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The Climate Change and Marine Biodiversity

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***Abstract*—there is very little doubt among the scientific community that human induced greenhouse gas emission has contributed significantly to the climate change. Most significant changes in the earth's temperature have been noticed since the advent of the industrial era in the late 1800s. Over the past 100 years, the earth's surface has warmed by approximately 0.6ºC. Human activities such as the large-scale burning of fossil fuels to operate power plants and automobiles are releasing greenhouse gases like CO2 into the atmosphere at an unprecedented rate.**

The anthropogenic climate change and its impact on a wide variety of life-forms in various ecosystems. The pole ward and altitudinal shifts in the distribution of various organisms (especially butterflies), the spread of pathogen-driven diseases, the bleaching of coral reefs, and the changes in community and tropic dynamics in various marine and terrestrial ecosystems.

The Earth's climate is changing and the impacts are already being felt by biodiversity and wildlife habitats across the planet. Individual sessions of Global Climate Change and Biodiversity covered a cross-section of the planet's major biomes: forests, marine, high latitudes and montane, managed landscapes and coasts. The impact of climate change on natural systems was shown to vary in different ecosystems in different parts of the world. But climate change is all-pervading and will have an increasing influence on the life systems of the Earth.

The rich variety of life on Earth has always had to deal with a changing climate. The need to adapt to new patterns of temperature and rainfall has been a major influence on evolutionary changes that produced the plant and animal species we see today. Variation in the climate is perfectly compatible with the survival of ecosystems and their functions, on which we each depend for the essentials of life.

There are several reasons why plants and animals are less able to adapt to the current phase of global warming. One is the very rapid pace of change: it is anticipated that over the next century. Many species will simply be unable to adapt quickly enough to the new conditions, or to move to regions more suited to their survival.

Keywords-adaptation, biodiverdity, climate change, global warming, marine ecosystems,mitigation.

I. Introduction

In the atmosphere, gases such as water vapors, carbon dioxide, ozone, and methane act like the glass roof of a greenhouse by trapping heat and warming the planet. These gases are called greenhouse gases. The natural levels of these gases are being supplemented by emissions resulting from human activities, such as the burning of fossil fuels, farming activities and land-use changes. As a result, the Earth's surface and lower atmosphere are warming. Even small rises in temperature are accompanied by many other changes. Rising levels of greenhouse gases are already changing the climate.

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Global warming can affect community composition by encouraging invasion by exotic species. In the marine environment, warm water species of plankton have increased in areas that previously had few of them. Evidence from North and Central America Arrival dates of short-distance migratory birds in North America seem to have been affected disproportionately by global warming (Butler, 2003).

The direct and more tangible consequences for human civilizations of such a temperature increase range from melting of glaciers and polar ice caps and the subsequent rising of sea levels and flooding of coastal areas, to increase in transmission of tropical diseases, to large-scale disruptions in global climatic patterns resulting in both unusual droughts and flooding world-wide(Kannan & James,2009).

Climate change is not new, and species have traditionally responded to such change over evolutionary timescales. he impact of such climate change on global biodiversity and it draws from the wide body of scientific evidence that has accumulated over the past few years. It is intended for students and the lay public to inform them that global warming is a real and growing problem that threatens the existence of human and other life forms.

II. CLIMATE CHANGE AND MARINE BIODIVERSITY

With the melting of large areas of the Antarctic ice shelf, more liquid and warmer water is available for colonization, and therefore, several plants and invertebrates have shown striking distributional changes (Smith 2001). Macroscopic plants like mosses have especially been influenced by the change in climate. But perhaps the Antarctic phenomenon that has not only regional but also global effects is the drastic reduction in population of krill (Euphausia superba) in the seas near that continent.

Reduction in sea ice area near the Antarctic Peninsula has affected krill recruitment rates. With Antarctic krill being a prime staple diet for numerous oceanic species (including whales) this reduction in krill numbers could have profound effects on the regional food web and subsequently on human economics. Coral reefs are especially sensitive to even miniscule amounts of warming. An increase in long-term summer water temperature averages in the tropics by 1.0ºC for several weeks is enough to trigger mass bleaching (Walther et al. 2002).

Global warming could directly affect human fishery industry. Variations in atmospheric air circulation over the Bering Sea impede the movement of juveniles away from adults of a commercially and ecologically vital species of fish, the Walleyed Pollock (Cushing 1995). This makes the juveniles increasingly vulnerable to cannibalism. Considering the fact that Pollock is an important forage fish for a wide variety of mammals (including people) and birds, negative consequences to the entire food web may be inevitable.

Global warming along with human overexploitation can exacerbate the situation of depleted fish stocks. Another species of commercially and ecologically important fish, the North Sea Cod, faces such a "double jeopardy" situation. The cod's long adult life span usually buffers it against times of poor recruitment, but over-harvesting of adult fish by people has increased the vulnerability of the species to population crashes in face of climate change (Plancue & Fredou 1999).

III. Climate Change, Marine Biodiversity and Food Security

Recent shortcomings of food supply led to riots in several countries and rose awareness to the pressing problem of global food security. Public attention however mainly focuses on the role of agricultural food production. Meanwhile it is of-ten forgotten that the world's oceans are one of the largest food reserves on the planet. According to estimates of the Food and Agriculture Organization (FAO), globally some 200 million people depend on fishing and aquaculture. In a number of developing countries consumption of fish provides close to or more than 50 percent of total animal proteins. Especially the extreme poor lack livelihood alternatives to fishing and are extremely vulnerable to environmental changes. Marine fishery depends even more on biodiversity than terrestrial agriculture as it harvests the produce of wild marine ecosystems and rests upon natural infrastructure.

Knowledge about the impact of climate change on the world's oceans is still poor and the complexity of the marine ecosystem calls for intensified research. Discussions focused on the impact of climate change on the world's oceans, the compatibility of biodiversity and food production as well as perspectives of fishery management and policy options.

IV. ImPact melting of polarl ice caps on marine biodiversity

There is strong evidence that polar ice-caps are, in places, rapidly melting. This is both in response to emergence from the last ice age but also current unprecedented rises in atmospheric carbon dioxide. Melting and the regional warming underlying it are highly complex and influences on life are debated. Ice reduction is leading to new sea-ways, and habitat for ice associated organisms is regionally vanishing. Coastlines are changing so more deep areas, shelf, intertidal zones and islands are available for colonization.

More light and heat will enter the water column, increasing primary productivity and sinks for CO2. Ice-bergs will increase with ice shelf collapses but ultimately decrease as glaciers retreat inland. Lack of ice scouring should increase biodiversity at local scales (less destruction) but greatly decrease it at larger scales as pioneer animals will be smothered by dominant competitors (as mussels do along temperate coastlines). Melt water flow into seas is causing freshening, stratification, and near-shore sedimentation. These negatively influence on biodiversity by clogging and burying the plankton eaters living on the seabed. (Barnes& Kaiser, 200)

Deglaciation and warming potentially threaten most Antarctic animals with change to their habitats beyond that they may cope with; effectively they may lose their habitat. In the short term though, the collapse of coastal ice shelves means new areas of continental shelf and slope become available for colonization and thus expanding their habitats.

A. A changing coastline

With the disintegration of some ice shelves and the retreat of coastal glaciers along the Antarctic Peninsula, especially at the northern end, the coastline is changing rapidly. The extent and rate at which this is happening has accelerated over the last half century. This is opening up new areas for colonization and thus increasing the area of shallows for seaweeds and animals.

The duration and timing of fast ice is highly variable anyway but mean reduction of this is reduction of a habitat to organisms that live in its matrix, on or associated with its undersurface. A major influence of fast ice to the global thermoregulation is surface albedo (changes in the degree to which light and heat are reflected).

Most of the marine environment can be described as 'deep sea', which covers 361 x 106 square meters, i.e. about 88% of the world ocean. Despite being rarely seen and poorly studied, the deep sea represents the largest habitat on Earth and makes a huge contribution to the heat balance of the World's climate system. In any discussion about influences of climate variability, such as here on melting of ice caps, the deep sea is too significant not to be considered.

V. Policies for Mitigation and Adaptation

Mitigation of climate change requires drastic cuts in greenhouse gas emissions. While mitigation of climate change is generally accepted as a global commons problem adaptation for a long time has been regarded as a challenge mainly for the local level. Inequalities in capacity to adapt to climate change now are be-coming increasingly apparent.

Poor countries are likely to suffer most from the impact of climate change but they usually lack capacities for adaptation. It was only recently that the global community recognized adaptation as a problem that needs to be addressed through international cooperation and requires large amounts of funding. Planning for climate change adaptation confronts governments in developing countries with challenges at many levels. Without effective adaptation, increased flooding and the degradation of fresh water fisheries are expected to lead to an escalation of socio-economic costs in coastal areas.

Adaptative measures would need to include:

- The development of knowledge on impacts and vulnerabilities to climate change.
- Information and education to enhance the level of awareness and understanding.
- The selection of culture sites.
- The integration of adaptation into comprehensive plans for managing coastal areas.

VI. Ecosystem-based Management for the Oceans.

Over half of the U.S. population lives along the coast, and more than $200 billion in economic activity was associated with the ocean. (U.S. Commission on Ocean Policy, 2004). Recently, the Pew Oceans Commission and the U.S. Commission on Ocean Policy concluded that a combination of human activities on land, along the coasts, and in the ocean are unintentionally but seriously affecting marine ecosystems by altering marine food webs, changing the climate, damaging habitat, eroding coastlines, introducing invasive species, and polluting coastal waters. These changes threaten the ability of ocean ecosystems to provide the benefits Americans expect from marine ecosystems.

Currently, each activity or threat is typically considered in isolation; coordinated management of cumulative impacts is rare. Both commissions call for a more comprehensive, integrated, ecosystem-based approach to address the current and future management challenges of our oceans. Both commissions describe ecosystem-based management as the cornerstone of a new vision for healthy, productive, resilient marine ecosystems that provide stable fisheries, abundant wildlife, clean beaches, vibrant coastal communities and healthy seafood for all Americans.

Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans. The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors. Specifically, ecosystem-based management:

- emphasizes the protection of ecosystem structure, functioning, and key processes.
- is place-based in focusing on a specific ecosystem and the range of activities affecting it.
- Explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species.
- acknowledges interconnectedness among systems, such as between air, land and sea; and integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences.

An ecosystem is a dynamic complex of plants, animals, microbes and physical environmental features that interact with one another. Humans are an integral part of ecosystems, marine and terrestrial. 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).

VII. B iodiversity Indicators

Biodiversity is the variability among life forms from all sources including, terrestrial, marine, and other aquatic ecosystems1 and the ecological complexes of which they are part. This includes genetic, species and ecosystems diversity. They are:

- Status and trends of the components of biological diversity - examines the state of biodiversity in terms of species, habitats and genes;
- Threats to biodiversity - examines some of the pressures on biodiversity such as pollution, invasive species and climate change.
- Ecosystem integrity and ecosystem goods and services identify major changes in the functioning of ecosystems.
- Sustainable use- considers the extent to which biodiversity is being used in a sustainable fashion.
- access and benefit sharing - tracks how benefits from biodiversity (mainly in terms of genetic resources) are being equitably shared.
- Status of resource transfer and use - depicts how much resources are allocated to biodiversity.
- Status of traditional knowledge innovation and practices - tracks traditional knowledge.

Climate change is one of many human-induced stressors on marine ecosystems and biodiversity. Other stressors include destruction and fragmentation of habitat, pollution, overexploitation, and invasive species. Recent research has demonstrated the staggering extent of multiple stressors on oceans with 40% of the world's oceans already heavily impacted by human activities, and no area of the global oceans left unaffected by human influence (Halpern et al 2007). Harley et al. (2006) note that "…marine ecological responses to climate change will hinge on human fishing pressure". Fishing impacts marine ecosystems through overfishing, destruction of habitat and by catch (Worm et al. 2006). Combined, these stressors affect the resilience of ecosystems, thereby increasing their vulnerability to climate change.

Ecosystems can recover from many kinds of disturbances. However, there is often a threshold beyond which an altered Hannah and Hansen (2005) stress the importance of making climate change an explicit consideration in connectivity design and provide specific steps for designing dynamic landscape or seascape plans. By taking into account projected changes in climate Determining the effectiveness of the management strategies and changing management regimes based on this information, is key to further adaptation success (Da Fonseca et al.2005). Since climate change impacts are uncertain, monitoring provides important information on which to base future management decisions.

These impacts may necessitate a fundamental rethinking in the approach to protection. Protected areas are rooted in the concept of permanence: protection works best as a conservation tool if the area remains protected for the foreseeable future. Protected area agencies have rightly resisted attempts to move protected area boundaries or de-designate protected areas for periods of time. But under climate change, species for which a particular protected area was established may no longer survive there. Some protected areas—for instance in coastal, arctic and montage regions may disappear altogether in their current form. The current extinction crisis is likely to become more intense as environmental conditions change and fluctuate at an unnatural rate.

VIII. SOLUTIONS

From the above it is apparent that all regions of the planet earth in some ways are being adversely affected by the global warming trend. Most of the corrective measures pertain mainly to the industrialized world, such as developing alternate sources of energy rather than depending heavily on fossil fuels, or manufacturing more petrol efficient automobiles, to name a couple of actions. In tropical biomes the big issue is preserving ecosystems that absorb atmospheric carbon dioxide. This measure would encourage the cessation of rampant clearing of tropical forests for conversion to agricultural production. Also in this regard, adopting programs to invigorate reforestation in formerly cleared but unproductive lands would be a stellar activity. As nations within the tropical biomes become progressively industrialized, there too, energy sources and means of transportation will become significant issues.

Preventing change: the optimum way to reduce the impacts of climate change on protected areas is to dramatically reduce the heat-trapping gases that cause climate change. Carbon dioxide, the main heat trapping gas, is emitted by the burning of fossil fuels (coal, oil and natural gas). If these emissions are not cut deeply and quickly, there will be little chance of saving many protected areas. The power sector is responsible for 37% of those emissions globally and has many opportunities to switch from coal to clean power.

Managing for change: many climate change impacts are exacerbated by other pressures: even climate-related phenomena like coral bleaching and dieback are increased by pollution and mechanical damage. WWF is publishing a guide to adaptation strategies, "Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems", 70 the first comprehensive account of how protected areas might be managed in a rapidly changing climate.

Planning for change: Protected area agencies need advice and political support for planning protected area networks to withstand or adapt to change as much as possible. This needs to be a collaborative, global exercise. WWF proposes that the World Commission on Protected Areas would be one obvious body to coordinate such an effort, perhaps as a task force under its theme on management effectiveness.

IX. CONCLUSIONS

It is clear that global warming has started negatively affecting a wide variety of organisms world-wide. Extinctions have started, and many organisms are being pushed closer to extinction or local extermination as a direct or indirect result of climate change.

It is becoming increasingly accepted that polar ice-cap melting is happening rapidly, is likely to continue to happen and may do so at an increasing rate, regardless of human progress towards CO2 reduction targets. Ice-cap melting and regional warming is clearly a complex issue, both in space and time. The most serious effects with respect to leading to impacts on biodiversity fall into six broad categories.

i) Ice sheet and fast-ice reduction (leading to new sea-ways).

ii) Coastline change (more deep areas, shelf, intertidal zones and islands).

iii) More light and heat entering the water column, leading to greater primary productivity and sinks for CO_2.

iv) Iceberg changes (increase then decrease) causing habitat alteration.

v) Fresh water flow into seas causing freshening, stratification, and near shore sedimentation.

vi) Changes in water mass properties and current dynamics.

These first and second order effects will lead to direct impacts on marine biodiversity. As with the future of melting and warming, predicting influences on biodiversity are difficult as the nature and richness of organisms differ so much between regions. Across the Earth's oceans, principal influences that are being seen currently and/or likely to be seen include five points.

1) Population changes. Population sizes of sea ice associated organisms are likely to drastically decrease. This

will affect many animals using the surface of ice, like mammals and birds, the ice itself such as the highly productive algae and bacteria and the primary consumers such as krill and an entire community dependent on this productivity as well as underlying benthos.

2) Species migrations. Resident species have few choices; to survive they must either adapt *in situ* to the many changes associated with polar ice-cap melting or move to stay in their niche (get back into their 'comfort zone').

3) Species extinctions. Many types of animal and species disappeared from Antarctica as it cooled, but now most recent species are endemic. Thus, species lost from the Southern Ocean is a loss of both regional and global biodiversity.

4) Species radiations. Major radiations of species have been associated with complex coastlines such as in archipelagos. Speciation events are known to have taken place around times of changing ice conditions in the past, but the time scale of radiations is large in comparison with current polar ice melting.

5) Non Indigenous Species. NIS will have invasions, establishment and spread.

Ocean ecosystems and biodiversity are at risk as a result of the stresses of climate change. Canada has obligations under the Convention on Biological Diversity and the UN Framework Convention on Climate Change to initiate measures that will facilitate adaptation strategies to protect ecosystems and biodiversity.

Most of marine environment is still threatened by the combined impacts of climate change and other stressors such as overfishing and habitat destruction.

It is clear that global warming has started negatively affecting a wide variety of organisms world-wide. Extinctions have started, and many organisms are being pushed closer to extinction or local extermination as a direct or indirect result of climate change. Since this is a problem that has been created by humans, it behoves us to solve it.

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