Forest Service Strategic Framework For Responding to Climate Change

Version 1.0

The conservation of natural resources is the key to the future. It is the key to the safety and prosperity of the American people, and all of the people in the world, for all time to come. The very existence of our Nation, and of all the rest, depends on conserving the resources which are the foundations of its life.

- Gifford Pinchot

FOREST SERVICE STRATEGIC FRAMEWORK FOR RESPONDING TO CLIMATE CHANGE

The Forest Service 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 Nation's forests and grasslands provide clean water, scenic beauty, biodiversity, outdoor recreation, natural resource-based jobs, forest products, renewable energy and carbon sequestration. Climate change is one of the greatest challenges to sustainable management of forests and grasslands and to human well-being that we have ever faced, because rates of change will likely exceed many ecosystems' capabilities to naturally adapt. Without fully integrating consideration of climate change impacts into planning and actions, the Forest Service can no longer fulfill its mission.

The Forest Service has a unique opportunity and responsibility to sustain forests and grasslands in the United States and internationally. This responsibility includes: 1) stewardship of 193 million acres of national forests and grasslands, 2) partnerships with States, Tribes, and private landowners for assisting communities and owners of 430 million acres of private and Tribal forests, and with other federal agencies, 3) international cooperation, 4) research and development to provide science and management tools. These responsibilities make it imperative that we understand and be able to respond to the effects of climate change on the Nation's forest and grassland resources.

This document provides a strategic framework for the Forest Service to guide current and future actions to meet the challenge of climate change. It incorporates the actions included in Chief Gail Kimbell's letter to the National Leadership Council of February 15, 2008.

VISION

We envision a future where:

- Ecosystem services are sustained as forests, grasslands and communities are successfully adapting to changing climate.
- Forest and grassland management actions and products contribute significantly to mitigating global climate change;
- New scientific information, tools, and technology increase understanding of climate change impacts, adaptation and mitigation options, and risks and uncertainties;
- New and stronger alliances are forged to address climate change related to forests and grasslands;
- Citizens are knowledgeable about climate change and its impacts on ecosystems, and are prepared to participate in decisions and actions affecting their Nation's forests and grasslands.

BACKGROUND

We are already seeing the effects of changing weather patterns and extreme events on our Nation's forests and grasslands. Many of the most urgent forest and grassland management problems of the past 20 years, including increased wildfire severity and area burned, large-scale bark beetle infestations, and changing water regimes, have been driven in part by changing climate. Land use change, management practices, and disturbances on forests and grasslands have also contributed to increasing greenhouse gases.

Even if global greenhouse gas emissions were eliminated today, the Intergovernmental Panel on Climate Change predicts with high certainty that global temperatures would continue to warm for the next 100 years (IPCC 2007). The Intergovernmental Panel on Climate Change predicts a broad range of effects of changing climate, including regional warming, changes in precipitation, extremes in weather, severe drought, earlier snowmelt, rising sea level, effects on water supply, and other changes that will lead to significant alterations in ecosystems and societies. Continued emission of greenhouse gases at current rates would intensify these impacts greatly.

While some ecosystems may be able to adapt rapidly enough to maintain viability and productivity in the face of changing climate, the impacts of climate change on most terrestrial ecosystems are expected to occur at a rate that will exceed the capacity of many plant and animal species and communities to migrate or adapt. Ecosystem processes, water availability, species assemblages, and the structure of plant and animal communities and their interactions will change. Some of these changes may enhance ecosystem productivity and carbon storage. For example, increased moisture and warmth, combined with increased carbon dioxide (CO_2), stimulate tree growth. Under a changing climate, however, many ecosystems will experience widespread mortality, increased fire and insect activity and other disturbances, changes in water regimes, and species losses, with associated loss of productivity and resilience and accelerated carbon loss. Disturbance events can also provide opportunities for recovery actions that will facilitate adaptation and enhance resiliency and ecosystem health in a changing climate. Management to maintain vegetation within the historic range of variability will increasingly not be an option in many areas. Strategies based on historical or current conditions will need to be

adjusted or replaced with approaches that support adaptation to the changing conditions of the future.

Strategies to address climate change must encompass two components:

- Facilitated adaptation, which refers to actions to adjust to and reduce the negative impacts of climate change on ecological, economic, and social systems; and
- Mitigation, which refers to actions to reduce emissions and enhance sinks of greenhouse gases, so as to decrease inputs to climate warming in the short term and reduce the effects of climate change in the long run.

In the face of current changes and future projections, critical work is needed to help ecosystems adapt to the changes that will occur in our lifetimes and pursue mitigation opportunities that can help ensure sustainable ecosystems for future generations.

The Nation's forests and grasslands contain vital components of biological diversity, an essential part of our national heritage. Their ecosystems, landscapes, and component species provide us with ecosystem services on which society relies heavily. These lands are the source of most water used for drinking, agriculture, and industry. They supply fiber for paper, lumber, and other wood products, as well as a portion of our renewable energy. They provide recreation opportunities, clean air, and feed for domestic livestock; and they support biodiversity and habitat for plants and wildlife. Healthy and productive forests have potential as significant sources of renewable energy and other offsets to fossil fuel emissions.

Facilitated Adaptation: Approaches to facilitating adaptation will need to be regional and site-specific, and they will fall into two major categories. *Anticipatory actions* intended to prevent serious disruptions due to changing climate may include thinning of forests to increase tolerance to drought and resistance to wildfire or insects, genetic conservation of species, assisted migration of species to suitable habitat, development of wildlife corridors to facilitate migration, or construction of new water storage facilities. *Opportunistic actions* that take advantage of man-made or natural disturbance events to facilitate adaptation to future climate may include planting of different species or genotypes from those that occurred on a site before disturbance or active conversion of vegetation structure to make it more resilient to changing climate.

Actions that minimize disruptions in the ability of ecosystems to provide ecosystem services and that facilitate adaptation to changing climate must be central priorities for the Forest Service because many of these services may be lost or significantly altered if the ecosystems are left to adapt on their own. Ecosystem health and resilience, productivity, biological diversity, and carbon storage are likely to decrease over large areas without direct intervention and management. Mitigation activities can only provide significant benefits if ecosystems are adapted to their new environments.

Mitigation: To significantly reduce its greenhouse gas emissions, the United States will need to implement a variety of mitigation strategies, including energy conservation, alternative fuels, clean energy, tree planting, sequestering more carbon in forests, soils, and wood products, product substitutions for more energy-intensive materials, and increased use of energy from wood. A wide variety of strategies can cumulatively contribute to a significant decrease in emissions.

Net carbon uptake by terrestrial ecosystems in the United States, coupled with storage in wood products and landfills, currently offsets about 12 percent of United States greenhouse gas

emissions from fossil fuel combustion and cement production. Recent estimates suggest that this might be increased through forest and grassland management. Globally, loss of forest land cover is responsible for about 20 percent of human caused carbon emissions. Management of forests and grasslands to enhance terrestrial carbon storage, including planting trees, reforestation and avoiding forest conversion, storage in durable bio-products, biofuels, and bio-energy, has considerable potential as an important component of the global capacity to mitigate effects of fossil fuel emissions.

Maintaining ecosystem services while contributing to mitigation will require integrated, landscape-level and regional approaches to management across ownerships. A substantial knowledge base already exists from a century of Forest Service and partner research on natural processes, management in forests and grasslands, and utilization options, as well as over twenty years of targeted global change research. This information forms a scientific foundation for climate change adaptation and mitigation, decision support, monitoring, adaptive management, and new research.

Key Terms:

Adaptation -

- *Natural Adaptation* – reactive responses by natural systems to the effects of a changing climate. In some cases, individuals, species, communities or ecosystems may adapt (migrate, shift, modify behavior, etc.); in other cases these entities may perish or cease to exist.
- *Facilitated Adaptation* - initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects; includes both anticipatory and opportunistic actions.

Ecosystem Services - are commonly defined as the benefits people obtain from ecosystems. They include basic services like the provision of food, fresh water, wood and fiber, and medicine; environmental services like carbon sequestration, erosion control, biodiversity, wildlife habitat, and pollination; cultural services like recreation, ecotourism, and educational and spiritual values; and supporting services like nutrient cycling, soil formation, and primary productivity

Mitigation - actions to reduce emissions and enhance sinks of greenhouse gases, so as to reduce the impacts and effects of climate change.

GUIDING PRINCIPLES

These principles provide guidance to the Forest Service in integrating responses to changing climate into the mission of *sustaining the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations.*

Principles Related to the Land

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1. Adaptation to the effects of climate change is essential if we are to sustain forests and grasslands to provide ecosystem services and continue to mitigate greenhouse gases

2. Management for adaptation will not be possible or needed everywhere; priorities will need to be set to determine the most beneficial outcomes.

3. Improved risk analysis and decision support tools will be critical to facilitate new policies and management approaches in the face of uncertainty.

4. Continual monitoring and incorporation of new science into planning, policies, and decision processes are essential to adaptation and mitigation in a changing climate.

Principles Related to People

5. Alliances and collaboration will be essential to achieving science-based, integrated approaches for adaptation and mitigation.

6. Institutional and public support and encouragement for implementing innovative approaches is essential.

7. Strategies, policies, and actions for addressing climate change will be integrated across all Deputy areas at all levels of the Forest Service.

GOALS

Seven key goals will help the Forest Service carry out the mission of sustaining forests and grasslands for present and future generations under a changing climate.

To achieve these goals the Forest Service will need to work collaboratively with a broad range of agencies, partners, and stakeholders, including other federal agencies, States, Tribes, communities, private landowners, the public at large, and internationally. Internally, the Deputy Areas and functional lines will need to work together to make full use of expertise and resources to accomplish this work.

Forest Service goals for addressing climate change for the benefit of human and ecological health and wellbeing:

1. **SCIENCE - Advance our understanding** of the environmental, economic, and social implications **of climate change** and related adaptation and mitigation activities on forests and grasslands.

2. **ADAPTATION - Enhance the capacity of forests and grasslands to adapt** to the environmental stresses of climate change and maintain ecosystem services.

3. **MITIGATION - Promote the management of forests and grasslands to reduce the buildup of greenhouse gases**, while sustaining the multiple benefits and services of these ecosystems.

4. **POLICY - Integrate climate change, as appropriate, into Forest Service policies, program guidance, and communications** and put in place effective mechanisms to coordinate across and within Deputy Areas.

5. **SUSTAINABLE OPERATIONS - Reduce the environmental footprint of** Forest Service **operations** and be a leading example of a green organization.

6. **EDUCATION - Advance awareness and understanding** regarding principles and methods for sustaining forests and grasslands, and sustainable resource consumption, in a changing climate.

7. **ALLIANCES - Establish, enhance, and retain strong alliances and partnerships** with federal agencies, State and local governments, Tribes, private landowners, non-governmental organizations, and international partners to provide sustainable forests and grasslands for present and future generations.

Goals Focused on Managing the Land

1. **SCIENCE - Advance our understanding** of the environmental, economic and social implications **of climate change** and related adaptation and mitigation activities on forests and grasslands.

   Through research and monitoring, the Forest Service has a long history of investigating and tracking many aspects of forest and grassland ecosystems, including how these ecosystems are affected by changing climate. Through entities such as the Intergovernmental Panel on Climate Change and the U.S. Climate Change Science Program, agency scientists have participated in global and national assessments of climate change impacts, mitigation, and adaptation, and have developed collaborative relationships with scientists around the world. Researchers are beginning to incorporate climate change into regional and local-scale models of potential impacts on plant and animal species, vegetation structure, stand dynamics, water supplies, and disturbance patterns. The Forest Service Global Change Research Strategy (August 2008) lays out a direction for the agency's research program over the next ten years. This strategy will need to be flexible over time in response to an organized interactive dialogue among researchers, land and resource managers, and other users in modifying research priorities and providing feedback.

   To successfully manage forests and grasslands in a changing environment, the Forest Service needs to translate relevant science into land management applications, using improved, coordinated, and enhanced monitoring systems, predictive models, decision support tools, and databases. These tools will aid resource managers by monitoring trends and predicting future changes. These tools are also critical to understanding the role and contribution of United States forests and grasslands in international agreements created to mobilize global action to address climate change. Managers and policymakers will be able to better evaluate the effects of management actions, consider alternative scenarios, and make decisions in an uncertain changing environment. Research is also needed to develop improved, cost-effective methods for biomass utilization, bioenergy, fossil fuel substitutes, soil carbon enhancement, storage in wood products, and greenhouse gas accounting.

   Also needed are unified multi-scale monitoring systems sufficient for:
   - Evaluating national and regional trends;
   - Assessing the effectiveness of management activities designed to mitigate climate change and adapt to its effects;
   - Assessing progress in working across landscapes and ownerships; and
   - Understanding the interactions with environmental, social, and economic conditions.

   The integration of science, monitoring, and management will aid land managers – federal, State, Tribal, and private - and citizens in making decisions and taking actions affecting the Nation's forests and grasslands.

2. **ADAPTATION - Enhance the capacity of forests and grasslands to adapt** to the environmental stresses of climate change and maintain ecosystem services.

   As climate changes, managers and policymakers will need to be nimble in using new information to adapt to evolving conditions. Risk and uncertainty will need to be part of management decisions, because the scope of climate change and its impacts on ecosystems are difficult to predict. In many cases, a lack of management will guarantee unacceptable disruptions to ecosystems.

   As noted under Goal 1, monitoring the effectiveness of our actions is essential so we can adjust our management in a changing world. Adapting to climate change, maintaining ecosystem resilience, and continuing production of ecosystem services are key aspects of this goal. Some methods may be expanded, such as planting more diverse species or genetic mixes in reforestation efforts. New management strategies (e.g., assisted migration of species, solutions to moderate and manage extreme stream flows) may be useful, but specific techniques need to be developed and evaluated. Experimentation, learning from experience, monitoring actions, and changing methods and techniques will help managers adjust actions.

   The primary focus of efforts on National Forest System lands will be to facilitate the adaptation of ecosystems to the effects of climate change. Many activities currently underway to restore forests and grassland health and reduce the risk of severe wildfires or pest outbreaks (such as thinning overstocked stands, thinning to alter species composition, fuels reduction, and prescribed fire) also serve to restore ecological health and resilience in the face of future stressors. More extensive application of such measures is vital for adaptation of forests and grasslands, and will need to be part of future planning and management actions to address climate change and its impacts. Lack of markets for the by-products of treatment activities, and institutional barriers are significant constraints on implementing adaptation-related projects on National Forest System lands. The Woody Biomass Utilization Strategy identifies goals to address the lack of markets and institutional barriers for marketing the by-products of treatment activities.

   Water is one of the critical ecosystem services provided by forests and grasslands. Water quality, quantity, and timing of waterflow have important environmental, social, and economic consequences. Because changing climate is expected to dramatically affect the amount and seasonal distribution of rainfall and snowpack, especially in the West, the Forest Service and other land managers will need effective approaches to addressing these changes. The Forest Service strategy on water and climate change is expected to address these needs.

   The Forest Service has authorities and the ability to assist private landowners and communities to voluntarily implement adaptation techniques on their lands, and to work collaboratively with other federal agencies and international partners. Science-based and easily accessible information and tools are essential.

3. **MITIGATION - Promote the management of forests and grasslands to reduce the buildup of greenhouse gases**, while sustaining the multiple benefits and services of these ecosystems.

   Effective mitigation requires balancing carbon sequestration with other ecosystem services. Mitigation activities on forests and grasslands in the United States, while potentially significant, can represent only a small portion of required reductions in human-caused greenhouse gases. For example, U.S. forests currently sequester about 10 percent of domestic carbon emissions. Even with a substantial increase in sequestration in forests, and increased use of biofuels, a significant reduction in U.S. carbon emissions will be needed to stabilize overall U.S. contributions to global atmospheric carbon. Nonetheless, forests and forest products have an important niche to fill for society.

   Adaptation and mitigation activities must complement each other. Carbon accrues in trees, soil, and wood products and the use of wood-based substitutes for fossil fuel-based products decreases the amount of greenhouse gas emissions. In addition, the loss of trees and stands to insects, disease, and wildfire is a loss of carbon to the atmosphere. Management will be important to improving the amount of carbon stored in forests and grasslands.

   Activities that mitigate include increased carbon sequestration, increased use of renewable fuels to offset fossil fuels, and reduced emissions from large-scale events, such as wildfires and insect epidemics. The key to sequestering carbon will be to move harvested biomass into solid wood products, biofuels, or other fossil fuel substitutes or incorporate carbon into the soil. The Forest Service should strive to optimize forest and grassland productivity and health and balance carbon sequestration with other ecosystem services.

   Most opportunities for increased sequestration of greenhouse gases on forests and grasslands are on private lands. The Forest Service can contribute research and decision support for mitigation-oriented management activities, sustainable forests, and work with partners in the United States and internationally.

   The potential of many National Forests to store additional carbon over the short and mid-term is limited because many areas have too many small trees making forests more susceptible to wildfire, insects, and disease. Management activities can reduce the number of small trees, allowing the remaining trees to grow larger, improve ecosystem health, and reduce the risk of damaging wildfire. Several policies and strategies, such as the Restoration Policy Framework, provide guidelines for managers. But even the management practices designed to restore forests and grasslands and protect communities (through thinning, fuels treatment, and prescribed fire) are likely, at least over the short- and mid-term, to reduce total carbon stocks below current levels. However, not taking action to improve ecological health will likely result in substantially lower carbon stocks and substantially increased carbon emissions in the future as the result of severe wildfire, and losses from insects, and disease.

   The Forest Service Open Space Conservation Strategy lays out actions for preventing conversion of forest land. These actions help reduce net emissions of greenhouse gases and improve carbon sequestration. But more research on the interactions of adaptation

and mitigation actions is needed. In addition, clear Forest Service management and policy can improve coordination both for National Forest lands and for engaging with partners and stakeholders.

The Forest Service should continue to improve existing methods and tools to enable accurate and consistent greenhouse gas accounting that can be applied to all lands. It can also provide technical and policy assistance in the development of federal, state, and private level protocols for carbon. Currently, different carbon credit/offset protocols are inconsistent in terms of components included and accounting methods used. The Forest Service goal should be to move toward full greenhouse gas accounting for Forest Service activities, and to improve existing methods and tools to enable more accurate and consistent accounting that can be applied to all lands.

4. **POLICY - Integrate climate change,** as appropriate**, into Forest Service policies, program guidance, and communications** and put in place effective mechanisms to coordinate across and within Deputy Areas.

   The Chief has made climate change a top issue for the Forest Service because of its significant impacts to forests and grasslands, and to society. The agency has begun considering climate change in policies, program guidance, and communications. In particular, several actions constitute important first steps in grappling with the issues of addressing climate change in forest plans, NEPA analysis, and budget guidance. As required by the 2008 National Forest System Land Management Planning Rule, the National Environmental Management System will include a land management component, which could be defined to address adaptation and mitigation on National Forest System lands.

   The uncertainties of outcomes in a changing climate will require the Forest Service to be flexible and adaptable. Addressing climate change will depend on reducing institutional barriers and increasing adaptive learning through experimentation. Monitoring and evaluation will assist managers in dealing with uncertainties and the risks of options, decisions, and actions. The Forest Service will need to build consideration of climate change into virtually all aspects of agency operations including consideration of life cycle analysis of activities.

   There are a variety of national strategies in place or under development that could complement and reinforce a truly cohesive approach to climate change. These include strategies on integrated vegetation management, biomass, open space, ecological restoration, water, research and development, and others.

   Collaboration and integration structures are essential to effectively coordinate across Deputy Areas. Some Regions and Research Stations have begun to identify governance actions to improve integration. These types of activities should be encouraged and reinforced. Coordination that integrates across regions and stations will assure that efforts are complementary and not redundant. Unless more effective integration and coordination mechanisms are put into place, this strategic framework has little chance of meaningful implementation.

Goals Focused on People

5. **SUSTAINABLE OPERATIONS - Reduce the environmental footprint of** Forest Service **operations** and be a leading example of a green organization.

   An environmental footprint is a measure of the demands of an individual or organization on the natural system in terms of consumption of renewable and non-renewable resources, and the ability of the natural system to regenerate resources and provide services. Collectively, the Forest Service and its employees can explore opportunities to reduce their environmental footprint and decrease the greenhouse gases emitted through day-to-day operations. Examples include changing personal work habits, such as increased telecommuting and use of video-conference technology in place of traveling to meetings, locating facilities near mass transit stations, and implementing recycling programs. In addition, implementing sustainable operations for facilities and fleet will help reduce the agency's environmental footprint.

   Requirements for sustainable operations come from different sources (e.g., Executive Order 13423; legislation such as the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007), and require the agency's continued vigilance and active involvement. The agency's Sustainability Summits and Sustainable Operations Accomplishment Reports document progress in reducing the Forest Service's environmental footprint. The sustainable operations policy is being incorporated into the Forest Service Manual, and includes guidance regarding recycling and waste reduction, energy conservation, water conservation, and green purchasing.

   Additionally, the National Environmental Management System (EMS) has the potential to provide a valuable, nationally consistent tool to monitor progress and inform management regarding some aspects of performance.

6. **EDUCATION - Advance awareness and understanding** regarding principles and methods for sustaining forests and grasslands, and for sustainable resource consumption, in a changing climate.

   Citizens knowledgeable about climate change and its impacts on ecosystems will be better prepared to participate in decisions and actions about their Nation's forests and grasslands. Environmental education builds knowledge and skills about climate change, forests and grasslands, sustainable management, and actions to promote sustainable consumption.

   The Forest Service, in partnership with other organizations, is uniquely placed to provide high-quality, science-based education and outreach to employees and to the public on the role of forests and grasslands and the impacts of climate change. The Forest Service has a long tradition of building environmental awareness and understanding through multiple programs and disciplines. The Chief's priority of "Kids in the Woods" fits well with these efforts. However, focused knowledge, skills, and experience about climate change - in the Forest Service and in society - are needed for meaningful participation in the decisions and actions the Forest Service and the Nation will need to take.

7. **ALLIANCES - Establish, enhance, and retain strong alliances and partnerships** with federal agencies, State and local governments, Tribes, private landowners, non-governmental organizations, and international partners to provide sustainable forests and grasslands for present and future generations.

   As stewards of 8 percent of land area of the United States, the Forest Service has a responsibility to share information and expertise and to work with other landowners. Climate change will impact ecosystems everywhere and will require coordinated action across ownership boundaries. The Forest Service has extensive experience in working with partners to achieve shared objectives, such as cooperative research, forest health, and fire suppression. The missions of State & Private Forestry and Research & Development clearly extend the Forest Service's responsibility to provide knowledge, tools, and assistance applicable to all lands.

   The significant challenge of climate change will mean building on this experience and making special efforts to expand existing partnerships and actively seek new ones in order to address common objectives. Many federal agencies are developing their own climate change strategies. Many conservation groups and other non-governmental organizations have been developing strategies or positions on climate change as well. Examples include the Forest Guild, Rural Voices for Conservation Coalition, the Wilderness Society, the Society of American Foresters, and the National and Western Governors' Associations. The Forest Service can contribute to and learn from working with these groups toward the common goal of adapting to climate change. The Forest Service also has an important role for the U.S. government as technical experts on forests, grasslands, and sustainable resource issues. Expanding traditional partnerships and actively seeking new ones will be essential to effectively addressing the multiple challenges of climate change across the United States, and internationally.

NEXT STEPS

The implications of climate change for natural resources and society, as well as the challenge of integrating adaptation and mitigation responses, are complex. To be successful, a common vision and goals for the Forest Service are essential leadership tools to set the tone and structure. The next step is to implement concrete actions to achieve the vision of this framework. Recommended actions to begin implementation can be found in Appendix 1.

The Forest Service 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.*

This mission is an integral part of the Forest Service identity. Climate change is one of the greatest challenges we have ever faced. Since the future under a changing climate is uncertain, a nimbleness and willingness to learn from mistakes will be essential. The Forest Service has a duty to work with others and share knowledge, skills, and experience to ensure sustainable forests and grasslands for present and future generations.

APPENDIX 1 - CLIMATE CHANGE STRATEGY GOALS & RECOMMENDATIONS

#	Goal	Recommendations to Achieve Goal
1	**SCIENCE - Advance our understanding** of the environmental, economic and social implications **of climate change** and related adaptation and mitigation activities on forests and grasslands.	1.1 **Develop and implement internal mechanisms** to assure a systematic, interactive dialogue between researchers, public and private land and resource managers, and other users to promote effective alignment of climate change science delivery efforts. (Links to Recommendation 4.1) 1.2 **Review and adjust priorities** for the most critical focus areas for Forest Service research, development, and application activities, including: ➢ Key **knowledge gaps** in the economic, social and environmental effects of climate change; ➢ **Implications of land use and land cover change** feedbacks to climate change; and ➢ **Effects of potential adaptation and mitigation actions** related to forest and grassland ecosystems and products. 1.3 **Effectively move science into application**, including synthesis of current research and monitoring information, incorporating science into decision support tools, disseminating new knowledge to managers, and integrating tools into common data and analysis structures. Among other things, decision support tools should focus on: ➢ **Predicting the ecological effects of climate change** at national, regional and local scales, ➢ **Predicting the effects of management activities** on the ability of forest and grassland communities and their component species to adapt to climate change and provide ecosystem services, ➢ **Assisting public and private land managers in prioritizing activities** to maximize effectiveness of adaptation strategies in the face of limited resources, and ➢ **Assessing the long-term implications of adaptation actions** and their effects on carbon storage and greenhouse gases over time. ➢ **Evaluating the feasibility and impacts of mitigation actions** that involve forests and grasslands and their products. 1.4 **Develop** a **unified multi-scale monitoring** approach building upon existing inventory efforts sufficient for: ➢ **Improving the evaluations of national and regional trends**, ➢ **Assessing the effectiveness of management activities** designed to facilitate adaptation to climate change and to mitigate its effects, ➢ **Assessing progress in working across landscapes** and ownerships, and ➢ **Understanding** the **interactions with** environmental, social, and economic **conditions**.

		1.5 In collaboration with partners and stakeholders, **carry out integrated regional and sub-regional landscape-scale assessments** of the multiple implications of climate change to improve adaptation, mitigation, and conservation activities on forest and grassland ecosystems and the values, outputs and ecosystem services they provide. 1.6 **Develop improved life cycle analysis of bio-products from forests and grasslands. Promote** development of **methods**, operational processes, and decision support tools **to enhance the capacity of** these **bio-products to offset fossil fuel emissions and to sequester carbon.**
2	**ADAPTATION - Enhance the capacity of forests and grasslands to adapt** to the environmental stresses of climate change and maintain ecosystem services.	2.1 **Set priorities for where, when and how to employ adaptation activities** and **implement actions** that will: ➢ **Facilitate adaptation** to the long-term effects of climate change by fostering resilient, productive, and functional ecosystems, ➢ **Prioritize** types and distribution of **management activities** for the greatest benefits to ecosystems and society. 2.2 **Work with partners**, including other federal agencies, international partners, State and local governments, Tribes, private landowners, managers, consultants, non-governmental organizations, and other stakeholders **to be most effective in** supporting their **efforts to adapt** lands, ecosystems, and species to climate change. 2.3 **Assess how land management activities** (e.g., fire suppression, fuels treatment, post-fire rehabilitation, timber harvest, forest health and invasive species management, ecological restoration, and watershed management) **contribute toward adaptation objectives** and how they can be modified to better facilitate adaptation to climate change at various spatial scales. 2.4 **Ensure that effects of climate change adaptation activities are monitored (**using the monitoring system established under Recommendation 1.4) **and that new knowledge is documented,** reported and used effectively to modify future management actions.

	MITIGATION - Promote the management of forests and grasslands to reduce the buildup of greenhouse gases, while sustaining the multiple benefits and services of these ecosystems.	3.1 **Participate in the development of protocols for carbon accounting** at the international, national, regional and state levels that fully incorporate the potential for forests, forest products, and grassland ecosystems and products to mitigate the build-up of greenhouse gases. ➢ Develop a consistent approach to guide that participation. ➢ Develop a national-level central "clearinghouse" for information and Forest Service positions on carbon protocols to provide consistency across efforts. 3.2 **Facilitate the participation of private landowners in ecosystem services markets**, including carbon, and promote needed technical assistance and incentives. 3.3 **Identify opportunities across all ownerships** for afforestation, reforestation, and forest management to reduce greenhouse gas emissions and increase sequestration, domestically and globally. 3.4 **Work internationally and with States and other partners to** identify opportunities to **reduce the rate of conversion of forests and grassland ecosystems** to other uses, and in cooperation with partners, facilitate participation by landowners in programs, including market incentives to retain forest cover. 3.5 **Determine** in real world situations**, the combinations of sequestration, bio-products, and bio-energy that are optimal** under different economic and policy conditions involving carbon (links to Recommendation 1.6).
4	**POLICY - Integrate climate change into all Forest Service policies, program guidance, and communications** and put in place effective mechanisms to coordinate across and within Deputy Areas.	4.1 **Create a rapid national analysis of the implications of climate change** for the Nation's forests and grasslands and our capacity to respond to them, including economic and social costs and benefits to the agency and society. 4.2 **Implement** the appropriate **mechanisms** and institutional structures **to promote effective collaboration between Deputy Areas of Research, National Forest System, and State & Private Forestry** to assure that relevant and helpful research and science is being conducted and distributed (Links to Recommendation 1.1). 4.3 **Address climate change as a part of agency plans and direction** to the field, including: ➢ Program budgeting. ➢ Forest planning and NEPA. ➢ Strategic plans at various levels (Forest Service Strategic Plan, Ecological Restoration Plan, Cohesive Fuels Management Strategy, Water Strategy, Open Space Conservation Strategy, and others) 4.4 **Evaluate and remove the institutional barriers**, policies, and constraints that exist to implementing effective management activities to address climate change

		4.5 **Implement approaches** and incentives **to encourage managers to make responsible management decisions in the face of uncertainty.** 4.6 **Clarify the appropriate role of National Forest System lands in participating in** or supporting the development of **carbon markets**. 4.7 **Promote innovation by incorporating the results of Environmental Management System's** scientifically-designed monitoring into decision-making . (links to Recommendation 1.5) 4.8 **Provide policy and guidelines addressing the development of non-biomass renewable energy resources** on National Forest System lands ➢ wind, solar, and other renewable energy ➢ geologic sequestration sites ➢ locations of corridor rights-of-way on National Forest System lands.
5	**SUSTAINABLE OPERATIONS - Reduce the environmental footprint of** Forest Service **operations** and be a leading example of a green organization.	5.1 **Finalize Forest Service directives** supporting standards for fleet, facilities, energy, water, recycling, and other operations **to reduce our ecological footprint**. 5.2 Finalize and **implement the Sustainable Operations portions of the Environmental Management System** and the applicable chapter of the Forest Service Manual. 5.3 Continue to **implement Executive Order 13423**, Strengthening Federal Environmental, Energy, and Transportation Management. 5.4 Make available to employees **opportunities for reducing individual environmental footprints**, such as recycling, telecommuting, and video conferencing. 5.5 **Incorporate life cycle analyses** into forest management and operations as appropriate.

6	**EDUCATION - Advance awareness and understanding** regarding principles and methods for sustaining forests and grasslands, and sustainable resource consumption, in a changing climate.	6.1 Work with scientists, land and community managers, educators, and communicators to **translate climate change science into** accurate, audience-appropriate, and **easily accessible tools and information**. 6.2 Recruit, hire, train, and support employees to **improve our ability to incorporate climate change into communication**, management, technical assistance, and research and development programs. 6.3 **Build environmental awareness, knowledge, and skills** through enhanced educational programs and materials for various audiences including: agency employees; private landowners, and communities; Tribes; educational institutions, non-governmental organizations (including youth groups); visitors to National Forests and grasslands, the public, and the international community. To carry out the above: ➢ Develop and **implement a range of climate change training courses** for employees; where possible, deliver through existing training venues. ➢ **Provide high quality educational and professional training** programs for educators and youth, in partnership with the Department of Education, other federal agencies, and environmental education organizations. ➢ Develop and **provide targeted, audience specific information and tools** to meet the needs of multiple audiences and landowners, including those who visit National Forests and grasslands.
7	**ALLIANCES - Establish, enhance, and retain strong alliances and partnerships** with federal agencies, State and local governments, Tribes, private landowners, non-governmental organizations and international partners to provide sustainable forests and grasslands for present and future generations.	7.1 **Work with others to provide technical, financial, and educational support for partners and landowners** to incorporate climate change in management decisions. 7.2 **Actively seek new partnerships** and cooperative relationships with other federal and non-federal entities, including non-traditional partners, to address the multiple challenges of climate change across the U.S. and internationally. 7.3 **Work collaboratively with international partners** to share technologies and innovations and develop new scientific information and tools in support of sustainable land management.

Background materials on climate change, impacts, adaptation, and mitigation:

CENR. 2008. **Scientific Assessment of the Effects of Climate Change on the United States. A report of the Committee on Environment and Natural Resources. National Science and Technology Council**. 261 p. Of particular interest: Section I. Executive Summary (17 p.); Section IV: Trends and Projections of Global Environmental Change (53 p.); Section V: Analysis of the Effects of Global Change on the Natural Environment and Human Systems (106 p.). Section I provides an excellent and concise overview. Download from: http://www.climatescience.gov/Library/scientific-assessment/

M.G. Ryan and S.R. Archer, R.A. Birdsey, C.N. Dahm, L.S. Heath, J.A. Hicke, D.Y. Hollinger, T.E. Huxman, G.S. Okin, R. Oren, J.T. Randerson, W.H. Schlesinger. 2008. **Chapter 3: Land Resources: Forests and Arid Lands. Pp. 75-120.** ***In:*** **Final Report, Synthesis and Assessment Product 4.3: The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States**, P. Backlund, A. Janetos, and D. Schimel, lead authors. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Note: There are also chapters on water resources and biodiversity, and an executive summary. Download from: http://www.climatescience.gov/Library/sap/sap4-3/final-report/default.htm

Joyce, L. A., G. M. Blate, J. S. Littell, S. G. McNulty, C. I. Millar, S. C. Moser, R. P. Neilson, K. O'Halloran, D. L. Peterson. **Chapter 3: National Forests. pp. 3-1 to 3-127**. ***In:*** **Final Report, Synthesis and Assessment Product 4.4**: ***Preliminary review of adaptation options for climate-sensitive ecosystems and resources***. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Julius, S.H., J.M. West (eds.). U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp. Download from: http://www.climatescience.gov/Library/sap/sap4-4/final-report/default.htm

IPCC. 2007. **Climate Change 2007: Synthesis Report. Summary for Policymakers. 22 p. An excellent overview of the main findings from the Fourth Assessment report of the Intergovernmental Panel on Climate Change.** Download from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

IPCC. 2007. **Climate Change 2007: Synthesis Report. 52 p. For those who want a little more detail on conclusions of the Fourth Assessment Report** of the Intergovernmental Panel on Climate Change, 2007. **Both of these IPCC publications synthesize information from all Working Groups:** WG I--The Physical Science Basis; WG II--Impacts, Adaptation, and Vulnerability; WG III-- Mitigation of Climate Change.
Download from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

EPA. 2005. **Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture.** United States Environmental Office of Atmospheric Programs (6207J) EPA 430-R-05-006 Protection Agency Washington, DC 20460
Download from: http://www.epa.gov/sequestration

There are also several excellent short brochures available on the US Climate Change Science Program website:

- **Climate Change and Ecosystems, Summary of Recent Findings:** http://downloads.climatescience.gov/sap/sap4-4/sap4-4-brochure-FAQ.pdf

- **Weather and Climate Extremes in a Changing Climate, Frequently Asked Questions:** http://downloads.climatescience.gov/sap/sap3-3/Brochure-CCSP-3-3.pdf

- **The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States** (4 separate brochures and an overview): http://www.climatescience.gov/Library/sap/sap4-3/final-report/default.htm#Brochures

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