: vi + 136.

GOC. 2011. National Framework for Canada's Network of Marine Protected Areas. Fisheries and Oceans Canada, Ottawa. 31 pp (Accessed at http://www.dfo-mpo.gc.ca/media/infocus-alaune/2011/mpa-zpm-eng.html).

Hogg, M.M., Tendal, O.S., Conway, K.W., Pomponi, S.A., Van Soest, R.W.M., Gutt, J., Krautter, M. and Roberts, J.M., 2010 Deep-sea Sponge Grounds: Reservoirs of Biodiversity. UNEP-WCMC Biodiversity Series No. 32. UNEP-WCMC, Cambridge, UK. (Accessed at: http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series 32.aspx).

References

Kenchington, E., Best, M., Cogswell, A., MacIsaac, K., Murillo-Perez, F.J., MacDonald, B., Wareham, V., Fuller, S. D., Jørgensbye, H. I. Ø., Sklya, V., and Thompson, A. B. 2009. Coral Identification Guide NAFO Area. Sci. Coun. Studies, 42: 1-35. doi 10.2960/S.v42ml.

Kenchington, E., Cogswell, A., Lirette, E., and Rice, J. 2010. A Geographic Information System(GIS) Simulation Model for Estimating Commercial Sponge By-catch and Evaluating the Impact of Management Decisions. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/040.vi + 40 p.

Knudby A, Kenchington E, Cogswell A.T., Lirette CG, Murillo F.J. Distribution modeling for sponges and sponge grounds in the northwest atlantic ocean. DFO, Dartmouth, NS (Canada), mailto:info@dfo-mpo.gc.ca]; 2013a. 79 p.

Knudby A., Kenchington E, Murillo F.J. Modeling the distribution of geodia sponges and sponge grounds in the northwest atlantic. PLoS One 2013b 12;8(12).

Knudby A, Lirette C, Kenchington E, Murillo F.J. 2013c. Species Distribution Models of Black Corals, Large Gorgonian Corals and Sea Pens in the NAFO Regulatory Area. N6276. NAFO SCR Doc 13/78, 17pp.

Lacharité M, Metaxas A. 2013. Early life history of deep-water gorgonian corals may limit their abundance. Public Library of Science One 8(6): e65394.

Mercier, A., and J-F. Hamel. 2011. Contrasting reproductive strategies in three deep-sea octocorals from eastern Canada: Primnoa resedaeformis, Keratoisis ornata, and Anthomastus grandiflorus. Coral Reefs 30(1): DOI: 10.1007/s00338-011-0724-8.

Mercier, A., Z. Sun, and Hamel J-F. 2011. Reproductive periodicity, spawning and development of the deep-sea scleractinian coral Flabellum angulare. Mar. Biol. 158:371-380.

Mortensen, P.B. and Buhl-Mortensen L. 2004. Distribution of deep-water gorgonian corals in relation to benthic habitat features of the Northeast Channel (Atlantic Canada). Marine Biology 144: 1223-1238.

MSC. 2010. Principles and Criteria for Sustainable Fishing. (Accessed at http://www.msc.org/documents/scheme-documents /msc-standards/MSC_environmental_standard_ for_ sustainable_fishing. pdf).

NAFO. 2011a. NAFO Conservation and Enforcement Measures 2011. NAFO FC Doc. 11/1 Serial No. N5867. (Accessed at http://www.nafo.int/publications/frames/general.html).

NAFO. 2011b. NAFO performing well. Annual Meeting Press Release. 23, September 2011. (Accessed at http://www.nafo.int/about/media/press/press-2011.pdf).

NAFO, 2013. Recommendations from the WGFMS-VME to the Fisheries Commission. NAFO FC Doc. 13/7. Serial No. N6238.

NOAA. 2010. NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 11. 67 pp.

Roberts, J.M., Wheeler, A.J., Freiwald, A. and Cairns, S. 2009. Cold-Water Corals; The Biology and Geology of Deep-Sea Coral Habitats. Cambridge University Press. New York.

Sherwood, O.A., Jamieson, R.E., Edinger, E.N., and Wareham, V.E. 2008. Stable C and N isotopic composition of coldwater corals from the Newfoundland and Labrador continental slope: examination of tropic, depth, and spatial effects. Deep Sea Research I: Oceanographic Research Papers 55, 1392 1402.

Sherwood, O.A. and Edinger, E.N. 2009. Ages and growth rates of some deep-sea gorgonian and antipatharian corals of Newfoundland and Labrador. Can. J. Fish. Aquat. Sci. 66: 142-152.

Sun, Z., J-F. Hamel, E. Edinger, and A. Mercier. 2010. Reproductive biology of the deep-sea octocoral Drifa glomerata in the Northwest Atlantic. Mar. Biol.157:863-873.

UN. 1992. United Nations Treaty Collection. (Accessed at:https://treaties.un.org/doc/Publication/CN/1992/DEPO-NOTIF-1992-LA-LT-422-489_154.pdf)

UN. 2006. Resolution 61/105. Resolution adopted by the General Assembly, Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments (Accessed at http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N06/500/73/PDF/N0650073.pdf?OpenElement).

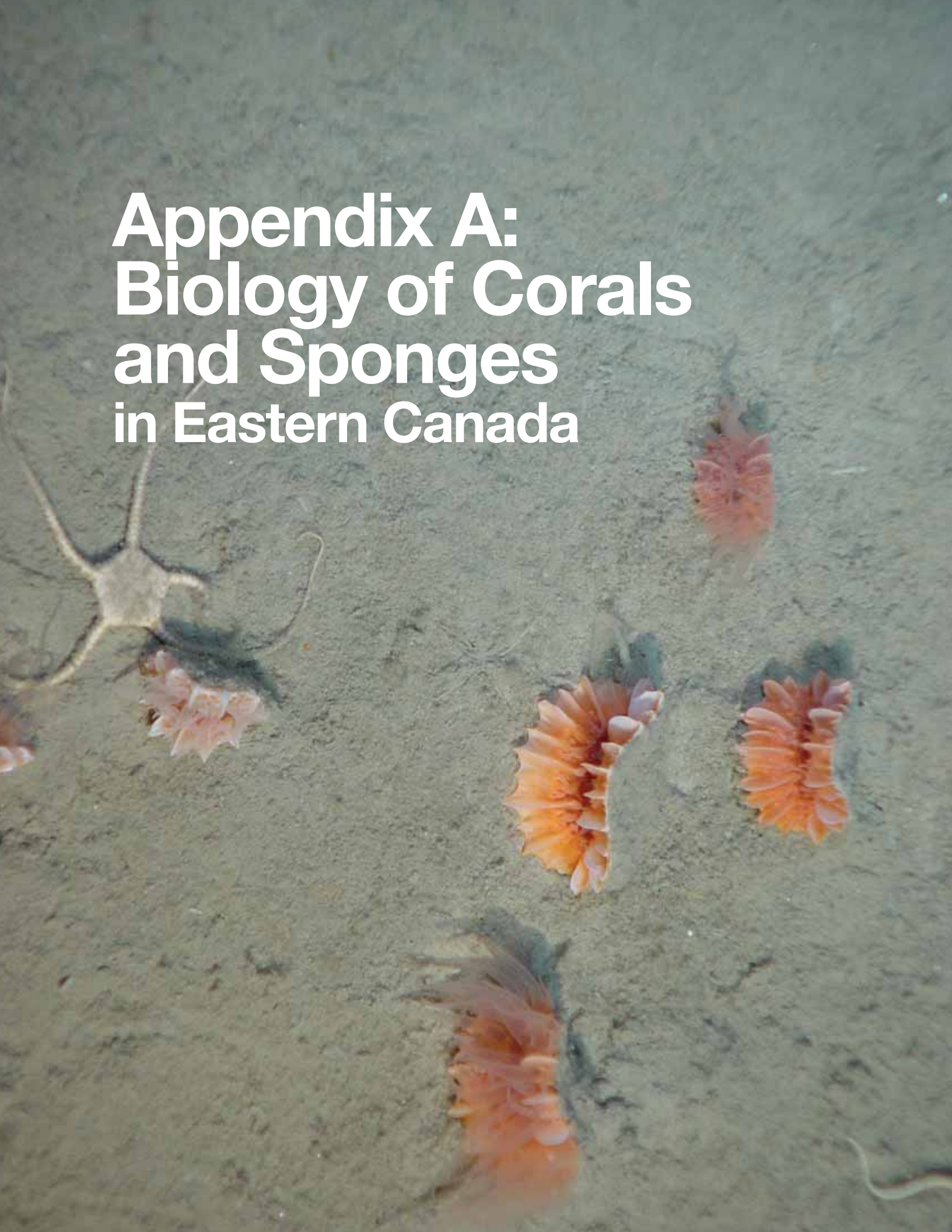
Wareham, V.E. and Edinger, E.N. 2007. Distributions of deep sea corals in Newfoundland and Labrador waters. Bull. Mar. Sci. 81: 289 311.

Wareham, V. 2010. Identification, distribution, & conservation of deep-sea corals in Canada's Northwest Atlantic. MSc. Thesis, Memorial University, St. John's, NL, Canada.

Wareham, V.E., Ollerhead, N.E. and Gilkinson, K.D. 2010. Spatial Analysis of Coral and Sponge Densities with Associated Fishing Effort in Proximity to Hatton Basin (NAFO Divisions 2G-0B). DFO Can. Sci. Advis. Sec. Res. Doc. 2010/058, 46 pp.

WSSD. 2002. World Summit on Sustainable Development. (Accessed at: http://www.un.org/jsummit/).

Appendix A: Biology of Corals and Sponges in Eastern Canada



There are many gaps in our understanding of the general biology of cold water corals and sponges including limited information on the distribution, age of maturity, fecundity, reproduction and recruitment, resilience and resistance to damage, as well as rates of recovery (Wareham 2010; Roberts *et al*. 2009, Hogg *et al*. 2010).

A1. Corals

The term "coral" is generally used to describe a group of marine organisms having marine polyps that produce calcium carbonate secretions that form hard parts or skeletons. Each polyp is composed of a ring(s) of tentacles used to capture food, a mouth to eat, and a tube (actinopharynx or stomadem) leading to a central gastrovascular cavity (coelenteron) to digest food. Corals can be solitary or colonial with many genetically identical polyps (Wareham 2010). With respect to soft corals, sea fans and sea pens, the skeleton lies within the body wall of the polyps. This inner skeleton helps strengthen the coral while maintaining flexibility. The stony corals have employed a different tactic: each polyp secretes a cup-shaped skeleton around itself forming a hard outer covering. Both soft and stony corals can support massive colonies, and the bubblegum coral *Paragorgia arborea*, has been recognized as the world's largest marine invertebrate species, with confirmed reports of colonies reaching six metres in height and unconfirmed reports of 10 metres. Coral colonies also provide habitat for many fish and bottom-dwelling creatures, like sea stars, shrimp, and anemones (Baillon *et al.* 2012).

The number of corals identified in eastern Canadian waters is approaching 60 species (V. Wareham Pers. Comm.). Cold water corals, unlike warm water corals do not require sunlight to grow. 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 solitary individuals. These coral taxa, including 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 (Campbell and Simms 2009).

Corals depend entirely on ocean currents and other oceanographic processes to transport food to them such as zooplankton and detritus, which has been imported from the water column near the water surface (Sherwood *et al*. 2008). Currents not only carry food but also prevent accumulation of silt, which can smother the polyp (Roberts *et al*. 2009).

Habitat

Coral habitats can range from the inter-tidal zone to depths of approximately three km or deeper. Corals are usually established after the settlement of coral larvae on a suitable substrate. Substrate preferences are species-specific, based on availability of hard or soft substrates as well as the physiology of individual species.

For non-reef building corals, species can be fixed to hard substrates by a holdfast or anchored in soft substrates by root-like appendages. The habitats created can range from micro-habitats between the branches of large individual colonies or macro-habitats between colonies when many coral colonies are concentrated within a specific area. For the latter, the type of habitat created can vary in size and scope from monotypic dominated by one or two species (e.g. sea pen fields, *Keratoisis* thickets), to polytypic with many species represented (e.g. coral gardens, or gorgonian forests).

For reef-building corals like *Lophelia* pertusa found on the Scotian Shelf, reefs are established as new polyps grow on top of older polyps. As the reef increases in size, the skeleton of the reef becomes vulnerable to bioerosion and breakage. If coral growth keeps pace with sediment infill, localized mound or reef formation is initiated. Corals are usually found in areas with currents, or in areas on the

continental slope where internal tidal waves enhance seabed food supply (Roberts *et al.* 2006).

Growth Rate

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, making them some of the oldest reef complexes on the Earth (Roberts *et al.* 2006). Sherwood and Edinger (2009) estimated growth rates of corals found off Newfoundland and Labrador at approximately less than two centime-ters 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).

Investigations into the histology of soft corals indicated that they too may exhibit slow growth rates especially in early stages of recruitment (Cordes *et al.* 2001; Sun *et al.* 2010). For example, newly settled *Drifa* sp. reached only 5 mm linear length in 7 months, while *Duva florida* exhibited no branching of polyps in 11 months, and *Gersemia fruticosa* reached only 10 mm linear length in 7 months (Sun *et al.* 2010).

Reproduction

Most knowledge of coral reproduction is from tropical species with very little known about deep-sea species (Wareham 2010). Sexual reproduction can be either hermaphroditic with male (spermatocysts) and female (oocytes) gametes located on the same colony, or gonochoristic with male and female gametes located on different colonies (Richmond and Hunter 1990; Waller and Tyler 2005). In the northwest Atlantic, nephtheid soft coral fertilization was found to be internal with the peak breeding season 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.

A2. Sponges

Information on sponge distribution in eastern Canadian waters is limited, primarily collected from fisheries observers and research trawl surveys (Campbell and Simms 2009; Kenchington *et al.* 2012). Sponges are aquatic animals with a fossil record that dates back over 580 million years (Hogg *et al.* 2010). These organisms lack organs but have specialized cells and a collangenous matrix. Their bodies are organized around a simple or complex aquiferous system, making them highly effective filter feeders (ICES 2009; Hogg et al. 2010). This system of canals and chambers allows water to be pumped in and out to supply food and oxygen and remove waste; this system is also used as a mechanism for the transport of reproductive elements (Hogg *et al.* 2010).

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).

Habitat

Sponge habitats can be found in every ocean from depths ranging from the inter-tidal zone to deeper than eight thousand meters (Hogg *et al.* 2010). Adult sponges are largely sessile and live in an attached position where a firm substrate is provided, such as rocky ocean bottom. The distribution of sponge grounds broadly conforms to environmental conditions conducive to their

growth, such as current strength for food supply and substrata needed for recruitment and growth, such as rocky or biogenic hard substrata. However, sponges may also inhabit sandy or muddy sediments (ICES 2009).

Growth Rate

Sponge reefs found in Canadian waters can be up to 9000 years old with individual sponges being up to 100 years of age and older. Sponges can undergo growth, shrinking, division, and fusion (Hogg *et al.* 2010). The growth rates of sponges vary due to their ability to change in response to environmental factors, therefore relying on body size is not a reliable indicator of age, but age can be determined by carbon and strontium isotopic dating (Hogg *et al.* 2010).

Reproduction

Sponges can reproduce both sexually and asexually. Asexual reproduction occurs in internal/external budding or fragmentation (ICES 2009). Fragmentation, often caused by mobile fishing gear, does produce more individual sponges but reduces their size and genetic diversity (Hogg *et al.* 2010). In sexual reproduction, sperm is dispersed by water currents and enters neighbouring sponges. Most sponges are hermaphroditic and produce eggs and sperm at complementary times, the young embryo develops internally (known as brooding), eventually releasing larvae that settle and metamorphose quickly (ICES 2009; Hogg *et al.* 2010).

Appendix A Citations

Baillon, S., Hamel, J.F., Wareham, V.E., and Mercier, A. 2012. Deep cold-water corals as nurseries for fish larvae. Frontiers in Ecology and the Environment. doi:10.1890/120022.

Campbell, J.S. and Simms, J.M. 2009. Status report on coral and sponge conservation in Canada. Fisheries and Oceans Canada. vii + 87.

Cordes, E.E., J.W., Nybakken J.W., and VanDykhuizen G. 2001 Reproduc-tion and growth of Anthomastus ritteri (Octocorallia: Alcyonacea) from Monterey Bay, California, USA. Marine Biology 138:491-501.

Hogg, M.M., Tendal, O.S., Conway, K.W., Pomponi, S.A., Van Soest, R.W.M., Gutt, J., Krautter, M. and Roberts, J.M., 2010 Deep-sea Sponge Grounds: Reservoirs of Biodiversity. UNEP-WCMC Biodiversity Series No. 32. UNEP-WCMC, Cambridge, UK. (Accessed at: http://www. unep-wcmc.org/resourcespublications/UNEP_WCMC_bio_series/32.aspx).

ICES 2009. Report of the ICES-NAFO Joint Working Group on Deep Water Ecology.

Kenchington, E., Siferd,T. et Lirette, C. 2012. Arctic Marine Biodiversity: Indicators for Monitoring Coral and Sponge Megafauna in the Eastern Arctic. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/003. v + 37 p.

Richmond, RH, and Hunter CL.1990. Reproduction and recruitment of corals: comparisons among the Caribbean, the tropical Pacific, and the Red Sea. Mar Ecol Prog Ser 60:185–203.

Roberts, J.M., Wheeler, A.J. and Freiwald, A. 2006. Reefs of the deep: The biol-ogy and geology of cold-water coral ecosystems. Science, Vol. 312: 543-547.

Roberts, J.M., Wheeler, A.J., Freiwald, A. and Cairns, S. 2009. Cold-Water Corals; The Biology and Geology of Deep-Sea Coral Habitats. Cambridge University Press. New York.

Sherwood, O.A., Jamieson, R.E., Edinger, E.N., and Wareham, V.E. 2008. Stable C and N isotopic composition of coldwater corals from the Newfoundland and Labrador continental slope: examination of tropic, depth, and spatial effects. Deep Sea Research I: Oceanographic Research Papers 55, 1392 1402.

Sherwood, O.A. and Edinger, E.N. 2009. Ages and growth rates of some deep-sea gorgonian and antipatharian corals of Newfoundland and Labrador. Can. J. Fish. Aquat. Sci. 66: 142-152.

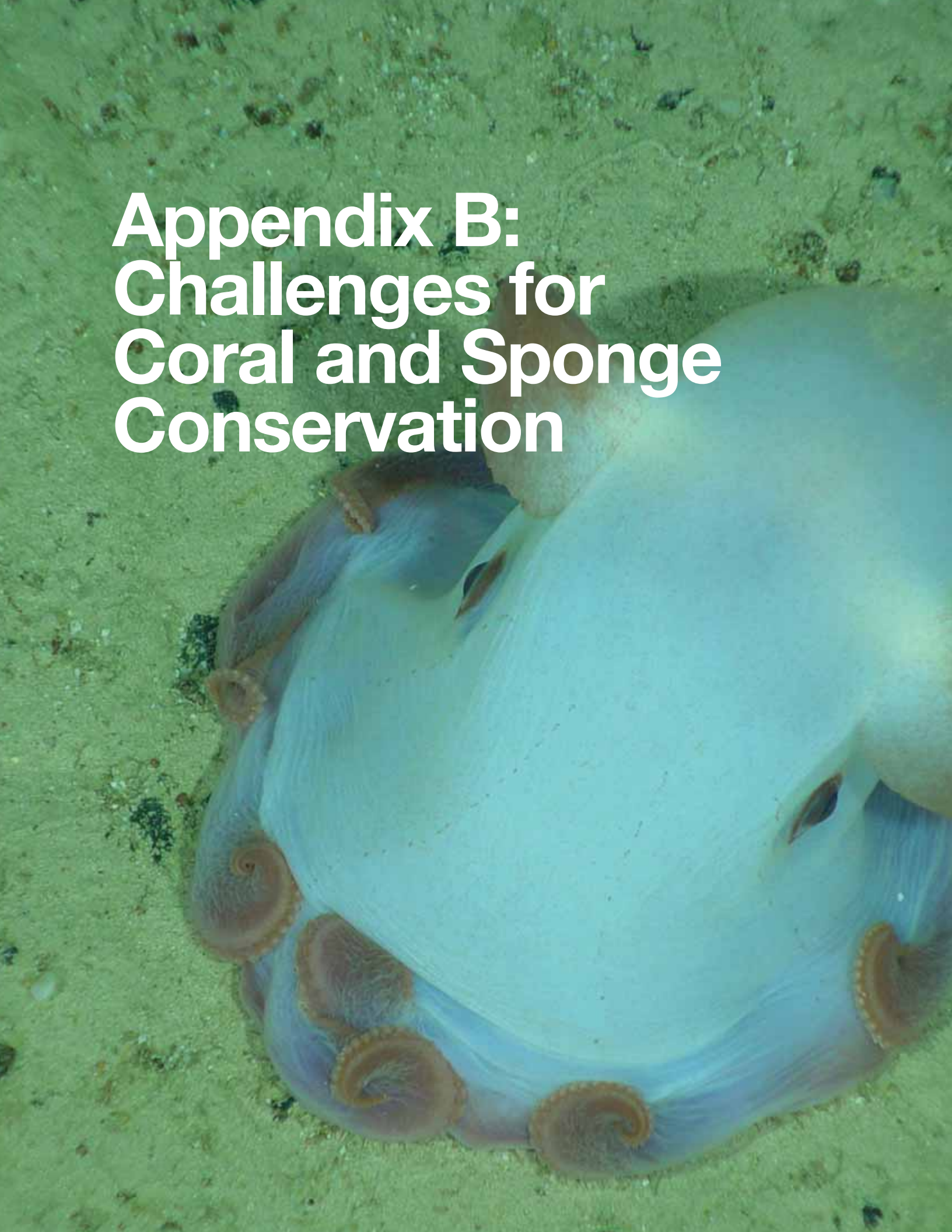
Sun, Z., Hamel, J.F., and Mercier, A. 2009. Reproductive Biology of deep sea corals in the Newfoundland and Labrador Region. In The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. Edited by K. Gilkinson and E. Edinger. Can. Tech. Rep. Fish. Aquat. Sci.2830: vi + 136 p.

Sun, Z., J-F. Hamel, E. Edinger, and A. Mercier. 2010. Reproductive biology of the deep-sea octocoral Drifa glomerata in the Northwest Atlantic. Mar. Biol.157:863-873.

Waller, R.G. and Tyler P.A. 2005. The reproductive biology of two deep-water, reef building scleractinians from the Northeast Atlantic Ocean. Springer-Verlag. Coral Reefs. 24:514-522.

Wareham, V. 2010. Identification, distribution, & conservation of deep-sea corals in Canada's Northwest Atlantic. MSc. Thesis, Memorial University, St. John's, NL, Canada.

Appendix B: Challenges for Coral and Sponge Conservation



B1. Impacts to corals and sponges

Many of the impacts to corals and sponges are either directly or indirectly associated with human activities. Globally, the principle causes of impacts are fishing, oil and gas activities, mineral exploration and production, and submarine cable and pipeline installation. Environmental risks include climate change (e.g. ocean acidification) and invasive species.

Fishing gear

Certain types of fishing gear can have both direct and indirect impacts on corals and sponges. Individuals can become caught, entangled, or crushed in the gear, resulting in damage or mortality (DFO 2010a; Fuller *et al.* 2008). The redistribution of sediment can smother corals and sponges which affects feeding processes necessary for species survival (Edinger *et al.* 2007; Curtis *et al.* 2012). To date, Science Advisory Reports have determined that the gear which most impacts corals and sponges is mobile bottom-contacting gear, due to the extent of the seafloor affected and the force exerted on the seafloor (DFO 2010a; DFO 2006). In structurally complex coral habitats, the initial pass is the most damaging (Krieger and Wing 2002; Anderson and Clarke 2003; Rice 2006) resulting in large quantities of coral by-catch (Probert *et al.* 1997; Kreiger 2001). DFO Science has published a number of Science Advisory Reports (DFO 2006; DFO 2010a; DFO 2010b) on fishing gear impacts to benthic habitats, including corals and sponges.

Oil and gas exploration and development

Drilling units, pipelines and production facilities can affect coral and sponge populations. Sediment disturbance can increase turbidity in the water which has a negative impact on both corals and sponges. Physical damage or displacement can occur as a result of anchoring or mooring vessels near the production platform (DFO 2010a). Also, there is the potential for drill cuttings to smother corals and sponges (Roberts *et al.* 2009; Lumsden *et al.* 2007) and accidental releases of oil and gas during drilling or transport can negatively affect the marine environment.

Sub-sea cables

Telecommunications and electrical cables are often placed across or buried within the seabed on the Atlantic coast. The processes used to bury and lay these cables may directly and/or indirectly impact benthic habitat, including areas where coral and sponge are found, via physical damage, sediment disturbance, increased turbidity and sedimentation, decreased substrate quality, and smothering.

Mining

The potential for mineral deposits make sub-sea mining a concern in terms of impacting corals and sponges, as exploration and mining activities would have direct contact with the sea floor. There is also the potential for sedimentation from sub-sea mining processes which would reduce the substrate quality for corals and sponges and smother surrounding individuals.

Climate change

Human induced climate change has a wide range of implications for the world's oceans. Impacts to the marine environment include sea level rise, changes to upwelling and ocean circulation patterns, changes in water column stratification, ocean acidification and warmer ocean temperatures. The oceans currently hold more than 88% of all the carbon dioxide (CO_2) on the earth. As the ocean's uptake of CO_2 increases to keep pace with increased CO_2 levels in the atmosphere, it causes an acidifying reaction with seawater, which decreases the oceanic pH and availability of carbonate ions (required by corals and sponges for calcification). As a result,

corals can have a much weaker calcium carbonate structure making them more susceptible to external impacts (Roberts *et al.* 2009). Acidification also occurs when the water has become hypoxic, primarily through respiration, meaning that CO_2 was produced as the oxygen was consumed. This problem is more serious for corals which secrete calcium carbonate, as this compound becomes more soluble in more acidic water, making its secretion more difficult and metabolically more costly.

Corals and sponges may also be impacted by temperature change. Warmer water may reduce the availability of phytoplankton and zooplankton due to increased feeding by higher order organisms. Increased water temperature may change the availability of carbonates in the benthic habitat. Corals and sponges which grow slowly and live for a long period of time may not be capable of adapting to conditions associated with climate change.

Other

Zones in the ocean which experience little or no oxygen are known as hypoxic (low O_2) or anoxic (no O_2) and are often called "dead" zones. The size and number of these zones is increasing as ocean temperature and acidification increase. To date, little research has been done on this topic in the waters surrounding eastern Canada. However, previous research on sponges in the Pacific indicates that they can survive hypoxic but not anoxic conditions (DFO 2010c). The tolerance of sponges and corals (including soft corals) to hypoxia is unknown, but as these animals are sessile, they are vulnerable to any reduction in dissolved oxygen levels. Such deterioration occurred between 1930 and 1980 in the St. Lawrence Estuary, caused by both changes in ocean circulation at the mouth of the Laurentian Channel and eutrophication.

Another potential challenge for corals and sponges is aquatic invasive species (AIS). The term AIS refers to those species which are not indigenous and whose introductions can cause environmental harm. To date, little research has been conducted on the effects of AIS on local coral and sponge populations, consequently the risk is undetermined.

Aquaculture may also impact coral and sponge in the future. The aquaculture industry is expanding and can have a potential impact on shallow-water soft corals (Haedrich and Gagnon 1991; Wareham 2010).

B2. Lack of information and available research

Although significant advances have been made on coral and sponge research in recent years, information gaps still exist. As discussed earlier targeted scientific cruises have been successful in increasing our knowledge of coral and sponge distribution and biology. However, the vast majority of the area has been unexplored. In the future, additional scientific surveys are likely to discover new areas of coral and sponge concentrations and perhaps new species.

Appendix B Citations

Anderson, O.F., and Clark, M.R. 2003. Analysis of by-catch in the fishery for orange roughy, Hoplostethus atlanticus on the South Tasman Rise. Marine and Freshwater Research, 54, 643-652.

Curtis, J.M.R., Poppe, K. et Wood, C.C. 2012. Indicators, impacts and recovery of temperate deepwater marine ecosystems following fishing disturbance. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/125. v + 37 p.

DFO. 2006 Coral Conservation Plan: Maritimes Region (2006-2010). Oceans and Coastal Management Report 2006-01.

DFO. 2010a. Potential impacts of fishing gears (excluding mobile bottom-contacting gear(s) on marine habitats and communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/003.

DFO. 2010b. Occurrence, sensitivity to fishing, and ecological function of corals, sponges, and hydrothermal vents in Canadian waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/041.

DFO. 2010c. Pacific Region Cold-Water Coral and Sponge Conservation Strategy 2010-2015.

Edinger, E.N., Wareham, V.E., and Haedrich, R.L. 2007. Patterns of groundfish diversity and abundance in relation to deep sea coral distributions in Newfoundland and Labrador waters. Bulletin of Marine Science, 81 (Supp. 1), 101 122.

Fuller, S.D., Picco, C., Ford, J., Tsao, C., Morgan, L.E., Hangaard, D., and Chuenpagdee, R. 2008. How We Fish Matters: Addressing the Ecological Impacts of Canadian Fishing Gear. Ecology Action Centre.Halifax, N.S.

Haedrich, R. L. and Gagnon, J. M. 1991. Rock wall fauna in a deep Newfoundland fiord. Cont. Shelf. Res. 11: 1199–1207.

Kreiger 2001 Coral (Primnoa) impacted by fishing gear in the Gulf of Alaska. In:Willison J.H.M., Hall J., Gass S.E., Kenchington E.L.R., Butler M., Doherty P. (eds) Proceedings of the First International Symposium on Deep-Sea Corals. Ecology Action Centre, Halifax, pp 106-116.

Krieger, K.J., and Wing, B.L. 2002. Megafauna association with deepwater corals (Primnoa spp.) in the Gulf of Alaska. Hydrobiologia, 471: 83-90.

Lumsden, S.E., Hourigan, T.F., Bruckner, A.W., Dorr, G. (eds.) 2007. The state of deep coral ecosystems of the United States. NOAA Technical Memo. CRCP-3. Silver Spring, MD. 365p.

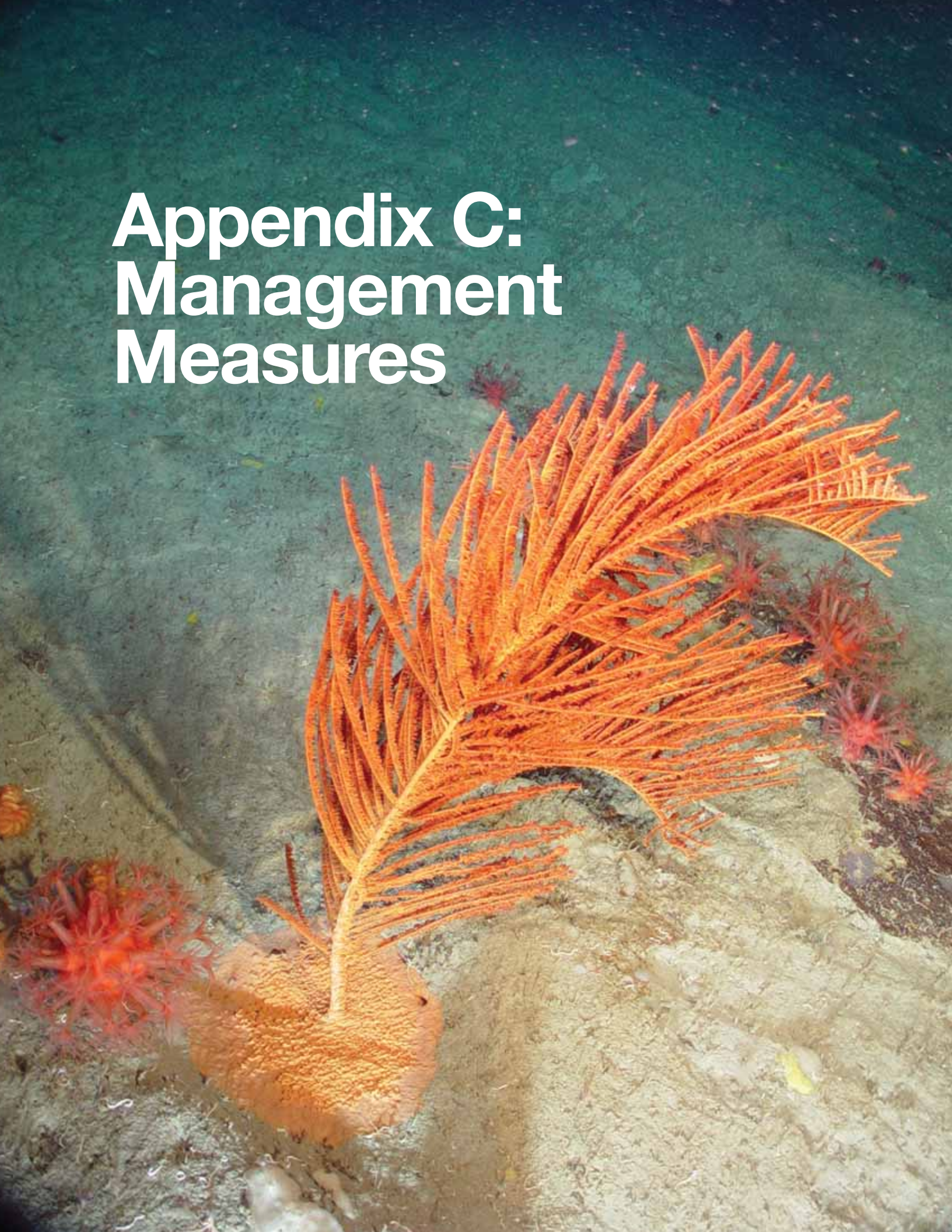
Probert P.K., McKnight, D.G. and Grove, S.L. 1997 Benthic invertebrate by-catch from a deep-water trawl fishery, Chatham Rise, New Zealand, Aquatic Conservation: Marine and Freshwater Ecosystems, Vol 7, 27-40.

Rice, J. 2006. Impacts of mobile bottom gears on seafloor habitats, species, and communities: a review and synthesis of selected international reviews. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/057.

Roberts, J.M., Wheeler, A.J., Freiwald, A. and Cairns, S. 2009. Cold-Water Corals; The Biology and Geology of Deep-Sea Coral Habitats. Cambridge University Press. New York.

Wareham, V. 2010. Identification, distribution, & conservation of deep-sea corals in Canada's Northwest Atlantic. MSc. Thesis, Memorial University, St. John's, NL, Canada.

Appendix C: Management Measures



There are a variety of management measures employed in Canada to protect corals and sponges. It may be appropriate to use different tools, or a combination of tools, to meet the different goals and objectives for a given area.

As well as the management tools outlined below, public education and outreach programs are important for the success of all management measures. They will help the public gain a better understanding of the conservation measures that have been put in place and the reasons behind them. Different closure mechanisms have varying levels of protection (see Figure 9), ranging from legislated closures, such as NMCA and MPAs, to stewardship and voluntary measures.

C1. Industry Initiatives

Industry initiatives such as voluntary measures, or agreements to avoid certain areas, may be a useful tool where risks to corals or sponges are low, or where compliance with the voluntary measures is expected to be high. They are industry driven and not implemented or enforced by DFO. Therefore, voluntary measures require a high level of cooperation among users.

Voluntary measures include formal or informal agreements by one or more industries to avoid specified areas with corals and/or sponges. Voluntary measures may be recognized through industry Codes of Conduct, Conservation Harvest Plans (CHPs) or Integrated Fisheries Management Plans (IFMPs) developed for specific fisheries in conjunction with regulators. Due to the fact these are non-regulatory measures and not legally enforced, it is difficult to assess how effective the initiative is in protecting corals and sponges.

C2. Regulatory Measures

Fisheries and Oceans Canada

Fishery (General) Regulations

Section 6 of the Fishery (General) Regulations (FGR) under the *Fisheries Act* permits the issuance of Variation Orders, a legal instrument which allows DFO to vary close times and close areas to specific fisheries. Close times that are subject to this variation are provided in the Atlantic Fishery Regulations by species and/or gear type and/or vessel size class. This tool is used by DFO to impose management measures for gear, monitoring, reporting, harvesting, allocation, catch requirements, etc..

Figure 9: Range of closure mechanisms (this list is not all inclusive)

Fisheries Management Measures

The Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009), provides a framework to employ appropriate management measures for effective conservation of sensitive areas. Available measures include variation orders, licence conditions, IFMPs and CHPs to achieve fisheries closures, gear modifications, and changes to timing of fishing activities.

A key tool for use in the implementation of the Policy is the Ecological Risk Assessment Framework (Appendix D), which outlines a process for identifying the level of ecological risk of fishing activity and its impacts on sensitive benthic areas in the marine environment. The Department has developed this framework specifically for use in managing cold water corals and sponge-dominated communities.

Fisheries Protection Program

Proposed works, undertakings, or activities (non-fishing) that have the potential to harm fish or fish habitat (including corals and sponges) are normally reviewed by the Fisheries Protection Program. If the review determines that the work or undertaking will result in serious harm to fish or habitat that supports a commercial, recreational or Aboriginal fishery, an authorization under section 35 of the *Fisheries Act* is required. The decision of whether or not to issue such an authorization will consider the contribution of the relevant fish and habitat to a fishery, fisheries management objectives, measures to avoid, mitigate offset serious harm, as well as the public interest.

Marine Protected Areas

Canada's *Oceans Act* tasks the Minister of Fisheries and Oceans to lead and coordinate the development and implementation of a national network of MPAs on behalf of the Government of Canada, following a collaborative approach. DFO can establish MPAs with prohibitions on specific activities throughout the MPA; within certain zones established in the MPA; or through temporal restrictions. An MPA is a tool that can provide comprehensive protection to coral and sponge communities. MPA designation provides permanent protection while allowing flexbility as management measures may be adapted to new activities or new information while maintaining consistency with the identified conservation objectives for the MPA.

The National Framework for Canada's Network of Marine Protected Areas (GOC 2011) sets out how a network of MPAs will be designed to meet Canada's domestic and international commitments to establish a national network of marine protected areas. This framework which organizes all ocean areas into bioregions, has been prepared in collaboration with federal, provincial, and territorial government agencies that have a mandate to protect marine areas. It presents the government's intended approach to network design, building on international guidance, the experience of other countries, and on the scientific, traditional and community knowledge of Canadians.

Other Government Departments and Agencies

Industry Canada

Industry Canada is the federal department responsible for regulating submarine cable installations under the *Telecommunications Act*. Cable installations through Canadian waters are subject to *Canadian Environmental Assessment Act* (CEAA) regulations.

Parks Canada

Parks Canada has the responsibility for designing a system of NMCAs, and is a federal partner in the development of the national network of marine protected areas. NMCAs are intended to represent the full range of Canada's marine ecosystems. Activities are restricted within these areas.

Nunavut Planning Commission

The Nunavut Planning Commission (NPC) is responsible for the development, implementation and monitoring of land use plans that guide and direct resource use and development in the Nunavut Settlement Area. The NPC consults with government, Inuit organizations and many other organizations but it is the Commission's responsibility to make the final decisions on how land use plans will be developed and how the plans will manage the land in Nunavut. Once these decisions are made the plans are sent to Government for approval. The Nunavut Planning Commission recently prepared a Draft Nunavut Land Use Plan to encourage discussion on land use planning in the Nunavut Settlement Area.

Management of offshore hydrocarbon operation activities

Administration of oil and gas rights in Nunavut and the Arctic Offshore remain under federal authority and the responsibility of the Minister of Aboriginal Affairs and Northern Development The Canada–Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) is responsible for the protection of the environment throughout all the stages of offshore oil and gas exploration and production for Newfoundland and Labrador. The Canada-Nova Scotia Offshore Petroleum Board (C-NSOPB) has the same role for the Nova Scotia offshore jurisdiction. With regard to Quebec, the Government of Quebec and the Government of Canada signed the Canada-Quebec Accord in March 2011 in respect to the joint management of offshore petroleum resources, but this will not come into effect until the two Governments develop the legislative framework.

The National Energy Board has regulatory responsibilities for oil and gas exploration and activities on frontier lands not otherwise regulated under joint federal/provincial accords (e.g. C-NLOPB, C-NSOPB). Regulatory responsibilities, under the *Canada Oil and Gas Operations Act* and certain provisions of the *Canada Petroleum Resources Act*, are administered for the Nunavut, Arctic offshore, Gulf of St. Lawrence, a portion of the Bay of Fundy and onshore Sable Island. C-NLOPB and the C-NSOPB have the responsibility for ensuring environmental assessments (EAs) are conducted for exploration projects and any other offshore petroleum projects for which an EA is not required pursuant to the *Canadian Environmental Assessment Act* (CEAA 2012). EAs required by the C-NSOPB are referred to as Accord Act (DOJ 1987) EAs. This includes all EAs for seismic activity and may include EAs for other forms of exploration. CEAA 2012 applies to exploration drilling, development programs, and some decommissioning programs. For those projects that trigger an EA pursuant to CEAA 2012, the EA would need to be completed prior to receiving approval from the C-NLOPB, the C-NSOPB or the National Energy Board.

Appendix C Citations

CEAA. 2012. Canadian Environmental Assessment Act, 2012. (Accessed at: http://www.ceaa-acee.gc.ca/default.asp?lang=en&n=16254939-1).

DOJ 1987 Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act, SNS 1987, c 3, s.1. (Accessed at https://www.canlii.org/en/ns/laws/stat/sns-1987-c-3/latest/part-1/sns-1987-c-3-part-1.pdf).

DFO 2009. Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas. (Accessed at: http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/benthi-eng.htm).

GOC 2011 National Framework for Canada's Network of Marine Protected Areas. Fisheries and Oceans Canada, Ottawa 31 pp. (Accessed at (http://www.dfo-mpo.gc.ca/media/infocus-alaune/ 2011/mpa-zpm-eng.html).

Appendix D: Ecological Risk Assessment Framework

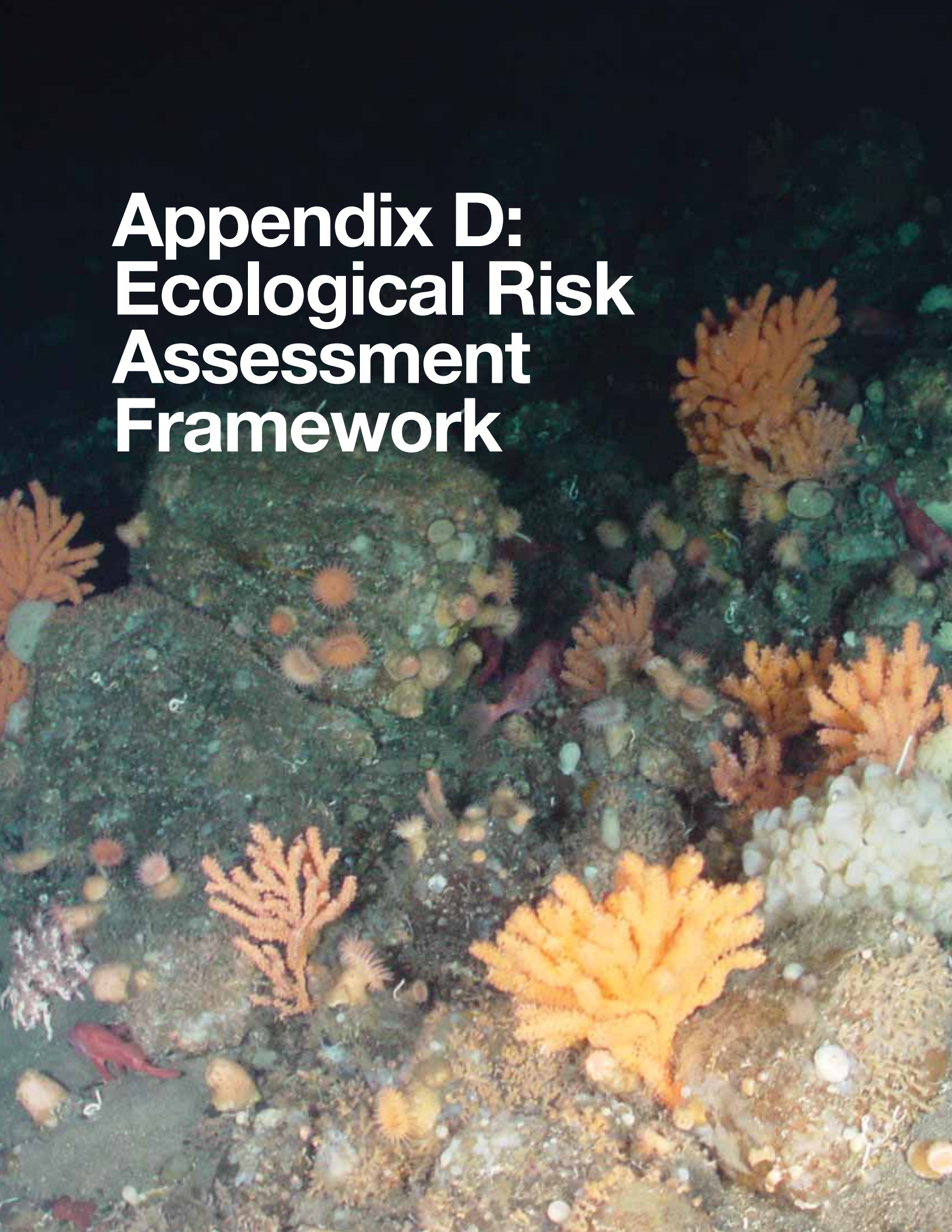
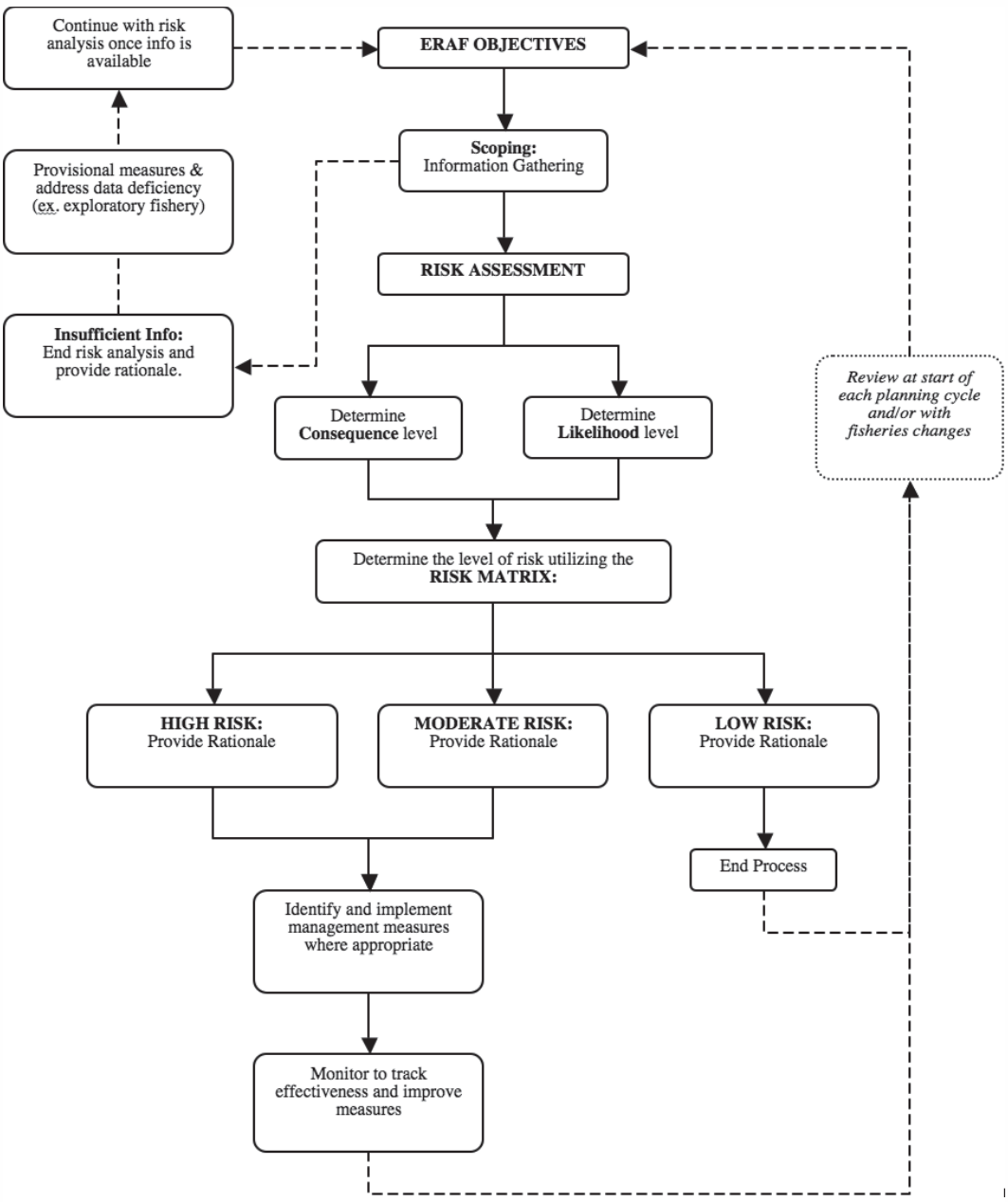
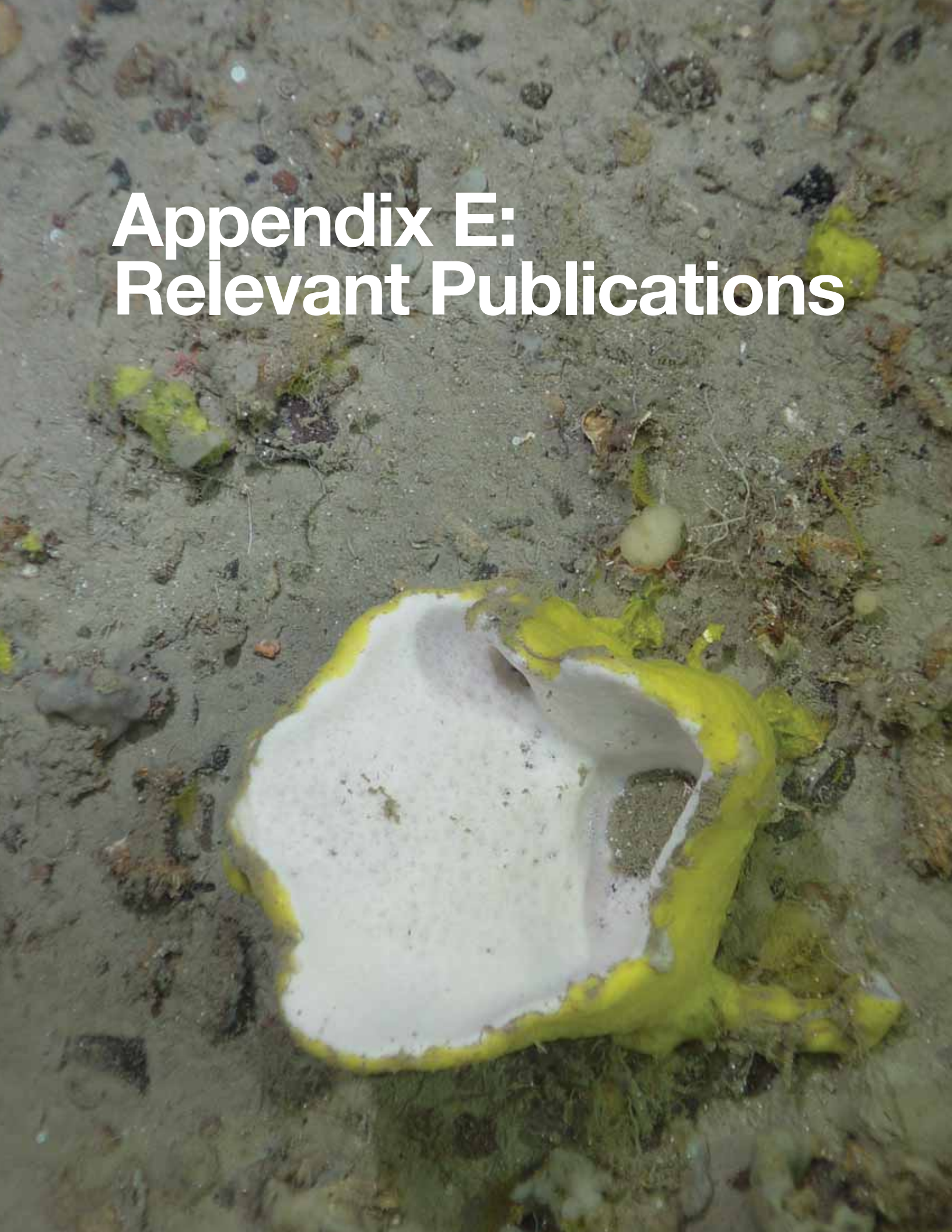


Figure 10: Ecological risk analysis process for cold water coral and sponge dominated communities (DFO 2013)



Appendix D Citations

DFO. 2013. Ecological Risk Assessment Framework (ERAF) for Coldwater Corals and Sponge Dominated Communities. (Accessed at http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/risk-ecolo-risque-eng.htm).



Appendix E: Relevant Publications

Appendix E: Relevant Publications

Bryan T, Metaxas A. 2006. Distributional patterns of deep-water corals along the North American continental margins: relationships with environmental factors. Deep-Sea Research I 53: 1865-1879.

Bryan T, Metaxas A. 2007. Predicting suitable habitat for Paragorgiidae and Primnoidae on the Atlantic and Pacific continental margins of North America. Marine Ecology Progress Series 330: 113-126.

Buhl-Mortensen, L. and Mortensen P.B. 2005. Distribution and diversity of species associated with deep-sea gorgonian corals off Atlantic Canada. In: A. Freiwald and J.M. Roberts, eds. Cold-water Corals and Ecosystems. Berlin: Springer. 849-879.

Butler, M. 2005. Conserving corals in Atlantic Canada: a historical perspective. In: A. Freiwald and J.M. Roberts, eds. Cold-water Corals and Ecosystems. Berlin: Springer. 1199-1209.

Butler, M. and Gass S. 2001. How to protect corals in Atlantic Canada. In: J.H.M. Willison, J. Hall, S.E. Gass, E.L.R. Kenchington, M. Butler, P. Doherty, eds. Proceedings of the 1st International Symposium on Deep Sea Corals. Halifax, NS: Ecology Action Centre and NS Museum. 156-165.

D'Entremont Environmental Ltd. 2004. International review of areas where activities are restricted to protect deep sea corals. Prepared for Oceans and Coastal Management Division, Maritimes Region, Department of Fisheries and Oceans, Dartmouth, Nova Scotia.

DFO. 2006. Our Waters, Our Future: Sustainable Development Strategy 2007 - 2009.

DFO. 2008. New Emerging Fisheries Policy. (Accessed at: http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/efp-pnp-eng.htm#1)

Doherty, P., R. Brosha, K. Barrett, M. Watkins, R. Galante, D. Davis and M. Butler. 2001. Nova Scotia's corals and canyons kit. In: J.H.M. Willison, J. Hall, S.E. Gass, E.L.R. Kenchington, M. Butler, P. Doherty, eds. Proceedings of the 1st International Symposium on Deep Sea Corals. Halifax, NS: Ecology Action Centre and NS Museum. 175-177.

DOJ. 1996. Ocean's Act. (Accessed at: http://laws-lois.justice.gc.ca/eng/acts/C-7.3/).

DOJ. 2002. Species at Risk Act. (Accessed at: http://lois.justice.gc.ca/PDF/Statute/S/S-15.3.pdf).

DOJ. 2014. Canada-Newfoundland Atlantic Accord Implementation Act (S.C. 1987, c. 3). (Accessed at: http://laws-lois.justice.gc.ca/eng/acts/c-7.5/).

Edinger, E., Baker, K., Devilliers, R. and Wareham, V. 2007. Coldwater corals off Newfoundland and Labrador: Distribution and fisheries impacts. World Wildlife Fund-Canada, Toronto. 41 p.

Edinger, E., Wareham, V., Baker, K., and Haedrich, R. 2009. Relationships between deep-sea corals and groundfish. In K. Gilkinson, and E. Edinger (Eds.), The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. (pp. 4-22). Canadian Technical Report of Fisheries and Aquatic Sciences No. 2830: vi + 136 p.

Fuller, S.D., F.J. Murillo Perez, V. Wareham and Kenchington E. 2008. Vulnerable Marine Ecosystems Dominated by Deep-Water Corals and Sponges in the NAFO Convention Area. NAFO SCR Doc. No. 22, Serial No. N5524, 24 p.

Fuller, S.D., Picco, C., Ford, J., Tsao, C., Morgan, L.E., Hangaard, D. et Chuenpagdee, R. 2008. How We Fish Matters: Addressing the Ecological Impacts of Canadian Fishing Gear. Ecology Action Centre, Halifax, NS.

Gass, S.E., and Roberts, J.M. 2006. The occurrence of the cold-water coral Lophelia pertusa (Scleractinia) on oil and gas platforms in the North Sea: Colony growth, recruitment and environmental controls on distribution. Marine Pollution Bulletin 52 (5), 549–559.

Hamoutene D., Burt, K., Samuelson, S., Wareham, V., and Miller Banoub, J. 2008. Adenosine triphosphate (ATP) and protein data in some species of deep sea corals in Newfoundland and Labrador Region (Northwest Atlantic Ocean). Canadian Technical Report of Fisheries and Aquatic Sciences 2801: 18 p.

Hamoutene, D., T. Puestow, J. Miller-Banoub, and Wareham V.E. 2007. Main lipid classes in some deep-sea corals in Newfoundland and Labrador Region (Northwest Atlantic). Corals Reefs 27 (1), 237-246.

Hughes, S.C., 2009. Identification of existing information in known and predicted Vulnerable Marine Ecosystems. International Governance Strategy Report. Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre.

Jones, D.P. and. Willison J.H.M. 2001. The role of the Canadian Ocean Habitat Protection Society in Deep-sea Coral Education and conservation advocacy in Nova Scotia. In: J.H.M. Willison, J. Hall, S.E. Gass, E.L.R. Kenchington, M. Butler, P. Doherty, eds. Proceedings of the 1st International Symposium on Deep Sea Corals. Halifax, NS: Ecology Action Centre and NS Museum. 166-174.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Levesque, M., Power, D., Siferd, T., Treble, M., and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/nnn, vi + 211 pp.

Leverette T.L. and Metaxas A. 2005. Predicting habitat for two species of deep-water coral on the Canadian Atlantic continental shelf and slope. In: A. Freiwald and J.M. Roberts, eds. Cold-water Corals and Ecosystems. Berlin: Springer. 467-479.

MacIsaac, K., C. Bourbonnais, E. Kenchington, D. Gordon Jr. and Gass S. 2001. Observations on the occurrence and habitat preference of corals in Atlantic Canada. In: J.H.M. Willison, J. Hall, S.E. Gass, E.L.R. Kenchington, M. Butler, P. Doherty, eds. Proceedings of the 1st International Symposium on Deep Sea Corals. Halifax, NS: Ecology Action Centre and NS Museum. 58-75.

Meredyk, S. 2009. State of knowledge for the Hudson hotspot: Interdisciplinary analysis of gelological, ecological, biological and oceanographic components resulting in an ecosystem based zonatin for Vulnerable Marine Ecosystem designations within the Hudson hotspot. International Governance Strategy Report. Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre.

Appendix E: Relevant Publications

Mortensen, P.B., and Buhl-Mortensen L. 2005. Deep-water corals and their habitats in The Gully, a submarine canyon off Atlantic Canada. In: A. Freiwald and J.M. Roberts, eds. Cold-water Corals and Ecosystems. Berlin: Springer. 247-277.

Mortensen, P.B., L. Buhl-Mortensen, D.C. Gordon Jr., G.B.J. Fader, D.L. McKeown and Fenton D.G. 2005. Effects of fisheries on deepwater gorgonian corals in the Northeast Channel, Nova Scotia. American Fisheries Society Symposium 41: 369-382.

Sammarco, P.W. 2013. Deepwater coral distribution and abundance on active offshore oil and gas platforms and decommissioned Rigs-to-Reefs platforms. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-217, 45.

Sherwood, Edinger, E.N., Guilderson, T.P., Ghaleb, B., Risk, M.J., and Scott, D.B. 2008. Late Holocene radiocarbon variability in Northwest Atlantic slope waters. Earth and Planetary Science Letters 275, 146-153.

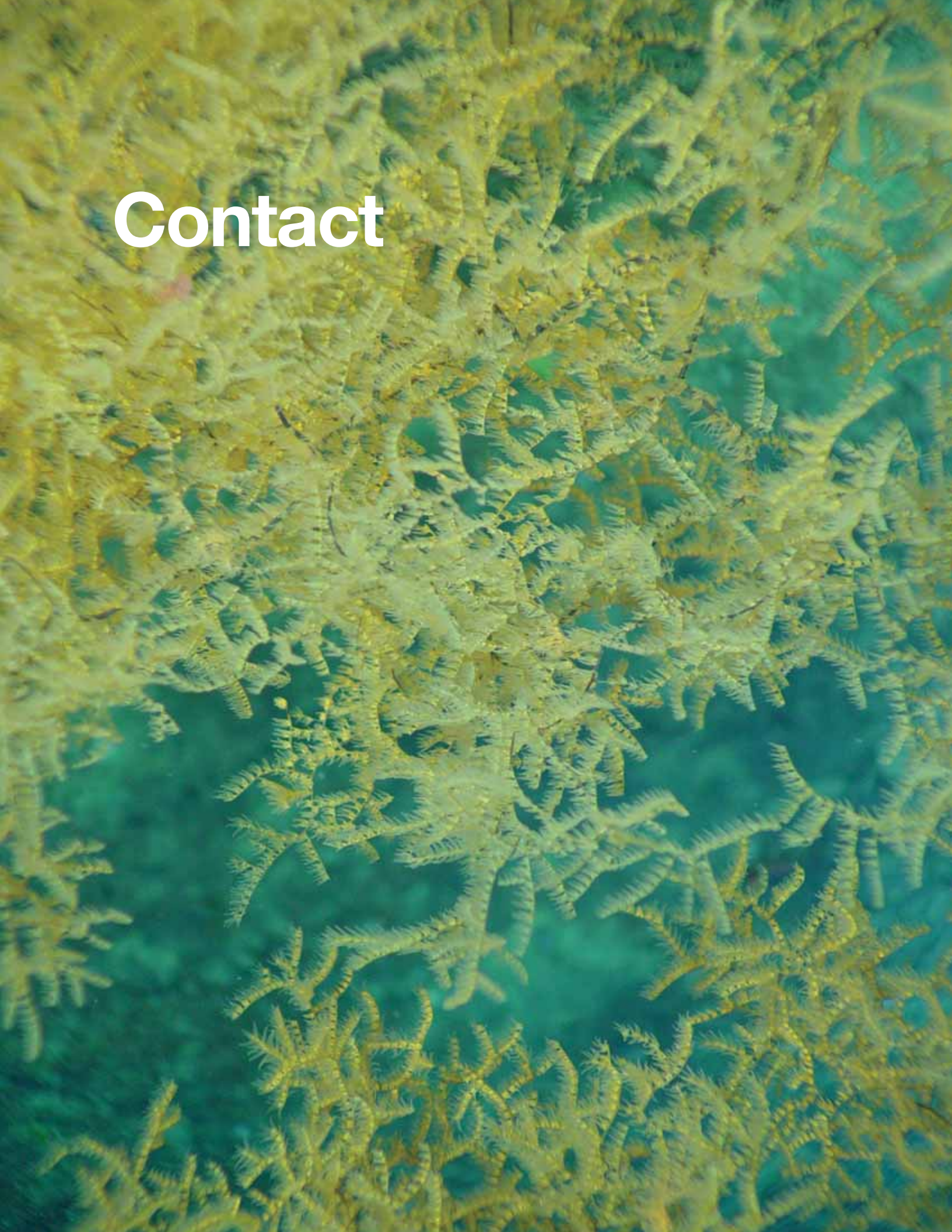
Strychar, K.B., L.C. Hamilton, E.L. Kenchington, and D.B. Scott. 2005. Genetic circumscription of deep-water coral species in Canada using 18S rRNA. In: A. Freiwald and J.M. Roberts, eds. Cold-water Corals and Ecosystems. Berlin: Springer.679-690.

Sun, Z., J-F. Hamel, and Mercier A. 2010. Planulation periodicity, settlement preferences and growth of two deep-sea octovorals from the northwest Atlantic. Marine Ecology Progress Series 410: 71-87.

Wareham, V.E. 2009. Update on deep-sea coral distributions in the Newfoundland Labrador and Arctic regions, Northwest Atlantic. In K. Gilkinson, and E. Edinger (Eds.), The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. (pp. 4-22). Canadian Technical Report of Fisheries and Aquatic Sciences No. 2830: vi + 136 p.

Watanabe S., Metaxas A., Sameoto J.A., Lawton P. 2009. Patterns in abundance and size of two deep-water gorgonian octocorals, in relation to depth and substrate features off Nova Scotia. Deep-Sea Research I 56: 2235-2248

Willison, J.H.M., D.P. Jones and Atwood S. 2002. Deep sea corals and marine protected areas in Nova Scotia. In: S. Bondrup-Neilsen, N.W.P. Munro, G. Nelson, J.H.M. Willison, T.B. Herman, and P. Eagles, eds. Managing protected areas in a changing world. Wolfville, NS: Science and Management of Protected Areas Association (SAMPAA).



Contact

Newfoundland and Labrador Region

Oceans Division
P.O. Box 5667
80 East White Hills Road
St. John's, Newfoundland
A1C 5X1
Email: oceans-nl@dfo-mpo.gc.ca

Maritimes Region

Oceans and Coastal Management Division
P.O. Box 1006
1 Challenger Dr.
Dartmouth, Nova Scotia
B2Y 4A2
Email: corals@mar.dfo-mpo.gc.ca

Quebec Region

Oceans Management Division
P.O. Box 1000
850 Route de la Mer
Mont-Joli, QC
G5H 3Z4
Email: oceans-qc@dfo-mpo.gc.ca

Gulf Region

Oceans Management Division
P.O. Box 5030
343 Université Avenue
Moncton, NB
E1C 9B6
Email: oceans-glf@dfo-mpo.gc.ca

Central and Arctic Region

Resource Management and Aboriginal Affairs
501 University Crescent
Winnipeg, MB
R3T 2N6
Email: XCAEAAInfo@dfo-mpo.gc.ca

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada