WEATHERING CLIMATE CHANGE:

Framing Strategies to Minimize Impacts on Pennsylvania Ecosystems and Wildlife

Perspectives from Conservation Leaders and Experts on Climate Change Adaptation

March 24, 2010

Pennsylvania Department of Conservation and Natural Resources
Pennsylvania Fish and Boat Commission
Pennsylvania Game Commission
The Nature Conservancy

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EXECUTIVE SUMMARY

Climate change will have growing impacts in coming decades on natural resources around the world. To minimize adverse effects, scientists and conservationists have started searching for actions that can help natural and human systems adapt to climate change.

This report presents the findings of interviews conducted with conservation leaders and experts in Pennsylvania to learn about their perspectives on climate change adaptation. The interviews focused on four issues:

- importance of climate change impacts to their organization’s mission;
- how their organization is responding to climate change impacts;
- the most important challenges and opportunities for responding to climate change impacts; and
- suggestions for developing statewide adaptation strategies.

The results will help inform efforts to address climate change impacts, including Pennsylvania’s next Climate Change Action Plan and revisions to the Pennsylvania Wildlife Action Plan.

Highlights from the interviews include the following:

- There was a strong sense among those interviewed that climate change is real; that it may already be having impacts (mostly negative, some positive) on Pennsylvania’s ecosystems and wildlife; and that their organization should be working to find ways to minimize adverse impacts.

- Education about climate change impacts, including clear examples of responses by Pennsylvania ecosystems / species to climate change, will be key to gaining broader staff and public support for addressing real and potential impacts. In part, an education effort is needed because climate change impacts in Pennsylvania are less dramatic than those seen in other regions, where rising sea levels, shrinking glaciers, and extensive droughts have stimulated early efforts to develop climate change adaptation strategies.

- Many organizations collect and maintain a variety of relevant datasets for monitoring climate change impacts on natural resources, even if they have not yet taken specific actions to minimize those impacts. Identifying existing relevant data and priority data gaps was widely recognized as a critical step in developing effective actions to reduce climate change impacts.

- Those interviewed believed adaptation efforts should also focus on existing stresses, such as loss of riparian cover, habitat fragmentation, and invasive species and pathogens, which will be exacerbated by climate change. An emphasis on reducing these stressors makes sense even if we are uncertain about the degree of coming climate change impacts.

- Many interviewed believed adaptation is best addressed in existing planning processes, but they also recognized the need for a collaborative approach to develop broader statewide strategies. Suggestions for a statewide strategy included identifying priority actions that
can be taken now, can be done for little or no additional expense (e.g., by integrating into current planning and budgeting), and will foster greater communication and collaboration. This collaborative approach could help Pennsylvania organizations be more competitive for grants from federal and foundation sources.

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INTRODUCTION

Overview: Climate Change Adaptation in Pennsylvania

For more than a century, scientists have predicted an increase in global temperatures caused by the burning of fossil fuels. In recent years, we have begun to observe the effects of a warming climate: glacial ice is melting, destructive natural phenomena like storms and wildfires are increasing in number and severity, and sensitive species and their habitat are under increasing stress. The scientific community is in agreement that climate change is real and is caused by emissions of greenhouse gases due to human activity. The time to take action to mitigate and adapt to climate change is now.

The observable effects of climate change vary from place to place. In regions with more extreme climates—for example, the Arctic region and the arid lands of Mongolia—the impacts of climate change are more marked than in temperate climates like that of Pennsylvania. Even in Pennsylvania, however, the effects of climate change are starting to appear. On average, spring is arriving sooner, summers are growing hotter, and winter snow cover has diminished. Pennsylvania’s ecosystems and wildlife are responding. Records from Audubon’s Christmas bird counts indicate that nearly 60 percent of North American wintering bird species have moved north – by an average of 35 miles – over the past 40 years. Several tree species in the northeastern U.S. are showing declining regeneration rates at the southern end of their ranges.

A June 2009 report of research conducted by Pennsylvania State University (PSU) and commissioned by the Pennsylvania Department of Environmental Protection (DEP) examined the potential impacts of climate change on many sectors in Pennsylvania. The model scenarios (based on those of the Intergovernmental Panel on Climate Change - IPCC) used in this report projected an overall temperature increase in Pennsylvania of at least 2 degrees Celsius, and potentially 4 degrees Celsius, by the end of the century. With either increase, the impacts of a warming climate (Figure 1) will affect our state’s natural ecosystems, human health, agriculture, forestry, water-related activities and tourism.

In October 2009, DEP released a draft Climate Change Action Plan, written in consultation with the Pennsylvania Climate Change Advisory Committee (CCAC). The CCAC was established by Act 70 (2008) to advise DEP on the development of this plan. In the plan, DEP recommends actions which will reduce Pennsylvania’s greenhouse gas emissions by 30% over 2000 levels by 2020.

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1 See timeline of scientific consensus on climate change (beginning in 1896 with the work of Svante Arrhenius) from the Environmental Defense Fund: http://www.edf.org/documents/381_FactSheet_globalwarming_timeline.pdf.


3 The final version of this plan (incorporating revisions to the draft arising from the public comment period) was submitted December 18, 2009 to the Governor’s office, the Pennsylvania legislature and the public. The plan is available online at: http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-10677.
In addition to the recommendations for emission reductions, DEP emphasizes the need to address adaptation to climate change in Pennsylvania, which was not included within the scope of Act 70. Both the Climate Change Action Plan and Penn State’s report on climate change impacts state clearly that attempts to mitigate climate change will not be enough – we must also plan for the adaptation\(^4\) of natural and human systems to the unavoidable impacts of a warming climate.

\(^4\) See pp. 11 and 12 of the PA Climate Change Action Plan, and pp. 25 and 26 of the Penn State Climate Change Impact Assessment.
Opportunities to Address Climate Change Adaptation

What actions can we take to help Pennsylvania’s ecosystems and wildlife to better withstand the stresses caused by climate change? Pennsylvania has several important opportunities to address this question.

**Statewide adaptation planning process**
First, as mentioned above, the CCAC and DEP have recommended initiating a process to engage stakeholders in the development of a statewide climate change adaptation plan.

**SWAP revisions**
Second, the federal government has asked states to update their State Wildlife Action Plans⁵ (SWAP) to include strategies that help target habitats and species adapt to climate change impacts. State Wildlife Action Plans will be important for allocating ecological adaptation funding from federal sources. A clear and thoughtful process for integrating climate change into Pennsylvania’s SWAP will help the state more effectively access federal funds.

**Organizational planning processes**
Finally, conservation organizations can integrate climate change adaptation actions into their regular annual and strategic plans. Integration, rather than separation, is the best way to ensure we will take effective steps to help ecosystems and wildlife adapt to climate change impacts.

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⁵ Congress established the State Wildlife Grants (SWG) program to support state fish and wildlife agencies in conserving low and declining populations of fish and wildlife. A significant requirement of the SWG program is that each state must produce a State Wildlife Action Plan, which provides a blueprint for allocating SWG funds (http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=496&q=162067).
About This Report

To help prepare for these and other opportunities, the senior leadership of Pennsylvania’s three state natural resource management agencies: the Department of Conservation and Natural Resources (DCNR); the Pennsylvania Game Commission (PGC); and the Pennsylvania Fish and Boat Commission (PFBC), in collaboration with The Nature Conservancy (TNC), convened a small team to meet with conservation leaders and experts to learn about their perspectives on climate change adaptation.

During October and November 2009, this team conducted interviews across the state with 24 individuals from 16 organizations, including state and federal agencies, non-profit conservation and environmental groups, and research organizations (see Appendix 1 for a list of interviews held). This report synthesizes the issues and ideas raised in those interviews. Perspectives shared are those of individual participants, and do not necessarily represent organizational positions or policies. The interview questions are provided in Appendix 2.

The report is organized into four main sections:

1. Relevance of climate change to organizational mission
2. Current actions in response to climate change
3. Organizational challenges and opportunities
4. Suggestions for a statewide adaptation planning process

6 The team included Nels Johnson (TNC), Jessica Seminara (TNC), Ben Jones (PGC), Sally Just (DCNR) and David Day (PFBC).

Mitigation vs. Adaptation

How can we respond to the threat of climate change?

Approaches tend to fall into two categories. Many strategies attempt to mitigate climate change by reducing greenhouse gas emissions. As we have come to understand that not all climate change is preventable, some organizations and agencies have also started to develop strategies to help human and natural systems adapt to the inevitable impacts.
1. RELEVANCE OF CLIMATE CHANGE TO ORGANIZATIONAL MISSION

Among those interviewed, there was a strong sense that climate change is real, that it may already be having impacts on Pennsylvania’s ecosystems and wildlife (mostly negative, some positive), and that their organizations should be working to find ways to reasonably minimize adverse impacts. The extent to which this consensus exists among staff and key external constituencies, however, varies considerably.

Key Points

- **Climate change is a major threat** to Pennsylvania ecosystems and wildlife according to those interviewed, and is highly relevant to their organization’s mission.

- **Understanding about climate change and its impacts** varies widely among staff at nearly all organizations. In some cases there are differing views among staff about the existence, causes, and severity of climate change. More information, awareness and collaboration among organizations are therefore needed to help create a common understanding of climate change and its impacts.

- **Organizational strategies** to address climate change have been completed or are under development by the U.S. Forest Service (USFS), DCNR, National Audubon Society, NatureServe, and TNC. Most other organizations have not yet developed policies and strategies, but expressed their intent to do so.

- **Strategies and actions** to minimize climate change impacts should be integrated into existing organizational planning and budgeting processes as much as possible, most interviewees believe.

- **Organizational constituencies** help determine the importance that institutions place on taking action to minimize climate change impacts. In some cases there is a large gap in views and understanding between an organization’s most important external constituencies and those of its leadership and staff.

- **Education and clear messaging** are key to gaining broader public and staff support about climate change impacts and related benefits of taking action (e.g., habitat connectivity enhances
wildlife population viability regardless of climate change impacts).

The interviews helped characterize how different types of organizations are engaged in climate change adaptation issues. These are summarized below.

**Research Organizations**

Individuals from research organizations were careful to state that their institutions do not take positions on policy-related issues per se. However, the interviewees and the vast majority of their research colleagues agree that climate change is real, that it is caused by human activity, and that its impacts on ecosystems and wildlife are likely to be substantial. PSU and the Academy of Natural Sciences (ANS) are heavily engaged in climate change research, including the study of how ecosystems and species respond to changes in temperature and precipitation at various scales.

**Government Organizations**

Interviewees from government organizations generally recognized the significance of climate change and its relevance to natural resource management. The USFS is perhaps the most advanced in its work on strategies to address climate change impacts. Among state natural resource management agencies, the DCNR has begun a strategy to integrate climate change adaptation measures into existing policies, operational plans, and educational programs. As an operational objective, the PGC included establishing protocols to evaluate climate change in its 2009–2014 agency strategic plan. The PFBC and the PGC are also addressing climate change in the context of SWAP revisions.

In addition, the leadership of the state’s three natural resource management agencies, together with TNC, launched this interview process to solicit views from Pennsylvania’s conservation leaders and climate change experts. DEP, while not a natural resource management agency, has been the lead state agency on climate change issues and will coordinate development of a statewide climate change adaptation plan in 2010.

**Non-Governmental Organizations**

Individuals from several non-governmental organizations indicated that climate related impacts were among their top priorities (especially TNC, the National Wildlife Federation - NWF, and the Pennsylvania Environmental Council - PEC). PEC, for example, indicated that every organizational program is based on its “Climate Change Roadmap.” NatureServe has developed a climate change adaptation strategy that focuses on increasing the resilience of natural systems to expected changes in temperature and precipitation. It also seeks to better understand how human responses to climate change (e.g., flood control measures) might affect biodiversity. Several others went nearly as far in describing how climate change impacts influence their priority issues. Despite the prominence of climate change, these organizations have not yet determined which strategies and actions to pursue. Several individuals from across
organizational types emphasized that climate change impacts are central to their organization’s mission. For example, climate change is likely to impact water flows, an integral component of the work of the Delaware and Susquehanna River Basin Commissions.
2. CURRENT ACTIONS IN RESPONSE TO CLIMATE CHANGE

When asked to describe actions their organization is taking to address climate change adaptation, almost all interviewees noted that they were still in the information-gathering phase. Most were not ready to begin implementing on-the-ground strategies to help species and ecosystems adapt, although many intended to or already had integrated climate change into their planning efforts.

Key Points

- **Terrestrial and aquatic data collection**, as well as monitoring ecosystems with regard to climate change vulnerability, is being conducted by various organizations. Certain species, areas and waterways are better represented in the data than others.

- **Climate change information** should be shared more readily among organizations, many interviewees noted.

- **Knowledge about climate change** and its impacts in Pennsylvania is still limited, despite data collection and research efforts. Interviewees identified data gaps that must be addressed as good science is needed for strategy development.

- **Collaboration** between state and federal agencies, non-profits, research institutions and other stakeholders is needed to determine what data to gather to create a statewide baseline against which the impacts of climate change can be assessed, interviewees noted. Without this baseline data, we will not be able to project or track future trends, nor respond proactively.

- **Strategies aimed at helping specific species** and / or reducing an organization’s greenhouse gas emissions are examples of direct actions some organizations are taking to address climate change. Overall, most organizations are not yet implementing actions and strategies “on the ground.”
Data Collection / Research

As mentioned above, Pennsylvania organizations are conducting research and collecting various data that can be used to assess climate change impacts on species and ecosystems.

Particularly important is species vulnerability research. Knowing which species may succumb to stresses brought on by a warming environment will allow us to strategize and target funding to those species that will have the greatest benefit.

The most comprehensive vulnerability analysis project described in the interviews is the Climate Change Vulnerability Index (CCVI), being conducted by the Pennsylvania Natural Heritage Program (PNHP). The CCVI focuses on Pennsylvania species of conservation concern, and analyzes each for its predicted vulnerability to climate change. The CCVI would benefit from increased funding, allowing an expansion in the number of species analyzed.

Another major project is the northeast regional vulnerability assessment, a multi-state analysis, being conducted by the National Wildlife Federation.

Climate Change Vulnerability Index (CCVI)

The Climate Change Vulnerability Index (CCVI) was developed by NatureServe to identify plant and animal species that are particularly vulnerable to the effects of climate change. The Index uses readily available information from PNHP’s data sets on a species’ natural history, distribution, and landscape circumstances to predict whether it will likely suffer a range contraction, population reductions, or both during coming years. The Index can be used as part of a variety of analyses, including assessing the relative risk of species listed in the Pennsylvania State Wildlife Action Plan or as part of any assessment of the vulnerability of species to climate change.

Other research projects include:

Water / Air

- The Delaware River Basin Commission (DRBC) and the ANS have been collecting data on the Delaware River and other waterways and lakes in eastern Pennsylvania for decades. Most relevant is flow data from DRBC and data on the distribution and abundance of aquatic species, including those sensitive to temperature and flow shifts.

- Since the mid-1980s, the Susquehanna River Basin Commission (SRBC) has collected aquatic data through sub-basin monitoring programs.

- DEP collects statewide water quality and atmospheric monitoring data.

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7 The Pennsylvania Natural Heritage Program is a partnership between the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Game Commission, the Pennsylvania Fish and Boat Commission, and the Western Pennsylvania Conservancy. PNHP provides scientific information, expertise and assistance to support the conservation of Pennsylvania's biological diversity. PNHP maintains the most comprehensive database of flora, fauna, natural communities and unique geologic features in PA.
Forests
- **Effects on forests** as a result of climate change are being studied by the USFS, the Natural Lands Trust (NLT) and the Pennsylvania State University - School of Forestry (PSU-SoF). Their work includes forest health monitoring, predicting changes in forest composition and regeneration, and effects on timber markets. As an example, the USFS has projected species shifts for 134 critical northeastern tree species across several climate change scenarios in its Climate Change Tree Atlas.

- **Christmas Bird Count data**, collected through voluntary monitoring, is being compiled by PA Audubon.

- **A Breeding Bird Atlas**, compiled by the PGC, PA Audubon and other partners, provides information based on long-term monitoring data.

Habitat
- The Nature Conservancy has identified a set of landscapes along the Central Appalachians from Virginia through Pennsylvania that are likely to be resilient in the face of climate change. This network of sites is more likely than other sites to retain a diverse biota and healthy ecosystems due to elevation range, topographic complexity, geologic and soil diversity, and habitat connectivity.

- The Conservancy has also created an online tool (*Climate Wizard*- see Appendix 3) to help users understand how various climate change scenarios might affect their region.

- PNHP’s county natural heritage inventory information is one of the most widely used sources of conservation planning information.

Plants and Animals
- **Pennsylvania’s most comprehensive database** of occurrences and range maps for plant and animal species of concern is maintained and updated by the PNHP.
Data Gaps

Despite the efforts outlined above, notable data gaps were mentioned by multiple interviewees.

A fundamental issue is the need to determine data relevancy and prioritize needs. A commonly-cited data gap is the need for increased statewide species and ecosystem monitoring, especially of those thought to be most vulnerable to climate change. In some cases, current monitoring programs could be revised to collect additional climate change related data.

Regarding the above gaps, interviewees also recommended establishing baseline data for species and ecosystems, against which climate change impacts could be projected and tracked. An interactive statewide map currently being developed by the PNHP could help establish such a baseline system for tracking select species and ecosystems.

Other specific data needs included:

**Water**
- Information on sea-level rise in the Delaware estuary of Pennsylvania
- Improved quality of hydrologic flow data and higher-resolution climate models

**Plants and Animals**
- Information on resiliency and ability to disperse for plant and animal species
- Increased quality and quantity of species sampling
- Sharing data through a long-term monitoring network

- Understanding how climate change will affect insects and disease

**Ecosystems / Habitat**
- Data on connectivity and migration corridors across the state
- Data on how energy development could impact connectivity and habitat
- Understanding how climate could affect interactions among organisms, and between organisms and ecosystems

**General**
- Modeling of various climate change scenario impacts on Pennsylvania ecosystems and species
- More sharing of climate change data across scales, from regional-level data to state and local levels.
Planning and Implementation

Although most organizations are focused on data collection and research, some are engaged in planning and implementation efforts to mitigate or adapt to climate change. As with the perceived relevance of climate change to organizational mission and strategy, the types of actions undertaken vary with the type of organization represented.

Planning Efforts

Most stakeholders noted they are in the process of planning and developing strategies. Some have integrated climate change into their strategic plans, while others have created or plan to create a specific climate change plan.

Specific planning efforts include:

- The Western Pennsylvania Conservancy (WPC) is creating committees to look at climate-related issues, such as carbon offsets, adaptation science, and policy.

- Conservation Opportunity Areas (COAs), the mapping component to the State Wildlife Action Plan (SWAP), are being identified by the PNHP. This project is funded by the Pennsylvania Fish and Boat Commission. In addition, with funding from the Wild Resource Conservation Program (WRCP), plants will also be incorporated. The effort will identify “irreplaceable” areas necessary to achieve an explicit conservation goal.

- The Climate Change Action Plan developed by the DEP is designed to reduce greenhouse gas emissions in Pennsylvania, as mentioned in the introduction.

- The DEP also recommended a statewide climate change adaptation process as part of the Climate Change Action Plan.

- A “Climate Change Roadmap” developed by the PEC guides virtually all of its actions.

- The PGC included establishing climate change protocols under the strategic objective to manage sustainable wildlife populations in its 2009–2014 agency strategic plan.

- The PFBC identified the need to integrate climate change into its planning processes.

- The NWF’s efforts to guide states as they integrate climate change into their SWAP revisions will be the background for a soon to be issued “lessons learned” report.

- “Confronting Climate Change,” NatureServe’s climate change strategy, was recently published online.

- The NLT is developing a scope of work related to climate change based on the information they have gathered over the past few years.
• **The Nature Conservancy** is developing a resilient conservation network analysis that identifies areas that can collectively sustain a diverse array of flora and fauna in the context of expected climate change.

**Implementation**

Some organizations are beginning to implement “on-the-ground” actions related to climate change mitigation and adaptation. Some of the actions mentioned were specific, such as the USFS revising standards to accommodate tree distribution shifts, or the DRBC studying upstream water flow and estuarine issues. More general strategies mentioned included PSU’s broad-based trend analysis, and the ANS providing public education on climate change issues.

In addition, the USFS, the PSU-SoF, and PA Audubon all mentioned implementing strategies to reduce or offset their organization’s carbon footprint, including Leadership in Energy and Environmental Design (LEED) certification for office spaces, reducing staff travel, and implementing energy efficiency measures. We believe other organizations and agencies are taking similar measures whether due to budget constraints or purely from a desire to reduce operations-related greenhouse gas emissions.

Links to more information on current actions, including projects and plan documents are provided in Appendix 3.

**Summary**

As noted above, the findings from the interviews indicated that current actions addressing climate change adaptation are a mixture of data collection, monitoring, research, planning, and implementation. Although most organizations are doing some type of research and/or data collection, interviewees noted that many data gaps remain. Most organizations have considered or begun planning efforts, and some are implementing “on-the-ground” actions to mitigate or adapt to climate change.

Aligned with these findings, many interviewees believed Pennsylvania organizations should increase data sharing and take a collaborative approach to climate change adaptation planning.

A systematic approach to data sharing would allow synergistic and efficient use of resources. As part of this effort, it is important to ensure consistent data collection standards and methods. The development of statewide baseline data and standards for data collection would allow us to develop strategies that meet the needs of Pennsylvania species and ecosystems.

In addition to increased data sharing and common standards, those interviewed strongly favored the collaborative development of specific, practical strategies addressing adaptation. A collaborative effort could aid organizations in their thinking about how to address climate change statewide, and what part their staff can play in the overall effort. Funding mechanisms that encourage long-term and collaborative approaches to data collection and sharing are much needed, but uncommon. One example of a funding source is the Wild Resource Conservation Fund (WRCP) (see footnote below and inset box on the next page).

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8 WRCP: The Wild Resource Conservation Fund was legislatively created in 1982 to conserve Pennsylvania's non-game wildlife and native wild plants. The program realizes this mission through funding scientific research, conservation projects and environmental education. The program is funded primarily through donations, tax check-off donations, and river otter license plate sales.
The Wild Resource Conservation Program (WRCP) can serve a key role in both facilitating collaboration among stakeholders and funding projects. WRCP has historically been the nexus between the research, conservation, and education communities and can continue that role as part of the state’s climate change adaptation process. As a first step, WRCP will bring together representatives from these three communities of practice in spring of 2010 at a climate change adaptation research symposium. WRCP has also been the primary source of matching funds for federal money received from the State Wildlife Grants Program, and will continue that role as long as funds are available.
3. ORGANIZATIONAL CHALLENGES AND OPPORTUNITIES

Addressing climate change impacts on Pennsylvania’s species and ecosystems will be challenging because changes up to now have been subtle, and are difficult to separate from other factors impacting natural systems. Although a number of challenges have been identified, each presents an opportunity to sharpen our collective efforts to handle this issue thoughtfully, collaboratively, and with an eye toward increasing efficiency and effectiveness.

Key Points

- **Communication** with the public should provide examples of climate change impacts and explain what steps can be taken locally to address them.

- **Long-term research** is required to develop informed adaptation strategies; however, research funding is not as readily available for such projects. Understandably, especially in a time of economic hardship, policymakers are often reluctant to allocate limited funds toward long-term concerns.

- **Complex stresses** like invasive species, pollution, pests and pathogens are other factors that have detrimental effects on natural systems. Some of these effects may be exacerbated by climate change.

- **A collaborative process for statewide data sharing** and strategy development should increase synergy and efficiency. Although necessary, creating an overarching collaborative work culture and system of resource allocation will be challenging.

- **Federal funding opportunities** for climate change adaptation strategies are available to Pennsylvania, e.g. through the SWAP or the USFS State and Private Forestry organization. Although many data gaps and potential actions were identified in the interviews, we must collaborate to determine which actions to prioritize.
Effective Communication

Communication about climate change in Pennsylvania should focus on providing examples of its occurrence and impacts. It should also provide illustrative steps that can mitigate those impacts and help species and ecosystems adapt.

As interviewees noted, there is still a significant amount of skepticism among their organizations’ constituents, and sometimes leadership, about the reality or extent of climate change. To reduce skepticism, communication with Pennsylvanians about climate change should include examples of emerging impacts and projections about which species may be affected by a warming environment. Where possible, interviewees believed that potential effects on human health and livelihood due to these changes should be emphasized.

Interviewees recommended that more should be said about practical steps to mitigate climate change impacts and help natural systems adapt to the inevitable impacts. Steps that demonstrate additional conservation and financial benefits will garner more support.

Avenues to facilitate information sharing and improve communication between Pennsylvania state agencies, research institutions, and non-profit organizations are critical to the statewide collaboration process. Collaboration will help to provide examples of impacts, defray costs, and ensure consistent messages about climate change adaptation.

Climate change is global but local efforts can successfully engage school students, outdoor enthusiasts, and the average person through citizen-science monitoring, application of green principles in local parks and open space, and distribution of information through existing educational networks (e.g., state park education centers, school science programs, etc.).

Long-Term Planning and Research

Although all interviewees recognized the importance of long-term planning and climate change research, for many, immediate demands have overshadowed this need. In addition, research funding infrequently supports projects more than a few years in duration.

The consequences of climate change are complex and variable. Right now there are more questions than answers, and consistent, long-term data collection is needed to help resolve these questions:

- What changes have already been occurring that may be related to climate change?
- Which natural systems are most vulnerable / most resilient to climate change?
- What current conservation problems could be exacerbated by future climate change?
- How can we reduce existing stresses and offset those we cannot control?
- How can we plan in order to minimize negative impacts and turn them into benefits?

Consistent long-term research at multiple scales (e.g., regional, state and local levels) will be essential in determining the possible impacts to natural resources in the years ahead. Monitoring and observation of species distribution and ecosystem conditions now can improve the accuracy of models that assess the long-term (>50 years) impacts of climate change. Data from
empirical monitoring will always be preferable compared to using assumptions about species and ecosystem responses to climate change, especially when major investments and resource management practices are being influenced by those projections. In the long run, many of those interviewed believed that a vigorous monitoring program on the distribution and condition of Pennsylvania’s biota and ecosystems is one of the smartest investments we can make to minimize climate change impacts.

Unfortunately, immediate problems and the lack of support for long-term research and planning make it difficult for organizations to devote sufficient time and resources. Land and natural resource managers face problems like increasing invasive plants; wide fluctuations in precipitation; increasing plant pests and diseases; continued development and encroachment pressures; and lack of forest regeneration. Further complicating matters, many of these shorter-term problems may be influenced by climate change.

Although allocating resources to long-term research and planning can be a challenge, collaboration among Pennsylvania stakeholders should increase efficiency and reduce costs. When it comes to implementation, incorporating adaptation strategies into existing land management strategies should be more cost-effective and efficient over the long term. Moreover, many additional benefits for people and natural systems can be realized through strategies designed to address climate change impacts.

**Interactions with Other Stressors**

As mentioned above, temperature and precipitation changes influenced by climate change can exacerbate other stresses on natural systems. Therefore, isolating climate change impacts on system health and resilience is extremely challenging. Thorough data analysis will be necessary to understand how climate change affects Pennsylvania’s natural systems, both alone and in concert with other environmental stresses.

**Interagency / Interdisciplinary Collaboration**

In addition to natural resources, climate change will impact many other sectors, including human health, agriculture, recreation, and the economy. Therefore, addressing climate change impacts will require carefully planned, formal collaboration among Pennsylvania’s non-profit organizations, academic and research institutions, political leaders, federal agencies, and state agencies, as well as with partners in adjoining states. Interdisciplinary collaboration will be important to share data, develop data standards, and develop and implement strategies to address climate change.

A holistic approach will be required, considering climate change from as many perspectives as possible, including effects on the economy, energy, health, infrastructure, and ecology. Collaboration has never occurred at this scale over an extended period, but this is precisely what is needed to share information, expertise, and resources to develop a practical approach to climate change in the decades ahead. Potential conflicts over organizational culture or resource allocation could hamper this collaborative process, and must be addressed proactively.
Prioritizing and Allocating Funding

When asked to describe the challenges their organization would face as a result of climate change, interviewees consistently mentioned funding as a major challenge. Determining funding and allocation priorities among the state agencies, research institutions and non-profit organizations will be difficult. This same challenge also presents an opportunity for stakeholders to decide which efforts lend themselves to collaboration.

The funding priorities interviewees mentioned overlap to a high degree with the noted data gaps. They reflect the need for collaboration on data collection, research, analysis, modeling, planning, and implementation. Specific priorities included additional research on species’ vulnerability and ability to disperse across the landscape; modeling of climate change scenarios; data sharing and collection standards; collaborative planning for habitat management and protection; and finally, increased outreach to the public on climate change issues.

Based on these responses, it seems prudent that funding priorities be considered as part of the collaborative approach to statewide adaptation planning. It is also important to determine in what order activities should be funded, as some of the later activities will depend upon a reliable, detailed baseline of species and ecosystem conditions. Funding for long-term data collection to identify trends and implement strategies developed in response to those trends will be essential.

Funding priorities must be determined as soon as possible to allow Pennsylvania to be competitive for federal funds. Programs such as the WRCP provide an opportunity for matching funds for research, education and restoration projects. Such programs need dedicated funding to leverage federal dollars. Funded projects must address the full spectrum of problems, species and habitats, regardless of which organization receives federal funding.
Pennsylvania’s Wildlife Action Plan (PA-WAP)

As a Congressional requirement to pro-actively address the decline of species and associated habitats, each State and U.S. Territory completed a State Wildlife Action Plan (SWAP) in 2005. In the intervening years, improved understanding of climate change has underscored the need to implement these plans and to incorporate new actions where suggested by new data or analyses. Although in its original plan Pennsylvania had acknowledged climate change as an issue, recent studies (Shortle, et al. 2009 – PA Climate Impacts Assessment) have provided additional information on potential future conditions.

In 2009, the Association of Fish and Wildlife Agencies (AFWA) developed guidance for states to update their SWAPs to address the issue of climate change. Consequently, Pennsylvania is initiating steps to enhance its plan to more fully address climate change in the context of the many threats to the Commonwealth’s species of greatest conservation need. These steps include the development of an amendment to the PA-WAP (approved in February 2010 by the U.S. Fish and Wildlife Service-USFWS) which provides a broad outline of strategies that include:

- Actions related to habitat protection and management
- Actions related to adaptive management
- Identifying Statewide Priority Conservation Actions

A detailed Climate Change Adaption Plan is beyond the scope of this current effort, but a detailed treatment is anticipated when the PA-WAP is revised in 2015.
4. SUGGESTIONS FOR A STATEWIDE ADAPTATION PLANNING PROCESS

The complexity of climate change and its implications for a multitude of social and ecological factors necessitates an integrated and broad-based approach to adaptation. In this section we provide suggestions for key processes that can assist agencies and organizations with adaptation-focused planning. Suggestions provided in the interviews fell into three major categories: fostering communication, identifying practical strategies, and establishing priorities.

Key Points

- **Climate change adaptation** should be integrated whenever possible into existing strategic planning processes.

- **Addressing climate change adaptation** fully is beyond the capacity of any individual organization or agency. Therefore, broad-based partnerships and collaboration will be required.

- **Practical, demonstrable benefits and effective communication** are important aspects of taking action to help species and ecosystems adapt to climate change.

- **Strategies** that will produce other benefits in addition to their climate change adaptation benefits should be chosen whenever possible.

- **To promote accountability** and foster involvement, priorities and timelines for sequencing actions should be determined.
Fostering Coordination and Communication

Interviewees emphasized that strategies to address climate change adaptation should be developed in a collaborative and coordinated approach, within current strategic plans. Agencies and organizations may be willing to modify their strategic plans to incorporate activities associated with climate change, but are unlikely to redirect their entire effort to this initiative. Although integration into existing plans may be more complicated than developing a specific climate change adaptation plan for a specific agency, the outcomes are expected to be more achievable and practical because they are part of an existing and implemented plan. When deciding how to include climate change adaptation in existing plans, organizations should consider activities that do not require major changes in daily operations or extensive costs, but collectively have measurable outcomes.

Communication and development of broad partnerships will foster successful implementation of strategies. Overall, the full scope of climate change adaptation is beyond the capacity of any individual organization or agency. Collectively, positive outcomes are more likely to be achieved. The success of these partnerships will be contingent upon frequent and thorough communication.

Interviewees made some specific suggestions in this area:

- Assist with **coordination and communication**, as well as ensure compatibility with on-the-ground activities by **establishing key contacts** within resource management agencies, research institutions, and non-governmental organizations. These contacts can provide current information on activities within their agency or organization and work to ensure compatibility where conflicts may occur.

- Enhance organizational communication by establishing a regularly scheduled (e.g., annual) **public climate change conference**.

- Ensure **communication with the public**.

- Use **current technologies** (e.g., web-based) to foster communication.

Identifying Practical Strategies to Address Climate Change Adaptation

To ensure climate change adaptation strategies have the greatest opportunity for success, strategies and actions undertaken must be practical. A component of this practicality is securing constituent support through outreach. Agencies and organizations are responsible to their constituents, so any application of resources to climate change adaptation must demonstrate a practical and beneficial outcome, ecologically, and where possible,
economically. As noted above in the subsection about communication challenges, the complexity of this issue requires that the public be provided sufficient information, in an easily interpretable format, and that activities and benefits resulting from implementation of strategies be clearly articulated.

Specific recommendations included:

- **Identify and promote specific “on-the-ground” activities** (e.g., developing riparian buffers; planting trees in local parks) to help the public recognize local opportunities for addressing climate change.

- **Develop a suite of strategies** that would benefit natural resources generally, in addition to helping minimize climate change impacts. There is still great controversy surrounding the scope and magnitude of climate change, so activities that have benefits regardless of climate change would be more acceptable to a skeptical public.

- **Show long-term cost savings** from implementation of good conservation measure whether in an urban, suburban or rural setting.

**Establishing Priorities**

The scope of climate change adaptation is large and requires a thorough, methodical approach. To secure long-term success of adaptation strategies, agencies and organizations should establish priorities and timelines for achieving success. A prioritization process will help to ensure that strategies are implemented in a sequence that will demonstrate success and foster involvement by agencies, organizations and the public.

Those interviewed suggested several mechanisms for addressing prioritization, including the following:

- Compile practical and effective actions to help agencies and organizations develop priorities.

- Include prioritization as part of a broader statewide climate change adaptation planning process.

- Survey organizations and experts for their sense of priorities.

- Although broadly-based, the “Keystone Principles” can offer guidance for any prioritization effort, including actions aimed to address climate change adaptation. See the link to the Keystone Principles in Appendix 3 for more information.

**Adaptation Strategy Process**

In these fiscally challenged times, the interview team recognized that an elaborate and expensive process to develop a Pennsylvania climate change adaptation strategy would be difficult to implement. At the same time, an effective strategy process needs be well-planned and managed.
interview team believed many of the following characteristics could be achieved through the creative use of electronic meeting and document sharing technologies.

**Process**

**Statewide** – Participation from across the Commonwealth should be encouraged, through regional workshops and / or webcasting.

**Diverse but knowledgeable participants** – Climate change impacts will be felt across many sectors and having participants from agriculture, public health, forestry, fisheries, recreation and tourism, conservation, transportation, energy and local governments will be important. To fully take advantage of diverse participation, however, it will be important to initially seek participants who already are somewhat knowledgeable about climate change issues so that more time can be devoted to identifying issues and potential actions.

**Wide and deep** – A process that brings all participants together (even if electronically) for a basic orientation on the science of climate change and its potential impacts across various sectors will help to provide a common knowledge base that facilitates in-depth discussions about issues and actions. Working groups organized around sectors or themes can then develop more detailed assessments of issues, actions and priorities.

**Expanding engagement** – Once initial participants have made progress identifying issues and potential actions, the process should be designed to solicit input from a wider range of participants, perhaps by posting drafts on the internet or holding workshops designed to provide greater access to interested stakeholders.

**Skilled facilitation** – Getting participants to focus on practical actions and prioritizing them is no small feat. Skilled facilitation can be immensely helpful to achieving these outcomes. Ideally, facilitation would be provided by professionals who are knowledgeable about climate change issues, respectful of diverse views, but committed to achieving as much consensus as possible.

**Technical support** – The issues tackled by the sectoral or thematic working groups are likely to be complex. Supporting each group with a technical support team (or resource persons in each group) would greatly facilitate progress toward identification of key issues, actions and priorities.

**Reasonable timetable** – Desirable participants will often have limited available time. Individual meetings should run efficiently and the overall timetable needs to balance sufficient time to generate meaningful results with the recognition that the process should be complete in a reasonable time frame.

**Outcomes**

**Practical actions and priorities** – Participants are more likely to engage seriously and constructively if they believe their participation will help frame meaningful strategies and actions that are likely to be implemented. A process that identifies practical actions and prioritizes those that should be taken first will help assure participants that their contributions could lead to meaningful results.

**Targeted outreach** – Even if participants numbered in the hundreds, action will not follow unless thousands more know about the process and its results. A deliberate outreach effort to reach leaders and opinion makers in various sectors and to highlight
key findings to executive agencies, the legislature, and the media will be essential.

**Ongoing engagement** – Participants in a statewide adaptation strategy process are likely to be key facilitators of action in the future. Finding ways to keep them engaged and involved would be very useful to promote the kind of interdisciplinary and collaborative action our interviewees felt is necessary. This might include electronic listservs, e-newsletters, annual reconvening of participants, and other mechanisms.

**Conclusion**

Those interviewed recognized both the necessity of integrating adaptation actions into existing organizational plans and the value of strategic planning at a statewide level. Among other benefits, a statewide planning process will foster greater collaboration, communication and learning amongst natural resource management organizations. It will yield a more accurate assessment of key information gaps and action priorities that need to be addressed first. Ultimately, a collaborative statewide planning effort can help to generate more cost-effective and competitive proposals for federal and foundation grants to improve natural resource management and conservation in Pennsylvania.
APPENDIX 1 – LIST OF INTERVIEWS

(Organization/Institution/Agency, Interviewee(s), Date of Interview)

- Academy of Natural Sciences – Clyde Goulden, David Velinsky – October 15, 2009
- Delaware River Basin Commission – Carol Collier – October 14, 2009
- Pennsylvania Audubon – Phil Wallis – November 16, 2009
- Pennsylvania Department of Environmental Protection – Joe Sherrick – October 20, 2009
- Pennsylvania Environmental Council – Davitt Woodwell, John Walliser, Scott Van De Mark – October 13, 2009
- Pennsylvania Fish and Boat Commission – Doug Austen – October 22, 2009
- Pennsylvania Game Commission – Carl Roe – November 18, 2009
- Pennsylvania Department of Conservation and Natural Resources – Greg Czarnecki* – October 23, 2009
- Pennsylvania State University – School of Forestry – Marc McDill – October 9, 2009
- Pennsylvania State University – College of Earth and Mineral Sciences, Department of Geography and Intercollege Graduate Program in Ecology – Erica Smithwick – November 18, 2009
- Natural Lands Trust – Andy Pitz – October 27, 2009
- Susquehanna River Basin Commission – David Heicher – November 20, 2009
- U.S. Forest Service – Andrea Hille – November 19, 2009
- U.S. Forest Service – Northeast Region – Susan Stout – October 13, 2009
- Western Pennsylvania Conservancy – Shaun Fenlon, Brian Gallagher, Charles Bier, Christopher Tracey*, Mary Ann Furedi* – October 13, 2009

* Pennsylvania Natural Heritage Program staff member.
APPENDIX 2 – INTERVIEW QUESTIONS

1. What is your organization’s position regarding the impacts of climate change on Pennsylvania’s natural resources?

2. Has your organization developed a strategy to address climate change impacts?

3. How do you think climate change will affect your organization’s mission and work in coming decades?

4. Is your organization collecting data that could be applied to assessing climate change impacts on Pennsylvania’s ecosystems and wildlife? What are the critical data gaps that need to be addressed first in order to inform adaptation strategies?

5. What challenges do you expect your organization to face in addressing climate change impacts on ecosystems and wildlife?

6. What strategies or actions is your organization taking (or could take without new funding) to reduce climate change impacts on Pennsylvania’s ecosystems and wildlife?

7. If new funding becomes available to implement strategies and actions to reduce climate change impacts, what strategies or actions would you invest in first?

8. Do you have any suggestions for developing a PA adaptation strategy addressing climate change impacts on Pennsylvania’s ecosystems and wildlife?
APPENDIX 3 – RESOURCES ON CLIMATE CHANGE ADAPTATION

Click on the blue underlined text to access the documents, websites and tools listed below.

California State Government

- California Climate Change Adaptation Strategy: http://www.climatechange.ca.gov/adaptation/

Commonwealth of Pennsylvania


Interagency Climate Change Adaptation Task Force (U.S. government)


National Audubon Society


National Wildlife Federation

- Climate-Smart Conservation: http://www.nwf.org/Global-Warming/Climate-Smart-Conservation.aspx

- Target Global Warming (website for hunters/anglers about climate change): http://www.targetglobalwarming.org/


NatureServe

- Climate Change Vulnerability Index: http://www.natureserve.org/prodServices/climatechange/ClimateChange.jsp
Pennsylvania Department of Conservation and Natural Resources

- Statement on climate change:  
  http://www.dcnr.state.pa.us/info/carbon/climatechange.aspx

Pennsylvania Department of Environmental Protection

- Climate Change Advisory CommitteeClimate Action Plan:  
  http://www.depweb.state.pa.us/portal/server.pt/community/climate_change_advisory_committee/10412

Pennsylvania Environmental Council

- Climate Change Road Map:  http://www.pecpa.org/node/242

Pennsylvania Fish and Boat Commission

- Statement on Climate Change:  
  http://www.fish.state.pa.us/images/exec/minutes/2008/10min_exh_b_climate.pdf

Pennsylvania Game Commission

- Pennsylvania Wildlife Action Plan:  
  http://www.portal.state.pa.us/portal/server.pt?open=514&objID=622722&mode=2

- 2009-2014 Agency Strategic Plan:  

Pennsylvania State University

- Pennsylvania Climate Impact Assessment:  
  http://enri.cas.psu.edu/announcements/ciar.pdf

Pew Center for Global Climate Change

- Overview of State Climate Change Adaptation Plans:  
  http://www.pewclimate.org/what_s_being_done/in_the_states/adaptation_map.cfm

The Nature Conservancy

- Climate Change Adaptation Strategies:  
  http://www.nature.org/initiatives/climatechange/strategies/art22952.html

- Climate Wizard:  http://www.climatewizard.org/
U.S. Environmental Protection Agency

- Adaptation Options for Climate Sensitive Ecosystems: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=180143

U.S. Fish and Wildlife Service

- Climate Change Strategic Plan: http://www.fws.gov/home/climatechange/strategic_plan.html
- Climate Change Home Page: http://www.fws.gov/home/climatechange/

U.S. Forest Service

- Climate Change Tree Atlas: http://www.nrs.fs.fed.us/atlas/tree/tree_atlas.html
- Climate Change Resource Center: http://www.fs.fed.us/ccrc/
- Northern Research Station Climate Research: http://www.nrs.fs.fed.us/disturbance/climate_change/

U.S. Geological Survey

- National Climate Change and Wildlife Science Center: http://nccw.usgs.gov/index.html