Climate Change

Concept Paper/Fact Sheet
Northwest Atlantic Indicators Workshop
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Regional Indicators for Climate Change

BACKGROUND

National and Regional Significance of Climate Change

"Climate change", "global warming", and the "greenhouse effect" have come to be household words in the society of the industrially developed nations of the world including the United States and Canada. The climate of the 21st century is likely to be significantly different from that of the 20th century. Whether the differences are a result of anthropogenically-induced climate change (man made impacts) or a result of natural long term cycles of climate and weather patterns or a combination of both is a matter that will be debated for years to come. Never-the-less, to US and Canadian citizens living and working in the northwest Atlantic region, these changes will be perceived mostly through the observation of increases in extreme weather events, changes in coastal landscapes, the appearance or disappearance of warm and cold water fish and shellfish, and shifts in maritime economy and uses. The Kyoto protocol and future initiatives, together with actions taken by the Canada and the US, are expected to reduce the impacts of the changes, but significant changes will still occur. Warming events such as the observed melting of the Greenland ice sheet and Canadian arctic icepack have been in the news recently.

Marine fish and crustacean species have experienced die-off and disease events along the North Atlantic seaboard of the US & Canada that many scientists have attributed (wholly or in part) to extreme warming or cooling events. For instance, an estimated 700 tonnes of Atlantic cod froze to death in late March 2003 off the Newfoundland coast. Scientists believe an extreme cooling event occurred to quickly for the fish to produce the natural antifreeze in their systems that would have prevented them from being killed by such chilly temperatures. The north Atlantic oscillation is thought to be shifting and having an impact on coldwater species, impacting migration patterns and range of warm and coldwater species. New invasive species that thrive in warmer waters and other warm water species of the Atlantic normally found off the southeastern continental US are now being found in northern waters never before seen.

Other indirect impacts are also anticipated. According to the Intergovernmental Panel on Climate Change (IPCC, 2001), rising sea levels as the ocean warms causing thermal expansion of ocean water and polar ice melt could innundate approximately 50% of North American coastal wetlands and a significant portion of dry land areas that currently are less than 50 cm above sea level. In some areas, wetlands and estuarine beaches may be caught between advancing seas and engineering structures. A 50-cm rise in sea level would cause a net loss of 17–43% of U.S. coastal wetlands, even if no additional bulkheads or dikes are erected to prevent new wetland creation as formerly dry lands are inundated. Furthermore, in the United States, 8,500–19,000 km2 of dry land is within 50 cm of high tide, 5,700–15,800 km2 of which is currently undeveloped. Several states in the United States have enacted regulations to adapt to climate change by prohibiting structures that block the landward migration of wetlands and beaches.

Rising sea level is likely to increase flooding of low-lying coastal areas and associated human settlements and infrastructure. Higher sea levels would provide a higher base for storm surge events; a 1-m rise would enable a once in 15-year storm to flood many areas that today are flooded only by a once in 100-years storm. Sea-level rises of 30 cm and 90 cm would increase the size of the 100-year floodplain in the United States from its 1990 estimate of 50,500 km2 to 59,500 km2 and 69,900 km2, respectively. Assuming that current development trends continue, flood damages incurred by a representative property subject to sea-level rise are projected to increase by 36–58% for a 30-cm rise and by 102–200% for a 90-cm rise.

Saltwater is likely to intrude further inland and upstream. Higher sea level enables saltwater to penetrate farther upstream in rivers and estuaries. In low-lying areas such as river deltas, saltwater intrusion could contaminate drinking water and reduce the productivity of agricultural lands

Reference

IPCC (2001). IPCC Special Report on The Regional Impacts of Climate Change An Assessment of Vulnerability, Chapter 8: North America ,IPCC. http://www.grida.no/climate/ipcc/regional/index.htm .

Consequently, coastal tidal wetlands are disappearing globally, with the northeastern US being no exception. The Pew Commission (2001, 2002) reported that over 20,000 acres of coastal habitat disappear each year, much of it attributed to development, rising sea level or subsiding land, and invasive species invasions. Changing precipitation patterns may compound searise effects, impacting the distribution and extent of brackish tolerant plant and animal species.

State of Climate Change in America and in the Region

The conception of adaptation strategies at a regional level to climate change requires a detailed analysis that is at present not often possible to realize because of the high level of uncertainty of future climatic events and their impacts in terms of amplitude and occurrence. Thus, even if historic climatic variations may not be representative of future conditions and may not allow a correct estimate of the level of risk, it is important to make the link with the historical climate statistics. In particular, for extreme climatic events, it is not desirable to wait until the signal becomes "statistically significant" before acting. It is indeed a question of developing an approach of management of risks at the regional level in an uncertain world.

To provide environmental managers with effective tools to minimize the human impact on climate change, there is a need to monitor and assess regional parameters of the northwest Atlantic ecosystem that reflect the causes and consequences of climate change.

KEY ASSESSMENT AND MANAGEMENT QUESTIONS

Key Considerations

“Climate Change” and “Seasonal weather patterns” are terms encompassing a range of processes and impacts that are tied to a global system that cannot be controlled by man. However, research data has suggested that anthropogenically generated physical and chemical pollutants can contribute to an altering of climactic and seasonal patterns both globally and regionally. The question environmental managers must ask themselves is ‘What strategies and management practices can be implemented that will have the most effective and long term benefits in minimizing climactic aberrations and assist (if possible) in shifting climate patterns back to historically healthy conditions’.

- What impervious surface patterns and structures can be changed to reduce stormwater temperatures entering coastal rivers, streams and near-shore waters?
- What management actions should be measured that could impact surface water temperatures and acidity? (i.e. extent of riparian buffers, riparian vegetation type and effectiveness in cooling waters and removing acid promoting compounds.)
- At what scale(s) must land use and imperviousness be monitored and assessed? At what scale should off shore waters be monitored for surface & deep-water temperatures?
- At what scale must acid rain be monitored? What are the best bio-indicators, chemical indicators, and physical parameters to monitor to aid managers in measuring the results and effectiveness of implemented pollution prevention actions.
- Which marine organisms are the best “canary” to monitor in terms of climactically induced thermo, haline, and DO impacts?
- Which commercially important marine species appear to be most impacted by climate changes and which geographical locations are best to monitor for migration and mating pattern shifts.

- Which recreationally and commercially important marine species would be best to monitor and benefit from set harvesting seasons and when should seasons be adjusted in response to temperature/climate induced seasonal migrations (both inshore/offshore and north/south) and mating and larval maturation rates.

The questions for type of monitoring methods are similar to Land Use issues. Advances in satellite & remote sensing science and technology have made possible observing and recording ocean surface temperatures and identifying extent, direction, and intensity of ocean currents.

- What are the trade-offs between resolution, repeatability, and price, and what is the best combination of remote and field monitoring techniques?
- What can we do to ensure comparable and uniform regional data?
- What technologies are most appropriate, accurate, and feasible to produce regionally comparable data?

Even though regime shifts in the NW Atlantic Ocean are less dramatic than those found in the Pacific Northwest that have impacted the Pacific salmon and sardine fisheries, they are probably manifested at the planktonic levels in the food chain passing upwards thru the pelagic forage fish and culminating in effects on seabirds, piscivorous fish and cetaceans. In the NW Atlantic there appears to be a relationship between the North Atlantic Oscillation (NAO), salinity variability, zooplankton and cod (Link, J.S. et al. 2002. Status of the Northeast U.S. Continental Shelf Ecosystem. Northeast Fisheries Science Center Ref. Doc. 02-11). Ken Drinkwater (Can. DFO) has shown similar relationships between the NAO, St. Lawrence River discharge, and pelagic fish species, while Bob Kenney (URI/GSO) has examined NAO relationships with cetacean species. The NAO cycles operate on shorter time scales than the regime shifts, but longer time scales than the seasonal weather patterns. Given the potentially different spatial/temporal scales for these events, it may be that the modelling approaches and field indicators from monitoring programs may differ in the type of management response required.

POTENTIAL INDICATORS & ASSESSMENT METHODS

Potential indicators relevant to this issue include, primarily, biological and physical indicators of aquatic health, and physical and socio-economic indicators of the maritime and fisheries industries. The potential indicators listed below are broken down into two major areal components - near shore and open ocean impacts.

Near Shore

- Trends of seasonal water temperatures over time
- Trends of regional ozone depleting gases and uv penetration in surface waters
- Trends of regional and seasonal CO_2 levels over time
- % tidal wetlands and changes due to subsidence and salt water intrusion over time
- % impervious surfaces and changes over time
- Trends of measured sea level rise (or fall)
- Trends of major weather events in the Northwest Atlantic Region
- Seasonal shifts of surface water temperature over time
- Seasonal stormwater temperature trends over time
- Annual precipitation trends in the watersheds of the northeast coastal region
- Freshwater flow trends from USGS gauging stations over time
- Trends of salt wedge extension up coastal river channels over time
- Trends of warm temperate invasive species
- Trends of parasitic and pathogenic warm water species on native near-shore flora and fauna
- Trends of new warmwater migratory finfish in near-shore waters
- Trends of warmwater algal species and blooms (species diversity and biomass)
- Trends of presence (or absence) of cold water finfish and shellfish species

- Trends of coldwater/warmwater species diversity of other near shore marine organisms (i.e. tunicates, crustaceans, jellyfish, etc.)
- Trends in changes of breeding timing and gestation duration of recreationally and commercially significant finfish and shellfish
- Trends of low dissolved oxygen (hypoxic) events in estuarine embayments related to warmer water temperatures both at the surface and near the benthos.
- Changes in depth and intensity of annual thermocline/halocline (a.k.a. pycnocline)
- Trends in the presence or absence of demersal vs. pelagic finfish.

<u>Offshore – Open Ocean</u>

- Trends of the North Atlantic oscillation over time
- Trends of the Gulf Stream and Labrador current over time
- Trends of nor'easter activity and other major weather events in the North Atlantic
- Seasonal shifts of surface water temperature over time
- Trends of new warm water migratory finfish in off-shore waters
- Trends of coldwater/warmwater finfish species diversity over time
- Trends of warm water/cold water algal species and blooms (species diversity and biomass)
- Trends of unusual finfish and marine mammal kills associated with temperature shift events and/or warm water pathogens
- Trends of finfish by catch (i.e. shifts in cold water to warm water species)
- Commercial fisheries shifts to warmer water species
- Trends of cold water fisheries catch over time
- Trends of dissolve oxygen levels in feeding areas
- Trends of ozone emissions from surface water
- Changes in migratory patterns inshore to offshore and north to south, and shifts in range of warm and cold water species
- Trends in changes of breeding timing and gestation duration of commercially significant finfish and shellfish
- Trends in the presence or absence of demersal vs. pelagic finfish.

➢ **<u>End purpose</u>:** What is to be done with the data once collected and interpreted? Who are the primary target audiences for this data, and how can the information be used to help influence changes to land use, impervious surface types, auto emissions, and sources of thermal and acidic pollutants. How can the data aid in adjusting socio-economic practices and patterns to benefit from climate change impacts beyond our control? What kind of 'early warning system' can managers develop to aid the maritime industry and other socio-economically tied communities in adjusting to and managing future changes in marine resource abundance and diversity?