SPECIES AT RISK

STATE OF THE GULF OF MAINE REPORT

Gulf of Maine
Council on the
Marine Environment

May 2013

SPECIES AT RISK

STATE OF THE GULF OF MAINE REPORT

TABLE OF CONTENTS

Gulf of Maine Council on the Marine Environment

Fisheries and Oceans Canada | Pêches et Océans Canada

This publication was made possible through the support of the Gulf of Maine Council on the Marine Environment and funding from Fisheries and Oceans Canada.

The Gulf of Maine Council on the Marine Environment was established in 1989 by the Governments of Nova Scotia, New Brunswick, Maine, New Hampshire and Massachusetts to foster cooperative actions within the Gulf watershed. Its mission is to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations.

Cover photo: Leatherback sea turtle (*Dermochelys coriacea*) by Kara Dodge/The Large Pelagics Research Center (NMFS Permit #1557-03)

Cover map (background): Courtesy of Census of Marine Life/Gulf of Maine Area Program

CONTRIBUTORS

AUTHOR:

Dan Walmsley
Walmsley Environmental Consultants
22 Amethyst Crescent
Dartmouth, NS B2V 2T7 Canada

ACKNOWLEDGEMENTS:

Thanks are extended to the following people who contributed comments and information:

David Gouveia, National Oceanic and Atmospheric Administration
Erin Burke, Massachusetts Division of Marine Fisheries
Douglas Grout and John Kanter, New Hampshire Fish and Game Department
Terry Stockwell, Department of Fisheries and Wildlife, Maine
Mary Sabine, Department of Natural Resources, New Brunswick
Karen Potter, Canadian Wildlife Service, Environment Canada
Scott Kraus, New England Aquarium

DESIGN AND LAYOUT:

Waterview Consulting (www.waterviewconsulting.com)

1. Issue in Brief

The number of biological species in the world that are considered to be under threat of extinction is overwhelming, with extinctions caused by human activities occurring at a rate thousands of times higher than the natural background rate (Millennium Ecosystem Assessment 2005; Vié et al 2009; Ceballos et al. 2010). Loss of biodiversity (genes, species, and ecosystems) is a priority issue that is receiving attention throughout the world as countries endeavour to reduce the rate of loss of biological species and their populations (SCBD 2006). The official species at risk (endangered species) designation is one given to organisms whose long-term survival is under threat and therefore they require special management attention to ensure that they do not become extinct (IUCN 2001). The presence of multiple species at risk in an area is of particular significance in that it provides a signal that their habitats are under stress. The Gulf of Maine provides numerous challenges to the management of species at risk that occupy coastal and marine habitats, as there are many social, economic, political, ecological, and biological driving forces that are at play (Wells 2010). Factors such as habitat loss and degradation, invasive species, pollution and nutrient load, overexploitation and unsustainable use, and climate change all separately, interactively, and cumulatively play a role in influencing the survival of species within the area (see Figure 1). In the case of endangered species, the situation is

LINKAGES

This theme paper also links to the following theme papers:

- The Gulf of Maine in Context
- Climate Change and Its Effects on Ecosystems, Habitats, and Biota
- Coastal Ecosystems and Habitats
- Coastal Land Use and Development
- Commercial Fisheries
- Emerging Issues
- Invasive Species
- Offshore Ecosystems and Habitats
- Watershed Status

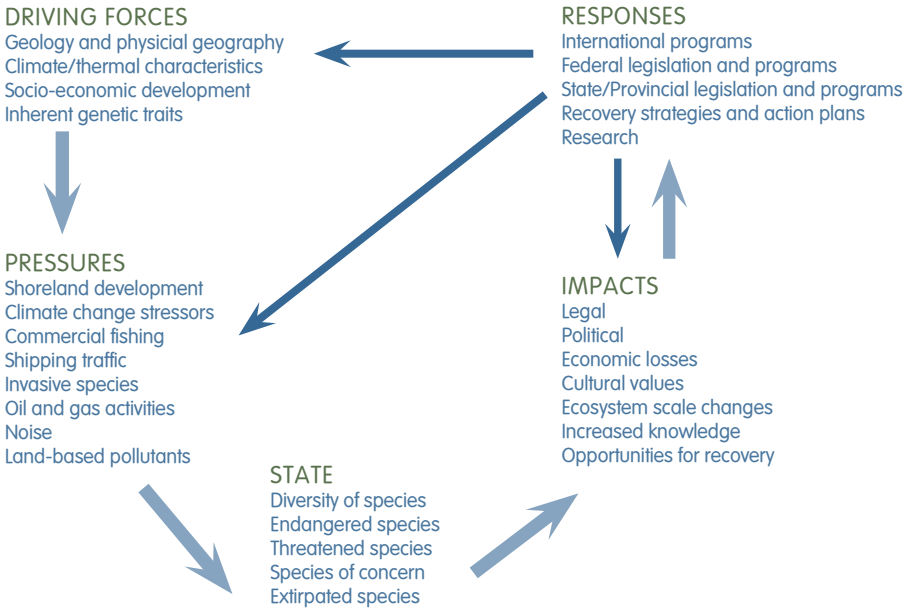


Figure 1: A summary framework of the driving forces, pressures, state, impacts, and responses (DPSIR) for endangered species in the Gulf of Maine. In general, the DPSIR framework provides an overview of the relation between different aspects of the environment, including humans and their activities. According to this reporting framework, social and economic developments and natural conditions (driving forces) exert pressures on the environment and, as a consequence, the state of the environment changes. This leads to impacts on human health, ecosystems, and materials, which may lead to societal or government responses that feed back on all the other elements.

especially complex as inherent biological traits render them susceptible to adverse changes in the environment (Table 1). A combination of traits—such as slow growth, long generation times, habitat and food specialization, low reproductive capacity, dependence on the timing of biological cues (e.g., breeding, migration, hibernation), low ability for dispersal, and susceptibility to human exploitation—all raise the risk of extinction (Foden and Cullen 2007).

Monitoring and assessment of endangered species, both nationally in the United States and Canada and internationally by the International Union for the Conservation of Nature (IUCN), is carried out using well-established criteria, procedures, and programs. Both federal governments and each of the provinces and states in the Gulf of Maine have official lists of endangered species based on legislation (Table 2). There is some variation among the lists of the federal governments, provinces and states, a reflection of different jurisdictions, priorities and perspectives within the region. From a coastal and marine perspective, there are four fish species, six cetaceans, five reptiles, and fifteen bird species that can be cited as being endangered or threatened in the Gulf of Maine (Table 3). Of these, four cetaceans and five reptiles are listed as endangered on the international IUCN Red List.

The outcomes of listing endangered species are varied and numerous in that apart from providing an indication of imbalances within the Gulf of Maine environment, there are many social, political, and economic repercussions on society for the way in which natural resources are managed and conserved, as well as the way that investment and development projects are planned and carried out (Linnell et al. 2010). The practice of legally listing species has led to better public understanding and awareness of the importance of species diversity and the need to ensure its protection.

There are numerous ongoing initiatives that are concerned with addressing species at risk within the Gulf of Maine. These range from linkages with international programs such as the United Nations (e.g., Convention on Biodiversity, Convention on the International Trade in Endangered Species, Ramsar Convention, Law of the Sea, etc.) and intergovernmental organization programs such as the IUCN (Red List program and Intergovernmental Platform on Biodiversity and Ecosystem Services) through to federal government (U.S. *Endangered Species Act*, Canadian *Species at Risk Act*), and state and provincial government programs (endangered species legislation). In addition, there are many non-governmental institutions that are involved in aspects of research, monitoring, education, awareness, advocacy, and general recovery-related activities. There is evidence to indicate that "species at risk" issues have become fairly well main-streamed into the management of natural resources throughout the Gulf of Maine.

2. Driving Forces and Pressures

There are numerous factors that influence the characteristics of the Gulf of Maine environment, all of which, either separately and/or cumulatively, play a role in affecting the diversity and well-being of its resident and migratory biological species. Published theme papers on the state of the Gulf of Maine have provided overviews of the many drivers and pressures that influence the region (see The Gulf of Maine in Context, Emerging Issues – Circa 2010), its climate (Climate Change and its Effects on Humans), ecosystems (Climate Change and its Effects on Ecosystems, Habitats and Biota), and habitats (Coastal Ecosystems and Habitats; Offshore Ecosystems and Habitats). The main drivers include:

- **Geology and physical geography** that dictate the variety and characteristics of habitats, both terrestrial and marine. Occupying a range of latitude between 42 and 48 °N, the Gulf of Maine area falls within the Acadian Atlantic marine ecoregion (Wilkinson et al. 2009). The coastline and the continental shelf area of the Gulf of Maine provide a wide range of habitats for different species to occupy (see Offshore Ecosystems and Habitats).
- **Climate and thermal characteristics** that are important in defining the geographical range of species and associated habitats. The Northwest Atlantic is highly influenced by atmospheric phenomena such as the Arctic Oscillation and the North Atlantic Oscillation (NAO) that render the Gulf of Maine highly susceptible to storms, hurricanes, and climate change (Burtis 2006). Ocean currents are highly influential in dictating the thermal regime of the Gulf of Maine (see Offshore Ecosystems and Habitats). Climate change is considered an important long-term issue that will have a great influence on the future geographical distribution of species (Royal Society of Canada 2012; see also Climate Change and its Effects on Ecosystems, Habitats and Biota).
- **Socio-economic activities** that have an enormous influence on the usage of resources both on and along waterways, coastline, and adjacent marine areas (see Emerging Issues – Circa 2010). Coastal and watershed development (especially around urban areas), commercial and recreational fishing, ocean aquaculture, tourism, commercial shipping, and navigation are all activities that influence the condition and suitability of terrestrial and aquatic habitats associated with the Gulf of Maine. Dams and culverts can impede or delay the movements of fish, amphibians and reptiles; hydropower projects can result in injury or death for individuals that pass through the turbines.

  The pressures that are exerted on ecosystems, habitats, and individual species within the Gulf of Maine are numerous and include shoreline/land development, climate change stressors, commercial fishing, barriers to movement, shipping traffic, invasive species, oil and gas activities, noise, and land-based pollutants. A summary of the situation for the North American eastern seaboard watersheds and adjacent ocean areas has been illustrated by Krause and Rolland (2007), who show the relative level of potential

cumulative impacts that organisms might experience in watershed and marine sea areas (see Figure 2). The factors considered in the analysis include fishing activity, shipping, offshore dump sites, population density, percentage of land in agriculture, and U.S. Environmental Protection Agency (EPA) Toxic Release Inventory. In general, watershed impacts are relatively low for the northerly Gulf of Maine watersheds, with Massachusetts having the highest watershed impacts. By contrast, there are few areas where there are low impacts from anthropogenic activities.

- **Inherent genetic traits** that increase the risk of extinction. Certain species possess biological characteristics that make them particularly susceptible to change, and when they occur in areas where environmental changes are most extreme, the threat of extinction increases (Vié et al.

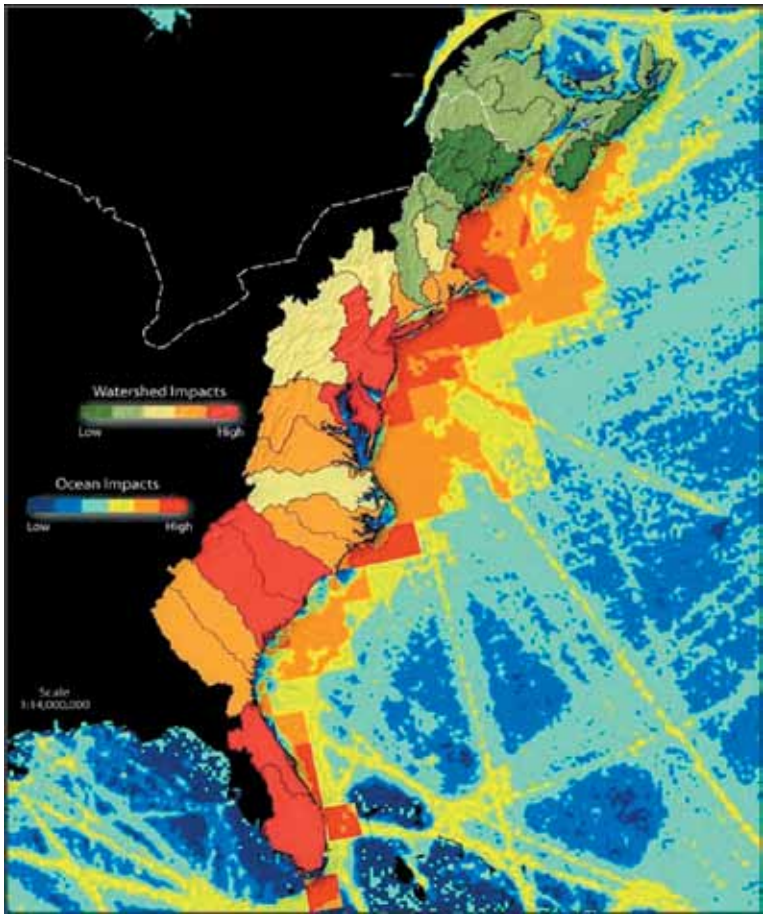


Figure 2: Map showing cumulative impacts of some select pressures for watersheds and adjacent ocean areas along the North American eastern seaboard. Area covers most of the spatial extent for resident and migrant species found in the Gulf of Maine. Pressures include fishing activity, shipping, offshore dump sites, population density, percentage of land in agriculture, and EPA Toxic Release Inventory (from Kraus and Rolland 2007).

2009). Some species are much more susceptible to change impacts than others, and the vulnerability of a species to environmental pressures depends on the species' exposure and sensitivity to environmental change, its resilience to perturbations, and its potential to adapt to change (Huey et al. 2012). There are 10 categories of traits (with more than 90 separate traits) that are associated with an elevated extinction risk for endangered species (Foden and Collen 2007; Seebacher and Franklin 2012), all of which can cumulatively or separately play a role in increasing the risk of extinction, depending on the circumstances. The traits and some examples of high vulnerability situations are given below in Table 1. Maine recently completed a climate change vulnerability assessment for over 440 species based on expert assessment using many of the vulnerability traits listed in Table 1 (Troy 2012).

Table 1: Categories of traits and examples of vulnerability attributes that can separately or collectively contribute to the vulnerability of species to extinction (from Foden and Collen 2007).

CATEGORY OF TRAIT	EXAMPLES OF VULNERABILITY TRAITS
Habitat range characteristics	Species have a limited range and/or requirements for specialized habitats.
Population size	Low population size and/or extreme fluctuations in population size.
Life history and breeding system	Low reproductive rates, long generation times, and complicated life history stages requiring different habitats and/or environmental conditions.
Behavioural characteristics	Tends to congregate for feeding and/or breeding and periods of inactivity (e.g., hibernation).
Morphological and physiological	Animal size and shape; high sensitivity and narrow tolerance range to physical and chemical factors.
Ability to disperse	Poor ability to disperse and colonize other habitats. Presence of physical barriers to dispersal (e.g., dams, roads, mountains, etc.).
Phenology	High dependence on environmental triggers for breeding, migration, egg-laying, hibernation, spring emergence, etc.
Multispecies interaction	Dependence and requirement to interact with specific prey, hosts, symbionts, pathogens, and competitors.
Genetic characteristics	Inbreeding and depression of genetic phenotypic variation.
Exposure to human exploitation	Usefulness as a resource for human usage and susceptibility to intentional or unintentional capture by humans.

3. Status and Trends

Understanding of the trends and status of species at risk is greatly enhanced when monitoring information is available for: 1) trends in abundance and distribution of selected species in a defined area; 2) numbers of endangered, threatened, and species of concern for the area; and 3) changes in the status of threatened species (CBD 2006; IUCN 2012).

The Gulf of Maine contains a diverse marine flora and fauna. The Gulf of Maine in Context (Thompson 2010) reports that there are:

- At least 3317 species of marine flora and fauna in the Gulf of Maine;
- More than 652 species of fish that have been documented living in, or migrating through, the area;
- 271 species of macrophytes;
- 1410 species of invertebrates;
- 3 marine turtles (although this report has identified 5—see Table 3);
- 32 species of marine mammals; and
- 184 species of marine birds.

Assessment of the status of endangered species has received considerable attention from international, federal, and state and provincial organizations, as well as academic and non-governmental institutions (see Thompson 2010; Parker 2012; Census of Marine Life 2012). Both federal governments, the provinces, and the states are continuously monitoring and updating the status of select species (Table 2; see COSEWIC 2012; U.S. Fish and Wildlife Service 2011; NMFS 2012). Assessment and listing in both Canada and the United States is based on criteria related to rarity, distribution, reproductive and population status, threats, specialization (as determined by unique habitat requirements), and vulnerability.

Box 1: Categories of Listed Species

- Extinct: a species that no longer exists.
- Extirpated: a species no longer existing in the wild
- Endangered: a species facing imminent extirpation or extinction throughout all or a significant portion of its range.
- Threatened: a species likely to become endangered within the foreseeable future.
- Special concern: a species that may become a threatened or an endangered species.
- Candidate species: a species where there is evidence to indicate that it requires assessment.

Table 2: Relevant sources of listings for species at risk in the Gulf of Maine.

JURISDICTION	WEBSITE SOURCES OF LISTINGS FOR SPECIES AT RISK IN RESPECTIVE JURISDICTIONS
International	The IUCN Red List of Threatened Species http://www.iucnredlist.org
U.S. federal	U.S. Fish and Wildlife Service: Endangered Species Program http://www.fws.gov/endangered/species/us-species.html U.S. Fish and Wildlife Service: Ecological Services http://www.fws.gov/northeast/EcologicalServices/endangeredspecies.html National Oceanic and Atmospheric Administration: Office of Protected Resources http://www.nmfs.noaa.gov/pr/
Massachusetts	Massachusetts Division of Fisheries and Wildlife http://www.mass.gov/dfwele/dfw/nhesp/species_info/mesa_list/mesa_list.htm
New Hampshire	New Hampshire Fish and Game http://www.wildlife.state.nh.us/Wildlife/Nongame/endangered_list.htm
Maine	Maine Department of Fisheries and Wildlife http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm
Canada federal	Government of Canada: Species at Risk Public Registry http://www.sararegistry.gc.ca/sar/index/default_e.cfm
New Brunswick	New Brunswick Department of Natural Resources http://www2.gnb.ca/content/gnb/en/departments/natural_resources/wildlife/content/SpeciesAtRisk.html
Nova Scotia	Nova Scotia Department of Natural Resources http://www.gov.ns.ca/natr/wildlife/biodiversity/species-list.asp

Although official definitions and lists vary, the current monitoring and assessment systems in Canada (see COSEWIC 2012) and the United States (see U.S. Fish and Wildlife Service 2011; NMFS 2012) recognize several levels of endangered species (Box 1). Since the 1970s there has been a continual increase in the number of assessed and listed at-risk species in both countries (see Suckling 2006; Mooers et al. 2010). By contrast, delisting of species is based on the achievement of recovery plan objectives, mostly requiring the attainment of specified increases in population numbers. As recovery plan population targets require decades of monitoring, and few species have achieved these, numbers of delisted species are not yet considered to be a good indicator of at-risk status (Suckling 2006).

EXTINCT AND EXTIRPATED SPECIES

There are several examples of species that have become extinct or extirpated from the Gulf of Maine area. Information on these species is scanty illustrating how easy it is for a species to become extinct without any knowledge of the details of how, when, or why it happened. Coastal and marine species that are part of this group consist of:

- *The great auk* (*Pinguinus impennis*) that became extinct after 1844 (Fuller 2003; see http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=9).

- *Labrador duck* (*Camptorhynchus labradorius*) where the last living individual was seen at Elmira, New York, in 1878 (Fuller 2001; see http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=9).
- *The sea mink* (*Mustela macrodon*) that was last captured at Campobello Island, New Brunswick, about 1894 (see http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=8).
- *Eelgrass limpet* (*Lottia alveus alveus)* that disappeared in the late 1920s (see http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=175).
- *The grey whale (Eschrichtius robustus)* that is extinct in the North Atlantic with no information as to when, or how, this status was reached (COSEWIC 2000).

ENDANGERED AND THREATENED SPECIES

There are currently some 30 coastal and marine species that are relevant in the Gulf of Maine (see list in Table 3). This list does not include species that are considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be in a state of endangerment but are not listed under Canada's *Species at Risk Act*, or species that are still undergoing assessment by the respective jurisdictions. The list indicates that not all of the jurisdictions have the same perspective on what species are at risk, despite most of these species having Gulf of Maine-wide distribution. It is also in part a reflection of the way in which jurisdictional responsibilities (marine and land) are separated between the respective federal, state, and provincial governments.

Fish

There are many species of fish that are considered to be at risk in the Atlantic area (Hutchings and Festa-Bianchet 2009; Walmsley 2011; Royal Society of Canada 2012). Anadramous species are particularly at risk largely because of their migratory requirement to move from an ocean environment into inland freshwater systems to breed. The Gulf of Maine fish species of concern include:

- The **shortnose sturgeon** (*Acipenser brevirostrum*), listed because of previous overharvesting in many estuaries and rivers along the U.S. seaboard from Florida extending north to New Brunswick. Pollution and river system habitat destruction (dams, weirs, bridge construction, etc.) are of major concern (NMFS 1998).
- The **Atlantic sturgeon** (*Acipenser oxyrinchus oxyrinchus*), with a large latitudinal range from the Gulf of Mexico to Labrador. Commercial fishing and pollution have reduced populations, as has river system habitat destruction (COSEWIC 2011).
- The **Atlantic salmon** *(Salmo salar),* not listed for the whole of the Gulf of Maine as populations in the Inner Bay of Fundy and Maine rivers are the focal areas of the endangered listing (see Figure 3). Populations

Table 3: Coastal and marine species that are listed as "threatened" or "endangered" in Gulf of Maine jurisdictions. Because designation of species at risk is not consistent across jurisdictions, this table includes only species that are "endangered" or "threatened" in one or more jurisdictions. If a species have been designated as "of concern" or "vulnerable" in another jurisdiction, that is also indicated. However, species that are listed solely as "vulnerable" or "of concern" are not listed here.

SPECIES AT RISK		United States				Canada			IUCN
		Federal	Mass	NH	Maine	Federal	NB	NS	Red Data Listing
COMMON NAME	SCIENTIFIC NAME								
Fish									
Great white shark	*Carcharodon carcharias*					E			V
Atlantic salmon (select river populations)	*Salmo salar*	E			E	E			LC
Atlantic sturgeon	*Acipenser oxyrinchus*	T	E						NT
Shortnose sturgeon	*Acipenser brevisrostrum*	E	E	E	E	SC			
Cetaceans									
Blue whale	*Balaenoptera musculus*	E	E			E			E
Fin whale	*Balaenoptera physalus*	E	E		E	SC			E
Humpback whale	*Megaptera novaeangliae*	E	E		E	SC			LC
North Atlantic right whale	*Eubalaena glacialis*	E	E		E	E			E
Sei whale	*Balaenoptera borealis*	E	E		E				E
Sperm whale	*Physeter macrocephalus*	E	E		E				V
Reptiles									
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E		E				CE
Leatherback sea turtle	*Dermochelys coriacea*	E	E		E	E	E		CE
Loggerhead sea turtle	*Caretta caretta*	T			E				E
Hawksbill sea turtle	*Eretmochelys imbricata*	E	E						CE
Green sea turtle	*Chelonia mydas*	E/T	E						E
Birds									
Arctic tern	*Sterna paradisaea*		SC		T				LC
Atlantic puffin	*Fratercula arctica*		T		T				LC
Bald eagle	*Haliaeetus leucocephalus*		T		SC		E		LC
Barrow's goldeneye	*Bucephala islandica*		T		T	SC		V	LC
Black crowned night heron	*Nycticorax nycticorax*		T		T				LC
Common tern	*Sterna hirundo*		SC	T	SC				LC
Great cormorant	*Phalacrocorax carbo*		T		T				LC
Harlequin duck	*Histrionicus histrionicus*		T		T	SC	E	E	LC
Least bittern	*Ixobrychus exilis*		E		E	T			LC
Least tern	*Sterna antillarum*		E		E				LC
Peregrine falcon	*Falco peregrinus*		E		E	SC	E	V	LC
Piping plover	*Charadrius melodus melodus*	T	T	E	E	E	E	E	NT
Razorbill	*Alca torda*		T		T				LC
Red knot	*Calidris canutus rufa*				SC	E		E	
Roseate tern	*Sterna dougallii*	E	E	E	E	E		E	LC

E= endangered
T= threatened
SC = special concern/species of concern
V= vulnerable
For IUCN Red List, LC=least concern, V=vulnerable, NT= near threatened, E=endangered, CE=critically endangered

a)

b)

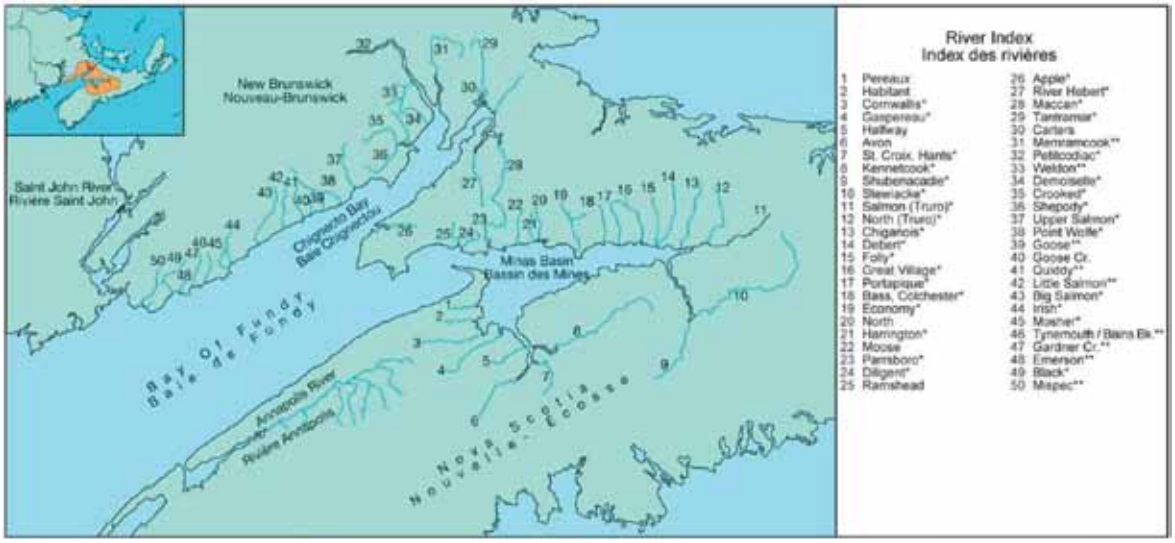


Figure 3: Rivers where Atlantic salmon populations have been declared endangered by a) the U.S. federal government and the State of Maine (T. Trinkc, NOAA) and b) the Canadian federal government for the inner Bay of Fundy designatable unit range (DFO 2010).

south of Maine have been extirpated, although there have been efforts to reintroduce salmon.

- The **great white shark** (*Carcharodon carcharias),* an infrequent visitor to the Gulf of Maine but considered by the IUCN to be globally vulnerable (COSEWIC 2006).

Cetaceans

There are six species of at-risk whales in the Gulf of Maine (see Table 3) and their populations were reduced dramatically because of past commercial whaling. Because of the migratory nature of each of these species, it is not possible to provide definitive figures for the size of their populations in the Gulf of Maine area. However, stock assessment evaluations carried out by the U.S. National Oceanic and Atmospheric Administration (see NMFS 2013) provide an indication of the reduction in population numbers that has taken place over time (see Table 4). Current populations are exposed to numerous adverse risk factors, such as collisions with ocean traffic, exposure to noise and chemical pollution, entanglement with fishing gear, and disturbance from whale watching activities. These risk factors, coupled with the fact that the species have long generation times, congregate in groups, are highly migratory, and have critical breeding and feeding habitat areas that are situated in highly utilized ocean areas, make them especially vulnerable (Kraus and Rolland 2007).

Of the species in Table 4, the North Atlantic right whale is considered to be the most endangered in the Gulf of Maine and the species has several identified habitats where it congregates, making it more vulnerable at particular times of the year (Figure 4).

Reptiles

Athough Thompson (2010) reports that there are three species of sea turtle in the Gulf of Maine area, this investigation has identified five species of sea turtle that periodically make use of open waters of the Gulf (Table 3). All of the species are migratory and nest in warmer areas south of the Gulf of Maine, but migrate north to forage. The IUCN considers these species to be either endangered or critically endangered from an international perspective. The limitations and threats in the Gulf of Maine include human interference, natural predation, ingestion of debris, entanglement in fishing gear, and incidental capture.

Birds

There are fifteen species of bird listed as either endangered or threatened, all of which have ubiquitous distribution throughout the Gulf of Maine and undergo some form of seasonal migration (Table 3). Two of the species, the piping plover and the roseate tern, are listed as either endangered or threatened within all of the Gulf of Maine jurisdictions. For almost all of the species, the main reason for

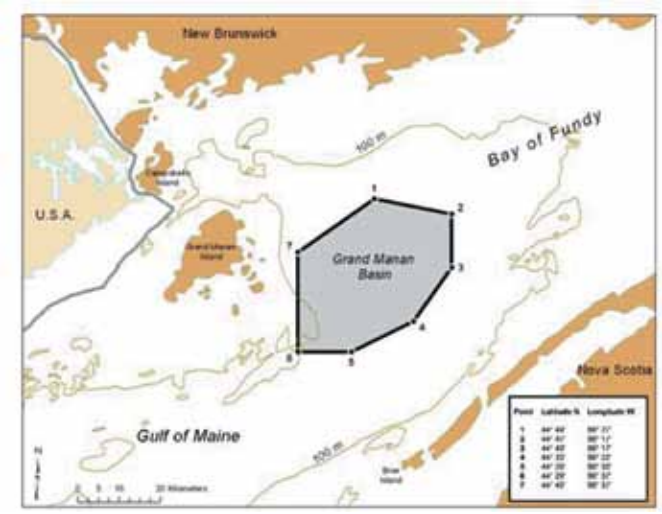
Table 4: Endangered cetacean species, Gulf of Maine, with best estimates of historic and current populations in the western North Atlantic. Estimates from National Oceanic and Atmospheric Administration marine mammal stock assessment reports (NMFS 2013).

SPECIES	HISTORIC POPULATIONS	CURRENT
North Atlantic right whale *(Eubalaena glacialis)*	At least 1000 in the Western North Atlantic during mid-1600s	396 in the western North Atlantic in July 2010
Fin whale *(Balaenoptera physalus)*	No estimate available	Western North Atlantic population of 3985 in 2007
Humpback whale *(Megaptera novaeangliae)*	12 000 in North Atlantic prior to whaling	Gulf of Maine stock estimated at 847 in August 2006
Blue Whale *(Balaenoptera musculus)*	1100–1500 in North Atlantic prior to whaling	At least 440 in the western North Atlantic in 2009
Sei Whale *(Balaenoptera borealis)*	No estimate available	386 for the Nova Scotia stock in 2004
Sperm Whale *(Physeter macrocephalus)*	>1 100 000 worldwide	4804 in the U.S. Atlantic in 2004

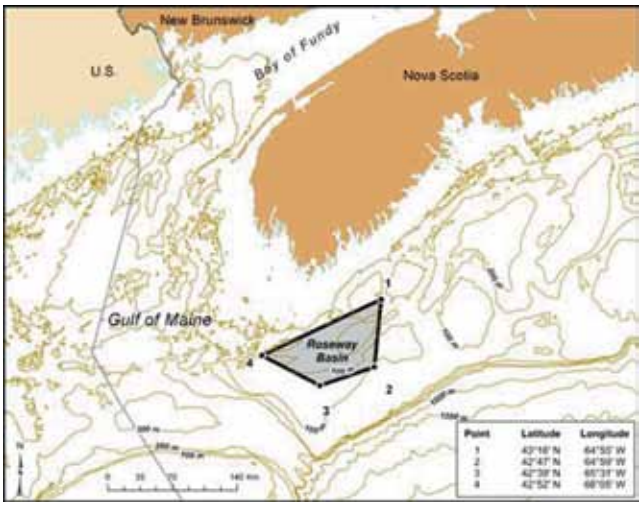
listing is breeding habitat disturbance leading to population declines (Birdlife International 2012). All of the listed bird species, with the exception of the piping plover ("near threatened"), are considered of "least concern" internationally by the IUCN.

Candidate Species

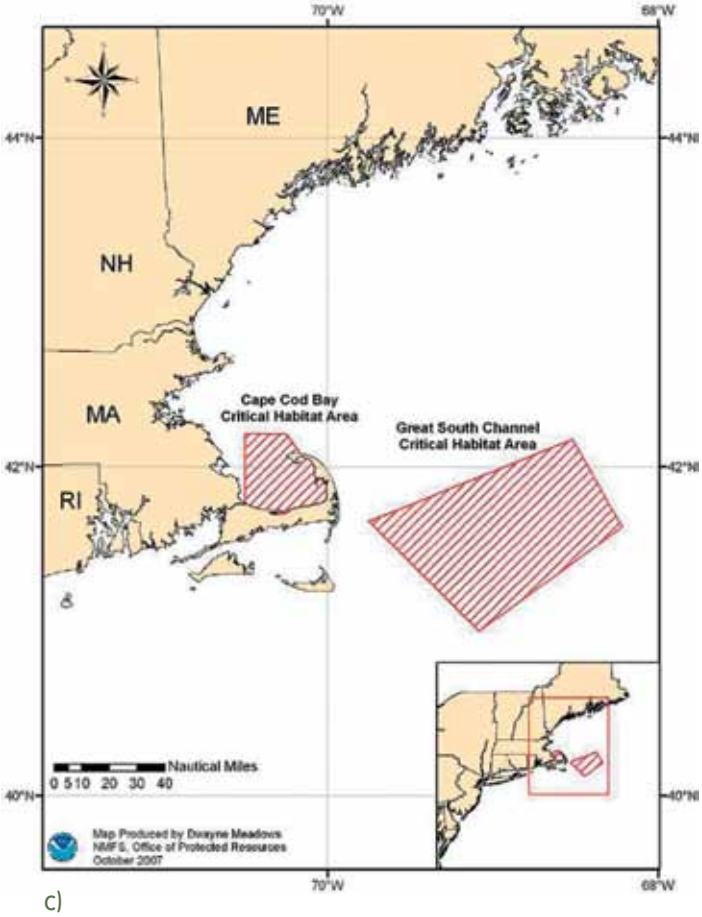
Both federal and state/provincial administrations in Canada and the United States have different processes by which species are continuously being monitored and assessed. These are listed as "candidate species" that require formal assessment because there is concern that their populations are decreasing and therefore need official assessment. In Canada, COSEWIC provides an annual prioritized list of candidate species that it uses to decide on the allocation of resources for status report production (see COSEWIC 2013; http://www.cosewic.gc.ca/eng/sct3/index_e.cfm). By contrast the United States responds to petitions from members of the public, or organizations, who wish to have a species assessed (see http://www.nmfs.noaa.gov/pr/listing). Because this listing is continuously changing, and cited candidate species are not always assessed, details and listings of these species are not given in this paper.



a)



b)



c)

Figure 4: Important summer habitat areas of the North Atlantic right whale in Canadian (a, b; Brown et al. 2009) and U.S. (c; NOAA 2013) waters.

4. Impacts

The implications of having legally listed endangered species within any area are numerous in that the achievement of two main objectives has to be taken into account (IUCN 2012). Firstly, the objective of preventing an increase in the number of endangered species within the region, and secondly, ensuring that those which are already designated as being endangered receive the conservation attention (protection and recovery) that legislation demands. Linnell et al. (2010) highlight that there are many costs and conflicts that will arise in pursuing the mission of protecting species at risk. Some key potential areas of impact on society (not in any order of priority) include, amongst others:

POLITICAL

There is a potential for any endangered species to become a political issue at any of international, federal, and state/provincial levels, particularly where the species influences development, investment and trade. Signing of international agreements, promulgation of federal and state/provincial endangered species legislation, and official listing of species carry numerous implications that will affect societal support of policy and decisions on natural resource management and development. The obligation to have congressional and/or parliamentary reporting for budgetary and resource allocation purposes means that species at risk is an ongoing topic on many political agendas.

ADMINISTRATIVE AND LEGAL

Official government listing via legislation is associated with numerous legal and institutional obligations that apply to the protection of species, as well as associated law enforcement systems. An increase in the number of species at risk requires associated increases in professional and administrative personnel and resources to meet these obligations. In addition, an increase in litigation can be expected from parties involved in developing and utilizing natural resources, as well as parties opposed to the use of natural resources.

SOCIAL

There will be increasing concern and a need for dialogue within and between sectors that make use of resources in the Gulf of Maine area. Many of the species have great social value (e.g., cultural, scientific, recreational, sense of wellbeing, etc.). Worm et al. (2006) consider that each species has an ecological existence value that society places a sentimental value on (e.g., salmon and whales). Consequently, there will be an increased need for negotiation processes to achieve consensus on natural resource utilization when species at risk are involved.

ECONOMIC

Potential aspects include constraints on the use and development of land and natural resources, increased costs of monitoring species and implementing conservation measures such as recovery plans, increased costs of using and maintaining biological resources, potential loss of livelihoods where resources can't be used, and increases in cases for subsidy and/or compensation. Many of the species contribute to the economy through tourism, and or recreation, thereby influencing incomes and expenditures in this sector.

ECOLOGICAL

There is the risk that loss or population decline of a single species might be linked to irreversible changes in ecosystem structure, which extends beyond just the loss of a single species. In addition, species recovery plans make provision for the identification and protection of critical habitat areas implying that species recovery will also lead to wider improvements in the habitats and ecosystems that are occupied by species at risk.

TECHNOLOGY AND RESOURCE MANAGEMENT APPROACHES

Changes may be required to the technologies and methods used in natural resource management (e.g., fishing gear modification, harvesting and capture methods, observation and communication, diminution of noise, and the speed and routes of ships).

DEVELOPMENT AND PLANNING

Future development of land and use of natural resources will have to accommodate endangered species in planning and implementation of development projects. Consideration of species at risk will form part of all environmental impact assessments for development projects.

KNOWLEDGE AND INFORMATION

There will be a need to ensure that appropriate research, monitoring, and communication of findings are carried out for all species that are at risk. Accordingly, each species at risk will require a supportive research, monitoring and communications program in order to keep stakeholders aware of its status over time. This will lead to an increase in general capacity and understanding of the species at risk situation, a better-informed public and improved decision making.

5. Actions and Responses

Over the last 30 years there has been considerable progress made throughout the world in developing appropriate policies and practices for the preservation of biodiversity and endangered species. This is reflected by a multiplicity of actions by both the United States and Canada at international, federal, and state/provincial levels.

INTERNATIONAL TREATIES AND PROGRAMS

Numerous international agreements aimed at the protection and conservation of biodiversity (ecosystems, habitats and species) have been developed and accepted by most countries throughout the world. Although the United States and Canada are not signatories to all of them, some examples of the relevant treaties that apply to the Gulf of Maine include:

- The 1975 United Nations Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) that ensures that international trade in specimens of wild animals and plants does not threaten their survival. CITES provides guidelines and lists of endangered species to which signatory countries are obligated to respond.
- The 1971 Convention on Wetlands of International Importance (Ramsar) that provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
- The 1992 United Nations Convention on Biological Diversity (CBD) that deals with international conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of benefits arising from genetic resources.
- The 1982 United Nations Law of the Sea (UNCLOS) defines the rights and responsibilities of nations in their use of the world's oceans and provides guidelines for businesses, the environment, and the management of marine natural resources.
- The 1946 International Convention for the Regulation of Whaling (ICRW) that provides for the conservation of whale stocks and the orderly development of the whaling industry.
- The 1974 International Convention for the Safety of Life at Sea that protects the safety of marine ships in international waters, particularly spills of chemicals and oil.

Both the United States and Canada are members of the IUCN and participate in activities that relate to the Red List (IUCN 2012) and have indicated that they

will contribute to the development of the recently-announced Intergovernmental Platform on Biodiversity and Ecosystem (IPBE) that is gaining momentum as an international forum dealing with the management of biodiversity (http://www.ipbes.net/).

FEDERAL AND STATE-PROVINCIAL PROGRAMS

Canada and the United States have initiated numerous responses that relate to the management and conservation of endangered species in the Gulf of Maine. This has involved the development and implementation of international, federal, and state and provincial legislation, and associated governance and supportive programs (see Table 5). Because many species at risk are migratory and continuously moving out of state, provincial, and national boundaries, it has required considerable interaction between all parties who have mandates and obligations to manage endangered species. For example, there is a Canada-U.S. Transboundary Steering Committee with a Species at Risk Working Group that jointly addresses common concerns related to species at risk (see http://www2.mar.dfo-mpo.gc.ca/science/sc/sc(1)-e.html). The working group is comprised of managers and scientists from Fisheries and Oceans Canada (DFO) Maritimes and the Northeast Region of the National Marine Fisheries Service (NMFS).

The general approach taken to address endangered species has been to:

1. Monitor the status of species and populations through research and formal monitoring programs.
2. Create appropriate legislation.
3. Have formal assessment procedures in place for official listing.
4. Specify critical habitats for listed species, and develop and implement strategies for their recovery.
5. Mobilize resources such as funding, human resources, technology, policing, recovery teams, networks, etc.
6. Inform and educate the public, resource users, and decision makers.
7. Develop networks and forums and support projects and programs aimed at recovery and protection of specific species and habitats
8. Monitor and report on progress.

Table 5: Legislation and institutions mandated to regulate and manage species at risk in the Gulf of Maine.

ORGANIZATION	RELEVANT LEGISLATION	COMMENT AND KEY LINKS
CANADA		
Environment Canada Fisheries and Oceans Canada (DFO) Parks Canada	The *Species at Risk Act* (2002) is coordinated by Environment Canada in collaboration with DFO and Parks Canada. DFO is responsible for aquatic species. *Fisheries Act* (1985) managed by Fisheries and Oceans Canada The *Oceans Act* (1997) managed by Fisheries and Oceans Canada	A species at risk public registry keeps a record of the status of all Canadian species at risk (http://www.registrelep-sararegistry.gc.ca). COSEWIC assesses and designates which wildlife species are in danger of disappearing from Canada (http://www.cosewic.gc.ca/eng/sct6/index_e.cfm). The Government of Canada has a Habitat Stewardship Program (HSP) for species at risk (http://www.ec.gc.ca/hsp-pih/default.asp?lang=En&n=59BF488F-1). Parks Canada has a species at risk program (http://www.pc.gc.ca/eng/nature/eep-sar/index.aspx). DFO has a regionally-based species at risk program for aquatic species (http://www.dfo-mpo.gc.ca/species-especes/search-location-recherche-endroit-eng.htm). DFO also administers the *Fisheries Act* and the *Oceans Act,* both of which have provisions for protection of species.
Nova Scotia Department of Natural Resources	Nova Scotia *Endangered Species Act* (1999)	Details of status reports and recovery action teams and plans for Nova Scotia are shown at. http://www.gov.ns.ca/natr/wildlife/biodiversity/species-recovery.asp
New Brunswick Department of Natural Resources	*Endangered Species Act*/proposed *Species at Risk Act*	http://www2.gnb.ca/content/gnb/en/departments/natural_resources/wildlife/content/SpeciesAtRisk.html The New Brunswick government has revised its legislation with the intention of promulgating a new act and listings in 2013. A species database is maintained for over 2300 species.
UNITED STATES		
U.S. Fish and Wildlife Service (FWS) National Marine Fisheries Service (NMFS)	*Endangered Species Act* (1973)	The FWS has primary responsibility for terrestrial and freshwater organisms (http://www.fws.gov/endangered/species/us-species.html). The NMFS is concerned mainly about marine wildlife (http://www.nmfs.noaa.gov/pr/).
Massachusetts Division of Fisheries and Wildlife	Massachusetts *Endangered Species Act* (2005)	The Natural Heritage and Endangered Species Program is involved with endangered species and maintains GIS shapefiles as well as a variety of site-specific information for use at town and area level. (http://www.mass.gov/dfwele/dfw/nhesp/species_info/species_home.htm).
New Hampshire Fish and Game Department	New Hampshire *Endangered Species Conservation Act* (1979)	The Nongame and Endangered Wildlife Program is involved in the protection of some 400 species including those that are listed (http://www.wildlife.state.nh.us/Wildlife/Nongame/endangered_list.htm).
Maine Department of Inland Fisheries and Wildlife Department of Agriculture, Conservation and Forestry	Maine *Endangered Species Act* (1975)	Species listed as endangered or threatened are protected under the Maine Endangered Species Act (http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm). Maine Natural Areas Program maintains a list of protected and endangered plants (http://www.maine.gov/doc/nrimc/mnap/index.html).

NON-GOVERNMENTAL ACTIVITIES

The Gulf of Maine represents one of the most extensively studied marine areas in the world with a wealth of literary resources and an extensive network of marine resource institutions and scientists that are researching the area's physical and biological relationships and linkages. Parker et al. (2007) report that there are more than 60 institutions and organizations in the Gulf of Maine area involved in mobilizing and allocating resources towards the understanding and management of biological species. Although not all of these institutions dedicate their resources exclusively to at-risk species, most of them have relevant programs and project activities that make a contribution. It is not possible in this paper to list all of these institutions and their involvement, but some examples are given below. Some of the main groups of organizations include:

- Academic institutions (e.g., Dalhousie University, University of New Brunswick, University of Maine, University of New Hampshire, Northeastern University).
- Museums and aquaria (e.g., Nova Scotia Museum of Natural History, New Brunswick Museum of Natural History, New England Aquarium).
- Non-profit and charitable organizations (e.g., Grand Manan Whale and Seabird Research Station, Marine Environmental Research Institute in Maine, Whale Center of New England, Atlantic Salmon Federation).
- Environmental organizations (e.g., World Wildlife Fund Atlantic).

6. Indicator Summary

INDICATOR	DPSIR ELEMENT	STATUS	TREND
Change in seawater temperatures due to climate change.	Pressure	Fair – General increases recorded to date have not resulted in status changes for species at risk.	Worsening – Monitoring shows a general increase over the region which is likely to lead to population declines in species with narrow temperature tolerances.
Cumulative impacts from human activities in the Gulf of Maine ocean areas.	Pressure	Poor – Much of the Gulf of Maine has been assessed as having high or near high impacts.	Unknown – No overall trend data: some human activities are increasing while the footprint of others is decreasing.
Cumulative impacts from human activities in the Gulf of Maine watershed.	Pressure	Fair – Most of the Gulf of Maine watershed has moderate to low watershed impacts.	Unknown – In general human activities appear to be increasing, but no trend data.
Inventory of species in the Gulf of Maine area	State	Fair – Good information on large organisms and waters above 200 metres.	Improving – Recent research has identified a number of species not previously known in the area.
Number of endangered and threatened species	State	Fair – 30 coastal or marine species are listed as threatened or endangered by one or more jurisdictions in the Gulf of Maine.	Worsening – Numbers will increase as more species are assessed and listed.
Number of delisted species	State	Poor – No species have achieved delisted status.	No trend – Delisting is dependent on the attainment of recovery plan population levels that require decades to achieve.
Ecosystem changes	Impacts	Unknown – most recovery plans have included mitigation measures to improve critical habitats of listed species. The overall impact of those mitigation measures on critical habitats is not yet known.	Unknown – While resource management changes have been implemented it is not clear what this means for the overall health of multiple habitats in Gulf of Maine.
Development of recovery plans	Response	Good – Most listed species have recovery plans as per legislation.	Improving – Gulf of Maine jurisdictions are publishing and implementing recovery and action plans for listed species.
Identification of critical habitat	Response	Poor – There are many species at risk where critical habitat has not yet been identified.	Improving – Gulf of Maine jurisdictions are achieving success in identifying and declaring critical habitats.

Categories for Status: Unknown, Poor, Fair, Good.
Categories for Trend: Unknown, No trend, Worsening, Improving.

Data Confidence

- Monitoring of marine water temperature is carried out by numerous organizations.
- Gulf of Maine jurisdictions maintain a good record of species status, management measures related to each species, and recovery plans.

Data Gaps

- The number of factors influencing each species is enormous and the interactions between them make it difficult to understand those most responsible for influencing population numbers of particular species.
- Cumulative impacts may present a good general picture of pressures in the area but do not work well for species for which there is a specific threat.
- Information on population size is generally poor because of migratory nature of species, the different jurisdictions involved, and lack of resources to monitor populations.
- Deep waters of the Gulf of Maine have not been fully explored and may identify species new to the region. Throughout the region, there are many microorganisms not yet discovered or identified.

7. References

Birdlife International. 2012. Fact Sheet: Piping Plover *Charadrius melodus*. http://www.birdlife.org/datazone/speciesfactsheet.php?id=3127&m=0

Brown MW, Fenton D, Smedbol K, Merriman C, Robichaud-Leblanc K and Conway JD. 2009. Recovery Strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 66 pp.

Burtis W (ed). 2006. Cross border indicators of climate change over the past century: Northeastern United States and Canadian Maritime Region. The Climate Change Task Force of the Gulf of Maine Council on the Marine Environment in co-operation with Environment Canada and Clean Air-Cool Planet.

Butchart SHM, Akçakaya HR, Chanson J, Baillie JEM, Collen B, Quader S, Turner WR, Amin R, Stuart SN and Hilton-Taylor C. 2007. Improvements to the Red List Index. PLoS ONE 2(1): e140. doi:10.1371/journal.pone.0000140. http://www.plosone.org/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1371%2Fjournal.pone.0000140

CBD (Convention in Biological Diversity). 2006. COP 8 Decision VIII/15: Framework for monitoring implementation of the achievement of the 2010 target and integration of targets into the thematic programmes of work. http://www.cbd.int/decision/cop/?id=11029

Ceballos G, García A and Ehrlich PR. 2010. The Sixth Extinction Crisis Loss of Animal Populations and Species. Journal of Cosmology 8: 1821-1831.

Census of Marine Life. 2012. Gulf of Maine Register of Species. http://www.gulfofmaine-census.org/about-the-gulf/biodiversity-of-the-gulf/lists/gulf-of-maine-register-of-marine-species/

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006. COSEWIC assessment and status report on the White Shark *Carcharodon carcharias* (Atlantic and Pacific populations) in Canada. Ottawa: Committee on the Status of Endangered Wildlife in Canada. vii + 31 pp. http://publications.gc.ca/collections/Collection/CW69-14-507-2006E.pdf

COSEWIC. 2011. COSEWIC assessment and status report on the Atlantic Sturgeon *Acipenser oxyrinchus* in Canada. Ottawa: Committee on the Status of Endangered Wildlife in Canada. xiii + 50 pp. http://publications.gc.ca/collections/collection_2012/ec/CW69-14-636-2011-eng.pdf

COSEWIC. 2012 COSEWIC's Assessment Process and Criteria. 18 pp. http://www.cosewic.gc.ca/pdf/Assessment_process_and_criteria_e.pdf.

COSEWIC. 2013. Candidate Wildlife Species. March 4, 2013. http://www.cosewic.gc.ca/eng/sct3/index_e.cfm

DFO (Fisheries and Oceans Canada). 2010. Recovery Strategy for the Atlantic salmon (*Salmo salar*), inner Bay of Fundy populations [Final]. Ottawa: Fisheries and Oceans Canada. xiii + 58 pp + apps. https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_atlantic_salmon_ibof_0510_e.pdf

Foden W and Collen B. 2007. Species vulnerability traits. Proceedings of an IUCN Workshop convened at Silwood Park, Imperial College, Berkshire, UK. 14 pp. http://www.iucn.org/about/work/programmes/species/our_work/climate_change___species/publications

Fuller E. 2001. Extinct Birds. New York: Comstock Publishing. pp. 85–87.

Fuller E. 2003. The Great Auk: The extinction of the original penguin. Piermont, NH: Bunker Hill Publishing.

Gustavson K. 2010. Coastal Ecosystems and Habitats. State of the Gulf of Maine Report. 20 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/aquatic-habitats

Huey RB, Kearney MR, Krockenberger A, Holtum JAM, Jess M and Williams SE. 2012. Predicting organismal vulnerability to climate warming: roles of behaviour, physiology, and adaptation. Philosophical Transactions of the Royal Society B 367: 1665–1679.

Hutchings JA, and Festa-Bianchet M. 2009. Canadian Species at Risk (2006–2008) with particular emphasis on fishes. Environmental Reviews 17: 53–65.

IUCN (International Union for the Conservation of Nature). 2001. IUCN Red List categories and criteria version 3.1. http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

IUCN. 2012. The IUCN Red List of threatened species. Version 2012.2. http://www.iucnredlist.org

Kraus SD and Rolland RM (eds). 2007. The urban whale: North Atlantic right whales at the crossroads. Cambridge, MA: Harvard University.

Linnell JDC, Rondeau D, Reed DH, Williams D, Altwegg CJ, Raxworthy JD, Austin N, Hanley H, and Evans FDM. 2010. Confronting the costs and conflicts associated with biodiversity. Animal Conservation 13: 429–431.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Biodiversity synthesis. Washington: World Resources Institute. 100 pp.

Mooers AO, Doak DF, Findlay CS, Green DM, Grouis C, Manne LL, Rashvand A, Rudd MA and Whitton J. 2010. Science, policy and species at risk in Canada. BioScience 60: 843–849.

NMFS (National Marine Fisheries Service). 1998. Recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 104 pp.

NMFS. 2012. Welcome to the Office of Protected Resources. http://www.nmfs.noaa.gov/pr/

NMFS. 2013. Marine Mammal Stock Assessment Reports (SARs) by Species/Stock. http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales

NOAA (National Oceanic and Atmospheric Administration). 2013. North Atlantic Right Whales. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm

Nye J. 2010. Climate change and its effects on ecosystems, habitats and biota. State of the Gulf of Maine Report. 20 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/climate-change.

Parker M, Wells P and Walmsley D. 2007. Developing a Gulf of Maine ecosystem overview report: A scoping exercise to identify key review literature and considerations for report production. A report to Oceans and Coastal Management Division, Fisheries and Oceans Canada. 43 pp.

Parker M. 2012. Offshore ecosystems and habitats. State of the Gulf of Maine Report. 41 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/aquatic-habitats

Royal Society of Canada. 2012. Sustaining Canada's marine biodiversity: Responding to the challenges posed by climate change, fisheries, and aquaculture. An expert panel report. Royal Society of Canada. 316 pp. http://rsc-src.ca/documents/RSCMarineBiodiversity2012_ENFINAL.pdf

SCBD (Secretariat of the Convention on Biological Diversity). 2006. Global biodiversity outlook 2. Montreal: Secretariat of the Convention on Biological Diversity. vii + 81 pp.

Seebacher F and Franklin CE. 2012. Determining environmental causes of biological effects: The need for a mechanistic physiological dimension in conservation biology. Philosophical Transactions of the Royal Society B 367: 1607-1614.

Scott WB and Scott MG. 1988. Atlantic fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences 219. 731 pp.

Suckling K. 2006. Measuring the success of the Endangered Species Act: Recovery trends in the Northeastern United States. A report by the Center for Biological Diversity, Tucson, Arizona. 125 pp.

Thompson C. 2010. The Gulf of Maine in context. State of the Gulf of Maine Report. 58 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report

Troy A. 2012. Valuing Maine's natural capital. Manomet, MA: Manomet Center for Conservation Sciences. 74 pp. http://www.manomet.org/sites/manomet.org/files/reports/Troy_2012_Value_of_Maine.pdf

U.S. Fish and Wildlife Service. 2011. Listing a species as threatened or endangered: Section 4 of the Endangered Species Act. Fact Sheet. 2 pp. http://www.fws.gov/endangered/esa-library/index.html#listing.

Vié JC, Hilton-Taylor C, Pollock CM, Ragle J, Smart J, Stuart SN and Tong R. 2009. The IUCN Red List: A key conservation tool. In: J-C Vié, C Hilton-Taylor and SN Stuart (eds), Wildlife in a changing world. An analysis of the 2008 IUCN Red List of threatened species. Gland, Switzerland: IUCN. pp 1–13.

Walmsley D. 2010. Climate change and its effects on humans. State of the Gulf of Maine Report. 16 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/climate-change

Walmsley D. 2011. Species at Risk. State of the Scotian Shelf Report. http://coinatlantic.ca/index.php/state-of-coast-and-ocean/state-of-the-scotian-shelf. 24 pp.

Wells P. 2010. Emerging issues – circa 2010. State of the Gulf of Maine Report. 22 pp. http://www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/emerging-issues

Wilkinson T, Wiken E, Bezaury-Creel J, Hourigan T, Agardy T, Herrmann H, Janishevski L, Madden C, Morgan L and Padilla M. 2009. Marine Ecoregions of North America. Montreal: Commission for Environmental Cooperation. 200 pp.

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR, et al. 2006. Impacts of biodiversity loss on ocean ecosystem services. Science 314 (5800): 787–790.