



May 2013

CLIMATE CHANGE

Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies

GAO Highlights

Highlights of [GAO-13-253](#), a report to congressional requesters

Why GAO Did This Study

Climate change poses a variety of threats to federally managed natural resources, such as forests and wildlife, including possibly more frequent and severe droughts and wildfires.

Adaptation—adjustments in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects—can be used to help manage the risks to vulnerable natural resources. GAO was asked to review federal agencies' efforts to incorporate climate change adaptation into their natural resource planning and management since GAO last reported on this issue in 2007.

This report examines (1) steps key federal natural resource management agencies—Forest Service, NOAA, Fish and Wildlife Service, National Park Service, and Bureau of Land Management—have taken since 2007 to address adaptation and (2) how these agencies have collaborated at the national level on adaptation since 2007. GAO analyzed the agencies' climate change adaptation guidance and planning documents and interviewed agency officials. GAO also visited one field location for each agency, selected using a nonprobability approach, so the results are not generalizable to all of the agencies' field locations.

GAO is not making any recommendations. GAO received written comments from the Department of Agriculture, which said the Forest Service agreed with the findings. GAO also received general and technical comments from the Departments of Commerce and the Interior, which were incorporated as appropriate.

View [GAO-13-253](#). For more information, contact Anne-Marie Fennell at (202) 512-3841 or fennella@gao.gov.

May 2013

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Various Adaptation Efforts Are Under Way at Key Natural Resource Management Agencies

What GAO Found

Since 2007, the Forest Service, the National Oceanic and Atmospheric Administration (NOAA), the Fish and Wildlife Service, and the National Park Service have taken steps to establish strategic directions for addressing climate change adaptation. For example, the Forest Service developed a strategic framework document that established climate change adaptation as a central agency priority and another document, known as "the roadmap," which identified actions that national forest managers were taking or could take to implement the direction outlined in the framework, including re-vegetating ecosystems that had been affected by fire with plant species that are better adapted to current and future climates. These four agencies have also developed guidance, training, and other tools for managers to use in adapting to climate change. For example, the National Park Service is developing guidance for park-based climate change adaptation plans that includes steps such as identifying conservation targets and conducting vulnerability assessments. The Bureau of Land Management has not established a strategic direction for addressing climate change impacts but is planning to develop a high-level climate change adaptation strategy by the end of the summer 2013. In addition, GAO visited one field location within each agency and found that managers at four of the five locations have taken steps to address climate change adaptation. For example:

- Chugach National Forest managers have begun an assessment of the vulnerability to climate change of key resources to help set priorities and identify adaptation actions. For example, the vulnerability assessment will include information on how changes in climate are likely to affect snow cover and salmon populations, as well as an analysis of how these projected changes may affect residents in the region who rely on snow-based tourism and salmon for their livelihoods.
- Florida Keys National Marine Sanctuary managers are beginning to assess whether parts of their management plan should be revised to address climate change adaptation and have taken actions to protect marine resources, such as coral reefs, from climate change impacts. For example, the sanctuary is collaborating with local stakeholders to develop systems and techniques to grow coral and other reef species for replanting in depleted reef systems.

Managers at the Bureau of Land Management's Kingman Resource Area, which manages its lands for livestock grazing and other uses, have not taken steps to address climate change adaptation and are awaiting agency direction.

The federal natural resource management agencies GAO reviewed are collaborating on climate change adaptation. For example, agencies are collaborating through landscape conservation cooperatives, comprising public and private organizations working to define shared goals and provide science for conservation planning, among other things. In addition, agencies have collaborated in developing national strategies for addressing climate change adaptation in the federal government. For example, the Fish and Wildlife Service, NOAA, and others collaborated on a strategy, released in March 2013, for addressing climate change adaptation in managing fish, wildlife, and plants.

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Abbreviation

NOAA National Oceanic and Atmospheric Administration

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May 31, 2013

The Honorable Max Baucus
Chairman
Committee on Finance
United States Senate

The Honorable Sheldon Whitehouse
Chairman
Subcommittee on Oversight
Committee on Environment and Public Works
United States Senate

According to multiple scientific studies, including those done by the U. S. Global Change Research Program,¹ climate-related changes will likely adversely affect many aspects of the natural environment in the United States.² These changes include increases in air and water temperatures, wildfires, and drought; forests stressed by drought becoming more vulnerable to insect infestations; rising sea levels; and reduced snow cover and retreating glaciers. In addition, various species are expected to be at risk of becoming extinct due to the loss of habitat critical to their survival. Many of these changes have already been observed on federally managed lands and waters and are expected to continue. As we reported in October 2009,³ policymakers are increasingly viewing adaptation—defined by the National Research Council⁴ as adjustments in natural or

¹The U.S. Global Change Research Program coordinates and integrates federal research on changes in the global environment and their implications for society. Led by a team of officials from each of the U.S. Global Change Research Program's 13 participating departments and agencies, the U.S. Global Change Research Program engages in a variety of activities designed to strengthen and strategically direct climate change research in the U.S. and improve the flow of that information to federal, state, and local decision makers, and the public.

²Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, eds., U.S. Global Change Research Program, *Global Climate Change Impacts in the United States* (New York, New York: Cambridge University Press, 2009).

³GAO, *Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions*, [GAO-10-113](#) (Washington, D.C.: Oct. 7, 2009).

⁴National Research Council, *America's Climate Choices: Adapting to the Impacts of Climate Change*, (Washington, D. C.: 2010).

human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects—as a risk-management strategy to protect vulnerable natural resources that might be affected by changes in the climate.

The federal government manages nearly 30 percent of the land in the United States. Specifically, federal agencies manage natural resources on about 650 million acres of land, including 401 national park units and 155 national forests. In addition, federal agencies also manage marine resources in the United States and its exclusive economic zone,⁵ including fisheries and protected species, and marine protected areas that include 13 national marine sanctuaries. These resources are managed primarily by the Department of Agriculture's Forest Service; the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); and the Department of the Interior's U.S. Fish and Wildlife Service, National Park Service, and Bureau of Land Management.

In August 2007, we reported that federal natural resource managers lacked specific guidance for incorporating climate change into their planning efforts and management actions.⁶ Without such guidance, we reported that their ability to address climate change and effectively manage resources was constrained. We recommended, among other things, that the Secretaries of Agriculture, Commerce, and the Interior develop clear written guidance that explains how federal natural resource managers are expected to address the effects of climate change. The three departments generally agreed with our recommendation and have been taking steps to address it. In addition, in October 2009, we reported that climate change is a complex, interdisciplinary issue with the potential to affect every sector and level of government operations and that government-wide adaptation planning and collaboration could assist climate change adaptation efforts.⁷ We concluded that adaptation will

⁵The United States has jurisdiction over the U.S. exclusive economic zone—an area typically extending from 3 to 200 nautical miles off the coast—including jurisdiction to manage natural resources and protect and preserve the marine environment. The U.S. exclusive economic zone is the largest in the world covering about 3.4 million nautical miles or 1.7 times the landmass of the contiguous United States.

⁶GAO, *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Lands and Water Resources*, [GAO-07-863](#) (Washington, D.C.: Aug. 7, 2007).

⁷[GAO-10-113](#).

require new approaches to match new realities and that old ways of doing business—such as making decision based on the assumed continuation of past climate conditions—will not work in a world affected by climate change. In 2013, we added climate change to our list of high-risk areas because it poses significant financial risks to the federal government. One of the areas where the federal government’s fiscal exposure is expected to increase is in its role as the manager of large amounts of land and other natural resources.⁸

In an October 2010 report, the Interagency Climate Change Adaptation Task Force, established by the President and made up of representatives from more than 20 federal departments and agencies, concluded that the federal government has the responsibility to manage climate-related impacts on federal resources by, among other things, leading and supporting actions that reduce vulnerability, increase resilience, and enhance coordination.⁹ In response to recommendations from the task force or initiatives from their Secretaries, the Departments of Agriculture, Commerce, and the Interior have developed various mechanisms to address climate change impacts on natural resources and the people, industries, and communities that depend on them.¹⁰ These mechanisms include, for example, climate change adaptation strategies within the departmental strategic plans, adaptation-related policies and guidance, and national interagency collaborative initiatives. In addition, the three departments have all, in various ways, informed their respective agencies to begin addressing climate change adaptation.

⁸GAO, *High-Risk Series: An Update*, [GAO-13-283](#) (Washington, D.C.: February 2013).

⁹The White House Council on Environmental Quality, *Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy*, 2010.

¹⁰In addition, the October 5, 2009 Executive Order 13514 on Federal Leadership in Environmental, Energy, and Economic Performance directs federal agencies to evaluate their climate change risks and vulnerabilities and manage the effects of climate change on the agency’s operations and mission in both the short- and long-term. In response to the Executive Order, the Departments of Agriculture, Commerce, and the Interior submitted adaptation plans for fiscal year 2013 to the Council on Environmental Quality in June 2012 as part of their annual Strategic Sustainability Performance Plans. The Council on Environmental Quality is an office within the Executive Office of the President that, among other things, oversees implementation of the National Environmental Policy Act and develops and recommends to the President national policies to foster and promote the improvement of environmental quality.

You asked us to review what federal agencies are doing to incorporate climate change adaptation into their natural resource planning and management activities. This report examines (1) steps key federal natural resource management agencies have taken since 2007 to address climate change adaptation and (2) how these agencies have collaborated with each other at the national level since 2007 to address climate change adaptation. While federal agencies have taken many different climate change adaptation actions, we focused on those actions that we determined were most directly relevant to helping guide the management activities of the field location we visited at each agency.

We selected the following four key federal natural resource management agencies to review because they administer over 90 percent of the federal lands in the United States. The four agencies are (1) the Forest Service, (2) the U.S. Fish and Wildlife Service, (3) the National Park Service, and (4) the Bureau of Land Management. We selected NOAA because it manages coastal and ocean natural resources, such as the national marine sanctuary system.¹¹ To determine how the five natural resource management agencies have addressed climate change adaptation since 2007, we reviewed and analyzed relevant strategic plans, actions plans, policies, resource management plans, and guidance documents for the five agencies and interviewed senior officials at each agency.

To learn how one natural resource site managed by each of the agencies has addressed climate change adaptation since 2007, we visited five sites, reviewed planning documents, and interviewed agency officials that manage the resources at those sites. The five sites we visited were (1) the Forest Service's Chugach National Forest in south-central Alaska; (2) NOAA's Florida Keys National Marine Sanctuary in southern Florida; (3) the U.S. Fish and Wildlife Service's San Pablo Bay National Wildlife Refuge in northern California; (4) the National Park Service's Glacier National Park in northwestern Montana; and (5) the Bureau of Land Management's Kingman Field Office in northwestern Arizona. We visited four of these sites—Chugach National Forest, Florida Keys National Marine Sanctuary, Glacier National Park, and Kingman Field Office—because they were also included in our 2007 review.¹² For the 2007

¹¹NOAA also manages coastal and ocean ecosystems, marine fisheries, protected resources, and other marine protected areas.

¹²[GAO-07-863](#).

review, we selected the sites we visited to ensure geographic representation across the country and to include the four principal ecosystem types that are managed by federal agencies—forests, grasslands and shrublands, coasts and oceans, and fresh waters.¹³ For this review, we included the San Pablo Bay National Wildlife Refuge so that we could review a site managed by the U.S. Fish and Wildlife Service. Because we selected a nonprobability sample of five sites,¹⁴ the results we obtained from these sites are not generalizable to all of the natural resource areas managed by the five agencies; however, they provide specific examples of how some federally managed natural resource areas have addressed climate change adaptation at the site level. We also interviewed stakeholders, including state, local, and tribal government officials and representatives from nongovernmental organizations, to discuss their adaptation efforts.

To learn how the natural resource management agencies have collaborated with each other at the national level since 2007 to address climate change adaptation, we reviewed documents such as the October 2011 Interagency Climate Change Adaptation Task Force progress report¹⁵ and the National Fish, Wildlife and Plants Climate Adaptation Strategy.¹⁶ We also interviewed officials from the five agencies, including officials who have roles and responsibilities related to collaboration.

We conducted this performance audit from December 2011 to May 2013 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain

¹³An ecosystem is a coexisting set of species and their habitat, generally characterized by a particular type of climate and other physical conditions (e.g., soil types on land, water depths in freshwater and marine environments), as well as by the set of species present.

¹⁴A nonprobability sample means that the five sites were not selected randomly.

¹⁵Interagency Climate Change Adaptation Task Force, *Federal Actions for a Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force* (October 2011). The task force includes representatives from more than 20 federal departments and agencies including the Departments of Agriculture, Commerce, and the Interior.

¹⁶National Fish, Wildlife and Plants Climate Adaptation Partnership. *National Fish, Wildlife and Plants Climate Adaptation Strategy*: Association of Fish and Wildlife Agencies, Council on Environmental Quality, U.S. Fish and Wildlife Service, Great Lakes Indian Fish and Wildlife Commission, and National Oceanic and Atmospheric Administration, (Washington, D.C.: 2012).

sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Climate change is having a variety of impacts on natural resources in the United States, including more severe drought and increased wildfires. The five key federal natural resource management agencies included in this review—the Forest Service, NOAA, U.S. Fish and Wildlife Service, National Park Service, and Bureau of Land Management—have unique roles and are facing a variety of management challenges related to climate change. Climate change is also altering assumptions that have been central to natural resource planning and management in the past and recent reports have highlighted the importance of establishing climate change planning in the federal government to help ensure it can continue to provide important services in a changing environment.

Climate Change Impacts in the United States

According to the U.S. Global Change Research Program, changes in the climate have been observed in the United States and its coastal waters and will adversely affect aspects of the nation's natural environment. As table 1 shows, changes in the climate—including warmer temperatures, changes in precipitation patterns, rising sea levels, and more intense storms—affect the natural environment in a number of ways including more severe drought, increased frequency of large wildfires, insect infestations, changed habitats, and possible loss of species that cannot survive in the changed conditions.

Table 1: Current and Projected Impacts of Climate Change in the United States

Category	Current and projected impacts	Examples of impacts to natural resources
Temperature	<ul style="list-style-type: none"> U.S. average temperature has risen more than 2 degrees Fahrenheit over the past 50 years and is projected to rise more in the future—how much more depends primarily on the amount of heat-trapping gases emitted globally and how sensitive the climate is to those emissions. Higher ocean temperatures. 	<p>Drought; increased frequency of large wildfires; insect infestations; changes to habitat and species loss; melting of glaciers.</p> <p>Stronger storms with higher wind speeds and more rainfall; coral bleaching.</p>
Precipitation	<ul style="list-style-type: none"> Precipitation has increased an average of about 5 percent over the past 50 years. Projections of future precipitation generally indicate that northern areas will become wetter and southern areas, particularly in the West, will become drier. The amount of rain falling in the heaviest downpours has increased approximately 20 percent on average in the past century, and this trend is very likely to continue, with the largest increases in the wettest places. In most regions of the country, the fraction of precipitation falling as rain has increased in the last 50 years. 	<p>Loss of snow cover; increased flooding in some areas; more severe drought in some areas.</p>
Extreme weather events and storms	<ul style="list-style-type: none"> Many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years. The destructive energy of Atlantic hurricanes has increased in recent decades. The intensity of these storms are likely to increase in this century, and along with it, associated wind, precipitation, and storm surges. In the eastern Pacific, the strongest hurricanes have become stronger since the 1980s, even while the total number of storms has decreased. Cold season storm tracks are shifting northward, and the strongest storms are likely to become stronger and more frequent. 	<p>Flooding, erosion, and inundation of coastal ecosystems.</p>
Sea levels	<ul style="list-style-type: none"> Sea level has risen along most of the U.S. coast over the last 50 years and will likely rise more in the future. The magnitude of sea level rise on the U.S. coast is expected to vary by region. Due to land subsidence, in some regions, local sea level rise is expected to exceed global mean sea-level rise, which is estimated to be .2 to 2 meters by the end of the century. In other regions, such as Alaska and the Pacific Northwest coast, land uplift may reduce the local effects of global sea level rise. 	<p>Inundation of some coastal areas; erosion; changes to habitats and possible species loss due to, among other things, saltwater intrusion.</p>

Category	Current and projected impacts	Examples of impacts to natural resources
Ocean acidification	<ul style="list-style-type: none"> Seawater becomes less alkaline (its pH decreases) when the ocean absorbs carbon dioxide from the atmosphere. The pH of seawater has decreased significantly since 1750, and is projected to drop much more dramatically by the end of the century if carbon dioxide concentrations continue to increase. 	Affects the process of calcification by which living things create shells and skeletons, with substantial negative consequences for coral reefs, mollusks, and some plankton species important to ocean food chains.

Sources: GAO analysis of information from the U.S. Global Change Research Program and NOAA.

According to a 2009 study by the U.S. Global Change Research Program, in areas where weather events become more intense and frequent with climate change, economic and social costs will increase.¹⁷ For example, insect pests are economically important stressors on forest ecosystems in the United States. Coupled with pathogens, they account for \$1.5 billion in damage every year, according to the study. Changes in climate have contributed to major insect pest outbreaks in the United States over the past several decades because rising temperatures increase insect outbreaks in a number of ways, according to the study. For example, longer and warmer seasons allow some insects to develop faster, sometimes completing two life cycles instead of one in a single growing season, and warmer conditions also help expand the ranges of some insects. In addition, recreation and tourism are important to the economy and the quality of life for many people. In many communities, according to the study, recreation and tourism generate billions of dollars for regional economies through activities such as fishing, hunting, skiing, hiking, and diving and some of these economic benefits could be reduced or lost as a result of the impacts from climate change.

Precisely how and to what extent changes in the climate will affect particular federal lands and waters in the future is uncertain, but climate-related changes have already been observed on federally managed lands and waters. Moreover, some of these changes are expected to continue and increase in intensity, according to the U.S. Global Change Research Program.

¹⁷U.S. Global Change Research Program, *Global Climate Change Impacts in the United States*, 2009.

Roles of the Five Key Federal Natural Resource Management Agencies and Climate Change Impacts to the Natural Resources They Manage

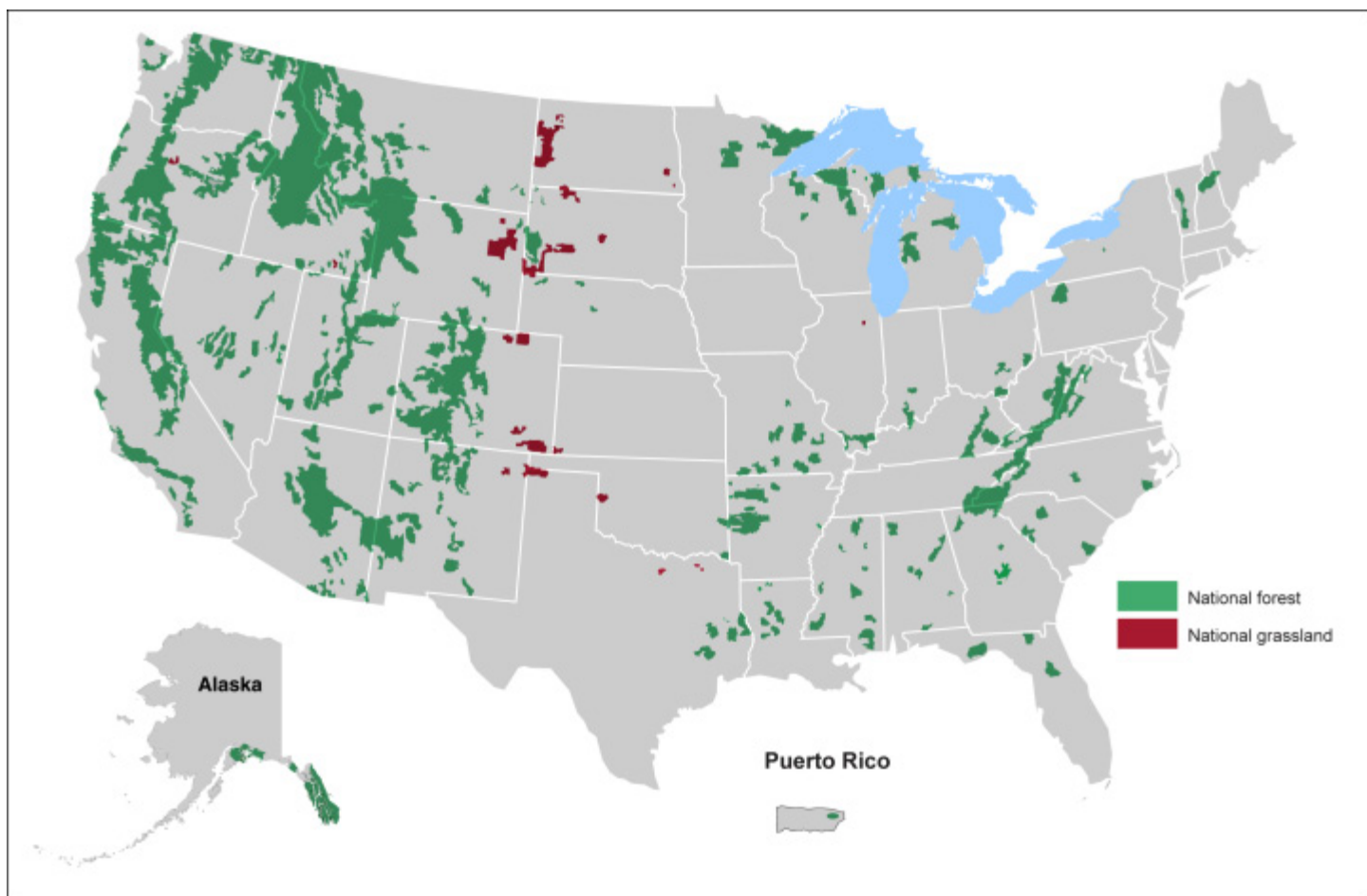
The Forest Service. The Forest Service's mission is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. The Forest Service manages 193 million acres of national forest and national grasslands. The nation's 155 national forests and 20 national grasslands contain much of the nation's terrestrial biodiversity and provide a range of ecosystem services.¹⁸ For example, national forests provide important habitat for many rare, threatened, and endangered species as well as timber and fresh water.¹⁹ The agency manages national forests for a variety of uses including recreation, timber harvesting, livestock grazing, mining, and wilderness protection. Wildfires, invasive species, and extreme weather events are among the critical stressors currently affecting national forests, and they are all expected to be exacerbated by climate change. According to a 2011 report by the Interagency Climate Change Adaptation Task Force, these impacts put at risk the many benefits Americans receive from forests.²⁰ See figure 1 for a map of the National Forest System.

¹⁸Ecosystem services are benefits to human society that result from ecosystem processes. Examples of ecosystem processes include photosynthesis by plants, respiration by a variety of organisms, and decomposition by bacteria. Examples of ecosystem services resulting from ecosystem processes are pollination of flowers and crops; purification of air, water, and soil; and the management of flows of fresh water.

¹⁹According to the Forest Service, nearly one-fifth of the nation's water originates in the national forest system.

²⁰Interagency Climate Change Adaptation Task Force, *Federal Actions for a Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force* (October 2011). The task force includes representatives from more than 20 federal departments and agencies.

Figure 1: Map of the National Forest System

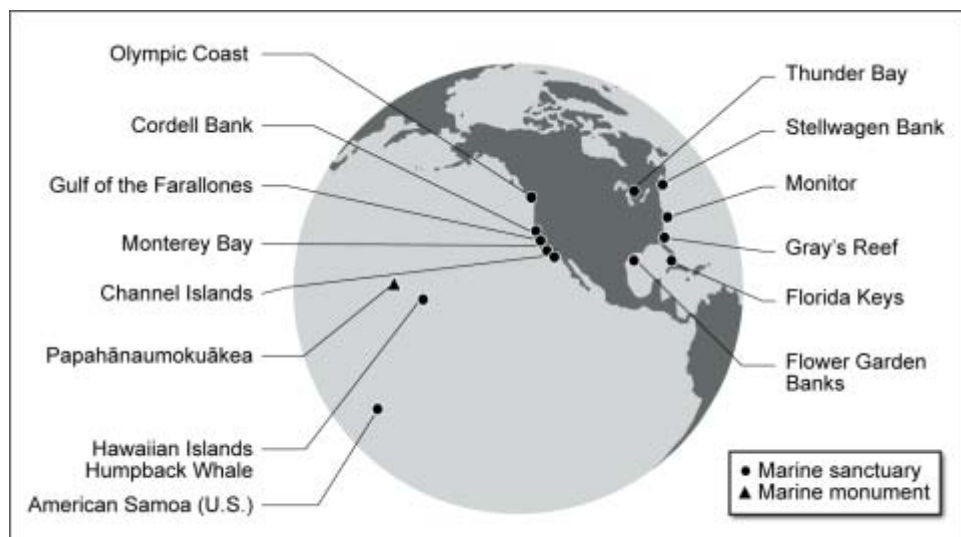


Sources: Forest Service; Map Resources (map).

NOAA. NOAA's mission includes understanding and predicting changes in climate, weather, oceans, and coasts and conserving and managing coastal and marine ecosystems and resources. Among its many diverse responsibilities, NOAA administers the 13 national marine sanctuaries and 1 marine national monument that make up the marine sanctuary system, according to a senior NOAA official. The system encompasses more than 165,000 square miles of coastal, ocean, and Great Lakes waters. Sanctuaries are managed to protect and conserve their resources

and to allow uses that are compatible with resource protection. For example, coral reefs are an important natural resource found in some sanctuaries, and they are susceptible to the effects of climate change,²¹ including increased temperatures that cause bleaching,²² and ocean acidification²³ that inhibit the production of coral skeletons. See figure 2 for a map of the national marine sanctuary system.

Figure 2: Map of the National Marine Sanctuary System



Source: NOAA.

²¹Coral reefs cover less than 1 percent of the ocean floor but support an estimated 25 percent of all known marine species. Scientists estimate that more than 1 million species of plants and animals are associated with coral reef ecosystems.

²²Changes in water temperatures—warming and cooling—can stress coral polyps, causing them to lose algae, which give coral their color. This results in the coral turning completely white or bleached. The algae also provide coral polyps the nutrition they need to survive. Bleached corals are under greater stress and are less resistant to other threats, such as disease. Corals can recover from bleaching events, but if they do not regain algae within a relatively short time frame, they do not survive.

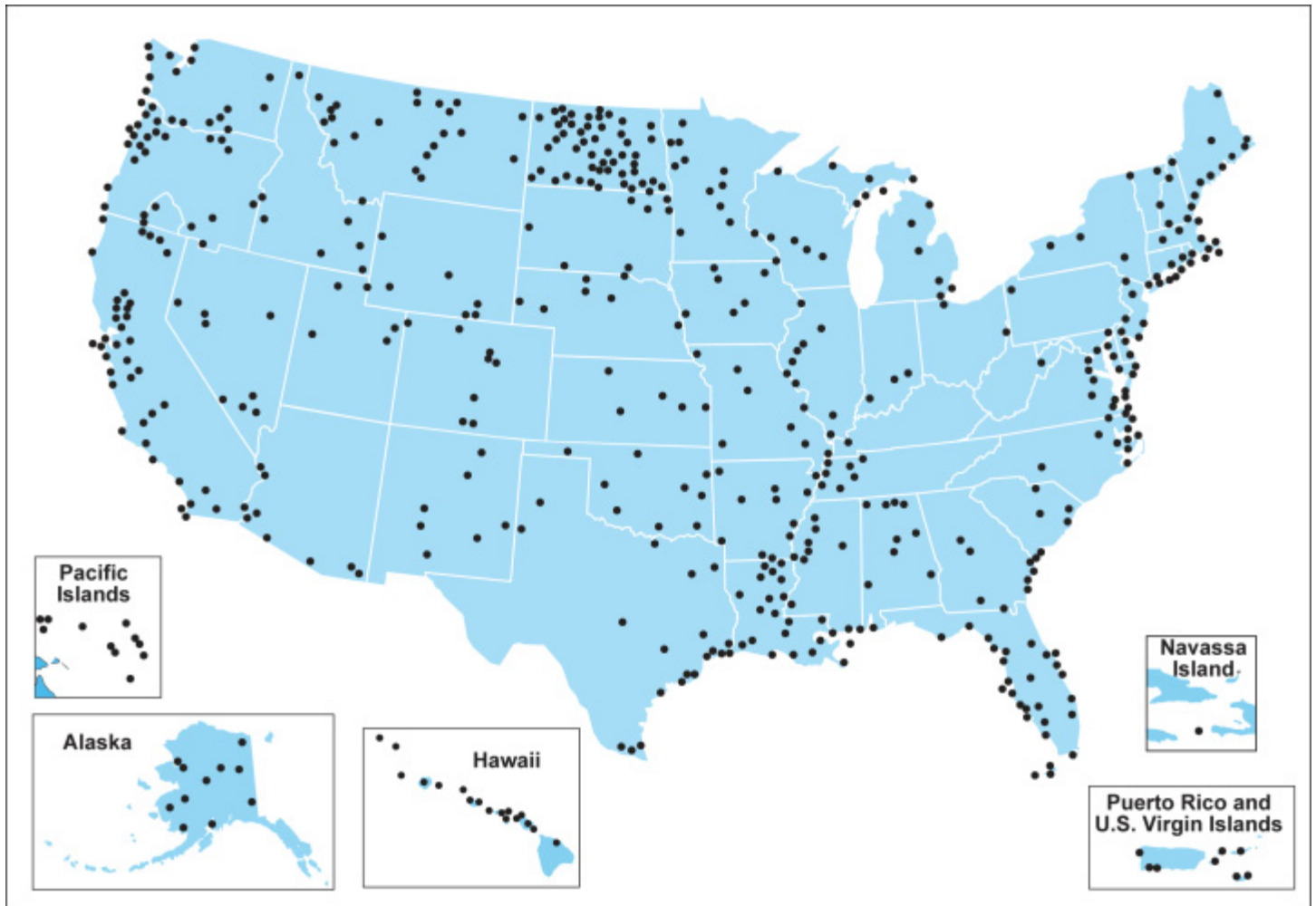
²³The ocean absorbs approximately one-third of the atmosphere's excess carbon dioxide, resulting in a more acidic ocean. For a coral reef to grow, it must produce calcium carbonate at a rate faster than the reef is being eroded. Ocean acidification slows the rate at which coral reefs generate calcium carbonate, thereby slowing the growth of coral skeletons.

U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service is responsible for managing lands under its jurisdiction primarily to conserve and protect fish and wildlife and their habitats, although other uses such as hunting and fishing are allowed when they are compatible with the primary purposes for which the lands are managed. The service manages 561 national wildlife refuges and 209 waterfowl production areas on about 150 million acres of land throughout the nation.²⁴ The national wildlife refuge system is a network of lands and waters across the country designated for the conservation; management; and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats. Wildlife refuges are home to, among other things, more than 700 species of birds, 220 species of mammals, and more than 200 species of fish. According to the U.S. Climate Change Science Program, one of the climate change-related issues of concern at refuges is that species may become separated from the resources they need to survive.²⁵ For example, projected sea level rise may significantly alter habitat at coastal refuges for certain protected plant and animal species. If these species do not have the ability to relocate, they may be unable to survive. See figure 3 for a map of the national wildlife refuges.

²⁴Waterfowl production areas are lands comprising small natural wetlands and grasslands that provide breeding, resting, and nesting habitat for millions of waterfowl, shorebirds, grassland birds, and other wildlife. These areas are administered by administrative units known as wetland management districts.

²⁵U.S. Climate Change Science Program, *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources* (June 2008).

Figure 3: Map of National Wildlife Refuges



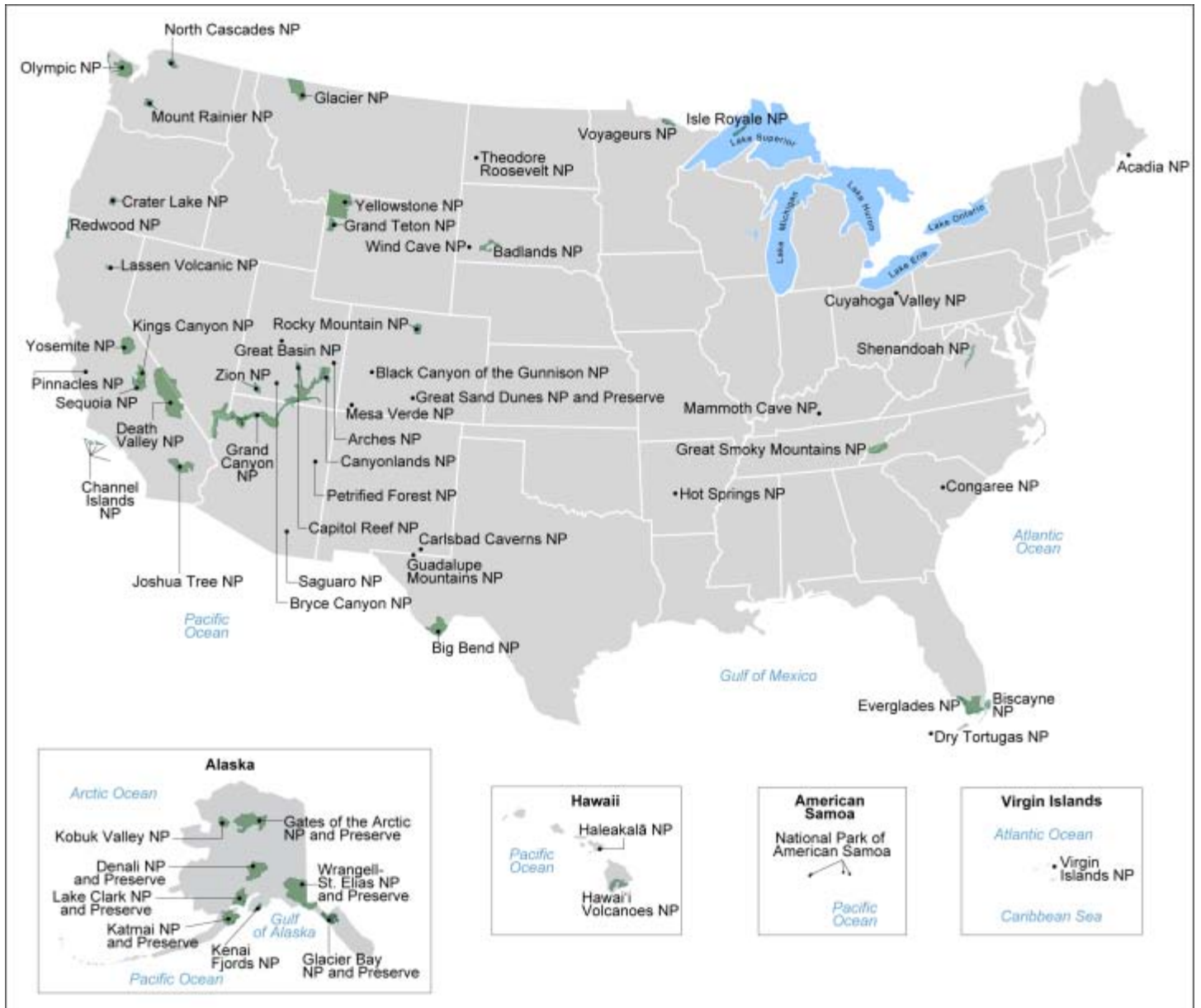
Sources: Fish and Wildlife Service; Map Resources (map).

National Park Service. The National Park Service's mission is to preserve unimpaired the natural and cultural resources of the national park units for the enjoyment of current and future generations.²⁶ The park service manages 401 national park units covering more than 84 million acres

²⁶National park units consist of, among others, national battlefields, historical sites, monuments, parks, reserves, and seashores.

throughout the United States and its territories. See figure 4 for a map of the 59 national parks. The national park system contains representative landscapes from all of the nation's ecosystems, and national parks can be found across a broad range of average temperatures (from tropical heat to arctic cold) and elevations (from the mountain tops to sea level). Climate change is expected to significantly alter the natural resources in national parks. For example, one computer-based model predicts that some of the park's largest glaciers in Glacier National Park will melt by 2030, according to the U.S. Geological Survey.

Figure 4: Map of the National Parks



Source: National Park Service.

Bureau of Land Management. The Bureau of Land Management manages federal land for multiple uses, including recreation; range; timber; minerals; watershed; wildlife and fish; natural scenic, scientific, and historical values, as well as for the sustained yield of renewable resources.²⁷ The bureau manages about 245 million acres of surface lands located primarily in 12 western states. The agency manages and issues permits for activities such as energy development, recreation, livestock grazing, timber harvesting, and mining. The bureau generally has a three-tiered organizational structure in the states where it manages land, beginning with the state office that oversees district offices, which coordinate between the state and field offices. Field offices are responsible for managing designated areas of land, which are known as resource areas. The field offices manage lands that are environmentally significant to the nation. For example, the Kingman Field Office in Arizona manages lands that include 9 wilderness areas,²⁸ 12 areas of critical environmental concern,²⁹ and 5 river segments under consideration for wild and scenic river designations.³⁰ Wildfires, invasive species, and droughts are among the stressors currently affecting land managed by the bureau and may be exacerbated by climate change, which may affect

²⁷The Federal Land Policy and Management Act of 1976 defines the term “multiple use” to mean, among other things, the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people. The act also defines the term “sustained yield” as the achievement and maintenance in perpetuity of a high-level of annual or regular periodic output of the various renewable resources of the public lands consistent with multiple use.

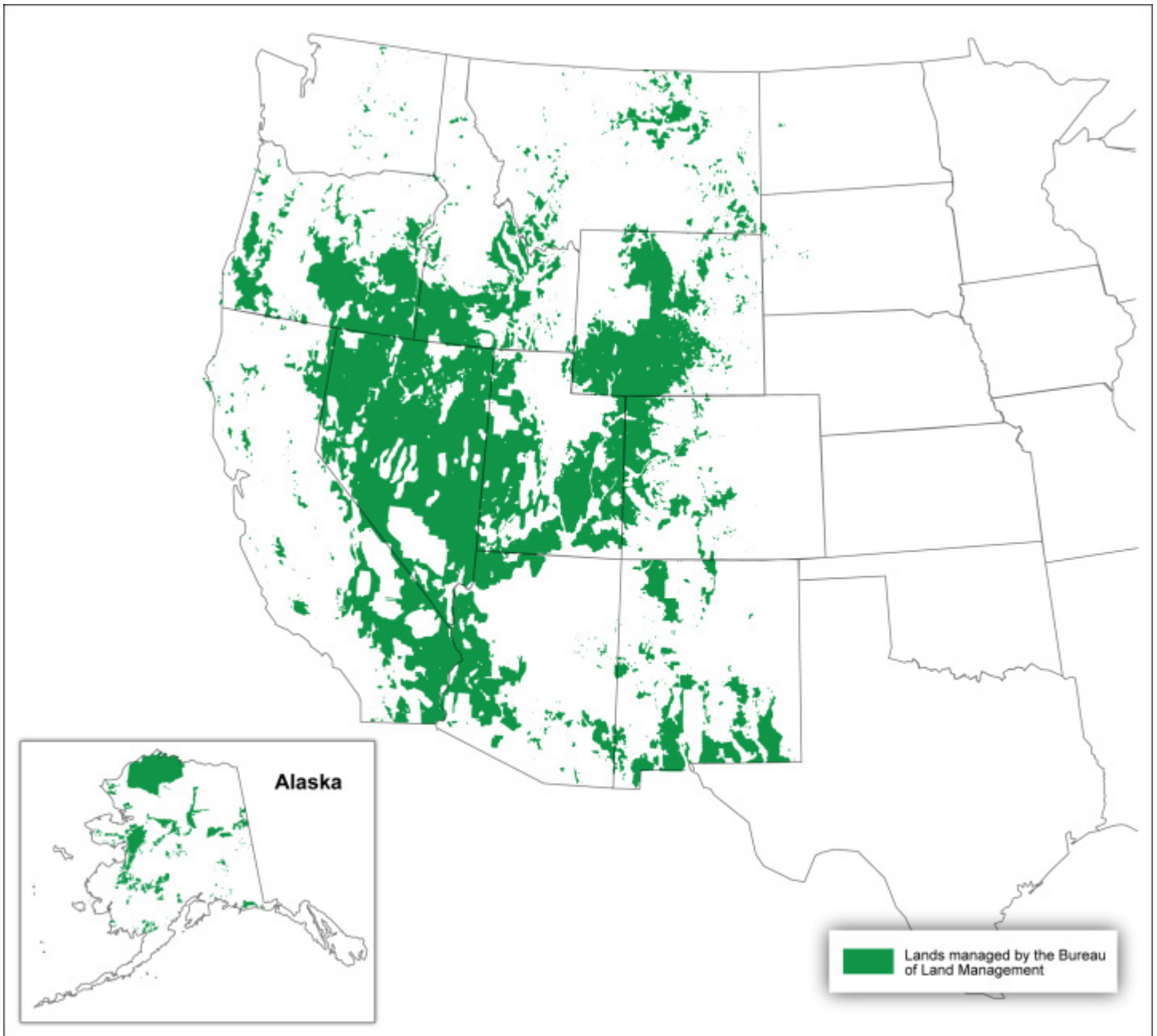
²⁸Wilderness areas are undeveloped federal lands retaining their primeval character and influence, without permanent improvements or human habitation, which are protected and managed so as to preserve their natural conditions and which generally appear to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable; have outstanding opportunities for solitude or a primitive and unconfined type of recreation; are at least 5,000 acres or large enough to make practicable their preservation and use in an unimpaired condition; and may also contain ecological, geological, or other features of scientific, scenic, or historical value.

²⁹When the Bureau of Land Management determines that certain public land areas require special management attention to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, it may designate, after public comment, such lands as areas of critical environmental concern.

³⁰The Wild and Scenic Rivers Act created the National Wild and Scenic River System in 1968 to preserve certain rivers with outstandingly remarkable scenic, cultural, recreational, and other similar values in a free-flowing condition and to protect their immediate environments for the enjoyment of present and future generations.

the land's capacity to be managed for multiple uses. For example, according to a senior bureau official, if droughts persist and increase, the bureau may have to consider limiting livestock grazing on certain land parcels to protect drought-stressed plant and animal species. See figure 5 for a map of the lands managed by the Bureau of Land Management.

Figure 5: Map of Lands Managed by the Bureau of Land Management



Sources: Bureau of Land Management; Map Resources (map).

Note: The Bureau of Land Management's Eastern States Office manages 30,000 acres of surface land (not shown on this map) and 40 million acres of land with subsurface minerals scattered throughout 31 states.

The laws governing resource management for the five key agencies generally do not require them to take specific actions but rather give them discretion to decide how best to carry out their responsibilities in light of their respective statutory missions, as well as the need to comply with or implement specific substantive and procedural laws, such as the Endangered Species Act,³¹ or the National Environmental Policy Act.³² The agencies are generally authorized to plan and manage for changes in resource conditions regardless of the cause that brings about the change. Therefore, although not specifically required to, the five key federal resource management agencies are generally authorized to address climate change adaptation in their planning and management.

Addressing Climate Change Adaptation in Natural Resource Management and Planning

According to a 2010 National Research Council report, climate change is altering assumptions that have been central to natural resource management and planning in the past.³³ Traditionally, natural resource management has assumed that past climate conditions would continue—with similar patterns of variation and the same probabilities of extreme events. However, according to the report, that assumption is no longer valid. Due to the level of greenhouse gases already in the atmosphere, even if significant efforts to reduce emissions of these gases are undertaken, climate change is expected to continue. Furthermore, natural resource management has historically been based on the idea of maintaining current environmental conditions or restoring species and habitats to some desired former condition. As the climate continues to

³¹The Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1544) protects plant and animal species that are either facing extinction (endangered species) or are likely to face extinction in the foreseeable future (threatened species) and protects the ecosystems upon which they depend. The act includes provisions for listing species that need protection, designating habitat deemed critical to a listed species' survival, developing recovery plans for the conservation and survival of listed species, and protecting listed species against certain harms caused by federal and nonfederal actions. The act is administered by the U.S. Fish and Wildlife Service and NOAA's National Marine Fisheries Service.

³²Under the National Environmental Policy Act (42 U.S.C. §§ 4321-4347) federal agencies must assess the effects of major federal actions—those they propose to carry out or to permit—that significantly affect the environment. The act has two principal purposes: (1) to ensure that an agency carefully considers detailed information concerning significant environmental impacts and (2) to ensure that this information will be made available to the public.

³³National Research Council, *Adapting to the Impacts of Climate Change*, (Washington, D.C.: 2010).

change, this approach to resource management will become increasingly more difficult if not impossible to maintain, according to recent studies highlighted in a July 2011 National Wildlife Federation report.³⁴ For example, national wildlife refuges were established as specific locations that could provide safe havens for species, but as climate change alters these environments, managers may not be able to maintain them in their current condition and, as a result, they may no longer provide the habitats necessary to help conserve and protect vulnerable species. According to a 2012 report,³⁵ protected areas like national parks, forests, or wildlife refuges, may not be sufficient to conserve a diverse array of biological resources in a changing climate, which will likely require a greater emphasis on landscape-scale conservation and connectivity among protected habitats.³⁶ As we reported in October 2009, efforts to build large, connected landscapes will become more important as species attempt to migrate or otherwise adapt to climate change.³⁷

The options for managing natural resources can be thought of as a continuum moving from promoting resistance to encouraging resilience to facilitating transformation, according to the National Fish, Wildlife and Plants Climate Adaptation Strategy report.³⁸ A natural resource system, such as a forest, can be managed to promote its ability to withstand disturbances, such as pest outbreaks, without losing any of its current functions. According to the report, this first approach focuses on

³⁴National Wildlife Federation, *Moving the Conservation Goalposts: A Review of Climate Change Adaptation Literature* (Washington, D.C.: June 2011).

³⁵Michelle D. Staudinger, Nancy B. Grimm, Amanda Staudt, Shawn L. Carter, F. Stuart Chapin III, Peter Kareiva, Mary Ruckelshaus, Bruce A. Stein. *Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services: Technical Input to the 2013 National Climate Assessment*, 2012.

³⁶Landscape level (and landscape scale) typically means a regional system of interconnected properties that is larger than the boundaries of any single land management jurisdiction, such as a national park. Managing natural resources at the landscape level involves defining the scope of the landscape to be managed, identifying specific conservation objectives, and collaborating with stakeholders to achieve them.

³⁷[GAO-10-113](#).

³⁸National Fish, Wildlife and Plants Climate Adaptation Partnership. *National Fish, Wildlife and Plants Climate Adaptation Strategy*: Association of Fish and Wildlife Agencies, Council on Environmental Quality, U.S. Fish and Wildlife Service, Great Lakes Indian Fish and Wildlife Commission, and National Oceanic and Atmospheric Administration, (Washington, D.C.: 2012).

managing for resistance. If that is not possible, a second approach could be to manage a forest to promote resilience, which, according to the report, means the ability to recover from disturbances and maintain current functions to the extent possible. For example, forest thinning, while not preventing forest fires, can make forests more resilient so that when fires do occur they are not as severe, and the forest can recover more quickly. A third approach, however, attempts to facilitate a transition of the natural environment by planning for anticipated changes and taking management actions to help guide them. For example, according to the Forest Service, managers could broaden the genetic variety of the trees and other plants used for restoration to help ensure they are better suited to projected future climatic conditions. However, the extent to which natural resource managers can use any of the approaches along the continuum is determined by, among other things, their agency's mission, laws, and regulations.

Several recent reports have highlighted the importance of establishing climate change adaptation planning throughout federal agencies and have identified similar frameworks for conducting such planning.³⁹ For example, in October 2010, the Interagency Climate Change Adaptation Task Force, co-chaired by the Council on Environmental Quality, NOAA, and the Office of Science and Technology Policy,⁴⁰ concluded that climate change will challenge the operations and programs of nearly every federal agency and that implementing adaptation planning would help ensure that the federal government has the capacity to execute its missions and maintain important services in the face of climate change.⁴¹

³⁹The White House Council on Environmental Quality, *Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy*, 2010. Michelle D. Staudinger, Nancy B. Grimm, Amanda Staudt, Shawn L. Carter, F. Stuart Chapin III, Peter Kareiva, Mary Ruckelshaus, Bruce A. Stein. *Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services: Technical Input to the 2013 National Climate Assessment*, 2012. National Research Council, *Adapting to the Impacts of Climate Change*, (Washington, D.C.: 2010). Glick, P., B.A. Stein, and N. A. Edelson, eds. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment* (Washington, D.C.: National Wildlife Federation, 2011).

⁴⁰The Office of Science and Technology Policy was established by statute in 1976 to serve as a source of scientific and technology analysis judgment.

⁴¹The White House Council on Environmental Quality, *Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy*, 2010.

The report recommended, among other things, encouraging and mainstreaming climate change adaptation planning across the federal government. The report also recommended that federal agencies should use a flexible planning framework for conducting agency adaptation planning that is both consistent across agencies and tailored to the specific planning needs of each agency.

Although different reports use different terminology, the climate change adaptation planning frameworks they outline generally consist of four key elements that are reviewed and revised as needed as new information emerges. These four elements are:

- *Identify conservation targets and success measures.* As part of this element, an agency sets a mandate for action on climate change adaptation; articulates clear goals and objectives related to the resources it manages; and identifies ways to measure whether it has been successful in meeting its goals.
- *Assess and understand the risks, vulnerabilities, and opportunities posed by climate change.* As part of this element, agencies seek to understand (1) what aspects of the climate are changing and over what periods; (2) which resources will be most at risk; (3) why these resources are likely to be vulnerable, including how climate changes are interacting with existing stressors, such as drought; and (4) what uncertainties are associated with the predicted climate change impacts and how this may impact adaptation efforts.
- *Develop and prioritize management adaptation actions.* As part of this element, agencies determine how they should respond to the risks they have identified by considering a wide array of possible adaptation measures. Agencies then determine the highest priority adaptation measures, based at least in part on technical, financial, or legal considerations.
- *Implement management options, evaluate the results, and use the lessons learned from the process to improve future adaptation.* As part of this element, an agency implements its adaptation actions and then monitors and evaluates its results to determine the actions' effectiveness and makes adjustments as necessary. Because the climate is expected to continue to change, adaptation actions will need to be regularly monitored to determine if they continue to be effective. Agency adaptation plans must also be able to incorporate new information about risks, lessons learned from implementation, and modified priorities to retain their effectiveness.

Four of the Five Agencies Have Developed Climate Change Adaptation Strategies and Four of the Five Sites We Visited Have Taken Steps to Address Adaptation

The Forest Service, NOAA, the U.S. Fish and Wildlife Service, and the National Park Service have all developed a strategic direction for addressing climate change adaptation through a variety of planning documents. The agencies have also developed guidance, training, and other tools for managers to use in adapting to climate change. The one field location we visited for each agency has taken various steps to address climate change adaptation, such as conducting vulnerability assessments. The Bureau of Land Management has not developed a strategic direction for addressing climate change impacts, but it has taken some adaptation-related steps. Managers at the bureau field location we visited, absent direction from headquarters, have not taken steps to address climate change adaptation.

The Forest Service Has Set a Strategic Direction, Established a Performance Goal, and Provided Tools for National Forests to Address Climate Change Adaptation

In October 2008, the Forest Service developed a strategic framework for responding to climate change.⁴² According to the framework, addressing climate change adaptation must be a central priority for the agency because many ecosystem services provided by national forests—which include water for drinking and agriculture, as well as lumber and fiber for paper—may be lost or significantly altered if national forest ecosystems are left to adapt on their own. The framework also stated that management strategies based on historical or current conditions will need to be adjusted or replaced with approaches that support adaptation to changing conditions brought about by climate change. According to the framework, Forest Service natural resource managers will use current science to better understand and predict the impacts of climate change on natural resources, including plant and animal species. The agency will also use an iterative approach, according to the framework, meaning that natural resource managers are to modify their management actions, if needed, as new scientific information emerges. They also are to collaborate with partners—including private landowners and tribal entities—to share technical expertise and coordinate management actions across land ownership boundaries to more effectively address adaptation.

⁴²Department of Agriculture, Forest Service, *Forest Service Strategic Framework for Responding to Climate Change* (Washington, D.C.: 2008).

In February 2011, the Forest Service published a document, known as “the roadmap,” which identified actions that natural resource managers in national forests were already taking or could take to implement the strategic direction outlined in the agency’s strategic framework.⁴³ According to the roadmap, ongoing actions that agency natural resource managers were already taking include collaborating with scientists to assess the vulnerability of key species to climate change and re-vegetating ecosystems that had been affected by fire or other major disturbances with plant species that are better adapted to current and future climates. Actions that natural resource managers could begin taking in the short term, according to the roadmap, include collaborating with partners to develop strategies for creating and protecting connected habitat by, for example, establishing corridors across private lands to allow species affected by climate change to migrate to landscapes to which they are better adapted. Longer-term actions include developing comprehensive strategies for maintaining and restoring the connectivity of habitats.

The Forest Service has also established a performance goal for national forests. In 2011, the Forest Service informed national forest managers that by 2015 they are expected to address at least one of the following three areas related to climate change adaptation: (1) assessing the vulnerability of key resources—such as the availability of clean and abundant drinking water from national forest watersheds—to the impacts of climate change, (2) reducing the vulnerability of key resources to climate change, and (3) monitoring and evaluating climate change impacts and the effectiveness of adaptation activities. To help track progress in achieving the goal, the Forest Service also directed each national forest to report annually on its status, plans, and actions for assessing vulnerabilities, reducing vulnerabilities, and monitoring and evaluating effectiveness. The agency also published guidance in 2011 to assist the national forests in preparing their annual reports, which are referred to as climate change performance scorecard reports. For example, regarding monitoring, the guidance provided examples of current national monitoring programs that could be used to track climate change impacts, as well as instructions on where to find additional information about such programs.

⁴³Department of Agriculture, Forest Service, *National Roadmap for Responding to Climate Change* (Washington, D.C.: 2011).

In addition, the agency has taken other steps to help national forests address adaptation. Specifically, in April 2012, the Forest Service finalized a new planning rule that includes climate change adaptation requirements.⁴⁴ Also, in February 2013, the agency issued draft guidance outlining specific steps that forests can take to implement these requirements. Each national forest is governed by a land management plan—referred to as a forest plan—which must be revised at least every 15 years to guide its long-term natural resource management actions. The planning rule is intended to ensure, among other things, that forest plans will be responsive and can adapt to issues such as the challenges of climate change. The rule also requires that each national forest have a monitoring program that addresses climate change impacts. To help the forests translate the monitoring requirement into action, the draft agency guidance we reviewed stated, for example, that in developing their monitoring programs, the forests could consider monitoring types of vegetation that are likely to be among the first affected by climate change. According to the draft guidance, doing so could help natural resource managers in the forests to identify opportunities to assist those natural resources in adapting to climate change. Agency officials told us they plan to finalize the guidance by the end of 2013.

The Forest Service has also begun developing decision support tools to help its natural resource managers address climate change adaptation. For example, in 2012, the Forest Service issued the Climate Project Screening Tool, which was developed by agency scientists to help natural resource managers determine how, if at all, climate change considerations could impact decisions to proceed with, modify, or cancel proposed projects. The tool includes, for a variety of project types, examples of key questions natural resource managers might consider to address climate change adaptation. For example, on a proposed project to restore an aquatic species, managers might consider whether the species is likely to survive in the landscape if the waters continue to grow warmer as a result of climate change. The tool provides a template that natural resource managers can use to record climate change considerations in their decision-making process. Specifically, the template allows managers to document information about the proposed project, climate change trends and local impacts, their responses to key

⁴⁴77 Fed. Reg. 21162 (Apr. 9, 2012).

questions, and their decisions about whether or how to proceed with the project.

The Forest Service is also providing information and training to help natural resource managers address climate change adaptation. For example, the agency continues to update its Climate Change Resource Center—a publicly accessible web portal it developed as a reference for natural resource managers and decision makers who need information and decision support tools to address climate change adaptation in the national forests, among other purposes.⁴⁵ The website includes peer-reviewed resources such as lectures on addressing climate change adaptation in natural resource management. In one of these lectures, for example, a Forest Service scientist discusses how agency scientists partnered with natural resource managers at the Olympic National Forest and Tahoe National Forest to address climate change adaptation at those forests, and what managers in other forests might learn from this effort.

The Chugach National Forest Has Begun to Conduct a Climate Change Vulnerability Assessment

In 2011, Forest Service officials at the Chugach National Forest began conducting a vulnerability assessment to determine how key natural resources, communities, and economies in and around the national forest may be affected by climate change. The officials we spoke with at the forest said that the vulnerability assessment will help them determine which resources may have a natural capacity to adapt successfully to climate change and which resources may not. This is a change from August 2007, when we reported that, while officials at the Chugach National Forest recognized that climate change was harming some natural resources in the forest, they had not taken steps to incorporate climate change adaptation into planning and management in part because it was not an agency priority.⁴⁶ Officials at the Chugach National Forest attributed the change to a number of factors, including the strategic direction provided by the Forest Service to address climate change adaptation. Figure 6 shows a map of the Chugach National Forest.

⁴⁵The Climate Change Resource Center can be found online at <http://www.fs.fed.us/ccrc>.

⁴⁶[GAO-07-863](#).

Name: Chugach National Forest

Location: Southeast of Anchorage, Alaska.

Managed by: Department of Agriculture, Forest Service.

Size: Approximately 5.4 million acres.

Ecosystem types: Boreal forests, temperate rain forests, and wetlands.

Wildlife: Over 230 vertebrate species such as brown bear, moose, and wolf populations. Aquatic species include grayling, trout, and salmon, and bird species include bald eagles, swans, and geese.

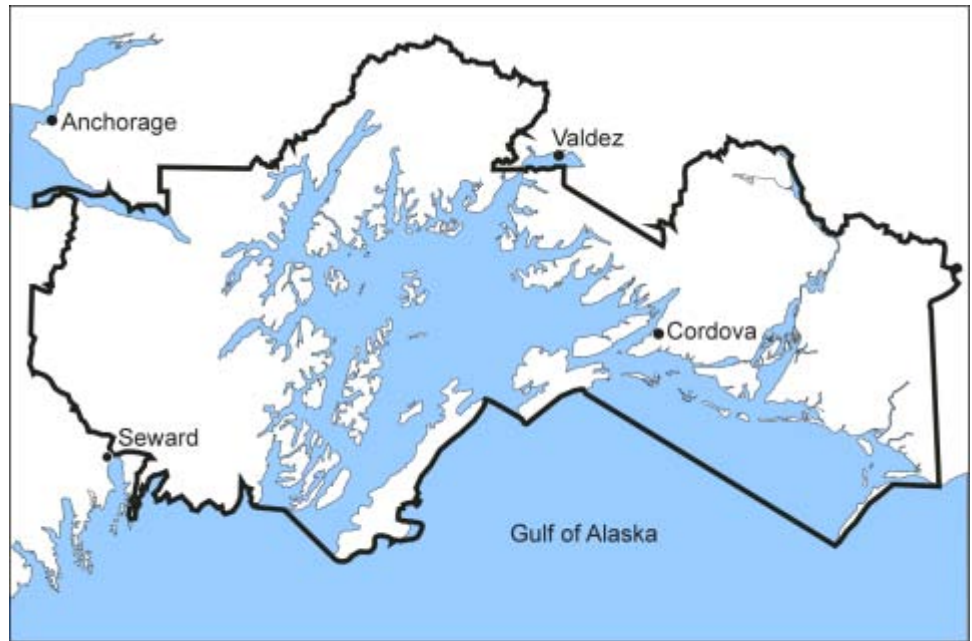
Vegetation: Sitka spruce, western hemlock, and mountain hemlock are the most common tree species.

Uses: Approximately 500,000 people visit every year to fish, hike, and kayak, among other things. Many south-central Alaska Native residents also rely on the forest's resources for subsistence hunting, fishing, trapping, and gathering activities.

Key management activities: The forest is largely managed for recreational purposes, which includes constructing and maintaining trails and campgrounds.

Other information: Approximately one-third of the forest is covered in rock and ice.

Figure 6: Map of Chugach National Forest



Source: Forest Service.

As of March 2013, the forest had established teams of subject area experts who were working on the vulnerability assessment. These experts included ecologists, physical scientists, and social scientists from the Forest Service's Research and Development branch, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, the National Park Service, and the University of Alaska. Chugach National Forest officials told us that the vulnerability assessment will include information on the expected ecological impacts of climate change on key natural resources, such as snow and salmon, as well as information on the expected social and economic impacts of these ecological changes. For example, some climate projections suggest that the forest will have more rain and less snow, and that, in some areas, changes in climate could result in salmon that are smaller and face more threats to their survival, according to Forest Service researchers. These projected climate change impacts may affect various users, including residents in the region who rely on snow-based tourism and salmon for their livelihoods and Alaska Native residents in the region who rely on forest resources for subsistence hunting, fishing, trapping, and gathering. Officials at the national forest

told us they plan to complete a draft vulnerability assessment by the summer of 2013.

Moreover, officials at the national forest told us that conducting a climate change vulnerability assessment is important because it will help the forest to successfully incorporate climate change adaptation when it revises its forest plan. They told us that the current forest plan—which was finalized in 2002—does not address climate change adaptation. The national forest has established a team that will be responsible for beginning to revise the forest plan in 2013. The Forest Service’s April 2012 planning rule requires that national forests use the best available scientific information, such as information about the impacts of climate change and the ability of species and habitat in the forest to adapt, to inform the forest planning process. Chugach National Forest officials said that the vulnerability assessment will help the national forest to implement these requirements. Revising the forest plan will include collaboration with tribes and other stakeholders, as well as outreach to the public, according to officials we spoke with. National forest officials expect to finalize the revised forest plan by 2016.

Officials we spoke with at the Chugach National Forest said they also plan to use information included in the climate change vulnerability assessment to identify specific steps that the forest can take to address climate change adaptation. These officials said that the results of the climate change vulnerability assessment could inform management decisions related to recreation in the forest, among other things. For example, they told us that the climate change vulnerability assessment could help them identify changes in forest conditions due to climate change, resulting in expansion of the distribution of important wildlife, such as the Sitka black-tailed deer. This could lead to new hunting and viewing opportunities for national forest users, according to forest officials.

A Chugach National Forest official identified a challenge to addressing climate change adaptation at the forest. The official said that the forest and its stakeholders in the region, including other resource management agencies and university researchers, will likely face challenges in collaborating on climate change adaptation. The official said this is due to limited resources, competing priorities, and a lack of formal mechanisms to ensure that forest officials and stakeholders communicate key information about climate change impacts and adaptation efforts.

NOAA Has Set a Strategic Direction and Provided Guidance and Tools for Marine Sanctuaries to Address Climate Change Adaptation

In January 2012, NOAA published a strategic plan that includes, among other things, a long-term goal of responding to climate change and its impacts.⁴⁷ The strategic plan includes four objectives to help achieve this goal: (1) improve scientific understanding of climate change and its impacts, (2) conduct assessments that identify potential climate change impacts and inform climate science decisions, (3) support adaptation efforts through a coordinated source of reliable and timely climate information, and (4) provide sources of information to educate the public about climate change. According to the strategic plan, understanding and predicting climate change is urgent, particularly at the regional and local levels. Therefore, scientists' ability to better understand and predict climate change trends and impacts will be critical to climate change adaptation planning and decision making. In addition, according to the strategic plan, assessments are needed to help identify gaps in climate science research and inform research priorities, a coordinated source of climate information is needed to provide decision makers with climate science information that is readily available and easy to use, and education is needed to help inform the public about climate change vulnerabilities and challenges.

In an effort to coordinate climate change adaptation activities across the agency and with its federal and nonfederal partners, NOAA established a climate adaptation team in January 2011. A senior NOAA official said the adaptation team is developing and coordinating a variety of initiatives that will help the agency address the impacts of climate change. For example, the adaptation team is developing a comprehensive inventory of NOAA's existing and emerging climate change adaptation activities, which is to help the agency coordinate, communicate, and promote adaptation activities across the agency. In addition, the adaptation team has proposed actions that NOAA can take to strengthen interagency relationships with the Department of the Interior's landscape conservation cooperatives.⁴⁸ For example, one of the proposed actions is for NOAA to provide clear guidance to all levels within the agency to seek

⁴⁷Department of Commerce, NOAA, *Chart of the Future, NOAA's Next Generation Strategic Plan* (Silver Spring, MD: 2012).

⁴⁸Interior has developed a network of collaborative landscape conservation cooperatives, comprising public and private agencies, working to provide the science and technical expertise needed to support conservation planning at landscape scales and to promote collaboration among their members in defining shared conservation goals.

opportunities to collaborate with landscape conservation cooperatives wherever applicable.

NOAA has also developed a framework for ensuring that climate change adaptation is considered at national marine sanctuaries. In March 2009, NOAA's Office of National Marine Sanctuaries, which guides the activities of the nation's marine sanctuary system, published its policy on addressing climate change impacts on sanctuaries' resources. According to the policy, the Office of National Marine Sanctuaries will work with NOAA's Climate Program Office, among others, to assess climate change impacts on sanctuaries' resources and develop options for addressing these impacts.⁴⁹ The policy also stated that the Office of National Marine Sanctuaries was developing a long-term initiative that would address climate change impacts on individual sanctuaries. Subsequently, the office developed the Climate Smart Sanctuary Initiative in June 2010 to help address climate change impacts throughout the national marine sanctuary system.⁵⁰

The goal of the Climate Smart Sanctuary Initiative is to have each national marine sanctuary meet specific standards that will allow it to receive climate smart certification. Examples of standards that sanctuaries must meet to receive climate smart certification include (1) preparing or updating a sanctuary condition report on resources so it is less than 5 years old,⁵¹ (2) developing a report that identifies climate change impacts over the next 50 to 100 years that are most consequential to a sanctuary's resources, (3) undergoing training on how to plan and manage for climate change impacts, and (4) developing and implementing a climate change action plan that addresses the impacts identified in the climate change impacts report. According to the Climate

⁴⁹Established in 2005, NOAA's Climate Program Office provides guidance and oversight for the agency's climate science and services program, and manages competitive research programs. NOAA funds, among other things, high-priority climate science, assessments, decision support research, outreach, education, and capacity building activities designed to advance an understanding of Earth's climate system, and to foster the application of this knowledge in risk management and adaptation efforts.

⁵⁰Department of Commerce, NOAA, *NOAA's Climate Smart Sanctuaries: Helping the National Marine Sanctuary System Address Climate Change* (Silver Spring, MD: 2010).

⁵¹A condition report provides a summary of a sanctuary's resources, pressures on those resources, current conditions and trends, and management responses to the pressures that threaten the integrity of the marine environment.

Smart Sanctuary Initiative, the action plan is to include strategies that, for example, consider addressing the most urgent issues first and are clear, simple, and explicit. However, the plan is not intended to address every climate impact—only those identified as priorities. Moreover, the strategies identified in the plan are supposed to be practically attainable within the resources currently or potentially available to the sanctuary. The initiative also includes a peer and public review and evaluation process that is designed to help determine whether the sanctuary has met the certification standards.

The Climate Smart Sanctuary Initiative is currently being piloted at the Gulf of the Farallones National Marine Sanctuary in California, the National Marine Sanctuary of American Samoa, and the Olympic Coast National Marine Sanctuary in Washington. According to a senior Office of National Marine Sanctuaries official, although the sanctuaries are not required to participate in the initiative, it is anticipated that all of them will work toward developing climate change action plans that eventually will be incorporated into their management plans.⁵² However, the official said the rate of climate change action plan development will depend on factors such as budget, individual sanctuary priorities, and timelines for the management plan review and update process.

Furthermore, coral reefs are one of the most important natural resources in national marine sanctuaries, and NOAA has taken steps to provide guidance to sanctuary managers and others about how to help protect them from threats related to climate change. In June 2009, NOAA's Coral Reef Conservation Program published guidance that identified four goals to help coral reef managers overcome climate change threats to coral reef ecosystems.⁵³ For example, one of the goals focuses on increasing coral reef resilience to climate change through effective management strategies such as reducing land-based sources of pollution and other stressors. The guidance also identifies objectives to help coral reef managers achieve each of the goals, such as providing training opportunities to increase their understanding of the management

⁵²A sanctuary management plan details the goals and objectives, management responsibilities, research activities, interpretive and educational programs, and enforcement, including surveillance activities, for the sanctuary.

⁵³Department of Commerce, NOAA, *NOAA Coral Reef Conservation Program Goals and Objectives 2010-2015* (Silver Spring, MD: 2009).

strategies available to address climate change impacts. A Coral Reef Conservation Program official said that they are currently in the process of drafting a climate change implementation plan that will help guide coral reef managers' efforts to address the goals and objectives outlined in the guidance document. According to the official, the plan is expected to be released in the spring of 2013.

In addition, NOAA has made climate information and products available to decision makers through its climate web portal for use in managing climate change impacts.⁵⁴ For example, users can access decision support tools such as NOAA's Coral Reef Watch Program. The program has a suite of map-based products from NOAA's Coral Reef Conservation Program that provide information on the environmental conditions of coral reef ecosystems. For example, satellite data provides current reef environmental conditions to quickly identify areas at risk for coral bleaching. Sanctuary managers can also access coral bleaching alerts that can be used to trigger bleaching response plans and support appropriate management decisions.

The Florida Keys National Marine Sanctuary Is Beginning to Consider How to Address Adaptation and Has Also Taken Steps to Increase Coral Reef Resilience

The Florida Keys National Marine Sanctuary is currently in the process of reviewing its management plan to determine whether its existing management strategies are sufficient to address threats, such as climate change, to marine resources.⁵⁵ This is a change from August 2007 when we reported that resource managers at the Florida Keys National Marine Sanctuary said that they did not have guidance for how or whether they should account for climate change in planning and management decisions.⁵⁶ A senior sanctuary official attributed the change to a number of factors, including the desire to address climate change impacts in accordance with the Climate Smart Sanctuary Initiative. Figure 7 shows the boundaries of the Florida Keys National Marine Sanctuary.

⁵⁴NOAA's climate web portal was established in February 2010 and provides access to the agency's and its partners' diverse portfolios of climate data and information. <http://www.climate.gov/about.html>.

⁵⁵Department of Commerce, NOAA, *Florida Keys National Marine Sanctuary Revised Management Plan* (Silver Spring, MD: 2007).

⁵⁶[GAO-07-863](#).

Name: Florida Keys National Marine Sanctuary

Location: South of Miami, Florida westward to encompass the Dry Tortugas, excluding Dry Tortugas National Park.

Managed by: Department of Commerce, administered by NOAA, and jointly managed with the State of Florida.

Size: Covers about 2,900 square nautical miles of waters surrounding the Florida Keys.

Ecosystem type: Coasts and oceans.

Wildlife: More than 6,000 species of marine life, such as bottlenose dolphins, West Indian manatees, and sea turtles.

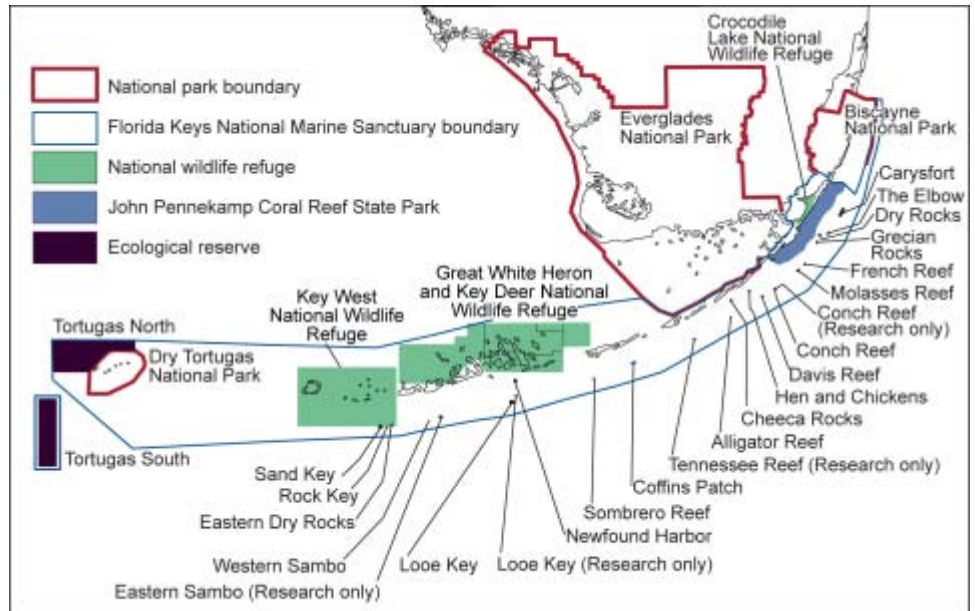
Vegetation: Mangroves—primarily the red, black, and white mangroves—line 1,800 miles of the sanctuary's shoreline. Seagrass—the most common types of seagrass in the Florida Keys are manatee, shoal, and turtle.

Uses: Approximately 3 million people visit the Florida Keys annually and engage in activities such as scuba diving, snorkeling, wildlife viewing, and recreational fishing.

Key management activities: The sanctuary works with multiple state and federal agencies, universities, and nongovernmental organizations to protect the Florida Keys coral reef system.

Other information: The sanctuary protects the third largest living coral barrier reef system in the world and also contains maritime heritage resources such as shipwrecks, sites that span the European colonial period to the modern era.

Figure 7: Map of Florida Keys National Marine Sanctuary Boundaries



Sources: Florida Keys National Marine Sanctuary; Map Resources (map).

According to a senior sanctuary official, the sanctuary is currently reviewing 2 of the 14 action plans—regulatory and marine zoning—that make up its management plan.⁵⁷ The regulatory action plan contains strategies for regulating certain activities within the sanctuary—through permitting, certification, and notification and review processes—depending on how specific areas of the sanctuary have been categorized or zoned. Marine zoning is designed to protect and preserve sensitive parts of the ecosystem, such as coral reefs, while allowing activities that are compatible with resource protection. The marine zoning action plan for the sanctuary includes five types of zones with varying levels of protection. During this review of action plans, the sanctuary and its advisory council—with input from the public—will evaluate whether existing regulations and marine zones are sufficient to address threats,

⁵⁷The action plans that make up the management plan cover a variety of other topics as well, such as science management; research and monitoring; education and outreach; enforcement; and damage assessment and restoration.

such as climate change, to marine resources.⁵⁸ Depending on the outcome of the review, the marine zoning action plan could be revised to include access restrictions to sanctuary waters in some zones as a way to protect bleached corals when they are most vulnerable, according to a senior Florida Keys National Marine Sanctuary official.⁵⁹ For example, the revised plans could restrict the amount of fishing allowed; limit snorkeling and diving; and prevent boats from dropping anchor. The plan revision process requires a significant amount of time to develop and review scientific data, collaborate with stakeholders, develop alternatives, and obtain internal and external comments on any new proposals, according to a senior sanctuary official. The regulatory and marine zoning review process began in December 2011, and officials anticipate that the process will continue into 2015.

To help establish a strategy to respond to the expected impacts of climate change on coral reefs, the Florida Keys National Marine Sanctuary contributed to the development of a climate change action plan for the Florida reef system.⁶⁰ According to a senior sanctuary official, the action plan is the culmination of several years of collaborative effort among coral reef scientists, managers, and others to ensure actions are taken to build coral reef resilience—the ability of the coral reef system to recover from climate change impacts. Furthermore, the action plan was developed to add Florida-specific actions to the framework outlined in NOAA’s Coral Reef Conservation Program Goals and Objectives 2010-2015 guidance document.⁶¹ The plan contains specific recommendations on coral reef

⁵⁸Sanctuary advisory councils are community-based advisory groups established to provide advice and recommendations about sanctuary operations and projects, including education and outreach, research and science, regulations and enforcement, and management planning. They are particularly critical in helping a sanctuary during its management plan review process, according to sanctuary documents. The Florida Keys National Marine Sanctuary advisory council includes representatives from federal, state, and local governmental agencies located in the Florida Keys.

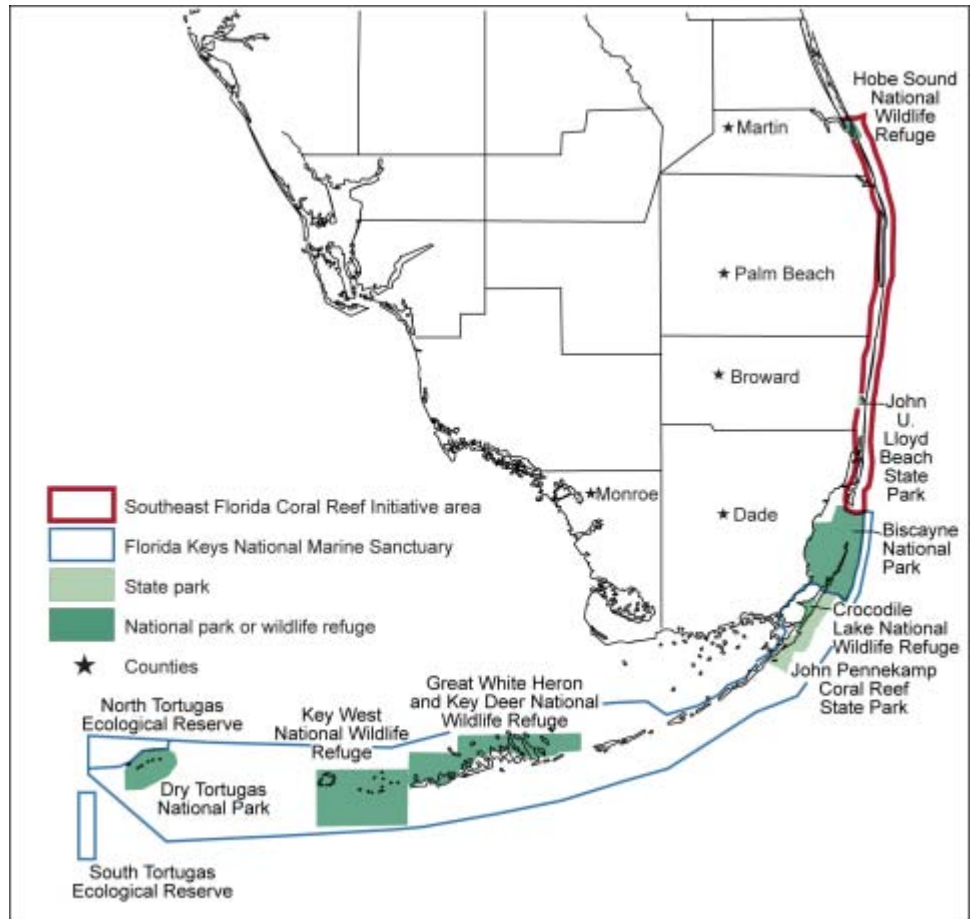
⁵⁹Extreme water temperatures—hot and cold—can stress coral polyps, causing them to lose algae, which give coral their color. This results in the coral turning completely white or bleached. The algae also provide coral polyps the nutrition they need to survive. While a bleached coral is not dead, and corals can survive bleaching events, they are under greater stress and are less resistant to other threats, such as disease.

⁶⁰*Climate Change Action Plan for the Florida Reef System 2010-2015*. Florida Reef Resilience Program (2010).

⁶¹Department of Commerce, NOAA, *Coral Reef Conservation Program Goals and Objectives 2010-2015* (Silver Spring, MD: 2009).

climate change adaptation actions for the Florida reef system and identifies management actions that can be taken to increase reef resilience to climate. For example, the plan recommends Florida's coral reef management jurisdictions work to improve regulations and management that facilitate adaptation to climate change and ocean acidification. Figure 8 shows Florida's reef management jurisdictions. Another key action in the plan is to identify the potential effects of climate change on reef-dependent industries such as commercial and recreational fishing to determine the costs and benefits of any proposed climate change adaptation measures. According to a senior sanctuary official, the sanctuary has not implemented any of the adaptation action items listed in the plan, and its ability to do so will depend on having adequate funding.

Figure 8: Map of Florida's Reef Management Jurisdictions



Sources: NOAA; Map Resources (map).

According to a senior Florida Keys National Marine Sanctuary official, the sanctuary has not conducted vulnerability assessments of the natural resources it is responsible for managing as of February 2013. However, a senior official with the Department of the Interior's Peninsular Landscape Conservation Cooperative in Florida said that the four landscape conservation cooperatives that represent the Gulf Coast states are among several agencies—including NOAA—that are implementing a Gulf Coast-wide vulnerability assessment project. The goal of the project is to enhance conservation and restoration planning by providing an understanding of the effects of climate change on Gulf Coast ecosystems. Furthermore, steps will be taken to develop Gulf Coast climate change

adaptation strategies after the vulnerability assessment is completed. According to the senior landscape conservation cooperative official, this type of coordinated effort is an attempt by the Department of the Interior and NOAA to better integrate their programs and to more effectively use agency resources.

The Florida Keys National Marine Sanctuary is currently in the process of taking a variety of management actions to help protect marine resources, such as coral reefs, from the stresses associated with climate change. For example:

- *Monitoring reefs for bleaching.* The sanctuary provides funds for and helps to coordinate a program known as BleachWatch through Mote Marine Laboratory.⁶² The program is designed to monitor the Florida Keys coral reef ecosystem for signs of coral reef bleaching. Trained volunteers monitor the reefs on a regular basis during the bleaching season in the summer for early warning signs of coral bleaching and report their field observations to the BleachWatch program coordinator. Information from this program and other sources is summarized and published at various intervals during the bleaching season in a report that describes the potential risk for coral bleaching and helps sanctuary managers determine what actions they need to take—such as closing areas at high risk of bleaching to human activities—to offset coral bleaching events, according to a senior sanctuary manager.
- *Monitoring overall reef ecology and health.* Since 1996, the sanctuary has collaborated in establishing a coral reef monitoring program that was developed to collect information about the sanctuary’s reef ecosystem. The sanctuary issues permits to scientists from Florida’s Fish and Wildlife Conservation Commission so that they can systematically monitor coral reefs throughout the sanctuary. This research program, called the Coral Reef Evaluation and Monitoring Project, studies various aspects of reef ecology and health and employs numerous survey methods, such as recorded digital video to track the effects of increasing ocean temperatures and sea level rise associated with climate change. As of 2009, the program was

⁶²Mote Marine Laboratory, headquartered in southwest Florida, was founded in 1955 as an independent marine research institution. The core function of this nonprofit organization is marine and coastal research that is designed to ensure the conservation and sustainable use of marine resources to benefit local, national, and international communities.

collecting and assessing data from 109 sampling stations throughout the sanctuary.

- *Coral restoration.* The Florida Keys National Marine Sanctuary is participating in a coordinated effort with Mote Marine Laboratory and The Nature Conservancy that is designed to develop systems and techniques to grow coral and other reef species for replanting in depleted reef systems. In 2009, NOAA's restoration center provided funding to The Nature Conservancy to expand Mote Marine Laboratory's restoration and coral nursery efforts.⁶³ The first planting of coral fragments was completed in the fall of 2010, and an additional planting occurred in the spring of 2011. According to Mote Marine Laboratory documents, as of early 2012, the survival rate for these corals was 90 percent.

A Florida Keys National Marine Sanctuary senior official told us that the sanctuary faces challenges in adapting to climate change. A key challenge that limits the sanctuary's ability to develop climate change adaptation strategies is the lack of scientific information specific to its location about climate trends or extreme weather events due to climate change, according to the senior sanctuary official. This was also the case in August 2007 when we reported that a lack of adequate scientific information limited the ability of sanctuary resource managers to plan for and manage the effects of climate change.⁶⁴ According to NOAA's 2012 strategic plan, scientific uncertainties limit decision makers' ability to understand and predict climate change, especially at the regional and local levels where such information is highly important for planning and decision-making purposes. A senior sanctuary official said that another challenge is that sanctuary staff have not received climate change adaptation training that focuses on specific climate change impacts that are relevant to the sanctuary's marine ecosystems. Instead sanctuary staff rely on high-level information gathered from conferences, workshops, on-the-job training, and lessons learned from colleagues. The official said it would be helpful to have training that is more focused than the high-level climate change information that is currently available; for example, training on why some corals that have experienced bleaching

⁶³ NOAA's restoration center was created in 1991 and is responsible for restoring the nation's coastal, marine, and migratory fish habitat. The center focuses on funding four habitat restoration approaches that have the biggest impact on fishery production—opening rivers to fish migration, reconnecting coastal wetlands, rebuilding shellfish populations, and restoring corals.

⁶⁴ [GAO-07-863](#).

are susceptible to disease, while other bleached corals are not. Understanding these differences could help managers determine climate change adaptation strategies, according to the official. A senior Office of National Marine Sanctuaries official said the office has developed climate change adaptation training courses, but budget constraints have limited the implementation of these courses in the field.

The U.S. Fish and Wildlife Service Has Established a Strategic Direction, Taken Steps to Implement that Direction, and Developed Resources to Address Climate Change Adaptation

In September 2010, the U.S. Fish and Wildlife Service established a strategic direction for addressing climate change adaptation in natural resource management in its climate change strategic plan.⁶⁵ According to the plan, the agency's approach to addressing climate change adaptation would be:

- *Science-based, iterative, and collaborative.* The strategic plan stated that the agency would use the best available science to better predict, understand, and address the effects of climate change on fish, wildlife, and their habitat. However, because of uncertainty about, among other things, how climate change will affect particular landscapes and interact with nonclimate stressors, such as invasive species, the plan stated that the agency would take an iterative approach and refine its planning and management actions as it learned more. Furthermore, the plan also stated that the agency would collaborate with partners to address climate change adaptation. For example, it would collaborate with state and tribal partners who share direct responsibility for managing some of the nation's wildlife resources to address climate change adaptation on landscapes that are beyond the reach or resources of any one organization to address.
- *Based on clear priorities.* The plan identified a need to be strategic with the agency's limited resources to effectively address climate change adaptation and stated that the agency would continue to establish and revise priorities to guide its actions. For example, one priority identified in the plan was to focus on protecting those species that are most vulnerable to climate change impacts, such as species that are dependent on sea ice. The agency stated that it would rely on the results of vulnerability assessments and field expertise to identify

⁶⁵Department of the Interior, U.S. Fish and Wildlife Service, *Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change* (Washington, D.C.: 2010).

plant and animal species that are especially vulnerable to climate change impacts.

- *Increasingly focused on facilitating change based on expected future conditions.* The strategic plan stated that in the near-term, the agency's climate change adaptation efforts would likely focus on maintaining current conditions, restoring historic conditions, or promoting the ability of a landscape to return to current or historic conditions after a severe wildfire or other disturbance caused or exacerbated by climate change. However, in the long-term, the agency stated that its climate change adaptation efforts would increasingly focus on facilitating changes based on predicted future conditions by, for example, using plant species that are more resistant to fire or better adapted to drier climates when restoring devastated landscapes. The plan said the agency would focus increasingly on such forward-looking efforts as it better understands how the climate is likely to change and how those changes will affect ecosystems.

The climate change strategic plan also outlined some of the steps the U.S. Fish and Wildlife Service would take to implement its strategic direction. For example, according to the plan, the agency would take the following steps:

- *Help develop landscape conservation cooperatives.* Within the Department of the Interior, the U.S. Fish and Wildlife Service has taken the lead in developing the system of 22 landscape conservation cooperatives, which are formal partnerships between federal and state agencies, tribes, nongovernmental organizations, universities, and others to define and address conservation goals and combat stressors at the landscape level.⁶⁶ Many of these stressors, such as water scarcity and the spread of invasive species, are caused or exacerbated by climate change. According to a senior U.S. Fish and Wildlife Service official we spoke with, all of the cooperatives are addressing climate change adaptation, but the extent to which climate change adaptation is a priority varies.
- *Review agency policies to more effectively address climate change adaptation.* The agency directed all of its regional and program offices

⁶⁶Landscape level (and landscape scale) typically means a regional system of interconnected properties that is larger than the boundaries of any single land management jurisdiction, such as a national park. Managing natural resources at the landscape level involves defining the scope of the landscape to be managed, identifying specific conservation objectives, and collaborating with stakeholders to achieve them.

to submit recommendations for policies that the agency should consider revising to allow for a more effective response to climate change adaptation. As of February 2013, the agency had received responses from most offices but had not determined which of its policies, if any, it needed to revise to more effectively address climate change adaptation. For example, based on a summary of responses from regional and program office officials prepared by the agency, some respondents recommended that the agency update its land acquisition policies to consider predicted climate change impacts when evaluating proposed land purchases. The agency planned to review these and other issues identified by respondents in 2013, according to an agency official we spoke with.

- *Enhance climate change monitoring capabilities.* In July 2009, the U.S. Fish and Wildlife Service began to develop and implement an inventory and monitoring program that is designed to help ensure that the wildlife refuges have the information they need to, among other things, successfully manage for climate change and other stressors. This includes, for example, baseline information on fish, wildlife, and plant communities, as well as water, air, and soil, which will help natural resource managers identify and respond to changes to these resources due to climate change, according to an agency official. In September 2010, the agency finalized a plan for the inventory and monitoring program that outlined six initial objectives and specific tasks to be completed by the end of fiscal year 2011. For example, one initial objective was to collect, synthesize, and manage information needed to assess the vulnerability of the refuge system's coastal and marine resources to sea level rise, rising ocean temperatures, and ocean acidification. One task identified in the plan was to model the potential impacts of sea level rise on the resources for all 147 coastal refuges where rising seas could impact coastal and estuarine wetland habitats. According to a U.S. Fish and Wildlife Service official we spoke with, by the end of 2012 modeling had been completed for all but 11 coastal refuges for which the necessary data were not available.

Furthermore, in its 2010 climate change strategic plan, the U.S. Fish and Wildlife Service directed its National Conservation Training Center to implement a climate change curriculum to train agency employees in methods to address climate change in their day-to-day activities. In response, the center has begun addressing climate change adaptation in some of its training courses, according to an agency official we spoke with. For example, the center has offered a 3-day in-person training course on how to conduct climate change vulnerability assessments. According to course documents, the training was intended to help

participants design assessments that would meet their needs and help them understand how to evaluate, interpret, and use a completed assessment, among other things. The center developed this training in collaboration with partners, including other federal agencies. The training center has also offered an 8-week online training course on decision analysis for climate change that is intended to help natural resource managers make management decisions despite uncertainty about how climate change will impact the natural resources they manage.

In addition, in June 2012, the U.S. Fish and Wildlife Service also published guidance on conducting climate change vulnerability assessments in a technical guide and a manager's guide.⁶⁷ The technical guide includes an 8-step process for assessing vulnerabilities and selecting management actions to address these vulnerabilities. It also provides detailed guidance for conducting each step of the vulnerability assessment process. For example, one step of the process is to identify data needs. The technical guide includes a checklist of potential data needs, such as projected information on invasive species, sea levels, and storm surges. The manager's guide includes information about time frames, cost, and other resources needed to complete a vulnerability assessment. For example, the manager's guide estimates that conducting a vulnerability assessment will cost from \$150,000 to \$200,000, and provides a budget outlining these estimated costs.

The San Pablo Bay National Wildlife Refuge Has Established a Climate Change Adaptation Goal and Objectives

In October 2011, the San Pablo Bay National Wildlife Refuge finalized its first Comprehensive Conservation Plan to guide its management actions for a 15-year period.⁶⁸ Among other things, the plan established, for the first time at the refuge, a goal to identify, assess, and adapt to current and future climate change impacts to refuge resources. Figure 9 shows a map of the San Pablo Bay National Wildlife Refuge.

⁶⁷Department of the Interior, U.S. Fish and Wildlife Service, *The Refuge Vulnerability Assessment and Alternatives Technical Guide* (Arlington, VA: 2012); Department of the Interior, U.S. Fish and Wildlife Service, *Manager's Guide to Refuge Vulnerability Assessment and Alternatives: Overview and Practical Considerations* (Arlington, VA: 2012).

⁶⁸Department of the Interior, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, *San Pablo Bay National Wildlife Refuge Final Comprehensive Conservation Plan* (Newark, CA: 2011).

Name: San Pablo Bay National Wildlife Refuge

Location: Near San Francisco, California.

Managed by: Department of the Interior, Fish and Wildlife Service.

Size: Eight noncontiguous units totaling approximately 17,390 acres

Ecosystem type: Coasts and oceans (tidal marshlands and other wetlands).

Wildlife: The endangered California clapper rail and salt marsh harvest mouse, as well as thousands of shorebirds and waterfowl that migrate through this area.

Vegetation: The tidal marshes are largely covered with Pacific cordgrass and pickleweed, a salty pickle-looking plant.

Uses: Recreational activities such as wildlife observation, hunting, and fishing.

Key management activities: Managing invasive plant species, restoring and enhancing tidal circulation to marshlands, and protecting and restoring habitat for threatened and endangered species.

Other information: Many of the marshes in the region have been filled, diked, or drained. Fifteen percent of the historic tidal wetlands remain.

Figure 9: Map of San Pablo Bay National Wildlife Refuge



Source: Fish and Wildlife Service.

To address this goal, the plan identified three climate change adaptation objectives as well as strategies for achieving these objectives. Specifically, the three objectives are:

- *Assess climate change impacts and conduct adaptation planning.* To achieve this objective, by October 2014, the refuge plans to (1) assess the potential impacts of climate change to refuge resources, including promoting and supporting research on the vulnerability of endangered species within the refuge to climate change impacts and (2) conduct adaptation planning, which includes developing strategies for addressing climate change adaptation and prioritizing management actions for addressing climate change adaptation in both the short-term and the long-term.
- *Prioritize acquisitions and projects based on projected climate change impacts.* During the life of the plan, the refuge intends to use climate change data to prioritize both land acquisitions—a method of increasing habitat for refuge species—and projects to restore or

enhance tidal marshes and other tidal habitat. One strategy identified in the plan for prioritizing acquisitions was to identify lands that will be important for the refuge to acquire to protect its marshlands by allowing them to migrate inland as sea levels rise.⁶⁹ The refuge also has ongoing and planned projects intended to restore or enhance tidal circulation to marshes.⁷⁰ For example, Cullinan Ranch—historically a tidal marsh within the refuge—was drained for oat hay farming in the late 1800s, and the refuge is working with the California Department of Fish and Wildlife and others to restore its historic marshlands by, among other things, breaching and lowering tidal levees. As of February 2013, refuge staff were reviewing information about which areas within the refuge are projected to be most vulnerable to sea level rise to help them prioritize critical restorations and avoid costly restorations that are unlikely to be successful because of climate change impacts to such projects, according to the refuge manager.

- *Develop and implement a climate change inventory and monitoring plan.* According to the conservation plan, by October 2016, the refuge intends to develop and implement a climate change inventory and monitoring plan to guide its long-term monitoring of natural resources such as wildlife populations and marshlands. An inventory and monitoring plan would facilitate more effective evaluation of how the refuge's natural resources are being affected by climate change impacts such as sea level rise, according to a refuge official we spoke with.

U.S. Fish and Wildlife Service officials we spoke with said that the climate change adaptation goal and objectives established by the refuge are ambitious and that the refuge will face challenges in achieving them because of limited resources. For example, the four U.S. Fish and Wildlife Service officials assigned to the San Pablo Bay National Wildlife Refuge,

⁶⁹The San Pablo Bay National Wildlife Refuge is largely located below sea level and, as a result, its natural resources are highly vulnerable to climate change impacts such as sea level rise. The refuge's natural resources include tidal marshes, which are vegetated wetlands that are inundated with water subject to the tidal influences of the Pacific Ocean. Even though tidal marshes are vulnerable to sea level rise, natural resource managers can help protect them by ensuring they have space to migrate inland as sea levels rise or restoring or enhancing tidal circulation to the marshes to help ensure that they can grow at a rate that outpaces sea level rise.

⁷⁰Marshes grow as water moves slowly through their soft-stemmed vegetation, allowing sediment to settle and accumulate on the floor of the marsh; however, some historic marshlands in the refuge have little or no tidal circulation as a result of, for example, dikes and levees constructed to develop farmlands, among other purposes.

including the refuge manager, are also responsible for two additional refuges in the region, according to officials we spoke with. One official told us that, although the U.S. Fish and Wildlife Service is providing the refuges with tools for addressing climate change adaptation, such as guidance on assessing vulnerabilities, limited resources make it difficult for staff at the San Pablo Bay National Wildlife Refuge to take on additional tasks beyond what they are already doing. However, the San Pablo Bay National Wildlife Refuge may be able to address its climate change adaptation goal and objectives, in part, by collaborating with partners, according to U.S. Fish and Wildlife Service officials. For example, the San Pablo Bay National Wildlife Refuge is collaborating with the U.S. Geological Survey to implement a tool to conduct monitoring of sediment growth in relation to sea level rise, according to a U.S. Fish and Wildlife Service official. According to the official, this tool could help natural resource managers at the refuge determine whether the marshes are growing at a sufficient rate to outpace sea level rise. The official said that a critical step for addressing climate change adaptation is to use information gathered from this tool and other information to identify specific management actions for addressing adaptation. However, according to the official, funding to identify climate change adaptation options using information from this tool and other information is not available at this time.

The National Park Service Has Developed a Strategic Direction, an Action Plan, and Training to Address Climate Change Adaptation

The National Park Service published a climate change response strategy in 2010 that established climate change adaptation priorities, goals, and objectives for natural and cultural resources and facilities.⁷¹ According to this strategy, one of the park service's priorities is the development of a climate change adaptation planning approach that includes conducting risk assessments, developing and implementing climate change action plans, and monitoring and evaluating the progress of adaptation actions. In addition, the response strategy established several goals, such as incorporating climate change considerations and responses at all levels of the agency's planning, as well as implementing climate change adaptation strategies that promote ecosystem resilience. The response strategy also includes key climate change objectives that the park service and its park managers could pursue to achieve the goals, such as

⁷¹U.S. Department of the Interior, National Park Service, *Climate Change Response Strategy* (Washington, D. C.: 2010).

developing guidance for addressing climate change in planning products and conducting climate change scenario planning.⁷²

To guide the implementation of its climate change response strategy, the National Park Service released a climate change action plan in November 2012.⁷³ This action plan outlines specific areas the park service plans to focus on in the short-term, such as (1) developing climate change guidance; (2) providing climate change science to parks; (3) fostering partnerships to address climate change; and (4) applying climate change adaptation tools, such as scenario planning. In addition, the plan identifies high-priority collaborative actions for the park service to undertake between 2012 and 2014. For example, one action involves the National Park Service's Climate Change Response Program,⁷⁴ park scientists, and others developing a park service climate change vulnerability assessment approach that will ensure vulnerability assessments are conducted consistently and comprehensively across all of the national parks.

The National Park Service has also provided training on climate change adaptation. For example, between 2007 and 2012, according to an agency official, the park service held 17 workshops to train park managers on scenario planning. During these workshops, participants discussed climate change-related case studies and how they might incorporate climate change scenario planning results into their planning. In addition, the park service's Climate Change Response Program has been providing climate change-related training to park service staff since 2007. For example, in July 2012, the park service held four webinars for national park superintendents to discuss approaches for addressing climate change-related issues at national parks. Specifically, participants discussed management actions that can be taken to address climate change, lessons learned from adaptation actions that have been taken, and available resources for park superintendents preparing to address

⁷²Climate change scenario planning is a tool that involves evaluating the possible impacts of climate change under a variety of plausible climate futures.

⁷³U.S. Department of the Interior, National Park Service, *Climate Change Action Plan 2012–2014* (Washington, D.C.: 2012).

⁷⁴The Climate Change Response Program supports initiatives to implement elements of the climate change response strategy, helps develop methods for assessing the vulnerability of agency resources to climate change, and develops adaptation strategies for natural resources in climate-sensitive areas, among other efforts.

climate change. For example, one webinar included lessons learned from the Assateague Island National Seashore's experience incorporating climate change adaptation into the park's general management plan using scenario planning and current climate science.

In addition, the National Park Service is developing additional climate change adaptation guidance and has identified a climate change adaptation tool that park managers can use. Draft climate change adaptation guidance has been created for the park service's Intermountain Region⁷⁵ that outlines a process for developing park-based climate change adaptation plans. The guidance includes steps such as identifying conservation targets, conducting vulnerability assessments, and implementing management actions. According to a senior park official, the primary audience for the guidance will be managers in the 89 national park units within the National Park Service's Intermountain Region, but it will also be available for other park managers to use. As of February 2013, the draft guidance was being reviewed internally, and the park service had not determined its release date. In addition, according to a senior park service official, the agency's Inventory and Monitoring Program can be used to address climate change. For example, park managers can use information gathered by the program to help understand the status and trends of natural resources in their parks, such as water availability and species occurrence and distribution. A park official said this information can be used in climate change vulnerability assessments and to develop climate change adaptation plans.

According to a senior park service official, the park service faces a challenge in addressing climate change adaptation because of a reduction in funding for the agency's Climate Change Response Program. Specifically, the official said the program received approximately \$10 million dollars in both fiscal years 2010 and 2011, but it received approximately \$3 million dollars in fiscal year 2012. The official said the reduced funding has limited the Climate Change Response Program's ability to provide financial support for enhanced monitoring as a part of the National Park Service's Inventory and Monitoring Program. For example, an official said the funding reduction affected the program's ability to monitor changes in park conditions, including those related to

⁷⁵The Intermountain Region includes Arizona, Colorado, Montana, New Mexico, Oklahoma, Texas, Utah, and Wyoming.

climate change such as water availability in desert national parks. A senior park service official said, with less funding, Inventory and Monitoring Program officials are not able to collect data as frequently, which affects the data's reliability. As a result, the official said the data's usefulness in helping park managers draw conclusions related to climate change has been limited.

Glacier National Park Has Taken Steps to Address Climate Change Adaptation

Glacier National Park managers have taken steps to address climate change adaptation in their management activities. This is a change from August 2007 when we reported that park officials said they had not addressed climate change because they had not received explicit National Park Service guidance or funding.⁷⁶ For example, Glacier Park managers said they are monitoring various species in the park, such as pika, to help determine their abundance and distribution.⁷⁷ This baseline data will be used to detect changes in pika distribution over time, according to a senior park official. In addition, according to the National Park Service, Glacier National Park is taking other adaptation steps including planting trees in new habitats, managing invasive plants, and restoring native vegetation. Glacier National Park managers also participated in a National Park Service climate change scenario planning workshop in 2010 to help inform future management decisions about the Crown of the Continent ecosystem, which includes Glacier National Park.⁷⁸ In preparation for and during this workshop, participants discussed potential climate change vulnerabilities and ecosystem changes within Glacier National Park and the Crown of the Continent ecosystem, including the sensitivities, vulnerabilities, and resiliency of

⁷⁶[GAO-07-863](#).

⁷⁷The American pika is a small mammal that inhabits vegetation in alpine and subalpine mountain areas extending south from central British Columbia and Alberta into the Rocky Mountains of New Mexico and the Sierra Nevada Mountains of California, according to the U.S. Fish and Wildlife Service. The pika is particularly sensitive to temperature changes; death can occur after brief exposures to ambient temperatures greater than 77.9 degrees Fahrenheit.

⁷⁸The Crown of the Continent ecosystem includes 42,000 square kilometers of land that encompasses the Rocky Mountain region of Montana; British Columbia; and Alberta, Canada. The ecosystem includes grasslands, rock, ice, mountain peaks, and forests.

Name: Glacier National Park
Location: Northwestern Montana near the Canadian border.
Managed by: Department of the Interior, National Park Service.
Size: More than 1 million acres.
Ecosystem type: Fresh waters.
Wildlife: Nearly 70 species of mammals such as Canada Lynx, bull trout, gray wolves, grizzly bears, and wolverines; 270 species of birds such as golden eagles and harlequin ducks.
Vegetation: Forests, grasslands, and alpine meadows.
Uses: Approximately 2 million people visit the park annually to camp, fish, view wildlife, and hike on more than 740 miles of trails.
Key management activities: Preserve and protect natural and cultural resources, such as the health of various park plants, animals, and physical features.
Other information: According to the National Park Service, Glacier supports natural populations of all indigenous carnivores and most of their prey species. It provides an opportunity for ecological management and research in one of the largest areas where natural processes predominate. The park has been designated as a biosphere reserve.

aquatic and terrestrial systems to climatic and nonclimatic stressors. Figure 10 shows a map of Glacier National Park.⁷⁹

Figure 10: Map of Glacier National Park

Glacier National Park resource managers said they have also taken steps to collaborate with several groups to address climate change adaptation. For example, Glacier National Park is a partner in the Crown Managers Partnership, which is a group of American and Canadian land management agencies within the Crown of the Continent ecosystem

⁷⁹In 1932, Glacier National Park was combined with Waterton Lakes National Park in Alberta, Canada to form the world's first International Peace Park.

working to, among other things, assess regional ecological health factors such as climate change to help inform management decisions. The partners include universities and federal, provincial, state, local, First Nations⁸⁰ and tribal governments. In particular, according to the 2011 to 2012 annual report, the Crown Managers Partnership has been developing approaches to identify the current condition of ecological health in the Crown of the Continent ecosystem. Specifically, the partnership is using indicators, such as landscape change, habitat connectivity, invasive species, and water quantity, to establish a baseline, so that these indicators can be tracked over time to identify any changes that may be related to climate change. Glacier National Park managers said they have also collaborated with the U.S. Geological Survey's Northern Rocky Mountain Science Center on mapping the effects of glacial melt on the park's alpine vegetation.

As of February 2013, Glacier National Park managers said that they had no plans to update their current general management plan for the park in the immediate future.⁸¹ While the current plan does not directly address climate change adaptation, park managers said it offers adequate guidance for both their natural resource management and climate change adaptation activities. For example, a park manager said the management plan guides the park's natural resource management activities—such as monitoring wildlife population trends, invasive species, and wildfires—which park managers also consider to be climate change adaptation-related activities. The plan also outlines guiding principles, management strategies, and regional cooperation methods for park natural resource preservation, among other things. In addition, a Glacier National Park official said the park is planning to begin developing—starting late in 2013—what is known as a “foundation plan,” which will describe the park's purpose, significant resources, and data and planning needs. It is also likely that the document will address climate change, according to the official. All parks are supposed to have completed their foundation documents by 2016, according to a senior National Park Service official.

⁸⁰First Nations refers collectively to individuals of Aboriginal origin residing in Canada.

⁸¹Glacier National Park, *Final General Management Plan and Environmental Impact Statement Volume 1* (West Glacier, MT: Sept. 2, 1999). According to a park official, management plans are generally updated every 20 years.

Glacier National Park managers said they have encountered challenges in addressing climate change adaptation because of limited funding. According to park managers, funding is needed to monitor existing natural resources and conduct vulnerability assessments that would inform the development and implementation of a risk management strategy to protect vulnerable resources that might be affected by climate change. For example, park staff said additional funding could be used to address increased western spruce budworm infestations. This insect normally infests trees for 3 years, but due to temperature increases, its infestation period has lengthened to 7 to 15-year cycles, according to park managers. As a result, hundreds of forested acres of Glacier National Park have been weakened, which could increase their susceptibility to fires.

The Bureau of Land Management Has Not Developed a Strategic Direction to Address Climate Change Adaptation but Has Taken Some Adaptation-Related Steps

The Bureau of Land Management has not developed a strategic direction for its state, district, and field offices to help guide their efforts to address climate change impacts.⁸² However, a Bureau of Land Management senior official said the agency is planning to develop a high-level climate adaptation strategy by the end of the summer 2013 in response to the climate change adaptation policy the Department of the Interior issued in January 2013. According to the official, this strategy will complement the agency's existing resource management strategies, such as those that guide its drought management activities. For example, the strategy may address how the agency plans to respond to the reductions, in cases of prolonged drought, of the availability of forage for domestic livestock, wild horses and burros, and wildlife, which may result from climate change.

In addition, the bureau has not provided guidance to its offices on steps they can take to incorporate climate change adaptation into their natural resource planning and management. A Bureau of Land Management senior official said the agency has guidance to help managers address issues such as drought and invasive species, which he believes is sufficient to help them address climate change. Another official said that the bureau's natural resource managers could consider climate change adaptation when they are preparing documents, such as environmental

⁸²The bureau has a three-tiered organizational structure within each state, beginning with the state office that oversees district offices, which coordinates between the state and field offices. Field offices are responsible for managing designated areas of land, which are known as resource areas.

assessments and environmental impact statements, in accordance with the requirements of the National Environmental Policy Act.⁸³ Another official said the bureau has not developed climate change adaptation guidance because it is waiting until the Council on Environmental Quality finalizes its draft National Environmental Policy Act guidance on how to consider the effects of climate change when preparing environmental assessments or environmental impact statements. An official from the Council on Environmental Quality said the council is continuing to move forward on developing the draft guidance but did not indicate when it would be finalized.

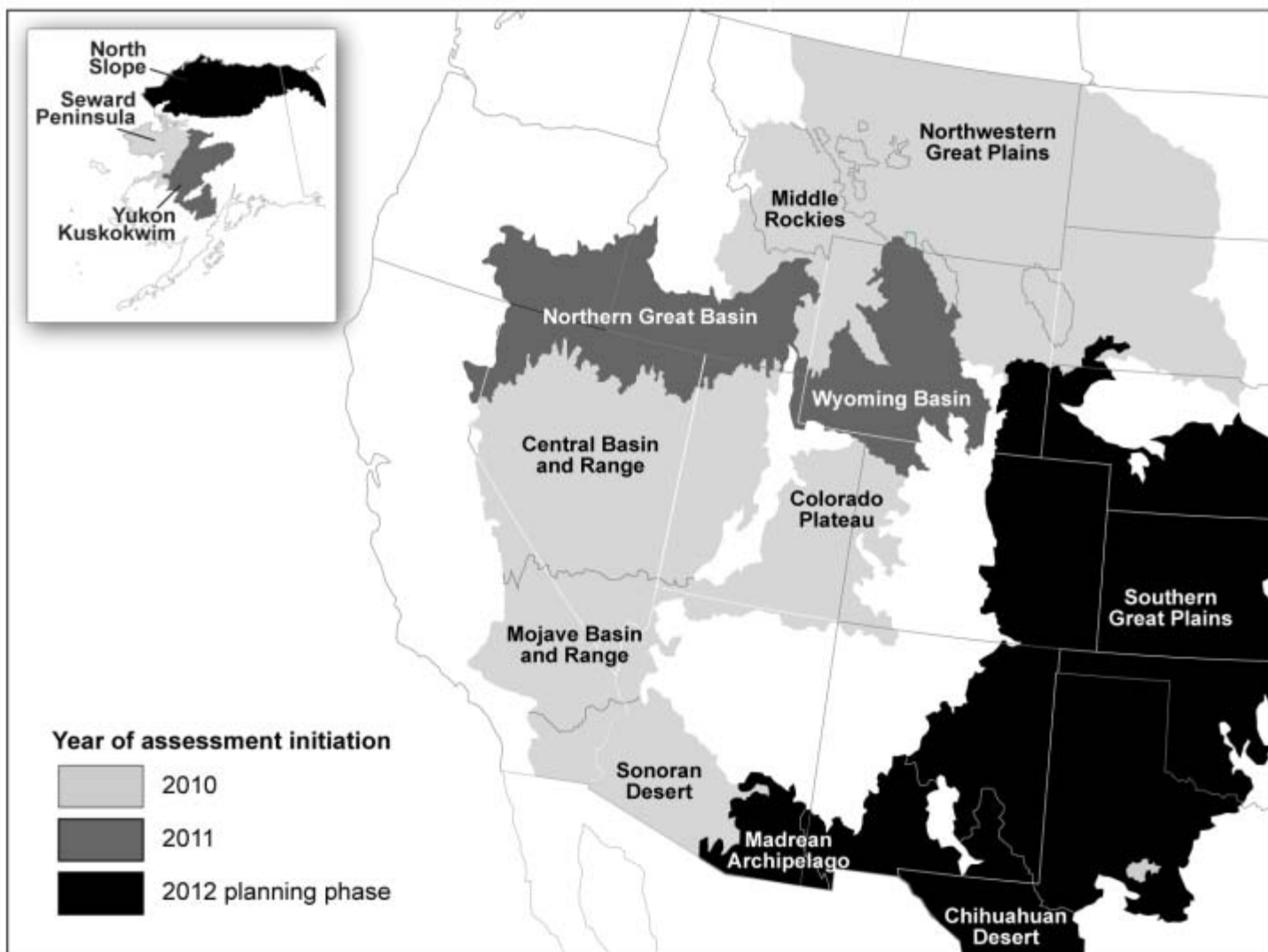
One step that the Bureau of Land Management has taken that may prove useful in addressing climate change adaptation is establishing a regional approach to managing public lands that includes an assessment of regional vulnerabilities. The bureau believes this regional approach is an essential and critical element of an effective climate adaptation strategy. A bureau information bulletin released in April 2012 indicates that stressors affecting landscapes—such as climate change and wildfires—called for an approach that would transcend traditional land management boundaries and enable the bureau to better respond to these stressors across programmatic, organizational, land ownership, and political boundaries. This bulletin also refers to what the Bureau of Land Management calls a “landscape approach for managing the public lands” to address the bureau’s land restoration needs in a broad context. The first step in implementing the new approach is conducting rapid ecoregional assessments,⁸⁴ which map areas of high ecological value, gauge their sensitivity and resilience to environmental change, and establish baseline data that can be used to help determine the

⁸³Bureau of Land Management offices and other federal agencies are required to prepare either environmental assessments or environmental impact statements, which are more detailed, when they evaluate certain proposed actions, such as drilling for oil on Bureau of Land Management land, to determine their impacts on the environment. These documents also evaluate alternatives to the proposed action, which could avoid or minimize adverse impacts to the environment. Ultimately, agencies may use the document to decide whether to prohibit a proposed action, allow it as proposed, or allow it with modifications.

⁸⁴An ecoregion is a large landscape that contains relative homogeneity in ecological systems or in relationships between organisms and their environments. It typically encompasses areas larger than those managed by an individual Bureau of Land Management field office and may include land managed by multiple federal, state, private, or other land managers. The Sonoran Desert in the southwestern United States is an example of an ecoregion.

effectiveness of management actions. Although the focus of the “landscape approach” is broader than just climate change adaptation, a senior bureau official explained that rapid ecoregional assessments address how already occurring stressors, such as drought, invasive species, and wildfire, may be exacerbated by climate change. For example, one of the assessments’ goals is to identify lands that are most susceptible to seasonal changes in temperature or precipitation as a result of changes in climate. As of February 2013, a bureau official said that one rapid ecoregional assessment was complete (Colorado Plateau), one was near completion (Sonoran Desert), eight others had been initiated, and four more were in the planning phase. Figure 11 shows the locations of the Bureau of Land Management’s ecoregional assessments.

Figure 11: Map of the Bureau of Land Management's Rapid Ecoregional Assessments



Sources: Bureau of Land Management; Map Resources (map).

Another step the bureau has taken that is related to climate change adaptation involves collaborating with other agencies to develop a draft field guide for vulnerability assessments. Bureau officials said that the completion date for the field guide was undetermined as of February 2013. The purpose of the field guide is to help inform natural resource managers about vulnerability assessments that are being conducted

throughout the nation and to help reduce duplication of vulnerability assessment efforts.

The Bureau of Land Management Kingman Resource Area Has Not Taken Steps to Address Climate Change Adaptation

Kingman Resource Area managers have not taken action to address climate change adaptation since we first reported in August 2007.⁸⁵ At that time, we found that they (1) were unaware of any requirements to address climate change, (2) did not have guidance for how to consider climate change in their planning and management efforts, and (3) did not include climate change among the highest priority issues for the Kingman Resource Area. The Kingman official we spoke with said that since 2007 the Bureau of Land Management has not provided any direction on integrating climate change adaptation into Kingman's natural resource planning and management. In addition, the official said Kingman Resource Area staff still do not consider climate change adaptation a priority because the bureau does not require them to address climate change. As of February 2013, resource area staff had not conducted any climate change vulnerability assessments, developed specific adaptation plans, or taken any adaptation management actions, according to a Kingman resource manager. Figure 12 shows where the Kingman Resource Area is located and the Arizona field office administrative boundaries.

⁸⁵[GAO-07-863](#).

Name: Kingman Resource Area

Location: Northwestern Arizona, including portions of the Sonoran, Mojave, and Great Basin Deserts, and the Colorado Plateau.

Managed by: Department of the Interior, Bureau of Land Management.

Size: Approximately 2.4 million acres.

Ecosystem type: Grassland and shrubland.

Wildlife: Desert bighorn sheep and the desert tortoise, among other wildlife.

Vegetation: Saguaro cactus, Joshua tree, sagebrush, pinyon-juniper woodlands, and ponderosa pine forests.

Uses: Livestock grazing, energy development, camping, hunting, and mining.

Key management activities: Range improvements, such as maintaining fences and corrals, pasture rotation on lands where livestock are grazing, and maintaining water quality for livestock.

Other information: The field office is home to the historic U.S. Route 66, national backcountry byway, and the largest wild burro population in the country.

Figure 12: Map of Kingman Resource Area and Arizona Field Office Administrative Boundaries

Although the Bureau of Land Management has not provided guidance to Kingman Resource Area managers to incorporate climate change adaptation into their planning, the bureau's Arizona state office—with assistance from the bureau's headquarters office—conducted an internal evaluation in 2010 of the Kingman resource management plan that found that Kingman could develop and document its strategy for adapting to

climate change in its management plan.⁸⁶ However, as of February 2013, a Kingman manager said no amendments or updates to the resource management plan to address climate change were planned, mainly due to budget constraints. According to the 2010 internal evaluation of the Kingman resource management plan, Kingman Resource Area managers need the Bureau of Land Management and its state offices to develop guidance for bureau resource managers on how to address climate change in their planning. As of February 2013, this need had not been addressed. According to officials from the bureau's Arizona state office, they did not develop any guidance, in part, because they are waiting to receive instructions from Bureau of Land Management headquarters.

The Agencies Have Begun Using Several Mechanisms to Collaborate and Have Prepared National Adaptation Strategies and Climate Assessments

The federal natural resource management agencies we reviewed recognize that there are limits to what they can accomplish on their own and therefore are also collaborating on climate change adaptation with, among others, each other, state and local government agencies, tribes, nongovernmental organizations, and other federal agencies. In addition, agencies have collaborated in developing reports that provide cross-cutting, national strategies for addressing climate change adaptation in the federal government and national climate assessments.

Federal Natural Resource Management Agencies Have Identified a Need to Collaborate on Climate Change Adaptation and Are Using Several Mechanisms to Do So

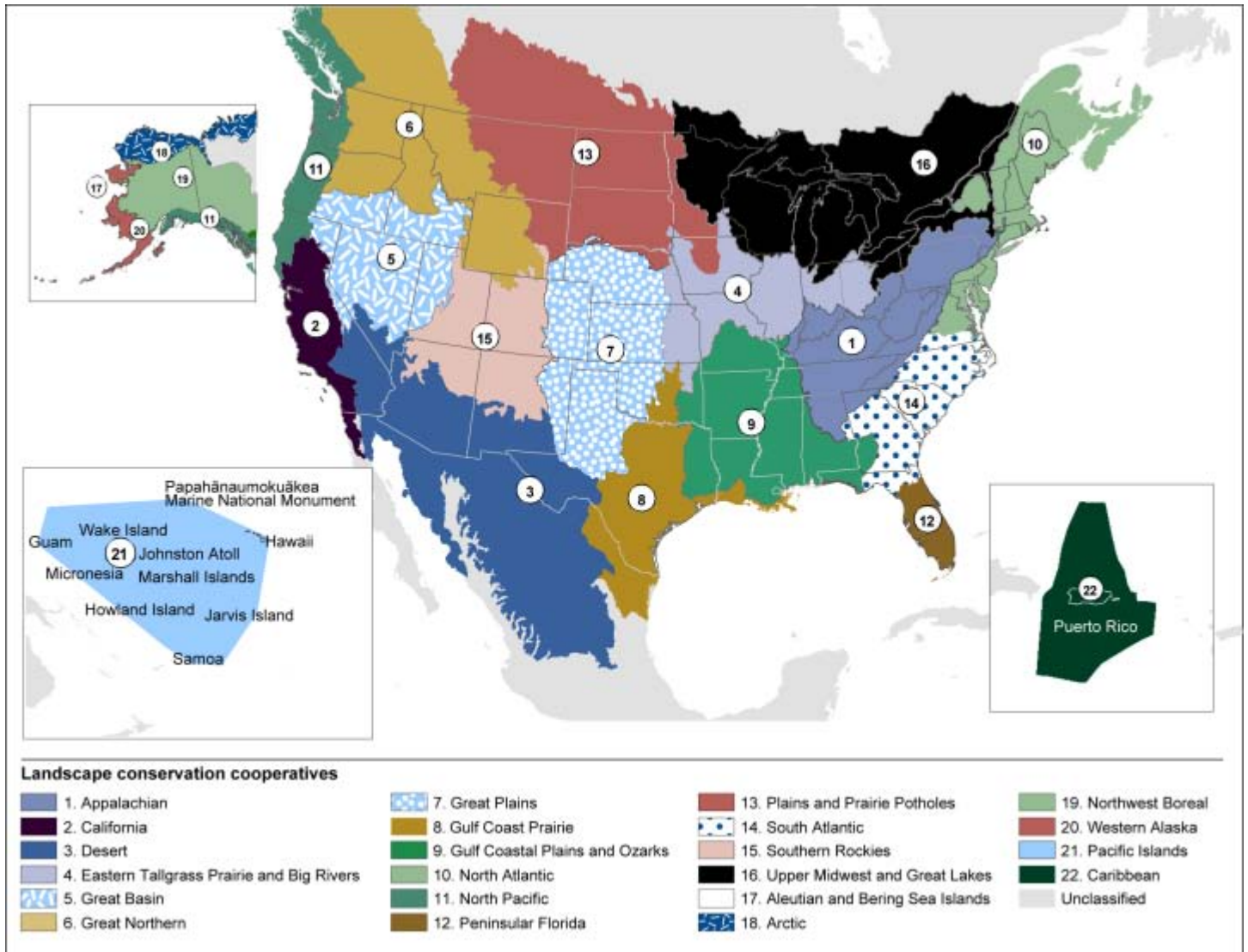
Since 2007, key federal natural resource management agencies have identified a need to collaborate on climate change adaptation to leverage funding, staff, and resources; develop common goals; develop tools and strategies to inform landscape-scale planning and management decisions; facilitate information exchange among stakeholders; and avoid duplication. For example, the Forest Service included a collaboration goal in its October 2008 strategic framework for responding to climate change because the agency believes that collaborating with partners will be

⁸⁶Department of the Interior, Bureau of Land Management, *Kingman Resource Area Proposed Resource Management Plan and Final Environmental Impact Statement* (Kingman, AZ: 1993). The resource management plan is the key document that Kingman resource managers use to guide their management of the public lands and associated resources within their jurisdiction.

essential to address climate change across land ownership boundaries. According to the framework, the Forest Service manages 8 percent of all lands in the United States, but climate change impacts will extend across land ownership boundaries, and the Forest Service has a responsibility to work with others to address those impacts. The U.S. Fish and Wildlife Service also included a collaboration goal in its September 2010 climate change strategic plan because the agency believes collaboration is necessary to build shared scientific and technical capabilities, among other reasons.

Landscape conservation cooperatives are one mechanism established since 2007 that enable federal agencies to collaborate in addressing climate change adaptation. At the direction of the Department of the Interior, the U.S. Fish and Wildlife Service began establishing the network of 22 cooperatives in fiscal year 2009. They provide a forum for federal agencies, including the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Forest Service and NOAA, to work collaboratively with state and local government agencies, tribes, and nongovernmental organizations to address at a landscape level climate change impacts on wildlife, water, land, and cultural resources. As of February 2013, all 22 cooperatives have been established, but because some were established more recently, they are at different stages of development. The cooperatives are located throughout the United States and extend into Canada and Mexico. Figure 13 shows the locations of the cooperatives.

Figure 13: Map of Landscape Conservation Cooperatives



Source: Fish and Wildlife Service.

Some landscape conservation cooperatives have begun taking actions to address climate change adaptation at the landscape level. For example, in August 2012, one cooperative, working with the nonprofit organization

Nature Serve, hosted a 2-day workshop to develop climate change adaptation strategies for managed lands including the Sonoran and Mojave Deserts in the southwestern United States.⁸⁷ Workshop participants included representatives from nonprofit organizations, universities, state agencies, and federal agencies including the U.S. Fish and Wildlife Service, Bureau of Land Management, and National Park Service. For major ecosystem types within the region, the participants identified “no-regrets” climate change adaptation management strategies they could take within 5 years, longer-term management strategies they could take further in the future, and priorities for research and monitoring to lower uncertainty around identified strategies. In addition, a cooperative has funded several projects to identify climate change impacts on a variety of species and their habitat. For example, in 2010, the cooperative funded a nonprofit organization to collaborate with partners, including federal agencies such as the U.S. Fish and Wildlife Service and the U.S. Geological Survey, to develop a plan and establish programs for long-term monitoring of wintering shorebirds in coastal California and northern Baja California, Mexico. This project was expected to, among other things, provide baseline information about these shorebirds to allow federal natural resource management agencies and others to identify changes as a result of climate change, according to the project proposal.

Landscape conservation cooperatives have also begun collaborating with the eight regional Climate Science Centers established by the Department of the Interior,⁸⁸ as well as other stakeholders to facilitate the coordination of climate science capabilities and monitoring activities across their regions, among other things. According to a Department of the Interior plan, the cooperatives and science centers are the cornerstones to an integrated approach to climate change science and

⁸⁷Nature Serve is a nonprofit conservation organization that provides information on rare and endangered species and threatened ecosystems. The information is used by, among others, government agencies, conservation groups, and academia to help inform natural resource management decisions.

⁸⁸According to Interior, the eight regional Climate Science Centers deliver basic climate change impact science to Landscape Conservation Cooperatives within their respective regions, including physical and biological research, ecological forecasting, and multi-scale modeling. Science centers will prioritize their delivery of fundamental science, data, and decision support activities to meet the needs of the cooperatives. This includes working with the cooperatives to provide climate change impact information on natural and cultural resources and to develop decision support tools for managers.

adaptation at the department.⁸⁹ The science centers are responsible for providing scientific information, tools, and techniques that land, water, wildlife and cultural resource managers and other interested parties can apply to anticipate, monitor, and adapt to climate change and other stressors at regional and local scales. In June 2012, the science center for the Southwest collaborated with four cooperatives and other partners to host a climate summit to identify the climate-related science needs of tribes and other stakeholders. For example, participating tribal members identified a need to develop climate change vulnerability assessments for species and locations that are culturally significant to tribes, among other needs.

The Interagency Land Management Adaptation Group is another collaborative mechanism established since 2007 by natural resource management agencies to address climate change adaptation in federal land management activities. The group was established in January 2012 and meets monthly as an informal network of high-level officials from federal land management and science agencies including the Bureau of Land Management, the U.S. Fish and Wildlife Service, the Forest Service, and the National Park Service. Key non-land management members include the Council on Environmental Quality, NOAA, and the U.S. Geological Survey. According to group documents, members have shared information on federal climate change adaptation-related programs and activities; identified gaps that need to be addressed in federal agency climate change adaptation planning and management; identified challenges that federal land management agencies encounter when attempting to address climate change adaptation; discussed potential policy changes; and explored opportunities for further collaboration. One of the challenges they identified was the difficulty in identifying past or ongoing climate change vulnerability assessments, which creates a potential for duplication of effort, according to documents developed by group members. To address this challenge, in January 2013, the group agreed to develop a web-based searchable database, which will contain climate change vulnerability assessments prepared by federal agencies. The U.S. Geological Survey has agreed to compile the assessments and make the information available to all resource managers working to develop climate change adaptation plans. The

⁸⁹Department of the Interior, *Interior's Plan for a Coordinated, Science-based Response to Climate Change Impacts on Our Land, Water, and Wildlife Resources* (Washington D.C.: 2010).

interagency adaptation group has also formed work groups to develop and guide national-level collaborative actions in key areas of interest, including options and best practices for conducting vulnerability assessments, as well as adaptation planning, monitoring, and training.

Federal natural resource management agencies have also collaborated to support NOAA's long-standing Regional Integrated Sciences and Assessments program, according to a program official. The program consists of 11 research teams that emphasize regional and local climate research and work with regional partners, such as NOAA's Regional Climate Centers, to help inform climate change adaptation planning and management.⁹⁰ For example, research team scientists provide information that decision makers can use to help understand the impacts of drought, understand climatic influences on wildfires, and assess climate impacts on air quality. Another function of the research teams is to develop tools that enable decision makers to take into consideration the potential impacts of climate change. For example, the Carolinas' research team developed a climate change planning tool referred to as the Vulnerability and Consequence Adaptation Planning Scenarios that can be used by decision makers in coastal regions to determine potential climate change impacts and identify climate change adaptation actions.

According to a program official, the Regional Integrated Sciences and Assessments' teams are collaborating with federal agencies on building regional capacity to address climate change.⁹¹ For example, NOAA initiated a fiscal year 2012 competitive grant process to promote collaborative research partnerships in support of regional climate adaptation. According to a Regional Integrated Sciences and Assessments program official, NOAA's priorities for selecting grant applications for funding include research related to: (1) addressing

⁹⁰NOAA's National Climatic Data Center manages six Regional Climate Centers that produce climate data and other resources for decision makers and other users at the local, state, regional, and national levels.

⁹¹Participating federal agencies include the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the Forest Service. Participating offices within NOAA include, among others, the National Marine Fisheries Service; the National Ocean Service; the Earth Systems Research Laboratory; the National Weather Service's Climate Prediction Center; and the Climate Program Office's Modeling, Analysis Predictions and Projections program and Climate and Societal Interactions program. The U.S. Geological Survey and the Forest Service were among the agencies that contributed funds to projects in the grants competition.

interactions between climate and nonclimate stressors in marine environments; (2) evaluating the use of climate information by coastal managers and the effectiveness of adaptation actions; (3) advancing the development and application of approaches for assessing the vulnerability of public lands; and (4) improving ways of communicating climate information to water managers across multiple regions of the United States. NOAA developed the funding priorities collaboratively with the Department of the Interior's Climate Science Centers and federal agencies, including the Agricultural Research Service, U.S. Army Corps of Engineers, Forest Service, and National Park Service. According to a Regional Integrated Sciences and Assessments program official, by setting priorities collaboratively, federal agencies can direct and leverage their resources and avoid potential duplicative or overlapping research projects.

Federal natural resource management departments and agencies have also collaborated through the Interagency Climate Change Adaptation Task Force, which the President established in 2009. The task force is co-chaired by the Council on Environmental Quality, the Office of Science and Technology Policy, and NOAA, and includes representatives from more than 20 federal departments and agencies. In a 2010 report, the task force recommended a set of climate change adaptation policy goals and actions.⁹² For example, the task force recommended that federal agencies establish and implement adaptation action plans that address the challenges that climate change poses to their missions, operations, and programs. The task force also recommended that agencies address cross-cutting issues by developing, among other things, (1) a national action plan to strengthen climate change adaptation for freshwater resources; (2) a strategy for reducing the impacts of climate change on the nation's fish, wildlife, and plant resources and their habitats; and (3) a strategic action plan for strengthening the resilience of coastal, ocean, and Great Lakes communities and ecosystems to climate change. In October 2011, the task force reported that federal agencies had made

⁹²The White House Council on Environmental Quality, *Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy*, 2010.

significant progress in addressing the goals outlined by the task force in 2010.⁹³

Federal Natural Resource Agencies Have Collaborated on National Strategies to Address Climate Change Adaptation and Climate Assessments

Since 2007, federal natural resource management agencies have collaborated to develop the three national strategies recommended by the Interagency Climate Change Adaptation Task Force. These strategies are as follows:

- *National Action Plan for Managing Freshwater Resources.*⁹⁴ Finalized in October 2011, the national action plan was prepared by officials from various federal agencies including the Bureau of Reclamation, the Forest Service, and NOAA. According to the plan, climate change impacts will pose challenges to protecting the quantity and quality of freshwater resources, including aquatic life and habitats. The plan established a national goal of having citizens and government agencies collaboratively manage freshwater resources in response to a changing climate to ensure adequate water supplies; safeguard human life, health, and property; and protect water quality and aquatic ecosystems. It included six recommendations for meeting that goal and outlined specific actions that federal agencies are taking or should take to address these recommendations. For example, one recommendation was to strengthen the assessment of water resource vulnerability to climate change. Actions identified to address this recommendation included ongoing Forest Service efforts to assess the vulnerability of watersheds and aquatic systems in national forests and grasslands. According to Forest Service officials, as of February 2013, the agency had completed all 12 pilot watershed vulnerability assessments.
- *National Fish, Wildlife and Plants Climate Adaptation Strategy.*⁹⁵ The national strategy, developed as directed by a congressional

⁹³Interagency Climate Change Adaptation Task Force, *Federal Actions for a Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force* (October 2011).

⁹⁴Interagency Climate Change Adaptation Task Force, *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate*, 2011.

⁹⁵National Fish, Wildlife and Plants Climate Adaptation Partnership. *National Fish, Wildlife and Plants Climate Adaptation Strategy*: Association of Fish and Wildlife Agencies, Council on Environmental Quality, U.S. Fish and Wildlife Service, Great Lakes Indian Fish and Wildlife Commission, and National Oceanic and Atmospheric Administration, (Washington, D.C.: 2012).

committee, was released in March 2013. It was developed with input from a steering committee led by the U.S. Fish and Wildlife Service, NOAA, and the New York Division of Fish, Wildlife, and Marine Resources with officials from 11 additional federal agencies, 4 additional state fish and wildlife agencies, 2 intertribal commissions, and the White House Council on Environmental Quality. The strategy stated that fish, wildlife, and plant resources are already being affected by climate change and described projected future impacts. The strategy also outlined goals for addressing climate change adaptation for fish, wildlife, and plants as well as strategies for addressing these goals. For example, one goal is to conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate. Strategies for addressing the goal include identifying areas that are likely to be resilient to climate change and taking steps to ensure that those areas are protected.

- *National Ocean Policy Implementation Plan*. Federal natural resource management departments contributed to preparing this plan, which identifies actions federal agencies will take to bolster the ocean economy, improve ocean health, and provide better science, among other things.⁹⁶ In July 2010, the President issued an Executive Order regarding stewardship of our oceans, coasts, and the Great Lakes.”⁹⁷ The national ocean policy calls for management practices that will enhance the understanding of and capacity to respond to climate change and ocean acidification, among other things. The National Ocean Council, which includes the Secretaries of Agriculture, Commerce, the Interior, and the NOAA Administrator, published the implementation plan for the national ocean policy in April 2013. Among other things, the plan stated that federal agencies will enable and support efforts to understand, minimize, and adapt to the impacts of climate change, ocean acidification, sea-level rise, and extreme weather events, strengthening the resilience of coastal communities. For example, according to the implementation plan, federal agencies will offer tools and training courses on how to design and implement vulnerability assessments and develop assessments of coastal and ocean climate impacts in support of the National Climate Assessment.

⁹⁶National Ocean Council, *National Ocean Policy Implementation Plan*, (Washington, D.C.: 2013).

⁹⁷Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes* (July 19, 2010).

Federal agencies have also collaborated on national climate assessments, which analyze current trends in global change, both human-induced and natural, and project major trends for the subsequent 25 to 100 years. The Global Change Research Act of 1990 requires publication of a national climate assessment not less frequently than every 4 years—the first and second assessments were first published by the U.S. Global Change Research Program in 2000 and 2009, respectively.⁹⁸ Thirteen federal agencies, including the Forest Service, U.S. Fish and Wildlife Service, National Park Service, and NOAA, contributed to the third assessment that was released as a draft for public comment in January 2013.⁹⁹ The draft assessment provides information on climate change impacts and the status of climate change science, and it highlights ongoing climate change adaptation efforts, among other things. For example, the draft assessment states that, although substantial climate change adaptation planning is occurring at all levels of government, adaptation actions have been limited. According to the draft assessment, challenges to implementing adaptation actions include lack of resources and leadership, and difficulties in using climate change projections, which can be complex and difficult to apply to management decisions. To help ensure that natural resource managers and other decision makers have timely and relevant information, the draft assessment includes information on creating a sustained climate assessment process to more efficiently collect and synthesize climate change science. The draft assessment also states that climate change adaptation actions have rarely been evaluated for effectiveness because such actions have only recently begun to be initiated and comprehensive metrics for evaluating these actions have not been developed. The assessment is expected to be finalized by the end of 2013.

Agency Comments and Our Evaluation

We provided a draft of this report for review and comment to the Departments of Agriculture, Commerce, and the Interior. In its written comments, which are included in appendix I, the Department of Agriculture stated that the Forest Service agreed with our findings and will

⁹⁸Pub. L. No. 101-606, § 106 (1990). In 2007, a federal district court held that the failure to complete an assessment at least every 4 years violated the Global Change Research Act. *Center for Biological Diversity v. Brennan*, 571 F. Supp. 2d 1105, 1131 (N.D. Cal. 2007).

⁹⁹The January 2013 draft *National Climate Assessment* was prepared under the leadership of the National Climate Assessment and Development Advisory Committee, a federal advisory committee appointed by the Secretary of Commerce.

continue to engage in the collaborative efforts we identified to more efficiently and effectively address climate change adaptation.

We received general comments from the Departments of Commerce and the Interior. The Department of Commerce stated that it appreciated our efforts to identify the progress made by key natural resource management agencies to address climate change. It also said that climate change adaptation efforts will improve over time through review and evaluation processes, and our report contributes to that effort. The Departments of Commerce and the Interior also said they have other programs, field locations, and climate change adaptation-related activities that were not discussed in the report. By design, our report focused on specific programs, and we visited only one field location in each of the five agencies we examined. We acknowledge in the report that, while federal agencies have taken many different climate change adaptation actions, we focused on those actions that we determined were most relevant to the field location we visited at each agency. We also received technical comments from the Departments of Agriculture, Commerce, and the Interior, which we incorporated as appropriate.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of the report to the Secretaries of Agriculture, Commerce, and the Interior; the appropriate congressional committees; and other interested parties. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have questions about this report, please contact me at (202) 512-3841 or fennella@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix II.



Anne-Marie Fennell
Director, Natural Resources and Environment

Appendix I: Comments from the Department of Agriculture



Forest Service Washington Office

1400 Independence Avenue, SW
Washington, DC 20250

File Code: 1420

Date:

MAY 03 2013

Ms. Anne-Marie Fennell
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Ms. Fennell:

Thank you for the opportunity to review and provide comment on the draft U.S. Government Accountability Office (GAO) Report on, "Climate Change: Various Adaptation Efforts Are Underway at Key Natural Resource Management Agencies" (GAO-13-253). The Forest Service has reviewed the report and agrees with its findings. GAO did not offer any recommendations.


The study's findings capture the agency's strategic, multi-faceted approach to such a complex and far-reaching issue as climate change adaptation. The findings also show that our strategy, policies, and guidance are being applied by one of our field units (Chugach National Forest) and integrated into its land management planning.

The U.S. Department of Agriculture's (USDA) Strategic Plan for 2010-2015 also provides broad guidance on climate change adaptation. The most relevant to the Chugach National Forest is Strategic Goal 2: Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources. In addition, the ~~USDA Climate Change Adaptation Plan~~ prepared in accordance with Executive Order 13514... presents broad strategies and actions to address the effects of climate change on key mission areas including forestry and natural resources conservation.

Although the Forest Service has made good progress since 2007 in addressing climate change through our own authorities and policies, we continue to ramp up national level collaboration with other agencies, partners, and stakeholders in the areas of science, monitoring, vulnerability assessments, and planning. Engagement in the formal and informal coordination efforts identified in the report will result in more efficient and effective responses to address this major environmental challenge.

Thank you again for the opportunity to review your draft report. If you have any questions, please contact Thelma Strong, Chief Financial Officer, at 202-205-0429 or tstrong@fs.fed.us.

Sincerely,


THOMAS L. TIDWELL
Chief



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Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Anne-Marie Fennell, (202) 512-3841 or fennella@gao.gov

Staff Acknowledgments

In addition to the individual named above, Stephen Secrist, Assistant Director; Leo G. Acosta; Mark Braza; Frederick K. Childers; Elizabeth Curda; Keesha Egebrecht; Emily Hanawalt; Richard Johnson; Alison O'Neill; Jeanette Soares; and Kiki Theodoropoulos made key contributions to this report. Candace Carpenter; Brad Dobbins; Armetha Liles; and Janice Poling provided additional technical assistance.

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