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NATIONAL *fish, wildlife & plants*
CLIMATE ADAPTATION STRATEGY

taking action

a progress report | 2014

Across the country, the agencies responsible for managing fish, wildlife, and plants are working with partners and stakeholders to take concrete steps to address the impacts and future threats of climate change.

On the cover
Girl with binoculars:
Monarch butterflies: Gene Nieminen/USFWS
Fish: R. Wilson
Sitka blacktailed deer: Steve Hillebrand/USFWS

Red crossbill

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Executive Summary

The National Fish, Wildlife, and Plants Climate Adaptation Strategy (NFWPCAS or Strategy) is a call to action that outlines seven key steps needed to safeguard the nation's valuable living natural resources in a changing climate. Produced by a coalition of federal, state, and tribal agencies with input from many partners, the Strategy is designed to inspire and enable natural resource managers and other decision-makers to take action to anticipate and adapt to a changing climate.

The Strategy was informed and shaped by the early efforts of leading federal and state agencies, local governments, and conservation partners to help prepare for and respond to the impacts of climate change. This Progress Report highlights examples of the growing effort by government and nongovernmental partners to prepare for and respond to the impacts of climate change on natural resources. These efforts are consistent with the recommendations of the Strategy.

Across the country, the agencies responsible for managing fish, wildlife, and plants are working with partners and stakeholders to take concrete steps to address the impacts and future threats of climate change. For this Progress Report, almost 100 case studies were submitted, representing partnerships with over 350 individual federal, tribal, and state agencies, departments, non-governmental organizations, private businesses and landowners. This Progress Report describes 50 of these projects that demonstrate implementation of a variety of actions recommended by the Strategy.[1] The projects are highly collaborative, have an emphasis on action over planning, reflect all levels of government, cover a wide geographic range, and respond to a diversity of climate impacts.

The examples highlighted in this report are not a comprehensive accounting of what has been accomplished, but rather illustrate the diversity of projects, scales of planning, and partnerships that can and are being be utilized to respond to the impacts of climate change. And now climate change impacts can be integrated into conservation planning. The Strategy recommended over 100 actions that were organized into 23 strategies under seven major goals. This Progress Report identifies activity in all 23 of the strategies.

1 See Appendix for full list of submitted case studies and further information.

The majority of the climate change adaptation projects were reported under Goals 4 and 5, suggesting that many agencies are already working to "Increase Knowledge and Information" and to "Support Adaptive Management." These projects include efforts to understand the impacts of climate change and completing climate change vulnerability assessments for species and habitats. In the next three to five years, more of the agencies undertaking this research will be in a position to integrate what has been learned into existing conservation and management plans and programs.

Fewer projects were reported under Goal 6: "Increase Awareness and Motivate Action." This represents a large opportunity for agencies that interact with the public and industry groups to better communicate with and engage constituents in understanding and encouraging action to combat climate change.

The diverse adaptation work highlighted in this report is part of a larger collective effort by a wide range of partners to safeguard the nation's fish, wildlife, plants, and the communities and economies that depend on them in a changing climate. Although there are critical actions being taken now, there is still much more to be done to address the challenging tasks ahead. The success of climate adaptation relies on continuing action by federal, tribal, state, and local governments and many partners. In particular, this will include building the skills, resources, tools, and capacity to implement the plans and recommendations that result from many of the ongoing efforts. A successful response to this challenge must also include increased engagement and coordination from agencies, managers and partners at all levels.

Introduction

Fish, wildlife, and plants are integral parts of ecosystems that provide jobs, food, fiber, clean water, storm protection, health benefits, recreation, and many other important services that support people, communities, and economies across the nation. Observed changes in the climate are already impacting these valuable resources and systems. Faced with a future climate that will be unlike that of the recent past, the nation needs to act now to reduce the impacts of climate change on its valuable natural resources, resource-dependent communities, and businesses. Preparing for and addressing these changes in the near term will increase the effectiveness and efficiency of actions to reduce negative impacts and take advantage of potential benefits from a changing climate.

A wide variety of adaptation projects aimed at reducing threats and building resiliency for fish, wildlife, and plants are already underway, ranging from the national to the local scale. This Progress Report highlights some important examples of the growing effort by government and nongovernmental partners to prepare for and respond to climate impacts on natural resources. The case studies in this report describe activities that are already taking place, are consistent with the Strategy, and could be replicated across appropriate ecosystems and landscapes. To improve upon the success of these adaptation actions, land managers and others need to complete additional research, incorporate new knowledge into management plans and actions, expand mitigation efforts, and promote collaborative landscape scale solutions.

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Background

In 2009, Congress recognized the need for a government-wide climate adaptation strategy for fish, wildlife, plants, and ecosystems. Congress asked the Council on Environmental Quality (CEQ) and the Department of the Interior (DOI) to develop a national strategy to "assist fish, wildlife, plants, and related ecological processes in becoming more resilient, adapting to, and surviving the impacts of climate change."[2] The National Fish, Wildlife, and Plants Climate Adaptation Strategy (NFWPCAS or Strategy) was released in March 2013 and was developed by a partnership of federal, state, and tribal plants, fish, and wildlife conservation agencies. This effort was led by the U.S. Fish and Wildlife Service (FWS), the National Oceanic and Atmospheric Agency (NOAA), and the New York State Department of Environmental Conservation (on behalf of states more broadly).

The Strategy is a call to action, laying out key recommendations for a collective response to climate change. The purpose of the Strategy is to inspire and enable natural resource administrators, elected officials, and other decision makers to take action to conserve our valuable natural resources, thus benefiting people that depend on them. It places priority on addressing impacts for which there is enough information to recommend sensible actions that can be taken or initiated over the next five to ten years in the context of climate change projections through the end of the century.

2 2010 Appropriations Bill for the Department of the Interior and Related Agencies.

Recent Developments

The current Administration has put a strong emphasis on creating opportunities for climate adaptation. The President's Climate Action Plan,[3] released in the summer of 2013, and the November 2013 Executive Order 13653, Preparing the United States for the Impacts of Climate Change[4] identify some of these opportunities. In May 2014, the U.S. Global Change Research Program released the Third National Climate Assessment (NCA),[5] the authoritative and comprehensive report on climate change and its impacts in the United States. The report concludes that evidence of climate change already appears in every region and impacts are visible in every state across the nation. Another strong call for adaptation comes from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report documenting global climate change Impacts, Adaptation, and Vulnerability, also released in 2014.[6]

3 See President's Climate Action Plan, <www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf>

4 See Executive Order 13653, <www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change>

5 Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

6 IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Reporting on Progress

According to the most recent NCA and IPCC reports, adaptation planning is occurring in the public and private sectors and at all levels of government. However, the IPCC noted that "most assessments of adaptation have been restricted to impacts, vulnerability, and adaptation planning, with very few assessing the processes of implementation or the effects of adaptation actions." This Progress Report begins to document the range of adaptation actions already underway that align with the Strategy's recommendations to help safeguard our nation's natural resources and the communities and economies that depend on them.

The intent of this report is to provide examples of how the Strategy is being implemented through collaborative adaptation projects on the ground; to demonstrate to both conservation practitioners and public decision makers the strong role they can play in adaptation; and to inspire and encourage stakeholders, managers, and the public to join the effort. While many of the activities described here were initiated by proactive agencies and managers before the Strategy was developed, all are consistent with the Strategy and illustrate the innovative and collaborative ways in which agencies and others can work together to advance the adaptation efforts recommended by the Strategy. Many of the projects described in this report were not conceived as climate adaptation projects but are the result of a conscious

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application of climate considerations into ongoing programs. A key message of the Strategy is that climate change can and should be a factor in a wide range of natural resource management contexts, and that both "adding a climate lens" to ongoing programs and designing intentionally climate-oriented projects are important.

MATT WILSON & JAY CLARK/NOAA, NMFS, APOC

Octopus or squid larva as seen under the microscope, collected in bongo nets.

Development and Overview

The Strategy called for the formation of a coordinating body with representation from federal, state, and tribal governments to meet semi-annually to promote and evaluate implementation of the Strategy and to report on progress. The NFWPCAS Joint Implementation Working Group (JIWG) was formed in the fall of 2013, and has supervised the production of this first Progress Report. The JIWG is led by FWS, NOAA, the Great Lakes Indian Fish and Wildlife Commission, and the California Department of Fish and Wildlife (on behalf of states more broadly).

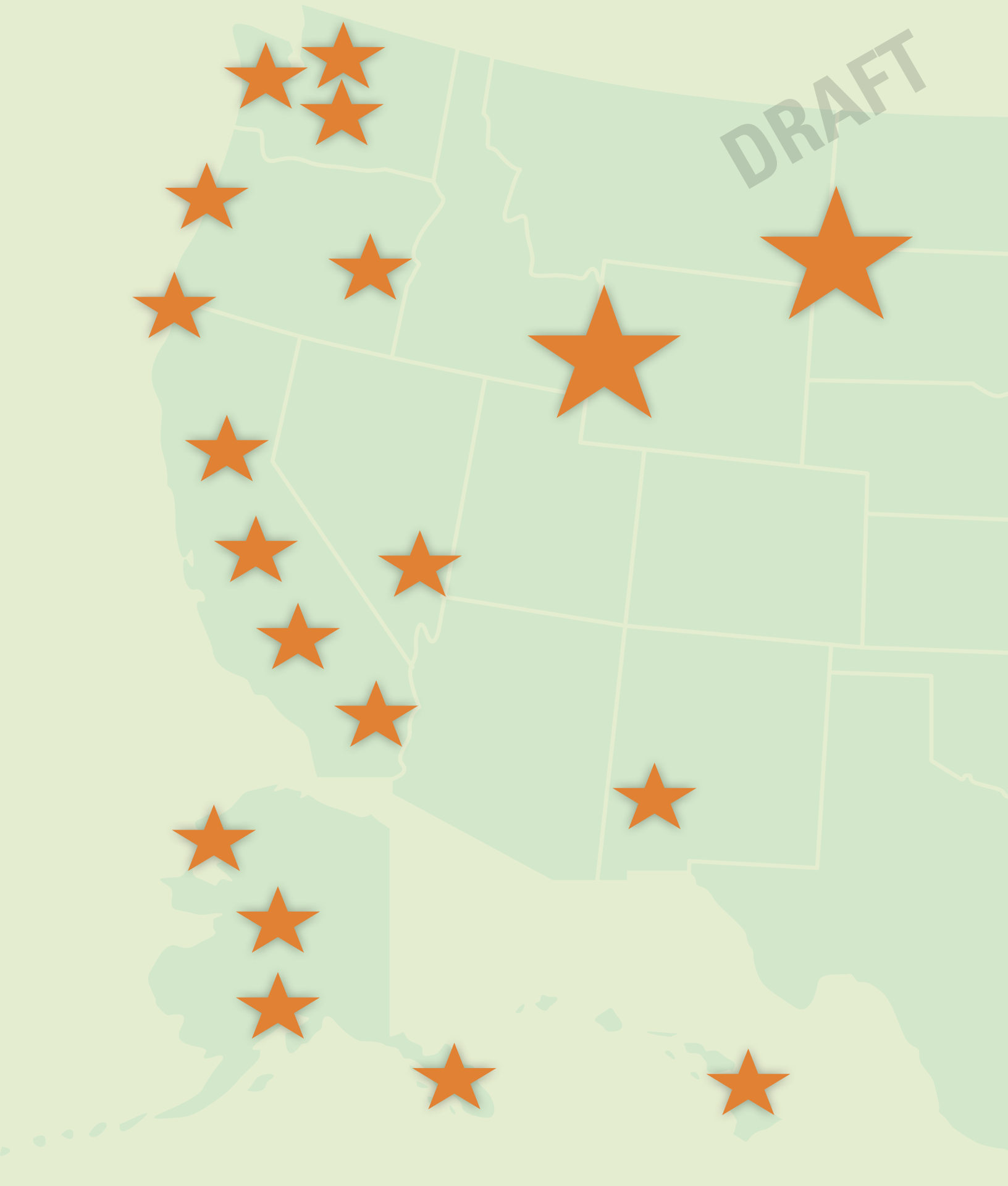
In early 2014, the JIWG asked federal, state, and tribal agencies as well as non-governmental stakeholders to share examples of climate adaptation projects that highlight the recommendations of the Strategy. The JIWG received almost 100 case studies representing partnership with over 350 individual agencies, departments, non-governmental organizations, private businesses and landowners. This Progress Report describes 50 of the projects that demonstrate implementation of a variety of actions recommended by the Strategy.[7]

Projects highlighted here are highly collaborative, have an emphasis on action over planning, reflect all levels of government, cover a wide geographic range, and respond to a diversity of climate impacts (i.e., drought, coastal inundation, increased stream temperatures, etc.).These examples illustrate what various levels of government with primary authority and responsibility for the living natural resources of the United States can do to improve natural resource resilience to the impacts of climate change. We hope that this Progress Report will encourage further collaboration and investment in these types of activities.

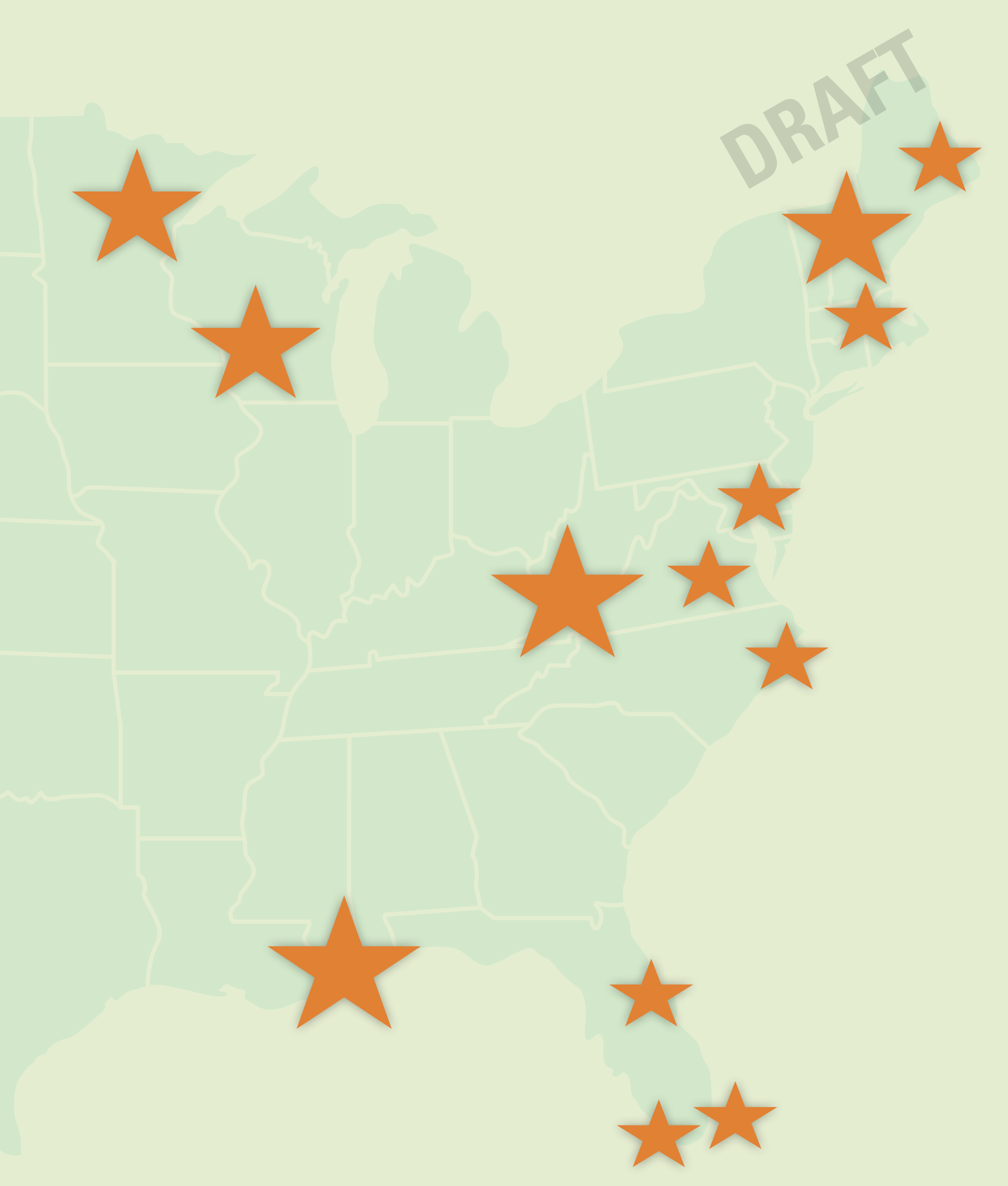
The case studies presented in this report are organized around the seven goals and 23 strategies of the NFWPCAS. Some of the projects were initiated before the release of the Strategy, while some are more recent. The case studies do not represent a comprehensive accounting of the wide variety of climate adaptation activities happening across the country, but instead seek to highlight the range of actions that can be and are being taken.

7 See Appendix for full list of submitted case studies and further information.

LOCATIONS OF SELECTED CASE STUDIES



Shapes indicate the relative geographic locations of the included case studies. Larger shapes indicate projects over larger regional landscapes. 22 national-level projects are not included.



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Goal 1

Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.

The loss and degradation of habitat is the leading threat to most species. Consequently, reducing this existing stressor is also expected to increase the resilience of species to current and future climate change. Even for those species not currently stressed by habitat loss, conserving a large and diverse amount of habitats will provide more opportunities for species to shift into new areas suitable for their needs as the climate changes in the future. Federal, state, tribal, and non-governmental groups are involved in many habitat conservation projects all across the country, including conservation planning, habitat protection, habitat restoration, and restoring connectivity.

Strategy 1.1: Identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.

The habitat conservation planning projects highlighted in this section identify those areas that will continue to provide important habitat and or biological connections in an era of climate change. Some projects are holistic in nature, factoring in all major stressors, while others are focused on identifying specific areas that will be resilient to climate changes.

Yakima River Basin Integrated Plan

The Yakima Basin Integrated Plan is a 30-year, $3.8 billion plan to restore ecological integrity and provide assurances for water needs for agriculture in the face of on-going climate change in the Yakima River Basin. This river basin, located in Washington State, is a tributary of the Columbia River. Five drought years in the past 15 years have severely impacted the multi-billion dollar agriculture sector and depleted the river's salmon and steelhead populations. This has caused the Yakama Nation and the local irrigators to join together along with local, state, and federal governments and conservation organizations to design and implement a basin-wide climate adaptation strategy that secures a future for fish, farms, and families in the Basin.

TOM RING PHOTO

The Yakima River Basin seen from upper Yakima Canyon.

The plan lays out seven key elements to help protect, mitigate, and enhance habitat; provide increased operational flexibility to manage in-stream flows to meet ecological objectives; and improve the reliability of the water supply for irrigation, municipal supply, and domestic uses. The first phase of the three phase project will be complete by 2025 and includes purchase of 50,000 acres of forested lands and management for restoration and conservation of watershed values, fish passages at Cle Elum Reservoir, Cle Elum pool raise, and the Kachess to Keechelus conveyance pipeline, $100 million in salmon restoration projects throughout the basin, and water conservation that will save 85,000 acre-feet of water primarily for in-stream flow improvements. The target outcome of this plan is stable water supplies to support recovery of salmon and steelhead populations and to ensure the existing agricultural water supplies at 70% of their allotted amounts during drought conditions.

Partners

- Yakama Nation
- Kittitas Reclamation District
- Kennewick Irrigation District
- Roza Irrigation District
- Sunnyside Valley Irrigation District
- Yakima-Tieton Irrigation District
- Washington Department of Ecology
- Washington Department of Fish and Wildlife
- U.S. Bureau of Reclamation
- American Rivers
- Trout Unlimited
- The Wilderness Society
- Benton, Kittitas, and Yakima County
- NOAA National Marine Fisheries
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Washington Department of Natural Resources
- Yakima Basin Fish and Wildlife Recovery Board
- 12 Local communities
- 12 Local businesses
- 3 Local recreation organizations

"Based on GIS analysis of the northwest tribes, the Yakama Nation is at the highest risk for the region's climate change because more than 80% of the land is below 4,000 feet."

—PHIL RIGDON, YAKAMA NATION DEPARTMENT OF NATURAL RESOURCES

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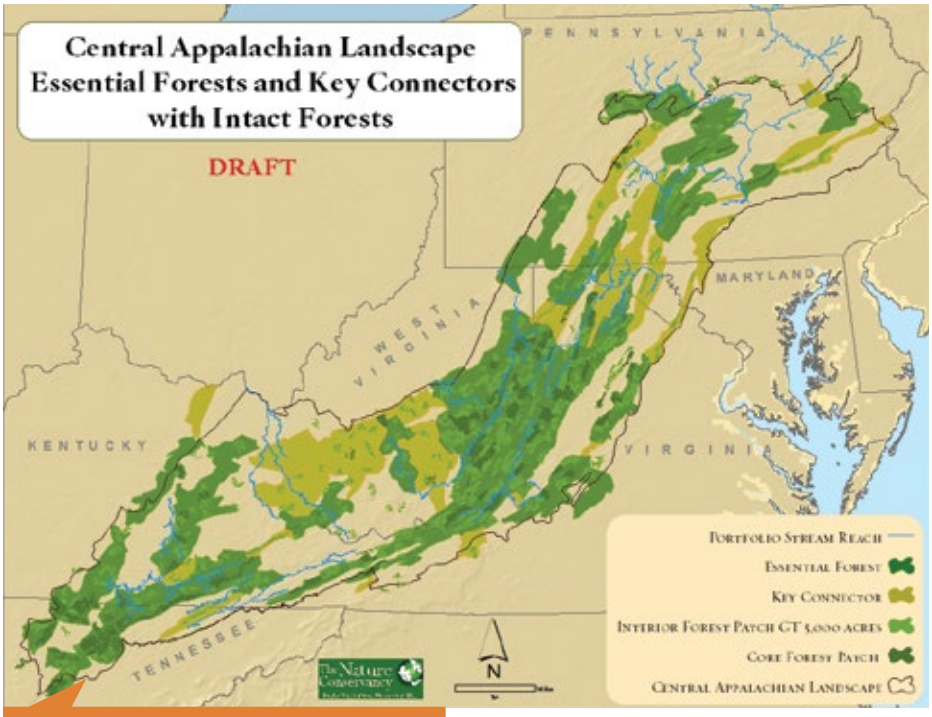
Central Appalachians Essential Forests and Key Connectors

This project aims to protect the ultimate drivers of biodiversity by focusing on the factors that underpin species richness and the long-term persistence of species and habitats across a landscape. This involves mapping and evaluating key geophysical settings and landscape characteristics such as intactness and connectivity in the landscape that buffer against harmful climate impacts. By doing this, researchers were able to identify the most resilient places within the Central Appalachian Forests that can serve as climate change strongholds at both the landscape and local scale. Through this resiliency approach, the Central Appalachians Whole System Program (including U.S. Forest Service Lands in Pennsylvania, Maryland, West Virginia, Virginia, Kentucky, and Tennessee) has developed a vision for the long-term conservation success of the region where land managers can assess threats and impacts and provide for investment prioritization—even in the face of climate change uncertainty.

The Central Appalachians Whole System Program has used this approach to design an Essential Forests, Streams and Key Connectors map to form a conservation vision of a dynamic landscape of connected, functional forests and rivers. This map is being used to give a coarse filter context for how a particular place or project fits into the larger landscape, its relative role for protecting current biodiversity, and its relative role for ensuring future adaption in the face of



Draft map of central Appalacian landscape.

climate change. Additionally, the Central Appalachians Program actively uses resiliency science at the local and landscape level to shape and drive conservation investment within the region. The ultimate conservation outcome of the Central Appalachians Whole System Program is to conserve a dynamic, functional, connected network of resilient forests and streams. Partners across the region are currently working to share this vision of a connected, resilient landscape.[8]

Partners

- Appalachian Landscape Conservation Cooperative
- Appalachian Mountain Joint Venture
- The Nature Conservancy
- U.S. Forest Service
- U.S. Fish and Wildlife Service

Strategy 1.2: Secure appropriate conservation status to complete an ecologically-connected network of public and private conservation areas that will be resilient to climate change and support a broad range of species under changed conditions.

Several climate change informed habitat protection projects are highlighted here. For example, the White Mountains to Moosehead Lake Program in New Hampshire and Maine is working to conserve 61,000 acres of forest lands providing resilient habitat and regional connectivity. In another example, Minnesota is leading and funding an effort to protect key lakes that can serve as refugia for coldwater fishes in a period of climate change.

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Landscape Scale Conservation in the White-Moose

The White Mountains to Moosehead Lake Program is a cross-sector collaboration to help preserve and strengthen the integrity of habitat connections at a broad landscape scale, strategically and deliberately integrate climate adaptation, and protect the nature-based assets (working forests and recreation) that underlie local economies across western Maine and eastern New Hampshire.

The White Mountains to Moosehead Lake region—spanning 2.7 million acres from northern New Hampshire, through western Maine to Moosehead Lake—is among the most ecologically significant, large landscapes in the Northeast. The region provides a connective corridor of contiguous, climate-resilient habitat between the White Mountain National Forest and more than two million acres of contiguous conservation lands extending from Moosehead Lake north to the Canadian border.

Crocker Mountain, Carrabassett Valley, Maine

8 <www.nature.org/ourinitiatives/regions/northamerica/areas/centralappalachians/overview/index.htm>

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The region is notable for its exceptionally productive large blocks of working forest, famed waterways that support wild native Eastern brook trout and endangered Atlantic salmon, important wetland complexes, and some of New England's most dramatic high elevation ridge-lines and mountain peaks. The Nature Conservancy, Trout Unlimited, The Wilderness Society, and the Appalachian Mountain Club have identified the White-Moose region as a top climate adaptation landscape that will provide a critical refuge for native fish and wildlife as the climate warms and shifts.

Over the past two decades, conservation partners, donors, and local communities have worked together to protect the lands and waters this region needs to thrive. To date, more than 250,000 acres were protected in the White Mountains to Moosehead Lake program area via a combination of fee and conservation easements as well as the establishment of public reserves.

The White Mountains to Moosehead Lake Program was formed to better align organizational strengths, raise public awareness to the importance of land conservation in a changing climate, and leverage public and private funding in order to protect multiple resources for the benefit of natural and human communities.

Partners

- Appalachian Mountain Club
- Appalachian Trail Conservancy
- High Peaks Alliance
- Mahoosucs Initiative
- Mahoosuc Land Trust
- Maine Audubon
- Maine Appalachian Trail Land Trust
- Northern Forest Center
- Rangeley Lakes Heritage Trust
- State of Maine
- State of New Hampshire
- Town of Carrabassett Valley
- The Trust for Public Land
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. National Park Service
- U.S. Navy
- The Wilderness Society

ERIC ENGBRETSON

Lake trout and other coldwater fish will benefit from the protection of private forest lands in the watersheds of refuge lakes.

Protecting Coldwater Fish in Minnesota

Coldwater fish such as cisco, lake whitefish, and lake trout have a requirement for cold, well-oxygenated water and, in Minnesota, primarily live in deep lakes that have good water quality. This requirement makes them especially vulnerable to two of the greatest threats for Minnesota lakes—eutrophication and climate warming.

Cisco and lake whitefish live in the cold waters of many Minnesota lakes. Unfortunately, oxygen concentrations in bottom waters decline throughout the summer in many deep lakes. As the upper layers of the lake warm, these coldwater fish can experience a "squeeze" as they move up in the water column to avoid low oxygen concentrations in the deep water only to encounter the warm surface waters. In some summers, the squeeze is so great that some will die as they get forced into lethally warm temperatures.

The Minnesota Department of Natural Resources (DNR) Fisheries Research Unit, in conjunction with the University of Minnesota, have identified 176 "refuge" lakes in north and central Minnesota that are deep and clear enough to sustain cisco, even after projected climate warming. Maintaining the water quality in these lakes is critical for them to function as refugia. The DNR is starting to protect the water quality in these important lakes, partnering with other state agencies, local units of

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government, and lake associations. These strategies primarily focus on keeping forested lands intact in the watersheds of these lakes to protect their water quality. Minnesota DNR Division of Forestry is actively using Clean Water Legacy funding to protect private forest lands in the watersheds of refuge lakes.[9]

Partners

- Minnesota Board of Water and Soil Resources
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- The University of Minnesota

Strategy 1.3: Restore habitat features where necessary and practicable to maintain ecosystem function and resiliency to climate change.

Restoration can be a critical part of promoting ecosystem resilience and facilitating adaptation as well as a critical response to many environmental threats. For example, private landowners in New Mexico have increased the water level of a natural spring by over a foot by restoring the surrounding ecosystem. The projects shared here cover the small, private landowner scale all the way up to regional restoration efforts.

Carefully engineered log jams built from locally sourced materials are placed in the Quinault River to re-establish natural processes that create good habitat for salmon and other fish and wildlife.

Improving Salmon Habitat on the Upper Quinault River

The glacier-fed Quinault River on Washington's Olympic Peninsula once supported hundreds of thousands of salmon that spawned and thrived in cool, gravel-bottomed streams flowing through deep forests and open glades. A century of clearcut logging and mismanagement of the river corridor have resulted in a significant loss of salmon habitat and what remains is a shallow, braided river channel. The glacier from which the Quinault River originates has melted and almost disappeared. Salmon populations have declined precipitously. Higher water temperatures and reduced streamflows associated with climate change could be the final stressor for the salmon.

The Quinault Indian Nation (QIN) has responded to declining salmon populations by re-creating habitat diversity and increasing resilience that will allow ecosystems to support stronger runs of salmon and adapt to changing climate regimes. Since 2008, the QIN has installed 23 engineered log jams on the upper Quinault River to protect remnant spawning habitat, stabilize streams and reduce erosion and siltation. Floodplains and log jams are being created using native tree species to anchor soils, shade deep pools and eventually add habitat complexity to flowing waters. Early evidence indicates the project is successfully improving salmon habitat and repairing habitat-forming processes in the upper Quinault River. The biological processes—including the return of stronger salmon runs—will follow.

Up to 27 engineered logjams are scheduled to be built in the Upper Quinault River in 2014–15. Approximately 400 logjams will be needed over a 12-mile reach of the river. This is a long-term restoration project that will continue in adaptive phases, as funding allows, through several decades.

Partners

- Quinault Indian Nation
- Grays Harbor County
- Jefferson County
- Multiple private landowners
- The Nature Conservancy
- Pacific Coast Salmon Recovery Fund
- University of Washington
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- U.S. National Park Service
- Washington Department of Natural Resources
- Washington Salmon Recovery Funding Board
- Wild Salmon Center

9 <www.dnr.state.mn.us/tullibeelake.html>

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SNAPSHOT

Saving Hotter and Dryer Ciénaga Habitat

Pitchfork Ranch is an historic cattle ranch in Grant County, New Mexico where the owners have been encouraging restoration, introducing at risk species, and pursuing climate adaptation strategies. The ranch is primarily rolling Chihuahuan grassland, one of the most biologically diverse arid regions in the world. The ranch also contains rare spring-fed ecosystems, including a unique ciénaga or perennial spring.

Extreme flood and drought cycles, eradication of beaver, sheep and corporate cattle overstocking in the late 1880s, and the absence of fire have dramatically altered the area's natural water balance. The overarching goal of management of the ranch is to repair the habitat using "flood-n-flow" based restoration practices and accompanying sediment deposition to restore the ciénaga and surrounding land toward its pre-settlement condition.

Through habitat restoration, the owners have raised the base level of the spring over 11 inches. They intend to continue capturing sediment and further expand the riparian zone for wildlife that may struggle to find water due to the impacts of climate change. Water retention has been achieved via ongoing installation of over 200 grade control structures that captured more than 30,000 tons of sediment, helping the ciénaga to be reclaimed and restoring the connection between surface and groundwater. Restored spring function has shortened the dry period on the ranch, which provides a vital stopover for migratory birds since this habitat has become the only available water source for 35-miles in any direction.

Albemarle-Pamlico Adaptation Project

Since 2008, the Albemarle-Pamlico Climate Change Adaptation Project has been addressing the needs and vulnerability of coastal wetlands in northeastern North Carolina that have arisen due to climate change and changes in land use. The three major approaches that are being developed, implemented, and taken to scale are hydrologic restoration, wetland plant community restoration, and oyster reef restoration.

North Carolina's Albemarle-Pamlico Peninsula epitomizes the critical importance and fragility of coastal natural communities where water and land meet. The low, flat peninsula forms a diverse, lush landscape of swamp forest, pocosins, marsh, blackwater creeks, and rivers. The area supports amazing biological diversity, from oysters and waterfowl to marsh grasses and fire-dependent pine pocosins. More than 540,000 acres are under conservation ownership in this region. An ever increasing rate of relative sea-level rise in North Carolina, threatens to inundate these conservation lands. The peninsula's ecosystems are being profoundly altered by increased shoreline erosion, saltwater intrusion, an existing ditch network, and disintegration of the region's peat soils.

The goal of the Albemarle-Pamlico Climate Change Adaptation Project is to ensure that ecosystems remain vibrant in the face of their inevitable alteration by climate change and sea-level rise. To date, the project has: established 1900 linear feet of oyster reef habitat and 7 acres of oyster sanctuary; protected 11 miles of shoreline along the Alligator River National Wildlife Refuge (NWR); completed a 65,000 acre water management capability plan for the Dare County Bombing Range and part of Alligator River NWR; controlled invasive *Phragmites* on 11.5 acres; planted 20,000 flood-tolerant trees in a 40 acre experimental area; and tested herbaceous marsh seeding techniques on a 0.5 acre area.

Partners

- The Nature Conservancy
- U.S. Air Force
- U.S. Fish and Wildlife Service
- U.S. Navy

Marl breakwater provides oyster habitat and shoreline protection of marsh at Swanquarter NWR.

C. PICKENS/THE NATURE CONSERVANCY

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Strategy 1.4: Conserve, restore, and as appropriate and practicable, establish new ecological connections among conservation areas to facilitate fish, wildlife, and plant migration, range shifts, and other transitions.

A number of ongoing habitat connectivity projects focus on restoring connectivity in freshwater stream and river habitats by removing or replacing man-made features or modifications that are impeding fish passage. Climate change has made some of these projects even more critical because in many instances, the very structures that impede fish passage to colder waters are also creating flooding and erosion issues for local people and communities due to more intense rainfall events that are increasing in frequency.

Taunton Mill River Restoration

The Taunton River watershed in Massachusetts hosts one of the largest river herring (blueback herring and alewife) runs in the Northeast region. River herring runs are declining in many other rivers throughout their range. Water quality, climate change, climate variability, and dams have been identified as threats to river herring. Removing dams is the first step in promoting resilience to the threat of climate change by allowing river herring to reach critical upstream spawning habitat, alleviating some of the existing stress on these species from habitat fragmentation and other pressures.

Dam removal has many environmental benefits, including improved water quality, restoration of natural sediment and nutrient transport regimes, aquatic habitat improvement, aquatic species passage, creation of wetlands, and increased floodplain connectivity.

(Top) The Whittenton Dam blocked fish passage along the Mill River for over 100 years. The obsolete dam almost failed during storms in 2005, leading officials to declare a state of emergency. (Bottom) The dam was removed and the floodplain restored in 2013.

SNAPSHOT

Partners for Fish and Wildlife Program in the Mountain Prairie region

From March 2013 to present, the Partners for Fish and Wildlife Program (PFW) in the Mountain Prairie Region of the U.S. Fish and Wildlife Service has restored or enhanced 37 miles of river and stream habitat to benefit high priority native fishes stressed by climate change. These projects also benefit many riparian obligate species such as the greater sage-grouse and many amphibians. In addition, the PFW program has restored, created or enhanced 4,555 acres of wetlands to benefit suites of high priority migratory birds, the imperiled Dakota Skipper, the boreal toad, and many other wetland dependent species that have been impacted by climate change. An additional 81,474 upland acres have also been restored and/or enhanced benefiting suites of grassland dependent birds, sagebrush obligate species, grizzly bear and other key species identified as part of the Mountain Prairie region climate change adaptation strategy.

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The main goals of this project are to remove three dams along the Mill River, a tributary to the Taunton River mainstem and provide fish passage at the fourth dam in order to: 1) restore riverine processes and ecosystem functions, such as flood storage, 2) improve passage for river herring and American eel, and 3) improve the resiliency of surrounding communities by eliminating the risk of dam failure. So far, Hopewell Mills and Whittenton Dams have been removed and a fishway has been installed at Morey's Bridge Dam. The final dam removal is scheduled for 2015.

Partners

- American Rivers
- City of Taunton, MA
- Massachusetts Audubon Society
- Massachusetts Division of Ecological Restoration
- Massachusetts Division of Marine Fisheries
- Massachusetts Environmental Trust
- National Oceanic and Atmospheric Administration
- Save The Bay/Restore America's Estuaries
- Southeastern Regional Planning and Economic Development District
- The Nature Conservancy
- Taunton River Watershed Alliance
- USDA Natural Resources Conservation Service
- US Fish and Wildlife Service

CATHY BOZEK

SNAPSHOT

Promoting Aquatic Connectivity and Fish Passage

The goal of The National Fish Passage Program is to prevent future fish passage barriers and aquatic fragmentation by preventing improper structures from being built after flood disasters. The incorporation of aquatic connectivity and fish passage principles into flood disaster community planning and government recovery efforts post flooding is a means to promote future flood resiliency across the country. These actions will protect financial investments, increase safety and protect streams, rivers, roads, homes and businesses from significant damage, all while restoring and protecting habitat, aquatic connectivity, and reducing sedimentation.

Aquatic connectivity will enable species movements to track with climate change within their habitats, and also provide benefits to local communities by restoring natural function to riverine systems increasing their resiliency to flood events. Outdated or improperly-sized road stream crossings that cannot withstand flooding are causing increased hazards to human health and safety as well as significant, sometimes repeated, replacement costs.

Since the flooding brought on by Hurricane Irene in August 2011 in Vermont, the U.S. Fish and Wildlife Service has been working with federal response agencies and the Vermont Fish and Wildlife Department to promote aquatic connectivity and barrier removal as a means to improve future flood resiliency. Across the country, FEMA and other partners are being engaged to develop national standards for post-flood aquatic connectivity that could be adopted across agencies.

Restoring Access to Salmon Habitats

For centuries, Moose Creek in south central Alaska was a flourishing salmon stream. However, in 1923, this essential fish habitat was drastically changed when a railroad spur was constructed up Moose Creek for a coal mine. This construction straightened and realigned much of the creek as a means to increase the space available for railroad operations and resulted in the creation of several waterfalls. The largest fall was completely impassable to spawning salmon, and the others were challenging barriers that only the strongest salmon could overcome.

Salmon have always been central to the way of life of the Ahtna people, including members of Chickaloon Native Village, who continue to use this traditional food source for sustenance. As temperatures rise, waters will warm, causing a decline in suitable habitat for these coldwater fish. The Chickaloon Native Village, in collaboration with other agencies and the local community, restored fish passage and improved habitat on Moose Creek for anadromous fish, particularly salmon, over a 3-year period.

Nearly half a mile of stream was realigned into its original, pre-railroad curvature which bypassed several waterfalls including the complete barrier to fish passage. Logjams were built to increase habitat options and provide stream bank protections. Anadromous fish like salmon now have access to more than five miles of upstream habitats for spawning and rearing. More than 200 adult Chinook salmon were counted upstream of the previous waterfall barrier immediately after the restoration actions. Salmon have restored access to ancestral spawning and rearing habitats that were blocked for many decades, which provides increased space and suitable habitat to help salmon maintain resilience to climate change.[10]

Partners

- Chickaloon Native Village
- U.S. Fish and Wildlife Service

10 <www.chickaloon.org/departments/environmental-stewardship/moose-creek>

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Goal 2

Manage species and habitats to protect ecosystem functions and provide sustainable cultural, subsistence, recreational, and commercial use in a changing climate.

Fish and wildlife conservation in the United States is largely the responsibility of a network of state, tribal, and federal management agencies that have the authority to manage species on behalf of the American public. Many agencies are actively considering climate change and what it means to their respective management mandates, and many have been or are in the process of updating their various conservation plans to include climate change and the necessary adaptation actions needed to help species and their respective habitats in the face of climate change.

Strategy 2.1: Update current or develop new species, habitat, and land and water management plans, programs and practices to consider climate change and support adaptation.

Many of the plans that guide current conservation efforts need to be updated to consider the added threat of climate change. The case study described here is the development of a planning framework to prioritize conservation actions to reintroduce Yellowstone cutthroat trout into streams that may be resilient to climate change. This framework will be incorporated into Yellowstone cutthroat management plans within its historic range.

STATE WILDLIFE ACTION PLANS

In 2005, State Wildlife Action Plans (SWAP) were developed in every U.S. state and territory. These plans represent a national blueprint for the conservation of the full array of fish and wildlife, which was an historic first. The plans assess the health of each state's wildlife and habitats, identify the problems they face, and outline the actions that are needed to conserve them over the long term. Congress charged each state and territory with developing a plan in order to receive funds through the State and Tribal Wildlife Grants (SWG) Program. SWG is the only federal program totally dedicated to preventing wildlife from becoming endangered by conserving Species of Greatest Conservation Need before they become too rare or costly to restore.

Congress requires states to review and revise their SWAPs at least every ten years, with the first deadline coming up in October 2015. Most states are currently in the process of conducting this required update and many are incorporating climate change as a threat for the first time. This presents an opportunity to incorporate the results of vulnerability assessments as well as adaptation strategies into the long-term vision for conservation in the states. The updated plans can address how the likely impacts of climate change will interact with existing threats to the Species of Greatest Conservation Need and their respective habitats and the actions necessary to address those threats

FISH EYE GUY PHOTOGRAPHY

Two Yellowstone cutthroat trout.

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Strategy 2.2: Develop and apply species-specific management approaches to address critical climate change impacts where necessary.

Managing Yellowstone Cutthroat Trout under Climate Change

Due to historic impacts of non-native fish, water diversion, and water management, genetically pure Yellowstone cutthroat trout occupy less than 28% of their historical range in Idaho, Wyoming, Utah, Nevada, and Montana. In addition to current threats, anticipated changes in global and regional climate are likely to considerably alter existing thermal and hydrologic regimes. The growing concern for native coldwater fish such as Yellowstone cutthroat trout in a changing climate stems from their relatively narrow thermal tolerances and the influences of climate-related attributes such as temperatures and stream flows on life-history patterns. Furthermore, recent research suggests that changing climatic conditions are likely to favor non-native species over Yellowstone cutthroat trout, thus increasing threats to extant populations.

A critical step in ensuring the long-term persistence of Yellowstone cutthroat trout across its historic range is the development of a comprehensive conservation strategy that encompasses existing data regarding species distribution and status, current limiting factors, and the potential threats from climate change. Within this framework it is becoming increasingly important to identify and prioritize population-specific restoration and management actions (particularly given the limited amount of resources available) and to evaluate these actions for their value as potential climate adaptation strategies.

State and federal partners along with collaborators have developed criteria and a framework for prioritizing populations of Yellowstone cutthroat trout with respect to risk from climate change. This framework will be applied with population-specific ranking of limiting factors and climate risks to identify and prioritize conservation actions to enhance resilience under a changing climate, as well as areas for identifying potential reintroduction of Yellowstone cutthroat trout into historically occupied streams that are likely more resilient to regional changes in climate.

Partners:

- National Park Service
- Great Northern Landscape Conservation Cooperative
- Trout Unlimited
- U.S. Geological Survey Northern Rockies Science Center
- Wildlife Conservation Society
- Western Native Trout Initiative
- Yellowstone Cutthroat Trout Multistate Working Group

In some cases, the impacts of climate change will need to be addressed with innovative management techniques that will be vital in developing climate adaptation approaches. Using vulnerability assessments to design new management actions will be a key part of this effort.[11]

Assessing Brook Trout Vulnerability to Inform Management in Wisconsin

Expected climatic changes in air temperature, precipitation, and water cycle patterns across the Upper Midwest and Great Lakes region may threaten the viability of inland trout resources. A vulnerability assessment was developed to understand how these expected changes may impact thermal conditions and trout populations in streams across the state of Wisconsin.

Partners developed watershed-scale models and downscaled climate projections for Wisconsin that were used to project mid-21st century climate impacts on water temperature and fish distribution, and to assess the vulnerability of 13 fish species in streams to future changes in climate. This vulnerability

11 Vulnerability assessments (VAs) are an integral part of preparing to deal with the impacts of climate change. Developing the methods and resources for conducting VAs and examples of actual applications are covered under Goal 4. Using the results of VAs to inform and guide management activities is covered here in Goal 2. Several research and modeling projects that include elements of assessing vulnerability are also described in Goal 5.

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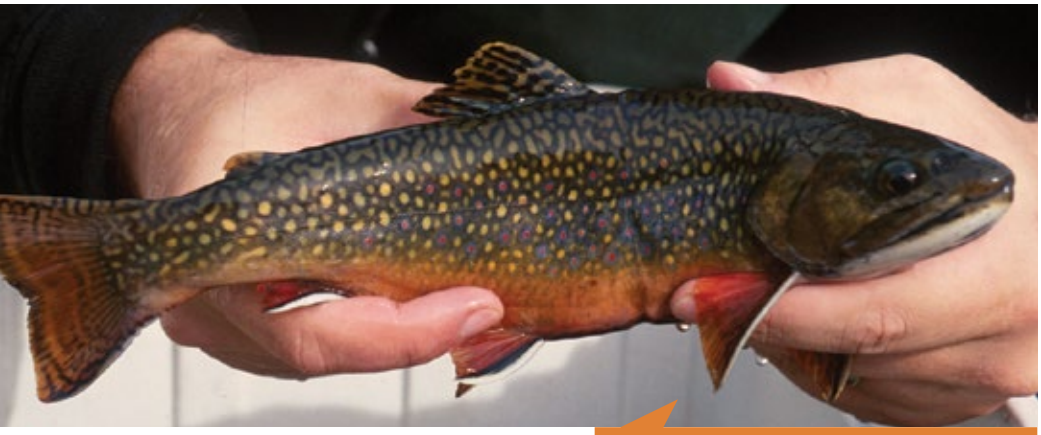

Brook trout spawning male, Florence Lake, Langlade County, a small trout lake in north-central Wisconsin, October 18, 2001.

JOHN LYONS/WISCONSIN DEPARTMENT OF NATURAL RESOURCES

assessment became a critical component of a regional planning process for the Driftless Area in Wisconsin,[12] in which adaptation strategies are being developed to lessen the impacts of climate change on coldwater fishes, particularly brook trout.

The Driftless Area regional planning process is ongoing and the vulnerability assessment has been used to identify Driftless Area brook trout streams that are: (1) at risk of being lost due to projected changes in climate: (2) in need of adaptation measures to enhance resiliency to climate impacts; and/or (3) are thermal refugia and are therefore prioritized for protection. Regional and statewide models suitable for assessing climate impacts on thermal conditions and fish distributions in streams have been completed and are available in an interactive website.[13]

Partners

- Wisconsin Department of Natural Resources
- Michigan Department of Natural Resources
- Michigan State University
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

"Brook trout and other coldwater species are projected to suffer major losses in stream habitat with climate warming, although the amount lost varies substantially based on which global climate model is used."

—JOHN LYONS, WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Lower Keys Marsh Rabbit Adaptive Management

Sea-level rise and storm surges pose management challenges for ecosystem sustainability in the Florida Keys and Florida Coasts. The Lower Keys marsh rabbit, which is identified in Florida's Wildlife Action Plan as a Species of Greatest Conservation Need, inhabits two distinct but interrelated wetland systems, one coastal and the other freshwater.

Partners are engaged in a collaborative project to model metapopulation dynamics of the Lower Keys marsh rabbit across the Keys, test assumptions, and quantify the impacts of habitat loss and fragmentation, non-native predators, sea-level rise, and storm surge on the rabbit and its environment. The partners also plan to implement an adaptive management program to enhance resiliency and population persistence.

Lower Keys marsh rabbit

CRAIG FAULHABER

12 Driftless Area Master Planning website: <dnr.wi.gov/topic/lands/masterplanning/driftlessstreams>

13 All Regional Model Results and Vulnerabilities are accessible in an interactive format at: <wimcloud.usgs.gov/apps/FishVisDev/FishVis.html>

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The project has applied models to a long-term data set to infer rabbit population dynamics, including important factors pertaining to dispersal ability and population turnover as a function of patch configuration, size and proximity to the shore. The project has also demonstrated that there is a higher probability of extinctions in coastal areas relative to nearby freshwater systems. These results will generate estimates of optimal actions to inform management decisions for protecting the Lower Keys marsh rabbit and this important ecosystem.

Partners

- Florida International University
- Institute for Regional Conservation
- U.S. Geological Survey, Patuxent Wildlife Research Center
- U.S. Geological Survey, Southeast Climate Science Center
- University of Louisiana, Lafayette
- U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuges Complex

Planting Future Forests in Northern Minnesota

Northern forests in the Great Lakes region are entering an era of compromised conditions due to climate change. Harvesting practices over the past century have converted the forests to more low diversity, even-aged stands of trees, leaving forests vulnerable to emerging stressors. Forest-dependent wildlife, most notably migratory songbirds, have experienced associated declines.

Traditionally, restoration goals have focused almost entirely on reintroducing historically abundant boreal conifers into the landscape. Recent research shows that warmer, drier conditions over the coming decades are likely to undermine these current restoration efforts. This project focuses on new climate informed strategies that favor diverse suites of tree species best suited to thrive under changing climate conditions through an adaptation forestry approach, or a combination of management and planting that increases complexity.

Adaptation forestry departs significantly from previous restoration efforts. The strategy is based on current and future modeled range maps for trees and emphasizes within-range plantings of tree species anticipated to thrive under warmer, drier conditions. Species of emphasis are all native, but are uncommon due to the legacy of past harvesting practices, past climate conditions, and dispersal limitations. Although suited to new conditions, without management intervention these species are unlikely to realize the full extent of their ranges as the rate of climate change outpaces their ability to disperse.

NANCY A. JOHNSON PHOTOGRAPHY

Forest Ecologist Mark White installs a mesh cage around a newly planted oak seedling to protect it from deer browsing.

In October 2012, partners began implementing adaptation forestry practices at 12 sites totaling 2,000 acres in northeastern Minnesota. A total of 88,000 climate-adapted native trees are scheduled to be planted by November 2014, including red oak, bur oak, and white pine from two different seed sources. The performance of seedlings of different species and origin under different conditions created by contrasting silvicultural treatments will be compared across four distinct forest plant communities. The goal is to explicitly test the effectiveness of adaptation forestry for transition to future suites of climate-adapted species.

Partners

- The Nature Conservancy
- Conservation Partners Legacy Fund
- Doris Duke Charitable Foundation
- Lake County
- Minnesota Department of Natural Resources
- Minnesota Forest Resources Council
- Northern Institute of Applied Climate Science
- Sustainable Forests Education Cooperative
- Saint Louis County
- University of Minnesota, Duluth
- University of Wisconsin, Madison
- U.S. Forest Service
- Wildlife Conservation Society

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SNAPSHOT

Climate Change and Assisted Migration

STEVE HILLEBRAND/USFWS

Under the current rate of climate change, many landscapes in the U.S. may experience climates that are incompatible with current vegetation by the end of the century. One potential adaptation strategy in such circumstances is assisted migration, also known as managed relocation, which is defined as the intentional movement of species in response to climate change. Although researchers have proposed frameworks and guidelines on how to apply assisted migration to native species, no consensus exists on implementation in the U.S. because of ecological and economic concerns and lack of supporting research.

The U.S. Forest Service's Research and Development group is compiling a database on native plant transfer guidelines, climate change, and assisted migration. The database identifies knowledge gaps and provides a central foundation for collaboration in generating research questions, conducting studies, transferring and acquiring data, expanding studies to key species and geographic regions, and guiding native plant transfer.

The database connects pieces of information from peer-review journal articles to decision-support tools, providing managers with the ability to understand assisted migration options. This research has and will continue to provide current information to land managers, policymakers and the general public on adaptive strategies that maintain resilient and functional native plant ecosystems across landscapes as the climate changes.[14]

14 For more information: <www.rngr.net/publications/assisted-migration>, <www.treesearch.fs.fed.us/pubs/43883>, <www.treesearch.fs.fed.us/pubs/44260>, <www.treesearch.fs.fed.us/pubs/45634>

Strategy 2.3: Conserve genetic diversity by protecting diverse populations and genetic material across the full range of species occurrences.

High genetic diversity in a population increases the probability of a species having an adaptive capacity that allows it to respond to climate change impacts. It is possible to manage a population for high genetic diversity. As an example of this type of work, the Quinault Indian Nation (QIN) is selectively propagating disease-tolerant Douglas-fir on their land to prevent the spread of a disease that will thrive with warmer temperatures. These types of projects ensure that populations of these species in the future will have the greatest possibility of survival.

Northwestern Tribal Forest Improvement

Climate change will likely bring warmer, wetter weather to the Pacific Northwest—ideal conditions for the spread of forest pathogens. Located on Washington's Olympic Peninsula, the QIN is selectively propagating and replanting disease-tolerant Washington Coast Douglas-fir to ensure healthy forests and resilient ecosystems exist well into the future.

The Swiss needle cast (SNC) epidemic in Douglas-fir forests of the coastal Pacific Northwest is unprecedented and intensifying. SNC is caused by a windborne fungal pathogen that causes Douglas-fir trees to prematurely shed needles. The disease reduces tree volume growth by 20–50%. The epidemic is associated with monocultures of Douglas-fir and the onset of warmer weather with associated

Douglas-fir seedlings - offspring of carefully selected reservation trees - are transplanted into logged areas on the Quinault Indian Reservation to rebuild strong forests.

fog and drizzle, milder winters and earlier springs—weather patterns typical in long-term climate change scenarios.

Approximately 5% of the Reservation's forest is already infected with SNC. Because the QIN and other tribes are restricted by reservation boundaries, their attachment to the land, and off-reservation treaty rights, moving to new areas to accommodate climate shifts is not a viable option. It is therefore critical that the QIN begin adapting its forests to changing conditions.

The QIN Forestry Department has been selectively propagating trees for growth, yield and pest tolerance for more than 30 years. In 2012, the QIN began a long-term effort to propagate SNC-tolerant Douglas-fir to mitigate the effects of the disease and to sustain the reservation forest and tribal economy. Select Douglas-fir seeds have been harvested from coastal "seed orchards" and are being propagated in a nursery. In 2015 approximately 5,000 nursery-grown seedling plugs will be planted on three test sites. They will be assessed in succeeding years for disease tolerance. The most tolerant Douglas-fir families will be selectively bred and propagated to replant in reservation forests.

Partners

- Quinault Indian Nation
- USDA Animal and Plant Health Inspection Service
- U.S. Forest Service
- Northwest Tree Improvement Cooperative
- Swiss Needle Cast Cooperative
- Washington Coast Douglas-fir Cooperative

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SNAPSHOT

Sagebrush Conservation for Greater Sage-Grouse

The greater sage-grouse is a candidate for listing by the U.S. Fish and Wildlife Service under the Endangered Species Act. Greater sage-grouse are dependent on sagebrush-dominated habitats, using sagebrush itself and other native plants for cover and food. Once seen in great numbers across sagebrush landscapes of the West, greater sage-grouse have declined over the past one hundred years because of the loss, degradation, and fragmentation of sagebrush habitats essential for their survival.

The Institute for Applied Ecology has partnered with the Bureau of Land Management (BLM) to improve habitat for greater sage-grouse by engaging state and federal correctional facilities in the production of sagebrush plant species for habitat restoration. A protocol is being developed for working with correctional facilities to grow locally sourced plants. This project has the potential to engage 24 correctional facilities across ten states throughout the range of the greater sage-grouse.

A pilot project to produce 10,000-20,000 sagebrush plants annually is underway at the Snake River Correctional Facility in eastern Oregon, and the plants grown at this facility will be planted into a site recently damaged by wildfire on nearby BLM lands. The pilot project will inform the protocol and demonstrate the potential for this innovative approach to contribute to greater sage-grouse recovery.

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Goal 3

Enhance capacity for effective management in a changing climate.

Natural resource managers are faced with the task of incorporating the effects of climate change into their existing management practices to ensure these management efforts are effective under changing climate and ecosystem conditions. This may involve altering the way they assess information, working with new partners, and learning new tools or skills. New information and tools become available at a rapid pace and can overwhelm individual managers. Enhancing managers' abilities to understand and utilize these new tools and skills is a vital step in improving management of natural resources.

Strategy 3.1: Increase the climate change awareness and capacity of natural resource managers and other decision makers and enhance their professional abilities to design, implement, and evaluate fish, wildlife, and plant adaptation programs.

There have been tremendous strides made in raising the awareness of natural resource managers to the current and potential impacts of climate change. This includes training opportunities at both the national and local level as demonstrated by efforts such as the National Conservation Training Center's (NCTC) Climate Academy, the California Department of Fish and Wildlife Climate College, and other efforts at the federal, state, tribal, and local levels.

Online Climate Courses for Natural Resource Managers

Natural resource managers are tasked with understanding climate change impacts and using this knowledge in their decision-making. A few online courses have been designed to foster the development of this understanding and participants can share what they have learned with colleagues. The courses also create a community of natural resource adaptation practitioners who will increase the capacity of the conservation community to address climate change impacts.

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"Climate Academy consolidates the most current, reliable climate change literature and presents the research in a logical sequence, making it easier for natural resource professionals like myself to utilize when making pertinent management decisions."

—ANNA HUCKABEE SMITH, SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES, CLIMATE ACADEMY PARTICIPANT

Climate Academy, led by the U.S. Fish and Wildlife Service's NCTC, is a 5-month online national course for natural resource managers and conservation professionals. It is designed to cover the fundamentals of climate science, provide tools and resources for climate adaptation, and increase climate literacy and communication. The course is also designed to encourage networking among conservation professionals and increase collaboration on landscape-level climate change response planning.

Course participants are required to participate in webinars, read required texts, discuss those readings online, and complete a final project that considers how they would incorporate climate change into their day-to-day work. One participant is chosen to submit their project to the Wildlife Professional for publication in the fall edition. Participants receive a Certificate of Completion from NCTC and can receive Continuing Education Credits offered through The Wildlife Society (TWS).

At the state level, the California Department of Fish and Wildlife (CDFW) created a California-specific course called the CDFW Climate College. It follows a similar structure as the Climate Academy, but focuses on issues that are of special relevance to CDFW staff and partners on climate change science and its impacts on fish, wildlife, and habitats in California.

The goals of these classes are to produce students who are able to:

- Explain the scientific basis of climate change
- Understand biological impacts of climate change
- Recognize and identify methods of addressing uncertainty
- Understand Climate Change Vulnerability Assessments
- Identify principles of adaptation planning and examples of adaptation action
- Effectively communicate climate change impacts to co-workers, stakeholders and management
- Identify methods to incorporate climate change into their work.

Many other online courses, trainings, and online resources are available to help agencies at all levels continue to build capacity for managers and other staff around climate change, and these type of opportunities are likely to grow in the future.

Partners

» U.S. Fish and Wildlife Service National Conservation Training Center
» Association of Fish and Wildlife Agencies
» California Department of Fish and Wildlife
» National Park Service
» The Wildlife Society

SNAPSHOT

Planning for Climate Change on the National Wildlife Refuge System

Climate change is a major challenge to the policies, planning, and management of the National Wildlife Refuge System. The Refuge System is required to incorporate climate change considerations into planning documents such as Comprehensive Conservation Plans, Land Protection Plans and other Refuge System planning documents as necessary.

A new report, Planning for Climate Change on the National Wildlife Refuge System[15], helps Refuge System personnel including refuge managers, biologists and planners to ascertain and address the relevant climate change considerations in these planning documents.

The report presents a comprehensive review of climate change issues facing the Refuge System, along with an overview of Refuge System climate change planning mandates and directives, climate vulnerability assessment, philosophical considerations in climate change planning, guidance for incorporating climate change considerations into Refuge System planning documents, case studies, and various other resources including more than 500 literature citations.

15 <www.fws.gov/refuges/vision/pdfs/PlanningforClimateChangeontheNWRS.pdf>

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SNAPSHOT

Interpreting Climate Change Competency

The National Park Service (NPS) provides training to interpretive staff working in parks in order to build capacity and create a cohesive and consistent approach to agency climate change communication messages. The role of NPS interpreters and communication professionals with regard to climate change is a critical one. Engaging with staff and park visitors about the science of climate change, climate change effects on park resources, and what the NPS is doing to mitigate and adapt to the changes helps to increase knowledge of this issue, shape agency direction and accelerate public awareness.

A four-day virtual course is currently offered twice per year and is open to any communicator or interpreter in the NPS or partner agencies. The goal is to give the front line interpreter or communicator the necessary tools to effectively engage audiences in communication about climate change and to understand the NPS orientation to the issue, site-specific climate impacts, and audience perspectives and values on the topic, as well as utilize a number of appropriate techniques for engaging with audiences on climate change.[16]

16 <idp.eppley.org/competencies/specialist/interpreting-climate-change>

Strategy 3.2: Facilitate a coordinated response to climate change at landscape, regional, national, and international scales across state, federal, and tribal natural resources agencies and private conservation organizations.

Many of the impacts of climate change will affect fish, wildlife, and plants across large landscapes. Coordinating a response across large regions and across jurisdictions will be a vital aspect of climate adaptation.

Landscape Conservation Cooperatives

Since 2009, the Department of the Interior has been working with a diverse group of federal, state, and other partners to establish a network of 22 regional Landscape Conservation Cooperatives (LCCs). The LCCs were developed to provide collaborative technical capacity for climate change adaptation and conservation design, and to promote landscape connectivity and cooperation across agencies and jurisdictions. Today, LCCs are formal partnerships between states, tribes, federal agencies, non-governmental organizations, universities and other groups to coordinate activities and leverage resources among partners. They work across agencies to identify shared conservation and research priorities and support the use of science-based management tools to address landscape-scale stressors, including habitat fragmentation, invasive species, and water scarcity, all of which are accelerated by climate change.

LCCs are unique vehicles for facilitating a coordinated response to climate change across conservation partners, and for developing and implementing conservation efforts designed to match the scope and scale of these types of broad challenges. They use a collaborative approach to meet unfilled conservation needs, develop decision support tools, share data and knowledge, and facilitate and foster partnerships. Information derived through LCC projects is filling gaps in scientific information that may be challenging for other entities to obtain due to the magnitude of issues associated with climate change. As part of a shared science strategy, LCCs coordinate closely with the National Climate Change and Wildlife Science Center and the eight regional Climate Science Centers.

The Strategy encourages LCCs to take a lead role in implementation of fish and wildlife adaptation efforts. The LCCs have a diverse membership of state, federal, tribal and private conservation organizations, and operate at scales appropriate to successfully facilitate implementation of the Strategy through a collaborative process. Many ongoing and planned LCC projects are well aligned with Strategy recommendations, including efforts to develop landscape conservation design approaches, identify refugia areas for vulnerable species, conduct research into impacts of sea level rise on coastal habitats, define shared conservation priorities and science needs, and develop and implement vulnerability assessments and other decision-support tools. Most of the LCCs are already using the Strategy to help inform their work and regional priorities, and several have drawn upon recommended strategies and actions to develop their work plans and activities.

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SNAPSHOT

Pacific Islands Climate Change Cooperative

JIM MARAGOS/USFWS

The Pacific Islands Climate Change Cooperative (PICCC) is an LCC partnership that seeks to understand and adapt to the critical impacts of climate change on native species, island ecosystems, and cultural resources in the Pacific Islands. The PICCC's members and partners span the Pacific region, from Hawai'i and the US affiliated islands in the Samoan, Mariana, and Micronesian archipelagoes.

The PICCC has funded a series of projects that are vastly improving our understanding of how global climate change is manifesting and to inform large-scale conservation planning and design. PICCC projects include:

- Regional climate modeling to produce climate change projections at a scale that is ecologically relevant to natural resources management on small islands.
- Global model showing projected coral bleaching and ocean acidification to support economic and coastal planning and coral reef management.
- Spatial and temporal modeling of sea-level rise on sites of high significance in order to define potential ecological and cultural impacts and support management responses.
- Projections of changes in the distributions of native Hawaiian plants and forest birds based on projected future temperature and precipitation estimates.

(Above) Coral reefs are the "rainforests of the sea." They provide habitat for a diversity of resident and migratory species, food security for island communities, recreational opportunities for tourists, and a buffer from wave-driven erosion. Corals are threatened by warming sea-surface temperature and changes in ocean chemistry driven by global climate change.

Fish are a vital resource in the Prince Wales area.

NICK RAHAIM/FLICKR CC

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Traditional Gathering Calendar

Traditional Ecological Knowledge (TEK) plays a key role for future decision-making by natural resource managers. The Organized Village of Kasaan, located in southeast Alaska on Prince of Wales (POW) Island, is made up of the Craig, Hydaburg, Kasaan and Klawock, or POW Tribes. This project provides an opportunity for federally recognized tribes to recommend indigenous stewardship to management and enforcement agencies.

Sixteen knowledgeable gatherers of natural resources (including two middle-aged and two elderly representatives from each community) have been interviewed from the four Tribal communities on Prince of Wales Island. Interviews will be used to determine how natural resources are gathered according to weather or seasonal factors and if the gathering calendar has changed over time. This will allow for the development of baseline data for state and federal agencies to make sound recommendations on protection and potential enforcement of natural resources mandates. This project will provide collaboration, consultation and communication between federally recognized Tribes concerning gathering of subsistence resources.

Partners

- Tribes of Prince of Wales (POW) Tribal Environmental Coalition
- North Pacific Landscape Conservation Cooperative
- Organized Village of Kasaan

SNAPSHOT

North Cascadia Adaptation Partnership

The North Cascadia Adaptation Partnership (NCAP) is a Forest Service—National Park Service partnership on climate change adaptation. NCAP addresses adaptation at a large scale of 6 million acres, including Mt. Baker-Snoqualmie National Forest, Okanogan-Wenatchee National Forests, North Cascades National Park Complex, and Mount Rainier National Park in Washington.

NCAP is working to increase awareness among park and forest staff to the projected impacts of climate change, to provide assistance in obtaining climate change information, to complete vulnerability assessments of key resources and ecological processes, and to develop local adaptation strategies. The USFS Pacific Northwest Research Station is leading the effort, and the Climate Impacts Group at the University of Washington serves as the primary climate science provider for the project.

NATIONAL PARK SERVICE

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Strategy 3.3: Review existing federal, state and tribal legal, regulatory and policy frameworks that provide the jurisdictional framework for conservation of fish, wildlife, and plants to identify opportunities to improve, where appropriate, their usefulness to address climate change impacts.

Many existing legal, regulatory, and policy frameworks were developed at a time when climate change was not in the forefront as it is today. Work to identify areas that need to be improved to better deal with the challenges posed by a changing climate has begun under the direction of the Council on Environmental Quality (CEQ).

Executive Order 13653

On November 1st, 2013 President Obama signed an executive order (E.O. 13653), to take actions to enhance climate preparedness and resilience across the federal government while simultaneously safeguarding our economy, infrastructure, environment, and natural resources. The E.O. established an interagency Council on Climate Preparedness and Resilience to coordinate a range of actions, appointed a task force of Tribal, State and Local leaders to inform the Administration's efforts, and set aggressive targets to lead by example and modernize existing federal programs to better prepare the nation for the impacts of climate change.

In the natural resources arena, federal agencies have been working hard to complete an inventory and assessment of proposed and completed changes to make land- and water-related policies more effective in promoting resilience in the face of a changing climate.

Strategy 3.4: Optimize use of existing fish, wildlife, and plant conservation funding sources to design, deliver, and evaluate climate adaptation programs.

Incorporating climate change considerations into existing conservation funding programs is just beginning. For example, the U.S. Fish and Wildlife Service has made climate change a factor in determining the allotment of Competitive State Wildlife Grants.

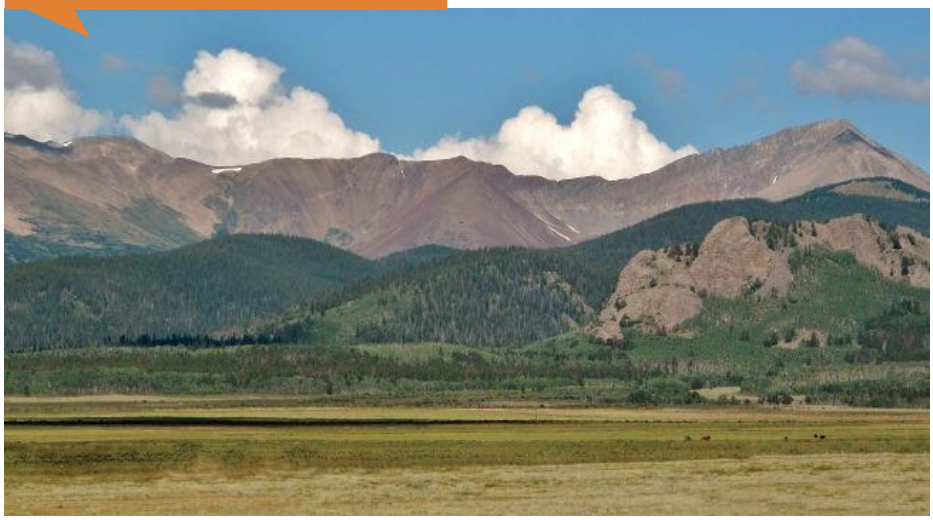
Climate Change and the State Wildlife Grants

The State and Tribal Wildlife Grants Program (SWG) provides federal dollars to match state funds to support states, territories, and tribes in cost-effective conservation. In Fiscal Year 2013, the Division of Wildlife and Sport Fish Restoration (WSFR) offered incentives to help States further integrate climate change adaptation planning into their State Wildlife Action Plans (SWAPs). SWG funds are used by state fish and wildlife agencies to develop and maintain their SWAPs and to implement the Plans for the benefit of state-identified Species of Greatest Conservation Need (see Box on SWAPs).

The Service has been working to integrate the best-available climate science into these grant programs to help incentivize adaptation planning at a variety of scales. WSFR modified the competitive portion of the SWG Program to provide incentives for states and their partners to incorporate climate change adaptation strategies for wildlife into the SWAPs. Some examples of the projects encouraged through this programmatic change include climate change vulnerability assessments for multiple species and using downscaled climate modeling for use at regional or landscape scales.

Due to the success of this modification in FY2013, WSFR has offered this subprogram again in Fiscal Year 2014.

Landscape scale project in Colorado funded by State Wildlife Grants.



NATIONAL PARK SERVICE

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Goal 4

Support adaptive management in a changing climate through integrated observation and monitoring and use of decision support tools.

Due to the inherent uncertainty regarding how climate change will affect wildlife and natural resources, the Strategy recommends that the continuous learning principles of adaptive management be used to regularly monitor the response to adaptation efforts, evaluate their effectiveness, build knowledge and understanding, and improve and inform future management decisions. Promoting adaptive management responses to climate change includes supporting integrated observation and monitoring efforts as well as the use of decision support tools such as vulnerability assessments and scenario planning exercises.

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Strategy 4.1: Support, coordinate, and where necessary develop distributed but integrated inventory, monitoring, observation, and information systems at multiple scales to detect and describe climate impacts on fish, wildlife, plants, and ecosystems.

A number of agencies are developing or building on monitoring programs to detect and describe climate impacts on fish, wildlife, plants, and ecosystems. These include the National Park Service's Arctic Network Inventory and Monitoring Program (ARCN), NOAA's Integrated Ocean Observing System (IOOS), and the Fish and Wildlife Service's Water Resource Inventory and Assessment (WRIA). Large-scale, interagency efforts such as the USA National Phenology Network (see Box) and National Ecological Observatory Network (NEON) are bringing together multiple partners to help establish baselines and build an understanding of how plants, animals and landscapes are responding to climate variation and change.

Developing Baseline Data to Respond to Coastal Change

Climate change impacts, including coastal erosion, reduction in sea ice and thawing of permafrost, are impacting Bering Land Bridge National Preserve (BELA) and Cape Krusenstern National Monument (CAKR) along the northwestern Alaska coast. Increasing ocean temperatures are causing a reduction in the summer sea ice extent in the Chukchi Sea, delaying the return of winter ice and the coastal protection it provides the northwest Alaska coastline. The resulting increase in storm erosion, combined with the thawing of permafrost, has accelerated the erosion of coastal natural resources and cultural sites in BELA and CAKR.

The barrier islands supporting the villages of Shishmaref and Kivalina are also eroding, and residents are considering relocating to inland sites. These systems currently provide habitat for globally important and threatened and endangered bird populations, and are home to the northernmost extent of eelgrass in North America.

NATIONAL PARK SERVICE

Biologist in Bering Land Bridge National Preserve.

Several ongoing projects are intended to provide baseline information and an updated evaluation of coastal resource vulnerabilities in order to make prudent management decisions related to climate change impacts, increased marine traffic, sensitive areas, and natural and cultural resource protection.

National Park Service climate change scenario planning has been done for BELA and CAKR. The NPS Arctic Network Inventory and Monitoring Program (ARCN) is developing long term monitoring protocols for coastal erosion and lagoon biology, and is already engaged in climate monitoring. Datasets include satellite and aerial imagery of coastal erosion, topographic maps, and improved accuracy of coastal maps. Other projects include post breeding bird surveys in BELA and CAKR, lagoon water mass budgets in BELA, permanent marine debris monitoring sites in BELA and CAKR, and a coastal survey of at risk cultural sites.

THE USA NATIONAL PHENOLOGY NETWORK

The USA National Phenology Network (USA-NPN) is a national-scale, multi-taxa science and monitoring initiative focused on phenology (the study of seasonal life-cycle events such as leafing, flowering, reproduction and migration). Timely and widely-distributed phenological information is critical for the management of wildlife, invasive species, and agricultural pests, understanding drought wildfire risk, managing risks to human health and welfare, including allergies, asthma, and vector-borne diseases, and for understanding how plants, animals and landscapes respond to environmental variation and change.

The goal of USA-NPN is to collect, synthesize, deliver and apply high-quality phenological data and information to address fundamental science and societal needs, and to facilitate decision-making relative to ecosystem services and climate change adaptation for natural resource management, agricultural systems, and human well-being. As a well-recognized indicator of climate impacts, phenology data provides critical baseline information needed to help measure and plan for ecological change.

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Strategy 4.2: Identify, develop, and employ decision support tools for managing under uncertainty via dialogue with scientists, economists, and stakeholders.

Vulnerability assessments can help to identify, quantify, or evaluate the degree to which natural resources or species are likely to be affected by changing climatic conditions, and can inform prioritization and other management decisions. There are currently a large number of vulnerability assessments at a variety of scales underway all across the country, ranging from small, local scale projects to landscape- or regional- scale efforts involving dozens of partners (see Box on Vulnerability Assessment Registry). This report highlights vulnerability assessments at multiple scales.[17]

Other decision support tools such as scenario planning can also help managers plan for and facilitate adaptation of key species and habitats, and help identify where changes to the built environment may conflict with ecosystem needs.

VULNERABILITY ASSESSMENT REGISTRY

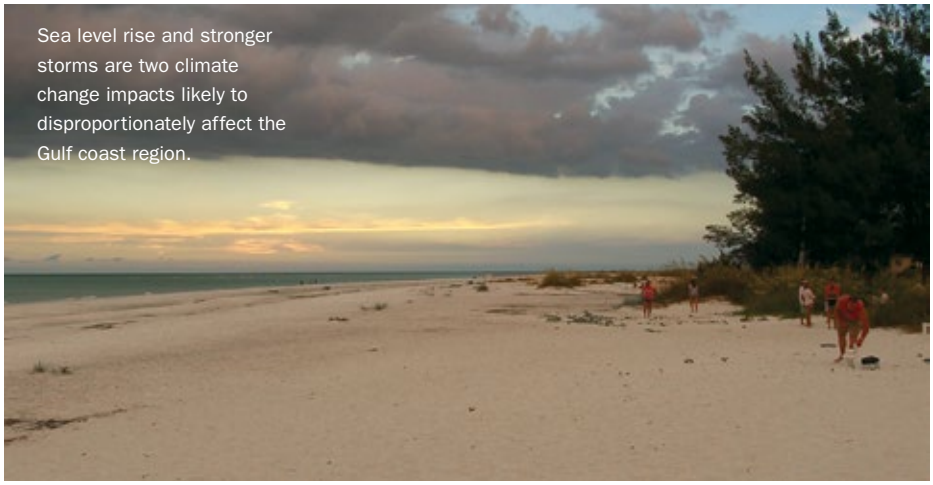
Federal agencies, states, tribes, NGOs, universities, and private corporations have all initiated vulnerability assessments for particular species, ecosystem types, and specific geographies. These assessments are useful for those who produce them, but their data, methods, and conclusions may also be useful for others who are planning similar assessments, or who wish to understand vulnerability across species groups or locations.

A steering group composed of Federal, state, NGO, and other partners identified the need for a searchable, public registry on climate change vulnerability assessments. The goal was to make information about ongoing and completed VAs more readily accessible and available, so that resources devoted to such assessments can be most efficiently used. The registry will host information from both federal and non-federal partners. The registry is being developed by the U.S. Geological Survey and will be hosted by EcoAdapt's Climate Adaptation Knowledge Exchange (CAKEx) website.

Once operational, users will be able to search for assessments by location, species of concern, or other endpoints, and learn what partners are involved, what methods have been used, whether the results were intended for specific decisions, the scale of analysis, and similar features—as well as who to contact for more information. While initially focused on fish, wildlife, and ecosystems, the steering group has encouraged expansion of the scope to include both cultural resources and the "built environment" (roads, dams, buildings, transmission lines, etc.).

Gulf Coast Climate Vulnerability

People in the Gulf Region recognize that coastal ecosystems powerfully influence their vibrant culture by providing benefits such as clean water, fish and wildlife habitat, recreation, storm/flood protection and carbon sequestration. The nation's third National Climate Assessment predicts that virtually the entire Gulf Coast will be vulnerable to sea level rise in the 21st century. Furthermore, unprecedented levels of funding will be directed toward Gulf Coast restoration over the coming decades as a result of the Deepwater Horizon oil spill.



Sea level rise and stronger storms are two climate change impacts likely to disproportionately affect the Gulf coast region.

DAVID BEYER/FLICKR CC

17 Vulnerability assessments (VAs) are fundamental to climate change adaptation efforts. For examples of how the results of VAs are informing management solutions, see Goal 2. Development of VAs and applications for particular species and habitats are covered here in Goal 4.

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This collaborative project will produce a vulnerability assessment for the Gulf Coast region. When completed, the Gulf Coast Vulnerability Assessment (GCVA) will provide managers, planners, researchers, and administrators with the information needed to better understand potential impacts to coastal ecosystems and species from climate change, sea level rise, and land use change in and along the Gulf of Mexico.

Stakeholders across the Gulf, as well as the Gulf LCCs (see Box on LCCs), have been tapped to create a multidisciplinary Core Planning Team, which is guiding the GCVA with assistance from a climate expert and four Ecosystems and Species Expert Teams covering barrier islands and beaches, tidal marsh, oyster reef, and mangroves. Stakeholders have developed and reviewed a detailed work plan, identified products to be developed by the GCVA, and defined and mapped the GCVA project area.

Partners

- Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative
- Gulf Coast Prairie Landscape Conservation Cooperative
- Gulf of Mexico Alliance
- Louisiana Coastal Protection and Restoration Authority
- National Oceanic and Atmospheric Administration
- The Nature Conservancy
- Peninsular Florida Landscape Conservation Cooperative
- South Atlantic Landscape Conservation Cooperative
- South Central Climate Science Center
- Southeast Climate Science Center
- U.S. Fish and Wildlife Service

Vulnerability Assessment of California Vegetative Communities

As stewards of the state's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, the California Department of Fish and Wildlife must understand and plan for the impacts of climate change. The revision of the state Wildlife Action Plan (see Box on SWAPs) presented an opportunity to integrate climate risks into a state-wide framework for conservation, and to ensure that work towards minimizing the negative impacts of climate change on California species and habitats is continuing. Developing conservation strategies that address the threats posed by climate change has been identified as a high priority for the SWAP revision, and climate considerations are already being taken into account in the revision process.

To more thoroughly incorporate climate change threats into the SWAP update, and to supplement the climate considerations currently taking place, it was determined that a state-wide, comprehensive climate change vulnerability analysis at the habitat-scale was needed.

HOLLY GELLERMAN/CDFW

Indian paintbrush northwest of Castle Peak, CA.

SNAPSHOT

Sea Turtle Vulnerability Assessment

DAVID RABON/USFWS

Sea-level rise, increased storm frequency, and altered temperature and humidity associated with climate change may reduce the suitability of nesting and foraging habitats used by federally threatened and endangered species, such as the federally threatened loggerhead sea turtle.

The U.S. Geological Survey and the University of Florida are producing a vulnerability assessment of coastal habitats representing important nesting grounds for loggerhead and other endangered sea turtles (e.g. Kemp's ridleys, green turtles, and leatherbacks) in Florida. This project will build upon work already being done to develop vulnerability maps under a number of current and future climate scenarios. These maps will provide management guidance and will serve to identify knowledge and data gaps as primary sources of uncertainty.

The leatherback is the largest, deepest diving, and most migratory and wide ranging of all sea turtles.

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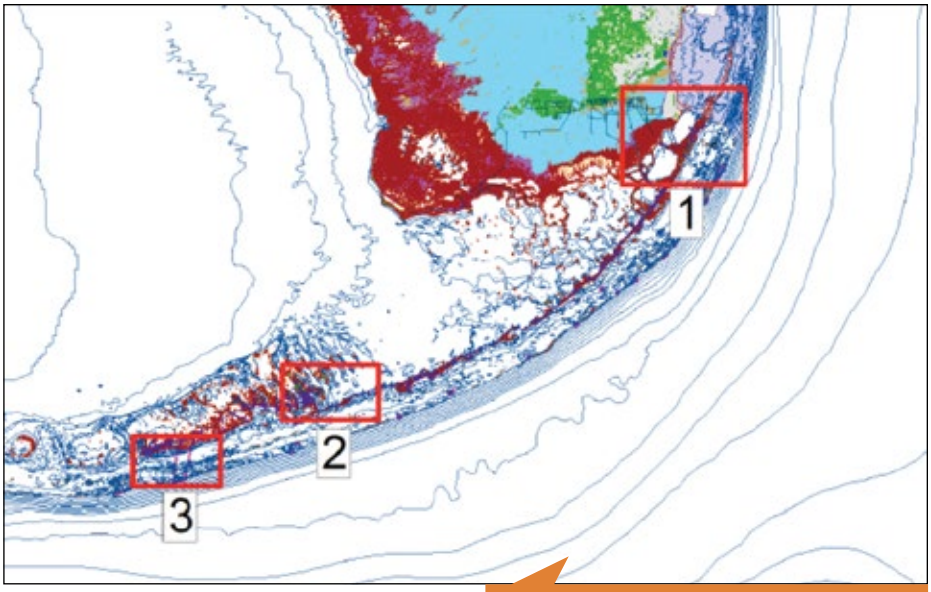
Specifically, this project is a California-wide, climate change vulnerability analysis at the macro-habitat scale for 42 different terrestrial vegetation types. Results of the vulnerability assessment will be compared with existing taxa-specific vulnerability studies to paint a more complete picture of vulnerabilities to projected climatic changes in the state, at the scale of analysis and planning being used for the SWAP revision.

This project will identify not only which species or habitats are most vulnerable to climatic changes, but why they are the most vulnerable. This information can help inform management actions that minimize or alleviate the contributing factors to a species or habitat's vulnerability and increase habitat and species resiliency to climate risks.

The conservation community will gain information on the exposure, sensitivity, adaptive capacity, and overall vulnerability of vegetative communities across the entire state. This information can be used to guide conservation priorities, will inform future revision of the Wildlife Action Plan, and will be used to inform other management and planning efforts at the Department.

Partners

- California Department of Fish and Wildlife
- University of California, Davis



FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

Alternative futures for the Florida Keys were considered for the 3 studies indicated above.

Alternative Futures for Florida Keys

Climate change is already beginning to impact habitats and species in the coastal and marine zones of south Florida. A scenario planning project is providing managers with scenario-specific actionable strategies for managing marine and coastal resources. The project is based upon input from managers and scientists and includes identifying a set of "alternative future scenarios" constructed by using impacts of climate change (sea level rise and increased sea surface temperature), as well as conservation (protected areas) and socio-economic factors (commercial fishing, recreational fishing and diving).

In the first phase, each alternative future scenario was examined against three critical habitats (mangroves, coral reefs, and beaches) to examine impacts to each habitat. The experts then examined the effects on three species of greatest conservation need from the State Wildlife Action Plan (spiny lobster, Goliath grouper, and loggerhead turtles) based on the anticipated changes to the habitats. In the final step, managers reengaged to determine what adaptation strategies are possible, what "trigger points" will activate a management response, and how to develop monitoring plans to know when a trigger point has been reached.

This project has a second phase that focuses on examining suites of important commercial and recreational species, coupling terrestrial inputs to marine and coastal resources, and broadening the spatial scale. A number of specific adaption responses will be developed.

Partners

- Fish and Wildlife Research Institute
- Florida Fish and Wildlife Conservation Commission
- GeoAdaptive, Inc.
- GeoDesign Technologies, Inc.
- National Oceanic and Atmospheric Administration

"Developing well-informed and robust adaptation strategies is the most effective pathway to ensuring the long-term sustainability of the resources with which we are entrusted."

—BOB GLAZER, FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

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Effects of Climate Change on California Coast

Climate change impacts, such as sea-level rise, are altering the productivity and diversity of ecosystems along the California coast. Understanding the physical processes and complex relationships within these nearshore habitats can be used to develop comprehensive vulnerability assessments for wildlife and ecosystems.

The goal of this project is to provide scientific information to support future planning and conservation of coastal natural resources as the climate changes by downscaling climate change models to understand how climate change will affect coastal habitats. The study will examine current weather patterns, elevations, tides, and sediment of connected coastal habitats to determine how they affect plants and animals, as well as to project how climate change may alter that balance. Improved climate modeling and downscaling can help build confidence in predictions of future climate and better inform management decisions.

Partners

- U.S. Geological Survey
- Pacific Coastal and Marine Science Center
- Pacific Science Center
- Pautxent Wildlife Research Center
- San Diego Wildlife Refuge Complex
- University of California, Davis
- University of California, Los Angeles
- U.S. Fish and Wildlife Service

Goal 5

Increase knowledge and information on impacts and responses of fish, wildlife, and plants to a changing climate.

Adaptation efforts within the context of climate change and other stressors will require detailed knowledge of the impacts of climate change on fish, wildlife, plants and ecosystems and the adaptive capacity of species. However, there are substantial gaps in our knowledge about how species and ecosystems will respond to climate variation and other stressors, particularly at scales relevant to natural resource decision-making and management.

Strategy 5.1: Identify knowledge gaps and define research priorities via a collaborative process among federal, state, tribal, private conservation organizations, and academic resource managers and research scientists.

This inclusive approach to identifying research needs is beginning to happen at the federal level with strong state and tribal partnership through regional collaborations like the DOI Climate Science Centers and Landscape Conservation Cooperatives (see Box on LCCs), NOAA's Regional Integrated Science and Assessments (RISAs), and the new USDA Climate Hubs.

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Climate Science Centers and the NCCWSC

In 2008, recognition of the likely effects of climate change on fish, wildlife and their habitats led to the establishment of eight Climate Science Centers (CSCs) to provide actionable science to assist resource managers in identifying and adapting to coming changes. Coordinated by the USGS National Climate Change and Wildlife Science Center (NCCWSC), the eight CSCs work directly with decision makers and other stakeholders from Federal, state, tribal, and other interests to identify needed information at the regional scale, and to work closely with them to tailor the resulting products. CSCs are joint university-based centers, often with multiple universities and other partners (including tribes, a tribal college, and other Federal labs).

The primary mission of CSCs is to meet the needs of regional decision makers for information about climate impacts and adaptation. Working with LCCs and other regional partners, each CSC develops a medium term science plan, and supports the implementation of that plan with annual funding and regional convening activities such as regional climate conferences and partner-based coordination activities. Complementing and based on these locally-focused and actionable activities is an emerging suite of multi-CSC-to-national scale activities that can synthesize information from multiple regions or draw more robust conclusions. Initial topics will include the effects of climate on migratory birds, the ecological effects of severe and extended drought, and improved guidance on the selection and use of climate projections.

CSCs, the NCCWSC, and the Strategy are ideally matched. Created nearly simultaneously, both focus on impacts and adaptation, are partnership-focused, work primarily at the "action level" (where resource managers face emerging challenges), and are committed to using the best science to support managers. By building capacity and infrastructure for both science and collaboration, CSCs and the NCCWSC hope to foster science based adaptation as climate change continues.

Regional Integrated Sciences and Assessments

NOAA's Regional Integrated Sciences and Assessments (RISA) program supports interdisciplinary research teams that help expand and build the nation's capacity to prepare for and adapt to climate variability and change. Since 1995, the RISA network has expanded to include 11 regions.[18] These teams engage public and private user communities to 1) advance understanding of policy, planning, and management contexts; 2) develop knowledge on impacts, vulnerabilities, and response options through interdisciplinary research and participatory processes; 3) innovate risk management products and tools to enhance the use of science in decision making; and 4) test diverse governance structures for managing scientific research.

RISAs are academically-based and work in regions to engage a diverse range of partners across sectors. RISAs work directly with managers to understand how climate impacts the resources they manage and develop strategies for adaptive management. RISA teams use their understanding of different decision contexts to develop knowledge tailored to suit specific needs across different timescales of climate and across different sectors. In addition to specific projects, RISAs often play a capacity building role in the regions in which they work through ongoing engagement with partners and stakeholders around an issue.

USDA Regional Climate Hubs

The USDA Regional Hubs for Risk Adaptation and Mitigation to Climate Change (USDA Climate Hubs) provide science-based knowledge, practical information and program support to farmers, ranchers, forest landowners, and resource managers to support decision-making related to climate change impacts, such as drought, flooding, pests and changing growing seasons. This effort is accomplished by translating science findings into information and tools that are usable by land managers and their advisors (Cooperative Extension, USDA Service Centers, certified crop advisors, and others). The Climate Hubs provide stakeholder feedback to the science community allowing them to better serve the needs of the working land managers. Healthy/resilient working lands (farms, ranches, forests, etc.) are crucial in order to maintain habitat needed for fish and wildlife.

18 <cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram/RISATeams.aspx>

DRAFT

Strategy 5.2: Conduct research into ecological aspects of climate change, including likely impacts and the adaptive capacity of species, communities, and ecosystems, and their associated ecosystem services, working through existing partnerships or new collaborations as needed.

Climate change research is a very broad and extremely active field, and is being conducted all across the country and at many different scales. Results from academic research on the ecological responses to climate change should be made available to managers, for incorporation into decision support tools, and to inform climate change adaptation planning, delivery, and evaluation.

Studying Coral Adaptations

The coral reefs in and around National Park of American Samoa (NPSA) support over 975 fish species, more than 250 coral species, and a high diversity of invertebrates. Disturbances such as cyclones are expected to increase with climate change, but the principal threat to coral reefs is increased near-shore water temperatures and increased coral disease and coral bleaching events. Coral reefs within NPSA and worldwide are expected to experience substantial mortality of up to 90% loss by the end of the century. Ocean acidification, which is caused by increased levels of carbon dioxide in the atmosphere, also weakens coral.

The corals in Ofu Lagoon are currently healthy despite experiencing multiple environmental stressors including high daily temperatures and large fluctuations in temperature, pH, and dissolved oxygen. In 2002 and 2003 when increased water temperatures caused extensive coral bleaching in the region, the corals in Ofu Lagoon were found to have experienced less bleaching than other nearby reefs. This unique tolerance to high temperatures and other stressors provides an opportunity to better understand coral resilience and the implications for the health of corals worldwide, to identify areas of reefs in Samoa that would benefit most from protection and conservation, and perhaps to use these corals to reseed areas where corals have been lost to climate change impacts.

Results of these studies will help the park in planning long-term management efforts, such as identifying new candidates for marine protected areas.

The NPSA laboratory on the island of Ofu supports coral reef research. Local NPS interns Sui Fautua and Vano Alosio take water samples while assisting visiting researchers.

Strategy 5.3: Advance understanding of climate change impacts and species and ecosystem responses through modeling.

The use of models to project potential changes in weather patterns and natural systems has already generated a great deal of useful information to help us plan for future climate impacts, especially at large scales. A growing number of predictive modeling projects of all types and scales have been conducted by government agencies and stakeholder partners, and results are already being used to inform planning and decision-making. This is the most active area of research in climate adaptation. These models can be used for scenario planning and the design of management strategies.

DAVID PITKIN/USFWS

Bandon Marsh National Wildlife Refuge consists of 289 acres of salt marsh on the southern coast of Oregon.

DRAFT

Pacific Coast Sea-Level Rise Modeling

Coastal areas are high risk zones for the impacts of global climate change. Projected sea-level rise (SLR) of up to 6 ft. by 2100 is expected to alter coastal estuaries, resulting in loss of tidal salt marshes and their associated species. Loss of salt marsh habitats along the Pacific coast tidal gradient will impact demographic and community structure of these sensitive communities, and targeted restoration and triage will be required to save remnant areas. Rather than downscaling global climate models that are difficult to interpret at a particular site, this project is working with local managers and communities to assess parcel-scale information from the bottom-up.

This project is assessing the effects of SLR at 18 different tidal marshes located in California, Washington and Oregon. The project team measured elevation, accretion rate, tidal inundation, and plant communities and used ArcGIS models to create comparable datasets across the Pacific coast tidal gradient. Marsh SLR response models were developed out to the year 2100 in 10-year increments to assist decision-making by site managers. The project leads met often in-person with the land managers to help them understand the products and incorporate results into local planning documents, vulnerability assessments and decision making processes.

A final report is complete for SLR modeling for 12 sites across San Francisco Bay. Results from the modeling suggest that 9 sites (representing about 95% of the total 5000 acre study area) would become mudflats by 2100 with a 4 foot sea-level rise. Three sites are projected to be low marsh habitat dominated by Spartina spp. by 2100. All upland transition, high- and mid-marsh habitats were projected to be lost by 2100.

Partners

- Bandon Marsh National Wildlife Refuge
- California State Parks and Ecological Reserves
- Gray's Harbor National Wildlife Refuge
- Morro Bay National Estuary Program
- Nisqually National Wildlife Refuge
- North Pacific Landscape Conservation Cooperative
- Northwest Climate Science Center
- Oregon State University
- Padilla National Estuarine Research Reserve
- San Diego and San Francisco Bay National Wildlife Refuges
- San Pablo National Wildlife Refuge
- Siletz National Wildlife Refuge
- South Slough National Estuarine Research Reserve
- Southwest Climate Science Center
- Tijuana Estuary National Estuarine Research Reserve
- University of California, Davis
- University of California, Los Angeles
- U.S. Fish and Wildlife Inventory and Monitory Program
- U.S. Geological Survey
- U.S. Navy
- Willapa Bay National Wildlife Refuge

Modeling for Virginia's Wildlife Action Plan

During 2009, the Virginia Department of Game and Inland Fisheries, the National Wildlife Federation, and the Virginia Conservation Network, with support from State Wildlife Grants and the Doris Duke Charitable Foundation, developed a strategy to safeguard Virginia's Species of Greatest Conservation Need from the effects of climate change (see Box on SWAPs). This planning process involved scores of partners and stakeholders and identified ten implementation strategies. With additional support from State Wildlife Grants and the Doris Duke Charitable Foundation, Virginia was able to implement one of these strategies by developing new climate models to help Virginians better understand the climatic changes predicted for the mid-Atlantic region and what those changes would mean for wildlife and habitats.

DRAFT

The modeling project considered dozens of climatic factors under two different green-house gas scenarios and at a finer geographic resolution than was previously available. The downscaled climate models were applied to describe how 20 plant and animal species, associated with Virginia's Wildlife Action Plan, are likely to be impacted by climate change. A series of workshops were held with conservation partners and stakeholders to determine the best ways to make the models available to the conservation community.

Data resulting from this project are being used to update Virginia's Wildlife Action Plan, which allows authors to discuss long-term, climate-related, concerns and "climate smart" actions. A follow-up project has been initiated to help Virginians understand how climate change is likely to impact the conservation and recreation values of currently conserved lands. It is hoped this effort will provide management agencies with tools to help evaluate the future value of existing lands and facilitate the prioritization of future land acquisitions with regards to climate change.

The green heron is one of hundreds of Virginia's species that will benefit from the climate-smart habitat actions to be implemented from Virginia's next Wildlife Action Plan.

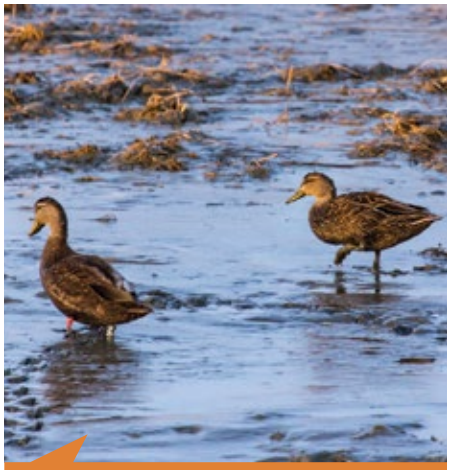
CAROL NORRIS

Partners

- Virginia Department of Game and Inland Fisheries
- Kutztown University
- National Wildlife Federation
- Virginia Conservation Network
- Virginia Tech's Conservation Management Institute

"Our climate modeling has confirmed Virginia's landscapes will change, but Healthy Populations in Healthy Habitats will have the best chance of adapting to changing climatic conditions—providing Virginia with an important goal for our next round of action plan implementation."

—CHRIS BURKETT, VIRGINIA DEPARTMENT OF GAME AND INLAND FISHERIES



Wild ducks at Forsythe National Wildlife Refuge.

STEVE DROTER

Habitat Modeling for Wintering Black Ducks

The U.S. Fish and Wildlife Service has been charged with increasing black duck habitat by 10% across the National Wildlife Refuge System to reach a 3-year population average of 100,000 wintering black ducks in the Chesapeake Bay by 2025.[19] Managing the black duck population at a time when land use and sea-level rise pose a recognized peril to this species and their habitats will require a strategic approach. The critical first step in this process is having a firm understanding of current black duck habitat utilization within the refuge system.

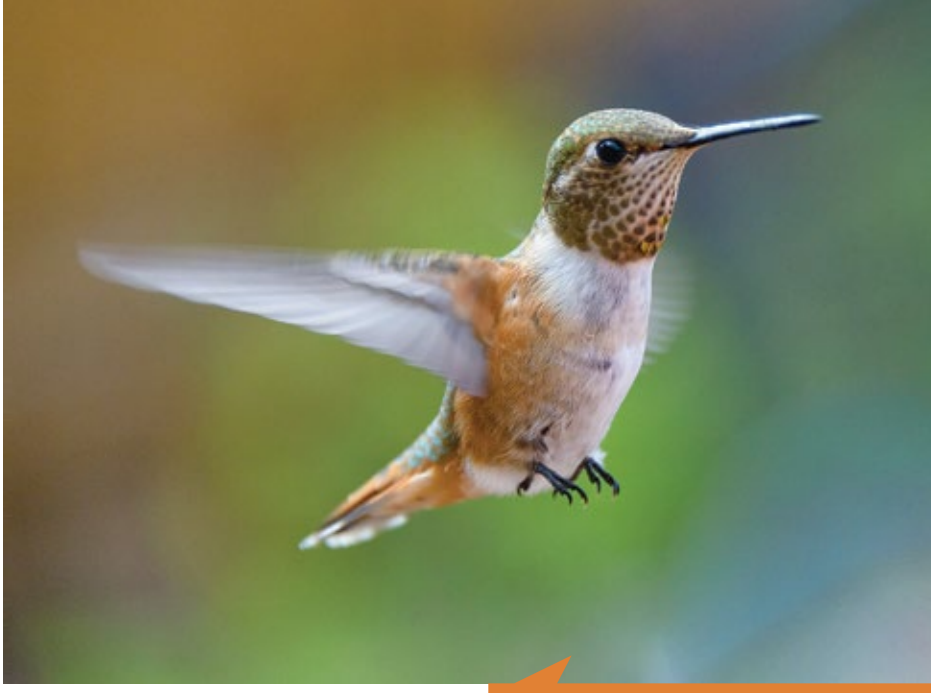
A bioenergetics model was used to determine the amount of energetically viable habitat as a function of quality prey, dispersal availability, and resultant food web interactions within the Chesapeake refuge system. The model produced from this study will demonstrate the extent to which sea-level rise and land-use change may affect black duck habitat at particular refuges. Using this information, refuge managers will be able to evaluate the effectiveness of different efforts for black duck habitat restoration across the refuge system.

19 Executive Order 13508,<www.whitehouse.gov/the_press_office/Executive-Order-Chesapeake-Bay-Protection-and-Restoration>

DRAFT

Partners

- Atlantic Coast Joint Venture
- Black Duck Joint Venture
- Blackwater National Wildlife Refuge
- Ducks Unlimited
- Eastern Neck National Wildlife Refuge
- James River National Wildlife Refuge
- Martin National Wildlife Refuge
- Patuxent National Wildlife Refuge
- Plum Tree National Wildlife Refuge
- Presquille National Wildlife Refuge
- Rappahannock National Wildlife Refuge
- University of Delaware
- U.S. Fish and Wildlife Service National Wildlife Refuges
- U.S. Geological Survey



Rufous Hummingbird

Birds of the North Pacific

This project aggregated existing bird observation data and then modeled the distribution and abundance of 26 species of land birds in the southern portion of the North Pacific LCC. The models are based on climate and modeled vegetation. Using the models, maps were created for the distribution and abundance of each species for current conditions and potential future conditions based on five future regional climate models. The bird models were also used to create maps of conservation priorities for all species and for species indicative of four different habitat types: conifer forest, oak woodlands, grasslands and riparian forest. A web-based decision support tool was created that can be used to support climate adaptation planning. The project also added one million new bird records from approximately 25 studies or data sets to the Avian Knowledge Network (AKN) database.

Disseminating the results via online decision support tools, other websites, direct outreach to stakeholders in the region (e.g., webinars), and peer reviewed literature was also a priority. The project created a web based decision support tool where the results from the project can be viewed, queried and downloaded, including reports of model results for user-defined regions.[20]

Partners

- North Pacific Landscape Conservation Cooperative
- American Bird Conservancy
- Bureau of Land Management National Landscape Conservation System
- Klamath Bird Observatory
- Point Blue Conservation Science

20 <data.prbo.org/apps/nplcc>

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Goal 6

Increase awareness and motivate action to safeguard fish, wildlife, and plants in a changing climate.

An informed professional community and engaged public is necessary to ensure successful and efficient adaptation action. Land managers and other practitioners with the responsibility to implement adaptation actions are only one side of the equation. Public awareness and engagement is also critical to the development and acceptance of adaptation actions.

Strategy 6.1: Increase public awareness and understanding of climate impacts to natural resources and ecosystem services and the principles of climate adaptation at regionally- and culturally-appropriate scales.

Familiar species and natural landscapes are cherished by the public, and public outreach and communication will be increasingly critical as climatic changes as well as adaptation and resilience responses alter those landscapes.

Pacific Northwest Tribal Climate Change Project

American Indian and Alaska Native tribes face disproportionate risks from a changing climate. Tribes have unique rights, cultures, and economies that may be vulnerable to climate change impacts. For indigenous peoples, the environmental impacts of climate change and some of the proposed solutions threaten ways of life, subsistence (including access to healthy foods), lands rights, future growth, cultural survivability, and financial stability.

The Tribal Climate Change Project is a collaborative project between the University of Oregon Environmental Studies Program and the USDA Forest Service Pacific Northwest Research Station. The project focuses on understanding and communicating the impacts of climate change on tribal sovereignty and culture through research, resource development, and facilitation of the Pacific Northwest Tribal Climate Change Network.[21] The project also focuses on understanding needs and opportunities for tribes in addressing climate change, examining the government-to-government relationship in a climate context and exploring the role of traditional knowledge in climate change studies, assessments and plans.

Resources include development of profiles featuring the innovative approaches of tribes across the United States addressing climate change through adaptation and mitigation strategies. The Tribal Climate Change Profiles are

21 <tribalclimate.uoregon.edu/network>

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intended to be a pathway to increasing knowledge among tribal and non-tribal organizations interested in learning about climate change mitigation and adaptation efforts. They are an example of a focused outreach effort aimed at engaging and communicating with a key audience about these critical issues.

Partners

- Tribes in the Pacific Northwest and beyond
- Columbia River Intertribal Fish Commission
- Northwest Indian Fisheries Commission
- Intertribal Timber Council
- Affiliated Tribes of Northwest Indians
- North Pacific Landscape Conservation Cooperative
- Northwest Climate Science Center
- Oregon Climate Change Research Institute

Strategy 6.2: Engage the public through targeted education and outreach efforts and stewardship opportunities.

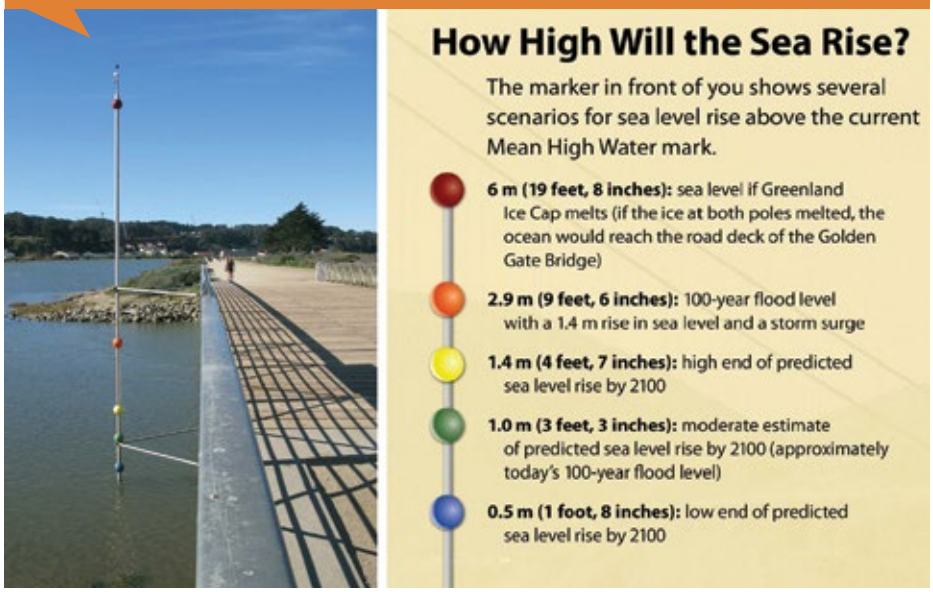
Public engagement offers a great opportunity for utilizing public lands to share information with visitors. An example of this type of effort comes from the National Park Service where wayside informational signs include information about the impacts of climate change while also providing digital access to information about other National Parks facing similar threats.

National Climate Change Wayside Project

National Park Service (NPS) sites throughout the country are beginning to experience impacts on natural and cultural resources associated with climate change, leading to a high priority communication project underway in several parks. A network of interpretive wayside exhibits in 13 parks will describe the impacts to local resources, as well as the national and global implications of climate change. This innovative project will convey current and projected effects of climate change to park visitors in a way that promotes understanding of the global nature of the issue and interconnected effects across the National Park System.

Through Quick Response (QR) codes and web addresses on the exhibits, visitors will see a list of parks with similar issues and links to which they can navigate for more information. As an example, while considering glacial melt information on the exhibit in Kenai Fjords National Park, visitors will simultaneously be able to examine projected sea level rise in the Dry Tortugas, and learn that continued melting of glaciers

An exhibit at Golden Gate National Recreation Area in California shares sea level rise projections with visitors and serves as the prototype for a new series of similar exhibits that will be installed in coastal national parks from Alaska to Florida.



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has implications for resources in other areas, such as Fort Jefferson in the Dry Tortugas. Thus, through a nationwide network of exhibits, visitors will receive consistent, focused messages to understand key climate change effects at the local level, and how these relate to effects in other areas.

Partners

- National Park Service Climate Change Response Program
- Big Cypress National Park
- Biscayne National Park
- Dry Tortugas National Park
- Everglades National Park
- Golden Gate National Recreation Area
- Great Smoky Mountain National Park
- Kenai Fjords National Park
- Kenilworth Park and Aquatic Gardens
- National Park Service Harpers Ferry Center
- Point Reyes National Seashore
- Rock Creek Park
- Sequoia and Kings Canyon National Parks
- Wolf Trap National Park

THE ISLAND INSTITUTE

Fishermen in Maine participate in an annual Roundtable.

Maine Fishermen's Climate Roundtable

The Fishermen's Climate Roundtable is an annual opportunity for fishermen and scientists to come together and share notes about the past fishing/research year, as well as longer term changes participants are noticing on the water. The event has been occurring for the last eight years. There is a core group of about 15 fishermen who attend every year and a larger group that attends intermittently. Depending upon the specific topics of interest identified by the fishermen, multiple different marine scientists are invited per year.

The Roundtables have resulted in a report, A Climate of Change- A Preliminary Assessment of Fishermen's Observation on a Dynamic Fishery in 2008 which was an overview of climate science and the major findings from the first two years of Climate Roundtables. Another report is forthcoming. The goal of these reports is to raise awareness about the impacts of climate change in Maine. The participating scientists and researchers want to encourage the residents of Maine to recognize the threat of climate change to culturally significant lobster fishing.[22]

Partners

- Island Institute
- National Oceanic and Atmospheric Administration
- Maine Department of Marine Resources

"As more observations are collected from other fishermen, we will be able to see more clearly how trends are changing over time and we will be better prepared to adapt to any resulting changes in the fishery. My hope is that our observations can and will be used by scientists to help document these trends."

—ELLIOTT THOMAS, FISHERMAN, YARMOUTH, MAINE.

22 Go to <vimeo.com/78754353> for a documentary produced by the fishermen as part of the Climate of Change series. This series can also be found on our website at <www.islandinstitute.org/climateofchange>.

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Engaging Youth with Climate Change

The National Park Service (NPS) is collaborating with the non-profit Global Explorers[23] to develop a suite of educational activities engaging middle and high school students with key climate change messages that range in duration and complexity for different purposes and demographics. All activities went through development and testing phases in 2013 for piloting and implementation in 2014.

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High school students participate in citizen science activities to monitor changes in plants and animals due to climate change at Great Smoky Mountains and other national parks across the nation.

The resulting curriculum aims to teach educators and students about the principles of climate change through a place-based approach. It shares overall climate science, and delves into how climate change is occurring on the landscape in parks, how resources will be affected and describes potential actions to get involved in the solution.

In the fall of 2014, Global Explorers will conduct an art contest over their website to generate student perspectives on climate change. The resulting art will be used as a communication tool for the NPS. This project will reach K-12 educators and students in urban or underserved environments that may not have the opportunity to travel to a national park or learn about climate change in the context of a national park.

Partners

- National Park Service Climate Change Response Program
- Denali National Park
- Global Explorers
- Kenai Fjords National Park

Strategy 6.3: Coordinate climate change communication efforts across jurisdictions.

Natural resource management agencies must communicate what they do to the public. Coordinating across jurisdictions leads to a stronger, more resounding message.

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Climate-Smart Conservation

The National Wildlife Federation and an expert workgroup consisting of leaders in climate adaptation from federal and state agencies and non-governmental organizations have collaboratively developed a guidebook for designing and carrying out conservation in the face of a rapidly changing climate. This guidebook, Climate Smart Conservation: Putting Adaptation Principles into Action, will help conservationists and resource managers incorporate climate change considerations into their work. The report demystifies the discipline of climate adaptation by offering a common-sense approach to adaptation planning and implementation that breaks the process into discrete and manageable steps.

23 <www.globalexplorers.org/programs/climate_change_academy>

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Goal 7

Reduce non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate.

The impacts of climate change are not the only threats to fish, wildlife, plants, and natural systems. Non-climate stressors include habitat loss, fragmentation, and degradation; invasive species; overharvesting and destructive harvest practices; and disease. The cumulative effects of these existing stressors is already a major threat to many species, some of which may not survive long enough to have a chance of adapting to climate change if existing stressors are not adequately addressed. Climatic changes such as rising temperatures and shifting rainfall patterns will interact and combine with these other threats in complex ways, creating synergistic impacts and novel situations.

One of the most important and frequently cited actions to help increase the capacity of fish, wildlife, and plants to cope with changing climate conditions is to reduce the negative impacts of existing stressors. The importance of conserving, restoring, and connecting suitable habitats as a way to enhance fish, wildlife, and plant resiliency has been discussed in Goal 1 of the Strategy, but reducing and mitigating the ongoing degradation associated with human development through such stressors as pollution, invasive species, etc., is also critical to maintain short-term survival for some species, as well as increase species' resilience in a changing climate.

While many of these projects are undertaken with the expressed goal of increasing resiliency to climate change, they vary in terms of how clearly they will actually increase resilience. In the future, it will be important to emphasize these linkages to the future climate conditions and make clear how reducing non-climate stressors will have the dual benefit of improving the ability for ecosystems to adapt to a changing climate.

Strategy 7.1: Slow and reverse habitat loss and fragmentation.

Conserving and connecting suitable habitat by reversing habitat loss and fragmentation gives species the best chance to move to more suitable locations as current habitats become no longer suitable. An example of this strategy is from the Bureau of Land Management which seeks to reduce habitat loss from future energy development on federal land.

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Bureau of Land Management (BLM) Regional Mitigation Strategy

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The Regional Mitigation Strategy for the Dry Lake Solar Energy Zone (SEZ) is intended to inform the decision-making process associated with leasing land for utility-scale solar development. It is a strategy for compensating for the unavoidable impacts that are expected from the development of the Dry Lake SEZ in southern Nevada. The Strategy consists of preliminary findings and recommendations for a process that identifies: (1) the unavoidable impacts of utility-scale solar development in the Dry Lake SEZ that may warrant regional mitigation; (2) mitigation actions that can be implemented in the region to compensate for those impacts; (3) how a regional mitigation fee could be calculated; and (4) how the impacts and mitigation actions could be monitored.

The models informed the identification of the BLM's Gold Butte Area of Critical Environmental Concern (ACEC) as the highest rated candidate site for conducting mitigation actions, in part, because the vegetation type in this area may persist longer under climate change than other areas that were considered. This project is complete and documented in the BLM's Technical Note 444.[24]

24 <www.blm.gov/pgdata/etc/medialib/blm/wo/blm_library/tech_notes.Par.29872.File.dat/TN_444.pdf>

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through land/ocean-use planning, water resource planning, pollution abatement, and the implementation of best management practices.

Improving habitat quality by reducing anthropogenic pollution increases the resilience and adaptive options for species responding to a changing climate. Many agencies, such as the Environmental Protection Agency (EPA), are currently working to reduce habitat degradation by reducing pollution of the air and water.

Promoting Healthy Watersheds

On February 22, 2013, EPA, The Nature Conservancy (TNC), and the Association of Clean Water Administrators (ACWA) jointly signed the Memorandum of Understanding (MOU) to promote EPA's Healthy Watersheds Program[25] (HWP).

This MOU formalizes a mutual collaboration between these groups as they strive to develop and implement healthy watersheds programs in states and with regional aquatic ecosystem programs. These programs include working with states and other partners to identify healthy watersheds state-wide and to implement healthy watershed protection plans, to integrate such protection into EPA programs and to increase awareness and understanding of the importance of protecting our remaining healthy

25 <www.epa.gov/healthywatersheds>

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watersheds. These partners recognize that healthy, intact watersheds can offset the potential impacts of climate change in a variety of ways including maintenance of baseflow during periods of drought, native vegetation that provides cooling during heat waves, carbon storage in native vegetation and soils, and enhanced stormwater infiltration capacity that mitigates downstream flooding.

The partners will promote data gathering/data sharing and evaluation of conservation and environmental outcomes resulting from the implementation of state and regional healthy watershed programs.

Partners

- Association of Clean Water Administrators
- Environmental Protection Agency
- The Nature Conservancy

Strategy 7.3: Use, evaluate, and as necessary, improve existing programs to prevent, control, and eradicate invasive species and manage pathogens.

Climate change can shift the range of invasive species, serve as the trigger by which non-native species do become invasive, and introduce and spread invasive species through severe weather events such as storms and floods. While most land and wildlife management agencies have long had programs in place to reduce impacts from invasive species, managers are now forced to consider these threats within a climate change context.

Strengthening Resiliency in Sierra Nevada Meadows

Sierra Nevada meadow complexes are wetland habitats with great ecological importance despite their limited extent. Invasive plants have long been recognized as a threat to the region's wildlife for their range of impacts. However, the Sierra Nevada is not yet impacted by invasive plants as much as other regions of California. It has been protected in part by the more challenging climate at higher elevations. As California's climate warms, many invasive plant species are expected to find hospitable range farther into the mountains. California's Wildlife Action Plan (see box on SWAPs) identifies climate change and invasive plants as top threats to wildlife in the Sierra Nevada.

This project intends to strengthen the resiliency of critical meadow habitat in the Sierra Nevada. It began in 2014, building on past work to limit the spread of invasive plants in the region. Using 2-year project funding from the Wildlife Conservation Society's Climate Adaptation Fund, a group of regional partners met to determine sites and species, select a set of meadows to serve as pilots and design invasive plant eradication efforts in and around these meadows.

California Invasive Species Council's CalWeedMapper[26] shows the current distribution of invasive plant species as well as their projected future ranges, and provides the basis for selecting sites and species for control actions. CalWeedMapper is a new online decision-support tool designed to help land managers set effective invasive plant management strategies by providing statewide maps of invasive plant distribution, spread, management and suitability.

Meadows along the Truckee River in the Sierra Nevada foothills are susceptible to future invasive plants.

26 <calweedmapper.cal-ipc.org>

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Through extensive partnerships with the Forest Service, county Weed Management Areas, and local watershed groups in the region, high-risk invasive plant populations will be eradicated from Sierra meadows that serve as critical habitat for climate adaptation. These pilot projects will inform future adaptation work on other Sierra Nevada meadows. Partners are well-situated for communicating the project's accomplishments, and will work to ensure the long-term sustainability of the effort.

Partners

- California Department of Fish and Wildlife
- California Invasive Plant Council
- El Dorado County Department of Agriculture
- Eldorado National Forest
- Nevada County Department of Agriculture
- Pacific Gas and Electric Company
- Placer County Department of Agriculture
- South Yuba River Citizens League
- Tahoe National Forest
- Truckee River Watershed Council
- U.S. Forest Service

"Controlling invasive plants helps keep meadow habitats healthy so they can continue to support wildlife and native plants as the climate changes. It's a proactive measure that may make these habitats more resilient to climate change."

—ED KING, PLACER COUNTY AGRICULTURAL COMMISSIONER'S OFFICE

SNAPSHOT

Vessel Discharge Standards to Reduce Invasive Species

In 2013, EPA issued a revised Vessel Discharge Permit for discharges of water from ships, including discharges of ballast water that have been associated with the release of invasive aquatic species. EPA finalized new, more stringent effluent limitations to replace the weaker limitations in the 2008 Vessel General Permit for ballast water. These changes will achieve significant reductions in the number of living organisms discharged via ballast water into waters subject to this permit. EPA has set the effluent limit for ballast water as numbers of living organisms per cubic meter discharged (i.e., as a maximum acceptable concentration) because reducing the concentration of living organisms will reduce densities of potential invasive species discharged in a vessel's ballast water.[27]

27 <www.epa.gov/npdes/pubs/vgp_overview2013.pdf>

Heightened Awareness for Emerging Pathogens

USDA APHIS Veterinary Services (VS) is developing and resourcing new approaches to identify and assess emerging pathogens. The recent detection and spread of pathogens such as corona viruses in swine in the United States demonstrates the need to increase our awareness of emerging pathogens of terrestrial and aquatic animals throughout the world, our understanding of the risk they may pose to animal health in the US, and improve measures to prevent entry and spread of the pathogens of concern. VS is currently finalizing an emerging diseases framework document to provide direction and consistency to this approach.

Engaging in emerging disease detection and response is not new to Veterinary Services. Since 2001, VS strategic plans have incorporated identification and response to emerging diseases within the major goals. The strategic approach being developed will incorporate new approaches, advanced technologies, and improved communication capabilities in order to enhance the ability to identify and respond to emerging diseases of concern.

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Strategy 7.4: Reduce destructive capture practices, over-harvesting, and illegal trade to help increase fish, wildlife, and plant adaptation.

Destructive capture practices of various species—whether birds, fish, marine mammals, or turtles—can have significant, biological, economic, and social impacts as well as reducing the ability of populations to adapt to the impacts of climate change. NOAA is leading efforts to reduce destructive marine capture practices such as by-catch through the National Bycatch Program.

SNAPSHOT

Bycatch Reduction Engineering Program

Preventing and reducing bycatch is a shared goal of fisheries managers, the fishing industry, and the environmental community. The cumulative effects of bycatch on certain fish populations is already a major threat, and reducing this impact is a critical part of ensuring populations are healthy and resilient enough to be able to adapt to additional climate change stressors.

The Bycatch Reduction Engineering Program (BREP) is a part of NOAA's National Bycatch Program. The mission of the BREP is to develop technological solutions and investigate changes in fishing practices designed to minimize bycatch of fish including sponges and deep sea and shallow, tropical corals, and protected species. The BREP also intends to minimize bycatch injury and mortality including post-release injury and mortality. The BREP awards grants to reduce bycatch and post-release mortality in commercial and recreational fisheries.

Summary & Conclusion

Across the country, the agencies responsible for managing fish, wildlife, and plants are working with partners and stakeholders to take concrete steps to address the current impacts and future threats of climate change on these valuable resources and the important services they provide.

Well before the Strategy was developed, federal, tribal, state, and local governments and conservation partners had initiated a variety of efforts to help prepare for and respond to the impacts of climate change. Successful implementation of the Strategy into the future will take commitment and resources by both government and non-government entities. The examples highlighted in this report are not a comprehensive accounting of what has been accomplished, but rather provide examples of the diversity of projects, scales of planning, and partnerships that are being utilized to respond to the impacts climate change.

The Strategy was designed to build on and assist these efforts across multiple scales and organizations by collectively identifying the major strategies and initial actions needed to help our valuable living resources in the face of climate change. The Strategy recommended over 100 actions that were organized into 23 strategies under seven major goals.

For this report, 100 case studies were voluntarily submitted, by members and partners of the Joint Implementation Working Group, describing projects being implemented by over 350 different partners at the federal, state, tribal, and local levels. This Progress Report includes case studies showing promising work in all 23 of the strategies.

The majority of the climate change adaptation projects were reported under goals four and five, suggesting that many agencies are already working to "Increase Knowledge and Information" and to "Support Adaptive Management." These projects include efforts to understand the impacts of climate change and completing vulnerability assessments of species and habitats. Fewer projects were reported under goal six: "Increase Awareness and Motivate Action." This represents a large opportunity for agencies that interface with the public and industry groups to better communicate with and engage constituents in understanding and encouraging action to combat climate change.

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The Strategy and the diverse adaptation work that has already been initiated or completed by a wide range of partners are part of a significant collective effort to safeguard the nation's fish, wildlife, and plants, and the communities and economies that depend on them in a changing climate. Although this report identifies critical actions that are being taken now, a challenging task lies ahead. The success of climate adaptation relies on continuing action by federal, tribal, state, and local governments and many partners. In particular, this will include implementing the plans and recommendations that result from many of the ongoing efforts reported here. In addition, there is still much to be learned about the specific impacts of climate change and the responses of plants, wildlife, and ecosystems. A successful response to this challenge must include increased engagement from agencies, managers and partners at all levels.

When the Strategy was released, the intent was to inspire realistic action on climate adaptation. The projects in this Progress Report serve as further examples and motivation for useful projects that can be successfully undertaken across the country. They help illustrate that any organization, large or small, can engage with federal, state, tribal, and local partners to improve the resiliency of ecosystems to the impacts of climate change.

To date, these projects have been undertaken because of the foresight, initiative and energy of those involved. They are not yet the result of a major, integrated, and coordinated effort to respond to the expected impacts of climate change on our living natural resources. Such an effort is needed and the Strategy provides a framework for its development.

Appendix. All submitted case studies

The following table lists the title, location, submitting agency, and habitat type for all of the case studies that were submitted during the production of this report. The table is arranged by location and divided in to seven different regions. These regions are Alaska, the Pacific Islands, West, Midwest, Southeast, Northeast, and National. The JIWG was only able to include full descriptions of about half of these projects in this Progress Report. For more information about any of these projects, including a list of partners, please contact the JIWG.

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TITLE	LOCATION	SUBMITTING AGENCY	HABITAT TYPE
Alaska			
Berries in Decline	South Central Alaska	North Pacific LCC	Arctic
Developing Baseline Data to Respond to Coastal Change	Alaska	NPS	Arctic
Integrated Ecosystem Model for Alaska	Alaska	USGS	Multiple
Restoring Access to Salmon Habitats	Alaska	Chickaloon Tribe	Inland Water
Pacific Islands			
Coral Adaptations at National Park of American Samoa	American Samoa	NPS	Marine
Pacific Islands Climate Change Cooperative	Hawaii and Pacific Island territories	PICCC	All
West			
A Coupled Assessment of Climate Change	Washington and Oregon	North Pacific LCC	Inland Water/Marine
Bear River Estuary Restoration	Washington	National Fish Habitat Partnership	Coastal/Inland Water
Birds of the North Pacific	Northern California, Oregon, Washington	North Pacific LCC	Multiple
BLM Regional Mitigation Strategy	Nevada	BLM	Shrubland
Branciforte Creek Dam Removal	California	National Fish Habitat Partnership	Inland Water
California DFW Climate College	California	California DFW	Multiple
Climate Change and Assisted Migration	Idaho	USFS	Multiple
Climate Change and Southwestern Terrestrial Species	Southwest	USFS	Multiple
Coastal Ecosystems and Climate	California, Oregon, Washington	North Pacific LCC	Coastal
Conner Creek Barrier Removal Project	California	National Fish Habitat Partnership	Inland water
Conservation Planning Atlas	North Pacific	North Pacific LCC	Multiple
Developing Regional Invasive Plant Strategies	California	California DFW	Grassland/Shrubland
Effects of Climate Change on California Coast	California	USGS	Coastal
Effects of Climate Change on Northwest Cheatgrass	NV, OR, ID	USGS	Grassland/Shrubland
Improving Salmon Habitat on the Upper Quinault River	Olympic Peninsula, WA	Quinault Tribe	Inland Water
Integrated Scenarios of Climate, Hydrology, and Vegetation	North West US	USGS	inland water
Local Outreach Coastal Response Modeling	California	USGS	Coastal
Managing Yellowstone Cutthroat Trout under Climate Change	ID, WY, UT, NV, and MT	NPS	Inland Water
North Cascadia Adaptation Partnership	Washington	NPS	Multiple
Northwestern Tribal Forest Improvement	Washington	Quinault Tribe	Forest
Pacific Coast Sea-Level Rise Modeling	California, WA, OR	FWS	Coastal
Pacific Northwest Tribal Climate Change Project	Oregon	U. of Oregon	Multiple
Pacific Northwest Vulnerability Assessment	WA, OR, ID	Washington State	Multiple
Restoration of the Salmon Creek Delta	California	FWS	Coastal
Rio Grande Water Fund	New Mexico	TNC	Inland Water/Forest

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TITLE	LOCATION	SUBMITTING AGENCY	HABITAT TYPE
Sagebrush Conservation	Western U.S.	BLM	Grassland/Shrubland
San Francisco Bay Wetland Restoration	California	NOAA	Coastal
San Francisco Conservation Lands Network	San Francisco Bay Area	FWS	Multiple
Saving Hotter and Dryer Cienaga Habitat on Pitchfork Ranch	Grant County, Southwest New Mexico	AT and Cinda Cole	Shrubland/Inland Water
Strengthening Meadow Resiliency	California	California DFW	Grassland/Shrubland
Supporting Colorado's Vulnerability Assessment	Colorado	FWS	Multiple
Traditional Gathering Calendar	South-central Alaska to Northern California	North Pacific LCC	Multiple
Vulnerability Assessment of California Vegetative Communities	California	California DFW	Multiple
Washington Connected Landscapes	Washington	North Pacific LCC	Multiple
Yakima River Basin Integrated Plan	Washington	WA DFW	Inland Water
Midwest			
Brook Trout Vulnerability Driftless Area	Wisconsin, Michigan	Wisconsin DNR	Inland Water
Climate Change and the Ceded Territories	Great Lakes Region	GLIFWC	Multiple
Determining Effects of Climate Change on Streamflow	North Central US	USGS	Inland Water
Effects of Climate Change on Woody Encroachment	MT, ND, SD, WY, NE	USGS	Grassland/Shrubland
PFW Program Climate Adaptation Restoration	USFWS Mountain Prairie Region	FWS	Inland Water
Planting Future Forests in Northern Minnesota	Minnesota	TNC	Forest
Protecting Coldwater Fish in Minnesota	Minnesota	MN DNR	Inland Water
Southeast			
Acton on Adaptation Cape Romain NWR	South Carolina	FWS	Coastal
Albemarle-Pamlico Adaptation Project	North Carolina	FWS	Coastal
Alternative Futures for Florida Keys	Florida Keys	Florida Fish and Wildlife Commission	Multiple
Assessing Climate-Sensitive Southeast Ecosystems	Southeast	USGS	Multiple
Buying Time Against Rising Seas	Florida	FWS	Coastal
Gulf Coast Climate Vulnerability	TX, LA, MS, AL, and FL	FWS	Coastal
Lower Keys Marsh Rabbit Adaptive Management	Florida Keys	FWS	Coastal and Inland Water
Pocosin Lakes NWR Peatland Restoration	North Carolina	FWS	Coastal
Resilient Sites in the Southeast	Southeast US (NC, SC, GA, FL, AI, TN, KY, WV, and VA)	TNC	Multiple
Sea Turtle Vulnerability Assessment	Florida	USGS	Marine/Coastal
Southeast Conservation Adaptation Strategy	SE United States	GCPO LCC (FWS)	Multiple
Tennessee Dam Removal	Tennessee	Tennessee DFW	Inland Water
West Tennessee Vulnerability Assessment	Tennessee	GCPO LCC (FWS)	Multiple

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TITLE	LOCATION	SUBMITTING AGENCY	HABITAT TYPE
Northeast			
Building Resilient Fisheries and Communities Through Diversification	Maine	NOAA	Marine
Central Appalachians Essential Forests and Key Connectors	Central Appalachian Forests (PA, MD, WV, VA, KY, TN)	TNC	Forest
Climate Change and Waterfowl Populations	Maryland	USGS	Coastal
Climate Change Impacts on Northeast Forests	Northeast	USGS	Forest
Coastal Vulnerability and Wetlands Impact Assessment	Hurricane Sandy Northeast	USGS	Coastal
Dorchester County SLR Assessment and Strategy	Maryland	FWS	Coastal
Habitat Vulnerability Assessment for Wintering Black Ducks	Chesapeake Bay	USGS	Coastal
Landscape Scale Conservation in the White-Moose	New Hampshire, Maine	Trust for Public Land	Forest
Maine Fishermen's Climate Roundtables	Maine	NOAA	Marine
Modelling for Virginia's Wildlife Action Plan	VA, MD, DE, WV	Virginia DFW	Forest
Resilient Sites in the Northeast	Northeast and Mid-Atlantic US and Maritime Canada	TNC	Multiple
Taunton Mill River Restoration	Massachusetss	TNC	Inland Water
National			
Adaptive Management Benchmarks	National	DOD	All
Climate Academy	National	AFWA	Multiple
Climate Change in Coastal and Estuarine Land Conservation	National	NOAA	coastal
Climate Change Planning - Refuge System	National	FWS	Multiple
Climate.gov			
National	NOAA	All	
Climate-Smart Sancturies	National	NOAA	Marine
Coral Reef Resilience	National	NOAA	Marine
Digital Coast	National	NOAA	Coastal
Engaging Youth with Climate Change	National	NPS	Multiple
Facilitating Tribal Climate Change Adaptation Planning	National	ITEP	Multiple
Heightened Awareness for Emerging Pathogens	National	APHIS	Multiple
Interpreting Climate Change Competency	National	NPS	Multiple
Monthly Climate Change Webinars	National	NPS	Multiple
National Climate Assessment - Forest Sector Report	National	USFS	Forest
National Climate Change Wayside Project	National	NPS	Multiple
National Phenology Network	National	USGS	Multiple
NWRS CC Engagement Strategy	National	FWS	Multiple
Promoting Aquatic Connectivity and Fish Passage	National	FWS	Inland Water
Using Sentinel Sites to Manage Natural Resources	National	NOAA	Coastal
Water Resource Inventory and Assessment	National	FWS	Inland water
Watershed Vulnerability Pilot Assessments	Multiple	USFS	Inland Water
WeatherBlur	National	NOAA	Coastal

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Council on Environmental Quality

Florida Fish and Wildlife Conservation Commission

Great Lakes Indian Fish & Wildlife Commission

North Carolina Wildlife Resources Commission

Northwest Indian Fisheries Commission

New York State Department of Environmental Conservation

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Animal and Plant Health Inspection Service
Farm Service Agency
Natural Resources Conservation Service
U.S. Forest Service

U.S. Department of Commerce, National Oceanic and Atmospheric Administration
National Marine Fisheries Service
National Ocean Service

U.S. Department of Defense
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U.S. Department of the Interior
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