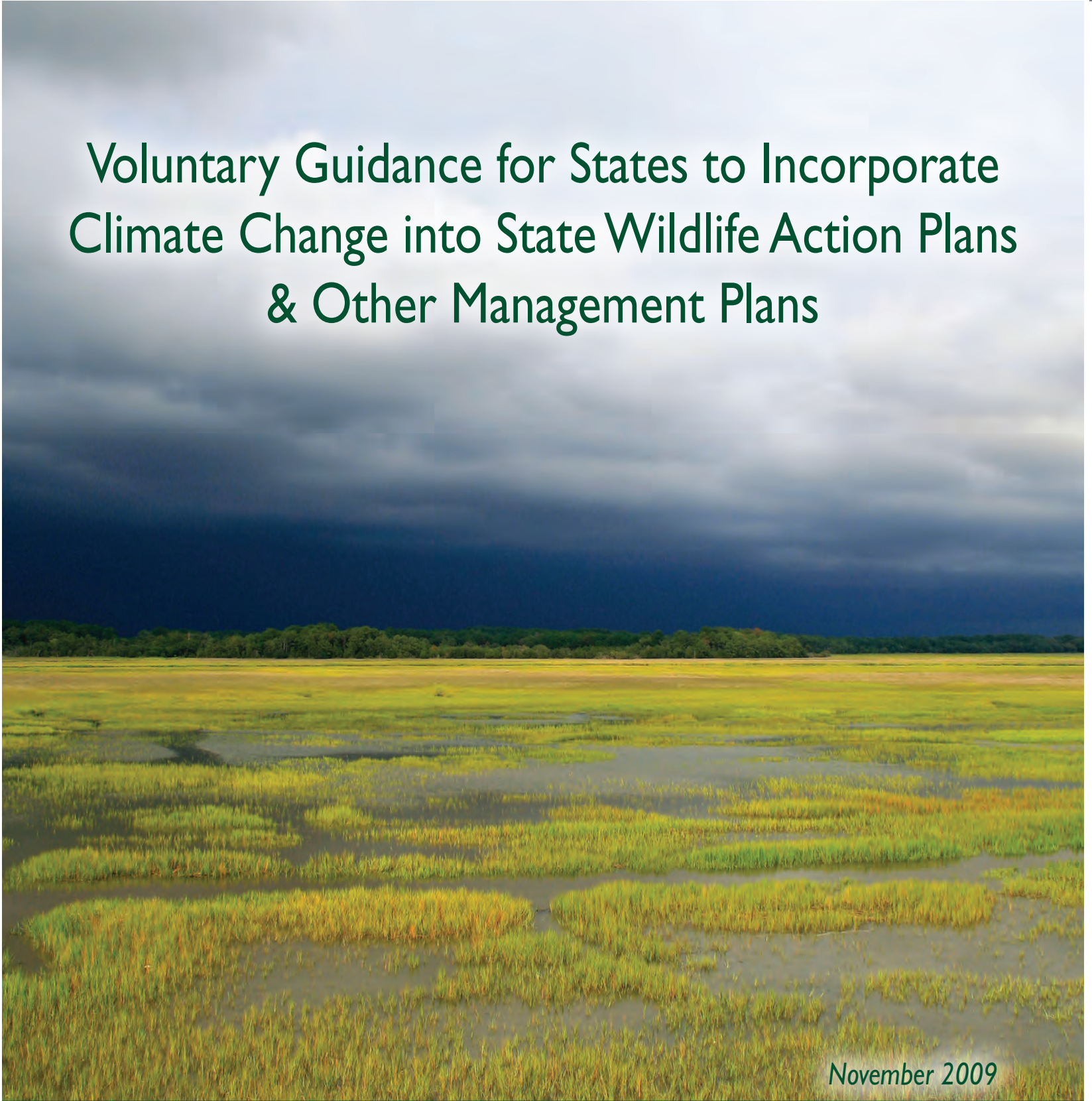
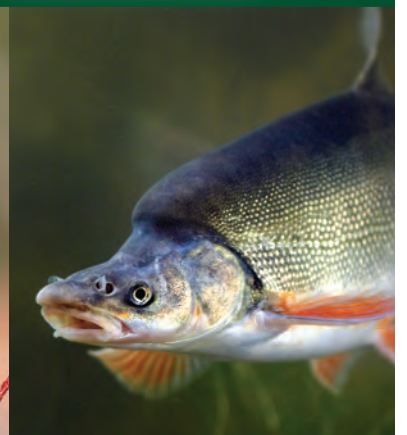


# Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans & Other Management Plans



*November 2009*





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ASSOCIATION of  
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AGENCIES

## Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans & Other Management Plans

A Collaboration of the Association of Fish & Wildlife Agencies'  
Climate Change and Teaming With Wildlife Committees  
November 2009

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For additional resources and the most up-to-date information,  
visit the State Wildlife Action Plan website at [www.fishwildlife.org](http://www.fishwildlife.org)

## ACKNOWLEDGEMENTS

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## EXECUTIVE SUMMARY

The Climate Change Wildlife Action Plan Guidance Document provides voluntary guidance for state fish and wildlife agencies wanting to better incorporate the impacts of climate change on wildlife and their habitats into Wildlife Action Plans. The approaches and techniques described in this document will also be useful in modifying other wildlife plans (e.g. big game/upland game/migratory bird plans, joint venture implementation plans, national fish habitat action plan, etc.) to address climate change. The document provides an overview of the information currently available on climate change, tools that can be used to plan for and implement climate change adaptation, voluntary guidance and case studies. Climate change is a large and growing threat to all wildlife and natural systems and will also exacerbate many existing threats. Efforts to address climate change should not diminish the immediate need to deal with threats that may be independent of climate change such as habitat loss/fragmentation from development, introduction of invasive species, water pollution and wildlife diseases. Since climate change is a complex and often politically-charged issue, it is understood that the decision to revise Wildlife Action Plans or other plans to address climate change, rests solely with each state fish and wildlife agency.

All states will be required to update their Wildlife Action Plans by 2015, although some states have opted for earlier revisions. Wildlife Action Plans may need to be revised earlier or more frequently than anticipated to account for the accelerating impacts of climate change. In addition climate change legislation passed in the U.S. House of Representatives in June 2009 would require each state to develop a state adaptation strategy and to incorporate that strategy into a revision of the state's Wildlife Action Plan (similar legislation in the U.S. Senate is being considered). Although revision of Wildlife Action Plans for climate change is not currently required, starting the revision process now can help states prepare for potential climate change funding through federal appropriations in FY10 and/or through funding that may become available if Congress passes comprehensive climate change legislation.

The Guidance Document consists of three major chapters that provide information and resources that could be used to update Wildlife Action Plans to incorporate climate change impacts. Chapter 1 introduces processes, approaches and key concepts that can be used to develop climate change adaptation strategies for fish and wildlife management. Chapter 2 describes tools, both old and new, that may be useful in developing, implementing and monitoring for these plans. Chapter 3 provides more detail on the process

of updating Wildlife Action Plans, summarizes existing guidance and discusses how addressing climate change might affect the plan revision process. The references section and appendices to the document are a source of additional information on climate change.

## Chapter 1: Adaptation Strategies

The first chapter provides guidance on how to develop climate change adaptation strategies. Adaptation is defined as *adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities* (IPCC). Key concepts, approaches and processes are discussed, but just as each state faces a unique set of climate impacts, each will need to customize its approach to adapt to those changes. To illustrate the diversity of potential strategies, the document contains several case studies to demonstrate how states have begun to identify and implement wildlife adaptation planning. Developing and implementing adaptation strategies will involve looking at what we are currently doing to conserve fish, wildlife and their habitats through the lens of climate change and identifying which strategies should be continued, which need to be significantly altered to avoid negative consequences, which might only require minor adjustments and which need to be reevaluated to determine urgency and priority. It will also require that states look at new approaches and tools to determine what additional conservation actions we should be taking in light of a changing climate. Taking an adaptive approach to fish and wildlife conservation will be especially important, given the uncertainties and our evolving understanding of the impacts and response of climate change to wildlife, ecosystems and ecological processes.

Climate change adaptation strategies will vary among regions and ecosystems depending on effects of climate change and the social-political contexts used for management decisions. Therefore, it is important to develop feasible site-based and target-based strategies for conservation action. Climate adaptation planning can include the following steps: 1) engage diverse partners and coordinate across state and regional boundaries; 2) take action now on strategies effective under both current and future climate conditions; 3) clearly define goals and objectives in the context of future climate conditions; 4) consider appropriate spatial and temporal scales when assessing wildlife adaptation needs; 5) consider several likely or probable scenarios of future climate and ecological conditions; and 6) use adaptive management to help cope with climate change uncertainties. Identifying the target species, communities, ecosystems, or ecological processes to be

addressed by climate change adaptation planning and action is a critical part of setting goals and objectives of an adaptation strategy. In many cases, wildlife adaptation may require managers to use a habitat or an ecosystem-based approach to conservation. Species conservation will become more challenging as habitats change, resulting in new and sometimes unfamiliar combinations of plants and animals. Species conservation efforts that focus on identifying and protecting those habitats most likely to persist as climate changes, will likely be better investments than those that depend on habitats which are likely to become unsuitable. The case studies in chapter one provides examples of how adaptation can be applied on the landscape.

## Chapter 2: Adaptation Toolbox

### Vulnerability Assessments

Understanding which species and habitats are most vulnerable and why is key to developing effective adaptation strategies. This process is often referred to as a vulnerability assessment. The goal of a vulnerability assessment is to describe the following elements: 1) exposure; 2) sensitivity; and 3) the capacity to adapt to climate change. A vulnerability assessment provides the scientific basis for developing climate adaptation strategies and uses information about future climate scenarios with ecological information about climate sensitivity and adaptive capacity to help managers anticipate how a species or system is likely to respond under the projected climate change conditions. The relative vulnerability of species or habitats can be used to set goals, determine management priorities and inform decisions about appropriate adaptation strategies. The following steps can be taken when assessing vulnerability to climate change: 1) determine the scope of the assessment; 2) collect relevant climate and ecological data; and 3) describe vulnerability qualitatively and/or quantitatively. The vulnerability case studies illustrate a range of methods for balancing the need for information on climate impacts and responses, the importance of stakeholder participation and limitations on the time and resources available for a vulnerability assessment.

### Adaptive Management

Adaptive management can be an important tool for making management decisions with incomplete information and high levels of uncertainty under climate change. As agencies struggle with problems associated with climate change under increasingly strained budgets, the flexibility of adaptive management allows agencies to continually acquire new information for decision-making without indefinitely postponing needed actions.

### Monitoring

Targeted monitoring is critical to adaptive management and should be comprehensive and detailed enough to evaluate a decision or action but not so complex or expensive that the monitoring program overwhelms an agency's capacity and impedes the management process. The following types of monitoring are explained: 1) status and trends (extensive) monitoring; 2) research (intensive) monitoring; 3) effectiveness monitoring; and 4) implementation monitoring.

## Chapter 3: Revision Process

The Revision Process chapter includes a review and summary of existing guidance related to Wildlife Action Plan development. The chapter also provides the following climate change-related guidance specific to each of the "eight elements" required for development of Wildlife Action Plans.

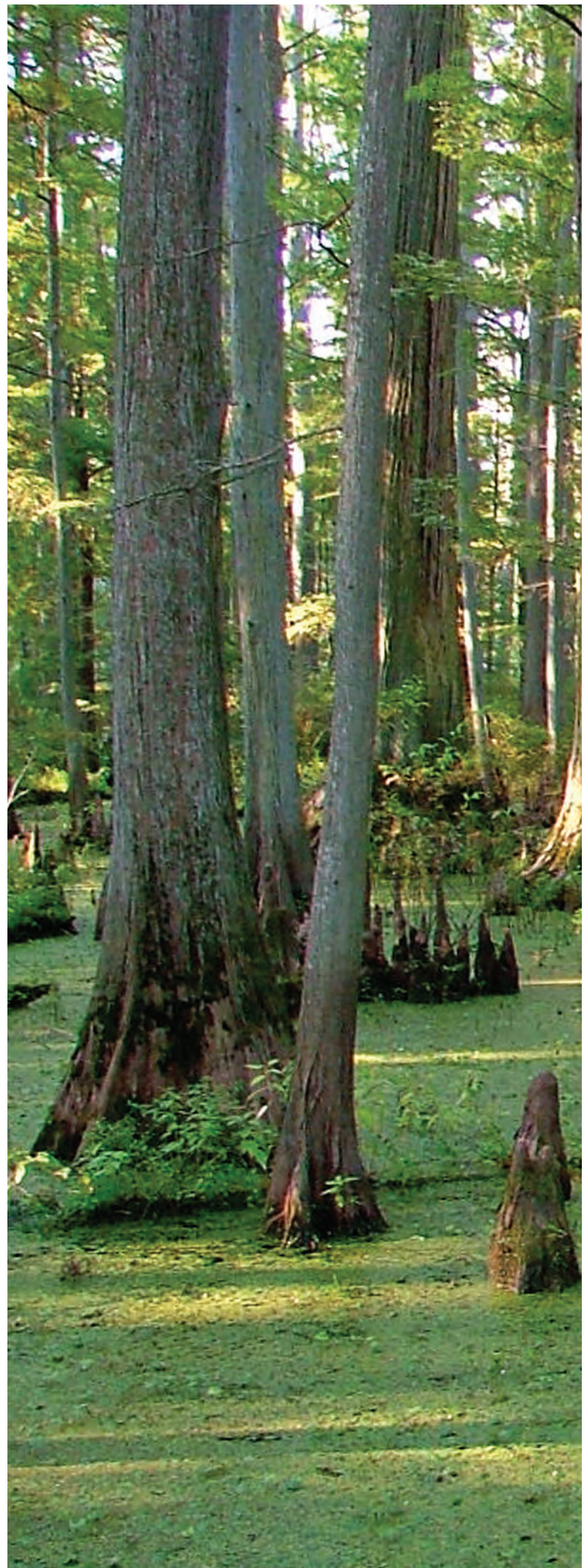
- **Element One** (species distribution and abundance) states may want to use vulnerability assessments to support the addition/removal of species from their list of species in greatest need of conservation and examine how climate change could impact distribution and abundance of species and their status as native or exotic.
- **Element Two** (location and condition of key habitats) states may want to assess how habitats and species ranges may change as a result of current and future climate change through scenario-building; both temporally and spatially and plan for novel communities/ecosystems that appear due to these shifts.
- **Element Three** (descriptions of problems and priority research survey efforts) states may want to consider both direct and indirect impacts of climate change; identify and execute research in partnership with other states/regions to gain economy of scale and consider climate change as an additional "layer" of threats to existing threats.
- **Element Four** (descriptions of conservation actions) states should consider actions for a range of likely future climate conditions; identify/describe how conservation actions will be prioritized when considering multiple threats; identify actions that minimize, not necessarily eliminate climate change impacts; provide for wildlife adaptation; and provide for resilience and/or facilitate movement to suitable habitats and conditions.

- **Element Five** (monitoring plans) states should strive to implement streamlined and affordable monitoring programs that inform management decisions under a changing climate and should consider working with other states and partners to monitor species and habitats across their entire range.
- **Element Six** (plans for revision) states should contact the US Fish and Wildlife Service regional office early in the revision process and refer to the 2007 FWS/AFWA Revision Guidance letter to determine if a “major” or “minor” revision will be required.
- **Element Seven** (coordinating with partners) states should consider coordinating and collaborating with partners since the scope, scale and uncertainty of climate change impacts will require a high level of expertise support and collaboration; agencies in coastal states should consider addressing marine environments and/or collaborating with sister agencies with jurisdiction over marine species.
- **Element Eight** (public participation) states should consider public participation planning since the potential for controversy associated with climate change could be high; strive to improve understanding of the impacts to wildlife and gain public support or acceptance for revising your Wildlife Action Plan; use terms that are tested with the public like “safeguarding wildlife” as opposed to “wildlife adaption” and involve conservation partners early during the public participation planning process, but recognize there may not be agreement on messages or approaches.

The case studies in chapter 3 provide examples of the processes being used in several states to update their Wildlife Action Plan.

## Resources Section – Appendix

Finally the guidance document includes a resources section that provides the reader with additional sources of information on the topics discussed in the document. The appendix includes the charter for the work group, legislative text on state adaptation planning and the 2007 FWS/AFWA Revision Guidance Letter. The Association of Fish and Wildlife Agencies will maintain a “living” and expanded version of this document on its website to ensure states have access to the most current information about climate change planning and implementation.



# WILDLIFE ACTION PLANS CLIMATE CHANGE GUIDANCE DOCUMENT

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## INTRODUCTION

### Overview

This document provides voluntary guidance that can be used by state fish and wildlife agencies to better incorporate current and expected impacts of climate change on wildlife and their habitats into Wildlife Action Plans. The approaches and techniques described in this document also will be useful in modifying other wildlife plans (e.g. big game/upland game/migratory bird plans, joint venture implementation plans, national fish habitat action plan, etc.) to address climate change. The document provides an overview of the information currently available on climate change, tools that can be used to plan for and implement climate change adaptation, voluntary guidance and case studies. The guidance document is divided into the following chapters 1) Adaptation; 2) Tools for Adaptation; 3) Plan Revision Process; 4) References and Resources. The guidance document will be a “living” document that will be housed on the Association of Fish and Wildlife Agencies’ website and updated regularly with new information and resources as they become available. Climate change is a complex and often politically-charged issue, the decision about whether or not to revise Wildlife Action Plans or other plans to address climate change, rest solely with each state.

### Climate Change and Wildlife Impacts

The Intergovernmental Panel on Climate Change’s 4th Assessment Report (IPCC 2007) found that global climate warming is “unequivocal” and largely attributable to human activities. Despite the certainty that climate change is currently underway and having an impact on natural resources, there are still many unanswered questions about how these climate effects will play out at local, state and regional scales and how ecosystems will respond to those changes.

According to the IPCC, global average temperatures have risen by 1.5 °F and can be expected to rise another 2-11°F by 2100, depending on future emission levels. The effect this will have on the nation’s wildlife and ecosystems will be dramatic. Although there is still uncertainty on regional variations in climate change impact, it is likely the nation’s fish and wildlife species and their habitats will experience many of the following impacts:

- Temperatures and precipitation changes will vary regionally but will lead to changes in the water cycle that will impact both aquatic and terrestrial species.
- Extreme events such as floods, heat waves, droughts and severe storms are expected to increase resulting in

increased wildfires, pests, diseases and invasive species that will alter habitat for many species.

- Sea level rise will result in significant losses to coastal wetlands and estuary habitats. Some regions will see large shifts in their coastline due to increased sedimentation and/or coastal erosion. Ocean acidification will impact marine life, particularly coral reef ecosystems.
- With increasing temperatures, flora and fauna will migrate northward and/or to higher elevations to escape warming conditions. For some species, the inability or lack of opportunity to migrate to a more suitable climate may lead to extinction or extirpation.
- Temperature increases will alter seasons and fall the physiological processes associated with certain seasons. This will result in phenological shifts which may cause misalignment of food availability and reproduction.
- Reduced snowpack and increased temperatures in streams, rivers and lakes will contribute to decreased populations of freshwater and anadromous fish such as salmon and trout and altered flooding regimes that will affect spawning and rearing habitat for many aquatic species.

Individual species and habitats will have very different responses to climate change. Many species and habitats will be negatively affected by climate change and will require a special set of actions in order to ensure their survival. Some species may benefit from a changing climate and could expand their range or increase in abundance; requiring a separate set of actions. In addition, the movement of species will create new communities of species for which there will be no previous examples and will require new management regimes. Wildlife management plans will need to reflect these changes and will likely need to be updated on a more frequent basis. Climate change is a large and growing threat to wildlife and natural systems, but it will also exacerbate many existing threats. Efforts to address climate change should not diminish the immediate need to combat threats that are independent of climate change, such as habitat loss, invasive species spread, pollution and wildlife diseases. Our goal should be to sustain ecosystems and viable wildlife populations regardless of the threat.

### Wildlife Action Plan Revision

All states will be required to update their Wildlife Action Plans by 2015, although some states have opted for earlier revisions. Wildlife Action Plans may need to be revised earlier or more frequently than anticipated to account for changing climate. Climate change legislation passed in the US House of Representatives in June 2009 would require each state to develop an adaptation strategy





and to incorporate that strategy into a revision of the state's Wildlife Action Plan (similar legislation is expected to be considered by the US Senate). Under the House bill, states would be required to revise their adaptation strategy every five-years to be eligible for federal natural resource adaptation funding. Although revision of Wildlife Action Plans for climate change is not currently required, starting the revision process now can help states prepare for potential climate change funding through federal appropriations in and/or through funding that may become available if Congress passes comprehensive climate change legislation.

States planning to revise their Wildlife Action Plan should contact the Wildlife and Sport Fish Restoration State Wildlife Grant Specialist in their USFWS regional office at the beginning of the revision process. States may choose to undertake a full revision/review of their plan or write an addendum. Guidance can be found in the 2007 FWS/AFWA Guidance Letter to determine if a revision would constitute a major or minor revision. A major revision of a plan is a significant change that includes changes to two or more elements in the plan and/or a change to the list of species of greatest conservation need (SGCN). For major revisions,

states will need to provide documentation describing how the revision meets each of the required eight elements, including an up-to-date public review process. Changes that are not considered to be major will be considered minor and will require that states simply submit a letter summarizing changes to the plan.

The chapters that follow provide information and resources that could be used to update Wildlife Action Plans and other management plans to address climate change impacts. Chapter 1 introduces processes, approaches and key concepts that can be used to develop climate change adaptation strategies for fish and wildlife management. Chapter 2 describes tools that may be useful in developing, implementing and monitoring these plans. Chapter 3 summarizes existing guidance for Wildlife Action Plan development and discusses how addressing climate change might affect the plan revision process. The references and resources section provide citations and links to additional information and the work group charter and text on state adaptation plans included in climate change legislation passed in the US House of Representatives are included in the appendices.

## Chapter 1: CLIMATE CHANGE ADAPTATION STRATEGIES

This chapter provides guidance on how to develop climate change adaptation strategies – strategies that will help conserve fish and wildlife species and their habitats and ecosystems as climate conditions change. Key concepts, approaches and processes are discussed, but just as each state faces a unique set of climate impacts, each will take a somewhat different approach to finding ways to adapt to those changes. To illustrate the diversity of strategies, several case studies demonstrate how states have begun to implement wildlife adaptation strategies.

### Approaches to Climate Change Adaptations

Developing and implementing adaptation strategies will involve looking at what we are currently doing to conserve fish, wildlife and their habitats through the lens of climate change and identifying which strategies should be continued, which need to be significantly altered to avoid negative consequences, which might only require minor adjustments and which need to be reevaluated for urgency and priority. It will also require looking at new approaches and tools to determine what additional conservation actions we should be taking in light of a changing climate. Taking an adaptive approach to fish and wildlife conservation will be especially important under climate change, given uncertainties and our evolving understanding of how climate change will impact fish, wildlife, ecological processes and ecosystems and the responses that will be encountered.

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities”. In the context of fish and wildlife conservation, climate change adaptation strategies can include on-the-ground management actions, land and water protection or regulations and policies that can be done to minimize the negative impacts and capitalize on opportunities brought about by climate change. An iterative and place-based approach to adaptation planning and implementation allow managers to develop and implement strategies based on incomplete or uncertain information and adjust those strategies as needed based on monitoring or new information. Climate change adaptation strategies will vary by region and/or ecosystem depending on local/regional climate and ecological conditions and social-political contexts that inform management decisions. Therefore, it is important to develop feasible site-based and target-based strategies.

Researchers are converging on the following interconnected steps to assist with climate change adaptation planning and action:

- Identify target species, habitats and/or ecological systems;
- Define management goals and objectives;
- Assess potential impacts, opportunities and vulnerabilities arising from likely future scenarios of climate, ecological conditions and other drivers;
- Compile system/species-relevant management actions and evaluate feasibility;
- Implement adaptation strategies and monitor strategy effectiveness;
- Reiterate the process by continually reviewing management objectives and actions, incorporate new information and adjust conservation actions as needed.

Climate change adaptation planning and implementation can be seen as a dynamic process, where tactics change as needed to accommodate shifting management or social priorities, updated ecological information or new data on projected climate change. The uncertainty and complexity of climate change can be paralyzing. A continuing or phased iterative process allows users to overcome the paralysis of uncertainty by alleviating the pressure to “get it right” on the first attempt. It also allows for a gradual build up in complexity that allows for making informed decisions and implementing conservation actions.

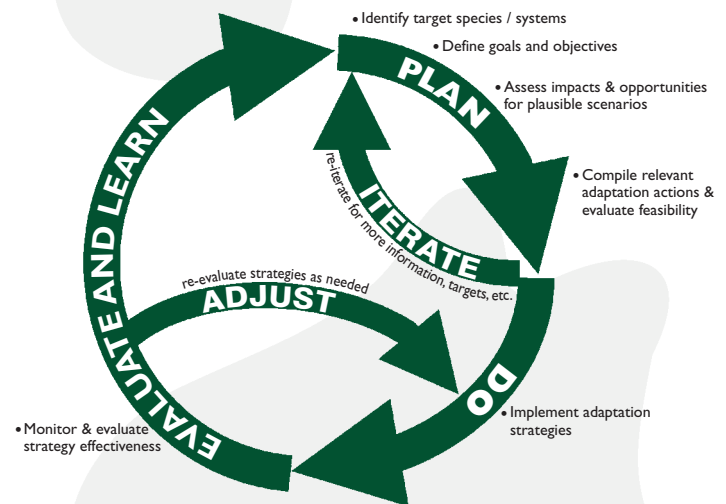


Figure 1. An iterative approach to adaptation planning and implementation (Adapted from The Heinz Center (2008), Glick et al. (2009), Heller and Zavaleta (2009), Cross et al. (in review)).

In this chapter, we highlight key recommended steps for moving through this iterative process and developing and implementing climate change adaptation strategies that will help conserve fish and wildlife species and their habitats

and ecosystems as climate conditions change (*Table 1*). We also highlight several case studies to demonstrate how particular projects have dealt with these issues while identifying and implementing wildlife adaptation strategies.

**Table 1: Recommended steps for developing and implementing adaptation strategies**

**1. Engage diverse partners and coordinate across state and regional boundaries**

The large-scale nature of climate change effects, combined with the importance of coordinating management at a large ecologically meaningful scale, suggests that coordination within and between state and federal agencies will need to improve. Fish and wildlife agencies should strive to involve diverse stakeholders throughout the development and implementation of adaptation strategies.

**2. Take action on strategies effective under both current and future climates**

Where the impacts of climate change are uncertain, agencies should focus on conservation actions likely to be beneficial regardless of future climate conditions. These can include reducing non-climate stressors, managing for ecological function and protection of diverse species assemblages and maintaining and restoring connectivity.

**3. Clearly define goals and objectives in the context of future climate conditions**

As climate changes, it may be difficult or even impossible to achieve conservation goals that are dependent on static conditions. Goals and objectives should therefore be informed by projected future climate conditions and explicitly address whether they aim to resist the impacts of climate change, promote resilience and/or facilitate changing conditions.

**4. Consider appropriate spatial and temporal scales**

The scale of adaptation planning should be based on that of natural systems and anticipated climate impacts. While management of wildlife tends to happen at local or state levels and over relatively short planning horizons, changes in climate will generally occur across very large scales and across entire ranges of wildlife and habitat types.

**5. Consider several likely/probable scenarios of future climate and ecological conditions**

It is important to assess the effects of climate change over multiple climate scenarios. Comparing conservation actions identified for each future scenario will highlight those actions likely to be effective across a range of scenarios along with those that may be effective under an individual one.

**6. Use adaptive management to help cope with climate change uncertainties**

Adaptive management is an effective way to make decisions in the context of incomplete information, uncertainty, risk and change. Adaptive management can help managers see if adaptation strategies are having their intended impact.

**Recommendations for Developing and Implementing Adaptation Strategies**

**1. Engage diverse partners and coordinate across state and regional boundaries**

The broad spatial and temporal scales associated with climate change suggest that management efforts that are coordinated on at least the regional scale will

likely lead to greater success. Greater coordination both within and among state and federal agencies, researchers, NGO's and industry (e.g. renewable energy) to meet adaptation challenges is needed. A nested approach, where responsibilities are split among the national, regional, state and local levels, may be most effective. For example, the need to do vulnerability assessments

could overwhelm a single state agency's resources and may be better conducted with partners at the regional scale, then translated into place-specific actions at the local or state scale. Similarly, species-specific or habitat-specific management efforts may benefit from range-wide coordination.

Agencies should aim to involve a wide array of stakeholders, including the interested public, local experts, neighboring states and other agencies throughout the process of developing and implementing adaptation strategies. Interested stakeholders may also include natural resource-based industries such as agriculture, forestry, hunting, fishing, wildlife viewing, tourism and other recreational user groups whose interests will be affected by climate change. States should consider looking for partnership opportunities with climate change researchers at universities and research organizations and with state, federal and private organizations.

Adaptation strategies will be most successful when they build on existing structures for collaboration. For example, a range-wide species or habitat management plan that crosses state boundaries can provide an effective coordination structure for considering climate change adaptation strategies. Range-wide management will be particularly important for species that respond to climate change by moving across state or national borders.

## **2. Take action on strategies effective under both current and future climates**

Climate change is already affecting some species and habitats and there is an urgent need to develop and implement management techniques based on the science available today. Some adaptation activities can begin even before a vulnerability analysis is completed. Many management strategies currently used to ensure viable species and habitats will be increasingly relevant in a climate changed environment and sticking to those strategies will be increasingly important. It is recommended that priority be given to conservation actions that are likely to be beneficial regardless of future climate conditions. These actions include the following:

### ***a. Reducing the impact of non-climate threats/stressors***

Because of the interconnectedness of climate and natural systems, climate change effects amplify long-standing ecological problems such as land use change, pollution, disruption of flood and fire regimes, habitat fragmentation and the spread of invasive species. Dealing with these existing stressors is one of the most valuable and least risky strategies available for climate change adaptation, in part because of the large existing body of knowledge about their impacts and solutions.

### ***b. Managing for ecological function and protection of biodiversity***

Natural systems are supported by basic processes such as fire and flood and by the diversity of life at all scales. As past goals designed around restoring or maintaining historic conditions become difficult or impossible to achieve, conservation actions should focus on maintaining and restoring ecosystem processes (such as fire regimes and hydrological cycles) and conserving as many native and/or desired non-native plants and animals as possible. For example, efforts to restore complexity and function to floodplains will benefit many fish and wildlife species regardless of future climate conditions. Translating these ecosystem approaches into key habitats essential to the conservation of SGCN will be an important part of revising Wildlife Action Plans.

One approach could be to protect a resilient network of conservation 'stages', for whatever composition of biodiversity may reside there in the future (adapted from M. Anderson (in press)). This may involve identification and protection of a suite of places that will likely be critical to wildlife in the future. In a simplified example, breeding habitat for piping plovers might be characterized as dunes, beaches and shorelines on coarse sands and gravel. Conserving a network of these settings across a spectrum of latitudes and elevations maintains an important stage for many species, under both current and future conditions. These geophysical settings will need to be of sufficient size to recover from disturbances and maintain space for the breeding requirements of component species. Further actions may be needed to enhance the resilience of the ecosystems by working at regional scales on hydrologic cycles and disturbance regimes, considering high quality source habitats and promoting connectivity across habitats for dispersal and migration.

### ***c. Maintaining and restoring landscape and habitat connectivity***

In fish and wildlife management, the ability of individuals and populations to move across the landscape has been important to maintaining biological diversity. Fragmentation of landscapes by changing land uses has restricted these movements. Managing species and their habitats in the context of climate change will require an increased and ambitious emphasis on connectivity. That will include the connectivity of core or crucial conservation areas as defined by each state with lands that are managed for multiple purposes (e.g., working landscapes) to enable species to shift towards more suitable climates (e.g., higher elevations or latitudes).

Wildlife linkages and buffer zones around core habitat will play an important role in this approach but will not be

sufficient, as species distributions and abundances change in unpredictable ways. Habitat connectivity at the scale needed for climate change adaptation will require strategic planning and investment and meaningful collaboration among public and private parties (see Adaptation Case Study 1).

**3. Clearly define goals and objectives in the context of future climate conditions**

Both climate change adaptation and fish and wildlife management require a clear statement of goals and objectives. Adaptation goals and objectives generally fall within one or more of the following broad approaches (Table 2): 1) increased resistance; 2) promoting resilience; 3) enabling ecosystem responses; and 4) realigning restoration and management activities to reflect changing conditions.

Focusing on increasing resistance and resilience may be possible for some target species or systems, or under

relatively moderate climate changes. As the magnitude of climate change increases, it will be necessary to identify conservation actions that focus on responding to changes and providing transitions to new states or systems. It will also be necessary to realign restoration and management activities that are currently based on historic conditions and range of variability, to reflect changing conditions. A sole emphasis on trying to build ecological resistance may be unachievable and could result in missed opportunities if managers do not plan for new species and ecological systems that may move into an area. Focusing on resistance is likely to prove a poor use of funding and resources over the long term. Realistically, however, some combination of these types of goals will likely be needed to meet broader conservation objectives in a changing climate. Adaptation case studies 2, 3 and 4 illustrate that different goals can be combined and that in some situations the lines between these approaches can be unclear.

**Table 2.** General approaches to management of natural resources under climate change, with example management goals (adapted from Millar et al. (2007) and the USFS on-line Climate Change Resource Center at <http://gis.fs.fed.us/ccrc/>).

MANAGEMENT APPROACH	DEFINITION	EXAMPLE GOAL/OBJECTIVE
Increase <b>RESISTANCE</b> to change	Forestall undesired effects of change and/or manage ecosystems so they are better able to resist changes resulting from climate change.	Maintain current distribution of coldwater-dependent bull trout in freshwater systems, despite long-term temperature increases.
Promote <b>RESILIENCE</b> to change	Manage for “viable” ecosystems to increase the likelihood that they will accommodate gradual changes related to climate and tend to return toward a prior condition after disturbance.	Thin and strategically protect eastern Cascade forests to improve resilience to fire and drought (See Adaptation Case Study 2).
Enable ecosystems to <b>RESPOND</b> to change	Intentionally accommodate change rather than resist it by actively or passively facilitating ecosystems to respond as environmental changes accrue.	Ensure that coastal ecosystems continue to support many species and complex natural communities, sequester large volumes of carbon and provide human ecosystem service as they are transformed by sea level rise (See Adaptation Case Study 3).
<b>REALIGN</b> management and restoration approaches to reflect current and future dynamics	Rather than restoring habitats to historic conditions, or managing for historic range of variability—realign “restoration” and management approaches to current and anticipated future conditions.	Create monitoring systems and conduct future modeling to inform restoration activities so that restoration can be realigned to reflect changing and future projected conditions (See Adaptation Case Study 4).

Identifying the target species, communities, ecosystems, or ecological processes to be addressed by climate change adaptation planning and action is a critical part of identifying goals and objectives. Targets might be selected because of existing priorities (e.g. species or ecosystems with high economic or recreation value) or because of regulatory requirements (e.g. endangered species). Targets may be selected because a species or habitat may be known or suspected to be vulnerable to changing climate conditions (e.g. polar bears). Some targets may fit both descriptions—a current conservation concern that is also known to be susceptible to climate change. All of these reasons are valid for selecting a target to be addressed through climate change adaptation planning. The challenge is deciding where to start since there may be hundreds of potential targets of conservation concern in a state or region. Managers should not be paralyzed because of uncertainty about which species or habitats will be most affected. Instead, they should recognize that additional targets can be developed and added in later plan updates. Both targets and management goals and objectives will likely need to be adjusted as the science improves and new data becomes available.

In many cases, wildlife adaptation will motivate managers to use a more habitat or ecosystem-centered approach to conservation. Species conservation will become more challenging as habitats change, resulting in new and sometimes unfamiliar combinations of plants and animals. For example, a species historically found within one state may shift partially or wholly to another state, or shifts in vegetation may reduce the viability of species or populations that are common today. Species conservation efforts that focus on identifying and protecting those habitats most likely to persist as climate changes will likely be better investments than those that depend on habitats which are likely to become unsuitable. An alternative approach would be to select an ecological process (e.g. - fire or river flows) or ecosystem (e.g. - wetlands, sagebrush steppe, or alpine meadows) as a target and then consider consequences to multiple species dependent on that process or ecosystem (see Adaptation Case Study 5). A balance will need to be struck between agencies' species conservation requirements and the need to manage for variability and uncertainty at the habitat or ecosystem level. A revision of Wildlife Action Plans will require that both species and habitats be considered. Given the different vulnerabilities of species and systems, conservation targets should be prioritized by their relative urgency, sensitivity and the capacity to achieve desired goals.

#### **4. Consider appropriate spatial and temporal scales**

While some species are currently managed in a coordinated range-wide manner, in most instances the manage-

ment of wildlife and habitats is done at the state or local level. In addition planning horizons tend to be relatively short (e.g. 5 years). Changes in climate will occur at very large scales, across entire ranges of wildlife and vegetation types. In most cases, the scale of planning should be based on that of natural systems and the anticipated climate impacts rather than on political boundaries, so that states do not develop redundant or contradictory strategies. Developing maps or other representations of shared conservation priorities may help some states manage species and habitats at the appropriate scale to cope with climate impacts.

The effects of climate change are already apparent on some landscapes, but more and different changes will emerge and develop over time. These changes are expected to accelerate through at least the next century. The appropriate time scale for climate planning will vary among projects. There is much more certainty about the impacts of climate over the next 20-30 years and a planning horizon of about 30 years is often considered reasonable for climate-sensitive projects. Other time scales may be important for projects with a shorter or longer life span (e.g. facility infrastructure). Beyond that period, the magnitude and type of changes will be greatly affected by greenhouse gas emissions now and in the immediate future. States should consider how this type of planning horizon and the increasing level of uncertainty over longer timeframes affects plans to revise and keep Wildlife Action Plans current and relevant.

#### **5. Consider several likely/probable scenarios of future climate and ecological conditions**

Building adaptation strategies around a limited set of likely future scenarios of climate and ecological conditions is a useful tool for making decisions when uncertainty is high and uncontrollable (Peterson et al. 2003). This can be done through a formal scenario planning process or could be done by simply anticipating a reasonable range of future conditions. In developing future climate scenarios, the emphasis should be on identifying what multiple futures could look like, rather than trying to predict exactly what the future will look like. They can be relatively simplistic (e.g. the local climate may become increasingly warm and dry or it may be increasingly warm and wet) or more precise (e.g. the local area may see 1°F, 3°F, or 5°F of warming by the year 2050). These scenarios can then be used to examine impacts and opportunities facing target systems and species.

Information on climate change vulnerabilities and opportunities can help identify which adaptation strategies are most relevant to the species or system being targeted for adaptation action. Science and management experts can

then assist with translating those strategies into feasible site and target-based actions for each future climate scenario being considered. Not all actions will be equally feasible or desirable, so an evaluation of the tradeoffs (e.g. costs versus relative contribution to achieving a particular management objective, and the likelihood the actions will have similar utility across climate scenarios) will be necessary to identify priority actions to be implemented. This type of evaluation can inform prioritization of actions identified in Wildlife Action Plans.

Highlighting how climate change impacts and opportunities facing a particular target ecosystem or species might vary across multiple future scenarios allows us to consider whether management responses would also vary. Some management actions may be consistently recommended across future climate scenarios, while others may differ. A comparison of management actions identified for each future climate scenario will highlight those actions that are likely to be effective across a range of scenarios, along with those actions that may be effective under a particular scenario, but less appropriate under others. This process might include recognizing how resource goals will be affected and identifying management actions that can help us achieve our conservation goals. It is important that we identify decision-making approaches that make use of the best-available science and do not postpone important

decisions while waiting for improvements in climate modeling.

## 6. Use adaptive management to help cope with climate change uncertainties

Adaptive management is an effective method for decision-making in the context of incomplete information, uncertainty, risk and change. Adaptive management is a form of “learning by doing” that can be used to gradually build the information needed for good decision-making without postponing needed actions. Management decisions are designed to test hypotheses and provide data to inform future decisions. In the context of climate change, adaptive management can help managers see whether their adaptation strategies are working. More information on adaptive management is available in the “Tools” chapter.

## Case Studies

Following are examples of projects that are underway to address climate change. These projects range from “no regrets” conservation activities (i.e., actions that meet other needs but can also address climate change) and activities that were developed to specifically respond to climate change. Updates of these projects and examples of new case studies will be made available at [www.fishwildlife.org](http://www.fishwildlife.org).

### **Adaptation Case Study 1: Re-establishing connectivity to enable fish movement under current and future climate in Kentucky**

The Kentucky Department of Fish and Wildlife Resources, Harrison County local government, US Fish and Wildlife Service and The Nature Conservancy are working together to reestablish connectivity in the West Creek of the Licking River watershed by removing a low-water bridge. The area is identified as a Priority Conservation Area and a Mussel Conservation Area in Kentucky’s Wildlife Action Plan. While this project was not developed as a result of examining specific climate change data, maintaining resilience of the river system as the climate changes is recognized as an important project goal. Many tributaries of the Licking River have lost connectivity to the main channel due to obstructions such as dams and poorly designed culverts, resulting in restrictions to fish migration and mussel reproduction. Improved connectivity at this scale would promote fish movement whether rainfall increases or decreases through time.

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## **Adaptation Case Study 2: Promoting resilience: Washington Tapash Sustainable Forest Collaborative**

The Tapash Sustainable Forest Collaborative is a partnership between The Nature Conservancy (TNC), the Washington State Department of Natural Resources, Washington State Department of Fish and Wildlife, the Yakama Nation and the U.S. Forest Service. The group's primary goal is to manage three million acres of Eastern Cascades forests with the goal of strengthening the landscape's resistance and resilience to the long-term effects of climate change (e.g. hotter, drier and longer fire seasons). Using TNC's Conservation Action Planning methodology, the partners conducted an assessment of the viability and critical threats facing key habitats within a 300,000 acre landscape of eastern Cascade forests. The assessment indicated that climate change is a major threat facing the forests. An acquisition strategy will be used that focuses on connectivity of landscapes to allow natural and prescribed disturbance processes to persist. Climate change has become an important prioritization factor in deciding where acquisitions are most likely to improve climate adaptation. The Tapash Collaborative is implementing several place-based adaptation strategies that will increase the number of acres restored through cooperative controlled burns and thinning projects. Selectively culling smaller trees will increase forest resiliency by creating fewer, bigger, more fire-resistant trees. Open patch habitats within the forest are critical for a variety of species and are naturally maintained by fire. Selective thinning will help restore the natural pattern of more frequent, less severe fires that benefit and balance the ecosystem.

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## **Adaptation Case Study 3: Enabling ecological systems to respond to changes: the Albemarle-Pamlico Peninsula Climate Adaptation Project**

The North Carolina Chapter of The Nature Conservancy and the US Fish and Wildlife Service are working with other federal and state agencies to ensure that as the ecosystems of the Albemarle-Pamlico Peninsula are transformed by changing climate and rising seas, they are transformed into ecosystems that still support many species and complex natural communities, sequester large volumes of carbon and provide human ecosystem services. To meet this management goal, TNC and the USFWS are planning and implementing a comprehensive set of strategies on the Alligator River National Wildlife Refuge to abate the effects of climate disruption. High-resolution models developed for TNC show that up to 469,000 acres on the Albemarle-Pamlico Peninsula could be flooded by as little as a 12-inch increase in sea level and that nearly 750,000 acres could be flooded by a 20-inch rise. Under these scenarios, many unique and diverse ecosystems on the Peninsula will be put at risk. Since the sea level model used for this project was unable to account for saltwater intrusion into the wetland interior and subsidence due to degradation of peat soils, the project coordinators anticipate inundation to be much faster than what the models indicate. As a result, managers developed an overarching goal of slowing the impacts of sea-level rise on the Albemarle-Pamlico Peninsula to avoid a catastrophic shift from pocosin/forested and wetland/brackish marsh habitat to open water.

The following activities were implemented starting in the summer of 2009: 1) Hydrologic restoration using water control structures equipped with flashboard risers and tide gates to rehydrate the peat soils while maintaining an appropriate water table and to prevent further saltwater intrusion into the interior; 2) Oyster reef restoration using marl (calcium carbonate fossil rock) to construct shoreline oyster reefs along the Peninsula to provide settlement habitat for naturally occurring oyster larvae and buffer the shoreline from eroding waves and storms; and 3) Restoration of wetland vegetation by planting salt/flood-tolerant trees (bald cypress and black gum note: green ash will no longer be included) in experimental plots to determine their growth and survival on peat soils. Adaptation efforts will also include establishing corridors for species migration inland and upland.



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### **Adaptation Case Study 4: Realigning to current and future conditions: Restoring floodplain forests in Missouri and Tennessee**

The Lower Mississippi Valley Joint Venture (LMVJV) is a conservation forum in which the private, state and federal conservation community develops a shared vision for bird conservation in the Lower Mississippi Valley (LMV). The JV Board established a goal of restoring 1 million acres of bottomland forest that will reduce forest fragmentation in a largely agricultural landscape and buffer floods with natural vegetation that stores carbon. Through state agency driven projects, thousands of acres of habitat have been acquired and restored in focal areas such as the Lower Obion River Project Area, identified by the Tennessee Wildlife Resources Agency, and River Bends Conservation Opportunity Area, identified by the Missouri Department of Conservation. Both states are presently working to restore 2,340 acres of bottomland forest and canebrake habitats in the LMV.

The proposed conservation actions for this project will restore resiliency of forests, but they also set the stage for realignment. Information management and modeling is designed to align restoration with current conditions, but also to realign to respond to future changes in the LMV. The LMVJV has processes in place to evaluate and respond to forest and hydrology changes. Bird monitoring related to species-habitat models and predictions based on potential natural vegetation under a changing climate will allow for a continuous system-relevant evaluation. Conservation goals and objectives are climate-informed and promote building resilience into a forested ecosystem that will change through time.

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### **Adaptation Case Study 5: Place-based climate change adaptation planning in two Montana ecosystems**

In December 2008, Montana Fish, Wildlife and Parks, World Wildlife Fund, the Wildlife Conservation Society and the National Wildlife Federation held a workshop to assess the implications of climate change for fish and wildlife management in two ecosystems in the state: the Yellowstone River and sagebrush steppe habitats. The workshop brought together science and management experts to discuss the impacts and opportunities of multiple future climate scenarios on a range of game and non-game fish and wildlife species in those ecosystems. Participants also identified potential management actions that would allow Montana Fish, Wildlife and Parks to achieve objectives related to conserving current native species in those areas, conserving habitat for species that find those areas suitable in the future and maintaining recreational hunting and angling opportunities. Several management responses that were discussed are similar to current management activities in these two systems, but with an added sense of urgency or priority (e.g., securing senior water rights and agreements, restoring riparian vegetation, removing non-native species, closer coordination with federal agencies that manage publicly-owned sagebrush steppe habitat). Other management actions considered represented slight or even significant adjustments in agency practice (e.g., reintroduction of beaver to increase high elevation water storage, monitoring sagebrush habitat condition and extent).

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For a complete workshop summary: <https://online.nwf.org/site/DocServer/FINAL-WorkshopReport.pdf?docID=7441>

## Chapter 2: TOOLS FOR PLANNING AND IMPLEMENTING ADAPTATION ACTIONS

Chapter 1 described several approaches and strategies for climate change adaptation. Some of these are closely aligned with past work in conserving fish and wildlife species and habitats and familiar tools can be used to implement them. Many existing policies, planning processes and management actions will also help support climate change adaptation and will continue to be relevant and useful. In some cases, however, the goals, objectives, or priorities of wildlife managers may change in response to current or future climate change, or the actions needed to support a species and habitat may shift with changing conditions. This chapter examines three tools that combine old and new means to address some of the unique challenges of climate change: vulnerability assessment, adaptive management and targeted monitoring.

### Vulnerability Assessments: Describing Ecosystem Responses to Climate Change

This section describes the process of assessing the vulnerability of species and habitats to climate change, outlines some of the trade-offs involved in different assessment methods and gives an overview of what a vulnerability assessment can and cannot do. Identifying and meeting the adaptation needs of species and ecosystems requires an understanding not only of current and future climate impacts but also of the likely responses of species and habitats to these changes. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as “the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change.” Vulnerability consists of the following:

- Exposure to climate change (i.e., the magnitude of the changes experienced);
- Sensitivity of the species or system to these changes; and
- The capacity to adapt to these changes.

A variety of factors influence the overall vulnerability of biological systems to climate change. These may include the following: 1) specific biological traits that limit adaptive capacity; 2) physical barriers to dispersal or other adaptation methods; 3) high exposure or sensitivity to specific climate impacts because of distribution or biological factors; 4) exposure to existing or future non-climate stressors. For example, species that are already in decline because of habitat loss or other factors could

be more at risk in a changing climate (greater sensitivity and less adaptive capacity). Likewise, habitat types that are found at or near sea level are much more likely to be affected by rising sea levels (high exposure). High-elevation species that are dependent on snow or cold temperatures may be vulnerable to range contraction because of rising temperatures (high exposure, high sensitivity and low adaptive capacity).

Human responses may also increase the vulnerability of natural systems. For example, rising sea levels may prompt the construction of new sea walls or other structures that may protect human property but limit the ability of estuarine ecosystems to migrate inland. Of course, some species or habitats may also benefit from climate change. This “flip side” of vulnerability merits attention, and is often poorly addressed in adaptation planning.

### Why Assess Vulnerability?

Understanding which species and habitats are vulnerable and why is key to developing effective adaptation strategies that will lessen climate change impacts to these resources. This process is often referred to as a vulnerability assessment. The goal of a vulnerability assessment is to describe these three elements – exposure, sensitivity and the capacity to adapt to climate change – in a way that supports better management and decision-making now and in the future. A vulnerability assessment provides the scientific basis for developing climate adaptation strategies. It combines information about future climate scenarios (i.e., exposure to climate impacts) with ecological information about climate sensitivity and adaptive capacity to provide an idea of how a species or system is likely to respond under the projected climate change conditions. The relative vulnerability of species or habitats can then be used to set goals, determine management priorities and inform decisions about appropriate adaptation strategies.

Vulnerability assessments do not have to be conducted, but they can be a useful tool in developing adaptation strategies. Assessments should be targeted to meet specific information needs and should match the unique priorities, goals and resources of the state or states involved in the assessment. The goal of a vulnerability assessment is to describe the degree to which relevant species and systems are susceptible to and unable to cope with the adverse effects of climate change. It may quantify the level of vulnerability and the factors that create it or it may simply describe which of the target species and systems are expected to be most vulnerable and why.

Examples of questions to address in a vulnerability assessment include the following:

- Which species, populations, habitats, or ecosystems are most vulnerable to climate change?
- Which are less vulnerable or are likely to benefit from climate change?
- Which are most vulnerable to climate extremes, climate variability and/or changes in average temperature or precipitation?
- Which expected climate impacts will be most or least significant for a target species or system?
- Which impacts can be managed by increasing the adaptive capacity of species or systems? Which are unavoidable?
- Where the details of future changes are uncertain, which of the likely scenarios are the most or least harmful?
- What species might be expected to move into the area under future climate conditions? What new assemblages might emerge?

The steps below outline a suggested process for conducting a vulnerability assessment, and the sections that follow describe a range of alternative strategies for building a useful and practical assessment process. There are many ways of assessing climate-related vulnerability and change, and states or other groups that choose to conduct a vulnerability assessment should develop a method that meets their specific goals and needs.

### Assessing Vulnerability to Climate Change: Suggested Steps

#### 1. Determine the scope of the assessment

Focus on achievable results, meeting specific information needs  
 Consider analyzing habitat types and a subset of species  
 Decide on an appropriate timeframe and spatial scale  
 Identify key products and users  
 Identify limitations and potential partners

#### 2. Collect relevant climate and ecological data

Use a method that can take advantage of available data  
 Reach out to internal and external experts  
 Build on existing work whenever possible

#### 3. Describe vulnerability qualitatively and/or quantitatively

Provide information needed for decision-making  
 Consider not only what is vulnerable but also why and how  
 Highlight opportunities to increase adaptive capacity

#### 4. Start outlining adaptation priorities and strategies

Continue involving stakeholders and partners  
 Use results to build consensus on strategies

#### 1. Determine the scope of the assessment

Each state will be affected by a different combination of climate change impacts, each will see different responses to climate change in biological systems, and each will have to determine which impacts and responses to address through a vulnerability assessment. For example, a state may choose to focus on the impacts of sea level rise and

increasing temperatures, especially if precipitation projections are highly uncertain. Alternately, a state might choose to address the full array of climate trends but focus on the responses of several species or systems that are expected to be especially vulnerable (e.g. high-elevation meadows; cold-dependent freshwater species) or on species that are expected to adapt by shifting to new areas.

### *Levels of assessments*

Most states will not have sufficient resources to conduct an exhaustive, species-by-species vulnerability assessment for each impact. Even where funding is available, creation of a detailed formal vulnerability assessment should not delay efforts to begin designing and implementing climate change adaptation strategies. Where time and resources are limited, even broad conclusions on the relative vulnerability of different species or habitats can help in developing and prioritizing adaptation strategies.

In determining the scope of the assessment, building the information needed for making management decisions and developing specific adaptation strategies should be given first priority. The quality and quantity of information available, the scope of the existing Wildlife Action Plan and the relative importance of different climate impacts may also affect this decision. Identifying key products or steps early on in the process will help both in the budgeting process and in ensuring that the assessment makes efficient use of the available time and resources. These products or steps may include creation of maps, holding meetings/workshops, creating internal/external publications, etc.

### *Types of assessments*

Vulnerability assessments may focus on individual species, groups of species, habitat types, or ecoregions as the level of analysis. In most cases, considering some combination of species and habitats or ecoregions will be most useful. For example, an agency may wish to assess the climate change vulnerability of broad categories of habitat types across its jurisdiction as well as examining a subset of species more closely. These might include keystone species, species of greatest conservation need, species for which a special management directive exists, or species suspected to be sensitive to climate change. Alternatively, an assessment could examine fish and wildlife in broad taxonomic categories and then focus in on listed species or habitats that are especially threatened within those broad categories. Identifying target species, habitats, or ecosystems is a significant step in conducting a vulnerability assessment.

### *Scales and timeframes*

Clearly defining the spatial scale and timeframe of the assessment early can help keep the process as efficient as possible. If an assessment is conducted at the state level, it is important to consider how it will take into account species that cross state boundaries, including species that may move into or out of the state or region under future climate conditions. In some cases, conducting a multi-state vulnerability assessment or coordinating with neighboring states can help resolve these problems. It may be helpful

to participate in a formal assessment at the regional scale, to be supplemented with less formal or less detailed state-level assessments. States may be able to look to federal partners for help with multi-state assessments.

In determining the appropriate timeframe for an assessment, consider that near-term projections of climate change scenarios tend to have a higher degree of certainty and greater detail than those that look further out. This is the case because it is difficult to anticipate how greenhouse gas emissions might change in the future, while the climate change we experience over the next few decades will be primarily caused by past emissions. As a result, 30 years is a common planning horizon when considering future climate impacts. It may be appropriate for some vulnerability assessments to consider a different timeframe, especially when a project being considered will have a lifespan longer than 30 years. However, an assessment that looks further into the future should take into consideration the high level of uncertainty involved with long-term climate projections.

### **2. Collect relevant climate and ecological data**

Two kinds of data are needed to assess vulnerability; 1) information on expected climate impacts and 2) information on ecological responses in the species or habitats considered. Climate data may or may not need to be “downscaled,” or translated from the global to the regional, state, or local scale, for analysis. The general circulation models (GCMs) that are typically used to describe future climate conditions are global in scale and do not show sufficient variation at the scale of a state or region to be useful in planning. However, acquisition of downscaled climate data can be costly and difficult to access and use. The Climate Wizard tool recently developed by The Nature Conservancy, the University of Washington and the University of Southern Mississippi provides access to some downscaled climate information at no cost.

Caution should be used when working with downscaled climate data, since the uncertainties involved in projecting future climate conditions can be considerable. The resolution and presentation of downscaled climate data may make them appear more accurate than they actually are, especially to audiences that are less aware of the weaknesses of climate models. Vulnerability Case Study 1 provides an example of a vulnerability assessment based on downscaled climate data and modeling that provides clear assessments of uncertainty for these products.

### *When time or resources are limited*

A less detailed vulnerability assessment using general knowledge of the expected trends may be sufficient when time is limited. For example, a state might assess the

vulnerability of different species or habitats under conditions that are warmer and drier than current conditions, without specifying a quantitative estimate of those changes. It may also be useful to consider two or more future climate scenarios to help accommodate the uncertainty inherent in climate projections. For example, in an area where precipitation trends are highly uncertain, a state might choose to consider two scenarios, one warmer and wetter and one warmer and drier. Adaptation strategies that are robust to multiple likely climate change scenarios would be considered “no-regrets” strategies.

### *When data are limited*

The availability of detailed data on ecological responses may be limited. Future climate conditions will be so unlike historical conditions that predicting how species and systems will respond is a significant challenge. When the influence of climate conditions on habitat requirements or other range determinants are known, modeling may help determine where species movements or extinctions are likely. Where sufficient information is not available or where the focus is on identifying general trends instead of developing detailed models, an expert panel approach may be more appropriate. Agency biologists, partners from other resource agencies, non-profit groups and university researchers may have a good understanding of the sensitivity and adaptive capacity of target species and systems, even when published data are not available. Information from both internal and external experts can supplement other available sources of data. Vulnerability Case Study 2 provides an example of an expert panel approach to vulnerability assessment.

### *Collaborating with partners*

In collecting information on vulnerability, it is important to build on existing work. This approach both limits the strain on agency resources and ensures that the vulnerability assessment and the adaptation strategies that develop from it are as transparent and inclusive as possible. State fish and wildlife agencies should consider participating in multi-state collaborations, partnering with other agencies to create a joint assessment, or seeking out funding to hire professionals with needed skill sets. In many cases, external partners will also benefit from the products of the assessment.

### **3. Describe vulnerability in a qualitative (and if possible quantitative) context**

A wide variety of traits and processes can make species more or less vulnerable to climate change. The effects of a changing climate tend to exacerbate the effects of other threats, such as habitat loss or pressure from invasive

species that may have already made a species susceptible to extinction. The IUCN has described five categories of biological traits that make species more vulnerable to climate change:

- Specialized habitat or microhabitat requirements;
- Narrow environmental tolerances or thresholds that are likely to be exceeded under climate change;
- Dependence on specific environmental triggers or cues that are likely to be disrupted by climate change (phenology – e.g. rainfall or temperature cues for migration, breeding, or hibernation);
- Dependence on interactions between species that are likely to be disrupted;
- Inability or poor ability to disperse quickly or to colonize a new, more suitable range.

### *Recognize uncertainty*

Whether utilizing downscaled climate data and complex ecological models or relying on general regional trends and an expert panel approach, it is important that the results of a vulnerability assessment clearly reflect the level of uncertainty involved. This can be accomplished through technical estimates of uncertainty or expert-based estimates of confidence levels. For example, the IPCC uses a system that describes quantitative estimates of confidence in accessible terms, ranging from “very low confidence” (less than 1 out of 10 chance) to “very high confidence” (at least 9 out of 10 chance). The case studies at the end of the chapter outline several approaches for describing uncertainties.

### **4. Start outlining adaptation priorities and strategies**

Once a vulnerability assessment is completed, the next step is to use the information to develop specific adaptation strategies and establish a decision-making process. Participants can start outlining the priorities and strategies that the results indicate. In particular, vulnerability assessments that include input from external experts and stakeholders can be used as a forum to begin developing goals and objectives that will follow logically from the information gathered. The chapter on adaptation strategies provides guidance on how to move from vulnerability assessment to adaptation planning and action.

### *Coping with new species or systems*

Because many vulnerability assessments focus on the species or systems that are already present, they often do not consider species or systems that may move to a new area as climate changes. Assessments that focus solely on existing species and systems in an area may result in adaptation strategies that attempt to resist ecological change and keep current assemblages intact. It must be

acknowledged that some changes will be unavoidable and uncontrollable. Vulnerability assessments should include a consideration of where species and ecosystems may move in the future.

### **Complexity within a species or system assessment**

Often, we look at a species' or system's vulnerability to changing climate in one place at a time. For example, is a species vulnerable if it is sensitive and negatively exposed to climate change in one section of its range, but it benefits from climate change in another portion of its range? The manner in which a vulnerability assessment addresses this question will affect how managers can use the information to make decisions. One possible way for dealing with this concern is to assess vulnerability across the entire range of a species or ecosystem type, so that the vulnerability of that species or system in one particular place is placed in a larger-scale context.

As these suggested steps indicate, conducting a vulner-

ability assessment can require a substantial investment in time and resources. However, bringing staff, external experts and stakeholders into the assessment process can both reduce costs and build support for the process and results. The ideal result of a vulnerability assessment is a broadly shared vision of what management success will look like under future climate conditions. The case studies that follow illustrate a range of methods for balancing the need for information on climate impacts and responses, the importance of stakeholder participation and limitations on the time and resources available for a vulnerability assessment. Vulnerability Case Studies 1 and 2 represent opposite ends of a continuum. The first case is a highly detailed assessment that includes data-rich modeling efforts, while the second is built primarily on expert opinion and represents less of an investment in time and resources. The other case studies combine these two approaches and provide a sample of the variety of approaches available for these assessments.

## **Vulnerability Assessment Case Study I: Assessing Potential Climate Change Impacts on Vulnerability of Species and Habitats in the Pacific Northwest**



This project will create a regional-scale climate change vulnerability assessment of species and habitats of conservation concern in the Pacific Northwest states of Idaho, Oregon and Washington. Portions of the assessment are currently underway with funds from the US Geological Survey and The Nature Conservancy, as well as technical assistance from the Washington Department of Fish and Wildlife. The assessment consists of two stages over a three year period. The first phase will identify those aquatic and terrestrial species and habitats of concern that are most vulnerable to climate change and develop initial climate adaptation action and monitoring based on this early information. The second phase will incorporate potential habitat changes as higher resolution climate and vegetation models become available. The project assesses both the sensitivity to climate change and potential exposure to climate but does not address adaptive capacity. The resources required for this type of assessment are significant (the project will likely require a total of \$800,000 and 3-4 years to complete), but it is being conducted at a regional scale, considers both selected species and broad habitat categories and combines the resources of state, federal, academic and non-profit partners.

The goals of the project are to: 1) create a database, based on expert workshops and literature review that assesses and ranks 400 target species and habitats according to their intrinsic sensitivity to climate change; 2) will use General Circulation Model (GCM) simulations of future climate to assess the magnitude and range of potential future climate change in the Pacific Northwest; 3) will model potential climate-driven shifts in vegetation across the Pacific Northwest; 4) will model the potential effects of climate change on the distributions of 30 selected species of greatest conservation need in the region; 5) will integrate the results of the project's first three parts to provide an assessment of climate change impacts for the Pacific Northwest including the potential impacts of climate change on conservation opportunity areas or other selected areas identified by or in association with each state's Wildlife Action Plan; 6) will apply these findings by retrofitting the plans – first for species (based on expert knowledge and existing literature) and then for habitats as higher resolution climate models and subsequent habitat models are completed; 7) will provide a template to assist other regions of the country in conducting vulnerability assessments and developing adaptation strategies.

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### Vulnerability Assessment Case Study 2: Vulnerability of Massachusetts Fish and Wildlife Habitats to Climate Change

This vulnerability assessment project used an expert panel of ecologists and wildlife biologists with professional expertise on the status, distribution, conservation and threats to fish, wildlife and their habitats. The main purpose of this expert panel was to provide answers to the following vulnerability questions: 1) How do the fish and wildlife habitats in the state wildlife action plan rank in terms of their likely comparative vulnerabilities to climate change? 2) How will the representation of these habitats in Massachusetts be altered by a changing climate? 3) What degree of confidence can be assigned to the above projections? 4) What other stressors are likely to be important in the future,



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the alleviation of which could promote increased habitat resilience and resistance to change? Experts evaluated the comparative vulnerabilities of twenty habitats for which they have expertise under two emissions scenarios and were asked to score habitats using a vulnerability scale (critically vulnerable; vulnerable; less vulnerable; likely to benefit, likely to greatly benefit). Experts were also asked to describe likely future ecological trajectories, assign confidence scores and identify other non-climate stressors that could interact with and exacerbate the effects of climate change. The results were compiled into a unified report and circulated within the entire expert panel for final review. The project cost approximately \$70,000, including travel and in-kind costs and took about 12 months to complete.

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### **Vulnerability Assessment Case Study 3: Using NatureServe's Climate Change Vulnerability Index to Assess Nevada Plant and Animal Species**

Motivated by the need to rapidly assess the vulnerability of species to climate change, NatureServe developed a Climate Change Vulnerability Index. The goal was to create a tool that would use distribution and natural history information for a species within a specific geographical area (such as a state) to rapidly estimate relative risk of local extirpation due to climate change. The Index is designed to complement other assessments of conservation status. The Index separates a species' vulnerability into two main components: exposure to climate change within its range and sensitivity of the species to climate change. Data include downscaled climate projections and scoring of the species against seventeen factors related to its anticipated climate change sensitivity, such as dispersal ability and habitat specificity. Additional factors addressing indirect exposure to climate change and documented responses to climate change are also included. The outcome for each species is one of six possible Index categories: three – Vulnerable (Extremely, Highly, or Moderately Vulnerable), two – Not Vulnerable (Presumed Stable, Increase Likely) and one – Insufficient Evidence. This Index allows users to divide species into groupings of relative risk to climate change and identify key causes of vulnerability. The results can be used to modify Wildlife Action Plans to address climate change and to help land managers anticipate the effectiveness of different adaptation strategies and select key species to monitor.

Key characteristics of the Vulnerability Index include the following: 1) uses information about the magnitude of predicted changes in temperature and precipitation across a species' range to calculate relative vulnerability; 2) contemplates vulnerability to climate change for a 50-year time frame (although users can modify this target timeframe); 3) has been developed for assessment areas ranging from the scale of a national park or wildlife refuge, to an entire state; 4) information required to complete the Index includes species-level distribution and natural history information, and historical and predicted temperature and precipitation data for the assessment area and maps of land use; 5) output from the Index is initially compiled in a table sorted by vulnerability categories and can be sorted in other ways. This approach requires a broad set of data on both climate trends and species, but the Index developed for the analysis is flexible and can be applied at a variety of scales.

The Nevada Natural Heritage Program and Nevada Department of Wildlife worked closely with NatureServe during the development of the Index and are currently in the process of ranking Nevada's Wildlife Action Plan species. The results of the Index ranking will be used to amend the Nevada Wildlife Action Plan with a chapter specific to climate change. Thus far, the Index has exceeded expectations as a "rapid" assessment tool. Once the distribution and natural history information on a species is researched and compiled -- NatureServe has already done this for many species (available at NatureServe Explorer, [www.natureserve.org/explorer](http://www.natureserve.org/explorer)) -- it can take as little as 30-45 minutes to rank a species. The cost of the assessment will be approximately \$160,000.

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### **Vulnerability Assessment Case Study 4: Application of an Integrated Climate Change Assessment & Adaptation Framework in the Four Corners Region**

To address the need for information and guidance on responding to the potential consequences of climate change, The New Mexico Chapter of the Nature Conservancy (TNC) initiated a climate change ecology and adaptation program in 2006. Building on the successful completion of a state-wide vulnerability assessment and two adaptation-oriented workshops for natural resource managers in New Mexico, TNC launched the Southwest Climate Change Initiative (SWCCI) in the Four Corners region. The Initiative seeks to further develop and apply an integrated assessment approach that examines regional climate





impacts, prioritizes adaptation actions based on vulnerability and identifies specific climate adaptation strategies in priority landscapes – one each in Arizona, Colorado, New Mexico and Utah -- using a new adaptation planning tool.

The SWCCI integrated framework begins with a spatially explicit regional assessment of climate using the Climate Wizard analysis tool. Specific climate metrics include departures and trend in temperature, precipitation and moisture stress. All variables were mapped and analyzed across the four states both retrospectively and prospectively. Annual and seasonal trends were evaluated within the time periods analyzed (1950-2006, 1970-2006, 2020-2039 and 2069-2099). Statistical summaries were generated for each climate metric and time period for the region and for each state, ecoregion and watershed. Important conservation areas were evaluated for each state with respect to exposure to recent and predicted future climate changes. Conservation priorities identified in TNC's ecoregional analyses and in Wildlife Action Plans were used as "surrogates of sensitivity." Although the approach does not measure a conservation priority's adaptive capacity, hypotheses of which conservation priorities are most and least vulnerable to ongoing climate change were developed. An evaluation of the level of climate exposure relative to conservation importance helped to prioritize vulnerable landscapes for adaptation action.

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## Adaptive Management: Using Management results to Inform Future Actions

As the uncertainties involved in vulnerability assessment illustrate, many of the challenges of adapting to climate change will require wildlife managers to make assumptions about future conditions and how best to cope with them, monitor the results of management actions closely, and then use those results to inform future decision making. This process describes adaptive management in its most basic form.

### What is adaptive management?

Adaptive management, often called “learning by doing,” is a critical tool for making management decisions with incomplete information and high levels of uncertainty. It is a way of gradually acquiring the information needed for decision-making without indefinitely postponing needed actions. At its core, adaptive management is simply a way of connecting monitoring and decision-making. Management decisions are based on the best available information but are also designed to provide more data and feedback in the future. The results of an action are closely monitored to evaluate the effectiveness of the action, and then monitoring results are used to inform future decisions or policies.

Adaptive management can provide a way of doing business that helps agencies move forward with conservation actions instead of waiting for complete information on future climate impacts. It does not need to be a rigorous scientific process in order to achieve these goals. Instead, a carefully targeted monitoring program and a clearly defined process for incorporating new information into the planning cycle can help states deal with uncertainty without creating a burdensome new structure. As agencies struggle with new problems and limited resources, this more flexible

form of adaptive management may be appropriate.

To limit policy failures and prepare for the unexpected, managers should carefully consider the potential results of decisions and plan responses to the full range of likely outcomes. For example, as part of its early decision-making process, an agency might include a back-up plan that can be implemented in short order if the initial plan fails to meet objectives. In the context of climate change adaptation, it may also be necessary to periodically incorporate new climate information into the

planning process. Instead of creating a single management plan, it may be necessary to create two or more plans to be implemented under different future climate scenarios, or to check back periodically and make sure assumptions about the changing climate continue to hold true. Climate-informed adaptive management can draw on a wealth of existing information on climate impacts and ecological responses to help define a range of potential actions and likely responses.

For example, a coastal state may be concerned about a high-priority estuary that is projected to be inundated by rising sea levels. The state could choose to protect an area just inland from the current estuary based on the assumption that inundation will occur as projected and that the system and its associated species can shift to the new area. If the trajectory of sea level rise is unclear, the agency might choose to protect several areas or to provide incentives to local landowners to manage their land in a way that will accommodate the shift inland in a number of directions. In this example, monitoring will be needed to determine whether sea level rise is occurring as projected, whether and where the estuary system is moving in response to changing sea level, and whether the new estuary supports the desired species and other values. The management strategy should outline what action will be taken if the objectives are not being met in the new area, and the results of the process should be used to inform future attempts to cope with sea level rise.

## Targeted Monitoring in a Rapidly Changing Climate

Targeted monitoring forms the basis for adaptive management and for the development and implementation of adaptation strategies. Monitoring programs should clearly demonstrate the biological response to particular adaptive management actions. In other words, monitoring is not an end in itself, but is conducted to illustrate why and how actions succeed or fail to meet management objectives. Data collected through monitoring should be comprehensive and detailed enough to evaluate a decision or action, but not so complex that the monitoring program overwhelms an agency’s capacity and impedes the management process.

Well-planned monitoring systems are key to determining if current conservation plans follow desirable ecological trends and are meeting management goals. Monitoring was a required element for Wildlife Action Plans (Element 5), but implementation of monitoring systems has been a challenge because most state fish and wildlife agencies have insufficient capacity and resources for monitoring. Under a changing climate, the importance of monitoring will be elevated.



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## Types of Monitoring:

**Status and Trends (extensive) monitoring:** tracks changes in wildlife and fish populations and their associated habitats over time.

Example: Track the population status of four target species in an area.

**Research (intensive) monitoring:** identifies cause-and-effect relationships between physical habitat conditions, ecological processes, land use practices and/or conservation strategies and the animal populations of interest.

Example: Identify the factors contributing to a population decline in one of the target species.

**Effectiveness monitoring:** documents the success of conservation actions in achieving the desired resource condition

Example: Determine if a prescribed burn achieved the desired result of maintaining plant diversity.

**Implementation monitoring:** Helps confirm that planned conservation actions were implemented.

Example: Document that a management program to purchase habitat for four target species was completed as planned

The type of monitoring should be closely focused to meet specific information needs. While many Wildlife Action Plans only address status and trend and effectiveness monitoring, research and implementation monitoring are also important in achieving conservation success. Monitoring efforts that aim to track climate-related changes involve identifying long-term trends in both physical and biological variables. Physical variables might include temperature, precipitation patterns, sea level rise, storm frequencies and season length. Biological changes may include species richness, altitudinal/latitudinal migrations in habitat, phenological changes, changes to population size or range of invasive species and expansion of diseases.

## Key monitoring components in a rapidly changing climate

1. Identify the conservation goals and objectives
2. Identify the scope of the monitoring program
3. Compile information relevant to monitoring program design
4. Identify target species and systems
5. Develop simple management-oriented questions
6. Identify monitoring recommendations and critical uncertainties
7. Determine strategy for implementing monitoring
8. Build a monitoring plan that allows for change and growth over time
9. Develop data quality assurance, data management, analysis and reporting strategies
10. Use monitoring results to provide effective feedback to decision-making
11. When possible, collect information valuable for other efforts

### The role of monitoring in climate change response

Ecological monitoring is a key component of biodiversity conservation and management. Given some of the uncertainties associated with climate change and how species will respond increases the importance and timeli-

ness of effective monitoring actions. In addition, effective monitoring is key to an adaptive management approach and will provide a useful method for decision making that can be applied to all climate change related activities and informs climate change adaptation efforts.

## Chapter 3: STATE WILDLIFE ACTION PLAN REVISION PROCESS

Chapter 3 includes a review and summary of existing guidance on Wildlife Action Plans and describes how climate change may reshape the original eight required elements. Congress required that state fish and wildlife agencies develop a Wildlife Action Plan as a condition for receiving State Wildlife Grant funding. The U.S. Fish and Wildlife Service and the Association of Fish and Wildlife Agencies have provided guidance on the development, approval, implementation and revision of Wildlife Action Plans and the expenditure of State Wildlife Grant funds to assist states in carrying out this mandate. The most recent guidance was a letter by the Director of the US Fish and Wildlife Service and the President of the Association of Fish and Wildlife Agencies regarding requirements for plan revision (FWS/AFWA Revision Guidance, 2007). Additional guidance may be included in future appropriation or climate change legislation. States should review their Wildlife Action Plans to determine the timeframe for required revisions. States may opt to revise their plan before they are required to do so.

### Existing Guidance Documents That Were Reviewed

1. Congressional Legislation – Required 8 Elements (2000)
2. AFWA Guiding Principles White Paper (2002)
3. AFWA Guidance Binder (2003)
4. NAAT One Year Out Guidance (2004)
5. FWS/AFWA Revision Guidance Letter (2007)
6. Draft 2 521 FWS State Wildlife Grant Chapter (2007)

Wildlife Action Plans were organized according to eight elements required by Congress. Each of these required elements must be addressed during a major revision of a Wildlife Action Plan. Following is a review of the eight required elements and suggestions to consider when revising your Wildlife Action Plans to better incorporate climate change:

### Climate Change Implications By Element

**Element 1: Information on the distribution and abundance of species of wildlife, including low and declining populations as the state fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife.**

According to the AFWA Guiding Principles White Paper (2002), Wildlife Action Plans should address the broad range of wildlife and associated habitats, as well as combine landscape/ecosystem/habitat-based approaches

and smaller-scale approaches (e.g. focal, keystone, and/or indicator species; guilds; species of special concern) for planning and implementation. The AFWA Guidance Binder (2003) provides specific criteria for the evaluation of species for inclusion as a species in greatest need of conservation. Many of those criteria may need to be reevaluated in the context of climate change, including criteria for the following categories: globally rare species; declining species; endemic species; disjunct species; vulnerable species; small, localized populations; species with limited dispersal; species with fragmented or isolated populations; species of special conservation concern; focal species; keystone species; wide-ranging species; species with specific needs; indicator species; responsibility species (i.e. species that have their center of range within a state) and species that rely on concentration areas (e.g. migratory stopover sites, bat roosts/maternity sites). The evaluation should describe how and why a state's species in greatest conservation need (SGCN) list priorities will change as a result of the evaluation.

### Climate Change Considerations:

- States should consider reexamining their SGCN list and make changes to account for current and future impacts of climate change. It may be necessary to specifically examine the likely effects of climate change on species with very low and declining populations. Climate change may significantly change the abundance of many wildlife species (including species which were not considered to be SGCN).
- States should consider the implications for range changes in recovery efforts of SGCN species. Climate change may significantly change the distribution of many wildlife species (including species not currently considered SGCN).
- States may need to reconsider their definitions/lists for native, exotic and invasive species.
- State's should consider using their revision process as an opportunity to address the needs of species groups not currently addressed in their Wildlife Action Plan (e.g. marine species, plants). If there are jurisdictional barriers states may want to show how those species are being addressed by the agencies in which the jurisdiction falls.
- States should consider using vulnerability assessments as a tool for identifying and describing the impacts of climate change on species. Vulnerability assessments can help states plan for new threats associated with

climate change and those that might be exacerbated by climate change.

- States should consider using species-based models that can incorporate both direct and indirect effects of climate change on survival, reproduction and other life history factors. For example temperature changes may lead to increased severe weather events that affect survival or reproductive capacity of migratory species.
- States should consider using vulnerability assessments to consider how climate change influences populations outside of a state's border.

***Element 2: Information on the location and relative condition of key habitats and community types essential to the conservation of each state's SGCN.***

Revision of Element 2 for climate change should address the broad range of habitats associated with SGCN. Both landscape and smaller scale approaches should be considered (AFWA Guiding Principles White Paper, 2002). Spatially explicit information such as GIS-produced maps can be a useful tool for describing habitat conditions and location and can be used by the agency and partners to guide conservation work and inform land-use decision-making (AFWA Guiding Principles White Paper, 2002). If possible, the revision process should consider habitats/biotic communities that serve as “umbrellas” for species assemblages. A habitat/vegetation approach can improve efficiency in managing for multiple species and serve as a way to conserve all species, including common and game species (AFWA Guidance Binder, 2003). Climate change revisions should consider the scale required for effective conservation of habitats in the face of a changing climate and suggest coordination processes for conservation at effective scales (NAAT One Year Out Guidance, 2004).

**Climate Change Considerations:**

- States should consider acquiring information on how habitats and communities are likely to change as a result of climate change (i.e. use scenario-building processes).
- States should consider how climate change will affect the future abundance and distribution of habitat types as well as changes in structure and physical characteristics.
- States should consider the implications of the appearance of novel (no-analog) communities as vegetation responds to changing climate.
- States should strive to identify the location and condition of priority landscapes and smaller site-specific habitats that may not be easily mapped but are important now or in the future to SGCN (e.g. seasonal habitats).
- States should consider that climate change will likely affect the extent and condition of habitats and community types at various spatial and temporal scales.
- States should consider using vulnerability assessments as a tool for identifying and describing the impacts of climate change on key habitats.

***Element 3: Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and their habitats.***

Revision of Element 3 will require that states examine the full range of issues, including non-wildlife factors that have substantial impact on wildlife conservation (AFWA Guiding Principles White Paper, 2002). Wildlife Action Plans should address issues at the state level and coordinate with parallel efforts in other states and countries (AFWA Guiding Principles White Paper, 2002). Threats analyses (or other comparable methodology) should be used to set goals and priorities and should identify knowledge gaps for future study (AFWA Guiding Principles White Paper, 2002).

**Climate Change Considerations:**

- States should consider climate change as a new problem for species and habitats, including potential direct and indirect impacts (e.g. sea level rise, invasive species, disease, snowpack extent and duration and increased number and severity of floods, droughts and wildfires).
- States should consider reviewing current threats, problems or impacts affecting wildlife through a climate lens and treat climate change as both a new and exacerbating threat.
- States should consider using vulnerability assessments to identify and prioritize threats.
- States should consider the impacts of fragmentation and land use to fish and wildlife movement as a barrier to wildlife adaptation across the landscape.
- States should consider using methodology that “steps down” global climate models to the state level so that the impacts of climate change can be better understood at scales that are useful for decision-making and management at the state scale.
- States should consider partnering with adjacent states or regions to identify and implement priority research and survey needs both within and across state border.
- States should consider using research and monitoring to identify how habitats or plant communities may change in response to climate change and how those changes influence conservation of SGCN.

- States should consider using research to understand which vital rates or life history characteristics are influenced by climate change (survival, reproductive capacity, foraging, etc.).

***Element 4: Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.***

Revision of Element 4 will require that states describe the conservation actions needed to address identified threats to SGCN and their habitats. Identification and prioritization of actions should involve all relevant partners and consider various approaches at appropriate state, regional and national scales (AFWA Guiding Principles White Paper, 2002). Actions should make full use of existing information, identify knowledge gaps and incorporate techniques such as vulnerability assessments to set priorities (AFWA Guiding Principles White Paper, 2002). Wildlife Action Plans should be a driving force in guiding activities under diverse wildlife and habitat conservation initiatives and should include all needed actions regardless of funding source or state wildlife agency capacity (AFWA Guiding Principles White Paper, 2002; NAAT One Year Out Guidance, 2004). Conservation actions should be described sufficiently to guide implementation of those actions through development and execution of specific projects and programs.

**Climate Change Considerations:**

- States should consider developing conservation actions that specifically address the direct and indirect impacts of climate change on species and their habitats over a wide range of likely future climate conditions.
  - States should consider identifying/describing how conservation actions will be prioritized in consideration of multiple threats/stresses and increased uncertainty.
  - States should consider identifying which actions are intended to minimize climate change impacts, which will provide for wildlife adaptation, which will provide for resilience and/or which will facilitate movement to suitable habitats and conditions.
  - States should consider identifying decision points or thresholds for actions that are designed to: 1) recognize that some species will go extinct despite our best efforts; and 2) minimize imminent loss of habitats and species.
  - States should consider including the identification, protection and maintenance of key corridors to improve connectivity as a key action to help wildlife adapt to climate change.
- States should consider linking conservation actions to specific objectives and indicators that will facilitate monitoring, performance measurement and changes or improvements to actions through adaptive management.
  - States should consider conservation actions that benefit the greatest number of SGCN and other more common and economically important species (e.g. game species).

***Element 5: Descriptions of the proposed plans for monitoring species identified in Element 1 and their habitats, for monitoring the effectiveness of the conservation actions proposed in Element 4, and for adapting these conservation actions to respond appropriately to new information or changing conditions.***

Revision of Element 5 will require that states identify proposed monitoring plans. When developing or adapting monitoring efforts for incorporation of climate change, states should base their Wildlife Action Plans in the principles of “best science,” “best management practices,” and “adaptive management,” with measurable goals, objectives, strategies, approaches and activities that are complete, realistic, feasible, logical and achievable (AFWA’s Guiding Principles White Paper, 2002). Wildlife Action Plans should describe the proposed plans for monitoring species and their habitats and the effectiveness of the conservation actions taken, with attention given to adapting conservation actions to new information and changing conditions (AFWA Guidance Binder, 2003). While all states addressed and included monitoring plans in their approved Wildlife Action Plans, most did not address or include monitoring specifically for climate change impacts or adaptation. States should consider how existing monitoring plans can or should be modified to address climate change or if climate change monitoring should be considered independently.

**Climate Change Considerations:**

- States should consider increasing monitoring effort to better inform adaptive management, which is of increased importance in responding to climate change.
- States should consider increasing monitoring effort to evaluate management decisions which will become increasingly complex because of the uncertainty of climate change.
- States should strive to use the most streamlined, affordable, scalable and broadly applicable monitoring methods available.
- States should consider new collaborations with other states, NGO’s, citizen scientist organizations etc. to improve species and habitat monitoring across entire ranges and regions.

***Element 6: Each State's provisions to review its strategy at intervals not to exceed ten years.***

Revision of Element 6 will require that states identify the timeframe for future plan revisions. The AFWA Guiding Principles White Paper (2002) recommended that Wildlife Action Plans include review procedures that ensure the plans are dynamic and can be improved and updated efficiently as new information is obtained. The NAAT One Year Out Guidance (2004) states that additions and changes to Wildlife Action Plans should be identified as part of the "element guide" and where appropriate demonstrates the linkages between changes in the elements. For example, a change in the SGCN list (Element 1) might require reprioritization of the actions necessary to conserve species and/or their habitats (Element 2). According to the FWS/AFWA Revision Guidance Letter (2007) all states should review/revise their Action Plans by October 1, 2015, or by the date specified in their approved Action Plan. Many states are currently revising their Wildlife Action Plan or may be doing so in the future to better incorporate climate change.

The FWS/AFWA Revision Guidance Letter (2007) instructs that states contact their Wildlife and Sport Fish Restoration State Wildlife Grant Specialist in their USFWS regional office for guidance at the outset of their revision process. If a state included only a brief mention of climate change, then the state may make a request of the Service to include climate change as an emerging issue. The request should be made as a letter to the U.S. Fish and Wildlife Service describing the emerging issue and committing the state to a thorough discussion of the climate change in the next scheduled revision of their Wildlife Action Plan. States planning to revise their Wildlife Action Plans to more fully incorporate climate change should refer to the FWS/AFWA Revision Guidance Letter (2007) in the Appendix to determine if a revision will be considered "major" or "minor" and to ensure the proper steps are followed.

***Element 7: Each State's provisions for coordination during the development, implementation, review, and revision of its Strategy with Federal, State, and local agencies and Indian Tribes that manage significant areas of land or water within the State, or administer programs that significantly affect the conservation of species or their habitats.***

Revision of Element 7 will require that states describe how they will coordinate with partner organizations. Coordination is encouraged, especially for border states and states where such coordination is needed for successful conservation of SGCN (NAAT One Year Out Guidance, 2004). Many efforts are underway by state agencies, federal agencies and private conservation organizations to plan for climate change. In addition, there is rapid growth in the volume of information becoming available about

climate change including vulnerability assessment, wildlife adaptation and research and monitoring. Coordination with partners will help ensure that state fish and wildlife agencies can use and distribute information on climate change in an efficient and effective manner.

**Climate Change Considerations:**

- States should consider involving/collaborating with partners (e.g. agencies, private conservation organizations, tribes, etc.) early during the revision process to ensure effective communication and sharing of information, expertise and resources.
- States should consider involving/coordinating with partners due to the uncertainty of climate change and the importance of coordinating management at large ecologically meaningful scales.
- States with coastal resources should consider collaborating with marine-oriented partners, particularly those states without full jurisdiction over marine species.

***Element 8: Each State's provisions to provide the necessary public participation in the development, revision, and implementation of its Strategy.***

Public participation is the process of inviting and involving the public in decision-making to promote trust, accountability and transparency. It serves the public interest, can lead to improved decision-making and helps to identify and recruit new constituencies. Public participation is a discipline and there are many sources of information, training, expertise and case studies available to assist with the process. Public participation can be accomplished through advisory committees, public meetings, town halls, forums, polling, open houses, workshops, focus groups public comment periods, social networking, etc. The International Association of Public Participation is a good source of information and their public participation spectrum can help categorize major stakeholder roles in the public participation process.

AFWA's Guiding Principles White Paper (2002) made a number of recommendations related to public participation including the importance of documenting decision points, involving partners early in the process and using traditional (e.g. public meetings) and technological innovations (e.g. internet polling) to engage the public. The Plan Revision Guidance Letter (2007) stated that "a major revision of a Wildlife Action Plan will require that states address element eight and provide an up to date public review process." The letter also stated that "states are encouraged to post an electronic version of their most recent Action Plan on the web along with the summary of significant changes and "road map."

The AFWA Guidance Binder (2003), made the following suggestions related to public participation. Agency capacity for leading a public participation process should be assessed and those leading the process should be experienced and well trained. Where capacity is lacking, professionals outside the agency should be utilized. Objectives for public involvement should be determined during the early stages of planning and be based on agency and public needs or requirements. These needs or requirements may change over time, which may require a change in objectives. It is important to anticipate controversies so relevant information can be acquired in advance of public meetings. Potential triggers can be defused by framing the planning process in terms that reduce the risks of public misunderstanding or intentional misrepresentation. The plan's purposes should be linked to established community values (e.g. bird watching, fishing, economic development, quality of life), existing conservation efforts should be acknowledged and the voluntary nature of the plan should be emphasized. Language should be direct and honest and it should be understood that the most involved or outspoken people may be opinion leaders but may not be indicative of the public at large. Including such people in the process is essential, but their viewpoints should be corroborated. Past experiences in public participation (good and bad) can serve as a guide for new processes.

**Climate Change Considerations:**

- States should consider using public participation planning processes because of the complexity and potential for controversy associated with climate change.
- States should take advantage of resources (e.g. Power-Point presentations) available from states and partners that can be useful in helping the public understand the science and impacts of climate change on wildlife.
- States should recognize that there are a variety of positions on climate change even among those who value wildlife. Controversy associated with policies to reduce greenhouse gasses (e.g. cap and trade protocol) should be separated from the necessity to immediately address the impacts of climate change to wildlife.
- States should consider choosing terms that are appropriate and if possible tested with your constituency groups. For example, the term “safeguarding wildlife” has been shown to be more readily understood by the public than “adaptation”.
- States should consider involving conservation partners early during the public participation planning process, but recognize there may not be agreement on messages or approaches.



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## REVISION PROCESS CASE STUDIES

### Revision Process Case Study I: Virginia Department of Game and Inland Fisheries

#### Overview

Virginia completed a revision of its state wildlife action plan in the fall of 2009. The revision was done to elevate the importance of climate change and provide guidance to the agency and partners who are working on climate change or will be in the near future. The climate change document will be attached as an appendix to the Virginia Wildlife Action Plan. Completion of an appendix is an interim step, and a major revision of the Virginia plan is planned for 2015 to incorporate climate change throughout the entire document. The key steps that were used include: 1) forming a partnership with the National Wildlife Federation and the Virginia Conservation Network; 2) holding a workshop that included agency leaders and partners in October 2008 to identify concerns and actions; 3) reviewing and synthesizing workshop input with three primary partners; 4) holding a second workshop in March 2009 to discuss potential solutions; 5) circulating workshop input to all partners for final round of comments; 6) linking the revision document to agency priority plans (e.g. State Wildlife Action Plan, Quail Plan, Wildlife and Sport Fish Restoration Programs, etc.); and 7) submitting the completed document to the USFWS as an appendix to their Wildlife Action Plan.



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#### Partner Roles

The Virginia Department of Game and Inland Fisheries provided facilities for the workshops and played a lead role in coordinating and writing the revision. The National Wildlife Federation secured grant funding, organized and provided staff for the workshops, and gave the process an elevated profile. The Virginia Conservation Network distributed and reviewed information from the workshops and helped put the climate change issue before policy makers. The plan revision process was deemed a successful collaborative effort, and without grant funding and partner support the agency would have had to scale-down the revision process.

#### Lessons Learned

Time spent doing agency in-reach at the outset of the planning process was important to the process. A partner-centered approach sent a message that climate change planning required thinking and resources that went beyond the agency's capacity. Major issues were placed into three broad categories (conservation of species and habitats, data and outreach). Focused and well thought-out questions for workshop discussions and well-prepared facilitators were key to obtaining useful information. Holding workshops in geographically distinct regions at different times of the year and having workshop participants identify additional partners were also important components.

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## Revision Process Case Study 2: Oregon Department of Fish and Wildlife

### Overview

Oregon has nearly completed a minor revision of its Wildlife Action Plan. The minor revision was done to provide immediate direction to agency staff and others working on climate change. The revised Wildlife Action Plan will be used as a companion to the Oregon Adaptation Strategy and will help stimulate communication on climate change. The revision process was started in March 2009 and was completed in the fall of 2009. The process slowed considerably during a busy legislative session. The document will be made available to agency staff and others as a transition document until a major revision of the Wildlife Action Plan is completed. The major revision will start in October 2009 and will incorporate climate change throughout the entire Wildlife Action Plan. The key steps that were used included: 1) a review of all information on climate in the Wildlife Action Plan; 2) solicitation of agency staff for additional information and review of SGCN; 3) development of an outline; 4) assembly of a mini-stakeholder group (consisting mostly of the same groups that helped develop the Wildlife Action Plan); 5) review of SGCN status by stakeholders; and 6) agency review of stakeholder recommendations.

### Partner Roles

The Oregon Department of Fish & Wildlife oversaw the revision process and provided technical review of the Wildlife Action Plan and SGCN list. The mini-stakeholder group (Oregon Department of Fish and Wildlife, The Nature Conservancy, Defenders of Wildlife, forest industry representatives and hunter/angler representatives) reviewed the recommendations of agency staff.

### Lessons Learned

Completion of the project was delayed by about three months because staff time was allocated to legislative activities. In hindsight, the agency would not have done the minor and major revisions back-to-back but wanted to be in a position to take immediate advantage of potential state and federal climate change funding. There will likely be confusion and some planning fatigue when the major revision starts, resulting in the reluctance of some staff and partners to participate in the major revision. A benefit of the minor revision is that the state is better prepared to work on climate change and can be more responsive to funding opportunities.

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More Information: [http://www.dfw.state.or.us/conservationstrategy/news/2008/2008\\_december.asp](http://www.dfw.state.or.us/conservationstrategy/news/2008/2008_december.asp)

## Revision Process Case Study 3: Florida Fish and Wildlife Conservation Commission

### Overview

Florida began a revision of its Wildlife Action Plan in March 2009 and is scheduled to complete the revision by July 2011. Plan revision began with a lot of introspection and discussions within the agency. The agency is evaluating the process used for developing and implementing the plan and will use these findings to inform the revision process. Changes that are expected include adding and updating GIS information, evaluating the Species of Greatest Conservation Need list, restructuring of the document, and incorporating Climate Change adaptation planning. The agency will be doing outreach so that key individuals/partners are not “surprised” by the revision. One of the key



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messages will be that the agency is not reinventing the plan, just keeping it relevant. The key steps that are being used include: 1) creation of an internal sub-team; 2) narrowing of issues to top priorities (SGCN list, climate change, GIS data, re-evaluation of threats and actions); 3) creating a timeline for implementation.

#### **Partner Roles**

The agency has not yet determined which partners will be used during plan revision. The scope of the revision will determine if partners or consultants need to be hired to assist.

#### **Lessons Learned**

The agency held a climate change stakeholder summit in the fall of 2008. The meeting was successful because much effort went into planning to create a structured agenda, there was good facilitation and work group leaders were empowered to plan and execute breakout sessions. To counter “planning fatigue” the agency’s message is that the entire plan is not being redone but instead is being surgically changed to make it better. Planning staff are “piggy-backing” on interest and structure (80 staff) that have been put in place to address climate change. Key internal staff are being involved in the process early and additional staff will be involved based on their recommendations. Regional biologists hired to implement the Wildlife Action Plan will play a key communication role.

Contact: Brian Branciforte, Wildlife Action Plan Coordinator, Florida Fish and Wildlife Conservation Commission, Phone (850) 410-0656 x17309, Email [Brian.Branciforte@MyFWC.com](mailto:Brian.Branciforte@MyFWC.com)

More Information: [http://myfwc.com/docs/Conservation/ClimateChange\\_SummitRept.pdf](http://myfwc.com/docs/Conservation/ClimateChange_SummitRept.pdf)

### **Revision Process Case Study 4: Tennessee Wildlife Resources Agency**

#### **Overview**

Tennessee began developing an addendum to its Wildlife Action Plan in the spring of 2008. The Climate Change Literature Review addendum was completed and released to the public in June 2009. The agency recognized a need to begin incorporating climate change into the Wildlife Action Plan to help secure climate related funding for wildlife management in Tennessee and to educate agency staff on the effects of climate change on wildlife and habitat. The key steps used in creating the addendum included: 1) Identifying and developing six habitat/species work groups for each section of the review; 2) Identifying key partners for a peer review; 3) Undergoing the peer review process; 4) Incorporating edits and hosting the finalized document online.

#### **Partner Roles**

The Climate Change Literature Review addendum was an in-house project completed by the Tennessee Wildlife Resources Agency. Key partners were identified to participate in the peer review process. These partners included the US Fish and Wildlife Service, the Nature Conservancy, in-state partners such as the Division of Forestry and the Tennessee Department of Environment and Conservation and regional Wildlife Action Plan Coordinators from Alabama, Florida, Georgia and Missouri.

#### **Lessons Learned**

The development of the addendum provided an ideal opportunity for agency staff to become versed in the peer-reviewed resources available relating to climate change and the flora, fauna and ecoregions in Tennessee. By reviewing the literature, agency staff feels more confident about incorporating climate change into the Wildlife Action Plan. Recognizing time constraints and realistic deadlines is a critical component to the planning and revision process. With lengthy priority lists for departments, a thorough evaluation of climate change related resources needs to be encouraged and tasked by agency heads to ensure completion.

Contact: Richard Kirk, Non-Game/Endangered Species Program Coordinator, Tennessee Wildlife Resources Agency, Phone (615) 781-6619, Email [Richard.Kirk@tn.gov](mailto:Richard.Kirk@tn.gov)

More Information: <http://www.state.tn.us/twra/climate.html>

## Revision Process Case Study 5: Nevada Department of Wildlife

### Overview

Nevada Department of Wildlife (NDOW) is beginning a revision of their Wildlife Action Plan. After receiving a state planning grant in January 2009, the agency has brought together the original Wildlife Action Plan Partners to work on the review. Both the agency and partners recognized a need to incorporate climate change in the Nevada Wildlife Action Plan. The goal is to produce a revised plan by December 2010. The key steps being used in Nevada's revision process include: 1) engaging key partners through monthly meetings of the "Phase II Implementation Team;" 2) securing grant monies to allow partners to work directly on Wildlife Action Plan revision projects and planning; 3) securing grant monies to enable agency staff to provide oversight, organize workshops and scoping meetings and to provide general staff support for the Wildlife Action Plan revision; 4) planning and hosting public scoping meetings to garner public participation; 5) planning and hosting smaller technical expert meetings to address habitat and species specific concerns; and 6) development and release of the draft revision plan online for public comment and peer review.

### Partner Roles

Agency staff from the Nevada Department of Wildlife are overseeing the review process and coordinating partner efforts. Partners involved in the review have a substantial role to play in gathering information. Some of these partner projects include: NatureServe, which will conduct species vulnerability assessments and will be hosting workshops to implement these assessments, The Nature Conservancy which is working on modeling to predict habitat shifts as a response to climate change. Other key partners involved in the revision process include the Nevada Natural Heritage Program (NNHP), the Lahontan Audubon Society (LAS) and the Great Basin Bird Observatory (GBBO).

### Lessons Learned

Maintaining engaged relationships with partners has been important in beginning the review process. The ability to be upfront with funding partners regarding the planning process has allowed processes to work smoothly. The objective of the revision process is to create a product that both the agency and stakeholders can use.

Contact: Laura Richards, Wildlife Diversity Chief, Nevada Department of Wildlife, Phone (776)688-1996  
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More Information: <http://www.ndow.org/wild/conservation/cwcs/>



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## Revision Process Case Study 6: Massachusetts Division of Fisheries and Wildlife

### Overview

Massachusetts has been working with its partners to identify and develop adaptation tools and approaches. A conference was held on November 15, 2008 at Bentley College to work on responses to climate change; 180 participants attended. Following the conference a survey was conducted that revealed (1) conservationists and land-managers are greatly concerned about the possible impacts of climate change on



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resources; (2) climate change could undermine efforts to conserve ecosystems in the Commonwealth; (3) collaborative efforts among agencies and conservation NGOs are needed to meet the scale and complexity of the threat posed by climate change; (4) Massachusetts can play an important role in advancing climate change adaptation planning, policy and funding regionally and nationally; and, most importantly, (5) constructive guidance and tools based on good science are needed to help conservationists and planners fulfill their missions under a rapidly changing climate. An ad hoc committee was formed after the conference to create a strategic vision document that identified goals and opportunities for collaboration based on each organization's strengths and capabilities and a "roadmap" for adapting to climate change.

### Partner Roles

Partners were important in organizing the workshop, drafting a strategic vision and serving on an Alliance that include Environmental League of Massachusetts, Manomet Center for Conservation Sciences, Massachusetts Audubon Society, Massachusetts Department of Fish and Game, Massachusetts Division of Fish and Wildlife, Massachusetts Land Trust Coalition, New England Wild Flower Society, The National Wildlife Federation, The Nature Conservancy, The Trustees of Reservations. The purpose of the Alliance is to promote and facilitate the dissemination of climate-related impacts and adaptation information, to advocate for the development and implementation of science-based adaptation strategies to conserve Massachusetts' ecosystems and the array of services they provide in the face of climate change and to engage in partnerships, communications and policy venues that enhance attention, planning, policy and funding for wildlife resiliency.

### Lessons Learned

The organization involved in the project committed to a common approach and are contributing to the process. The Alliance could be expanded to other agencies to include a wider variety of stakeholders, particularly those with stronger coastal and marine expertise.

Contact: Hector Galbraith, Manomet Center for Conservation Sciences, E-mail [hg2@hughes.net](mailto:hg2@hughes.net).

More Information: [www.climateandwildlife.org](http://www.climateandwildlife.org)

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## APPENDICES

### Appendix I: Climate Change/Wildlife Action Plan Workgroup - Charter

#### Purpose:

A workgroup will be formed to develop guidance and recommendations and facilitate communication to help states incorporate climate change into Wildlife Action Plans.

#### Workgroup Members:

The workgroup will be chaired by the Climate Change and Teaming With Wildlife Committee chairs or their designees and will be comprised of state agency staff and key federal and private partners.

#### Guiding Principles:

Wildlife Action Plans were completed for all states and territories in 2005 according to specific guidelines and with similar outcomes. These plans offer an excellent framework for states and partners to collaborate in the development of adaptation strategies for climate change and to communicate these efforts to the wildlife conservation community. This workgroup will provide the best guidance and information possible for those states interested in modifying their State Wildlife Action Plan or other wildlife management plans to address climate change. It's entirely up to individual states to determine if it's in their interest to modify their State Wildlife Action Plan or to use the guidance produced by this workgroup.

#### Workgroup Charges:

1) *Produce a guidance document that can be used as a resource by states to modify/update their Wildlife Action Plan to better address the impacts of climate change. Coastal states should specifically address coastal issues and coordinate closely with the state agency responsible for management of coastal resources. The document will include the following:*

- a. Examples of processes that can be used for plan modification
- b. Compilation and/or references to synthesized data/information on climate change (TWS online bibliography, websites)
- c. Guidance on conducting vulnerability assessments including recommendations on species and systems approaches at multiscales (state, regional, national)
- d. Known climate change impacts and tools, including regional models to identify impacts
- e. Adaptation strategies and conservation actions needed to address climate change. Suggested processes to translate to on-the-ground use

f. Recommended monitoring programs for species and habitats and approaches to modify the conservation actions through adaptive management and assumption driven research

2) *Serve as a communication portal to the states to:*

- a. Improve awareness of climate change work underway by the states through frequent and efficient communication

**Who Will Be Served:** Members of the Association of Fish and Wildlife Agencies and key partners.

#### Measures of Success:

1. # of states that respond to information requests/contribute information  
*Low success (0-5 states); Moderate success (6-24 states); High success (25+ states)*
2. # of states reporting that they have or will use the guidance document  
*a. Low success (0-5 states); Moderate success (6-24 states); High success (25+ states)*

**Products/Deliverables:** Printed and electronic formats of the guidance document will be distributed via mail, websites and email.

### Appendix II: American Climate and Energy Security Act (HR 2454)

Text related to state natural resource adaptation plans included the American Climate and Energy Security Act (HR2454) passed by the House of Representatives by a vote of 219-212 on June 26, 2009.

#### SEC. 479. STATE NATURAL RESOURCES ADAPTATION PLANS.

(a) REQUIREMENT.—In order to be eligible for funds 22 under section 480, not later than 1 year after the development of a Natural Resources Climate Change Adaptation Strategy required under section 476 each State shall prepare a State natural resources adaptation plan detailing the State's current and projected efforts to address the potential impacts of climate change and ocean acidification on natural resources and coastal areas within the State's jurisdiction.

(b) REVIEW OR APPROVAL.—

(1) IN GENERAL.—Each State adaptation plan shall be reviewed and approved or disapproved by the Secretary of the Interior and, as applicable, the Secretary

of Commerce. Such approval shall be granted if the plan meets the requirements of sub11 section (c) and is consistent with the Natural Resources Climate Change Adaptation Strategy required under section 476.

(2) APPROVAL OR DISAPPROVAL.—Within 180 days after transmittal of such a plan, or a revision to such a plan, the Secretary of the Interior and, as applicable, the Secretary of Commerce shall approve or disapprove the plan by written notice.

(3) RESUBMITTAL.—Within 90 days after transmittal of a resubmitted adaptation plan as a result of disapproval under paragraph (3), the Secretary of the Interior and, as applicable, the Secretary of Commerce, shall approve or disapprove the plan by written notice.

(c) CONTENTS.—A State natural resources adaptation plan shall—

(1) include a strategy for addressing the impacts of climate change and ocean acidification on terrestrial, marine, estuarine, and freshwater fish, wildlife, plants, habitats, ecosystems, wildlife health, and ecological processes, that—

(A) describes the impacts of climate change and ocean acidification on the diversity and health of the fish, wildlife and plant populations, habitats, ecosystems, and associated ecological processes;

(B) establishes programs for monitoring the impacts of climate change and ocean acidification on fish, wildlife, and plant populations, habitats, ecosystems, and associated ecological processes;

(C) describes and prioritizes proposed conservation actions to assist fish, wildlife, plant populations, habitats, ecosystems, and associated ecological processes in becoming more resilient, adapting to, and better withstanding those impacts;

(D) includes strategies, specific conservation actions, and a time frame for implementing conservation actions for fish, wildlife, and plant populations, habitats, ecosystems, and associated ecological processes;

(E) establishes methods for assessing the effectiveness of strategies and conservation actions taken to assist fish, wildlife, and plant populations, habitats, ecosystems, and associated ecological processes in becoming more resilient, adapt to, and better withstand the impacts of climate changes and ocean acidification and for updating those strategies and actions to respond appropriately to new information or changing conditions;

(F) is incorporated into a revision of the State wildlife action plan (also known as the State comprehensive wildlife strategy)—

(i) that has been submitted to the United States Fish and Wildlife Service; and

(ii) that has been approved by the Service or on which a decision on approval is pending; and

(G) is developed—

(i) with the participation of the State fish and wildlife agency, the State coastal agency, the State agency responsible for administration of Land and Water Conservation Fund grants, the State Forest Legacy program coordinator, and other State agencies considered appropriate by the Governor of such State; and

(ii) in coordination with the Secretary of the Interior, and where applicable, the Secretary of Commerce and other States that share jurisdiction over natural resources with the State; and

(2) include, in the case of a coastal State, a strategy for addressing the impacts of climate change and ocean acidification on the coastal zone that—

(A) identifies natural resources that are likely to be impacted by climate change and ocean acidification and describes those impacts;

(B) identifies and prioritizes continuing research and data collection needed to address those impacts including—

(i) acquisition of high resolution coastal elevation and near shore bathymetry data;

(ii) historic shoreline position maps, erosion rates, and inventories of shoreline features and structures;

(iii) measures and models of relative rates of sea level rise or lake level changes, including effects on flooding, storm surge, inundation, and coastal geological processes;

(iv) habitat loss, including projected losses of coastal wetlands and potentials for inland migration of natural shoreline habitats;

(v) ocean and coastal species and ecosystem migrations, and changes in species population dynamics;

(vi) changes in storm frequency, intensity, or rainfall patterns;

(vii) saltwater intrusion into coastal rivers and aquifers;

(viii) changes in chemical or physical characteristics of marine and estuarine systems;

(ix) increased harmful algal blooms; and



(x) spread of invasive species;

(C) identifies and prioritizes adaptation strategies to protect, restore, and conserve natural resources to enable them to become more resilient, adapt to, and withstand the impacts of climate change and ocean acidification, including—

(i) protection, maintenance, and restoration of ecologically important coastal lands, coastal and ocean ecosystems, and species biodiversity and the establishment of habitat buffer zones, migration corridors, and climate refugia; and

(ii) improved planning, siting policies, and hazard mitigation strategies;

(D) establishes programs for the long-term monitoring of the impacts of climate change and ocean acidification on the ocean and coastal zone and to assess and adjust, when necessary, such adaptive management strategies;

(E) establishes performance measures for assessing the effectiveness of adaptation strategies intended to improve resilience and the ability of natural resources in the coastal zone to adapt to and withstand the impacts of climate change and ocean acidification and of adaptation strategies intended to minimize those impacts on the coastal zone and to update those strategies to respond to new information or changing conditions; and

(F) is developed with the participation of the State coastal agency and other appropriate State agencies and in coordination with the Secretary of Commerce and other appropriate Federal agencies.

(d) **PUBLIC INPUT.**—States shall provide for solicitation and consideration of public and independent scientific input in the development of their plans.

(e) **COORDINATION WITH OTHER PLANS.**—The State plan shall take into consideration research and information contained in, and coordinate with and integrate the goals and measures identified in, as appropriate, other natural resources conservation strategies, including—

- (1) the national fish habitat action plan;
- (2) plans under the North American Wetlands Conservation Act (16 U.S.C. 4401 et seq.);
- (3) the Federal, State, and local partnership known as “Partners in Flight”;
- (4) federally approved coastal zone management plans under the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.);
- (5) federally approved regional fishery management plans and habitat conservation activities under

the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.);

- (6) the national coral reef action plan;
- (7) recovery plans for threatened species and endangered species under section 4(f) of the Endangered Species Act of 1973 (16 U.S.C. 1533(f));
- (8) habitat conservation plans under section 10 of that Act (16 U.S.C. 1539);
- (9) other Federal, State, and tribal plans for imperiled species;
- (10) State or tribal hazard mitigation plans;
- (11) State or tribal water management plans; and
- (12) other State-based strategies that comprehensively implement adaptation activities to remediate the effects of climate change and ocean acidification on terrestrial, marine, and freshwater fish, wildlife, plants, and other natural resources.

(f) **UPDATING.**—Each State plan shall be updated not less than every 5 years.

(g) **FUNDING.**—

(1) **IN GENERAL.**—Funds allocated to States under section 480 shall be used only for activities that are consistent with a State natural resources adaptation plan that has been approved by the Secretaries of Interior and Commerce.

(2) **FUNDING PRIOR TO THE APPROVAL OF A STATE PLAN.**—Until the earlier of the date that is 3 years after the date of the enactment of this subpart or the date on which a State receives approval for the State strategy, a State shall be eligible to receive funding under section 480 for adaptation activities that are—

(A) consistent with the comprehensive wildlife strategy of the State and, where appropriate, other natural resources conservation strategies; and

(B) in accordance with a work plan developed in coordination with—

- (i) the Secretary of the Interior; and
- (ii) the Secretary of Commerce, for any coastal State subject to the condition that coordination with the Secretary of Commerce shall be required only for those portions of the strategy relating to activities affecting the coastal zone.

(3) **PENDING APPROVAL.**—During the period for which approval by the applicable Secretary of a State plan is pending, the State may continue receiving funds under section 480 pursuant to the work plan described in paragraph (2)(B).

Appendix III: FWS/AFWA Revision Guidance Letter (2007)



JUL 12 2007

To: State Fish and Wildlife Agencies  
Secretary, Department of Natural Resources  
of the Commonwealth of Puerto Rico  
Governor of Guam  
Governor of U.S. Virgin Islands  
Governor of American Samoa  
Governor of Commonwealth of the Northern Mariana Islands  
Mayor of the District of Columbia

The purpose of this letter is to provide guidance for future Wildlife Action Plan (Comprehensive Wildlife Conservation Strategy) review and revisions.

Congress required that all States commit to reviewing and, if necessary, revising their Wildlife Action Plans within 10 years. Every State made this commitment.

The attached document, drafted by a State and Federal team, identifies the process and requirements that all States must use for the future review and revision of their Wildlife Action Plans. This guidance provides a flexible framework for States to incorporate new information and changing circumstances into their Wildlife Action Plans as easily as possible while providing national consistency.

The Wildlife Action Plans are monumental achievements. We are very encouraged by the early successes and cooperation they have spawned. We hope that this guidance will help to ensure that these excellent plans are a guiding force for conservation for years and even decades to come.

Sincerely,

Handwritten signature of Dale Hall.

Dale Hall  
Director of the U. S. Fish and Wildlife Service

Handwritten signature of Edward Parker.

Edward Parker  
President of the Association of  
Fish and Wildlife Agencies

Enclosure

# Guidance for Wildlife Action Plan

## (Comprehensive Wildlife Conservation Strategy)

### Review and Revisions

#### Purpose

The purpose of this document is to identify the process and requirements that all States/territories must utilize for the future review and revision of their Wildlife Action Plans (Action Plans).

#### Introduction

The Action Plans were developed by the States to be dynamic, adaptive documents that would guide agency and partner conservation planning for years to come. Each State committed to reviewing or, if necessary, revising (review/revise) their Action Plan within 10 years as per Element 6 of the original legislation. Many States committed to do so at much shorter intervals.

The U.S. Fish and Wildlife Service (USFWS), encourages States to review and revise their plans as often as is useful to them and their partners. Recent Congressional report language indicates that Congress expects the USFWS to develop guidance/standards that will be utilized by all States/territories to revise their action plans. The Congress also expects that USFWS will apply the standards consistently in all Regions. (cf. Senate Report 109-275: Department of the Interior, Environment, and Related Agencies Appropriations Bill, 2007. House Report 109-465: Department of the Interior, Environment, and Related Agencies Appropriations Bill, 2007). This guidance document will ensure national consistency while allowing States and their partner's flexibility to update their Action Plans without undue burden.

#### Review Process

Original plan review, with approval recommendations to the Director of the USFWS was provided by a National Advisory Acceptance Team (NAAT) -- the Assistant Director of Wildlife and Sport Fish Restoration, each of the seven USFWS Assistant Regional Directors for Migratory Birds and State Programs (ARD), Assistant Manager (AM) of the California/Nevada Office, a representative State Director from each regional Association of Fish and Wildlife Agencies (AFWA), and a representative of the national AFWA organization.

Although a NAAT may be reconvened in the future to consider general policy matters or particularly complex review/revision issues, it is not anticipated that a NAAT will evaluate Action Plan review/revisions. Instead, that task will be accomplished by Regional Review Teams (RRTs). The RRTs were an integral part of the original Action Plan evaluation process and we feel that future evaluations of Action Plan review/revisions will be carried out more effectively using this regional approach. There will be eight RRTs, one within each FWS region. The RRTs are comprised of one ARD, AM or equivalent; and one State Director appointed by each of the four regional associations (e.g. Southeastern, Midwest, Northeast, and Western). State Directors serving on RRTs will not evaluate the Action Plan from their own agency. In such cases, the Action Plan would be sent to another RRT for review. Federal Assistance Program and State staff may assist the RRTs as necessary. RRTs will assist States with guidance on Action Plan revisions and be available for any Action Plan related issues that may arise

#### General Requirements

All States must review/revise their Action Plans by October 1, 2015, or the date specified in their original, approved Action Plan and send the updated version and summary documentation to the USFWS. This summary documentation must demonstrate that the entire Action Plan was examined and that all of the original Eight Required Elements (attached) were met, including an up-to-date public review process specified in Elements 7 and 8. If no changes were made, the State must document and explain why no changes were necessary and what process was used to make that determination. For more details, see Section A. Once Action Plan review/revisions are approved, States are not obligated to review/revise their Action Plans for another 10 years or until a date specified in the Action Plan. A State may also revise only a part of its Action Plan without reviewing/revising its entire Action Plan. Some Action Plan revisions, including but not limited to the addition of a species, are defined as "major" (see definition on page 5). As such, States must provide documentation that demonstrates all of the original Eight Required Elements are adequately addressed, including an up-to-date public review process as specified in Elements 7 and 8. "Major" revisions must follow the requirements outlined in Section B. All other revisions are considered "minor" and must follow the requirements outlined in Section C.

## Specific Requirements

### Section A.

#### *Requirements for Planned Review/Revision of Entire Plan*

- (1) State agency director notifies its Regional USFWS Federal Assistance office by letter of intent to review or revise the Action Plan.
- (2) State and USFWS meet to discuss guidance to ensure all elements will be addressed prior to submission of documentation and reviewed/revise Action Plan.
- (3) State submits reviewed/revise Action Plan package by October 1, 2015, or the date specified in its original, approved Action Plan to the Regional Federal Assistance office.

This package will include:

- summary of any significant changes and documentation describing how the current version of Action Plan adequately addresses the Required Eight Elements, including an up-to-date public review process specified in Elements 7 and 8;
  - “Road map” (summary of location of elements in document) to locate revisions in Action Plan.
- (4) States are encouraged to post an electronic version of their most recent Action Plan on the web along with the summary of significant changes and “road map.”
  - (5) RRT reviews Action Plan with input from Federal Assistance staff and determines whether it is approvable or not approvable. The ARD or AM will send a letter to the State Director with documentation of the decision and description of any required action if the Action Plan is not approvable. State Directors can appeal to the Regional Director.
  - (6) ARDs and AM are responsible for communicating significant issues with members of all the RRTs to ensure consistency among RRTs.
  - (7) States that specified a review/revision within 10 years (prior to the October 1, 2015, deadline) in their Action Plan and wish to change that date must submit a “minor” revision letter (see Section C below) to their Regional Federal Assistance office.
  - (8) Federal Assistance must track revisions and due dates and maintain an administrative record of Action Plan revisions.

### Section B.

#### *Requirements for “Major” Revisions Prior to the Planned Review/Revision Date*

- (1) State agency director notifies its Regional FWS Federal Assistance office by letter of intent to make

“major” revisions to the Action Plan (See definition below).

- (2) State submits modified Action Plan and includes:
  - summary of all significant revisions;
  - documentation describing how the revision meets the Required Eight Elements, including an up-to-date public review process specified in Elements 7 and 8;
  - “road map” to locate revisions in Action Plan.
- (3) States are encouraged to post an electronic version of their most recent Action Plan on the Web with the summary of significant changes and “road map.”
- (4) RRT reviews Action Plan with input from Federal Assistance staff and determines whether it is approvable or not approvable. The ARD or AM will send a letter to the State Director with documentation of the decision and description of any required action if the Action Plan is not approvable. State Directors can appeal to the Regional Director.
- (5) ARDs and AM are responsible for communicating significant issues with members of all the RRTs to ensure consistency among RRTs.
- (6) Federal Assistance must track these revisions and maintain an administrative record of Action Plan revisions.

### Section C.

#### *Requirements for “Minor” Revisions Prior to the Planned Review/Revision Date*

- (1) State Director notifies the Regional FWS Federal Assistance office by letter of intent to make minor revisions with a description of the change and why the change is considered a minor revision.
- (2) State submits letter that includes:
  - summary of all revisions;
  - “road map” to locate revisions in Action Plan.
- (3) States are encouraged to post an electronic version of their most recent Action Plan on the web along with the summary of significant changes and “road map” (summary of location of elements in document).
- (4) Federal Assistance must track these revisions and maintain an administrative record of Action Plan revisions.

## Definitions

**“Major”:** A significant change or changes that requires revision of two or more elements in the Action Plan. Any addition of a species of greatest conservation need (SGCN) would be a major revision. This is considered a major revision because it would require the State to substantially address subsequent elements (i.e., habitats, threats, actions). Similarly, a revision of its threat assessments for SGCN species and/or habitats that are essential to conservation of SGCN would be a major change because it would likely result in changes to conservation actions and prioritization of those conservation actions.

**“Minor”:** All revisions not considered “major.”

**The RRT will determine if a change is minor or major when it is unclear. This decision may be requested by either the State or staff of Federal Assistance. State Directors can appeal decisions to the Regional Director.**

Note that States and other eligible jurisdictions that wish to use State Wildlife Grant (SWG) funds to address critical priority issues not identified within an Action Plan should refer to the USFWS 2007 Administrative Guidelines for State Wildlife Grants (SWG Guidelines), Section X.H.

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## Appendix IV: Additional References, Resources, and Training Tools

### General Information on Climate Change and Current and Future Impacts

#### Official Reports:

Bipartisan Policy Center. Sportsman scientific research on the effects of global warming on fish and wildlife

California Climate Change Center. Our Changing Climate: Assessing the Risks to California

Congressional Research Service. Global Climate Change and Wildlife. Report for Congress

Intergovernmental Panel on Climate Change:

IPCC, 2007. Climate Change 2007: Synthesis Report.

IPCC. 2007. Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability: Summary for Policymakers.

IPCC 4th Assessment Report. Climate Change 2007: Summary for Policymakers. (5.6 MB PDF)

Natural Resource Defense Council. “Hotter and Drier: The West’s Changed Landscape”

Natural Resource Management Ministerial Council. 2004. National Biodiversity and Climate Change Action Plan 2004-2007.

Australian Government, Department of the Environment and Heritage, Canberra, ACT.

The Pew Center on Global Climate Change:

Pew Center. 2007. Impacts of Climate Change: Four U.S. Case Studies

Pew Center. 2002 Coastal and Marine Ecosystems and Global Climate Change: Potential Effects on U.S. Resources

Pew Center. 2007. The Importance of Climate Change for Future Wildfire Scenarios in the Western United States

US Global Change Research Program. US National Assessment of the Potential Consequences of Climate Variability and Change Sector: Coastal Areas and Marine Resources

The Wildlife Society. 2004. Global Climate Change and Wildlife in North America . Technical Review 04-2

#### Publications & Peer Reviewed Articles:

Holdren, John P. 2007. Meeting the Climate Change Challenge. Eighth Annual John H. Chafee Memorial Lecture on Science and the Environment. 26 pp.

National Academies Press. Ecological Impacts of Climate Change

Scientific Publication: Parmesan, Camille. Annual Review of Ecology and Evolution Supplement. 2006.37.637-669 “Ecological and Evolutionary Responses to Recent Climate Change” (PDF)

Thomas, CD, Cameron, A, Green, RE, Bakkenes, M, Beaumont, LJ, Collingham, YC, Erasmus, BFN, Siqueira, MFD, Grainger, A, Hannah, L, Hughes, L, Huntley, B, Jaarsveld, ASV, Midgley, GF, Miles, L, Ortega-Huerta, MA, Peterson, AT, Phillips, OL, Williams, SE. 2004. Extinction risk from climate change. Nature 427(6970): 145-148.

United States Global Change Program. Global Climate Change Impacts in the United States. 2009. Karl, T.R., J.M. Melillo, and T.C. Peterson (Eds). Cambridge University Press.

The Wildlife Society. Fall 2008. Adapting to Climate Change. Wildlife Professional Special Issue. Vol. 2(3).

The Wildlife Society Climate Change Bibliography from “Adapting to Climate Change” (PDF). Wildlife Professional Special Issue. Vol. 2(3).

#### Web Resources:

The National Center for Atmospheric Research’s Climate and Global Dynamics. (Current climate news)

National Science Foundation . Global Climate Change Research Explorer

Florida’s Wildlife: On the Frontline of Climate Change

U.S. Climate Change Science Program

Season’s End: Global Warming’s Threat to Hunting and Fishing

## Adaptation

A Climate of Change: Adaptation strategies for Water Resources. California Department of Water Resources Canadian Climate impacts and Adaptation Research Network – Archives

CCSP. 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp.

CCSP, 2009: Thresholds of Climate Change in Ecosystems. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Fagre D.B., Charles C.W., Allen C.D., Birkeland C., Chapin F.S. III, Groffman P.M., Guntenspergen G.R., Knapp A.K., McGuire A.D., Mulholland P.J., Peters D.P.C., Roby D.D., and Sugi-hara G.] U.S. Geological Survey, Department of the Interior, Washington D.C., USA.

Cruce, Terri L. 2009. Adaptation Planning – What U.S. States and Localities are Doing. PEW Center on Global Climate Change.

Florida Coastal and Ocean Coalition. 2008. Preparing for a Sea Change in Florida – a strategy to cope with the impacts of global warming on the state's coastal and marine systems. 40 pp.

Fox, Douglas. 2007. Back to No-analog Future? *Science* vol. 316: 823-825.

Glick, P., A Staudt, B. Stein. 2009. A New Era for Conservation: Review of Climate Change Adaptation Literature. National Wildlife Federation.

Halpin, P. N. 1997. Global climate change and natural-area protection: Management responses and research directions. *Ecological Applications* 7:828-843.

Hannah, L., G. F. Midgley, T. Lovejoy, W. J. Bond, M. Bush, J. C. Lovett, D. Scott, and F. I. Woodward. 2002. Conservation of biodiversity in a changing climate. *Conservation Biology* 16:264-268.

Hannah, L., and L. Hansen. 2005. Designing landscapes and seascapes for change: in *Climate Change and Biodiversity*, T. E. Lovejoy, and L. Hannah, editors. Yale University Press, New Haven, CT.

Hopkins, J.J., H. M. Allison, C. A. Walmsley, M. Gaywood, G. Thurgate. 2007. Conserving biodiversity in a changing climate: guidance on building capacity to adapt. Department for Environment, Food and Rural Affairs. London, England.

Hulme, P. E. 2005. Adapting to climate change: is there scope for ecological management in the face of a global threat? *Journal of Applied Ecology* 42:784-794.

Huntley, B. 2007. Climatic change and the conservation of European biodiversity: towards the development of adaptation strategies. A discussion paper prepared for the 27th meeting of the Standing Committee, Convention on the Conservation of European Wildlife and Natural Habitats, Strasbourg, 26-29 November 2007. Council of Europe.

Mawdsley, J. R., R. O'Malley, and D. S. Ojima. 2009. A review of climate-change adaptation strategies for wildlife management and biodiversity conservation. *Conservation Biology* Early View On-Line.

Williams, John W. and Stephen T. Jackson. 2007. Novel climates, no-analog communities, and ecological surprises. *Front. Ecol. Environ.* 5(9) 475-482.

Presentation: Confronting Climate Change -- The Challenge of Adaptation (PDF)

The Massachusetts experience, by Hector Galbraith, PhD

## Vulnerability

### *Publications & Peer Reviewed Articles:*

Florida Wildlife Federation. 2006. An Unfavorable Tide – global warming, coastal habitats and sport fishing in Florida. 56 pp.

Stanton, Elizabeth A. and Frank Ackerman. 2007. Florida and Climate Change – the costs of inaction. Tufts University. 91 pp.

Stuart Butchart. Climate Change - Species Vulnerability Workshop Report

### *Web Resources:*

IUCN Red List: SPECIES SUSCEPTIBILITY TO CLIMATE CHANGE IMPACTS

Long Term Ecological Research

The National Ecological Observatory Network.

The National Phenology Network

USDA Forest Service Global Change Research provides long term research, scientific information, and tools that can be used by managers and policymakers to address climate change impacts to forests and rangelands.

USGS Ecosystem Global Change Research

USGS National Climate Change & Wildlife Science Center

## Connectivity

Beier, P and Noss, R.F. 1998. Do habitat corridors provide connectivity? *Cons Bio* 12:1241-1252.

Calabrese, J. M., and W.F. Fagan. 2004. A comparison-shop- per's guide to connectivity metrics. *Front Ecol Environ* 2(10): 529–536

Crooks, Kevin R., M. A. Sanjavan. 2006. *Connectivity Conservation*. Cambridge University Press.

Hilty, Jodi A, W. Z. Lidicker, A.M. Merenlender, P. Andrew. 2006. Corridor ecology: the science and practice of linking landscapes for biodiversity conservation. Dobson Island Press.

Lindenmayer, D., Fischer, J. 2006. Habitat fragmentation and landscape change: an ecological and conservation synthesis. Island Press.

Western Governor's Association. Climate change and Connectivity

## Monitoring Tools

### *Publications & Peer Reviewed Articles:*

Brown, J. L., S.-H. Li, and N. Bhagabati. 1999. Long-term trend toward earlier breeding in an American bird: a response to global warming? Proceedings of the National Academy of Sciences of the United States of America 96:5565–5569.

Cooch, E. G., R. F. Rockwell, and S. Brault. 2001. Retrospective analysis of demographic responses to environmental change: an example in the lesser snow goose. Ecological Monographs 71:377–400.

Gitay, H., A. Suarez, D.J. Dokken, and R.T. Watson (eds). 2002. Climate Change and Biodiversity. IPCC Working Group II.

Harvell, C. Drew, Charles E. Mitchell, Jessica R. Ward, Sonia Altizer, Andrew P. Dobson, Richard S. Ostfeld, Michael D. Samuel. 2002. Climate Warming and Disease Risks for Terrestrial and Marine Biota. Science 21. Vol. 296(5576): 2158 – 2162

Parmesan, Camille and Gary Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421: 37-42

Rose, G.A., 2005. Capelin (*Mallotus villosus*) distribution and climate: a sea “canary” for marine ecosystem change. ICES Journal of Marine Science: Journal du Conseil 62(7):1524-1530

Schneider, Stephen H. and Terry L. Root (eds.). 2001. Wildlife responses to climate change: North American case studies. Island Press, Washington, DC, 437 p.

Schneider, Stephen H. and Terry L. Root. 2003. Wildlife Responses to Climate Change: North American Case Studies. The Quarterly Review of Biology, Vol. 78(1): 115

Spellerberg, Ian F. 2005. Monitoring ecological change, Edition 2. Cambridge University Press. 391 pages

Thomas, J.A. 2005. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. Philos Trans R Soc Lond B Biol Sci 360(1454):339-357

Wiersma, G.B. 2004. Environmental monitoring, CRC Press, Boca Raton/London 767 p.

### *Web Resources:*

Environment Canada. Framework for monitoring biodiversity change (species and species subgroups) within the ecological monitoring and assessment network in Canada.

Natural Resource Monitoring Network.

UCLA, Institute of the Environment, Southern California Environmental Report Card, 2006. Innovations in Environmental Modeling.

## Adaptive management

Department of Interiors. Adaptive Management

National Conservation Training Center's Adaptive Management Course Web Page

## Mitigation

Biello, David. 2007. 10 solutions for climate change. Scientific America .

Choudhury, K, C. Dziedzioch, A. Hausler, and C. Ploetz.,. 2004. Integration of biodiversity concerns in climate change mitigation activities: a toolkit. Federal Environmental Agency (Umweltbundesamt), Berlin. 70 pp.

IPCC. 2007. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2005. IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H. C. de Coninck, M. Loos, and L. A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442 pp.

Pacala, SW and RH Socolow. 2004. Stabilization wedges: solving the climate problem for the next 50 Years with current technologies. Science 305: 968–972. <http://carbonsequestration.us/Papers-presentations/htm/Pacala-Socolow-ScienceMag-Aug2004.pdf>

Socolow, RH and SW Pacala. 2006. A plan to keep carbon in check. Scientific America.

Sousounis, P. J., and J. M. Bisanz, editors. 2000. Preparing for a changing climate—the potential consequences of climate variability and change. Great Lakes. U.S. Environmental Protection Agency, Washington, D.C., USA.

The National Energy Lab. Carbon Sequestration Page.

## Partners

### Federal Partners

Bureau of Land Management, California  
Environmental Protection Agency  
National Oceanic and Atmospheric Administration  
National Park Service  
Natural Resources Conservation Service  
U.S. Fish and Wildlife Service  
U.S. Forest Service  
U.S. Geological Survey

### Non-Governmental Organizations

*(AFWA does not endorse any specific organization. These are for informational purposes)*

Audubon  
California Native Plant Society  
California Partners in Flight  
California Waterfowl Association  
Center Biological Diversity  
Central Valley Joint Venture  
Defenders of Wildlife  
Ducks Unlimited  
Environmental Defense  
National Wildlife Federation  
NatureServe  
The Nature Conservancy  
Natural Resource Defense Council  
Planning and Conservation League  
Point Reyes Bird Observatory  
Riparian Habitat Joint Venture  
Resource Law Group  
Trout Unlimited  
The Wildlife Conservation Society  
The Wildlife Society  
Union of Concerned Scientists: Global Warming

### International/Territories/Provinces

Australian Government's Department of Climate Change  
Natural Resources Canada: Climate Change Impacts and Adaptation Division  
United Kingdom's Department of Energy and Climate Change  
The United Nations Environment Programme



## NOTES:

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