An analysis of an evaluation of deep-water coral conservation and management initiatives in the Canadian Maritimes

By

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Abstract

Protected areas have been identified as the tool of choice for marine conservation, however, their implementation and use can only be deemed successful if regular evaluation of their management occurs. The purpose of this study is to create an evaluation framework and complete the framework to determine whether Fisheries and Oceans Canada – Maritimes Region (DFO) is effectively managing the conservation of deep-water corals off the coasts of Nova Scotia and New Brunswick. Using objectives and actions outlined in the Coral Conservation Plan, created by DFO in 2006, an evaluation of the Northeast Channel and Lophelia Coral Conservation Areas was completed. Findings indicate that there are several general challenges that impede the ability of DFO to effectively manage coral conservation in the Maritimes including: vague language throughout the Coral Conservation Plan, a lack of communication and collaboration with other research bodies, and a general lack of resources such as funding and personnel. Further analysis of the evaluation process and management actions, including an examination of tactics used in Norway, the United States and the United Kingdom, suggests that DFO may view deep-water coral conservation management more positively than is deserved. Recommendations for legislation and management planning, ecological and socioeconomic criteria are provided to improve conservation management of deep-water coral ecosystems in the Canadian Maritimes.

Key words: deep-water coral, conservation, evaluation, Northeast Channel, Lophelia Coral Conservation Area, Maritimes, management, Fisheries and Oceans Canada

List of Abbreviations Used

ACCI	Atlantic Canada Coral Initiative
CCA	Coral Conservation Area
CCG	Canadian Coast Guard
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CNOSPB	Canada-Nova Scotia Offshore Petroleum Board
C & P	Conservation and Protection
CSAS	Canadian Science Advisory Secretariat
DFAIT	Department of Foreign Affairs and International Trade
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
DSIS	Deep Seabed Intervention System
EAC	Ecology Action Centre
EBSA	Ecologically and biologically significant area
EEZ	Exclusive Economic Zone
ESRF	Environmental Studies and Research Fund
ESSIM	Eastern Scotian Shelf Integrated Management
IGS	International Governance Strategy
IMFP	Integrated fishery management plan
IMR	Institute of Marine Research
IOI	International Ocean Institute
ISDSC	International Symposium on Deep-Sea Corals
IUCN	International Union for Conservation of Nature
LCCA	Lophelia Coral Conservation Area
LEK	Local ecological knowledge
MPA	Marine Protected Area
NECCCA	Northeast Channel Coral Conservation Area
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NRCAN	Natural Resources Canada
NSERC	Natural Sciences and Engineering Research Council of Canada
RFMO	Regional fisheries management organization
OCMD	Oceans and Coastal Management Division
ROPOS	Remotely Operate Platform for Ocean Science
ROV	Remotely operated underwater vehicle
SARA	Species at Risk Act
SEA	Strategic environmental assessment
UK	United Kingdom
US	United States
VEC	Valued ecosystem component
VDC	Virtual Data Centre
VMS	Vessel monitoring system

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Chapter 1. Introduction

Canada has the largest coastline and, consequently, one of the largest exclusive economic zones (EEZ) of any nation in the world. Given the spatial extent of our EEZ, marine biodiversity is expected to be high, the human impact on these marine ecosystems largely unknown, and management of human activities largely undeveloped. Fisheries and Oceans Canada (DFO)[1] has been designated with the task of managing these human activities and conserving Canada's marine resources. DFO's management strategies play an important role in sustaining marine species and ecosystems. One such ecosystem, which has only been focussed upon within the past decade, is deep-water corals (also known as cold-water corals). Due to their preference for deep water (below 50 metres) habitats and the poor knowledge of deep-water marine benthic environments in general, the ecology and biology of deep-water corals is not well understood. Whenever faced with uncertainty, the adoption of precautionary and ecosystem-based management approaches to ensure effective and sustainable conservation management of these organisms and their habitat becomes necessary. In this study, I develop and complete an evaluation for the two coral conservation areas in the Canadian Maritimes (the Northeast Channel Coral Conservation Area and the Lophelia Coral Conservation Area) based on actions and objectives outlined in the Coral Conservation Plan that was developed by DFO – Maritimes Region in 2006. Such an evaluation can identify areas where improvement or changes to current management methods may be required. An analysis of methods used and ratings provided was performed to develop recommendations for

[1] DFO is a national agency with regional offices throughout Canada. Generally, the use of the acronym in this study refers to all agencies. Where recommendations and actions are specific to a particular region (e.g. Maritimes), they will be specified.

future evaluations. Other nations, including Norway, the United States (US) and the United Kingdom (UK), have implemented conservation measures for deep-water corals and provide opportunities for Canada and DFO to adopt some of these best practices to improve conservation. DFO should be able to use the recommendations provided in this study to implement new actions allowing for a holistic approach that encompasses social, ecological and economical considerations into the management of conservation and protected areas.

1.1 Background on Deep-water Coral in the Canadian Maritimes

In the Northwest Atlantic, corals are found along the continental shelf and slope at depths greater than 200 metres (m), typically at the end of channels between fishing banks or in submarine canyons (Campbell & Simms, 2009). The ocean floor of the Northwest Atlantic provides an ideal substrate (typically found on hard surfaces) for settlement of deep-water coral due to the presence of hard substrates created by glaciation (Campbell & Simms, 2009; Watanabe, Metaxas, Sameoto, & Lawton, 2009). There are between 25 to 30 species of deep-water corals off the coast of Nova Scotia.[2]

Between 2001 and 2003, new information and data on deep-water corals in the Maritimes Region were collected and analyzed through a DFO research program developed through funding from the Environmental Studies Research Fund (ESRF) and researchers at Dalhousie University in Halifax (Cogswell et al., 2009). Patterns in the abundance and distribution of deep-water corals (particularly of *Paragorgia arborea* and *Primnoa resedaeformis*) off Nova Scotia have been recorded by a number of studies

[2] A range between 25 and 30 species is accepted because some underwater photos or videos do not provide a clear enough picture of the coral to be able to ensure 100% certainty in naming the species.

(Mortensen & Buhl-Mortensen, 2005; Bryan & Metaxas, 2006; Watanabe et al., 2009). Additionally, the environmental conditions have been used to predict preferred habitat for deep-water corals (Leverette & Metaxas, 2005; Bryan & Metaxas, 2007; Mortensen & Buhl-Mortensen, 2005; Buhl-Mortensen & Mortensen, 2005). This research has been conducted through a number of research cruises using various technologies, including remotely operated vehicles (ROVs) such as the Remotely Operated Platform for Ocean Science (ROPOS) and the deep-water camera, Campod, as well as through the analysis of information received through local fishermen (Leverette & Metaxas, 2005).

The density and distribution of deep-water coral varies throughout the region, but there are some key areas that have been identified as particularly dense habitats for one or more species. For example, *Primnoa resedaeformis* and *Paragorgia arborea* are the numerically dominant species in Georges Bank and Browns Bank, and as a result, DFO – Maritimes Region implemented the Northeast Channel Coral Conservation Area (NECCCA) to protect these populations, demonstrating that information on distribution and density can help inform management decision for coral conservation (Metaxas & Davis, 2005; Mortensen & Buhl-Mortensen, 2005; Watanabe, et al., 2009).

1.2 Threats to Deep-water Coral in the Canadian Maritimes

The human activities that are the most prominent threats to deep-water corals in Maritime waters include bottom fishing, petroleum exploration and development, disposal of materials, cable and pipeline placement, and scientific research (Breeze & Fenton, 2007).

Fishing gear can be either active (*i.e.* it is mobile and is physically dragged along the seafloor) or passive or fixed gear (*i.e.* lowered to the seafloor for some period and

retrieved) (Freiwald, Fossa, Grehan, Koslow, & Roberts, 2004). Both of these methods can result in damage to corals. Trawling is most destructive as it can clear entire coral colonies in one drag, but some passive gear can result in smothering or partial breakages (Freiwald et al., 2004; Hall-Spencer, Allain, & Fossa, 2002). In the waters off Nova Scotia's coast, trawling, bottom-set gillnet, bottom-set long-line, and pot and trap fisheries pose the greatest threat to coral populations. It is believed that during a typical fishing trip, a trawler can sweep approximately 33 square kilometres (km^2) of seafloor (Hain & Corcoran, 2004). ROV surveys that took place in 2000 and 2001 in the NECCCA showed that while it is common for octocorals, a particular subclass of deep-water corals, to grow in areas with cobbles and boulders, colonies were damaged in 29% of the surveys by long-line and trawl fishing, primarily as a result of the redfish (*Sebastes mentella*) fisheries (Hain & Corcoran, 2004).

Petroleum exploration and development, cable and pipeline placement and the disposal of materials can also smother coral colonies (Foley, van Rensburg, & Armstrong, 2010; Roberts, Long, Wilson, Mortensen, & Gage, 2003). Scientific research can be damaging, particularly when samples are being collected in a trawl, and can have effects like those of trawl fisheries, but over a smaller area.

Some studies have suggested that, a consequence of technological advancements that improve the efficiency of human activities, is that no area on the Earth's surface is unaffected; however, there are some areas that may be less affected than others, such as the deep-sea (Halpern et al., 2008; Ramirez-Llodra et al., 2011). This may change as the oil and gas industry is beginning to acknowledge the resources that may be available for offshore development in the Atlantic Ocean. It is expected that interest from various oil

and gas industries will continue to grow, and to accommodate such growth and development, the Government of Nova Scotia is streamlining approval and regulatory processes (Province of Nova Scotia, 2009). Additionally, while most fish populations in the Atlantic waters have been overfished, there is no evidence to suggest that the fishing industry will shrink. Rather, as fish populations decline, fishermen are adapting to the changes and fishing different species or areas (Harvey & Hammill, 2011). Consequently, since it is not likely that human activity will cease to have impacts on deep-water coral ecosystems, the implementation of conservation measures are required to ensure these areas are protected.

1.3 The Management Problem

The ecological, social and economic values of deep-water corals are becoming increasingly apparent and, as a consequence, corals have become a conservation priority around the globe (Selig & Bruno, 2010). Marine protected areas (MPAs) and fisheries closures are the tool of choice for many nations to protect corals and other marine habitats from human activities (Guerreiro et al., 2011). Norway, the US, the UK and Canada have implemented conservation measures using a variety of tools to develop the regulations, location, boundaries and enforcement of conservation sites. While the conservation efforts are commendable, given that the vast majority of the global ocean's benthic environments remain unexplored, it is difficult to determine whether these conservation efforts are actually effective (Foley et al., 2010). It is uncertain whether the right areas are being protected, that coral habitats that have been degraded and set aside for conservation will actually recover, or whether the activities that are being restricted are the ones causing the damage (Foley et al., 2010). With this high level of uncertainty

and the unique role that deep-water corals play in benthic ecosystems, the methods of management used to conserve deep-water corals should be governed by the precautionary approach and ecosystem-based management. In addition to these guiding principles, scientific research should inform conservation efforts of deep-water corals, particularly since much information on their biology and characteristics is still lacking (Ramirez-Llodra et al., 2010).

DFO – Maritimes Region has implemented coral conservation measures through both the Fisheries Act (1995) and the Oceans Act (1996), but some researchers have expressed concern about the effectiveness of conservation sites with respect to their locations, boundaries, enforcement and state of populations of deep-water corals they are meant to protect (Breeze & Fenton, 2007; Brock, English, Kenchington & Tasker, 2009). This study evaluates the methods of deep-water coral conservation that are being used in the Maritimes region of Canada to: a) determine whether the objectives described in the Coral Conservation Plan (DFO, 2006a) are being met; b) to ascertain whether the objectives and management strategies are guided by appropriate scientific, socioeconomic and ecological criteria; and c) to provide recommendations for the improvement of deep-water coral conservation strategies in Maritime Canada.

1.4 Research Questions

- Are the objectives in the Coral Conservation Plan (DFO, 2006a) being met?
- How can scientific and socioeconomic research better inform the management of deep-water coral conservation in the Maritimes region?

- What lessons can be learned from coral conservation strategies of other nations and what recommendations can be made, based on these findings, to improve deep-water coral conservation in the Canadian Maritimes?

1.5 Research Strategy

To address the above-mentioned research questions, several strategies were used. I developed an evaluation framework based on the objectives outlined in DFO's Coral Conservation Plan (DFO, 2006a). Through informal discussions with DFO employees and an extensive review of internal and external documents, a series of relevant questions was developed and answered using indicators that have been arranged on a rating scale. Comments were provided to justify the ratings and recommendations (if applicable) specifically for DFO were developed. Discussions with DFO employees were possible because I served as an intern in the Oceans and Coastal Management Division (OCMD) at the DFO – Maritimes Regional office, based in Dartmouth, Nova Scotia. Before beginning my internship, I made clear my interest in performing an evaluation of the existing coral conservation areas (CCA) and received guidance on how to complete the evaluation. From this evaluation, it could be determined which of DFO's Coral Conservation Plan objectives are being met, and which require further action. The evaluation was completed within my six-week internship. For the purposes of this paper, the evaluation was deemed to be complete at the end of this six-week period, however, it should be noted that this is an ongoing process at OCMD and therefore, the recommendations provided in this study are meant to address the management issues at present. A more detailed description of the evaluation methodology will be presented in Chapter 4.

The goal of the evaluation and recommendations was to evaluate only the objectives outlined in DFO's Coral Conservation Plan (DFO, 2006a). Therefore, while some questions may have received high ratings, these objectives may not be adequately addressing coral conservation. In the second part of this study, I reassessed the scores that were given to each question within the coral evaluation and determined whether the ranking was reasonable, or whether more information was needed to evaluate the objective. This assessment was based on my interpretation of the requirements as outlined in the Coral Conservation Plan and a literature review of coral conservation methods in nations other than Canada. The literature was utilized in particular to determine what information (ecological and socioeconomic) is needed and how it might be collected to better inform coral conservation management in the Maritimes. I provide recommendations for the improvement of the process I used to evaluate the Coral Conservation Plan, as well as the management issues themselves.

Chapter 2. Biology and Ecology of Deep-water Coral

Deep-water corals are found in different habitats, but most commonly in fjords, canyons, along continental shelves and around offshore submarine banks and seamounts (Frank et al., 2011; Freiwald et al., 2004; Roberts, Wheeler, Freiwald, and Cairns, 2009). While their existence has been known since the early 19th century, it has only been within the last two to three decades that research has focused on deep-water corals. Deep-water corals have been found in all of the world's oceans and located within the waters of approximately 41 countries; however, since 95% of the seafloor is yet to be explored, it is likely that other coral species and populations have yet to be discovered (Freiwald et al., 2004; Ramirez-Llodra et al., 2010; Roberts & Hirshfield, 2004). Deep-water corals are found at depths between 39 and 3000 m and temperatures between 4° and 13°C (Frank et al., 2011; Foley et al., 2010). The distinguishing characteristic of deep-water corals, that makes them different from their warm-water counterparts, is that they do not possess photosynthetic symbiotic algae, called zooxanthellae, and consume particulate matter, such as zooplankton, instead.

All corals belong to the phylum Cnidaria, further divided into the classes Anthozoa and Hydrozoa. The focus of this study will be on corals of the class Anthozoa. Within this class, there are 3,132 species of deep-water corals, constituting the majority (93%) of the known deep-water coral species throughout the world (Roberts et al., 2009). Anthozoa consist of two subclasses: Hexacorallia and Octocorallia. In turn, Hexacorallia includes three orders: Scleractinia (hard corals, stony corals *etc*.), Zoanthidea (zoanthids, gold corals) and Antipatharia (black coral, whip coral *etc*.). Together, these three orders include approximately 777 species (Roberts et al., 2009; Cairns, 2007). The subclass

Octocorallia includes 2,325 deep-water coral species including soft corals, gorgonians, and sea fans (Table 1). Further classification of corals may consider whether they possess zooxanthellae or build framework structures. Of the 3,356 species of deep-water corals, 771 are classified as Scleractinian (stony) species and of these, 18 are constructional (Roberts et al., 2009). Deep-water corals provide habitats to a large number of marine species (polychaetes, molluscs, echinoderms, sponges, bryozoans, and a variety fish) and are a major contributor to the ocean's biodiversity (Roberts et al., 2009).

Table 1. Classification of the seven coral groups with some common names. (modified from Cairns, 2007; Roberts et al., 2009)

Taxon	Common names
Phylum Cnidaria (= Coelenterata)	
Class Anthozoa	
Subclass Hexacorallia (= Zoantharia)	
Order Scleractinia (= Madreporaria)	hard corals, stony corals, true corals, cup corals, star corals, solitary corals, zooxanthellate corals, azooxanthellate corals
Order Zoanthidea (in part)	zoanthids, gold coral (*Gerardia* spp.)
Order Antipatharia	black corals, whip corals, wire corals, thorny corals
Subclass Octocorallia (= Alcyonaria)	soft corals, gorgonians, sea fans, sea whips, sea feathers, precious corals, pink coral, red coral, golden corals, bamboo corals, leather corals, horny corals, sea pens
Class Hydrozoa	
Subclass Hydroidolina	
Order Anthoathecata (= Athecata)	athecate hydroids
Suborder Filifera	
Family Stylasteridae	'hydrocorals', lace corals, sylasterids
Family Hydractiniidae (in part)	longhorn hydrozoans (*Janaria, Hydrocorella*)
Suborder Capitata	
Family Milleporidae	'hydrocorals', fire corals, millepores

2.1 Reproduction

All types of corals exhibit different reproductive strategies; for example, some have separate sexes (gonochoric), whereas others are hermaphrodites. Additionally, some

corals spawn gametes into the water column, while others may hold their larvae internally (Mercier & Hamel, 2011; Roberts et al., 2009). While reproductive strategies vary among species, most scleractinian deep-water corals are gonochoric and spawn their gametes into the water column. The remaining species of scleractinian corals are hermaphrodites and thus fertilize internally (Roberts et al., 2009; Freiwald et al., 2004).

Very little is known about the spatial or temporal factors that can influence reproduction processes for deep-water corals (Mercier & Hamel, 2011). It has been suggested that the timing of reproduction in some deep-water coral species is seasonal or lunar and influenced by the physical properties of the seawater, such as changes in temperature and sedimentation (Freiwald et al., 2004; Mercier & Hamel, 2011). Alternatively, some species, such as *Enallopsammia rostrata,* reproduce continuously (Freiwald et al., 2004). Once reproduction occurs, coral planulae are released into the water column, and disperse various distances and eventually settle onto the seafloor.

2.2 Life Cycle

Most planula larvae of deep-water corals are ciliated, rich with lipids and have chemoreceptors, allowing them limited control of their motility before settlement (Roberts et al., 2009). Deep-water corals tend to colonize hard substrates that may be natural (*e.g.* rocks) or manmade (*e.g.* shipwrecks). Once settled, coral larvae grow at a rate of 4-25 millimetres per year, as long as conditions such as temperature and food supply are suitable (Davies, Wisshak, Orr & Roberts, 2008; Freiwald et al., 2004).

2.3 Settlement Preferences

Stony corals (Scleractinia), such as *Lophelia pertusa,* are often found on hard and rocky substrates, though they can be found on soft or sandy bottoms (Roberts, Wheeler &

Freiwald, 2006). Framework-forming corals include *Lophelia pertusa, Madrepora oculata, Enallopsammia profunda, Goniocorella dumosa, Solensosmilia variabilis*, and *Oculina varicose* (Freiwald et al., 2004; Davies et al., 2008). When (on the order of decades) these framework-forming corals grow to a large size, they begin to break, and become colonized by secondary framework-forming species of the genera Madrepora, Desmophyllum, Oculina, Coniocorella, and Solensomillia (Davies et al., 2008).

The constructional corals continue to grow and when the older coral polyps begin to die, they leave portions of hollowed out calcium-carbonate skeletons, which are subjected to bioerosion from different species, such as clionid sponges (Roberts et al., 2006). Broken skeletons form new hard substrates for colonization, and the reefs spread over a larger area. Some species of deep-water frame-building corals can form colonies up to 300 m high and several kilometres (km) long (Roberts et al., 2006). Most (98%) scleractinian corals, however, consisting of a single polyp, in a calcareous skeleton, do not build extensive colony structures and can settle on both hard and soft substrates (Freiwald et al., 2004).

2.4 Distribution

Deep-water corals have been found throughout the world's oceans (Figure 1). Their distribution varies with temperature, salinity, depth, and latitude. However, since much of the seafloor has not been explored and corals are solitary, accurate distributional maps are limited.

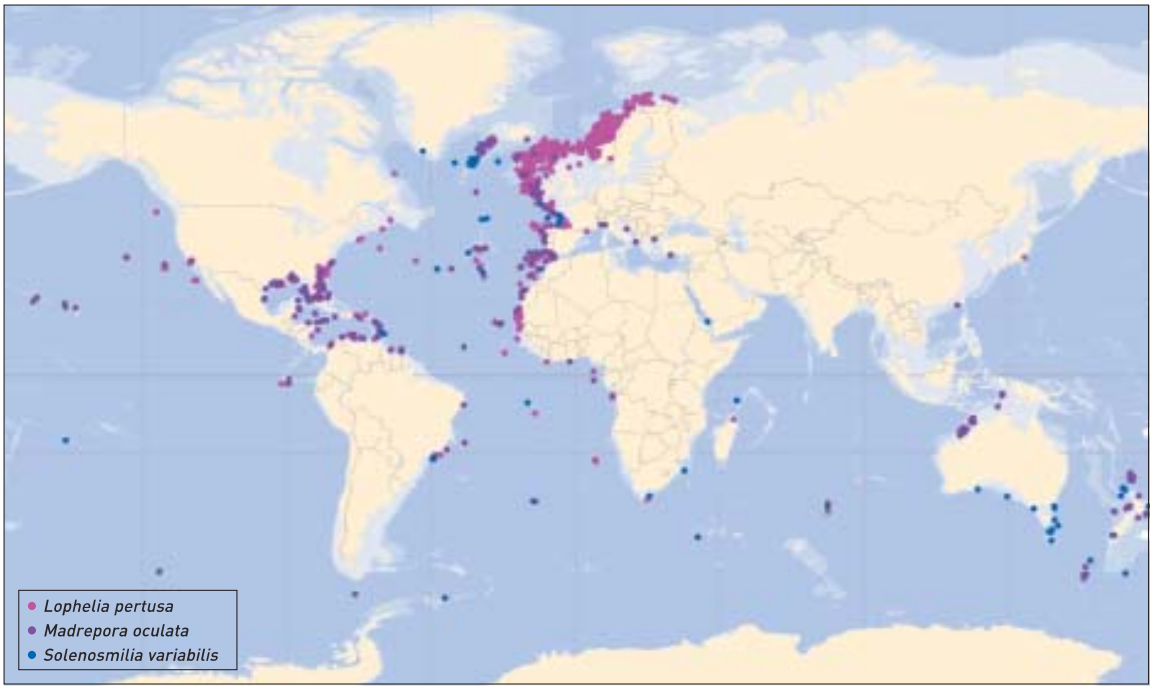

Figure 1. Currently known global distribution of deep-water corals. Areas of high density may indicate areas of intense research (reproduced from Freiwald et al., 2004).

Many deep-water coral species require productive waters with an abundant supply of suspended sediment, dissolved organic matter, bacteria and both phyto- and zooplankton (Freiwald et al., 2004; Mortensen & Buhl-Mortensen, 2005; Roberts et al., 2006). These species are primarily found on continental margins and seamounts. Some species, such as *Lophelia pertusa*, colonize areas with strong local currents (Davies et al., 2008). Corals are sensitive to nutrient levels, particularly nitrogen, and levels that are too high or low may result in coral mortality due to starvation (Davies et al., 2008).

2.5 Ecological Significance

Coral ecosystems are believed to include 1/4 to 1/3 of all the marine species on the planet (Plaisance, Caley, Brainard, & Knowlton, 2011). Shallow-water tropical reefs harbour the greatest biodiversity of vertebrates on the planet, and are often called "rainforests of the sea" (Roberts et al., 2009). It is believed that the biodiversity of deep-

water coral ecosystems rivals that of shallow-water corals, as well as that of rainforests (Ramirez-Llodra et al., 2010). Over 1,300 species have been found on reefs of *Lophelia pertusa* alone, a number comparable to the number of species found in tropical reef sites (Roberts et al., 2006). While some fish species, such as the alfonsino (*Beryx decadactylus*) and roughtip grenadier (*Nezumia sclerorhynchus*), use deep-water corals as nursery grounds or for protection, others, such as brittle stars, sea stars and crinoids feed or live directly on the corals themselves (Foley et al., 2010; Roberts et al., 2009). In some areas where deep-water coral ecosystems are found (such as seamounts), species endemism is high. It is believed that 34% of species found around the seamounts and deep-water coral ecosystems in the Pacific are endemic (Roberts et al., 2006; O'Hara, Rowden, & Williams, 2008).

While the biodiversity and species endemism in deep-water coral ecosystems makes them ecologically valuable, their age and growth rates make them particularly vulnerable to disturbance. Using radioactive dating, it has been determined that some deep-water coral colonies are as old as 8000 years, and geological records have proven that corals have existed for millions of years (Freiwald et al., 2004; Roberts et al., 2009). As a result, destroying patches of deep-water corals can destroy some of the ocean's natural history records.

2.6 Threats

Technological advancements, such as improved mapping and navigational equipment, fish-finding devices and stronger materials for manufacturing fishing nets have resulted in far-reaching human impacts throughout the world's oceans (Ramirez-Llodra et al., 2011; Roberts & Hirshfield, 2004). For deep-water corals in particular, the

main threats include: fishing activities (particularly bottom trawling, trap, and long-line), hydrocarbon exploration and production, cable and pipe placement, research activities (sampling), waste disposal, exploitation and trade of corals, and more recently, climate change (Freiwald et al., 2004). Between 1968 and 2008, the temperature of the Global Ocean has been estimated to have increased by approximately 0.60°C above a depth of 700 m and it is expected to continue to rise (Levitus et al., 2009). In addition to this warming, the increasing amount of carbon dioxide that is being discharged into the Earth's atmosphere through the burning of fossil fuels and deforestation is also contributing to pH reductions and chemical alterations of seawater (Doney, Fabry, Feely, & Kleypas, 2009). This phenomenon, termed 'ocean acidification', along with increasing temperatures, can impede the growth of the calcareous skeletons of corals and result in widespread mortality (Doney et al., 2009). The impacts of ocean warming and acidification are already being observed in shallow-water reefs and although the threat to deep-water corals is not as immediate, it is suggested that effects on these ecosystems will be severe. Since deep-water corals have not been exposed, and thus acclimatized, to increasing pH and temperatures, they may be particularly vulnerable (Thresher, Tilbrook, Fallon, Wilson, & Adkins, 2011). While the purpose of this paper is to examine the effects of human activities that have a direct impact on deep-water corals, it is important to note that improving the conservation and management strategies (such as those used for coral conservation areas) of deep-water corals can help enhance the resilience of marine ecosystems in general and increase their chances of survival in the face of climate change (McLeod, Salm, Green, & Almany, 2009).

Chapter 3. Canada's Legislation and Conservation Measures in the Maritimes

DFO, along with the Canadian Coast Guard (CCG), are charged by the Government of Canada with the responsibility to "deliver programs and services that support sustainable use and development of Canada's waterways and aquatic resources." (DFO, 2012a). The Minister of Fisheries and Oceans oversees the actions of DFO, and the roles and responsibilities are described in the Department of Fisheries and Oceans Act (1985). The Fisheries Act (1985) and the Oceans Act (1996) are the most relevant pieces of legislation for deep-water coral conservation in Canada.

3.1 Fisheries Act (1985)

The Fisheries Act (1985) gives the Minister of Fisheries and Oceans authority to manage freshwater and marine fisheries. Deep-water corals are addressed in the Fisheries Act under references to habitat, specifically habitat protection and pollution prevention.[3] Section 35(2) states that no person shall cause the "alteration, disruption, or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council…" (Section 35(2), Fisheries Act, 1985). Under the Fisheries Act (1985), corals are considered to be "fish" or "fish habitat" and as such, corals can be protected. Section 36 addresses pollution prevention and restricts the disposal of "deleterious" substances into waters considered to be significant fish habitat (Section 36, Fisheries Act, 1985). Both these sections are applied to various marine

[3] This section of the study was written prior to the implementation of changes to the Fisheries Act announced in the Government of Canada's 2012 Budget. The implication of such changes remains elusive for now, but may need to be considered in the future.

sectors, including oil and gas exploration and fisheries. DFO can use the Fisheries Act (1985) to set regulations on these sectors and to implement conservation measures.

3.2 Oceans Act (1996)

The Oceans Act (1996) outlines Canada's responsibilities with respect to its oceans and encourages the pursuit of sustainable development in marine related activities. By authority of the Minister of Fisheries and Oceans through the Oceans Act (1996), DFO can implement MPAs. The International Union for the Conservation of Nature (IUCN) defines protected areas as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." (Dudley, 2008). MPAs have the same definition but may contain, either wholly or in part, a marine ecosystem. An MPA in Canada may be designated for one or more of the following reasons, outlined in the Oceans Act (Section 35, 1996):

(a) the conservation and protection of commercial and non-commercial fishery resources, including marine mammals, and their habitats;
(b) the conservation and protection of endangered or threatened marine species, and their habitats;
(c) the conservation and protection of unique habitats;
(d) the conservation and protection of marine areas of high biodiversity or biological productivity; and
(e) the conservation and protection of any other marine resource or habitat as is necessary to fulfill the mandate of the Minister

In addition to the MPA designation guidelines, the Oceans Act (1996) also outlines a number of governance regimes intended to guide Canadian marine policy. The two most relevant ocean governance regimes to this study are the precautionary approach and ecosystem-based management. The Preamble of the Oceans Act (1996), states that "Canada holds that conservation, based on an ecosystem approach is of fundamental importance to maintaining biological diversity and productivity in the marine environment" and "Canada promotes the wide application of the precautionary approach to the conservation, management and exploitation of marine resources in order to protect these resources and preserve the marine environment" (Preamble, Oceans Act, 1996). Section 30 of the Oceans Act (1996) further defines the precautionary approach as "erring on the side of caution." (Section 30, Oceans Act, 1996). Although ecosystem-based management is not defined in the Oceans Act (1996), it is broadly viewed as "involving the management of species, other natural commodities, and humans as components of the larger ecosystem" (Arkema, Abramson, & Dewsbury, 2006). These two governance principles have broad implications for the conservation of deep-water corals and will be discussed throughout this study.

3.3 Current Coral Conservation Initiatives in the Canadian Maritimes

Researchers from the government and various Canadian universities have been conducting studies on the populations of deep-water corals found off the coast of Canada's Maritimes and have identified some key areas of population density and distribution (Bryan & Metaxas, 2006; Bryan & Metaxas, 2007; Cogswell et al., 2009; Mortensen & Buhl-Mortensen, 2005; Watanabe et al., 2009). Many of these coral populations have been impacted by human activities including fisheries and pipeline

placement (Cogswell et al., 2009). As a result, at the urging of researchers and non-governmental organizations (NGOs) such as the Ecology Action Centre (EAC) in Halifax (Breeze & Fenton, 2007), DFO – Maritimes Region implemented certain conservation initiatives for deep-water corals off the Atlantic coast. These include the Northeast Channel Coral Conservation Area (NECCCA) established in 2002, the Lophelia Coral Conservation Area (LCCA) (sometimes called the Stone Fence Conservation Area) established in 2003, and the Gully Marine Protected Area established in 2004 (DFO, 2011b) (Figure 2). These conservation regions were created using different legislation (*i.e.* through the Oceans Act or Fisheries Act), and decisions were based on the best measure for the particular region (Breeze & Fenton, 2007).

3.3.1 Northeast Channel Coral Conservation Area

The NECCCA was established in June 2002 through the Fisheries Act. It is located off the southwest coast of Nova Scotia between Georges Bank and Browns Bank, two popular commercial fishing spots (DFO, 2011b) (Figure 2). The purpose of the NECCCA was to protect the high densities of octocorals, specifically bubblegum (*Paragoria arborea*) and seacorn coral (*Primnoa resedaeformis*) (Metaxas & Davis, 2005; Breeze & Fenton, 2007). The area of the NECCCA is 424 km^2, 90% of which is closed to all bottom fishing. The remaining 10% is open only to authorized fishing activities, such as long-line groundfish fishing, but an observer is required onboard (DFO, 2011b).

3.3.2 Lophelia Coral Conservation Area

The LCCA, located southeast of Cape Breton (Figure 2), was established through the Fisheries Act in September 2003 and covers an area of 15 km^2. The original plans for

the LCCA included a larger area, which was not implemented because of concerns by local fishermen (Breeze & Fenton, 2007; Cogswell et al., 2009). The LCCA mainly targets *Lophelia pertusa,* because it includes one of the only known colonies in eastern Canada (Cogswell et al., 2009). The LCCA is completely closed to all bottom fisheries (Breeze & Fenton, 2007).

3.3.3 The Gully Marine Protected Area

The Gully MPA, unlike the other two conservation areas, was implemented through the Oceans Act and coral conservation is not the sole goal (DFO, 2011b). The Gully MPA was established in May 2004, and is significantly larger than the two conservation areas at 2,364 km^2 (Breeze & Fenton, 2007). The Gully is divided into three zones, each with different restrictions on use levels. Zones 1 and 2 have the highest level of restrictions and these are the areas where the corals are found (Breeze & Fenton, 2007). The deep-water coral assemblages in the Gully MPA represent the most diverse populations currently known to exist in the Maritime Region. Some of the species found here include *Paragorgia arborea* (bubblegum coral), *Primnoa resedaeformis* (popcorn coral), *Flabellum alabastrum, Pennatula aculeate,* and *Lophelia pertusa* among others (Cogswell et al., 2009).

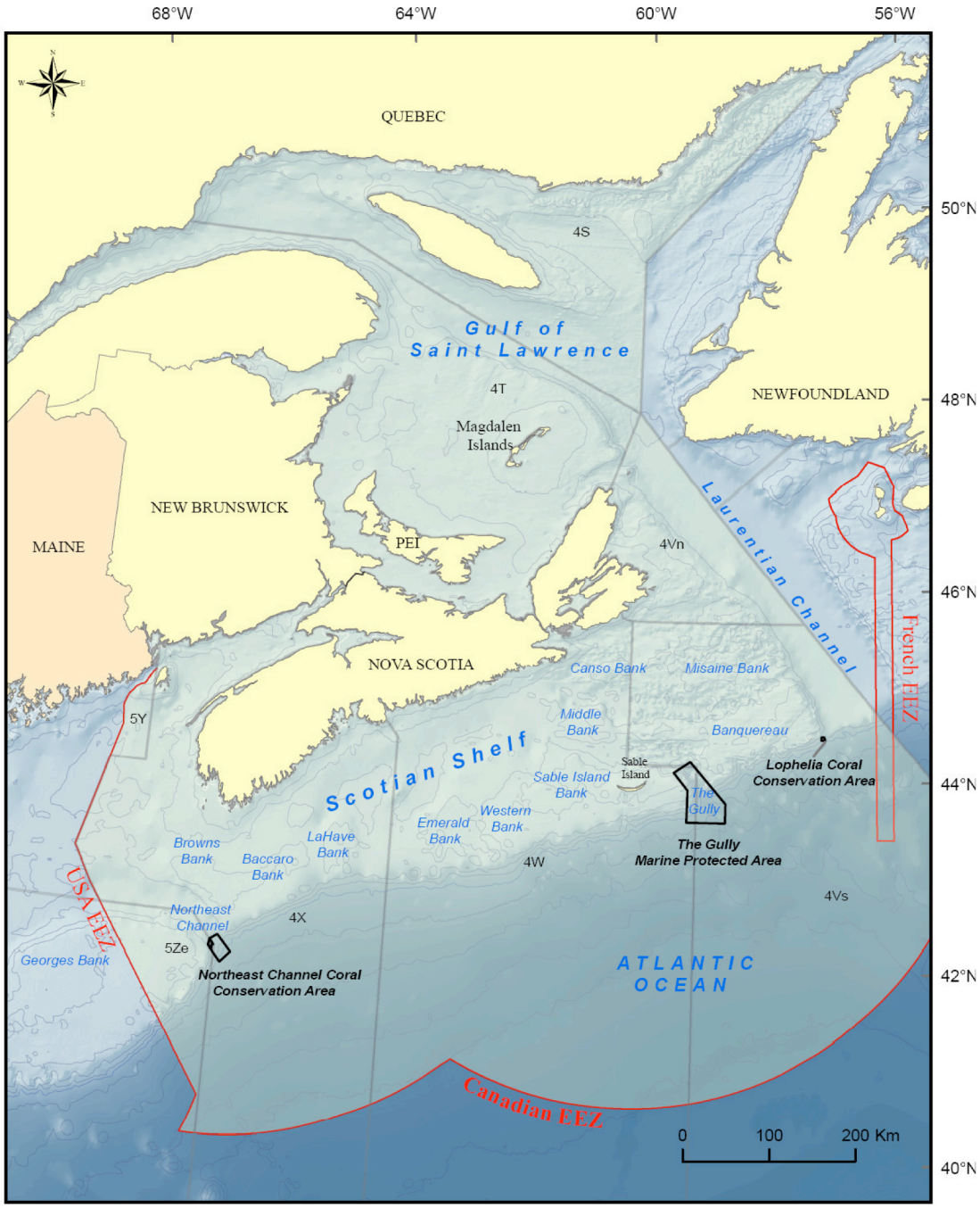

Figure 2. Coral Conservation Areas and the Gully MPA highlighted in black. Red line indicates exclusive economic zones (EEZ) for the US, Canada, and France (reproduced from Cogswell et al., 2009).

3.3.4 The Coral Conservation Plan

DFO – Maritimes Region is responsible for the management and enforcement of all three areas. In 2003, DFO began consultations with relevant stakeholders to develop

recommendations for a Coral Conservation Plan (DFO, 2006a). In consultation with stakeholders, DFO established key management and conservation issues (such as how to balance fisheries and conservation) and, in 2006, the Coral Conservation Plan was finalized (DFO, 2006a). The Coral Conservation Plan was created to meet some general management needs including: "to document what has been done to conserve corals, put forward a more comprehensive approach on coral conservation, to identify issues where more work is needed, and to build collaboration among a variety of groups to address coral conservation" (DFO, 2006a, p. iii). Several objectives are outlined in the Coral Conservation Plan that fall into the three categories of conservation, management and research. The Coral Conservation Plan states that it "will be reviewed and revised every five years (i.e. by 2010) or sooner…" (DFO, 2006a, p. v), however, this has not been completed to date. In addition to this lack of review, studies have suggested that deep-water coral conservation sites are difficult to enforce for a variety of reasons including their remoteness and, in some cases, their small size makes prosecution of violators difficult (Reed, 2002). While the objectives in the Coral Conservation Plan provide a good basis, regular evaluation is required to determine whether the goals listed in the plan are being met.

Chapter 4. Evaluating the Coral Conservation Areas in the Canadian Maritimes

While some studies have been done to determine the effects that MPAs and closures have on fish populations (Powers & Abeare, 2009), very few have examined the effects of various types of closures on corals (Weeks, Russ, Alcala, & White, 2009). These studies have primarily focused on whether protected areas include representative and biodiverse habitats or whether they fulfil coverage targets provided through regional or international legislation (Weeks et al., 2009; Friedlander et al., 2003). Part of the reason for this lack of research is due to the fact that deep-water corals, in particular, are difficult to study. There are many different ways to evaluate protected areas, such as those mentioned above, or by focusing on particular socioeconomic or biological aspects of the protected area, such as increased fish populations in adjacent regions (spillover effect) (Powers & Abeare, 2009; Friedlander et al., 2003). In the case of CCAs in the Maritimes, determining whether or not they are meeting the objectives outlined in the Coral Conservation Plan (DFO, 2006a) can help assess actions that have been taken to advance deep-water coral conservation and determine areas of improvement.

4.1 Developing the Evaluation Framework

The Deep-water Coral Evaluation Framework (hereafter referred to as Coral Evaluation Framework) was developed using the template created by DFO – Maritimes Region to evaluate the Gully MPA (Koropatnick & Macnab, n.d.). The questions chosen for the Coral Evaluation Framework were derived from the objectives and actions set out in the Coral Conservation Plan for the Maritimes Region (DFO, 2006a). The objectives in the Coral Conservation Plan are divided into three categories: conservation, management and research (DFO, 2006a). Within these categories, there are 24 main actions and 41

sub-actions meant to help DFO achieve the objectives. From the actions outlined in the Coral Conservation Plan, I developed 27 questions for the Coral Evaluation Framework (Appendix 1). For the most part, these questions followed the layout of the Coral Conservation Plan, but in some instances, questions were reallocated to more appropriate sections. Some of the actions within the Coral Conservation Plan targeted the Gully MPA; however, since an evaluation of the Gully had already occurred, this evaluation focuses on the NECCCA and LCCA. Additionally, many of the questions in the Research Strategy category of the Coral Conservation Plan were combined into one or two questions for the Coral Evaluation. Some of the sub-actions were used as guiding questions to help determine the ratings (Appendix 1). The questions were largely based on the main actions outlined in the Coral Conservation Plan; where sub-actions were deemed to be too different from the main action, a new question was created to accommodate this difference. The questions were divided into seven sections outlined in Table 2.

Table 2. The Coral Evaluation Framework was divided into 7 sections adapted from the Coral Conservation Plan (DFO, 2006a). The number of questions varied within each section.

Conservation and Management

Section 1 (Questions 1.0 – 1.4)	Support and enhance effectiveness of existing CCAs
Section 2 (Questions 2.0 – 2.1)	Identify and protected important coral areas that are not already protected
Section 3 (Questions 3.0)	Minimize impacts on corals outside CCAs
Section 4 (Questions 4.0 – 4.2)	Stakeholder engagement

Research

Section 5 (Questions 5.0 – 5.9)	Research capacity and data collection
Section 6 (Questions 6.0 – 6.3)	CCA design and boundary extension
Section 7 (Questions 7.0 – 7.1)	Assess socioeconomic impacts

Once the questions were developed, I created an indicator column that allowed for answers to the questions to be provided and rated on a scale of (0) (no action had been

taken) to (3) (action had been taken and little to no improvement is needed to achieve the relevant objective). I created two additional columns: one for comments to provide justification for the rating to each question; and another to outline the data sources that were used to determine the ratings. I provided recommendations within the Coral Evaluation, but it should be noted that these are written in general terms and are meant to directly address the ratings provided in this framework. These recommendations were provided to DFO – Maritimes Region, but further analysis of the ratings will be provided in the upcoming chapters of this report.

4.2 Completing the Evaluation

In order to assign an indicator to each of the questions, I conducted a series of informal discussions with DFO managers. Additionally, these managers provided documents and research materials containing relevant information for evaluating the answers to each question. Some of these documents were internal and not available for public viewing, and thus, for confidentiality reasons, could not be cited. Several meetings with Mr. Derek Fenton and Ms. Tanya Koropatnick, both managers within the OCMD at DFO – Maritimes Region, took place over the course of one month. Once the Coral Evaluation Framework was completed, subsequent discussions with Mr. Fenton and Ms. Koropatnick were scheduled to determine other experts within DFO who could provide further information for a more accurate assignment of indicators to each question. Information through literature reviews was also collected and discussions with suggested contacts conducted. Once completed, I met again with Mr. Fenton and Ms. Koropatnick to have a discussion about which indicator should be assigned to each question. It was my intent to provide an unbiased rating for each of the questions, and thus use information

gathered in discussions with DFO staff as guidance, however, with my limited knowledge and understanding of management strategies, the ratings provided in the Coral Evaluation were more heavily influenced by these discussions. As a result, the ratings are mostly awarded by DFO, thus creating more of a self-evaluation. Indicators were awarded largely based on actions already undertaken, while keeping in mind the resources available to DFO. In the months following the completion of this evaluation, I was able to conduct further analysis and be more critical of the ratings awarded.

4.3 Deep-water Coral Evaluation

The Coral Evaluation depicted a self-evaluation of the actions and effort DFO – Martimes Region has undertaken in order to achieve the objectives set through their own Coral Conservation Plan (DFO, 2006a). The completed Coral Evaluation can be found in Appendix 2.

4.4 Results Summary

The results of the Coral Evaluation provided some important information regarding the current activities that are being undertaken in the Canadian Maritimes region with respect to coral conservation, as well as a good understanding of the ways in which DFO – Maritimes Region perceives their actions. A more detailed analysis of the findings is provided in the following chapter; here I provide an overview of the results by examining the average rating of the scores within each of the seven sections (Table 3).

Table 3. Average (and range in brackets) rating of indicators for each section within the Deep-water Coral Evaluation.

Section Number	**Average Rating (scored from 0 to 3)**
Section 1 (Questions 1.0 – 1.4) – Support and enhance effectiveness of existing CCAs	2.25 (2 - 3)
Section 2 (Questions 2.0 – 2.1) – Identify and protect important coral areas that are not already protected	2 (1 - 3)
Section 3 (Question 3.0) – Minimize impacts on corals outside CCAs	2 (2)
Section 4 (Questions 4.0 – 4.2) – Stakeholder engagement	2* (2)
Section 5 (5.0 – 5.9) – Research capacity and data collection	2.1 (1 - 3)
Section 6 (6.0 – 6.3) – CCA design and boundary extension	1.5 (0 - 2)
Section 7 (Questions 7.0 – 7.1) – Assess socioeconomic impacts	1 (1)

*Includes an N/A option that was not included in the average calculation.

It should be noted that while some sections (*e.g.* Section 1) appear to have a high rating, there are questions within these sections that require improvement and/or implementation of suggested recommendations. This summary of ratings effectively demonstrates the areas of conservation management of deep-water corals where improvement is most needed at present. Section 6, which specifically addressed the design and boundary extension of the CCAs, and Section 7, which addresses socioeconomic impacts received the lowest scores. A possible explanation for these low scores may be that the actions within these sections are meant to fulfil monitoring objectives, which often cannot be done until several years after implementation of a protected area. While these two sections received low scores, it is important to note that question 2.1 (management measures being applied to other coral areas) and question 5.5 (a coordinated and collaborative research approach) also both received low scores. Additionally, 16 out of the 27 questions (approximately 60%) received scores of 2, which

suggests that actions have been taken, but improvement is required. Overall, 21 out of 27 (almost 80%) received scores of 2 or lower, suggesting improvement is needed across all areas of deep-water coral conservation.

Chapter 5. Discussion and Analysis of the Coral Evaluation

Although the Coral Evaluation can be used to evaluate individual CCAs, I incorporated two CCAs, the NECCCA and the LCCA, into the same evaluation because they were implemented at approximately the same time and have similar management strategies. This template can also be used for evaluating future sites, however, some changes would likely be needed to increase the relevance of the evaluation to those sites. The evaluation provided an opportunity to determine whether the CCAs are meeting objectives set out in the Coral Conservation Plan (DFO, 2006a).

The development of the questions for the Coral Evaluation was dictated by the amount of time that was available, which was limited. However, a more detailed and comprehensive overview should consider further dividing the subsections. For example, question 4.0 of the Coral Evaluation asks whether opportunities for public input have been provided to help inform management and regulatory decisions concerning coral conservation. It was intended that "public input" would encompass all groups including industry, affected sectors and the general public (which are separated in the Coral Conservation Plan). While each of these groups was included in the comments and rating for the question, further categorization can consider input by these groups individually. Additionally, research on all aspects of the biology and ecology of deep-water corals was combined into a single question (5.8) in the Coral Evaluation, rather than examining specific areas, such as reproduction, recruitment or environmental data.

The limited time frame also did not permit all relevant managers or other individuals to provide input. Prioritization for completing the evaluation was placed on ensuring that a number of different sources were consulted when awarding ratings;

however, more time would have allowed for a wider coverage and understanding of the various factors that could affect the ratings. Additionally, while the questions in the evaluation came directly from the Coral Conservation Plan (DFO, 2006a), some changes in wording were required to convert the objectives to questions. All questions were reviewed by OCMD staff prior to the evaluation to ensure they made sense and addressed the key issues, but an evaluation by a team with broader perspective may be beneficial before the next use.

Lastly, while the summary of results presented in the previous chapter indicates that approximately 80% of the questions received a score of 2 or higher, the ratings are based on the information provided by the DFO managers. Therefore, it is possible that if some of these questions were answered using information from coral conservation initiatives in other nations or even through external interviews, scoring would be different. In this chapter, I will examine the questions and ratings more comprehensively, using examples from other nations and the literature. I have divided the following analysis into in the seven sections, corresponding to the evaluation framework, preceded by addressing some common themes.

5.1 General Findings

Throughout each of the sections in the evaluation, it was apparent that some areas require further investigation or improvement in management. However, there were some common themes that were evident through more than one section.

5.1.1 Vague Language

The evaluation was designed using the objectives and actions outlined in the Coral Conservation Plan (DFO, 2006a), which contains some vague language, resulting

in vague questions, throughout various sections. For example, under the Conservation and Management Strategy 1 and 2 of the Coral Conservation Plan (DFO, 2006a), the description of some of the actions developed by DFO - Maritimes Region to achieve their objectives includes phrasing such as "develop appropriate restrictions and guidelines for other research activities" and "apply appropriate management measures to protect important coral habitats". This resulted in the evaluation question 1.3, which asks whether the research activities are appropriately managed to ensure minimal harm to corals. The use of the word "appropriate" can be interpreted differently by different parties and may result in conflicting ideas as to the accurate rating. Other similar terms appearing throughout the Coral Conservation Plan (DFO, 2006a) include "adequate" and "effective". Additionally, terms such as "conservation measures" which may seem more specific are not actually defined, leaving interpretation open. In Research Strategy 2 of the Coral Conservation Plan, one of the actions suggested for conducting research to evaluate the effectiveness of CCAs is the examination of "the impacts of permitted activities and activities in adjacent areas on the CCAs." While the word 'adjacent' would imply areas next to the CCAs, there is no indication of how far these adjacent areas should extend.

Vague or unclear language is not a unique issue to DFO, or Canadian marine policy in general. Criticism of vague targets or language has long been paid to international marine policies or statutes, including the United Nations Convention on the Law of the Sea (Wilder, Tegner, & Dayton, 1999). International marine policy or legislation are meant to serve as guidelines for nations in developing their own legal framework, but often, generalizations and non-specific language means that

enforceability is practically impossible and targets cannot be set (Wilder et al., 1999). For nearly a decade, it has been accepted that one of the main reasons for this vagueness, particularly in environmental policy, is due to the uncertainty surrounding variability within the natural environment (Janicke & Jorgens, 2000). As policy-makers, scientists and governments acknowledge this issue of uncertainty, emphasis is increasingly being placed on the use of the precautionary principle (Wilde et al., 1999). If used properly, a precautionary approach provides an opportunity for environmentally harmful activities to be halted before it is too late; however, the concept has been distorted and the word is being used with little understanding or application (Wilder et al., 1999). More recently, Elliott (2009) suggested that this vague language can lead to a false sense of security not just within government, but within stakeholders and research scientists. With very little knowledge about deep-water corals, it is not surprising that vague language is used throughout the Coral Conservation Plan (DFO, 2006a); however, if conservation management is to be evaluated, eliminating such language is an important step to ensuring that an evaluation is meaningful and accurate.

5.1.2 Communication and Collaboration

It was evident throughout the Coral Evaluation process that one of the key issues for current coral conservation management is a lack of collaboration and communication among different parties, including other national governments, local scientists, researchers, and stakeholders. Improvement of these processes may lead to more efficient and effective management in many areas of current coral management process. There were several questions (4.2, 5.5 and 5.9) throughout the evaluation where issues of communication and collaboration were addressed that covered coral management

measures, as well as research methods and findings. While it was clear that some communication occurred through attendance and presentations at various conferences, the actual collaboration piece seemed to be weak. Additionally, in response to question 5.5, it was determined that there is minimal coordination and no collaborative approach between research parties on research priorities. Due to the limited data on deep-water coral ecosystems, collaboration becomes exceedingly important to increasing the knowledge base for these ecosystems. While the Coral Conservation Plan (DFO, 2006a) addresses the need for collaboration, it is evident that actions to date have been minimal.

5.1.3 Lack of Resources

As mentioned throughout this study, access to deep-water corals is challenging because they are found offshore and at great depths, and require specialized and expensive sampling methods. One of the main issues raised throughout the Coral Evaluation was the lack of resources available to carry out deep-water coral research and actions associated with conservation management (such as compliance monitoring). In order to prepare for a research expedition, up to six months of preparation and paperwork may be required (D. Fenton & E. Kenchington, personal communication, July 12, 2012). Furthermore, equipment required for these expeditions, such as ROPOS, is housed on the west coast of Canada and transportation costs for moving it to the Atlantic coast are high. The combined use of research vessels and ROVs, requires daily rental fees that amount to hundreds of thousands of dollars for a 2-week expedition (A. Metaxas, personal communication, July 4, 2012). While these expeditions are costly and may not be within DFO's budget, excursions by university researchers have been conducted in previous years and are planned for the future; these opportunities can be used to leverage

funds and increase capacity for the region. Therefore, while a lack of resources may be a valid explanation for some of the inaction, it is important to be proactive in utilizing different approaches to conduct research of deep-water corals.

5.2 Future Threats

In addition to changes in process that may be required in future evaluations, consideration should also be given to future threats that were insufficiently addressed in the initial development of the Coral Conservation Plan (DFO, 2006a). The Coral Conservation Plan (DFO, 2006a) describes some human activities that may pose threats to conservation initiatives, but only acknowledges fisheries as the main threat. Potential impacts of oil and gas are indicated and there is a recommendation that corals be included in all strategic environmental assessments (SEA) for the industry; however, this industry is not viewed as a major threat. It is possible that at the time the Coral Conservation Plan was created, the oil and gas industry was not a threat to deep-water corals. However, recent investments by oil and gas industries, such as Shell, have demonstrated the growing interest in oil and gas exploration along the Scotian Shelf (Province of Nova Scotia, 2009). It is likely that this threat will continue to grow since consumer demand for offshore oil and gas is increasing and hydrocarbon companies are being pressured to find new reserves and explore in areas that have not been tapped before (Davies, Roberts, & Hall-Spencer, 2007). Many industries are viewing deep water as an opportunity for further exploration and expansion. An oil spill or leak during oil and gas operations could have a great impact on deep-water corals, which typically inhabit regions with strong ocean currents. These currents could disperse contaminants over wide areas and potentially wipe out entire ecosystems (Davies et al., 2007).

Ocean acidification and climate change are increasingly becoming a threat to deep-water coral ecosystems. These threats are only mentioned briefly in the Coral Conservation Plan (DFO, 2006a), but are not addressed in any of the objectives or actions in the plan. Although there is still much uncertainty surrounding the effects of ocean acidification, it is widely proposed that scleractinian deep-water coral will be severely affected (Maier, Watremez, Taviani, Weinbauer, & Gattuso, 2012; Tittensor, Baco, Hall-Spencer, Orr, & Rogers, 2010). Since the distribution of deep-water corals is largely dictated by temperature, their preferred habitats are in high latitudes or deep-water, and these areas are predicted to be the first to be affected by ocean acidification and temperature changes (Maier et al., 2012). Vulnerability is further enhanced because deep-water corals are azooxanthellae organisms, which means they lack the single-celled plant organisms most often found in shallow-water corals. Zooxanthellae have a mutualistic relationship with corals where the corals provide them with shelter and a place to live in their calcareous skeleton, while the zooxanthellae provide the coral with food. While both zooxanthellae and azooxanthellae coral have calcareous skeletons that are at risk of dissolving in increasingly acidic waters, recent studies have suggested that zooxanthellae may be able to adapt to and regulate pH levels in their surrounding waters, prolonging the impacts of ocean acidification (McCulloch, Falter, Trotter, & Montagna, 2012). Such findings suggest that deep-water corals, which lack zooxanthellae, may be more at risk than shallow-water corals. Tittensor *et al.* (2010), using present-day data, predicted that coral suitable habitat in the North Atlantic Ocean, in particular, will be severely reduced by the year 2099 because of ocean acidification. This imminent and severe threat should

be addressed in the Coral Conservation Plan (DFO, 2006a), but as yet, has not been included.

5.3 Analysis of Coral Evaluation Findings

The following sections provide a more specific analysis of some of the findings from the Coral Evaluation. They are divided into sections that parallel the structure of the Coral Evaluation.

5.3.1 Section 1: Support and enhance effectiveness of existing Coral Conservation Areas

Section 1 of the Coral Evaluation primarily addresses enforcement and compliance of fishing and research activities. There were five questions within this section, all of which received ratings of 2 or 3.

Significant efforts have been made to incorporate the CCAs into wider planning and management processes for ocean use. This is likely largely because the Coral Conservation Plan was born out of the Eastern Scotian Shelf Integrated Management (ESSIM) initiative, which in itself and as the name suggests, is focused on integrated management which typically includes conservation initiatives, as well as management guidelines for sustainable use of marine resources. However, it must be noted that ESSIM is a pilot initiative, which ended in 2012. While the ending of ESSIM could be viewed as a concern for the implementation of the Coral Conservation Plan into wider ocean use planning, the Coral Conservation Plan is viewed as a stand-alone document and therefore, deep-water corals can continue to be integrated with other ocean management processes. The integrated fisheries management plans (IFMPs) provide a good example of developing initiatives that incorporate coral conservation into other management processes. It is important that DFO continue to develop IFMPs for all fisheries, even

those that are currently not active in or around coral areas, particularly because as more conservation or marine protected areas are established, fishermen will adjust to the closures by changing fishing effort and locations (Powers & Abeare, 2009).

The IFMP template created by DFO – Maritimes Region allows for the consideration and inclusion of many important conservation measures to protect corals, as well as benthic habitats in general. Perhaps one area for improvement could be to include an objective in the IFMP that allows for fishermen to help collect data that can be used to evaluate the effectiveness of fisheries closures.

What becomes overall apparent in Section 1 of the Coral Evaluation is that more information and investigation needs to focus on the methods of enforcement and compliance monitoring. It is difficult to evaluate whether enforcement is addressing infractions (question 1.2) without knowing how many infractions there have been and, of these, how many have been prosecuted. Due to confidentiality issues, this information was not readily available for use in this particular evaluation, but DFO staff should compare it to that of other nations. Currently, there is no information available on DFO's website about the type of marine enforcement and compliance measures that are used. Creating a mechanism for others to report suspicious activity could validate the information that DFO receives through their data, as well as provide another monitoring method that could be available when DFO is not on the water.

In general, DFO is employing a variety of methods for compliance monitoring and enforcement of the CCAs and, currently, new actions may not be required. However, an evaluation of the effectiveness of current practices is imperative, particularly as the number and boundaries of CCAs expand.

5.3.2 Section 2: Identify and protect important coral areas that are not already protected

Section 2 of the Coral Evaluation addresses primarily whether other coral or sponge ecosystems, besides those within the CCAs, are being identified and whether conservation measures are being discussed to ensure their protection. This section consisted of two questions, which received scores of 3 and 1. The gap between these two ratings stems from DFO's acknowledgement that while coral areas have been identified, there has been little to no progress in implementing new conservation measures. The Coral Conservation Plan (DFO, 2006a) outlines some of the other areas throughout the Maritimes region where fishermen have brought up coral bycatch (Figure 3). Jordan Basin, Misaine Bank and Corsair Canyon, in particular, were all identified in the Coral Conservation Plan as research priority areas (DFO, 2006a, p. 36); however there have not been any DFO-led research excursions to these areas since they were identified. It is important to note that while bycatch may indicate broadly areas where corals may be present, it does not necessarily reflect the spatial extent of the entire coral ecosystem. One method that can improve DFO's understanding of locations and distribution of coral populations is habitat mapping.

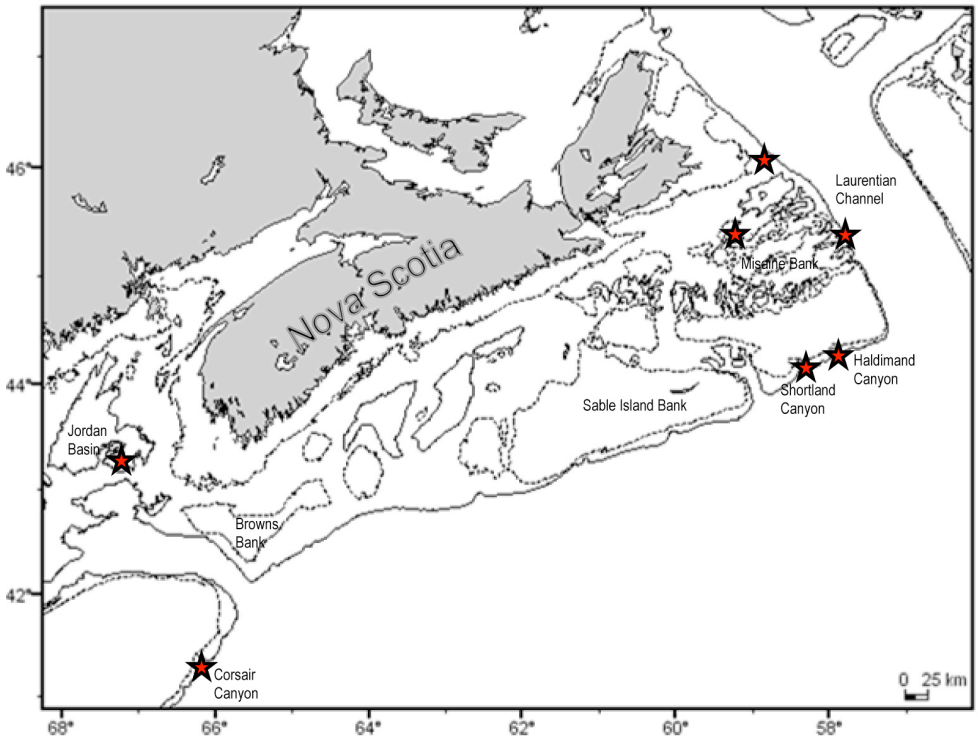

Figure 3. Areas identified by fishermen as having corals and listed as research priority areas in the Coral Conservation Plan (taken from DFO, 2006a, p.13, based on Breeze, Davis, Butler, & Kostylev, 1997; Gass 2002)

While habitat mapping methods may be outside the budget of DFO, information already exists to support targeting of some locations. Bryan & Metaxas (2007) used a modelling program called Biomapper to determine suitable habitat (specifically for coral Families Paragorgiidae and Primnoidae), based on the relationships between the physical seascape and biological data on coral occurrence. More specifically, Bryan & Metaxas (2007), using the distribution of various biological parameters within habitats to predict what combination of these would predict coral occurrences, showed that corals are predicted to occur in areas of complex topography along the continental shelf break and on seamounts. The findings from this study along with those of others, such as the fact that deep-water coral habitats are associated with strong currents (Mortensen, Hovland, Fossa & Furevik., 2001) and that gorgonian abundance is correlated with bottom

temperatures (Mortensen & Buhl-Mortensen, 2004), can assist in the identification of possible locations of deep-water corals. Though ground-truthing and further research would be required to test the accuracy of these findings, were DFO to incorporate a truly ecosystem-based management approach into their coral management strategies, using this information is an important step in helping to determine and identify important areas of coral habitat. This information could also feed into the larger ocean management strategies, such as network planning.

5.3.3 Section 3: Minimize impacts on corals outside CCAs

Section 3 of the Coral Evaluation includes a single question, which addresses whether research guidelines have been developed and disseminated for areas outside the existing CCAs. The purpose of the question was to determine whether the guidelines are in place, and to determine existing mechanisms for coordinating research priorities among research parties. This question received a rating of 2 because guidelines have been developed and are usually disseminated to researchers (both those within DFO and external researchers) but not consistently. While DFO may not be able to restrict or regulate all research activities in Maritime waters, most researchers do not wish to damage marine resources and, thus, will take a number of steps independently to minimize their own impact.

While it may be beneficial to determine whether the guidelines are useful to the researchers, a more important consideration is whether the guidelines are actually influencing the impacts on corals and currently permitted research methods are damaging deep-water corals. More specific guidelines, such as the amount of coral a researcher can collect or the type of equipment that can be used, should be developed. To create such

guidelines, DFO could host a workshop with experienced researchers to gain a better understanding of the type of required equipment and regulations to implement. The conventional sampling technique using dredges and trawls is no longer considered appropriate by many scientists, particularly for sensitive benthic areas (Roberts et al., 2009). Submersibles, ROVs and underwater cameras are more often used instead, but the research guidelines do not accommodate this change. Ultimately, however, ecological information on the distribution of coral ecosystems is required (and must be conducted) to allow effective management of research efforts.

5.3.4 Section 4: Provide opportunities for industry and public involvement in conservation and management activities.

Section 4, which addresses the involvement of the public and industry in conservation and management, consists of three questions. One of the questions was deemed to be unanswerable and, thus, received a non-applicable rating, while the other two received scores of 2. The non-applicable rating was selected by DFO – Maritimes Region because there have not been any management decisions that required input from the public since the implementation of the CCAs. Public input and industry involvement was important in the early stages when conversations around boundaries and locations of the CCAs were occurring. Affected stakeholders and members of the general public were permitted to provide comments, which were then considered throughout the implementation. While involvement during the implementation of the CCAs is important, there may be opportunities for public and industry involvement after this initial stage. For example, these parties may be able to assist with monitoring and determining the effects of the CCAs on industries and the public. Interestingly, the next question, which received a high rating, addresses whether DFO has an outreach plan to raise awareness in the

general public about deep-water corals, which they do. This is an important step in determining whether the public understands the role and importance of the CCAs.

5.3.5 Section 5: Research capacity and data collection

Section 5 of the Coral Evaluation includes questions addressing research capacity and data collection for deep-water corals in Maritime waters. This is the largest section, partly because several separate sections from the Coral Conservation Plan were merged together in the Coral Evaluation, thus allowing for a comprehensive overview of the research activities throughout the region. This section consists of 10 questions varying in ratings across all levels, and with an overall average rating of 2.1.

The first two of the questions addressed whether funding is available for research on deep-water corals and the manner in which it is distributed. Current funding for deep-water coral research by DFO – Maritimes Region is minimal. The main method of funding is through International Governance Strategy (IGS) funds and one of the stipulations of this funding is that the research must be carried out in international waters, thus excluding current CCAs and those areas identified as priorities for further research. It is unlikely that funding for research conducted by DFO – Maritimes Region will increase in the near future, given many of the budget cuts occurring throughout the Government of Canada; however, as previously discussed, there are other ways in which information and data on deep-water corals within the Maritimes region can be collected. Universities and NGOs can provide leverage for funding through collaborative projects, particularly through funding bodies such as the Natural Sciences and Engineering Research Council of Canada (NSERC). Though it may not always be possible for DFO – Maritimes Region to participate in research expeditions with these other parties, it is

important that they become informed on the locations and the types of collected data. Researchers from Dalhousie University have been on several expeditions since 2001 that have been focused on collecting more information and data about the benthic environment, including deep-water coral ecosystems, in collaboration with DFO-Science but not with OCMD (A. Metaxas, personal communication, July 4, 2012). This seems to be an issue particularly in the DFO-Maritimes Region, as communication and collaboration between outside researchers and DFO-Newfoundland Region seems to be better (A. Metaxas, personal communication, July 4, 2012). In the Maritimes region, communication and collaboration between DFO-Science, OCMD and external researchers is required in order to provide useful scientific information (role of DFO-Science and external researchers) to help inform management decisions (role of OCMD). It should be noted that the onus should be placed on both sides to communicate with the other. Another expedition is being planned for 2013 and there may be opportunities for such collaboration at this time (A. Metaxas, personal communication, July 4, 2012). If it is not possible for DFO to participate in these expeditions, they should at the very least, communicate their needs for data that can inform conservation management.

Although the Coral Evaluation seems to suggest otherwise, efforts by DFO – Maritimes Region to track the distribution, recruitment and reproduction of corals within the CCAs has been extremely limited. Cogswell *et al*. (2009) used a number of data types to develop their report on distribution of deep-water corals throughout Maritime waters, including groundfish trawl survey bycatch data, commercial bycatch data collected through the DFO Fisheries Observer Program, information from interviews with fisherfolk, and targeted benthic survey data (Cogswell et al., 2009). The data were

collected in 2001 and 2003 through a DFO research program that received funds through the ESRF (Cogswell et al., 2009). In addition to these studies, data were collected during two ROPOS missions and one Deep Seabed Intervention System (DSIS) mission conducted in 2006 and 2007, and two missions using Campod in 2005 and 2008 (Cogswell et al., 2009). The study provides some valuable insights into the taxonomic composition and distribution of deep-water corals, but does not address some of the ecological aspects such as recruitment, reproduction, and the role of environmental data in regulating abundance. Understanding of all these aspects is key to determining best practices for management.

As discussed in Chapter 2, much data are still needed on the ecology and biology of deep-water corals, although more and more studies are attempting to fill in some of the gaps (Thresher, Adkins, & Thiagarajan, 2011; Mortensen & Buhl-Mortensen, 2005; Bryan & Metaxas, 2006). To accurately evaluate the effectiveness of CCAs, more data are needed. Cogswell *et al.* (2009) provide a good basis, but this study alone cannot be used to assess some of the important ecological characteristics of deep-water corals required to monitor their health. For example, understanding recruitment and reproduction patterns can identify critical coral areas for both maintenance of existing coral ecosystems and the recovery of disturbed ones.

DFO has access to some of the equipment to perform benthic research but funding is required to lease and use the equipment. Therefore, the high rating given to the question regarding capacity to perform deep-water research is not accurate. The capacity for DFO to conduct benthic research is clearly limited both financially and by personnel. Although DFO has managed to conduct some research despite the limited resources, the

amount of research possible through existing funds is insufficient to address the requirements of the Coral Conservation Plan. As discussed throughout this section and others, there are ways in which funds and knowledge can be leveraged through partnerships with other organizations. Collaborative processes such as workshops could be organized by DFO – Maritimes Region using minimal resources to enhance regional understanding of deep-water coral ecosystems and thus, improve management practices.

Another important management action assessed in this Coral Evaluation section was that of international collaboration and cooperation (question 5.9). As with many of the questions throughout Section 5, the rating for this question is higher than can be justified. As discussed in some previous sections, there is some communication with international communities through participation in conferences, including the International Symposium on Deep-Sea Corals (ISDSC), however, the collaboration is minimal. Collaboration with the US is particularly important because of neighbouring regions, such as the Gulf of Maine, which share many marine populations and ecosystems. While DFO has participated in some conferences and communication sessions with the US, formal collaboration on deep-water coral research has not occurred to date. The Coral Conservation Plan (DFO, 2006a) identifies the pursuit of opportunities to collaborate with the international community on coral conservation, but there are no clear actions on how this might be achieved.

5.3.6 Section 6: Coral Conservation Area design

Section 6 addressed some immediate concerns and interests that DFO – Maritimes Region has with respect to the current boundaries of the CCAs. There are four questions within Section 6, which received ratings ranging between 0 to 2 with an average of 1.5,

making it the second lowest scoring section. DFO – Maritimes Region has already had some discussions about options for boundary expansion, and Cogswell *et al.* (2009) outline some recommendations for both linear and depth boundary expansions. These are important steps, but as outlined in Section 5, some key ecological characteristics of the deep-water coral populations important in determining boundary modification, remain unknown. However, there also exists a trade-off between delaying-decision making until the data become available and the precautionary approach may need to be utilized in the interim to inform these decisions.

Socioeconomic information can feed into the decision to extend boundaries. One important piece of information is determining the location of the major fisheries when the CCAs were established, now, and possible predictions for the future. Such information can facilitate the demarcation of boundary extensions, as well as identify new areas for conservation. Understanding the impacts of human activities in areas that are not protected can help determine the type of restrictions that are needed.

There are many factors to be considered in the modification of the current boundaries of the CCAs. DFO - Maritimes Region has already taken some steps toward gathering information but more are required. Much like many of the other recommendations, there are ways in which information can be leveraged and used for this as well as other goals.

5.3.7 Section 7: Socioeconomic Research

Section 7 addresses socioeconomic research, and both questions in this section received a score of 1, making it the lowest ranking section in the evaluation. The low ranking may be because this research involves activities commonly completed in the

monitoring or evaluation stages of the protected area management process, which is often considered to be five to ten years after implementation (Cicin-Sain & Knecht, 1998). However, since the CCAs were implemented almost ten years ago, it may be argued that this is not a valid excuse for the lower ratings. The questions in this section address the use of local ecological knowledge (LEK) and the impact that the CCAs are having on the livelihoods of fishermen. Before addressing each question individually, there are some general comments about this section that are worth making. Firstly, throughout this evaluation, the only major stakeholder discussed is the fishing industry, except in Section 1 where the SEA of the oil and gas industry is used as an example where the CCAs are included in larger ocean management processes. In large part, this is due to the fact that the evaluation was modelled after the Coral Conservation Plan which does not acknowledge industries associated with oil and gas, seismic exploration, cable placement or shipping as stakeholders despite the fact that all of these pose risks to deep-water coral ecosystems. This does not suggest that these industries were purposely ignored, but indicates that they were not relevant at the time that the Coral Conservation Plan was created. At this point, it is important that DFO adopt an adaptive management approach where they will be able to incorporate future threats and stakeholders who may not be involved in the early stages of planning of a protected area.

Secondly, since the legislation that DFO follows for designating marine conservation suggests that an ecosystem-based approach should be used, it is important to remember that humans are a key part of this approach. Ecological and socioeconomic data are equally important in informing management decisions for protected areas.

The first question in Section 7 addresses the use of LEK in providing information about the ecosystems that are within and surrounding the CCAs. A report by Gass (2002) discusses the challenges associated with collecting LEK and provides some recommendations and tips on how to do so successfully. While this is an important report, it was written in 2002, prior to the establishment of the CCAs. Although many of the recommendations are still relevant to current management, a more detailed discussion about how LEK can be used within the CCAs may be useful for DFO. While LEK may have appeared to only serve a purpose in the identification of the important coral habitats, it arguably should play a role throughout the management process. Seeking information from local fishermen helps them identify with the management process and studies have shown that such involvement can increase compliance and support for additional conservation measures (Christie & White, 2007). DFO needs to improve the rating of this particular question and can do so by identifying key groups and undertaking interviews or discussions with relevant individuals.

The second issue addressed in this section is different than most questions throughout the evaluation, in that instead of evaluating the effects that humans may be having on the coral, it is evaluating the impacts that the closures are having on the fishing industry. Of particular significance in this question is the 10% restricted fishing zone within the NECCCA. DFO – Maritime Region is keen to know if it is being used and how use patterns have changed since implementation. As mentioned previously, this type of evaluation can help determine changes in fishing effort and provide support for altering the boundaries of CCAs and developing new protected areas. DFO must identify the important fisheries in the region, both currently and a few years prior to CCA

implementation, and perform interviews to determine whether fishermen are operating within the closure or whether they have decided to fish elsewhere and if so, why.

Socioeconomic research is a valuable part of the monitoring process and, therefore, resources should be directed toward collecting data. An important distinction that DFO needs to make is the difference between stakeholder involvement and public outreach. Arguably, both are equally important since stakeholder involvement allows for inclusion of all affected bodies providing a holistic view of the ecosystem, while public outreach addresses the message and education that is sent out to the general public. Given that DFO is associated with the Federal Government, public outreach is important since it affects electoral capacity. Now that DFO has implemented the CCAs, it is important that they begin directing some attention to monitoring and outreach, and socioeconomic research is one part of this process.

Chapter 6. Management Recommendations and Conclusion

The Deep-water Coral Evaluation highlighted some of the key issues associated with conservation management in the Maritimes Region. As discussed in Chapter 5, some of these issues were apparent throughout various stages of conservation management, while others were more specific to a particular section. Given the often limited resources and timelines associated with addressing management concerns, it becomes important, particularly for government agencies, to prioritize their actions. The purpose of this chapter is to prioritize some of the issues raised through the Coral Evaluation and present realistic recommendations based on knowledge gained through the Coral Evaluation and through a review of strategies undertaken by other nations for deep-water coral conservation.

6.1 Legislation and Management Planning

The Coral Conservation Plan (DFO, 2006a) was established in 2006 by DFO Maritimes Region with the intent of being revised in 2010. The needs it addressed included a documentation of then current conservation practices, a proposal of a more comprehensive approach on coral conservation, the identification of issues where more work was needed, and the building of collaboration among a variety of groups to address coral conservation (DFO, 2006, p. iii). The questions that were developed in the Coral Evaluation were based on a number of actions that were created to help accomplish these goals. Based on the outcomes of the evaluation, much work still remains to be done.

The vague language presented throughout the Coral Conservation Plan, was a major shortcoming, which makes evaluation and effectiveness difficult to pursue and measure. Moving forward, DFO needs to make revising and updating their current Coral

Conservation Plan a priority. Establishing a working group that is comprised of DFO managers, scientists (from both inside and outside DFO), and stakeholders to review and define language used in the Coral Conservation Plan is suggested.

The existing Coral Conservation Plan identifies its scope as including the waters off the Atlantic coasts of Nova Scotia and New Brunswick to the limit of Canada's jurisdiction (DFO, 2006a, p. 3). A report on coral distribution and research for Newfoundland and Labrador has been created and methods for coral conservation have been recommended (Edinger, Baker, Devillers, & Wareham, 2007). It could be of significant benefit to develop a regional Atlantic-wide strategy for DFO Newfoundland and DFO Maritimes to work collaboratively and possibly allow more access to resources and researchers.

The Coral Evaluation indicated that DFO Maritimes Region has effectively included the CCAs into a number of oceans management processes, largely as a result of the Coral Conservation Plan's creation through the ESSIM initiative. While including the CCAs into the IFMPs is an important move, there may be other ways to integrate fishing activity and coral conservation. The International Council for the Exploration of the Seas (ICES) and the US National Research Council have both stated that there are three ways to minimize impacts from fisheries to deep-water corals: 1) reduce fishing effort; 2) close areas; and 3) modify and substitute gear (Butler, 2005). Since fishing reduction is a much bigger issue and closures have already occurred, the modification of gear may be a suitable management action for DFO to pursue. As yet, they have not pursued such an action (Butler, 2005), likely due to the pushback they would receive from the fisheries. In particular, rockhopper or roller gear, which allows trawls to be able to move over rough

or rocky terrain has devastating effects on corals (Butler, 2005; Reed, 2002). Prohibiting this type of gear in areas where corals are believed or known to be present may significantly reduce the impacts of fishing activities and would fall within DFO's responsibilities under a precautionary approach. Butler (2005) suggests that every dragger or trawl fishery can be converted to a long-liner, with the major obstacle being political will. DFO should explore opportunities and work with fishery groups to determine the feasibility of gear regulations and possible modifications. Gear regulations should certainly be further considered by DFO – Maritimes, but as Edinger *et al* (2007) point out in their examination of coral populations in Newfoundland and Labrador waters, regulating fishing gear modifications on its own, may not be effective for coral conservation. Fisheries closures, such as those implemented through the NECCCA and LCCA are key but more legal support may be needed for their justification and implementation.

A legislative initiative DFO could consider in the conservation management of deep-water corals is including some of the at-risk species in the Species at Risk Act (SARA) (2002). The purpose of SARA is to "prevent wildlife species from becoming extinct and secure the necessary actions for their recovery" (Government of Canada, 2012). Species can be recommended to be placed on the list but in order for the listing to become official, the recommendations must be reviewed by the Canadian Endangered Species Conservation Council, which is made up of the Minister of the Environment, the Minister of Fisheries and Oceans, and the Minister responsible for the Parks Canada Agency and other relevant ministers from the province or territory being discussed (SARA, 2002, Section 7(1)). A good case for a particular species to be put on the SARA

list must be made because such a designation can restrict any human activities that may have an impact on that species. Therefore, if deep-water corals were to be put on the species list, fisheries would be required to avoid any area where that coral species is believed to inhabit. In addition to the effect the listing may have on fisheries, data showing their value as an ecosystem are scarce. Internationally, several species of deep-water corals have been protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES aims to ensure that the international trade of wild animals and plants does not threaten their existence (CITES, n.d.). CITES was established in 1975 and now counts 175 nations as parties (CITES, n.d.). *Lophelia pertusa* and black coral species belonging to the Order Antipatharia are included on the CITES list. At the very least, the Government of Canada should recognize that *Lophelia pertusa* is a unique and rare species that should be listed under SARA. In doing so, DFO may be able to more efficiently enforce closures and protection of deep-water coral sites in the Atlantic region.

6.2 Ecological Criteria for Conservation Management

MPAs and area closures are becoming the most common management practice to address marine conservation issues (Murawski, Brown, Lai, Rago & Hendrickson, 2000; Guerreiro et al., 2011; McClanahan, Marnane, Cinner & Kiene, 2006). However, they are often implemented without an understanding of the ecological and socioeconomic scientific information that underlies conservation management (Agardy et al., 2003). It is evident from the Coral Evaluation that there are large knowledge gaps in the ecological and socioeconomic realms with respect to deep-water coral conservation management in the Maritimes region. The Coral Conservation Plan (DFO, 2006a) outlines two categories

for research priorities: research in support of the existing coral conservation measures, and research aimed at gaining a more complete picture of the distribution of corals and other sensitive benthic habitats (DFO, 2006a, p. 36). Many of the issues associated with ecological criteria and the current management of the CCAs has been acknowledged and addressed through the recommendations for improved collaboration and communication between research parties. However, an important consideration for DFO is what to do with the ecological information that currently exists and how should it and future studies be incorporated into management of CCAs.

Most studies on deep-water corals in the Maritimes thus far have been focused on the species *Lophelia pertusa*, *Primnoa resedaeformis*, and *Paragorgia arborea* (Mortensen & Buhl-Mortensen, 2005; Bryan & Metaxas, 2007; Watanabe et al., 2009; Leverette & Metaxas, 2005), likely because they are the most abundant. There are conclusions that can be drawn to help inform management of the current CCAs as well as plan for future CCAs. For example, DFO – Maritimes Region has used a Marxan analysis to identify priority areas for the establishment of MPAs and develop a bioregionalism plan. Marxan, a program developed by the University of Queensland to help identify zoning boundaries for the Great Barrier Reef in Australia, uses different layers of data, each with a particular focus (*e.g.* corals), and overlays the layers onto a map (University of Queensland, 2012). The data that are used to create these layers, however, is only as good as the existing research. Therefore, using results from studies such as Bryan and Metaxas (2007), where habitat suitability for deep-water coral species is predicted, can enhance the information that is entered into a Marxan analysis and provide a more

accurate picture of coral distribution, improving the effectiveness of areas that are selected for coral conservation.

To determine the effectiveness of their boundaries, the purpose of the CCAs must be clearly articulated. The purpose of the NECCCA is to protect the diverse population of deep-water corals (specifically octocorals) in the area. The implementation of this CCA was somewhat contentious as it was being placed in an area of intense fishing activity (Breeze & Fenton, 2007). As a result, several boundary options were discussed with fisheries groups before the current boundaries were settled upon, and included a 10% limited fishing zone to allow for the continuation of some long-line fisheries. In contrast, the LCCA was implemented to protect *Lophelia pertusa*, and the boundaries remained relatively narrow to reduce impact to fisheries. Cogswell *et al.* (2009) suggest that there is considerable evidence to support that the NECCCA is optimally placed to protect the highest density and least impacted population of deep-water corals. Despite this, Cogswell *et al.* (2009) suggest that a boundary extension should be considered because there are some coral populations outside the boundaries of the current NECCCA boundaries. However, the authors also state that this area is not at risk of being impacted by trawlers because it is at a greater depth than they can presently access, but this will likely change in the future with improved technology (Cogswell et al., 2009). If this is the case, I propose that, habitat mapping and validating predictions based on habitat suitability studies, such as those by Bryan & Metaxas (2007) and Watanabe *et al*., (2009), should be a priority for DFO rather than investing more resources into determining whether the boundaries of NECCCA should be expanded. In contrast, the LCCA, may be a better candidate for consideration of boundary extension. While the current LCCA

boundaries are believed to be encompassing the entire population of *Lophelia pertusa* (Cogswell et al., 2009), the area's small size has made enforcement and compliance difficult to address. Additionally, since fishing is occurring directly outside the LCCA boundaries, it is difficult to ascertain the impact of these actions (either through sedimentation or smothering) on the *Lophelia* corals. More research is needed to better understand the impacts of fishing activities, but in the meantime, a precautionary approach would suggest that an expansion of LCCA boundaries is important.

Fishing is one of the major threats to deep-water coral ecosystems in Atlantic Canadian waters and worldwide; therefore, it is not surprising that most protection efforts around the globe to date have focused on regulating fishing (Hourigan, 2009). However, if these protection efforts are implemented solely because fisheries effort (and subsequently coral damage) in a particular area seems to be high, and adjacent areas which may not be as intensely fished are ignored, key areas including important coral habitat or species may be jeopardized in the future. Investing resources into an expansion of a protected area that may not need expanding, while delaying the implementation of protection measures in areas that may be more vulnerable or at-risk in the future, can be detrimental. To effectively use a precautionary approach and ecosystem-based management, DFO needs to consider the biological and ecological information available when implementing coral conservation measures.

6.3 Socioeconomic Criteria for Conservation Management

Determining the past and current impacts of CCAs on human activities has been identified as a priority issue for DFO – Maritimes Region. Since the number of stakeholder groups involved in deep-water coral conservation is likely to be less than that

associated with inshore closures or MPAs, addressing socioeconomic concerns may not seem as daunting as some other protective measures. Since the existing CCAs are in fact fisheries closures, emphasis should be placed on fisheries groups as the key stakeholders. However, representatives from the oil and gas industry should also be engaged in decision-making processes as more CCAs are developed.

Before beginning the process of actually evaluating socioeconomic impacts, the key stakeholders should be identified and a distinction between public outreach and stakeholder involvement articulated. Although these distinctions appear clear in the actions of the Coral Conservation Plan, they are not defined in the document. Often, when managers are attempting to use ecosystem-based management, public outreach or education gets confused with stakeholder involvement (Arkema et al., 2006). Public outreach or education usually involve a number of actions with the purpose of informing the general public of conservation measures, whereas stakeholder involvement allows for some element of decision-making to be bestowed upon individuals or sectors who may be affected by the conservation or management plans (Arkema et al., 2006). While DFO – Martimes Region has developed an outreach plan, revisions and updates are necessary to ensure that it is effective and actually being implemented. The awareness of deep-water corals seems to be growing among the general public (Freiwald et al., 2004); consequently the outreach plan should be revised to define the partnerships that can help distribute messages about deep-water corals. For example, DFO – Maritimes Region has already developed a teaching tool-kit on deep-water corals that is available through the Natural History Museum in Halifax, Nova Scotia (Martin, n.d.). Working with such organizations further could generate mechanisms for incorporating information on deep-

water corals into the curriculum. Another important ally could be found in NGOs. The EAC was critical in raising awareness and persuading DFO – Maritimes Region to implement conservation measures (Breeze & Fenton, 2007). If mutual respect and understanding is applied, DFO and these NGOs could work together to implement public outreach methods.

With respect to stakeholder involvement and determining the impacts that CCAs have on affected groups, DFO – Maritimes Region may have missed some opportunities. One of their priorities, at this time, is assessing the impacts the CCAs have had on fisheries. It would have been beneficial for DFO – Maritimes Region to work with fisheries throughout and after implementation of the CCAs to determine what (if any) changes fishermen had to make to adjust to the new closures. Such a study may be completed today, but given the time that has passed, it may be difficult to get a comprehensive overview of the changes and distribution of fishing effort, as some vessels may not be reachable or captains may not remember or be willing to assist. This is not to say that this action should not be undertaken. DFO should make it a priority, but in the future, it would be better to implement such monitoring measures in the earlier stages, rather than assume that because there are no immediate management decisions to be made, stakeholders need not be involved.

6.4 Deep-water Coral Conservation in Other Nations

A useful exercise for DFO – Maritimes Region may be to look to other nations that have also engaged in deep-water coral conservation initiatives. Although management variations between nations may exist as a result of legislative and geographic differences, best practices may be identified. Norway, the US, and the UK

have each implemented deep-water coral conservation strategies in their waters and have some similarities to Canada either through ecological or political comparisons. An overview of some of the deep-water coral protected areas in these nations is presented in Table 4.

There are some important findings that can be observed by looking at a comparison of the deep-water coral conservation management in other countries. One such finding is the use of buffer zones to enhance protection of the particular coral assemblage. All deep-water coral protected areas in Norway have a 5 km buffer zone to protect against fishing gear and the Darwin Mounds MPA in the UK has a 2.2 km buffer to serve the same purpose (D'Entremont Environment Ltd., 2004). Buffers can prevent fishing gear from drifting into the coral area. Implementation of a buffer zone in the LCCA, for example, may mean that fisheries would not be fishing close to the boundaries and putting the corals within the boundaries at risk. While buffer zones can help reduce impacts from fisheries, it may be best to use them as an interim solution since expanding the boundaries of the LCCA would be more effective.

Another key finding that can be observed through a comparison of deep-water coral conservation strategies in other countries (Table 4) is the varied use and types of legislation. Similar to the CCAs in the Canadian Maritimes, most of the protected areas were created through fisheries closures, with the exception of the Tautra Ridge in Norway and the Sitka Pinnacles in Alaska, US. Implementing protected areas through fisheries closures can be done faster than going through the process of establishing an MPA or reserve. For the Canadian Maritimes, beginning as fisheries closures may be beneficial, however, once closed, the site should not be disregarded. As demonstrated in

the case of the Darwin Mounds, it is possible for efforts to be made to formally close the areas. Such an action would hold the management body responsible for long-term monitoring and research of the area. While this may not be appealing to management bodies for the very reason of increased responsibility, an ecosystem based management approach would dictate that this is the best way to manage.

Lastly, a comparison of nations (Table 4) has also further highlighted the difficulties associated with compliance and enforcement. Norway, the US, and the UK, use most (if not less) of the same tools as DFO – Maritimes Regions for compliance and enforcement of CCAs or protected areas, including VMS and over flights. One of the primary criticisms is that because particular types of fisheries are permitted within the protected areas, prosecution is difficult because the enforcing bodies must prove that a vessel caught within the boundaries of the protected area is performing one of the named illegal fishing activities (De Santo & Jones, 2007; Hourigan, 2009). It would be easier to restrict all fishing activity within the protected area. While implementing total fishing restrictions may have implications for the fisheries themselves in large protected areas, smaller sized areas such as the LCCA or the 10% limited fishing zone within the NECCCA may not have dire effects and could possibly be negotiated with the fishermen. Perhaps creating restricted fishing zones in the area where corals are known to be and implementing buffers where some types of fishing are allowed would help to improve the effectiveness of enforcement.

Table 4. A comparison of deep-water coral conservation management processes in Norway, the US, and the UK. (Information for table obtained from D'Entremont Ltd, 2004; Hourigan, 2009; De Santo & Jones, 2007; Armstrong, 2008).

	Norway	**United States**	**United Kingdom (Scotland)**
Protected Area(s)	Røst Reef, Sula Ridge, Iver Ridge, Tautra Ridge, Tisler Reef	Aleutian Islands (Alaska), Oculina Bank (Florida)	Darwin Mounds
Size	Varies depending on area. Røst is the largest at 43 km long and 6.8 km wide. Note: The protection areas cover the entire reef complexes and have a 5 km buffer zone to protect against fishing gear	Sitka Pinnacles Marine Reserve (Aleutian Islands) – 3.1 nautical miles $(nm)^2$, Oculina Bank – 300 nm^2	169 km^2 but 1530 km^2 when including the 2.2 km buffer
Type of Protected Area	Fisheries closures (bottom-trawl free zones) except Tautra Ridge which is an MPA	Sitka Pinnacles is a marine reserve, but there are 10 other sites identified as Habitats of Particular Concern. Oculina Bank is a Habitat of Particular Concern	Began as a fisheries closure (2001), established as a permanent fisheries closure (MPA) (2004)
Relevant Legislation	Amendments to the Regulations Relating to the Protection of Coral Reefs (1999)	Magnuson-Stevens Fishery Conservation and Management Act (1984); Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region	1992 Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora; revised Common Fisheries Policy
Known Species Protected	Primarily *Lophelia pertusa*	Aleutian Islands – *Primnoa resedaeformis* (identified as rockfish habitat); small coral gardens, submarine canyons Oculina Bank – *Oculina varicosa*	Mainly *Lophelia pertusa* and *Madrepora oculata*, but other species have been identified
Restricted Activities	The Regulations state that all fisheries must demonstrate special care when operating near areas of known coral reefs, but fishing gear that touches the sea floor is prohibited. This restriction applies to both Norwegian and foreign vessels. Some of the areas have been identified as promising fields for oil and gas, but more research occurred before these industries were permitted to go into the areas,	Sitka Pinnacles and Aleutian Islands– Groundfish fishing and anchoring prohibited Oculina Bank – Closed to all bottom-tending fishing gear	Bottom-trawl vessels or towed nets are prohibited. Oil and gas industry must conduct an SEA prior to receiving a license for exploration. If license is granted, industry is subject to regulation under the Offshore Petroleum Production and Pipelines Regulations (1999) and The Offshore Petroleum Activities Regulations (2001).

Table 4. cont.

	Norway	United States	United Kingdom
	ultimately however, it seems the perception is that oil and gas pipelines are a one-time disturbance and therefore, more easily permitted than fisheries.		
Compliance and Enforcement	The Norwegian Coast Guard surveys all protected areas within Norway's EEZ.	The NOAA – National Marine Fisheries Service (NMFS) and the US Coast Guard are responsible for enforcement. Sitka and Aleutian Islands – Trawl vessels must carry VMS and 100% coverage of fisheries observers are required for vessels over 125 feet. However, NOAA points out that enforcement would be easier if all fishing were prohibited. Oculina Bank – Enforcement for this area is difficult due to the inability of the NMFS to apprehend or prosecute violators without support from the US Coast Guard. Illegal shrimp trawling is known to occur in this area.	Marine Scotland (formerly Scottish Fisheries Protection Agency) is primarily responsible for enforcement. Marine Scotland patrols the areas and vessels are required to use VMS. The area would be more easily enforced if it were entirely closed to fisheries, but since pelagic trawling is permitted, enforcement is difficult.
Science Monitoring	The Institute of Marine Research (IMR) conducts annual cruises where coral areas are monitored and registered. Findings are provided to Norwegian authorities and used to inform management decisions. Approximately 50% of funding for IMR research comes from the Ministry of Fisheries and Coastal Affairs.	NOAA scientists primarily perform research in the area. Research is largely focused on determining the link between coral and valuable commercial fish species and whether the closures are having an impact on these fish populations.	Research is conducted by a variety of different parties, but most commonly by the Joint Nature Conservation Committee and the Scientific, Technical and Economic Committee for Fisheries. The European Commission takes research information from these organizations to help inform policy.

The comparison of deep-water coral conservation strategies in Norway, the US, and the UK is useful in understanding how other nations overcome general challenges associated with conservation management, and also helps to provide validation in the notion that, in general, conservation management, particularly of deep-water corals is difficult. Based on some of the shortcomings of deep-water coral conservation that were identified through the Coral Evaluation of the CCAs in the Canadian Maritimes, there are some key management strategies and best practices that can be highlighted from Norway, the UK, and the US.

One of key successes Norway has had in the establishment of their deep-water CCAs (Rost Reef, Sula Ridge, Iver Ridge, Tautra Ridge, and Tisler Reef) is the acceptance and support the areas have received from the general public and stakeholders. Biologists, fishers, and NGOs collaborated with the Norwegian government to develop legislation and implement a number of conservation measures, including bottom trawl free areas within Norway's coastal waters (Armstrong & van den Hove, 2008). Implementation of these measures was effective because the views of all parties were acknowledged and addressed. For example, it became apparent that Norwegian fisherfolk had a dual attitude toward coral; they viewed it as a nursery and a home for the fish that they caught, but also as a nuisance since if caught, it likely ruined their gear (Armstrong & van den Hove, 2008). The communication of such viewpoints facilitated decision-making during the selection of closure areas and the collective development and implementation of conservation measures (Armstrong & van den Hove, 2008). Similarly, DFO should not steer away from regulations or management planning, such as gear modifications or area closures, simply because of possible pushback from the fisheries.

Gaining the trust and including fisheries in the planning and management of conservation areas can enhance compliance and ensure the implementation of future conservation areas are not jeopardized or prolonged by pushback from the public. Additionally, if stakeholder groups have a good understanding of and support the goals of a conservation initiative, they would be more willing to spread the message about the conservation to the general public (Arkema et al., 2006). Norwegian NGOs were critical in raising awareness among fishermen and the general public, which resulted in open and efficient communication between several parties and the Norwegian government (Armstrong & van den Hove, 2008). Given the role that the EAC played in the initial development of the CCAs in the Maritimes, lessons from Norway may be beneficial in helping to determine how to keep NGOs involved throughout the conservation management process.

One of the highlights of conservation management of the Darwin Mounds MPA off the coast of Scotland can be observed in their compliance and enforcement process. Marine Scotland, an agency under the Scottish Government, has been charged with the responsibility of protecting Scotland's marine areas and fisheries (Scottish Government, 2012). Marine Scotland provides information on their website about the various methods used to monitor and regulate fishing activities in their waters, lists information on recent enforcement activity and offers an online option for reporting suspicious activity (Scottish Government, 2012). It should be noted that Marine Scotland, and the European Union, in general, use many of the same tools as Canada to enforce offshore protected areas, such as VMS, and thus faces the same challenges (De Santo & Jones, 2007); however, the transparent nature of the website of Marine Scotland is a key aspect of this

agency that DFO should strive to achieve. It may not be necessary to replicate Marine Scotland's website, particularly since there may be confidentiality or privacy issues associated with posting information about those who have been prosecuted for violations, but being clear about the processes that are used to enforce marine conservation areas and providing opportunities for public involvement in reporting can enhance the relationship DFO has with the public and contribute to overall support of the process.

Lastly, it may be worthwhile to look to the US for best practices regarding management and strategic planning for conservation. In the US, the fishery management plan for the pelagic long-line fishery includes an objective focused on reducing discarded bycatch of endangered or threatened non-target species, including blue and white marlin, and protected species such as sea turtles and bluefin tuna (Powers & Abeare, 2009). A similar objective could be included in the IFMP template for the Canadian Maritimes whereby coral species are included as the non-target species. Including this objective helps to achieve a more comprehensive picture of fisheries effort and also makes clearer the goal to reduce coral bycatch, an issue that is somewhat lacking in the current IFMP template for the Maritimes region. By helping to map fishing distribution effort, data collected as a result of this objective could inform development and placement of new conservation areas.

In addition to the fisheries management planning example provide through the US, the nation also seems to have a better grasp on the importance of collaborating with other nations. The National Oceanic and Atmospheric Administration (NOAA) in the US recently published the Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (NOAA, 2010), in which 'International Strategy' is identified as important and clear

objectives on how to enhance international collaboration toward conservation of deep-sea corals are provided (NOAA, 2010, p. 45). For the first objective, NOAA will "promote international partnerships to conserve deep-sea coral and sponge ecosystems through the sustainable management of deep-sea fisheries activities impacting those resources" (NOAA, 2010, p. 45) and includes clear actions, such as participating with and establishing new regional fishery management organizations (RFMOs). These organizations can assist with the compliance and enforcement of deep-sea coral conservation, and work with other nations to raise awareness about deep-sea coral ecosystems in their EEZs. Since the Maritimes Coral Conservation Plan (DFO, 2006a) requires updating, it would be beneficial to look to other plans and strategies, such as NOAA's, to develop concrete actions toward achieving objectives.

6.5 Conclusion

In summary, the completion of the Deep-water Coral Evaluation for the Canadian Maritimes has highlighted the following recommendations to improve conservation management:

- Establish a working group comprised of DFO managers, scientists (from both inside and outside DFO), and stakeholders to review current conservation plan and define language used.
- Consider the creation of an Atlantic-wide deep-water coral conservation strategy for DFO Newfoundland and DFO Maritimes.
- Explore opportunities and work with fishery groups to determine feasibility of gear regulations or modifications.

- Make a case for the designation of *Lophelia pertusa* and/or other at-risk coral species to be listed under SARA.
- Communicate and collaborate with university researchers to enhance biological and ecological knowledge of deep-water corals and use the findings to inform management decisions.
- Make habitat mapping a priority for research.
- Undertake research to better understand the impacts of fishing activities on deep-water coral, both inside and outside of the CCAs.
- Include representatives from the oil and gas industry in consultations and decision-making processes.
- Make a distinction between public outreach and stakeholder involvement and ensure stakeholder involvement occurs throughout the management process.
- Revise and update the public outreach plan.
- Develop a strategy for working with NGOs to facilitate public outreach.

These recommendations are cost-effective and can be implemented using minimal resources. Furthermore, examples of how to better involve stakeholders, be more transparent in compliance and enforcement efforts, and make collaboration and cooperation with research parties a priority, can be observed through an analysis of conservation management in other nations.

The implementation of protective measures, such as MPAs and CCAs, is an important tool for marine conservation and will continue to be used by most nations throughout the world. While their use is indicative of a goal to protect marine ecosystems, their effectiveness can only be assessed through regular evaluations. Deep-

water coral ecosystems represent a unique and important component of the marine environment and while little is known about them, new information is being collected with each expedition, which suggests that their social, ecological and economic benefits to humans could be significant. The Coral Evaluation of the two CCAs currently located in Maritime waters highlighted some of the areas where DFO's conservation management requires improvement, specifically, increased collaboration with other research parties and the establishment of a more prominent role for stakeholders in monitoring and evaluation. Based on my analysis of the Coral Evaluation, along with an examination of conservation efforts in Norway, the US and the UK, I provide what I consider concrete and feasible recommendations for DFO that if implemented can improve conservation practices of deep-water coral ecosystems. If DFO is able to adopt some of the recommendations in this study, they will be using both a precautionary and ecosystems-based management approach to deep-water coral conservation.

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Appendix 1. Developing Questions for Coral Evaluation based on Actions in the Coral Conservation Plan

Original section headings (shaded), action (bold) and sub-actions outlined in the Coral Conservation Plan (DFO, 2006a)	**Adapted section headings (shaded) and questions developed for the Coral Evaluation Framework.**
Conservation and Management Strategy 1: Support and enhance effectiveness of existing Coral Conservation Areas (CCAs) and Marine Protected Area (MPA)	Section 1: Support and enhance effectiveness of existing Coral Conservation Areas (CCAs)
A1 Ensure CCAs and MPA are incorporated into ocean use planning and management processes A1.1 Include in fisheries management plans A1.2 Include corals in Gully MPA Management Plan A1.3 Include CCAs and MPA in other sector-based plans and environmental assessments	1.0 Have the CCAs been incorporated into ocean use planning and management processes (i.e. fisheries management plans and environmental assessments)? *Guiding questions that were asked to help determine rating for Question 1.0: where have the CCAs been incorporated? What gaps (if any) are there?*
A2 Continue activity monitoring of the CCAs and the Gully MPA A2.1 Surveillance and enforcement of management measures A2.2 Development of integrated fisheries monitoring system A2.3 Work with affected users to address compliance issues associated with area restrictions	1.1 Are the existing surveillance and compliance monitoring measures ensuring effective protection of the CCAs? *Guiding questions that were asked to help determine rating for Question 1.1: which measures work? which do not? are compliance issues associated with area restrictions being assessed with affected users?* 1.2 Is enforcement capacity effective for addressing infractions that are caught through surveillance and compliance monitoring?
A3 Identify damaging research activities and develop appropriate restrictions for CCAs and MPA A3.1 Restrict DFO Research surveys from CCAs and coral areas of the Gully MPA A3.2 Develop appropriate restrictions and guidelines for other research activities within these areas	1.3 Are research activities appropriately managed to ensure minimal harm to the corals?

A4 Review conservation measures on a regular basis (every 2 years) to take into account new scientific and other information	1.4 Are conservation measures (for the specific coral sites) being reviewed regularly to account for new scientific or other information?
Conservation and Management Strategy 2: Identify and protect important coral areas that are not already protected	Section 2: Identify and protect important coral areas that are not already protected
A1 Identify important coral areas	2.0 Have other important coral and sponge areas (besides those found within the CCAs) been identified and prioritized for conservation measures?
A2 Apply appropriate management measures to protect important coral habitats, if the site evaluation process determines this is necessary	2.1 Have conservation management measures been applied to protect other coral habitats?
Conservation and Management Strategy 3: Minimize impacts on corals outside CCAs and the MPA	Section 3: Minimize impacts on corals outside CCAs
A1 Use fisheries management processes to reduce impacts on corals in general A1.1 Continue using the Fisheries Observers Program to collect information on coral bycatch A1.2 Investigate the use of best practices for reducing impacts on corals, including coral bycatch	*This action was deemed to be more appropriate in the Research Section of the Coral Evaluation due to the fact that while it is management processes that are used, the information that is collected is research. These actions are addressed in Question 5.3.* 5.3 Are the Fisheries Observer Programs and coral bycatch data from this program being used to reduce impacts on corals?
A2 Use management processes (including environmental assessment processes) in all other relevant ocean use sectors (e.g. petroleum, submarine cable) to ensure that areas with corals (outside CCAs and MPA) are avoided or best practices are used. A2.1 Ensure corals are identified in environmental assessment process A2.2 Identify best practices in relation to corals for ocean use sectors	*Since oil and gas is the primary sector occurring in the deep sea, it was felt that this question was addressed in Question 1.0. An inclusion of environmental assessments was made.*
A3 Ensure that research on benthic habitats is carried out appropriately in areas with corals A3.1 Develop a research protocol with guidance for research in coral conservation areas and other areas with corals	3.0 Have research guidelines been developed that outline methods for carrying out appropriate research and are the guidelines disseminated to researchers?

Conservation and Management Strategy 4: Provide opportunities for industry and public involvement in conservation and management activities.	Section 4: Provide opportunities for industry and public involvement in conservation and management activities.
A1 Provide opportunities for public input to decision-making on coral conservation A1.1 Provide opportunities for affected sectors to have input on management and regulatory decisions concerning coral conservation A1.2 Provide opportunities for other interested parties and the general public to have input	4.0 Have opportunities for public input been provided to help inform management and regulatory decisions concerning coral conservation? *Guiding questions that were asked to help determine rating for Question 4.0: were their equal opportunities for affected sectors versus general public?* *The original Evaluation Framework divided this question according to type of public input (i.e. industry, general public, affected sectors) but DFO felt that the term 'public' could incorporate all of these groups. Further discussion of this issue occurs in Chapter 4.*
A2 Develop outreach plan and disseminate information on corals and coral conservation: A2.1 To affected sectors (e.g. fisheries, oil and gas) A2.2 To the public (e.g. schools, media)	4.1 Has an outreach plan for public education regarding deep-water corals and coral conservation been developed and implemented? *Guiding questions that were asked to help determine rating for Question 4.1: were their equal opportunities for affected sectors versus general public?*
A3 Pursue opportunities to collaborate with international community on coral conservation	4.2 Have opportunities to collaborate and communicate with international and national communities on coral conservation been pursue? *Given the fact that Canada has a long coastline and multiple management bodies along the coast, the word 'national' was included in Question 4.2.*
Research Strategy 1 (RS1): Develop an on-going benthic habitat research program that includes research on corals; Research Strategy 2 (RS2): Conduct research in support of current management actions; Research Strategy 3 (RS3): Conduct other research in support of management strategies; Research Strategy 4 (RS4): Provide opportunities to share information and collaborate on research	Section 5: Research capacity and data collection *These 4 Research Strategy sections in the Coral Conservation Plan were incorporated into one section in the Coral Evaluation since it was felt that they all addressed varying aspects to do with research and could be better assessed as one section.*

(RS1) A1 Secure funding for benthic habitat and cold-water coral research A1.1 Build core capacity within DFO Science A1.2 Pursue funding opportunities with research funding bodies	5.0 Has funding for research of benthic habitats and deep-water coral been secured through funding bodies to build capacity within DFO Science? 5.1 Has funding for project-specific research, including those research bodies outside of DFO, been secured through funding bodies?
(RS1) A2 Build and enhance coral information collection in ongoing science surveys A2.1 Identification of corals caught in research trawl surveys A2.2 Continue efforts to identify and to improve accuracy of identification of corals by fisheries observers A2.3 Incorporate coral research into Gully MPA research program A2.4 Encourage coral identification in work carried out by other research programs in the region	5.2 Are efforts to collect information on corals in science surveys being routinely conducted? *Guiding questions that were asked to determine rating for Question 5.2: identification of corals caught in trawl surveys? efforts to identify and improve accuracy of identification of corals by fisheries observers? encourage coral work carried out by other research programs?*
(RS1) A3 Review research priorities regularly (every 2 years)	*This action was addressed in Question 1.4.*
(RS2) A1 Conduct research to evaluate the effectiveness of CCAs A1.1 Evaluate boundaries of conservation areas A1.2 Track recovery of *Lophelia* reef complex A1.3 Compare status of corals within conservation areas with those just outside A1.4 Examine impacts of CCAs on other species including species associated with corals and commercial fish species A1.5 Examine impacts of permitted activities and activities in adjacent areas on the CCAs and A1.6 Examine impacts of CCAs on fishing activities A1.7 Track recovery of Northeast Channel gorgonians	5.4. Have there been efforts to track recovery of various coral species within the CCAs? *There are important sub-actions under the main action which are worth assessing. DFO identified boundaries of the CCA as an area they wished to focus on in the Coral Evaluation. As a result, some of the questions from this section were taken out and moved to Section 6: CCA Design. Therefore, the following questions addressed these sub-actions:* 6.0 Are the boundaries of the CCAs being assessed and evaluated to determine whether there is representative coverage of coral areas and are findings from such an assessment being implemented? *Guiding questions that were asked to help determine rating for Question 6.0: what suggestions have been made? plan for action? do the boundaries of the CCAs still fulfil the goals for which they were originally established?*

	6.1 Has the status of corals within the CCAs been compared to those found just outside the boundaries 6.2 Have the impacts of the CCAs on other species (including species associated with corals and commercial fish species) been assessed?
(RS2) A2 Conduct research on impacts of human activities on corals and sensitivity of different coral taxa, including types of damage and recovery rates	6.3 Have the impacts of permitted human activities within the CCAs and activities occurring in adjacent areas to the CCAs been examined? *Guiding questions that were asked to help determine rating for Question 6.3: fishing activities? Impacts on different taxa and recovery rates?*
(RS2) A3 Conduct social science research to support management A3.1 Assess socioeconomic costs and benefits of coral conservation for human activities	*Socioeconomic impacts were another area DFO wished to focus on in this evaluation and as a result, Section 7: Socioeconomic Research was created. The question for this action is addressed in Question 7.1.* 7.1 Have the socioeconomic impacts of CCAs on fishing activities been examined?
(RS3) A1 Identify important coral areas A1.1 Build capacity to conduct deep-water research on benthic habitats (i.e. below 500 metres) A1.2 Carry out research on coral distribution including creation and testing of predictive models, and evaluate research results against criteria for important coral areas A1.3 Update information gained through traditional ecological knowledge A1.4 Review and compile information on corals from existing databases (e.g. GSC archives, industry archives)	5.6 Is DFO's capacity for conducting deep-water research on benthic habitats (below 500 metres) being developed? 5.7 Has the review and compilation of information on corals from existing databases been completed? *Guiding questions that were asked to help determine rating for Question 5.7: database with information on areas where corals are sampled? list of publications?* *It was determined that traditional ecological knowledge should fall under Section 7.0: Socioeconomic Research. Therefore, to address A1.3 of this action, Question 7.0 was created.* 7.0 Is local ecological knowledge (LEK) being collected to help inform management decisions related to corals?
(RS3) A2 Conduct research on the biology, behaviour, genetics, and ecological role of cold-water corals A2.1 Conduct research on coral reproduction and recruitment	5.8 Is locally-directed research (by both DFO and university researchers) on the biology and ecology of deep-water corals being conducted?

A2.2 Collect environmental data at coral sites (e.g. depth, temperature, salinity) A2.3 Conduct research on species associations, richness, and diversity on and around corals A2.4 Conduct research on behaviour, genetics and ecological role of corals	*Guiding questions that were asked to help determine rating for Question 5.8: reproduction or recruitment? environmental data (depth, temperature, salinity)? species associations? richness? diversity?*
(RS4) A1 Continue to share information on research and other activities through the Atlantic Canada Coral Initiative (ACCI)	*The ACCI no longer exists. Therefore, this action was modified for the Coral Evaluation.* 5.9 Has information sharing and collaboration on coral research with the national and international community (e.g. Gulf of Maine) occurred?
(RS4) A2 Share information on coral research to others in the Atlantic Canada through other means	5.5 Are research priorities being coordinated to allow for a collaborative approach between research parties?
(RS4) A3 Compile and maintain database of coral research off Nova Scotia A3.1 Database with information on areas where corals are sampled A3.2 List of publications on corals	*This action is somewhat addressed in Question 5.5 & 5.7.*
(RS4) A4 Share information and collaborate on coral research with the international community (e.g. in the Gulf of Maine)	*This action is addressed in Question 5.5.*

Appendix 2. Deep-water Coral Conservation Area Evaluation

MANAGEMENT & CONSERVATION			
QUESTION	**INDICATOR**	**COMMENTS AND RECOMMENDATIONS**	**DATA SOURCES (for full listings, see References page)**
Section 1: Support and enhance effectiveness of existing Coral Conservation Areas (CCAs)			
1.0 Have the CCAs been incorporated into ocean use planning and management processes (i.e. fisheries management plans and environmental assessments)?	(0) The CCAs have not been incorporated into ocean use planning and management processes. (1) The CCAs have been incorporated into some plans but not others and there are many gaps. (2) The CCAs have been incorporated into most plans with only one or two gaps. **(3) The CCAs have effectively been incorporated into ocean use planning and management processes.**	The CCAs were developed through the Eastern Scotian Shelf Integrated Management (ESSIM) initiative and, as such, were incorporated into other planning and management processes because of the emphasis on integration developed through ESSIM. Integrated fisheries management plans (IFMPs) are used to help guide sustainable use of fisheries resources and are created to manage a particular fishery. The IFMPs developed for fisheries that are known to have impacts on areas where deep-water corals may be present incorporate guidelines to ensure minimal impact. Currently, a template has been developed for some of the bottom fisheries (snow crab) and is being developed for longline fisheries. This template requires particular fisheries to manage the fishery sustainably in order to protect such attributes as productivity, biodiversity, and habitat. Corals can be addressed in Sections 3.2 (Stock Assessment, Science and Traditional Knowledge) under Biological Synopsis and Ecological Interactions and 3.7 (Management Measures for the Duration of the Plan) under	D. Fenton (personal communication, May 10, 2012). T. Koropatnick (personal communication, May 10, 2012). S. Coffen-Smout (personal communication, June 12, 2012). DFO, 2012b DFO, 2010a Hurley Environment Ltd, 2011 CNSOPB , n.d.

		of Species at Risk Act (SARA) Requirements and Habitat Protection of the IFMP template (DFO, 2010a). License conditions are implemented that allow for a license to be revoked or suspended should repetitious violations occur. Through a strategic environmental assessment (SEA), the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) identified coral populations within the Northeast Channel CCA as valued environmental components (VECs). In the CNSOPB Call for Bids, Section 2.8 outlines the requirements for environmental exploration. Fisheries and Oceans Canada (DFO) acknowledged that the SEA recognizes CCAs as special areas but does not specifically define conditions or recommendations for activities in the area. DFO sent a letter to the CNSOPB requesting that future decisions on oil and gas activities take these areas and associated species into account. The Oceans and Coastal Management Division (OCMD) is currently undertaking plans to develop a network planning strategy for protected areas. The two main objectives for this plan are to protect ecologically and biologically significant areas (EBSAs) and to protect a number of representative ecosystems. The hope is that the current coral and sponge sites (which are considered EBSAs) will act as starting points for the network of protected areas.	

		RECOMMENDATIONS *Ensure areas with coral are incorporated into all IFMPs and license conditions.* Although the coral areas are included in most IFMPs and license conditions, the locations of fisheries may change; thus a mechanism should be established to regularly evaluate license conditions and IFMPs and ensure they accommodate these changes. *Create policy that guides the implementation of coral areas into IFMPs and license conditions.* As it stands right now, inclusion of coral areas into IFMPs and license conditions is not required, nor are there clear regulations with respect to violations. A policy would help outline the processes for these situations and allow for consistent action.	
1.1 Are the existing surveillance and compliance monitoring measures ensuring effective[1] protection of the CCAs?	(0) The current methods of surveillance and compliance are not ensuring effective protection of the CCAs. (1) There are surveillance and compliance monitoring mechanisms in place but they are not effective. **(2) There are surveillance and compliance monitoring mechanisms in place**	Conservation and Protection (C&P) officers are responsible for fisheries surveillance and enforcement, and the OCMD at DFO play a supporting role. The following methods of surveillance and compliance monitoring are currently being used: **Aerial surveillance –** Flights over the Lophelia Coral Conservation Area (LCCA) occur at least once weekly. Flights over the Northeast Channel Coral Conservation Area (NECCCA) occur more often (approx. 2-3 times weekly). Sightings are reported through DFO's surveillance information system. **At sea observer program** – Typically 5% of the activity of each fishery is randomly	T. Koropatnick (personal communication, May 21, 2012). Data unavailable due to confidentiality.

	that are mostly effective for ensuring the protection of the CCAs. (3) All current methods of surveillance and compliance monitoring are effective.	selected for monitoring. In areas where fishing intensity is high (such as George's and Brown's Banks), coverage ranges anywhere between 25-100%. This is similar for the LCCA, while NECCCA has 100% coverage in the limited fishing area. **Vessel monitoring system (VMS) –** Most fishing vessels that are in the area of the CCAs are required to carry a VMS unit which transmits vessel position via satellite at hourly intervals. This data can be viewed by C&P and OCMD staff through an online VMS viewing system. **Fishing logbooks** – They provide a record of estimated catch weights landed at specific geographic coordinates. **Virtual Data Centre (VDC)** – A tool used for information retrieval and analysis. Users can create maps, graphs etc. using information gathered from a variety of databases. This collection can help develop applications to continue the facilitation of surveillance and compliance monitoring. For both CCAs, an automated email report alerts OCMD staff when VMS indicates that a vessel has crossed the CCA boundaries. If suspicious activity is detected, C&P is notified. C&P staff do not have the resources to always address suspicious activity occurring in the CCAs. C&P officers must address a variety of infractions in Atlantic waters and need to prioritize their actions.	

		RECOMMENDATIONS Given the limited resources available to DFO and C&P officers, surveillance and compliance monitoring initiatives are mostly sufficient. However, should there be increased access to resources and funding, there are improvements that could be made. *Reduce reliance on VDC.* Funding is being reduced for surveillance and compliance monitoring and there is minimal capacity to maintain a human presence in the department. While technology has certainly contributed to efficiency within the surveillance and compliance monitoring processes, checking for errors and staff management requires a human presence. To do this, an investigation should be conducted to determine options for expansion that the department can support. Surveillance and compliance monitoring should be institutionalized as a priority for conservation area monitoring nation-wide. *Move to more frequent pings.* Recent studies (Lambert et al., 2012) have indicated that VMS on its own has limitations and is not sufficient to monitor location and intensity of bottom fishing activities. One of the limitations of VMS that is discussed in the study by Lambert *et al*. (2012) is due to the frequency of VMS pings. However, Lambert *et al*. (2012) are referring specifically to VMS in European waters where pings are sent every 2	

		hours. Currently, the VMS systems on fishing vessels in Atlantic Canada send pings every hour; however, studies suggest that more frequent pings (10 or 15 minute intervals) are necessary for true maritime enforcement (Ardron, 2011). The difficulty with such an action is that the cost is incurred by the fishermen and there may be pushback. *Increase LCCA surveillance coverage.* The NECCCA is extensively monitored by over flights and other surveillance methods because it is in an area of high fishing activity. Fishing vessels have been observed within the LCCA but in some cases, due to delays in communication, following up with these vessels has not occurred in a timely manner. Increasing surveillance coverage of the LCCA may lead to more effective enforcement. More information would need to be gathered to determine if such an action is cost-effective, given the low activity in the area. In order to determine the best plan of action, more information on what other nations are doing with similar challenges will be helpful. *Implement automated email notification of CCA boundary crossings for C&P officers.* While OCMD receives alerts when VMS indicates vessel has crossed a CCA boundary, C&P surveillance staff do not receive these alerts and they should be added to the list of recipients.	

1.2 Is enforcement capacity effective[1] for addressing infractions that are caught through surveillance and compliance monitoring?	(0) Enforcement capacity is not effective and infractions are not addressed. (1) Enforcement capacity is lacking and minimal effort is directed toward addressing infractions. **(2) Enforcement capacity is fairly consistent and most infractions are addressed as needed.** (3) Enforcement capacity is fully effective and addresses all infractions.	Currently, while a small amount of money is directed toward surveillance of CCAs, there is no money specifically directed toward enforcement. However, there is consistent tracking of infractions through surveillance and compliance monitoring and this consistent logging allows C&P officers and the OCMD division at DFO to keep track of infractions and begin an investigation if necessary. While infractions may occur, it is up to DFO and C&P officers to determine if further investigation is needed. **RECOMMENDATIONS** It should be noted that while it is true that some infractions of CCA boundaries may go without reprehension, this does not necessarily represent a failure of the enforcement system. Enforcement discretion is up to the C&P officers who are familiar with fishing vessels and the captains aboard. Some of the recommendations suggested in Indicator 1.1 can help to enhance surveillance and thus apply to this Indicator as well. *Maintain consistent logging of investigations and continue dialogue between C&P Officers and OCMD staff.* The current method of communication between C&P and OCMD staff (i.e. when OCMD staff notice a possible infraction, they inform C&P, C&P investigate and report back), seems to work well for addressing possible infractions. As new technologies	D. Fenton (personal communication, May 10, 2012).

		become available, it will be important to ensure that these methods incorporate such technologies.	
1.3 Are research activities appropriately managed to ensure minimal harm to the corals?	(0) Appropriate management has not been implemented and research surveys have not been restricted in the CCAs. (1) Some management has been implemented, but research surveys are still permitted with little review. **(2) Management has been implemented to some degree and there is an extensive review and approvals process for research surveys.** (3) Research surveys have been entirely restricted in the CCA.	DFO has an application process that must be completed prior to conducting research in the CCAs. The application requests information on purpose of research, proposed location, and data collection methods. With particular reference to DFO Research Surveys, activity has been considerably restricted since August 2002 when a DFO research vessel mistakenly entered the NECCCA and performed 30 minutes of trawling, damaging deep-water coral. Since then, CCAs have been removed from the selection algorithm making it impossible for the sites to be chosen for DFO research vessel surveys. Foreign research vessels must go through a different process. Applications by foreign vessels to conduct scientific research in Canadian waters are submitted to the Department of Foreign Affairs and International Trade (DFAIT) in Ottawa. They are then forwarded onto the Vessel Clearance Committee, DFO Science, Ottawa, and the Foreign and Domestic Licensing Officers, in Fisheries Management, Maritime Region. The application is reviewed and changes may be made to reduce impacts of the research activities. There are 2 conditions that may be added by OCMD which make the researcher	D. Fenton (personal communication, May 10, 2012). T. Koropatnick (personal communication, May 10, 2012). G. Herbert (personal communication, June 12, 2012). "DFO trawlers damage rare coral off Nova Scotia," 2002 DFO, 2006b DFO, 2011c DFO, 2012b Fishery (General) Regulations, 1993

		aware of coral: 1) Known/expected coral concentrations occur in the areas of greater than 200 metres depth in Northeast Channel, along the edges of Georges Bank, and in the Jordan Basin area. These corals are considered important habitat and are the subject of conservation measures in Canadian waters. Caution should be taken to minimize gear interactions with corals if they are found during the study; and 2) R/V to avoid the Northeast Channel Coral Conservation Area. These conditions may be added to the form to ensure researchers are aware coral presence. Once the application has been reviewed by all parties, an approval is issued and the Licensing Officer prepares license conditions for the vessel. The number of research excursions into the CCAs is extremely low, as a result, impacts to corals from these excursions are not a major concern. **RECOMMENDATIONS** *Ensure all research applicants apply for research permission; develop legal drivers to require such a request to be submitted.* While the number of research missions that occur within the CCAs may be relatively low, there is no legal mechanism to ensure that all research vessels apply for permission and no consequences for those that do not. A possible method of creating this legal mechanism may be to go through relevant existing legislation.	

		Section 52 of the Fishery (General) Regulations (1993) addresses licensing conditions and suggests that the Minister of Fisheries and Oceans may be able to create stipulations in licensing for scientific purposes. An amendment could be made to this section to require a request for research be submitted. In the Maritimes region, there is no set process for this, but the Pacific Region has developed an online application (DFO, 2012c) and clear process for fishing for scientific purposes. A similar template could be adopted for the Atlantic Region. *Update the Foreign Vessel License Approval Form for Scientific Research.* The form is outdated and contains old titles and information of various DFO departments. Additionally, the conditions are not as explicit as they could be. *Develop online application for research application and provision of information.* Currently, the application to conduct research is only available by contacting DFO by email and having it sent electronically. There is extremely limited information on the CCA websites about conducting research. Making this information available online would make the process more efficient. An online approach similar to that of the Endeavour Hydrothermal Vents MPA in British Columbia is recommended. The management plan and regulations are available online. While this is	

		an MPA, a similar strategy could be adopted for the CCAs.	
1.4 Are conservation measures[2] (for the specific coral sites) being reviewed regularly to account for new scientific or other information?	(0) Conservation measures have not been reviewed since the Coral Conservation Plan was developed. (1) Conservation measures have been reviewed at random intervals and on an infrequent basis. (2) Conservation measures have been reviewed somewhat consistently. **(3) Conservation measures have been reviewed at regular intervals to account for new scientific information.**	An instituted review process has not been established for review of conservation measures. However, review of data collected from research cruises has been conducted. The report by Cogswell *et al.* (2009) examined the status and health of various species of coral in both CCAs. **RECOMMENDATIONS** *Reconsider the 2 year term for review of conservation measures suggested in the Coral Conservation Plan.* Currently, the Coral Conservation Plan states that the conservation measures should be reviewed every 2 years. While a timeline is helpful to ensure that a review of certain management measures is actually completed, the choice to review on a 2 year term seems arbitrary and may require more research and review to determine a better timeframe. Given the slow growth of corals, it may make sense to implement a longer review period and ensure that it is actually completed.	D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30, 2012). Cogswell *et al.*, 2009
Section 2: Identify and protect important coral areas that are not already protected			
2.0 Have other important coral and sponge areas (besides those found within the CCAs) been identified and prioritized for conservation measures?	(0) Other important coral areas have not been identified and prioritized. (1) Some other important coral areas have been identified but not yet	Regional benthic surveys have been completed and Cogswell *et al.* (2009) identified some other areas in the Atlantic region as possible coral or sponge sites. However, most effort has primarily focused on existing or known areas of corals and the development of a better understanding of the boundaries of the current	Cogswell *et al.*, 2009 DFO, 2010b. M. King (personal communication, June 18, 2012).

	prioritized. (2) Some important coral areas have been identified and prioritized but there are some gaps. **(3) Other coral areas have been identified and prioritized.**	sites. The Canadian Science Advisory Secretariat (CSAS) Report (DFO, 2010b) indicates the locations of important benthic habitats and identifies the threats that may impact them. Data from 1997 to 2007 was collected and indicated that there are populations of *Vazella pourtalesi* (Russian Hat sponges) (DFO, 2010b) and measures are being taken to designate a Russian Hat sponge conservation area. **RECOMMENDATIONS** *Begin discussions of possible new areas for conservation.* Discussion and designation for the Russian Hat conservation area is well under way. Priority should be placed on developing and enhancing management measures for this and the other existing CCAs. Cogswell *et al.* (2009) identified some other sites throughout the Atlantic region for which possible management strategies for conservation may be worth considering.	
2.1 Have conservation management measures been applied to protect other coral habitats?	(0) There has been no movement to protect other coral habitats aside from the NECCCA and LCCA. **(1) Discussion has begun with respect to the appropriate management**	As mentioned above, the main focus with respect to management of CCAs has been on improving current conservation measures, rather than developing new areas. There is an active proposal to implement conservation measures for a Russian Hat sponge area. **RECOMMENDATIONS** *Create a list of current research on*	D. Fenton (personal communication, May 30, 2012).

	measures but they have not been applied. (2) Some appropriate measures have been applied to other coral habitats, but there are gaps. (3) Appropriate management measures have been applied to other coral habitats.	*conservation of other sites, prioritize and implement.* With many departments and conservation initiatives being discussed, it can be difficult to keep track of all the initiatives. Listing each one and prioritizing can allow for more efficient implementation.	
Section 3: Minimize impacts on corals outside CCAs			
3.0 Have research guidelines been developed that outline methods for carrying out appropriate research and are the guidelines disseminated to researchers?	(0) Research guidelines have not been developed. (1) Research guidelines are being developed but have not been disseminated. **(2) Research guidelines have been developed but are not always disseminated.** (3) Research guidelines have been developed and are always disseminated.	Informal discussion on the type of research required to better inform management has taken place (2004 Workshop). Guidelines on Conducting Research in Areas with Deep Sea Corals have been created and are usually distributed to DFO when they apply to conduct research in the area. **RECOMMENDATIONS** *Determine whether guidelines are useful for researchers.* While research guidelines have been developed and are usually disseminated, whether their useful to the researchers must be determined. Questions could include: "have you seen this document?" "did you find it useful?" and "how could it be more useful?". *Determine whether guidelines are consistent with other international research efforts and with goals of conservation of deep-water*	DFO, 2010b

		corals. The usefulness of guidelines to researchers is important, but it is also important to consider the biology and ecology of the corals and determine what effects various research methods have on them. Information about this can be gained by examining research guidelines from other nations, as well as hosting a workshop with local and international experts. *Develop a strategy for research coordination.* Depending on the organization for which the researcher is conducting research, it can be difficult to obtain exact information on the data the researcher collected. It may also be difficult for other researchers to find out what their colleagues are studying. As part of the guidelines, it may be possible to develop a mechanism for coordinating and sharing information on active research programs. DFO could recommend that research findings (post publication) be shared as part of the approval process.	
Section 4: Provide opportunities for industry and public involvement in conservation and management activities.			
4.0 Have opportunities for public input been provided to help inform management and regulatory decisions concerning coral conservation?	**N/A This indicator is not relevant for CCA management at this time.** (0) No opportunities for public input were provided at any stage of conservation and management activities.	Public involvement occurred throughout the establishment phases of the CCAs. For the NECCCA, a fisheries advisory group was established and helped inform decisions regarding size and boundary of the CCA. Other stakeholders were not involved. In the LCCA, a fisheries advisory and an advisory group composed of other stakeholders,	Breeze & Fenton, 2007 Personal communication with Derek Fenton and Tanya Koropatnick.

	(1) Some opportunities were provided at the initial stages of conservation and management activities but very little was used and involvement is not ongoing. (2) Opportunities were provided during various stages of conservation and management activities and the information has been used in some management and regulatory decisions but there are gaps. (3) Many opportunities were provided during various stages of conservation and management activities and information is being used in management and regulatory decisions.	including representatives from the oil and gas industry was established. This was formed through the ESSIM initiative. In addition to these advisory groups, a stakeholder workshop was delegated to help inform the creation of the Coral Conservation Plan. Since establishment of the CCAs and Coral Conservation Plan, there has been no forum for discussion of coral management. Management decisions have not been required and thus, there was no opportunity to involve stakeholders, making this indicator not applicable.	
4.1 Has an outreach plan for public education regarding deep-water corals and coral conservation been developed and implemented?	(0) An outreach plan has not been developed. (1) An outreach plan has been developed but not implemented. **(2) An outreach plan has been developed and**	A four year plan for Deep-Sea Corals Outreach and Education Strategy (Martin, n.d.) was developed and outlines some of the key messages and initiatives that could be implemented to increase education and awareness of deep-water corals. The strategy uses some of the high priority actions outlined	Martin, n.d. D. Fenton (personal communication, May 30, 2012).

	partially implemented. (3) An outreach plan has been developed and fully implemented.	in the Coral Conservation Plan to inform the strategy including: the need to provide information to the public on corals and coral conservation measures; to support and promote scientific research on corals; and to disseminate information on corals and coral conservation to affected activity sectors. Six target audiences are identified: educators, fisheries and oceans managers, the fishing industry, the general public, members of the oil and gas industry, and scientists. Initiatives that are outlined in the strategy include the use of brochures, posters, presentations, and other items that can be distributed to the public. Some of these have already been created including: multiple brochures and posters, a laminated factsheet that was mailed out to fisheries, web materials, and an informative DVD. In addition to these items, the Centre of Expertise for Cold Water Corals and Sponge Reefs, based out of Newfoundland has implemented a Wiki website. The website provides photos of coral and sponge species found in the Atlantic region, houses relevant publications as well as conference proceedings and meeting minutes. The Wiki website is only accessible to government employees. **RECOMMENDATIONS** *Update the current outreach plan.* Minimal revision of the outreach plan is needed since it clearly outlines the target	

		audiences, key messages and some suggested initiatives, and many of the initiatives are kept fairly general and can be applied regardless of the number of CCAs in place. However, as the author points out, the outreach plan requires evaluation to determine whether the implementation strategies have actually been implemented and are effective. This evaluation needs to be completed to inform outreach plan updates. *Pay particular focus to the curriculum and education outreach strategies*. Many of the recommendations for outreach in this plan are focused on those audiences that are directly impacted by coral conservation strategies (e.g. fishing industry, oil and gas, government managers, scientists). This makes sense for the initial development of the outreach plan because emphasis should be placed on compliance and enforcement of the newly (at the time) developed CCAs. Now that many of the strategies have been implemented, it is time to re-evaluate education strategies for schools and the general public. Someone should be designated to investigate and develop strategies for these audiences and to determine whether and how corals should be incorporated into curriculum.	
4.2 Have opportunities to collaborate and communicate with international and national communities on coral	(0) No opportunities for collaboration or communication have been pursued. (1) Some communication	Communication regarding coral conservation with both national and international audiences has occurred primarily through conference attendance and participation. Every year, the International Ocean Institute (IOI) holds a	D. Fenton (personal communication, May 30, 2012). Koropatnick, T.

conservation been pursued?	has occurred, but there is minimal collaboration and more opportunities should be pursued. **(2) Some opportunities for communication and collaboration have been pursued.** (3) Many opportunities for collaboration and communication have been identified and pursued.	gathering where managers from around the world meet to discuss various marine issues. A discussion on corals is included and DFO sends representatives. Information sharing has occurred through other international conferences in Spain and British Columbia with different themes and audiences. An example includes the International Marine Conservation Conference that occurred in Victoria, BC, in 2011 where DFO staff gave a presentation. The focus of this particular talk was on enforcement and compliance methods. It seems that opportunities for international collaboration are available and the Atlantic region participates as resources are available. International management of coral conservation efforts have been previously documented by a contractor. While this information sharing is occurring, a formal agreement with the United States has never been created to encourage collaboration on conservation effort. While communication has occurred, collaboration has been minimal. **RECOMMENDATIONS** *Develop and participate in workshops with the United States that focus on sharing management strategies and possibly develop collaborative initiatives.* Such workshop development would allow for communication between Canada and the United States and perhaps eventually lead to collaboration.	(personal communication, May 30, 2012).

RESEARCH			
QUESTION	**INDICATOR**	**COMMENTS AND RECOMMENDATIONS**	**DATA SOURCES**
Section 5: Research capacity and data collection			
5.0 Has funding for research of benthic habitat and deep-water coral been secured through funding bodies to build capacity within DFO Science?	(0) Funding has not been secured. (1) Minimal funding has been secured. Not enough to perform comprehensive or long-term research. **(2) Some funding has been secured but more is needed to perform comprehensive research.** (3) Funding has been secured and will allow for comprehensive and long-term (5+ years) studies.	Funding for research is provided through International Governance (IG) funds. However, this funding is primarily for site or project specific studies and in most cases, the research must be conducted in international waters. Despite the fact that there has been minimal funding, key projects such as the ones described in Cogswell *et al* (2009) have been conducted and the Centre of Expertise based in Newfoundland has been established and have allowed for particular focus on deep-water coral research. While these projects provide valuable information and resources, they are becoming dated. DFO has not been able to visit the CCAs to study corals since 2006 and the primary reason for this is a lack of funding. Very few organizations provide funds to government-led research excursions, and as a result, if DFO wishes to embark on a research mission, they must join forces with universities or non-profit organizations. While such collaboration is important, it may be more difficult to organize such a project with multiple research parties. **RECOMMENDATIONS** It is difficult to make recommendations for this section since research funding is obtained where possible. Developing a research strategy	D. Fenton (personal communication, May 30, 2012). A. Cogswell (personal communication, June 26, 2012).

		as suggested in Indicator 3.0 may be useful in helping direct the limited funding that is available to areas where it is most needed. *Collaborate with universities and/or non-profit organizations so that funding may be shared or leveraged.* Since funding for DFO projects is difficult to obtain, it is necessary to form partnerships with other organizations. Such collaborations open up opportunities with other funding bodies such as the Natural Sciences and Engineering Research Council of Canada (NSERC). Furthermore, even if DFO can bring some money or the use of equipment to the table, they may be able to leverage funds and satisfy the research interests of all involved parties.	
5.1 Has funding for project-specific research, including those research bodies outside of DFO, been secured through funding bodies?	(0) Funding has not been secured for project specific research. (1) Minimal funding for project specific research has been secured. **(2) Some funding for project specific research has been secured.** (3) Funding for project specific research is adequate.	As mentioned above, for DFO, funding is secured through IG funds for project specific research. Regular access to funding and equipment is not always possible for DFO researchers. Currently, because of the use of IG funding, much of the research is being conducted in international waters, rather than within Canada's exclusive economic zone (EEZ). University researchers, however, have embarked on a number of research excursions between 2001 and 2010 and are planning one for 2013. Many of these excursions have been funded through the universities and NSERC and have provided funds for ship time or equipment. In some cases, DFO has provided	A. Cogswell (personal communication, June 26, 2012). A. Metaxas (personal communication, July 4, 2012).

		some of the funding. While these are project-specific research excursions, they provide continuity so that university researchers can go back to study sites (including the NECCCA), allowing for long-term research.	
5.2 Are efforts to collect information on corals in science surveys being routinely conducted?	(0) Efforts to collect information on corals are not being conducted. (1) Efforts to collect information on corals are being conducted at a minimal level. (2) Efforts to collect information on corals are being collected but there are some gaps. **(3) Efforts to collected information on corals are extensive and routinely conducted.**	There is a standard protocol in place which ensures that information on corals is recorded in scientific surveys. When multibeam research is conducted, DFO attempts to target areas with coral. **RECOMMENDATIONS** *Re-evaluate and revisit data collected through science surveys to determine how it may inform management or improve knowledge base.* Though data is collected through science surveys, it is not evaluated and thus key findings may be missed. A process should be in place to review data as well as the processes being used to collect the data.	D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30th, 2012).
5.3 Are the Fisheries Observer Program and coral bycatch data from this program being used to reduce impacts on corals?	(0) Neither the Fisheries Observer Program, nor coral bycatch data are being used to reduce impacts on corals. (1) The Fisheries Observer Program and coral bycatch data is being used to a minimal degree to reduce impacts on corals. (2) The Fisheries Observer Program and coral bycatch data are being	The Fisheries Observers Program is being used to reduce impacts on corals. Fisheries Observers are put through a training process whereby they are taught how to identify and properly record bycatch. Protocols for reporting have also been developed. These methods are established through the Science department at DFO. Some bycatch was documented in Cogswell et al (2009), but determining whether bycatch from bottom long liners is a problem has not been systematically reviewed. However, a current study in the OCMD department is	Cogswell et al., 2009 D. Fenton (personal communication, May 30, 2012).

	used to reduce impacts on corals to some degree, but there is room for improvement. **(3) The Fisheries Observer Program and coral bycatch data is being used and findings are reviewed regularly to reduce the impacts on corals.**	being conducted to determine whether demersal longline bycatch in the Limited Fishing Zone might be a concern for the NECCCA. **RECOMMENDATIONS** No specific recommendations since data is being collected; however, data collected could be used to help inform decisions on boundary changes.	
5.4 Have there been efforts to track the recovery of various coral species within the CCAs?	(0) There have not been any efforts to track the recovery of coral. (1) There have been minimal efforts to track the recovery of coral. **(2) There have been some efforts to track the recovery of coral but there is room for improvement.** (3) There are comprehensive and intensive efforts to track the recovery of the coral.	LCCA –In 2009, efforts were made to track the recovery of various coral species particularly *Lophelia pertusa*. Research through a DFO excursion has shown that the Lophelia is recovering but this data has not yet been published. NECCCA – Damage that has occurred due to trawling was recorded in Cogswell *et al*. (2009), but recovery evaluation is difficult since baseline data are required. It is also difficult to get a full picture of the NECCCA since visual surveys of such a large area are expensive. **RECOMMENDATIONS** *As part of the researcher guidelines, ask that researchers track recovery information when and where possible.* Since recovery of corals is a key piece of information that can help determine whether CCAs are effective, priority should be placed on collecting such information. In the	D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30, 2012). E. Kenchington (personal communication, July 11, 2012).

		guidelines, information could be provided about why the information is needed and details given on how to collect and share data when conducting research in CCAs.	
5.5 Are research priorities being coordinated to allow for a collaborative approach between research parties?	(0) Research priorities are not coordinated and there is no collaborative approach. **(1) Research priorities are somewhat coordinated, but there is no collaborative approach.** (2) Research priorities are coordinated and the approach is somewhat collaborative, but further communication between parties is needed. (3) Research priorities are fully coordinated and collaboration is occurring between all research parties.	Research priorities within DFO Science are usually discussed and coordinated, however collaboration of research between DFO and other research facilities, such as Dalhousie University or foreign research groups, can be difficult and improvement is needed. Reports generated by foreign research vessels are usually submitted back to DFO, but not usually reviewed. **RECOMMENDATIONS** *Develop a workshop for main researchers (i.e. DFO Science, Dalhousie, Memorial University, etc.) to establish research priorities.* Much like the recommendation on developing research strategy listed in Indicator 3.0, this would allow for some coordination between regional research bodies. *Coordinate information sharing between Dalhousie University and DFO.* While it is understood that some data may not be able to be shared due to publication and privacy issues, any information that can be shared should be put into a shared database system.	G. Herbert (personal communication, June 12, 2012).
5.6 Is DFO's capacity for conducting deep-water	(0) Capacity for conducting deep-water research on	When coral research first began, access to technology locally was fairly limited. Since	D. Fenton (personal communication, May

research on benthic habitats (below 500 metres) being developed?	benthic habitats is not being developed. (1) Minimal capacity for conducting deep-water research on benthic habitats has occurred. (2) **Some capacity for conducting deep-water research on benthic habitats has occurred but there are one or two gaps.** (3) There is effective capacity for conducting deep-water research on benthic habitats.	then, much research and consideration has gone into options for improving research methods. All options have been examined. ROPOS, an underwater submersible, has been used occasionally and options for collaboration with the Department of National Defence (DND) and their remotely-operated vehicles (ROV) have been assessed. Of most significance, Campod, an underwater video surveillance machine owned by DFO, has been upgraded from an ability to dive 500 metres to 750 metres. Additionally, the Deep Seabed Intervention System (DSIS), another ROV owned by DND is also available for research missions. Natural Resources Canada (NRCAN) has their own system and equipment for conducting research. While many departments within the Government of Canada have access to technology required for deep-water coral research, inter-departmental communication and collaboration is poor. Furthermore, in-house capacity for DFO to conduct research on deep-water corals is low since they heavily rely on these other departments. In addition to the issues associated with the high expense and equipment sharing for deep-water coral research, it is also difficult at any given time to obtain information over a large area of the deepsea. As a result, there is high data output for only low spatial coverage. Much more research is needed to obtain a comprehensive overview of the deep-sea ecosystems of Canadian Atlantic waters.	30, 2012). A. Cogswell (personal communication, June 26, 2012).

		RECOMMENDATIONS *Increased capacity for conducting research on deep-water corals is required.* Deep-water coral research is largely restricted by funding and thus, it is difficult to recommend improvement of methods for collecting data until funding is obtained. However, improved communication between the departments would allow for the most efficient use of the minimal funds that are available. For example, the costs associated with transporting equipment to the site are quite high. A communal database or scheduling system that allows researchers to use equipment when it is in a convenient location would be helpful.	
5.7 Has the review and compilation of information on corals from existing databases been completed?	(0) The review and compilation of information on corals from existing databases has not begun. (1) Minimal review and compilation has begun. **(2) Some review and compilation has begun and some has been completed.** (3) Extensive review and compilation has begun and is near completion.	The Maritimes Region Coral Database is a user friendly, Microsoft Access database that allows for data entry, retrieval and editing depend on the level of permission the user is granted (Cogswell et al., 2009). It is currently used by the Centre of Expertise in Newfoundland. It is structured so that other taxonomic groups may be included in the database, and that it may be integrated with larger existing databases (Cogswell et al., 2009). At DFO, there are data management processes in place and people are dedicated to particular tasks around organizing and inputting data. **RECOMMENDATIONS** *Make the database known to other researchers and allow for collaboration and accessibility.*	Cogswell et al., 2009

		The use of a database can help improve collaboration efforts between DFO and other researchers as long as it is accessible and researchers other than those associated with DFO are permitted to input data.	
5.8 Is locally-directed research (by both DFO and university researchers) on the biology and ecology of deep-water corals being conducted?	(0) No research on such aspects of deep-water corals is being conducted. (1) Minimal research on these aspects of deep-water corals is being conducted. **(2) Some research on these aspects of deep-water corals is being conducted.** (3) Extensive research on these aspects of deep-water corals is being conducted.	There has been some research conducting through DFO Science, as well as other research facilities, on various aspects of deep-water coral biology and ecology. There is an increasingly expanding international body of research on deep-water corals that details the biological and ecological characteristics of various species, which can help to inform current locally-directed research in the Atlantic region. **RECOMMENDATIONS** *Ensure regular review and reporting of international coral research is monitored and tracked.* Conducting research on the biology and ecology of deep-water corals will likely not be a priority for DFO since many studies on these aspects of deep-water corals are being conducted throughout the world. However, a process of review and collection of data is important to ensure that any new or relevant information is recorded and can be used to inform management.	D. Fenton (personal communication, May 30, 2012). A. Cogswell (personal communication, June 26, 2012).
5.9 Has information sharing and collaboration on coral research with the national and international community (e.g. Gulf of	(0) Information sharing and collaboration on coral research with the international and national community has	This indicator is similar to the national and international information-sharing indicator in the management section of this evaluation. However, this particular indicator addresses information sharing specifically related to	T. Koropatnick (personal communication, May 30, 212).

Maine) occurred?	not occurred. (1) Minimal information sharing and collaboration on coral research with the international and national community has occurred. **(2) Some information sharing and collaboration on coral research with the international and national community has occurred.** (3) Extensive information sharing and collaboration on coral research with the international and national community has occurred.	research and science. Much like the management Indicator 4.2, this information sharing occurs primarily through attendance and participation in conferences. The first International Symposium on Deep-Sea Corals was held in Halifax in 2000. While DFO was not the organizer, members from the department were in attendance. There were over 100 attendees from 18 different countries and this set the stage for some future international efforts and collaboration of various stakeholders including scientists, conservationists and fishers. Since then, other international workshops have occurred in Germany (2003), Miami (2005), New Zealand (2008) and the Netherlands (2012). **RECOMMENDATIONS** *Enhance collaboration efforts with international communities.* While it appears that some efforts have been made towards better information sharing with international communities, actual collaboration between these parties has been minimal. For Canada in particular, research collaboration with the United States would be beneficial and therefore, steps to achieve such a goal should be undertaken. Such steps could include a conference or meeting dedicated solely to developing collaboration initiatives rather than focusing on information sharing.	ISDSC, 2012
Section 6: CCA design			
6.0 Are the boundaries of the	(0) The boundaries are not	The boundaries of the CCAs are being assessed	Data on boundary

CCAs being assessed and evaluated to determine whether there is representative coverage of coral areas and are findings from such an assessment being implemented?	being assessed and evaluated. (1) The boundaries have been somewhat assessed and evaluated but no actions have been determined and more information is required. **(2) The boundaries have been somewhat assessed and evaluated and discussion on actions has begun.** (3) The boundaries have been assessed and evaluated and results have been implemented.	for effectiveness. The limited fishing zone that is located within the NECCCA is being assessed to determine the level of use. Surveys have been undertaken to determine the densities of coral populations surrounding the CCAs that are currently in place. Cogswell *et al*. (2009) examined the depth boundaries of the CCA and made suggestions for whether the NECCCA boundaries should be deeper. In the LCCA, regular gear incursions on the north side have led to discussions of new boundary limits or the introduction of a "gear drift" buffer. While some assessment has been done, suggestions or recommendations for changes that should be made to boundaries have not yet been implemented. Other processes such as stakeholder engagement will need to occur before such changes can be implemented. **RECOMMENDATIONS** *Continue investigation into boundary expansions for the CCAs.* Suggestions on how to expand the CCAs (depth and southern boundary of LCCA) have already been made by Cogswell *et al* (2009), as well as through some preliminary discussions with OCMD staff. Due to the fact that deep-water corals are often found at depths greater than most fisheries can access, expanding the depth boundary would not have an impact on fisheries and therefore, could be implemented relatively quickly. Expanding the other	assessment for the NECCCA and LCCA unavailable due to confidentiality. D. Fenton (personal communication, May 30, 2012). Cogswell *et al*., 2009

		boundaries requires consultation with fisheries. *Determine next steps to develop a case for boundary changes and begin formal discussion and assessment.* Once information on possible boundary expansions has been collected, meetings with stakeholders should begin.	
6.1 Has the status of corals within the CCAs been compared to those found just outside the boundaries?	(0) The status of corals within the CCAs has not been compared to those found just outside the boundaries. (1) Some informal research on the status of corals outside of the CCAs has been conducted, but not consistently recorded. **(2) Status of corals within the CCAs has been compared to those outside of the boundaries, but there are some gaps in the research.** (3) Extensive research has occurred with the focus of comparing corals within the CCAs to those outside of the boundaries.	Cogswell *et al* (2009) provides detail on the status of corals and some information on those found within a 15 and 45 km buffer outside of the CCA boundaries. Cogswell *et al* (2009) examined types of deep-water coral throughout the Atlantic region. However, this type of research is fairly sporadic and does not necessarily occur in a timely fashion. **RECOMMENDATIONS** *Study corals outside the boundaries to determine effects of CCAs on corals versus corals that are not protected.* Priority-wise, this may be a relatively low action item, however, continuing with this research can help inform management decisions and determine how effective CCAs actually are in coral conservation.	Cogswell *et al*., 2009
6.2 Have the impacts of the CCAs on other species (including species associated with corals	**(0) The impacts of the CCAs on other species have not been**	The impacts that the CCAs have on other species have not been assessed. However, in the network planning initiatives that DFO is	D. Fenton (personal communication, May 30, 2012).

and commercial fish species) been assessed?	**assessed.** (1) Minimal research of the impacts that the CCAs have on other species has been assessed. (2) Some research on the impacts that the CCAs are having on other species has been assessed with one or two gaps. (3) Extensive research has been conducted to determine the impacts that the CCAs are having on other species and the information is being used to inform management decisions.	undertaking, the location of coral sites is taken into consideration and assessment is made as to how such site selection might fit in with conservation objectives, which means habitats or species associated with coral ecosystems may also be addressed through this plan. **RECOMMENDATIONS** *Begin developing research projects where the impacts of CCAs on other species are being assessed.* Like assessing coral recovery, this is a difficult indicator to measure but could provide valuable information on impacts CCAs might have on surrounding ecosystems (i.e. spill over effects). Information has already been collected or observed with respect to changes in fish populations in the Atlantic region and the correlation of these changes to CCAs may also serve to inform decision-making in the network planning processes.	M. King (personal communication, June 18, 2012).
6.3 Have the impacts of permitted human activities within the CCAs and activities occurring in adjacent areas to the CCAs been examined?	(0) The impacts of permitted activities occurring in adjacent areas to the CCAs have not been examined. (1) Minimal research has gone into studying the impacts of permitted activities occurring in adjacent areas to the CCAs. **(2) Research has gone into studying the impacts**	To some degree, the impacts of permitted activities and activities occurring in adjacent areas to the CCAs have been examined. The primary activity that would be occurring in adjacent areas to the CCAs is fishing. Some of this has been done through evaluation of the CCA boundaries. However, the process is not systematic. **RECOMMENDATIONS** *Continue monitoring impacts of activities.* Since the locations of fishing and research activities vary with time, it is important to have	D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30, 2012).

	of some permitted activities occurring in adjacent areas to the CCAs. (3) Extensive research has gone into studying the impacts of permitted activities occurring in adjacent areas to the CCAs.	continued monitoring in place to assess the impacts and make necessary changes to either the regulations for the various activities or the boundaries of the CCAs.	
Section 7: Socioeconomic research			
7.0 Is local ecological knowledge (LEK) being collected to help inform management decisions related to corals?	(0) LEK is not being collected and recorded. **(1) Minimal LEK is being collected and recorded.** (2) Some LEK is being collected and recorded. (3) LEK is effectively being collected and recorded.	LEK was used in the early stages of coral management initiatives. Local fishing populations were key in helping to identify the locations of coral colonies, but since implementation of the CCAs, no interviews regarding the CCAs and their impacts have occurred. DFO sometimes receives support through interns who, as part of a MMM, MSc or PhD requirement, conduct research into a particular area of interest. One such study examined the different ways of gathering information on corals, including through LEK. The author (Gass, 2002) identified some of the challenges associated with using LEK but also highlighted the benefits. Ongoing inclusion of LEK to help inform management decisions may be beneficial. LEK may not be directly used to inform management decisions, but it may help inform areas where more research might be needed.	Gass, 2002 D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30, 2012).

		RECOMMENDATIONS *LEK should continuously be collected and recorded.* While it is true that LEK many not be used solely on its own, it would be useful to keep record of LEK to help designate aspects of coral conservation that may require more research. Given DFO's limited resources, collection of LEK may occur through processes already in place, such as stakeholder engagement meetings or interviews.	
7.1 Have the socioeconomic impacts of CCAs on fishing activities been examined?	(0) The impact of CCAs on fishing activities has not been examined. **(1) Minimal research has gone into examining the impact of CCAs on fishing activities.** (2) Some research has gone into examining the impact of CCAs on particular fisheries but there are gaps. (3) Extensive research has gone into examining the impact of CCAs on particular fisheries.	There are no efforts to examine the impacts that the CCAs are having on fishing activities. This is not a regular part of fisheries management and if completed, would be above and beyond the required actions of CCA management. It should be noted, however, that monitoring and research has gone into assessing how the areas in which fisheries are located have changed over the years and this information can help determine where further socioeconomic study may be needed. Interest among OCMD staff has been expressed to complete such a study, but details of the methodology would be needed. **RECOMMENDATIONS** *Identify fishermen who previously fished in CCA areas (limited fishing zone), and continue to do so or have stopped and conduct interviews.* Currently, staff at OCMD are working to develop the methodology for the best approach to discussions with fishermen.	D. Fenton (personal communication, May 30, 2012). T. Koropatnick (personal communication, May 30, 2012).

[1]For the purposes of this study, whether or not an action is 'effective' will be determined based on DFO's capacity and by examining actions of other nations that have developed conservation measures for deep-water corals. Further explanation will be provided in the 'Analysis' section of this report.

[2]The term 'conservation measures' is used throughout the Coral Conservation Plan but not defined. This is an issue within itself that will be addressed in the 'Analysis' section of this report. For the purposes of this evaluation, it will be used to describe management methods that have been implemented to protect deep-water corals, such as a fisheries closure, policy, or regulation associated with the purpose of protecting corals.