Gulf of Maine Council on the Marine Environment

Climate Change Network Task Force

Background Document for Climate Change Network Inaugural Event And ESIP Meeting

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Introduction

Inspired by the successful November 2006 ecosystem indicators workshop in Wells - Maine, the Gulf of Maine Council's Ecosystem Indicator Partnership (ESIP) and Climate Change Network have decided to host an ESIP Meeting as part of the Inaugural Climate Change Network Event, one day prior to the next Gulf of Maine Council working group meeting. ESIP members have expressed an interest in learning more about how climate change will impact the Gulf of Maine ecosystems and whether their indicators and monitoring techniques should change accordingly. This meeting will start a process by which many of these questions will be answered.

The event's three objectives are:

1. Discuss how climate change projections and the use of environmental indicators affect current and future research on ecosystem health and sustainability indicators.
2. Determine what information and data researchers need to receive from the climate change working group and network to help them adapt their work to climate change.
3. Facilitate the networking between individuals and groups interested in the Gulf of Maine and climate change, and thereby develop partnerships and strategic alliances on these issues.

The goal of this background document is to provide participants with an understanding of the issues to be discussed and prepare them for the day's activities. The first section of this document gives a brief summary of the Gulf of Maine Council, the ESIP subcommittees and the Climate Change Network. The second section provides summarised information about the Gulf of Maine, climate change and indicators. The third section includes information that should facilitate discussions on gaps relevant to the issues. The final section provides clarification information such as a glossary and references.

1.1 Gulf of Maine Council on the Marine Environment

The Gulf of Maine Council on the Marine Environment is a Canadian-American partnership of "government and non-government organizations working to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations" (Gulf of Maine Council on the Marine Environment (GoMC) (C), 2007). The Gulf of Maine Council conducts environmental monitoring, organizes conferences and workshops, and provides science translation to management. It also offers grants and recognition awards; raises public awareness about the Gulf; and connects people, organizations, and data sources (GoMC (C), 2007).

The Gulf of Maine Council's long-term goals are to ensure:

- "Coastal and marine habitats are in a healthy, productive, and resilient condition.
- Environmental conditions in the Gulf of Maine support ecosystem and human health.
- Gulf of Maine coastal communities are vibrant and have marine-dependent industries that are healthy and globally competitive" (GoMC (B), 2007, p. 1).

More information on the Gulf of Maine Council can be found on their website at www.gulfofmaine.org .

In 2004, the Gulf of Maine Council with the U.S. Environmental Protection Agency held a workshop, the Northeast Coastal Indicators Workshop, to bring together scientists and managers in the goal of developing ecosystem indicators, which would be specific and applicable to the northeast coastal region of the United States and Canada (Ibid.). Inspired by the findings of the workshop, the Gulf of Maine Council formed the Ecosystem Indicator Partnership (ESIP) to look specifically at the Gulf of Maine region. As a committee within the Gulf of Maine Council, ESIP has begun the development of indicators and the integration of "regional data for a new Web-based reporting system for marine ecosystem monitoring" (GoMC (B), 2007, p.12).

1.2. Ecosystem Indicator Partnership

"The Gulf of Maine Ecosystem Indicator Partnership (ESIP) is a group of public and non-profit environmental managers, policy analysts, and scientists which is working in partnership with the Gulf of Maine Council (GoMC) to prepare a set of regional indicators" (Della Valle, 2006, p.1).

The Gulf of Maine Council vision for the region is for "a sustainable northwest Atlantic ecosystem that ensures environmental integrity and that supports and is supported by economically viable, healthy human communities" (GoMC (A), 2004, p.2). The ESIP mission is "to track the status and trends in ecosystem integrity throughout the northwest Atlantic region through collaborative partnerships. To provide information for management decisions at regional and local scales" (Ibid). This information must be presented in a timely manner and should be responsive to the needs of decision-makers and consider public concerns. [The work of the ESIP groups should be able to help decision-makers become more aware and understand the connections between ecosystem health and the health and needs of surrounding communities.]

As such, ESIP's activities revolve around regional practitioners choosing to participate in one, or more, of six subcommittees focusing on specific indicators: namely coastal development, contaminants and pathogens, eutrophication, aquatic habitat, fisheries and aquaculture, and climate change (Mills, 2006).

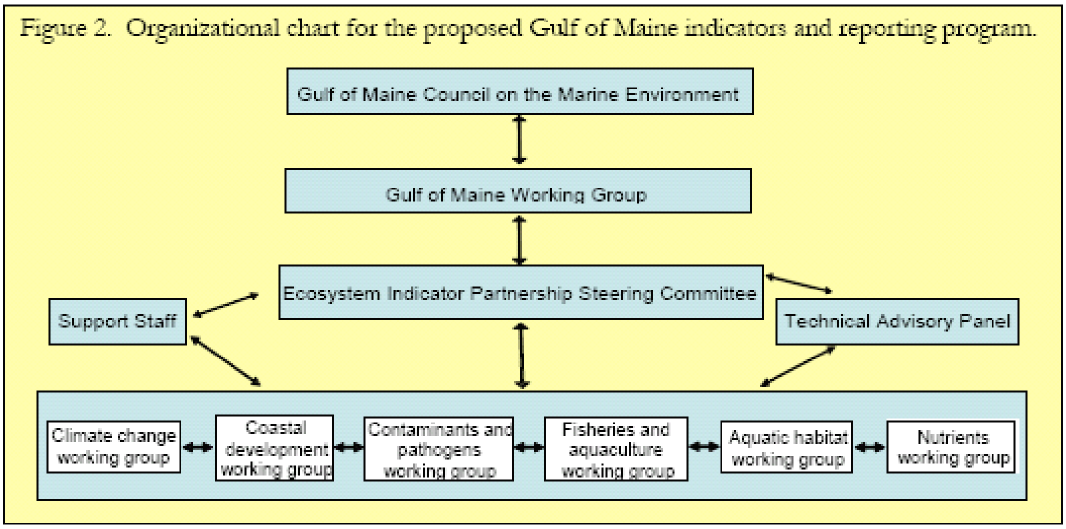

Figure 1 Organizational chart of ESIP within Gulf of Maine Council (Mills, 2006)

So far, the efforts in these groups has been in "defining program goals and ecosystem objectives, engaging and harmonizing existing efforts, creating regional indicators, developing a data and information management structure, building and sustaining partnerships, and providing effective communication and outreach to the public and decision-makers" (GoMC (D), 2006). Each group functions according to the involvement of their members and availability of data, therefore each group has achieved a different level of advancement.

In developing a strategy to move things forward a reporting initiative was instigated last year and involved the following objectives:

- "Provide baseline data and information, using historical data where available, about ecosystem conditions against which future changes can be compared;
- Develop ecosystem indicators for assessing the state of the Gulf of Maine and Bay of Fundy that have a scientific grounding and that are relevant to management issues of concern in the region;

- Provide consistent, scientifically-sound, credible information that can be used to strengthen environmental policy and guide management decisions with environmental and social implications;
- Utilize a collaborative, interactive process that involves a variety of partners and data sources; and
- Ensure that information reaches decision-makers within the Gulf of Maine and Bay of Fundy region in a manner that is useful to them" (Mills, 2006, p.4).

Ultimately the success of ESIP depends on the level of commitment and involvement of the multiple partners including "government agencies, environmental organisations, community groups, business and trade groups, academic institutions, and other programs operating within the region and at national and international scales" (Ibid.). It is hoped that the scope of the work done by ESIP will eventually spread "to expand 1) the depth and breadth of management-relevant issues that are covered, 2) the level of integration across specific management issues, 3) the spatial scale of focus, and 4) the audience that is reached through products of this program" (Ibid.)

Given the current interest and need by decision makers and the public for more climate change relevant information, the Gulf of Maine Council decided that each group's efforts, regardless of level of advancement, now needs to be viewed through a climate change lens. This will prepare the various group members for ecosystem changes and how best to analyse them, as well as what data is needed in light of these changes.

1.3. Climate Change Network

Following all these developments within the Gulf of Maine Council, the Climate Change Network Task Force (CCN) was created in 2003. The goal of the CCN is to 1) help enhance awareness of how projected climate change will impact the Gulf of Maine region, 2) help those working on other environmental issues to understand how climate change will influence their work, 3) work toward adaptation strategies, and 4) facilitate networking between the various groups, agencies and academics. The CCN is focused on providing relevant climate change information to the Gulf of Maine Council including indicators, projections and potential impacts.

The Network published in 2006 a document entitled "Cross Border Indicators of Climate Change over the past Century: Northeastern United States and Canadian Maritime Region" (Wake, C. et al., 2006). Climate Change indicators are important elements of understanding the health of the Gulf of Maine region. The document includes research based on climate data recorded since 1900 and determines what lays ahead using models and other scientific tools. The report seeks to clarify the relation between the indicators it has identified and studied and the health of the region's human communities. The indicators in section 2.3.1 are taken from this report and will be of help in the work to be done during the CCN Inaugural event and ESIP Meeting. These indicators are but one aspect of the information required by the decision makers to address the need for climate change impacts and adaptation relevant data. Other information, such as the description of the Gulf area presented below, regarding the ecosystems of the region, is essential to properly assessing the impacts and adaptation needs of our region.

2.1 Description of the Gulf of Maine Area

The Gulf of Maine is a semi-enclosed part of the Northwest Atlantic Ocean bordered by the United States and Canada and encompassing three states (New Hampshire, Maine and Massachusetts) and two provinces (New-Brunswick and Nova Scotia). The area is approximately 93,000 square kilometres (36,000 square miles) of ocean, 12,000 square kilometres (7,500 miles) of shoreline, and around 5,000 islands (Tyrrell, 2005). Its watershed is very extensive and covers a land area greater than these political borders. The marine area known as Georges Bank makes up the south-eastern point of the Gulf.

Figure 2: Gulf of Maine, (Gulf of Maine Ocean Observing System (B), 2007)

The Gulf of Maine has a rich biodiversity of flora and fauna ranging from the endangered North Atlantic Right Whale to the interconnected underwater gardens fed by the microscopic phytoplankton. This diversity is greatly influenced by the ocean's underwater topography including mountains and canyons, and the action of currents and tides. The habitats present in the area include salt marshes, seagrass beds, kelp beds, tidal mudflats, and many other marine ecosystems (Tyrrell, 2005). The area's biodiversity is reflected in the over fifty species harvested by the Gulf's fishing industries and the presence of millions of shorebirds and seabirds which migrate to the Gulf annually (Gulf of Maine Ocean Observing System (A), 2007). The rich environment is the primary reason why millions of residents choose to live along the shores of the Gulf. It also contributes to the large numbers of tourists that visit the region each year.

Human activities in the Gulf of Maine have increased in both quantity and intensity over the last century. The increased complexity of these activities, along with their inputs and outputs, put a strain on the capacity of the Gulf to provide for all living components, including humans (Tyrrell, 2005). Researchers, decision-makers, and residents of the Gulf must consider the implications of rapid changes to the climate of the region.

2.2. Description of Climate Change

Climate change is a term coined by the scientific community to address the issue of global warming. The warming occurs as the incoming solar radiation from the sun becomes trapped within the Earth's atmosphere, causing an increase in temperature (Clean Air-Cool Planet, 2004).

The atmosphere is a mixture of gases that surround the Earth, acting as insulation to prevent heat loss and maintain temperatures within a range that can sustain life (Clean Air-Cool Planet, 2004). Gases and aerosols in the atmosphere absorb most of the infrared heat transmitted by the Earth, preventing it from radiating back to space. This phenomenon has been called the "greenhouse effect" (Environment Canada, 2005). Certain gases within the atmosphere, such as carbon dioxide and methane are known as "greenhouse gases" because they work to enhance the natural greenhouse effect and cause a warming of the climate (Environment Canada, 2005).

The term climate change refers to both the natural and human-induced changes in climate. The Earth's climate is constantly changing, however the climate change we are seeing today is occurring at a much faster rate and at a greater magnitude than ever before (Environment Canada. 2007). Current studies are showing that humans are interfering with the natural cycles of the earth (Environment Canada, 2005). Through processes such as burning fossil fuels we are changing the composition of the atmosphere by adding more greenhouse gases. This increase in greenhouse gases is responsible for the changes in climate being seen around the world (Environment Canada, 2005).

Increases in temperature are projected to cause changes to climate patterns and natural systems around the world (Warren, 2004). As the temperature rises ice caps will begin to melt, releasing enormous quantities of fresh water into the oceans. This will not only cause a rise in sea level, but also alter the entire hydrologic cycle, including the atmosphere (International Panel on Climate Change (IPCC) (A), 2001). Severe storms and flooding are projected as a result of climate change, which will in turn affect crop production, species distribution, and resource availability (IPCC (A), 2001)

The rate at which climate change is projected to occur will present difficulties for humans to adapt to the warmer climate. It will also present difficulties for numerous plant and animal species that are already threatened, living in vulnerable areas, or experiencing habitat loss due to human activities to adapt to climate change (IPCC (A), 2001). In order to help humans and wildlife adapt and attempt to reduce our contributions to climate change, various scientific efforts have been put forward. One effort involves the use of ecosystem indicators to determine the presence and rate of climate change and establish the effects of projected impacts on the earth's ecosystems.

2.3 Description of Indicators

Environmental indicators "are used to describe the status and trends of our natural resources, environmental health, and ecological condition. They help raise awareness about important issues, can inform environmental policy decisions, and serve as a tool for evaluating the effectiveness of management actions…and help give scientists and managers a picture of the state of our ecosystems" (GoMC (E), 2007).

Specifically, indicators are "physical, economic or social factors that, when measured and analyzed over time, help detect change and help us understand cause and consequence (Southern Gulf of St-Lawrence Coalition (SGSLC), 2004, p.5). To be relevant and meaningful indicators preferably need to have characteristics which:

- "Are sensitive enough to detect changes
- Track effects over time
- Have low natural variability
- Are cost-effective
- Are responsive to management strategies
- Have low measurement error
- Have simple sampling technique" (Ibid.)

The following four types of indicators are usually used by monitoring agencies to help define the environmental conditions:

- "Stressors are agents or chemicals that change living conditions. These would include pollutants, wildfires, crime, climate change interest rates and social suicides.
- Exposure indicators reflect change in a) the intensity of stressors or b) the accumulated dose over time. An example is lead, associated with transportation.

- Response indicators reflect changes in organisms or communities, caused by exposure to stressors. These can be physiological changes (such as cancers) or productivity changes (such as photosynthesis) affecting yield or mortality.
- Habitat indicators identify conditions on a local or landscape scale such as vertical/spatial lake stratification" (Ibid.).

There are two main types of indicators used in the fields of research and policy making that are of concern in the Gulf of Maine. Ecosystem indicators are "quantitative or qualitative measures that provide information about the status of or changes in natural, cultural, and economic aspects of an ecosystem" (GoMC (D), 2006), while sustainability indicators are "interdisciplinary and combine environmental (biophysical), social and economic data to provide a picture of the past, present and future situation" (SGSLC, 2004, p5). Both kinds of indicators are needed in order to reduce knowledge gaps, to effectively implement adaptation measures to deal with climate change. Below are short descriptions of the indicators as determined at this time by the GoMC Climate Change Network and ESIP subcommittees.

2.3.1 Climate change indicators

The indicators in this section are from *Cross Border Indicators of Climate Change over the past Century: Northeastern United States and Canadian Maritime Region* (Wake, C. et al., 2006). Each of these indicators were chosen based on their relevance to climate change impacts, their measurability, the available existing data and research, and the overall contribution to permitting a proper assessment of changes through time. Each indicator is looked at from a temporal and spatial scale and includes physical and biological indicators.

Average Temperature: Temperature is one of most frequently used indicators of climate change. Changes in temperatures affect not only our lives but also numerous aspects of ecosystems and natural cycles.

Average Annual Precipitation: Precipitation is vital for life on Earth, affecting both human and non-human communities. Changes to precipitation patterns, in combination with changes in temperature, can alter our climate considerably.

Extreme Precipitation Events: This indicator records and analyzes frequency and intensity of extreme precipitation events, (which are defined as precipitation of more than 50mm of rain over a 48-hour period). These events affect water levels, wastewater systems, infrastructure, agricultural systems, and many other aspects of the natural world.

Total Snow Fall and Days with Snow on the Ground: These are important elements that can impact not only natural processes such as spring rejuvenation, but human activities such as agriculture and tourism. Although it is harder to measure, it is an important indicator that is connected to changes in temperature and precipitation.

Timing of High Spring Flow: This indicator looks at rivers that are free of man-made barriers and measures the timing (early, on time or late) of the river's spring flow. The timing of the delivery of fresh water to estuaries and near coastal marine waters affects estuarine and marine ecology through changes in the timing of nutrient cycling and the inland migration of the salt water.

Lake and River Ice: An easily observable indicator of climate change is monitoring the coverage and density of ice on lakes and rivers from season to season. In addition to impacting human activities such as transportation and recreation, changes in ice cover may lead to changes in lake and river ecosystems or increase the risk of flooding.

Growing Season: Defined as the number of days between last spring frost and first fall frost, this indicator is most relevant to agricultural sectors. However, it is also an important indicator for ecological systems because vegetation, regardless of use to humans, will be affected by changes in climate.

Sea Level Rise: Sea levels are affected by transfers of heat to the oceans and fresh water inputs, and as the climate warms, both of these processes will contribute to sea level rise. With increases in human development on coastal lands people are becoming increasingly vulnerable to rising sea.

Sea Surface Temperatures: Sea surface temperature is an important moderator of regional climate because the oceans are huge reservoirs of heat. Over the past century, ocean temperatures have been warming thus causing changes in climate on both regional and global scales

Land Falling Hurricanes: Periods of hurricane frequency fluctuate in response to changes in our climate. It has been found that the Gulf region has experienced an increase in hurricane activity. This is an important indicator because hurricanes have huge impacts on both humans and natural ecosystems. These storms can cause habitat destruction and impede local conservation efforts.

2.3.2 ESIP indicators

As stated in the ESIP strategy, the goal of the six indicators is to enable the evaluation of ecosystem integrity (Mills, 2006). Results of the various indicators research will need to be integrated to create a depiction of the health of the Gulf of Maine region, and to permit better tracking and reporting. Conceptual pressure-state-response models were used in organising the indicators, and conceptual mechanistic models used to evaluate the purpose of the indicators (see glossary for details) (Mills, 2006). Predictably, it is the areas that have the highest human populations in the region that seem to have the most useable information for the subcommittees (see ESIP Monitoring Map at http://www.gulfofmaine.org/esip/).

The indicators were selected by evaluating availability, consistency, quality, gaps, compatibility and timeliness in current monitoring data and indicator reporting in the region (Mills, 2006). They are based on the "1) relevance of the indicator to management questions of interest and responsibilities in the region; 2) relevance of the indicator to the target audience, the public, and government; and 3) the presence of a scientific rationale behind an indicator and its interpretation" (Ibid. p.11).

The list of indicators is divided among the six subcommittees. Still incomplete, the list is too exhaustive to include in this document. Therefore only a few examples and short descriptions of indicators are identified here to illustrate the focus of each subcommittee.

Fisheries and aquaculture: The type of indicators looked at in this group include aquatic species population trends, areas of distribution, reproductive behaviour, changes in sizes and ages availability, harvest numbers, presence of invasive species, and so on. A regional baseline data assessment was done for this group as part of the Tides of Change report (Mills, 2006).

Contaminants and pathogens: The type of indicators looked at in this group include presence and levels of toxins, dioxins and furans in biological tissue (fish, shellfish, etc.), in water and in sediments, levels of mercury, coli form bacteria, and so on. A regional baseline data assessment was done for this group as part of the Tides of Change report (Mills, 2006).

Eutrophication: The type of indicators looked at in this group include dissolved oxygen, water quality, presence and type of aquatic vegetation, levels of nutrients, concentration of phosphorus and nitrogen, presence and type of aquatic species, and so on.

Coastal Development: The type of indicators looked at in this group include acres of protected land and developed land, type of human activities on coastal habitat, number and type of protected coastal areas, extent of human sprawl, presence of hardened (impervious) coastal surface, density of human population on coastal lands, and so on. A regional baseline data assessment was done for this group as part of the Tides of Change report (Mills, 2006).

Aquatic Habitat: The type of indicators looked at in this group include presence and extent of invasive species, changes in the habitat, population levels, age and distribution, quality and quantity of micro- and macro-flora and- fauna, biodiversity, presence and distribution of waterfowl and seabirds, and so on.

Climate Change: The indicators for this group are indicated above in the climate change indicator section (Section 2.3.1).

3.1 Gap analysis

As mentioned, the use of indicators in the Gulf of Maine is to help paint a picture of the health of the region's ecosystems and how they will be affected by climate change. Discussing the needs of indicator researchers, monitors and managers on this issue will help address the implementation of climate change adaptation at the grass roots.

Some questions need to be asked regarding the combination of the indicators. Is it really useful to combine indicators? Can these combinations help determine adaptation needs? Is it more effective to use these indicators separately or in combinations when addressing the policy needs for adaptation? Can research on one indicator be adapted to integrate the climate change indicators?

The GoMC organised a meeting late last year to look at these indicators and the work being done by the groups and try to determine how to approach the issue of linking those two groups of indicators within a vision of sustainability. The brief summary of the meeting found in the following section should help us in analysing what gaps still exist.

3.2. Wells Maine meeting

At the Wells meeting in Maine in November 2006, scientist, researchers and decision makers met to discuss and work on possibilities for the next steps of the GoMC. The workshop was organised by RARGOM, the Regional Association for Research on the Gulf of Maine. The idea was to focus discussions on "the science, development and application of ecosystem-related regional indices" (GoMC (F), 2006). The workshop touched "upon the chemical, physical, biological, geological and socio/economic factors that affect the ecosystem, and contrast how indices reflect specific measures versus overall ecosystem health" (GoMC (F), 2006).

During the events participants discussed, analysed and debated various ways to "identify the distribution and condition of regional habitats for assessment, protection and restoration, consider methods to combine various data types, and comment on the level of detail and specificity required to achieve index development goals" (GoMC (F), 2006). The resulting conclusions lead to a call for a subsequent meeting to better link climate change indicators with those identified by the other ESIP subcommittees, and the need for focusing and directing the groups' efforts within the current and most up to date climate change impacts and adaptation information. Hence the idea to have a key note speaker present on the findings of the fourth assessment of the International Panel on Climate Change.

3.3. International Panel on Climate Change

As part of the Inaugural event a key note speaker will be presenting on the findings of the Fourth Assessment of the International Panel on Climate Change.

The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organisation (WMO) and United Nations Environmental Programme (UNEP) "to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation" (IPCC (B), 2007).

The IPCC produces assessment reports divided into three Working Groups which are based on peer-reviewed scientific and technical research and literature (Ibid). Three assessment reports have already been produced and the fourth one is due to be released in full by the end of 2007. "The First Assessment Report was completed in 1990, the Second Assessment Report in 1995 and the Third Assessment Report in 2001. Assessment Reports normally consist of the full scientific, technical and socio-economic assessment reports of the IPCC Working Groups and their Summaries for Policymakers, and a Synthesis Report" (IPCC (C), 2007). The assessments by the IPCC have provided much information to policy markers around the world, and the Fourth Assessment will be the subject of our keynote speaker at the event. This information should help in determining what information, data and knowledge is still missing for the ESIP subcommittees, and increase the understanding of all involved in the challenging but exhilarating tasks ahead.

Conclusion

The Gulf of Maine Council on the Marine Environment – Climate Change Network inaugural event will permit the networking of the climate change researchers in the region with the indicators researchers, and bring forth information which will help all subcommittees and other interested parties in the region to move forward on adaptation to climate changes.

The GoMC, its Climate Change Network Task Force and ESIP subcommittees have determined approaches which through the use of indicators and partnerships provide decision makers with an image of the health of the Gulf of Maine. In light of climate change impacts these groups are taking steps to integrate climate change projections and indicators in their work to provide those same decision makers with knowledge to develop plans for adaptation and dealing with the impacts of climate change. This background document and the inaugural event will help identify the gaps in the knowledge and in the analysis of the combined effect of the climate change indicators and the ESIP indicators. With the fourth assessment of the IPCC due out this year, the groups will be well prepared for integrating that information into their actions, research and analysis.

Glossary

Conceptual Models: "Conceptual models are needed for three purposes: 1) to organize indicators; 2) to clarify the purposes and assumptions associated with indicators; and to communicate clearly about the objectives and goals of the strategy and suggested programs" (Mills, 2006, p.10).

Cumulative effects: The combined effect of human activities on the ecosystems. They can come from point source and non point source pollution, can be multiple to one activity, unique to one type of activity or resulting from the repetition of the same activity. The result is a combination of human activities and developments that immediately or after a period of time combine to affect the ecosystems whether meant or unintentional (McLeod *et al.*, 2005).

Ecosystem: A dynamic complex of plants, animals, microbes, and physical environmental features that interact with one another. The interconnectedness within and among ecosystems is provided both by the physical environment (for example, currents transporting larvae from one part of the ecosystem to another) and by biological interactions (for example, kelps or sea grasses creating habitat or predators consuming prey) (GoMC (B), 2007, p. 28).

Eutrophication: "A process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae, and nuisance plants weeds). This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die" (USGS, 2007).

Habitat: The place where an animal or plant lives and that has the environmental conditions needed for that species to survive (GoMC (B), 2007, p.29).

Indicators: Quantitative or qualitative measures that provide information about the status of or changes in natural, cultural, and economic aspects of an ecosystem (Ibid.).

Invasive species: A non-native plant or animal species that has been deliberately or accidentally transported and released into a foreign environment through human activities and has successfully taken hold in that environment, causing ecological damage in the process (Ibid.).

Mechanistic models: "…Conceptual mechanistic models are needed to evaluate the purpose for each indicator (i.e., "What is it indicating?") and the assumptions behind its presumed causal links (i.e., "What is assumed to be happening in the ecosystem to cause a certain trend in an indicator?"). Clarifying these presumed mechanistic relationships is crucial for evaluating an indicator's usefulness as well as for guiding its interpretation (e.g., Mendelson, 2004). These conceptual models are needed within each focus issue and across issues encompassed in the gulf-wide indicators and reporting program" (Mills, 2006, p.11).

Metadata: Information on data (where it is store, when it was taken, who collected the data, what is its use, and so on).

Non point source pollution: Pollution originating from diffuse sources, such as runoff of chemicals from the land and deposition of airborne pollutants (GoMC (B), 2007, p.29).

Point-source pollution: Pollution originating from a well-defined point, such as a pipe. Discharge from a sewage treatment plant is an example of point-source pollution (Ibid.).

Pressure-state-response (PSR) models: "The PSR model is based on causal links between human activities that place pressures on the ecosystem that may change the ecosystem's state; in turn, societal responses may lead to actions to relieve or manage the human-induced pressures. Working groups for each of the six indicator issues have selected indicators within each category of the PSR framework, and the PSR models have gained consensus within the relevant work groups" (Mills, 2006, p.10).

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