

# Forest Service Strategic Plan for FY 2007 – 2012

## Climate Change Companion Document

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Spruce Beetle Outbreak – Chugach National Forest

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## Climate Change in the Forest Service Strategic Plan for FY 2007 – 2012

### Framework for the Forest Service's Strategic Approach to Climate Change

Forest Service Chief Gail Kimbell has identified climate change as one of our top priorities. The purpose of this document is to illustrate the relationship between this climate change priority and the Forest Service priorities presented in the goals and objectives of the agency's Strategic Plan for FY 2007-2012 (<http://www.fs.fed.us/publications/strategic/fs-sp-fy07-12.pdf>). The agency's budget is developed and allocated every year and our work is planned to further our priorities, using the Strategic Plan as guidance. This climate change companion document to the Strategic Plan is intended to help agency employees understand the relationship between climate change and Strategic Plan goals and objectives in order to identify opportunities for contributing toward climate change solutions in the course of budget development and allocation, and subsequent formulation and execution of annual programs of work.

Climate change is recognized as an external factor, or driver, with profound potential to affect the continued provision of ecosystem services provided by the Nation's forests and rangelands to the American people. The Intergovernmental Panel on Climate Change (IPCC) agreed at its November 2007 plenary "Most of the observed increase in globally averaged temperatures since the mid-20<sup>th</sup> century is very likely due to the observed increase in anthropogenic greenhouse gas emissions." (IPCC, 2007. Summary for Policymakers. Climate Change 2007: Synthesis Report).

Management actions taken to sustain forest and rangeland productivity and resilience in anticipation of predicted deleterious effects of climate change and in response to observed climate change are adaptation measures, which are discussed in more depth below. Adaptation is defined by the IPCC as the "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC WG II Report, 2007). Substantial potential also exists for managing the Nation's forests to contribute to global efforts to counter the threat of climate change by reducing net greenhouse gas (GHG) emissions, termed mitigation, which is also discussed in more depth below. Mitigation is defined by the IPCC as "... implementing policies to reduce GHG emissions and enhance sinks." Each of the agency's deputy areas, National Forest System, State & Private Forestry, Research & Development, and Business Operations, plays an integral role in furthering measures that address both adaptation and mitigation. The Forest Service also contributes toward United States participation in international climate change dialogue and research, such as the United National Framework Convention on Climate Change and IPCC, as well as climate-relevant international development assistance in partnership with the U.S. Agency for International Development. Ultimately, every agency employee and our partners with whom we work will make decisions and execute actions that will incrementally and collectively affect the agency's success at dealing with the climate change challenge.

## Adaptation

Climate change, by definition, will bring about changes in precipitation and humidity, temperature (including means and extremes), and intensity and frequency of extreme weather events. These changes will ultimately affect the resources we manage and the operations of our employees and partners. Our stewardship responsibility for the 193 million acres of National Forest System (NFS) lands and our partnerships with the States and tribes for assisting communities and owners of the approximately 300 million acres of non-industrial private and tribal lands require the agency to understand and respond to potential impacts of climate change on the Nation's forest and rangeland resources. Agency Research & Development (R&D) provides the resource, social, and economic science basis and tools for agency, other public, tribal, and private stakeholders to understand likely climate changes and their impacts on abiotic and biotic forest and rangeland resources, including impacts on individual species and ecological communities. R&D will also equip managers to apply this understanding of species and resource responses to management actions to adaptively manage in a way that retains and enhances the resilience of these forests and rangelands to future climate change.

Incorporation of climate change adaptation into agency resource management requires adjustments to many established operational guidelines, such as silvicultural prescriptions, species and populations used in revegetation, riparian management standards, logging contract provisions, and seasonal closure of threatened, endangered, and sensitive species habitat. An important framework for considering adaptation needs and opportunities in anticipation of or response to climate change is the ecological classification and inventory system developed by R&D and partners (<http://www.ncrs.fs.fed.us/gla/>). Forests that are actively managed and monitored to detect ecosystem responses to past management and changes in environmental stressors are more likely to continue to provide the American public with ecosystem goods and services than forests that are passively managed on a custodial basis.

Although it will be possible to develop general principles and guidelines concerning adaptation to climate change, adaptation measures will be location-specific, aimed at changing management to ensure continued ecosystem structure and function in view of anticipated or observed climate change in the location and its effects on physical resources and organisms. Climate change projections are based on very complex models, which are quite reliable on a global basis, but less so as the area for which projections are desired is reduced. Projections probably are not sufficiently reliable for anticipating specific changes at the national forest level, but are more so at the regional level. Over the long term, climate change adaptation will require adaptive management that will monitor past management interventions and base future management decisions on periodic consideration of the results of past action and changes in climate, resources, and social and economic conditions. The agency's long-term Forest Health Monitoring and Forest Inventory and Analysis plots provide a framework for broad-resolution monitoring of climate and vegetation changes. Declared wilderness areas provide natural landscapes where vegetation is not actively managed and can therefore serve as reference landscapes for monitoring climate effects. Management decision frameworks will reflect ecological relationships within communities and changing ecological gradients. Examples of possible climate effects and adaptation responses include: increased risk of stand-replacing wildfire or bark beetle attack due to prolonged drought might require reduced stocking density;

changes in forage productivity and annual availability might indicate need for revision of grazing allotment management plans; heavy early snowfall would possibly prevent ground freezing and preclude skidder logging of stands with seasonally saturated soil; early melting of snow pack in the western United States might be associated with prolonged summer drought and require preparation for extreme fire seasons; altered timing of migratory songbird nesting might indicate modification in timber harvest schedules; heating of brooks and streams could require a change in riparian management guidelines. The potential adaptation changes that would be required to retain and enhance the resilience of ecosystem service productivity are as numerous as the site-specific characteristics of each local forest or range management unit, and are always specific to the climatic changes in the location and their effects on the resources.

Human use of forest and rangeland ecosystems has adapted to climate change over millennia, but as climate change accelerates, humans must also respond more promptly to climate-induced changes to resource productivity, structure, and function. The human dimensions of climate change are many, including forest commodity production, community water supplies, wildfire and pest risk, forest recreation, non-timber forest products, and green infrastructure management in communities. Forest Service human dimension R&D provides socio-economic science and tools to assist resource managers and planners with adaptation interventions for these dimensions of climate change.

National forest land and resource management plans provide the guidelines for managing units of the National Forest System, and will be amended or revised to incorporate likely climate change scenarios and planned adaptation measures. Climate-induced changes to resource productivity, availability, and demand will inform amended or revised projections of socio-economic benefits in the updated plans. The Forest Service will work with State Foresters, tribal foresters, and Urban and Community Forestry Program partners and the NIPF owners, tribal members, and urban residents they serve to improve climate change awareness, identify common concerns about impacts to forest and grassland resources, and identify and implement adaptation measures that retain and enhance the ecosystem benefits from these important ecosystems.

### Mitigation

The Nation's forests and rangelands store a large quantity of terrestrial carbon in living tree biomass, both above and below ground, understory vegetation, downed woody debris, and soil organic carbon. The Forest Service's active management of NFS lands, and the agency's facilitation of management by State and private forest and range owners, can affect the size, age, composition, productivity, area of forests and range vegetation, and frequency and severity of disturbance events, and thus the amount of stored carbon. While carbon sequestration was not one of the purposes for which the forest reserves, now the national forests, were authorized by Congress, there are opportunities to increase carbon sequestration and reduce GHG emissions as collateral benefits of management actions taken for other management purposes. An immutable fact is that the success of mitigation efforts involving forest management will depend on our ability to facilitate adaptation and maintenance of healthy, productive, and resilient ecosystems across ownerships.

The Forest Service recognizes the right and responsibility of NIPF owners and tribes to determine management goals for their forest land. The 2002 Farm Bill authorized the Forest Land Enhancement Program and identified “increasing and enhancing carbon sequestration opportunities” among the program objectives for which technical, financial, and educational assistance would be provided through State and tribal foresters. The Forest Service is working with several States and tribes to promote development and gain experience in markets for ecosystem services. Sale of carbon credits provides a potential additional financial incentive for NIPF owners and tribes to retain and manage their lands under forest cover.

Utilization of forest biomass has been identified in the agency’s Woody Biomass Utilization Strategy (<http://www.fs.fed.us/woodybiomass/strategy/index.shtml>) as a valuable tool to contribute toward forest restoration and economic viability of non-industrial private forest land. Biomass from hazardous fuel reduction, wildlife habitat enhancement, and timber management treatments on national forests potentially provides a substantial feedstock for production of durable forest products and bioenergy and can possibly help offset treatment costs. Production of both biobased products and bioenergy provides climate change mitigation benefits. Forest Service utilization researchers have contributed toward life cycle analysis of forest products and bioenergy, accounting for the energy budgets and material inputs involved in forest production, feedstock transportation, processing, resource use, and ultimately disposal. Life cycle analysis is globally recognized for energy and carbon budget accounting that will inform and facilitate growing carbon markets.

Converting wood into durable forest products stores its carbon for long periods. Because forest products have low energy requirements for harvest, transportation, and processing, compared with almost all alternative materials, the substitution of forest products for these alternatives can reduce net GHG emissions. Forest products are a traditional commodity produced on national forest, other Federal, State and local government, tribal, and NIPF lands. These lands present additional opportunities to increase carbon sequestration through durable forest product manufacture from active vegetation management for reduction of risk from wildfires and forest pests, enhancement of wildlife habitat and watershed health, and production of traditional forest products.

Substitution of renewable energy for fossil fuel energy is a mitigation tactic that avoids the carbon emissions from fossil fuel combustion. NFS, NIPF, and tribal lands offer substantial opportunity for increased production of renewable energy from several sources, the most widely recognized being wind, solar, hydropower, bioenergy, and geothermal. The Woody Biomass Utilization Strategy identifies bioenergy as an important strategic national resource that the Forest Service is striving to increase. Renewable energy development on NIPF and tribal lands might provide an additional financial incentive for NIPF owners and tribes. Mitigation benefits are provided when we substitute renewable energy for fossil fuel energy in Forest Service facilities and vehicles because GHG emissions are offset.

Biomass has a relatively low energy value per volume, which results in higher transportation costs per unit of energy than fossil fuel energy sources, and limits the distance that biomass can be economically transported as feedstock for energy facilities. For that reason, biomass is most practical as a feedstock for distributed energy production systems. Small-scale heating systems

that burn wood chips already available as a local commodity have proven their ability to pay for themselves in just a few years in rural schools and other facilities where the Forest Service Fuels for Schools program has provided national leadership. Many opportunities to apply this technology remain, both for Forest Service facilities and for other rural and small community buildings. Heating systems based on wood pellets, as well as combined heating and cooling systems, are being analyzed and implemented in many locations. Wood pellet manufacture employs low capital investment technology and low capital operations to produce a bioenergy fuel source that is becoming more widely accepted and used.

There is great expectation that technological breakthroughs will lead to commercially feasible systems that use biomass to produce ethanol and/or other liquid fuels that can be substituted for gasoline and possibly diesel in the transportation sector. Availability of a sustainable biomass feedstock supply, including possible competition for raw material with existing forest products facilities using the same resource, and requirements for process water, have been identified as possible barriers to feasibility and operation of large-scale biofuels production facilities and biorefineries.

### Sustainable Operations

In addition to addressing climate change through management of the National Forest System, technical assistance to NIPF owners and tribes for their management, and development of the scientific basis and tools for management contributing to climate change solutions, we can contribute to both climate change adaptation and mitigation in our day-to-day operations in our offices and travel. If Forest Service operations are to be sustainable, they must adapt to future climatic conditions that are different than current conditions. Some of the adaptation options also provide mitigation benefits.

Measures that could be taken to moderate negative impacts to Forest Service operations from climate change, i.e. adaptation measures, would include strategies to lower the impacts to facilities from increased temperature, increased wind speed, changes in precipitation, and/or extreme weather events. Increasing building insulation as an adaptation response to anticipated lower winter and/or higher summer temperatures would also provide mitigation benefits through reduced energy needs for heating and/or cooling. Trees planted to shelter buildings from the sun or the wind are long-understood strategies for energy conservation and climate amelioration that also provide mitigation benefits. Tree cover not only protects buildings from hot sun or cold winds, but also reduces the urban heat island effect, lowering summer cooling costs. Changing landscaping of facilities in arid areas to more xeric vegetation could retain their visual attractiveness while adapting to drought and lower water availability. Green infrastructure applications aim to manage rainfall and snowmelt by providing vegetated infiltration structures, and can provide an adaptation response to either increased or decreased rainfall amounts and increased rainfall intensity. In areas experiencing increased drought, improved infiltration can help to sustain aquifers.

Increasing energy efficiency of our facilities and our transportation is required under the Energy Policy Act of 2005 and Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," therefore agency operations to implement all strategic goals

and objectives will provide mitigation benefits if they result in reduced consumption of fossil fuel-produced energy or reduced petroleum-based transportation fuels. We reduce GHG emissions when we increase the energy efficiency of our vehicles and facilities that are powered, heated, and cooled by fossil fuels. EO 13423 also requires increased use of renewable energy, mentioned above when discussing mitigation benefits during implementation of the strategic plan. Our operations present many other opportunities for reducing our carbon footprint, such as promotion of increased telecommuting, use of videoconference technology in place of traveling to meetings, and locating facilities near mass transit stations.

### Strategic Plan—Management Principles

An introductory section of the Strategic Plan presents and discusses some fundamental principles that underlie Forest Service resource management and operations. As the Strategic Plan was being developed, climate change was recognized as a transformational external factor affecting management of the Nation’s forests and rangelands, but the phenomenon was only addressed directly or indirectly in the context of several management principles, rather than in the agency’s strategic goals and objectives for the planning period.

#### Sustaining the Nation’s Natural Resources

The discussion under this heading of the underlying principles on which sustainable resource management is based, integrating environmental, social, and economic issues and values, explicitly mentions climate change:

“The Earth’s *climate* is undergoing a period of relatively rapid change both in temperature and in the variability of climate patterns. Climate change will impact forest, range, and human well-being by potentially altering the ability of ecosystems to provide life-supporting goods and services. The implication for natural resource management is to be flexible and adapt management strategies to help mitigate the effects of climate change. In short, we need to develop new knowledge so that we can manage for future change, ensuring the continued provision of goods, services, and values from forests and rangelands.”

#### International Engagement

A subsequent discussion that recognizes the ubiquitous economic, social, and resource globalization that we face highlights the international relevance of climate change:

“*Understanding climate change internationally.* Tracking climate changes that occur overseas can inform U.S. policy and help develop new markets for mitigation strategies, such as carbon sequestration.”

#### Ecosystem Services

Natural resources economic analysis and valuation concepts increasingly recognize the many economic benefits that are provided by forests but not traditionally valued in the marketplace or



considered in global, national, regional, or national forest economic analyses. The discussion of ecosystem services in the Management Principles chapter of the strategic plan mentions climate regulation among the ecosystem services provided by forests. The role for the Forest Service to promote advancement of ecosystem services markets and to serve as a natural laboratory for informing knowledge and policy on ecosystem services is disclosed.

### Strategic Plan—Goals and Objectives

#### Goal 1: *Restore, Sustain, and Enhance the Nation's Forests and Grasslands*

Outcome: Forests and grasslands with the capacity to maintain their health, productivity, diversity, and resistance to unnaturally severe disturbance.

Goal 1 focuses on restoration and enhancement of our Nation's forests and grasslands in response to disturbance. Climate change is a major driver of ecosystem disturbance, and this strategic goal addresses restoration of ecosystems that have already experienced climatic changes such as drought and more frequent and intense extreme weather such as hurricanes that, coupled with stand conditions altered by past management decisions, present a risk of catastrophic ecosystem changes. Management focus will also be on maintaining and increasing the resiliency of the Nation's forests to environmental changes resulting from climate change.

Climate change-relevant existing SP text in Goal 1: Means and Strategies:

- “Assess the ecological and socioeconomic impacts of global environmental change to the Nation's forests and grasslands.”

Objective 1.1: *Reduce the risk to communities and natural resources from wildfire.*

Some of the areas for which climate change influences implementation of Objective 1.1 are:

- Hazardous fuel reduction will reduce the risk of catastrophic fire due to drought and increased temperatures. Collateral fuel reduction benefits are provided by thinning for reducing pest risk (Obj. 1.4) and for enhancing wildlife habitat and watershed health (Obj. 1.5)
- Aggressive suppression because of climate change-induced increased wildfire risk might be necessary to protect communities and target species until adaptive fuel reduction reduces wildfire risk.
- Biomass removed during fuel reduction and other thinning can be used for durable forest products and bioenergy, mitigating climate change.
- Science and technology solutions for understanding projected climate change effects and needed management response will help achieve this objective.

Objective 1.2: *Suppress wildfires efficiently and effectively.*

Some of the areas for which climate change influences implementation of Objective 1.2 are:

- Wildland Fire Use can reduce fuel loading economically, reducing climate effects on future fire and pest susceptibility, adapting wildlife habitat, and sustaining water flows by reducing transpiration through reduction in leaf area index.
- Wildfire suppression directly reduces GHG emissions from forest fuel combustion, while biomass harvested from protected forests for durable forest products and bioenergy provides additional mitigation benefits.
- Wildfire management research will provide the scientific basis for understanding wildfire suppression and climate change benefits, providing science-based tools for managers.

Objective 1.3: *Build community capacity to suppress and reduce losses from wildfires.*

Some of the areas for which climate change influences implementation of Objective 1.3 are covered above for Objective 1.1. Additionally, the following opportunities to address climate change exist for implementing this objective:

- Human dimensions research contributes to socio-economic understanding of managers who make decisions on priority wildland fire management, including hazardous fuel reduction.
- Community Wildfire Protection Plan development efforts could benefit from increased community awareness of climate change impacts and opportunities.

Objective 1.4: *Reduce adverse impacts from invasive and native species, pests, and diseases.*

Some of the areas for which climate change influences implementation of Objective 1.4 are:

- Climate change may favor exotic species that are better adapted to the new climate than local native species, which will be gradually displaced.
- Increased drought, higher temperatures, and changed chronology of insect temperature thresholds will increase risk of invasive insect and disease infestation, requiring more active management, search for, evaluation, and introduction of natural enemies, etc. Bark beetles are a native insect group that has demonstrated increased outbreak frequency and severity in response to impaired host tree resistance and climate-induced changes in insect behavior.
- Similarly to Objectives 1.1 and 1.3, thinnings to increase stand resistance to bark beetles and other pests can provide mitigation benefits from durable forest products and bioenergy.

- Continuing research will enhance the understanding of increased risk of invasive and native pest and disease outbreaks due to climate change-induced stand environmental conditions and might indicate appropriate adaptive management responses.

Objective 1.5: *Restore and maintain healthy watersheds and diverse habitats.*

Some of the areas for which climate change influences implementation of Objective 1.5 are:

- Altered hydrological regimes might require aggressive vegetation management to sustain water availability by reducing transpiration.
- Different species in ecological communities will respond differently to temperature and moisture gradients resulting from climate change, often disrupting trophic relationships and jeopardizing species' viability when obligate associates are no longer site-adapted.
- Vegetation management such as thinning to improve habitat can provide mitigation benefits from durable forest products and bioenergy based on biomass feedstocks.
- Key species and ecological associations might require deliberate management interventions for their migration along changing ecological gradients, such as temperature and rainfall. In many if not most cases, individual species will respond differently to temperature or other gradients, and species assemblages will not migrate as intact communities.
- Providing increased tree cover along water courses might help maintain suitable water temperatures for coldwater fish.
- Understanding how abiotic environmental factors affect the viability of individual species and their habitat, how species interact within ecosystems, and how these species interactions and species viability will be affected by climate change and adaptive management responses will require continued research and transfer of research results and technology to managers.

Goal 2: *Provide and Sustain Benefits to the American People*

Outcome: Forests and grasslands with sufficient long-term multiple socioeconomic benefits to meet the needs of society.

Goal 2 focuses on the products and services provided to the Nation from its forests and rangelands. Climate change will affect the productivity of forest and rangeland resources.

Climate change-relevant existing SP text in Goal 2: Means and Strategies:

- “Develop and disseminate technologies and market strategies to produce energy and products from renewable forest and rangeland resources.”

- “Monitor changes in U.S. natural resource-based markets in response to globalization and provide information to decision makers and the public.”
- ”Develop tools and provide technical and financial assistance to increase the production of energy from woody biomass.”
- “Help State forestry agencies and other partners monitor, evaluate, and advance market-based approaches to enhance and protect ecosystem services on private and community lands.”

Objective 2.1 *Provide a reliable supply of forest products over time that (1) is consistent with achieving desired conditions on NFS lands and (2) helps maintain or create processing capacity and infrastructure in local communities.*

Some of the areas for which climate change influences implementation of Objective 2.1 are:

- Changed temperature and rainfall regimes will change growth curves of timber species, requiring adaptive changes in silvicultural prescriptions for thinnings and regeneration harvests.
- Species regeneration capability and probability will change due to temperature and rainfall changes, climate-associated changes in tree flowering and seed phenology, as well as changes in aggressiveness of competing vegetation. Silvicultural prescriptions might need to be adapted to regenerate desired species, and changes might be required in species managed for on particular sites. This could entail use of different seed sources of a species or a completely different species.
- For NFS lands where timber productivity increases due to climate change, mitigation benefits might result from increased biomass use for increased production of durable forest products that substitute for more energy-intensive building materials and bioenergy.
- Managers and landowners will need to understand climate change influences on timber stand productivity and benefit from delivery of technology solutions for maintaining and enhancing productivity under changing climate.
- Carbon accounting procedures for forest stands, technology solutions for increasing stand carbon sequestration, and carbon offset solutions resulting from durable product use and biomass energy might help achieve this objective.

Objective 2.2 *Provide a reliable supply of rangeland products over time that (1) is consistent with achieving desired conditions on NFS lands and (2) helps support ranching in local communities.*

Some of the areas for which climate change influences implementation of Objective 2.2 are:

- Changes in range vegetation composition, productivity, and chronology might require changes in grazing allotment management plans, including allowable stocking levels.
- Increased intensity of grazing management can reduce methane emissions per unit of meat or milk production, producing a potential mitigation benefit.
- Scientific understanding of climate change-induced impacts to range productivity will help inform adaptation responses that protect resources and retain productivity.

Objective 2.3 *Help meet energy resource needs.*

Some of the areas for which climate change influences implementation of Objective 2.3 are:

- Increased focus on bioenergy applications for biomass utilization would provide mitigation benefits as the Woody Biomass Utilization (WBU) Strategy is implemented.
- A nationwide renewable energy strategy would identify the national priority for greater development of renewable energy applications on NFS and NIPF lands; the WBU Strategy would be incorporated. Forest Land and Resource Management Plan revisions and/or amendments might focus increased priority on renewable energy opportunities.
- Continued research on woody biomass feedstock production, harvesting, transport, and conversion to heat, power, and transportation fuels carried out by agency and partner research scientists and transferred to biomass energy entrepreneurs by agency technology transfer specialists would contribute to increased biofuel availability.

Objective 2.4 *Promote market-based conservation and stewardship of ecosystem services.*

Some of the areas for which climate change influences implementation of Objective 2.4 are:

- National forests can provide a living laboratory for gaining a scientific understanding of carbon budgets in natural ecosystems and how management options can affect them. Forest Service and other ecological researchers have long investigated carbon content and budget in separate tree tissues, other vegetation, duff, and soil, and research protocols are being adapted to carbon accounting protocols for determining effects of management on sequestered carbon.
- Agency scientists and managers can participate in national, regional, and State initiatives to regulate GHG emissions and market GHG emissions offsets or credits. Examples are State renewable portfolio standards and emissions caps, State and multi-State greenhouse gas initiatives, and carbon markets such as the Chicago Carbon Exchange (CCX).
- Increased understanding of ecosystem services provided by the Nation's forests and rangelands will be gained through agency and partner research.

- The potential for ecosystem services markets, including carbon markets, to provide increased financial incentive for NIPF landowners and tribes could be demonstrated at the State and tribal level by S&PF and at the national level through ecosystem services pilot projects on national forests.

Goal 3: *Conserve Open Space*

Outcome: Maintain the environmental, social, and economic benefits of forests and grasslands by reducing and mitigating their conversion to other uses.

Open space provides many environmental, social, and economic benefits to rural and urban communities. Undeveloped forests and grasslands, including working farms, ranches, and timber lands, help protect water quality, conserve native wildlife, and provide renewable timber and non-timber products, places to recreate, and scenic beauty. The NRCS National Resources Inventory shows a steady loss of these vital open spaces to developed uses. The Forest Service, in partnership with State forestry agencies, protects forests and grasslands from conversion to other uses through conservation easements of priority forest areas and support for sustainable NIPF management planning and implementation under forest stewardship plans.

Climate change-relevant existing SP text in Goal 3: Means and Strategies:

- “Provide technical assistance to landowners to accomplish the following goals:
  - “Increase the economic viability of private forest lands with income derived from the marketing of forest products, woody biomass, ecosystem services, and recreation....”
- “Provide educational, technical, and financial assistance to urban communities and urban/suburban landowners to restore environmental services through urban forestry, agroforestry, and “green infrastructure” approaches.”

Objective 3.1: *Protect forests and grasslands from conversion to other uses.*

Some of the areas for which climate change influences implementation of Objective 3.1 are:

- Increased economic viability of NIPF and tribal lands through owner and tribal marketing of carbon offsets can influence decisions by land owners and tribes to retain land in forest cover.
- Research on possible influences of climate change effects on NIPF and tribal forest health and productivity will inform landowner and tribal decisions to continue management of forest lands and NIPF owners to retain possession of their lands.

Objective 3.2: *Help private landowners and communities maintain and manage their land as sustainable forests and grasslands.*

Some of the areas for which climate change influences implementation of Objective 3.2 are:

- NIPF owners and tribes are becoming more aware of projected future impacts of climate change on their forests, and could be provided tools and assistance to understand likely climate change impacts and incorporate anticipatory adaptation actions into future management, including cutting cycles, regeneration strategies, wildlife habitat, and other management considerations. Adaptation measures could be incorporated into Forest Stewardship Plans. Forest Legacy project proposals could incorporate climate change adaptation considerations such as species migration corridors when identifying priority areas for conservation easements.
- NIPF owners and tribes could be made aware of opportunities and methods for climate change mitigation opportunities from managing stands for carbon sequestration and for marketing of this carbon, as possible additions to their Forest Stewardship Plan management objectives.
- Forest Service R&D products and services will assist with climate change adaptation and mitigation opportunities for S&PF programs.

Goal 4: *Sustain and Enhance Outdoor Recreation Opportunities*

Outcome: A variety of high-quality outdoor recreational opportunities on the Nation's forests and grasslands are available to the public.

The Forest Service is challenged with sustaining adequate high-quality outdoor recreational experiences to meet the Nation's needs while maintaining the ecological integrity of national forests and grasslands. If public lands are to provide additional recreational benefits without unacceptable resource impacts, we must emphasize effective management solutions that have a solid scientific foundation. The condition of the land, recreation facilities, and transportation infrastructure, including off-highway-vehicle access, must be considered if we expect to preserve high-quality recreation experiences. We must maintain specially designated protected areas.

Climate change-relevant existing SP text in Goal 4: Means and Strategies:

- “Develop the tools necessary to protect and sustain designated wilderness areas and the ecological and social values derived from designated wilderness areas.”
- “Provide recreational opportunities consistent with an area's physical, biological, and social characteristics and capabilities.”

Objective 4.1: *Improve the quality and availability of outdoor recreation experiences.*

Some of the areas for which climate change influences implementation of Objective 4.1 are:

- Recreation facilities will incorporate energy efficiency improvements and renewable energy applications.

- Road and trail infrastructure will be changed as needed to adapt to increased rainfall and extreme weather events.
- Developed sites where water availability and quality decline as aquifers and other water sources are affected by climate change will be evaluated for feasibility of continued operation.
- Management plans for climate-sensitive attractions such as glaciers and wilderness areas will be amended as necessary to reflect changed conditions and adjust permitted visitor density.
- Forest Service recreation research will investigate how climate change affects National Forest System and other recreation area attractions and provide managers with technology solutions for responding to these effects.

Objective 4.2: *Secure legal entry to national forest lands and waters.*

Some of the areas for which climate change influences implementation of Objective 4.2 are:

- Not applicable to climate change.

Objective 4.3: *Improve the management of off-highway vehicle (OHV) use.*

Some of the areas for which climate change influences implementation of Objective 4.3 are:

- Recreation research could investigate how NFS OHV use is influenced by increased public awareness of the societal need for energy conservation and alternative fuels as measures to mitigate climate change.
- Renewable fuel standards could be established for agency, contractor, and permittee OHV's and the public could be encouraged to use more environmentally benign biofuels and biobased lubricants for their OHV's.
- OHV trail systems that experience climate-induced vegetation changes will be evaluated to determine if they are still appropriate for OHV use.

Goal 5: *Maintain Basic Management Capabilities of the Forest Service*

Outcome: Administrative facilities, information systems, and landownership management with the capacity to support a wide range of natural resource challenges.

Natural resources are affected by a wide range of forces, including natural events, overuse, and various management activities. The Forest Service maintains a workforce with the skills and capabilities to deal with the impacts of these events. Reliable information, quality facilities, and land protection are necessary to effectively manage natural resources in a perpetual state of change.



Climate change-relevant existing SP text in Goal 5: Means and Strategies:

- “Recruit and train personnel to develop and maintain strong technical and leadership skills in Forest Service program areas to meet current and future challenges.”
- “Retrain existing employees or recruit new personnel to meet new workforce needs when the current workforce does not possess the necessary skills.”

Goal-level climate change implementation action for which no relevant strategic objective exists:

- Create and implement an employee climate change education and awareness program.
- Recruit and hire resource management, research, technology transfer, and administrative personnel with the necessary climate change education and training to equip the Forest Service to meet the Climate Change Challenge.

Objective 5.1: *Improve accountability through effective strategic and land-management planning and efficient use of data and technology in resource management.*

Some of the areas for which climate change influences implementation of Objective 5.1 are:

- Resource data in corporate information systems, including national forest compartment data and plot data from the Forest Inventory & Analysis and Forest Health Monitoring programs are critical for establishment of ecological baselines to support analysis of vulnerability of forest and range ecosystems to climate change impacts and assessment of adaptation options and to monitor ongoing climate change effects and results at broad scales of adaptive management.
- Resource data in corporate information systems, including national forest compartment data and plot data from the Forest Inventory & Analysis and Forest Health Monitoring programs are critical for establishing carbon accounting baselines for studies of management effects on net GHG emissions and for GHG offset marketing on NIPF lands.
- Operations data such as vehicle fuel use and energy consumption in facilities will be used to monitor compliance with sustainable operations policy. Access to these data will be improved and measures based on these data will be defined to monitor and improve implementation of sustainable operations policy and regulations.
- Climate change will be incorporated in forest plans through revision or amendment and in direct and cumulative effects analysis for project decisions.
- As a tool for forest planners, stakeholders, and agency decision makers to incorporate climate change into forest plans, Forest Service R&D will provide syntheses of projected climate change at the scale of broad-scale ecological assessments and of likely climate change impacts to sensitive, threatened, and endangered species, to currently viable

populations of desired species, to fire management, to timber and range productivity, to ecological associations and processes, to recreation uses, and to fisheries and watershed management.

Objective 5.2: *Improve the administration of national forest lands and facilities in support of the agency's mission.*

Some of the areas for which climate change influences implementation of Objective 5.2 are:

- Energy efficiency improvements and renewable energy applications will be installed in new agency facilities and retrofitted into existing facilities to gain mitigation benefits, capitalize on bioenergy options to reduce operating cost and offset GHG emissions, and to contribute toward sustainable operations.

Goal 6: *Engage Urban America With Forest Service Programs*

Outcome: Broader access by Americans to the long-term environmental, social, economic, and other types of benefits provided by the Forest Service.

The three branches of the Forest Service collectively promote public understanding of the value of well-managed public and private forest lands and the urban forest and better connection of urban residents with the benefits of agency programs. The Forest Service works closely with a variety of partners at the federal, State, and local levels to improve our understanding of what urban residents think of and want from their local parks, nearby woodlands, and national forests and to build productive relationships with urban neighbors.

Climate change-relevant existing SP text in Goal 6: Means and Strategies:

- “Continue urban forest inventory and analysis to monitor the health and benefits of ecological and social services of urban forests and more effectively manage these complex landscapes.”
- “Develop and disseminate strategies and options such as “green infrastructure” to effectively manage resources to maintain environmental quality and services in urban and urbanizing landscapes.”
- “Develop and disseminate tools to ensure that urban trees and forests are strategically planned and managed to maximize ecosystem services and benefits.”
- Engage partners and educators in the development, distribution, and use of high-quality conservation education materials and interpretive programs.”

Objective 6.1: *Promote conservation education to increase environmental literacy through partnerships with groups that benefit and educate urban populations.*

Some of the areas for which climate change influences implementation of Objective 6.1 are:

- Incorporate climate change into Forest Service conservation education materials and programs and assist conservation education partners to do the same.

Objective 6.2: *Improve the management of urban and community forests to provide a wide range of public benefits.*

Some of the areas for which climate change influences implementation of Objective 6.2 are:

- The strategic placement of urban and community trees can provide climate change adaptation benefits by ameliorating climatic extremes.
- Mitigation benefits can be derived from strategic placement of urban trees and minor vegetation when fossil fuel energy consumption for heating and cooling are reduced.
- Assist communities to develop bioenergy applications for managing urban wood waste, including residues from urban forest tree pruning and removal of pest-infested, over-mature or oversize, and inappropriately located trees.
- Continue and expand Forest Service research on climate change effects on, and opportunities from, urban & community forestry. Develop technology solutions for S&PF urban & community forestry partners to transfer to communities and homeowners.
- Provide urban Forest Inventory & Analysis results to urban & community forestry partners for use in evaluating, planning, and executing adaptation and mitigation measures.

Goal 7: *Provide Science-Based Applications and Tools for Sustainable Natural Resources Management*

Outcome: Management decisions are informed by the best available science-based knowledge and tools.

The Forest Service provides science and technology solutions for clients' and partners' priority issues in ways they find effective and useful for sustainably managing forests and grasslands.

Climate change-relevant existing SP text in Goal 7: Means and Strategies:

- “Develop and make available cost-effective methods for transferring scientific information, technologies, methods, and applications.”
- “Provide information and science-based tools that are used by managers and policymakers.”
- “Develop and deploy analysis and decision-support systems.”

- “Develop tools for evaluating the efficiency and effectiveness of alternative management practices.”
- “Ensure that current resource information is available to address the strategic, tactical, and operational business requirements of the agency.”

Objective 7.1: *Increase the use of applications and tools developed by Forest Service R&D stations and T&D centers.*

Some of the areas for which climate change influences implementation of Objective 7.1 are:

- Science syntheses and assessments of climate change will support forest plan revisions and project planning to address both adaptation and mitigation.
- Climate change is being incorporated into the program of work of the Eastern and Western threat assessment centers.
- The agency will continue internal and extramural research to enhance ecosystem health and sustainability, such as abiotic and biotic influences on sensitive species viability, with special focus on likely effects of anticipated climate change. Particular focus will be on interactions of organisms within ecosystems and differing responses of ecological associates in obligate and facultative trophic relationships.
- Research will be undertaken to assist managers to enhance carbon sequestration via management that could increase forest growth rates and area of forested land, increase retention of newly sequestered carbon, avoid carbon losses from major disturbances, enhance biomass extraction and utilization, and understand long-term carbon storage pools in forest products through life cycle analysis.
- Results of ecosystem health and sustainability research and research on carbon sequestration improvements will be integrated to develop decision support tools and approaches for policymakers and land managers.
- Shared research opportunities will be determined and executed for infrastructure, scientific collaboration, and technology transfer needed over the next decade to facilitate and implement natural resources planning, research, and applications.

#### Strategic Plan—Business Foundation

This section of the Strategic Plan outlines proposed improvements in business management and agency functions that support our workforce to increase the efficiency and effectiveness in achieving desired outcomes. They are elements of the means to the ends of the strategic goals, and therefore not ends in themselves. Generally, the Forest Service is required to practice these improvements through legal or regulatory direction. They represent good business practices.

Human resource management interventions to enhance Forest Service workforce capability to address climate change are largely discussed under Goal 5 above.

Improving agency service to the public through electronic government will lower our carbon footprint by replacing publications printed on paper, which generally represent a significant input of fossil fuel energy, as a source of information on recreation opportunities and technology applications, with web sites on which the information is available. Web-based information transfer allows information to be updated as needed and avoids the disposal of outdated publications in landfills, sometimes with associated methane emissions.

Research and Development investment criteria, and the five-year cycle under which research programs are evaluated, provide a mechanism to target needed climate change research. Research relevance is one of three principal criteria, and climate change is clearly a highly relevant research topic. Research program quality and performance are the other two criteria. The relevance, usefulness, and accessibility of R&D products and services are being monitored using a nationally recognized customer satisfaction survey protocol. The high level of public concern over climate change will provide a third-party corroboration of agency prioritization of climate change research.