

..... A Special Conference Report

RESPONDING TO CLIMATE CHANGE

WORKING TOGETHER TO CONSERVE LAND, WILDLIFE AND HABITAT

..... September 2009



“Virtually all scientists recognize that we are in an era of rapid climate change that will adversely affect ecological resources and that innovative conservation strategies for wildlife, plants and habitat must be implemented to ensure a sustainable future. This Massachusetts-led conference on climate change adaptation is truly a groundbreaking opportunity and defining moment for developing science-based responses to a crisis that affects all life on earth.”

—E.O. WILSON



A CONFERENCE COMMITTED TO CHANGE

ON NOVEMBER 15, 2008, ten non-profit and Massachusetts state organizations sponsored a groundbreaking conference at Bentley College in Waltham, Massachusetts: *Responding to Climate Change: Working Together to Conserve Land, Wildlife and Habitat*.

The first of its kind in the Commonwealth of Massachusetts and the nation, the conference brought together nearly 200 conservation leaders from across 60 organizations, including scientists, land stewards, hunters, anglers, government officials, advocates, foundation officers, policy-makers and others.

This report, compiled by Manomet Center for Conservation Sciences (Manomet), shares information about climate change and its impacts to wildlife presented at the conference and includes resources and contact information for each of the sponsors. A DVD of conference presentation

highlights has been included with this report, and is also available at www.climateandwildlife.org.

We hope you will be inspired to work with the newly formed Climate Change and Wildlife Alliance—Massachusetts to conserve land, wildlife, and habitat.

Manomet would like to thank all of the organizations that contributed to the content of this report, along with our partners who helped make the conference such a success.



On Friday, February 27, 2009, Governor Deval Patrick joined wildlife experts for a black bear population survey in Whately, MA.



Commissioner Mary Griffin assisted in banding a juvenile bald eagle in Middleborough in June 2009 as part of MassWildlife's research and restoration program for the state endangered species.

Message from Massachusetts Governor Deval Patrick

The Commonwealth through its Executive Office of Energy and Environmental Affairs and the Department of Fish and Game is working closely with our conservation partners to protect fish and wildlife for future generations. We are making big investments to conserve land of the highest ecological importance. While we must do all that we can to reduce emissions and promote clean energy, we must also act to develop the best practices to protect these lands and our fish and wildlife populations for future generations in the face of climate change.

View of Climate Change From the State

— Commissioner Mary Griffin, Massachusetts Department of Fish and Game

The Massachusetts Department of Fish and Game and its Division of Fisheries and Wildlife were pleased to co-sponsor the conference on *Responding to Climate Change* that brought together almost 200 conservation leaders from across our state and around the country to share best practices on conserving fish and wildlife in response to this dynamic period of climate change. Along with our conservation partners we continue to work on scientific tools to focus our land protection and restoration efforts in the places that matter the most, informed by what these wildlife habitats are today, and what they may become in a more rapidly-changing climate. Participation by the Department of Fish and Game and the Division of Fisheries and Wildlife in co-sponsoring the conference demonstrates the Commonwealth's leadership in climate change solutions.

A CHANGING CLIMATE AND HOW IT WILL IMPACT OUR REGION

— JOHN HAGAN, PH.D., PRESIDENT,
MANOMET CENTER FOR CONSERVATION SCIENCES

THE EVIDENCE that the planet is warming is now unequivocal. Over the last century the global temperature has risen by over 1.3°F. In the Northeast, the mean annual temperature has risen by more than 1.5°F since the 1970s, while mean winter temperatures have risen by almost 4°F over the same period. When we project into the future using climate models, we find that that over the remainder of this century we can expect mean annual temperatures in the Northeast to rise by another 5-10°F, bringing our climate close to that currently experienced in New Jersey or North Carolina. And it's not only temperatures that will change: while our climate models are less definitive about precipitation, it is likely that annual precipitation in the Northeast will increase by about 10% over the next century. Extended severe heat waves and droughts will become more frequent, and storms and flooding more severe.

Climate is a major determinant of the status and distributions of many species and the integrity of ecosystem processes, and we are already seeing clear climate change signals in the planet's ecosystems, including shifts in the distribution of vulnerable species; changes in the timing of breeding, migration, flowering, and hibernation seasons; species extinctions; and increased

ADAPTATION—Any action or policy intended to reduce the vulnerability of natural systems to actual or expected climate change effects and can include:

- Reducing the effects of non-climate stressors such as contaminants or invasive species
- Promoting or protecting biodiversity
- Establishing plant and wildlife corridors that bridge habitat patches
- Preserving large blocks of habitats and buffer zones
- Proactive habitat management aimed at reducing climate change impacts.

The net effect of these actions will be to increase the *resilience* of natural systems—that is, to enhance their ability to recover from a climate change impact and return to their natural state.

frequency and intensity of pest outbreaks. In the Northeast, changes in the migration seasons of fish, a longer plant growing season, earlier leaf-out and flowering in plants, and amphibians breeding earlier in the year have already been recorded.

Climate models also tell us that because of the inertia of the “climate machine,” even if we were to stop all greenhouse gas emissions overnight the climate would continue warming for several decades. This, together with the fact that we are already seeing ecological responses, means that emissions control, though crucial, is not the entire solution to our problem. If we are to protect ecosystems from the warming that has already occurred and will continue to occur, we also need to make our conservation strategies and practices “climate-smart.”

As conservationists and land managers begin to plan adaptation to climate change, many urgent questions present themselves. How will our systems change? How will their conservation values change? Which of our valued systems are likely to be more or less vulnerable? Where do we then allocate scarce resources? What practical and effective management tools and solutions are available to us? We have only just begun to address these adaptation questions. Our knowledge is still in its infancy.

Adaptation planning in Massachusetts took a major step forward in November 2008 with the *Responding to Climate Change* conference. This first-of-its-kind event brought together nearly 200 conservation practitioners from federal and state agencies, NGOs and private landowners to explore ideas about the adaptation approaches needed to conserve the Commonwealth's sites and natural resources under a changing climate.

In this report, we present the main messages and themes from the conference, from how the Northeast's climate is expected to change in the next century, the need for adaptation thinking, and the comparative vulnerabilities of ecosystems, to adaptation opportunities presented by local and national conservation policies. A participant survey taken after the conference elicited opinions from conference attendees about how serious a problem they believe climate change to be, how it will affect their responsibilities as conservationists and land managers, and what is needed if we are to successfully confront climate change in the Northeast. A summary of that survey is included on page 13.

One result: We need urgent action, and soon! The last part of this report describes how the Massachusetts conservation community is moving forward to tackle the most pressing issues raised by the conference and by the participants' poll.



“CONVERSATIONS” ON CLIMATE CHANGE

AN INTRODUCTION BY BERNIE MCHUGH, DIRECTOR, MASSACHUSETTS LAND TRUST COALITION

Massachusetts has been protecting land for the public good for over 375 years, since 1634, when citizens of Boston agreed to tax themselves to place in public ownership what later became known as the Boston Common. Protection of vital natural resources and civic engagement through democratic actions are woven into the very fabric of the “New England Way.” So it is no surprise that a conversation about safeguarding nature in the era of climate change has arisen from the grassroots of Massachusetts conservationists. It is also no surprise that their shared impulse from the beginning was to have a broad discussion across boundaries and interests, seeking to engage everyone with a stake in protecting our land, water and wildlife. The voices in this conversation are those of scientists, wildlife managers, landowners, hunters and anglers, philanthropists, land protection activists, policy-makers, environmental advocates and concerned individuals, all sharing a common goal of continuing to protect the wildlife we have worked hard to nurture and manage for many years against a threat which exacerbates so many of the other challenges we face. We are united in our concern for the world we live in and cherish.

CONFRONTING CLIMATE CHANGE IN MASSACHUSETTS

—MELANIE FITZPATRICK, PH.D., CLIMATE SCIENTIST,
UNION OF CONCERNED SCIENTISTS

FROM LUSH Berkshire valleys to the sandy Cape Cod shore, the climate of Massachusetts is changing. Records show that spring is arriving earlier, summers are growing hotter, and winters are becoming warmer and less snowy. These changes are consistent with global warming, an increasingly urgent phenomenon driven by heat-trapping emissions from human activities.

Massachusetts can expect dramatic changes in climate over the course of this century, with substantial impacts on vital aspects of the state's economy and character. Emission choices we make today—in Massachusetts, the Northeast, and worldwide—will help determine the climate our children and grandchildren inherit and shape the consequences for their economy, environment, and quality of life. Here we consider a higher-emissions scenario, which assumes continued heavy reliance on fossil fuels, causing heat-trapping emissions to rise rapidly over the course of the century, as well as a lower emissions scenario, which assumes a shift away from fossil fuels in favor of clean energy technologies, causing emissions to decline by mid-century.

Temperature: Average temperatures across the Northeast have risen more than 1.5 degrees Fahrenheit (°F) since 1970, with winters warming most rapidly—4°F between 1970 and 2000. If higher emissions prevail, average temperatures across the state are projected to rise 8°F to 12°F above historic levels in winter and 6°F to 14°F in summer by late-century, while lower emissions would cause roughly half this warming. Under the higher-emissions scenario, Massachusetts' cities can expect a dramatic increase in the number of days over 100°F.

Snow Cover: Snow is an iconic characteristic of Massachusetts winters—part and parcel of many favorite winter activities. Historically, Massachusetts has averaged one to three weeks of snow cover per winter month. Under the higher-emissions scenario, most of the state is projected to lose all but a few snow-cover days per winter month by late-century. Under the lower-emissions scenario, however, most of the state would retain between one and two weeks of snow cover per winter month, on average.

Sea-level Rise: Global warming affects sea levels by causing ocean water to expand as it warms, and by melting land based ice. With higher emissions, global sea level is projected to rise between 10 inches and two feet by the end of the century (7 to 14 inches under the lower-emissions scenario). These projections do not account for the recent observed melting of the world's major ice sheets—or the potential for accelerated

melting—and may therefore be conservative. However, even under these projections, Massachusetts' densely populated coast faces substantial increases in the extent and frequency of coastal flooding, erosion, and property damage.

Drought: In this historically water-rich state, rising summer temperatures coupled with little change in summer rainfall are projected to increase the frequency of short term (one- to three-month) droughts and decrease summer stream flow, particularly if higher emissions prevail. By late-century, for example, short-term droughts are projected to occur annually under the higher-emissions scenario compared with once every two years, on average, historically.

Fishing: Fishing pressure has depleted Northeast cod stocks in recent decades. Compounding this, rising water temperatures will place additional pressures on cod. Georges Bank, historically the Northeast's most important fishing grounds, is projected under either emissions scenario to become too warm to support the growth and survival of young cod by late this century, but would be able to support adult cod populations under the lower-emissions scenario. Lobster currently provides the highest dockside value for Massachusetts fishermen. Under either emissions scenario the nearshore waters south of Cape Cod are likely to warm by mid-century beyond the range tolerated by lobsters. Lobster habitat in certain shallow, nearshore waters of Massachusetts Bay may also be at risk.

Forests: Forests now dominate much of the Massachusetts landscape, providing recreation and tourism opportunities, wildlife habitat, and timber, while protecting watersheds, conserving soil, and storing carbon. Climate change has the potential to dramatically alter the character of the state's forests. Particularly vulnerable are the Berkshires' spruce/fir forests—home to treasured bird species including the Blackpoll Warbler and Yellow-Bellied Flycatcher. By late century, climate conditions suitable for these forests are projected to disappear from the state under either emissions scenario.

Conclusion: Global warming represents an enormous challenge, but we can meet this challenge if we act swiftly. The emissions choices we make today in Massachusetts, the Northeast, and globally will shape the climate our children and grandchildren inherit. The time to act is now.

Reference: Northeast Climate Impacts Assessment (NECIA). 2006. Climate change in the U.S. Northeast. Cambridge, MA: Union of Concerned Scientists.

THE CASE FOR ADAPTATION: CONSERVATION STRATEGIES IN THE FACE OF CLIMATE CHANGE

—WAYNE KLOCKNER, MASSACHUSETTS STATE DIRECTOR,
THE NATURE CONSERVANCY OF MASSACHUSETTS

CLIMATE CHANGE is upon us. Now. Farmers on North Carolina's Albemarle-Pamlico Peninsula are finding their drainage canals less effective and their fields increasingly flooded as sea level inches higher and higher. Coastal communities in the Asia Pacific region depend upon coral reefs for their livelihoods, and these ecosystems are threatened by increasing sea temperature and ocean acidification. Ancient glaciers in the high Andes are rapidly retreating, threatening the water resources of up to 60 percent of Peru's population. As Massachusetts warms, flowers are blossoming, trees are leafing out and birds are returning as many as three weeks earlier than they did in Thoreau's time, and weather data show that the average spring temperature in Concord has increased by approximately 4.5 degrees. The Intergovernmental Panel on Climate Change (IPCC) estimates that even if atmospheric greenhouse gas concentrations could be stabilized at 2000 levels, past emissions will still lead to unavoidable warming by the end of the 21st century. As a result, helping wildlife and natural habitats adapt to a changing climate is critically important.

What does adaptation mean? While mitigation strategies are intended to reduce climate change by limiting the build-up of greenhouse gases in the atmosphere, adaptation strategies are actions to reduce vulnerability to climate change, cope with its impacts, or take advantage of its potentially beneficial consequences.

Adaptation can mean enacting measures to increase natural resilience in species and ecosystems so they can recover more quickly from climate disturbances or adjust to new patterns of climate variability and climate extremes. It can also mean taking proactive steps to help species and ecosystems survive under new conditions or move to new locations where they can survive. Or it can mean attempting to enhance resistance to climate change by helping ecosystems fend off impacts in order to protect valued resources in their present locations or conditions. Different strategies will make sense in different situations. In some cases, the best approach will be to employ multiple strategies simultaneously.

Adaptation Strategies for Resilient People and Nature

The key to fostering resilient natural systems is to maintain overall ecosystem health and to conserve important areas. Conservation strategies must be implemented at large scales and with awareness that natural systems may already be changing in undetected yet significant ways. Effective conservation in the face of a rapidly changing climate requires us to think not only about where plants, animals and natural communities are currently

found, but where they might be found in the future. Developing adaptation strategies is not a simple, one-time exercise; it is a process that builds on itself. Adaptive management is critically important in order to respond to advances in our understanding of climate change and its impacts on wildlife. Strategies should be continually reassessed and adjusted as new information becomes available.

Climate change will likely cause moderate to severe disturbances to many of the natural systems that people throughout the world rely on for their livelihoods, for essential resources, for recreation and for spiritual renewal. To help natural systems be more resilient—or to retain their natural capacity to bounce back from disturbances—some time-honored and practical strategies are as follows:

Reduce Non-Climate Threats: To improve ecosystem resilience it is important to reduce non-climate threats. For example, limiting discharges in freshwater systems from industry and wastewater treatment plants and stormwater runoff from urban areas can reduce damage from pollution. Conservation organizations have been working to address most of these non-climate threats for years. Now they must address them with renewed energy because as climate change intensifies, the consequences will likely be even greater.



Walden Pond, Concord, MA

Pablo Sánchez—flickr.com



St. John River Forest, Maine

Protect Adequate and Appropriate Space: Protecting adequate space means setting aside core habitat for species that live in a region today and also habitat for species that migrate there as climate conditions change. Species and ecosystems have been adapting to gradual climatic change for millions of years primarily due to their ability to migrate to suitable new habitat. Today, fragmentation of natural systems by roads, infrastructure and other alterations has created obstacles to migration.

Protecting appropriate space means identifying areas that have high diversity and habitat and potential refuge to a wide range of species. Ecosystems will likely respond differently in the face of change; some will not survive while others will, ensuring that the area, though altered, remains a viable natural system. Highly diverse areas, with their varied gene pools and rich assortment of species, adapt better to change. Some locations are likely to remain relatively stable because they have physical features that make them less susceptible to rising temperatures and other climate impacts. These “climate refugia” should be considered priority sites for conservation.

Facilitate Adaptive Responses to Climate Change: In many places, climate impacts will be so severe, and non-climate stresses may already have produced so much alteration of natural systems, that it will be impossible for them to recover from disturbances on their own or adapt to new changes. To succeed here, adaptation will require more than providing corridors and buffers or reducing non-climate threats. It entails large-scale ecosystem restoration and assisted migration.

St. John River Forest in Maine is an example of managing ecosystems so that they can respond to predicted changes. The Nature Conservancy’s management plan for the region identifies tree species likely to become more abundant in a warmer climate.

Pollen records from a warmer period 500 years ago indicate that hemlock and white pine were once far more abundant than they are now. Today, no hemlock or white pine are harvested, but instead are maintained as “sentinel trees” at the outer edge of their ranges.

Build Natural “Resistance” to Climate Change: In some instances, especially in developed areas where valuable public and private investments are at stake, the immediate response to climate change may not be adaptation but resistance: building dikes and seawalls, filling flood-prone areas, enlarging reservoirs, deepening river channels. Whenever possible, The Nature Conservancy advocates using *nature-based strategies* as an effective, sustainable, often cheaper alternative to major infrastructure projects. These actions foster healthy ecosystems, lessen the impacts on human communities, and reduce the need for engineered approaches:

- Build or restore wetlands and marshes to create habitat for important species and provide a protective buffer against floods and wave surges
- Use dunes rather than seawalls to prevent seawater from inundating coastal areas while also supplying sand to replenish what is eroded away by wave and storm activity
- Protect and restore forests to reduce flood damage and erosion from more frequent and severe storms while maintaining access to clean water and food.

A Call To Action

Climate change in all of its many expressions is the most serious threat faced by wildlife and natural habitats. And the challenge of mitigating the causes of rapid climate change is enormous. But the good news is two-fold...first, we already know how to effectively implement conservation strategies to help nature adapt to many of these changes...most of us have been effectively deploying these strategies for years. Second, nature is often more resilient than we give her credit for. The resurgence of Massachusetts’ forests after the massive deforestation of the nineteenth century and the return of formerly extirpated species such as Fisher and Moose are evidence of that. We have the beginnings of wisdom and the benefit of a little time to help wildlife and natural habitat adapt to the inevitable changes to come IF we have the will to learn, cooperate, and act.

SAFEGUARDING OUR FUTURE: ADVANCING NATURAL RESOURCES ADAPTATION TO CLIMATE CHANGE

—JOHN KOSTYACK, EXECUTIVE DIRECTOR, WILDLIFE CONSERVATION AND GLOBAL WARMING,
NATIONAL WILDLIFE FEDERATION

NATURAL RESOURCES adaptation is the primary focus of this narrative; however, we wish to emphasize that such work takes place in the context of accelerating climate change, with disruptions of ecosystems occurring at a pace far greater than scientists had predicted even just a few years ago. If we fail to rapidly reduce greenhouse gas emissions, such ecosystem disruptions will only worsen, rendering ineffective much of the adaptation efforts put in place to conserve native species and habitats.

Regardless of our success in reducing future emissions, we have put the world on an irreversible path toward substantial additional warming and ocean acidification. This will force major adjustments in the way society organizes itself. It is almost inevitable that some coastal populations will require relocation, some agricultural areas will become less suitable for farming, and some forested areas will become unavailable for human use due to widespread tree mortality and catastrophic wildfires.

Recognizing that today's generation has a moral duty to pass on its natural inheritance to future generations, conservationists must ensure that ecosystem protection and restoration goals are a major component of how society adjusts to the changing climate. Conservationists and resource managers must therefore focus on preparing for and responding to the impacts of climate change and ocean acidification on species, habitats, ecosystems, and ecological processes. Healthy



Meadow Beach on the Cape Cod National Seashore, Truro, MA

ecosystems serve to successfully pass on a rich natural heritage to future generations. They are the planet's life support systems, providing a wealth of goods and services ranging from food and medicine, clean water, soil regeneration, and carbon sequestration, to buffers for people and property against storms, floods and droughts.

In today's warming world, protecting and restoring ecosystems will require deployment of the full array of conservation tools—habitat acquisition, management and restoration, species management, conservation planning, scientific research and monitoring, and public outreach and education. How, where, and when these tools are deployed, however, may need to differ from current practice in light of what is known about the effects of our changing climate.

Meeting the Financial Challenge

The natural resources adaptation agenda is an ambitious one. This year, the 111th Congress enacted comprehensive climate change legislation. For the first time ever, on June 26, 2009, the House of Representatives passed comprehensive climate change legislation. Known as H.R. 2454, the American Clean Energy and Security Act (CSA), the law places an annual and declining cap on greenhouse gas emissions and, as with last year's CSA, uses polluter payments for emission permits to support a variety of public purposes. Among these public



Tidal marsh, Rye, NH



Ipswich River at the Julia Bird Reservation in Ipswich, MA

purposes is natural resources adaptation. The bill provides an average of roughly \$1.7 billion annually over the bill's first 19 years for U.S. natural resources adaptation. It also provides extensive policy direction to the federal, state and tribal agencies to design and implement a national natural resources adaptation strategy.

Although H.R. 2454 is a positive start, the bill can be improved in two respects as it moves through the Senate and toward the President's desk for signature. Specifically, unless funding is insulated from the annual appropriations process, there is risk that it will be diverted toward purposes other than natural resources adaptation. (H.R. 2454 adequately shields the state share of the funds from the appropriations process, but not the federal share.) Second, natural resources adaptation should receive five percent of the value of all emissions permits. H.R. 2454 provides a one percent share for the first 10 years of the program, a two percent share for the next five years, and a four percent share for the remaining years. Five percent would amount to an average of \$4.3 billion annually over the 2012-2030 period. Although the cost of conserving natural resources threatened by climate change will be far greater than \$4.3 billion annually, this represents an appropriate level of investment given the numerous other pressing and legitimate demands for a share of polluter payments.

No study has yet tabulated the full cost of conserving species and ecosystems in the face of climate change, but it is clear that the cost will be substantial. For example, a series of studies on the costs of restoring the Everglades, Chesapeake Bay and Great Lakes suggests that the cost over five years ranges from at least \$10 billion to \$20 billion each. Another study found that \$350 billion would be needed over 30 years to make up a viable

habitat conservation network across the lower 48 states (using conservation easements to acquire interests in land).

While most of the conservation actions considered in these studies would build ecosystem resiliency in the face of climate change, these studies did not specifically take into account the impacts of climate change in arriving at their cost estimates. Natural resources adaptation also will inevitably require the development of novel tools and approaches. Unfortunately, little federal research and development funding to date has gone into adaptation planning and implementation. Substantial public investments are needed to spur innovation in this area. Considering that climate change magnifies the impact of existing stressors, policy makers must assume that these cost estimates significantly understate the overall costs of conserving ecosystems in the face of climate change. Indeed, early estimates of the additional cost of addressing climate change impacts on particular landscapes suggest at least a tripling in management costs.

Four billion dollars annually may appear to be a large price tag to some, but studies show that the economic benefits of conservation reach into the hundreds of billions annually and therefore far exceed these costs. As history has shown repeatedly, healthy, well-functioning ecosystems provide the foundation for a healthy economy.

Please note that this author's perspectives were provided shortly after the conference and for that reason certain information may have subsequently changed.



Nicewicz Farm in Bolton, MA

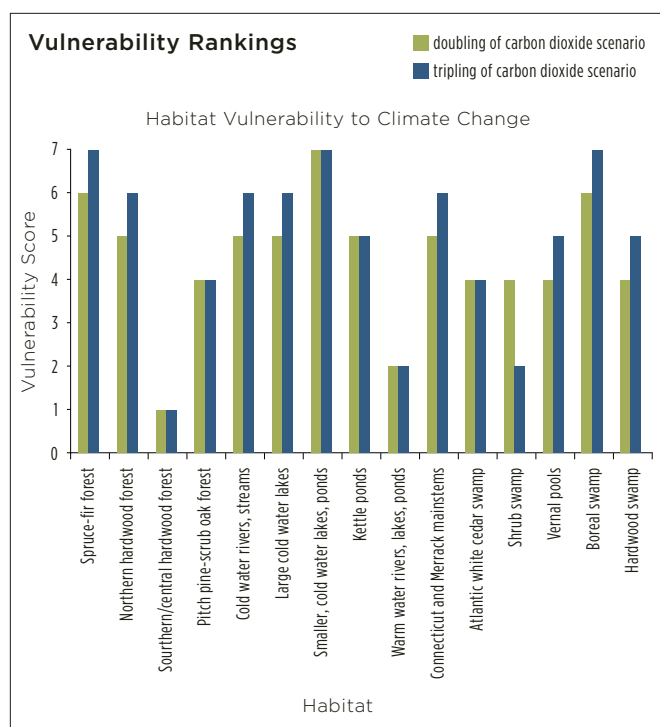
ASSESSING HABITAT VULNERABILITY TO CLIMATE CHANGE IN MASSACHUSETTS

—HECTOR GALBRAITH, PH.D., DIRECTOR, CLIMATE CHANGE INITIATIVE,
MANOMET CENTER FOR CONSERVATION SCIENCES

AS THE CLIMATE of New England changes and the rate of change accelerates, conservation agencies are confronted with a number of urgent and difficult questions. Which fish and wildlife habitats are the most vulnerable? How will habitats change? How do we manage important resources under climate change? It is essential that we answer these and other questions if we are to successfully manage valued resources in the future. In a collaborative project funded by the Wildlife Conservation Society, Manomet Center for Conservation Sciences (Manomet) and the Massachusetts Division of Fisheries and Wildlife (DFW) are addressing the most pressing of these adaptation questions.

A primary step in adaptation planning is assessing the comparative vulnerabilities of fish and wildlife habitats to future climate change. Without such an evaluation, it is difficult to know where to most effectively assign finite conservation resources. Working with an expert panel of DFW personnel, and focusing on 19 important habitat types, we have found that the likely vulnerabilities of Massachusetts wildlife habitats vary widely. Some important habitats are at high risk of being eliminated entirely from the state, while others may benefit greatly (Figure).

The State's fish and wildlife habitats fall into four main vulnerability categories:



1. Highly Vulnerable to Climate Change. These include high elevation spruce-fir forest, smaller cold water lakes and ponds, and spruce-fir boreal swamp. Category 1 habitats are cold-adapted, are predominantly northern in their distribution and close to the southern edges of their ranges in Massachusetts, and are relatively intolerant of disturbances such as drought, fire, or insect attack. They also support fish and wildlife species rarely found in other habitats. Under even relatively modest climate change, there is a high risk of large-scale reductions in the extents of these habitats in the Commonwealth. It is conceivable that some category 1 habitats and the species that they support may be eliminated entirely from the state.

2. Vulnerable to Climate Change. These include northern hardwood forest, cold water rivers and streams, and large cold water lakes. These are also cold-adapted, though not to the same degree as highly vulnerable habitats. Also, they are not so exclusively northern in their distribution, with some extending substantially south of Massachusetts into already warmer climates. Under even a low emissions scenario there is a high risk of major reductions in the extents of these habitats, but the changes are not likely to be as great as for highly vulnerable habitats.

3. Unlikely to Change Greatly in Extent Under Climate Change. These include pitch pine-scrub oak forest; shrub, cedar, and hardwood swamps; and riparian forests. Their distributions extend much further south than Massachusetts and they are not likely to be limited by the temperature changes expected under expected levels of climate change (although uncertainty in predicting future precipitation regimes confers a comparatively high degree of uncertainty on the projections for the wetland habitat types).

4. Likely to Benefit from Climate Change. Warm water and southern/central hardwood forests are largely southern in their distribution and flourish in areas with much higher temperatures than are typical for Massachusetts. They might be expected to extend their ranges further north and higher in elevation under a warming climate. This could result in these habitats eventually replacing more vulnerable types in the Commonwealth, such as cold water aquatic habitat and more northern forest types.

The information being generated by the Manomet/DFW vulnerability assessment will be crucial for future conservation planning in the state. Without a realistic appraisal of how a changing climate may affect the distribution and status of wildlife habitats in the state, developing effective management and future acquisition strategies is difficult. This study helps provide some of that essential information.

WORKING FROM THE BOTTOM-UP: LOCAL COMMUNITIES ARE KEY TO WILDLIFE ADAPTATION

—ANDREW WHITMAN, DIRECTOR, NATURAL CAPITAL INITIATIVE,
MANOMET CENTER FOR CONSERVATION SCIENCES

IF WE ARE TO SUCCEED, we ultimately need to rely upon both bottom-up and top-down approaches to climate change adaptation for wildlife. Both have inherent limitations and inherent opportunities. A multi-scaled integration of both types of strategies can be complementary and will prevail in providing the greatest success in conserving wildlife in the face of climate change.

Top-down approaches can be relatively simple and fast when enacted by few at the top, but the lack of local participation and knowledge can erode the effectiveness of top-down approaches (Table 1).

Table 1: Advantages and disadvantages of bottom-up and top-down approaches	
Bottom-up	Top-down
Advantages: <ul style="list-style-type: none">• Creates social legitimacy• Leverages relevant knowledge• Empowers locally appropriate solutions	Advantages: <ul style="list-style-type: none">• Simplicity• Speed
Disadvantages <ul style="list-style-type: none">• Complexity (many decision makers)• Time consuming• Timing may not link to funding	Disadvantages <ul style="list-style-type: none">• Lack of ownership• Lacks local knowledge inputs• Competes with local issues• Lack of local \$\$ resources

A Bottom-up approach is one that works from the grassroots – from a large number of people working together, causing a decision to arise from their joint involvement. Working from the bottom-up is a crucial part of conservation work in the northeast because local home rule (town by town) prevails in land use planning across the region. This has resulted in a lack of regional planning. Exceptions are local watershed groups, land trusts, and regional land conservation efforts which see beyond town lines.

There is opportunity for local efforts to build local capacity and support for climate change adaptation for wildlife and conservation values. However, bottom-up approaches have several challenges, including: (1) complex decision-making due to many decision makers, (2) slow progress because of the reliance on volunteers or lack of paid staff, (3) lack of synchrony between projects and funding opportunities, (4) lack of local

planning resources (staff and money), (5) lack of local political will (wildlife take a backseat to other local issues), (6) lack of interest to take the long view (wait until it is a serious problem), and (7) the tendency for local efforts when focusing on wildlife to concentrate exclusively on endangered species and biological hot spots.

Despite these somewhat messy challenges, working from the bottom-up offers important advantages. The primary advantage of local participation is that it creates “buy in,” which builds local social legitimacy and leverages knowledge. That can create a menu of practical and effective solutions appropriate to the local values, capacity, and ecosystems from which other communities can select, instead of a one-size-fits-all solution that may be a poor fit in every community.

Massachusetts is fortunate in that it has many established, local organizations working at the grassroots level (Table 2). Many do not directly work to conserve wildlife, but they do have an interest in ecosystems services and have the capacity to make or support decisions that are favorable to wildlife.

Massachusetts is also fortunate to have over 10% of communities participating in the Massachusetts Climate Action Network (Table 3). This network is laying down important ground work building local capacity and addressing local climate change issues.



Wood Frog in Essex County Boxford, MA

Table 2. Examples of organizations that make or influence locally-made decisions

- Community land use planning
- Regional watershed groups
- Local land trusts
- Farmer co-ops (e.g., Ocean Spray, AgriMark, etc.)
- Massachusetts Forest Landowners Association
- Massachusetts Woodlands Cooperative
- Massachusetts Wood Producers Association
- Massachusetts Association of Professional Foresters
- Massachusetts Farm Bureau
- Massachusetts Climate Action Network

It is essential that existing grassroots efforts become better integrated to leverage knowledge and reduce duplication and waste of scarce resources.

Learning from other local efforts is also essential if adaptation efforts are to avoid re-inventing the wheel (e.g., City of Keene 2007, Center for Science in the Earth System 2007). Many communities have tremendous emergency planning structure in place that includes features of sound climate change adaptation: they are multi-scale, cross-sector, work interdependently, and focus on risk.

Overcoming challenges to climate change adaptation will require:

- Building capacity
- Generating public support
- Strengthening integration
- Providing adequate funding, and then
- Implementing new (but few) actions.

Building capacity includes conducting simple research on local impacts (can be simply gathering information from published sources), changing or developing new regulations, codes, plans, policy or programs, internal organizational development, awareness-raising, working in partnership, and creating new relationships for addressing widespread challenges. For communities this requires using a variety of outreach tools for making municipal leaders knowledgeable about climate change. It also requires strong relationships so that local institutions can share climate change information from a variety of sources and leverage existing and new relationships to efficiently accomplish adaptation goals.

Generating greater support for climate change adaptation for wildlife is a tough sell when most local communities are strapped for resources. To overcome this resistance, it is critical to make climate change adaptation for wildlife relevant at the local level by broadening the conversation from wildlife to ecosystem services—the goods and services provided by nature that sustain us and our well-being: clean water and air, open space, local food, and wood fiber. Conserving ecosystem services connects people directly to wildlife habitat conservation. For example, keeping water clean for human consumption requires healthy aquatic



The tern and piping plover nesting area at the Shifting Lots Preserve in Plymouth, MA

ecosystems; open space for recreation and enjoyment of nature can also be habitat for upland wildlife.

Local conservation efforts will need to focus on three adaptation concepts: resistance, resilience, and response.

Resistance actions reduce the impact of climate change by “hardening” our systems, such as by assuring landscape connectivity for movement and dispersal of wildlife, improving stream crossings to reduce blow-out threats from climate change related extreme precipitation events, and changing management of impervious surfaces to reduce extreme peak flows.

Resilience actions reduce the threats of climate change (vulnerability) by changing our systems.

Response refers to what can be done to facilitate adaptation.

Table 3. Massachusetts communities that participate in the Massachusetts Climate Change Action Network

Arlington	Groton	Newton
Bedford	Harvard	Salem
Belmont	Hudson	Somerville
Boston	Lenox	South Berkshire
Brookline	Lexington	South Shore
Cambridge	Littleton	Sudbury
Carlisle	Marlborough	Wakefield
Cape Ann	Medfield	Watertown
Concord	Medford	Wellesley
Greenfield	Milton	Williamstown
Great Barrington	Needham	Winchester

CLIMATE CHANGE ADAPTATION POLICY IN MASSACHUSETTS

—STEVE LONG, DIRECTOR OF GOVERNMENT RELATIONS,
THE NATURE CONSERVANCY OF MASSACHUSETTS

—JACK CLARKE, DIRECTOR OF PUBLIC POLICY AND GOVERNMENT RELATIONS, MASS AUDUBON

IN RECENT YEARS, the Massachusetts conservation community, in partnership with the Legislature and Administration, have worked together to create climate change adaptation public policy and funding, some of which was highlighted by The Nature Conservancy (TNC) and Mass Audubon at the conference and updated for this report.

During the summer of 2007, the conservation community convened several meetings that brought together land and conservation organizations with Administration officials and legislators to advocate for adaptation policy. For example, when the Administration announced that it was developing a “Climate Change Roadmap” to reduce emissions, TNC and Mass Audubon organized land and water conservation organizations to meet with the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) to ensure the plan included sections on adaptation related to biodiversity, water and forests.

In November 2007, TNC hosted a climate change adaptation forum at the Massachusetts State House at which representatives of land and water conservation organizations and state agencies described the impacts of climate change on wildlife and ecosystems. Environmental agency administrators and state legislators described their support for adaptation legislation and policy.

During the spring of 2008, the conservation community led advocacy efforts to ensure that climate change adaptation funding was included in the Environmental Bond Bill (the Bond), which provides capital funding to state agencies over a five-year period. The Bond includes climate change adaptation in four line items, totaling \$69 million:

- Connectivity of freshwater systems, such as funding for dam removal through the Massachusetts Department of Fish and Game’s Riverways Program



Eel River, Plymouth, MA, location of proposed dam removal project

- Protection, restoration and conservation of coastal habitat and communities through the Massachusetts Office of Coastal Zone Management
- Comprehensive State Wildlife Action/Management Plan through the Massachusetts Department of Fish and Game
- Integrated energy and environmental projects for the development of new programs, including those related to adaptation through the Massachusetts Executive Office of Energy and Environmental Affairs (EEA).

In the summer of 2008, the Legislature enacted, and the Governor signed, the Global Warming Solutions Act (GWSA). GWSA requires EEA to develop an economy-wide greenhouse gas reduction plan (80 percent reduction from 1990 levels by 2050). The conservation community supported the bill and advocated for the inclusion of a provision requiring EEA to convene an Adaptation Advisory Committee and draft a report analyzing and proposing recommendations on statewide adaptation measures. This report, due in December 2009, replaces the Roadmap Report which EEA abandoned once the GWSA mandated the new report.

The Adaptation Advisory Committee has been meeting throughout the summer of 2009 to analyze strategies for adapting to the predicted impacts of climate change in the Commonwealth. The Committee created five subcommittees, including: Local Economy, Key Infrastructure, Coastal Zone, Natural Resources and Habitat, and Human Health and Welfare.

Please note that this author’s perspectives were provided shortly after the conference and for that reason certain information may have subsequently changed.



Massachusetts State House, Boston, MA

WHAT DID THE PARTICIPANTS THINK?

—HECTOR GALBRAITH, PH.D., DIRECTOR, CLIMATE CHANGE INITIATIVE,
MANOMET CENTER FOR CONSERVATION SCIENCES

SHORTLY AFTER the conference, Manomet Center for Conservation Sciences (Manomet) staff organized an email questionnaire via www.SurveyMonkey.com that was sent to all of the attendees. The goal was to elicit opinions about the next steps that the Massachusetts conservation community needed to take to most effectively conserve ecological resources under a changing climate. A total of 88 participants from over 60 conservation organizations responded.

Three clear messages emerged from the results of the survey:

- 1. Collaborate:** Federal, State and non-governmental conservation organizations need to collaborate more closely if we are to effectively confront the challenges posed by climate change. Climate change poses the same challenges to all Massachusetts conservation organizations and our responses will be most effective if we collaborate.
- 2. Regionalize:** The challenges posed by climate change will be most effectively met at a regional scale. The methods of evaluating habitat and species vulnerability in Massachusetts are important, but we need to apply such analyses at the scale of the entire Northeast or New England if we are to make sound and cost-effective decisions about the focus and allocation of scarce conservation resources. We have already achieved such a level of cross-jurisdictional collaboration in the Northeast with the Regional Greenhouse Gas Initiative, which seeks to limit emissions rates. We need the same level of collaboration in the field of adaptation.
- 3. Develop Tools and Solutions:** Practical and effective tools and approaches for managing sites and habitats in the face of climate change are needed. We have successfully identified some of the overarching principles of adaptation management, such as building connectivity and preserving resilience; however, we have yet to fully address the problem of how, exactly, we will manage sites and habitats as the climate changes. To identify and develop the most effective tools and approaches will require collaboration among scientists and land managers—bringing us full circle to message #1!

These messages were taken to heart by the conference organizers. How we are moving forward to meet the challenges is the subject of “The Way Ahead,” the final section of this conference report.



Scenes from the conference. Photo credit: Linda Damon, Manomet Center for Conservation Sciences.



THE WAY AHEAD

—HECTOR GALBRAITH, PH.D., AND JACK BUCKLEY, DEPUTY DIRECTOR,
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THE CONFERENCE on *Responding to Climate Change: Working Together to Conserve Land, Wildlife and Habitat*, was a seminal event because it brought together for the first time state, federal and non-governmental agencies to begin planning region-wide adaptation of fish and wildlife habitats and ecosystems. The conference was the beginning of a process and a catalyst for forward movement, not an end in itself, and set an example for other states and regions faced with the same challenges.

Shortly after the conference, the ten organizations on the Conference Steering Committee formed the *Climate Change and Wildlife Alliance—Massachusetts (Alliance)*, with the objective of fostering and coordinating climate change adaptation within the Commonwealth. At the helm of the Alliance is the Executive Committee, which has members from all of the major conservation agencies within the state. In addition, the Alliance formed various technical Working Groups to address issues that will be crucial to addressing climate change in Massachusetts. Those Working Groups are: 1) Landscape-scale Assessment and Planning, 2) Site-Level Adaptation Tools and Implementation, 3) Adaptation Policy, and 4) Communications and Messaging. Members of the Alliance are collaboratively seeking funding from foundations and other sources to begin to initiate projects that will address the major issues raised by the conference.

The next two urgent challenges that the Alliance will face are how to regionalize adaptation planning and implementation and how to develop effective on-the-ground management tools and solutions. We are already seeking funding to initiate these projects.

The Commonwealth of Massachusetts has a long and enviable record of conserving ecological resources. Due to the efforts of state, federal and non-governmental agencies, we now have over 20% of the state's land being conserved. However, times are changing. Most importantly, the rapidly changing climate poses major challenges to the continued conservation of fish and wildlife and their habitats. We need to respond to this challenge, and do it quickly, if we are to consolidate our past successes and move forward to expand our conservation base. The rate at which the climate in the Northeast is changing is unprecedented, and we do not have time on our side. Nevertheless, the conference marked an important first step forward. We must now build on this to rapidly move ahead.

Please visit the Climate Change and Wildlife Alliance—Massachusetts web site at: www.climateandwildlife.org.

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