

Protecting Biodiversity in a Changing Climate: The State of Adaptation Policies Dedicated to Enhancing the Resiliency of Biota

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Introduction

Due to the unprecedented rate of human-induced climate change, there is now widespread consensus that unless proactive adaptation efforts are embraced, significant and sustained biodiversity loss will occur. Climate change has already begun to impact biodiversity, and trends are becoming visible, including modification of migration patterns, length of growing seasons, species distributions, and invasive species outbreaks (Parmesan 2006). While conservation biologists have performed extensive research on climate impacts to biodiversity and have dramatically improved scientific understandings of the problem, as well as adaptation tools to contend with the challenge, the influence of this knowledge in shaping policy responses has been limited. Mitigation of greenhouse gas emissions remains the focus of climate change policy, and advancement of adaptation measures, especially for biodiversity conservation, has been slow to take form. This prioritization is problematic because institutional coordination for biodiversity at all scales will be essential in a changing climate (Lovejoy and Hannah 2005).

A few jurisdictions have developed adaptation policies for enhancing biodiversity resiliency in a changing climate. However, an unexplored puzzle has emerged: these policies have diverged with regard to the tempo of policy advancement—with some jurisdictions embracing adaptation policies more readily than others—and have begun to converge with regard to the type of measures that the final policy embraces. In other words, no policy has yet to incorporate precautionary targets and timetables that contend with the magnitude of the problem, as defined by scientific assessments. This paper will provide an overview of climate impacts to biodiversity, an introduction to adaptation measures for biodiversity conservation, and a brief assessment of the current state of adaptation policies for enhancing the resiliency of biodiversity in a changing climate.

Overview of climate impacts to biodiversity

Human-induced climate change has been recognized as one of the greatest challenges facing our planet. It is already rapidly transforming our world, affecting both human-built and natural environments. Overall, the Earth has already warmed 0.8°C in the last century, having increased 0.2°C per decade within the last thirty years. Even if we were to stabilize emissions at lower levels, we would still witness significant impacts. For example, if greenhouse gas levels were stabilized at 2000 levels, atmospheric temperatures would increase by 0.5°C by the end of this century and the amount of sea level rise would increase by 320% by the end of this century (Meehl et al. 2005). And if we were able to halt greenhouse gas emissions altogether, the Earth would still undergo significant increases in both temperatures and sea level rise as a result of the lag effects of greenhouse gases in the atmosphere, as well as thermal inertia. Hence, the science is clear; even if we were to stabilize at lower emissions lev-

els, or eliminate emissions, we would still have already committed to substantial impacts, supporting the need for adaptation policies.

Changes in ecosystems often parallel changes in local climates. As climates are altered, ecosystems can, in turn, be affected. Rising temperatures will have significant implications on precipitation trends and hydrological cycles, as some regions become wetter, while others become drier due to the changes in atmospheric circulation and water-holding capacity of a warmer atmosphere. Changes to biota can be carried out at the micro scale of the cell—and, scientists are now finding, even the genetic composition of some species is changing—to the macro level of the biome. Species will vary in their responses to a changing climate, and several indicators have been developed to assess vulnerability to climate change impacts. Some species will have high tolerances to change, while others will quickly become threatened or extinct, namely those with poor dispersal capabilities, restricted ranges, habitat or niche specialization, low tolerance to climate sensitive variables, and isolated population distributions such as mountaintops or islands. And some species will migrate to more tolerable regions. For example, species in high latitude regions are likely to shift tens of kilometers poleward by 2050, whereas temperate and tropical montane species are likely to shift hundreds of meters in altitude by mid-century (Forrest 2003). Species migration will in turn affect ecosystem composition.

Climate change will likely become a leading driver of biodiversity degradation in the 21st century. The Intergovernmental Panel on Climate Change (IPCC), an international body created by the United Nations Environment Program and the World Meteorological Organization to provide authoritative assessments on climate science and impacts, has recently suggested that 20% to 30% of species will likely be at a higher risk of extinction with temperature increases greater than 1.5°C to 2.5°C, and risks will increase with additional temperature rise (IPCC 2007). For those species that can adapt, they may dramatically change their ranges (Forrest 2003). As species migrate—and species will migrate individually—new assemblages of species will be created, which can have adverse impacts to food chain and community dynamics, presenting new challenges to biodiversity management and conservation. Moreover, other human-induced stressors, such as land conversion and fragmentation, habitat destruction, pollution, and overexploitation, leave ecosystems and biodiversity more fragile in a changing climate. Thus, non-climate drivers of degradation act synergistically with climate change impacts, a combination of effects that arguably presents the greatest challenge facing conservation today (Lovejoy and Hannah 2005).

Overview of adaptation for biodiversity conservation

As indicated above, because thermal inertia and the lag of climate change impacts will result in significant effects (Meehl et al. 2005), a two-pronged policy approach that employs both mitigation and adaptation will be required to ameliorate future environmental degradation. While mitigation activities will direct efforts to curb greenhouse gas emissions, adaptation efforts will bolster biodiversity resiliency. Although adaptation strategies will not protect all species from climate change impacts (e.g., there may be physical barriers to migration), adaptation is a critical component of biodiversity conservation in a changing climate.

The notion of adaptation is not novel. Ecologists have long used the concept of adaptation to depict the evolution of organisms in a new environment. Broadening this definition, adaptation in the context of climate change connotes the evolution of humans and ecosystems to new environments caused by climate change (Abramovitz et al., undated). (However, it should be noted that this change will not occur on an “evolutionary” time frame, as human-induced climate change has ensued at a much faster rate.) Indeed, adaptation has been defined similarly by climate change experts. The IPCC defines adaptation as the “adjustment in natural or human systems in response to actual and expected stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC 2007:6).

Adaptation strategies to bolster biodiversity resiliency require assessments of vulnerability and impacts on the local level, primarily through the advent of sophisticated modeling (Abramovitz et al., undated). There are a number of modeling tools now available for assessing climate change impacts to biodiversity, including regional climate models, dynamic and equilibrium vegetation models, species bioclimatic envelope models, and others. After vulnerabilities are assessed, adaptation strategies could include: rigorous monitoring and evaluation, control of invasive species, establishment of corridors, reduction of non-climate stressors, and acquisition of new reserves (AHTEG 2005). In addition, rehabilitation of previously degraded ecosystems can aid in the maintenance of viable habitat (Dharmaji et al. 2003). Another essential component of adaptation for biodiversity conservation is the reduction on non-climate stressors, such as habitat fragmentation, over-harvesting, pollution, and other factors which augment the impacts of climate change on ecosystems and biodiversity (AHTEG 2005). Ultimately, the most effective basket of adaptation tools for strengthening biodiversity resiliency will be context-specific and require rigorous assessments by trained experts in conservation biology, managers and other scientific knowledge holders.

Adaptation measures for protecting habitat and species diversity will benefit not only ecological communities but also human communities that depend on ecosystem services. Ecosystems and biodiversity constitute food, water supply, and medicine, as well as water filtration systems, arable land, and other provisions (Dharmaji et al. 2003). The benefits that can be obtained from ecosystems are known as “ecosystem services.” Ecosystem services translate natural assets, such as trees, snow cover, soil fertility, etc., into valuable benefits for humans, such as wood production, winter tourism, and arable land. Climate change has implications for ecosystem transformation, which can in turn impact services from ecosystems and compromise human wellbeing. Thus, the conservation of biodiversity is inextricably bound to the safeguarding of ecosystem services that provide for basic human needs.

Adaptation policies for biodiversity conservation also have ramifications for sustainable development agendas. In its Third Assessment Report, the IPCC claims that developing countries will be most vulnerable to climate change impacts, as a result of their low adaptive capacity and dependence on ecosystem services (IPCC 2001). Due to institutional and financial barriers to the establishment of adaptive capacity, developing countries are accordingly more vulnerable. Strengthening adaptive capacity entails reducing natural resource depletion, alleviating poverty, mitigating pressures on resources, improving management of risk, and other facets of sustainable development goals. Thus, as the IPCC aptly notes,

strengthened adaptive capacity can lead to the enhancement of sustainable development and vice versa, and these goals are “mutually reinforcing” (IPCC 2001:8).

Overview of the state of adaptation policies for biodiversity conservation

Dharmaji et al. categorize adaptation policy responses into four classes: (1) *maintenance of status quo*, which could result in significant risks and costs in the future; (2) *no regret strategies*, which employ only strategies that do not present great costs to communities; (3) *precautionary measures*, which are based on the premise that actions should be taken to contend with predicted impacts; however, precautionary strategies must be cost-effective; and, lastly, (4) *proactive strategies*, which entail the implementation of far-reaching and aggressive measures in an attempt to mitigate adverse climate impacts (Dharmaji et al. 2003). The majority of adaptation measures remain in the “maintenance of status quo” or “no regret strategies” categories; yet adaptation measures for the enhancement of biodiversity resiliency, given that species loss is irreversible, require both “precautionary measures” and “proactive strategies.”

A brief overview of adaptation policies for biodiversity conservation in five case studies follows: Finland, Australia, Canada, United States, and international deliberations.

Finland. In 2003, Finland’s Parliament commenced work on its National Strategy for Adaptation to Climate Change. The strategy calls for evaluating existing protected areas networks, reducing non-climate stressors in degraded areas, improving monitoring and planning, and studying thresholds of biodiversity to climate impacts. The document also has a number of short-, medium-, and long-term measures (MAFF 2005).

Australia. The Australian government has backed widespread monitoring of climate effects in protected areas and, most significantly, adaptation measures for management. The government has released a “National Biodiversity and Climate Change Action Plan” which is the first national adaptation strategy of its kind (NRMMC 2004). Most significantly, as of late February 2007, state and federal governments, led by the New South Wales government, have decided to create a 2,800-km conservation corridor from Victoria to Queensland, known as the “Alps to Atherton” corridor, to assist species migration in a changing climate. While land will not be acquired by the governments, and, thus, participation remains voluntary, this project is one of the first corridors to be designed to address climate impacts to biodiversity and will be among the longest conservation corridors in the world (Wood 2007).

Canada. Paralleling the Australian government, the Canadian government has been a leader in adaptation efforts for biodiversity management. The government’s report entitled *The State of the National Parks* identifies climate change as a leading factor in ecosystem degradation, and Parks Canada has since launched a project to improve the resiliency of their park network (Scott 2003).

United States. While the U.S. Environmental Protection Agency has developed a pilot “Climate Friendly Parks” project, which calls for voluntary action to address climate change, measures resulting from the project focus on mitigation efforts solely, e.g. energy-efficient buildings and facilities. The U.S. Climate Change Science Program is finalizing a review of “adaptation options for sensitive ecosystems and resources” (USCCSP 2006).

International. Although no timetables or binding targets exist for adaptation for biodiversity conservation on the international level, adaptation measures have increasingly been folded into multilateral environmental agreements and funding mechanisms, including the U.N. Framework Convention on Climate Change, Kyoto Protocol, Convention on Biological Diversity, Ramsar Convention on Wetlands, and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) World Heritage Convention. However, the large majority of measures define adaptation broadly and do not stipulate that parties must carry out adaptation activities for the preservation of species diversity and habitat. In addition, with the exception of the World Heritage Convention's Danger List, these measures fail to establish a methodology for project prioritization, which is necessary given global constraints in capacity (AHTEG 2005).

Conclusion

Despite scientific advancements on assessing climate impacts to biodiversity, as mentioned above, decision making on adaptation for biodiversity conservation has yet to progress towards "precautionary" or "proactive" policy solutions on either the international or national levels. While a number of adaptation strategies can be employed to strengthen the resiliency of biodiversity in a changing climate, a coordinated policy response has yet to emerge, and binding targets and timetables are needed to ensure that appropriate strategies are adopted to contend with climate effects.

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