



## USDA Forest Service Climate Change and Wilderness Briefing Paper

---

*“Climate change makes droughts worse, causing worse insect outbreaks and worse fires, which in turn means more smoke and carbon in the atmosphere – and more climate change. This cycle threatens the capacity of our forests to provide all kinds of environmental services that people have come to expect, including clear air and water, habitat for fish and wildlife, and opportunities for hunting, fishing, skiing, and other kinds of outdoor recreation”.*

– Forest Service Chief Gail Kimbell

### **Wilderness must be an important and integral part of an effective Forest Service climate change strategy.**

- Wilderness, as a land use designation, contributes positively to the mitigation of climate change. Mitigation refers to reducing emissions and enhancing sinks of greenhouse gases. However, there is no clear evidence that changing how wilderness is managed would have a significant effect on the mitigation effectiveness of Forest Service lands.
- How wilderness is managed can have a substantial effect on adaptation to climate change. Adaptation refers to actions taken to reduce the adverse effects of climate change on ecological, economic and social systems.
- Almost one in every five acres of the Forest Service is designated wilderness and wilderness lands are disproportionately critical to a climate change adaptation response.
- For a Forest Service climate change strategy to be effective, wilderness must be better integrated with the rest of the Forest Service. Other Forest Service staff areas must contribute more time and resources to wilderness and wilderness staff must be more willing to work with others to find compromise large-scale solutions to climate change and biodiversity conservation issues that work within and outside of wilderness boundaries.

### **To support an effective Forest Service climate change program, traditional wilderness management must be strengthened and stewardship goals need to be reassessed.**

- Appropriate wilderness management is particularly important in minimizing the adverse effects of climate change on biodiversity conservation and the ecosystem services of fresh water and regulation of the hazards associated with wildfire.

- It is critically important to ensure that (1) grazing, recreation, mining and other threats to water quality are appropriately managed; (2) wildfire hazard is more effectively managed by better balancing suppression policies with strategies that reduce long-term risk by allowing more fires to burn, and (3) biodiversity conservation strategies are developed at large spatial scales.
- Given climate change, wilderness stewardship goals will need to be reassessed. Goals based on the traditional concept of naturalness, will need to be supplemented or replaced by goals that more precisely describe the desired ecological outcomes of stewardship programs, particularly where they involve intentional manipulative intervention and restoration.
- Monitoring and research needs to be increased in wilderness to provide the ecological foundation for effectively responding to climate change. Wilderness provides some of the best large undisturbed landscapes available as natural laboratories.

### **Background**

As discussed in the Forest Service Strategic Framework for Responding to Climate Change, strategies to address climate change must encompass two components: mitigation and facilitated adaptation. Mitigation “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.” Facilitated adaptation “refers to actions to adjust to and reduce the negative impacts of climate change on ecological, economic, and social systems.” Forest Service wilderness contributes to both mitigation and, in particular, must be an integral part of Forest Service adaptation strategies.

### **Mitigation**

The designation of lands as wilderness, when contrasted with land development, contributes substantially to climate change mitigation efforts. Largely undisturbed wilderness lands are significant sinks for greenhouse gases and most activities in wilderness do not emit large quantities of the greenhouse gases. However, in terms of mitigation effectiveness, it is unclear how wilderness compares with other appropriately managed national forest lands. It seems unlikely that mitigation effectiveness would vary substantially with differences in how wilderness is managed, as long as management is consistent with The Wilderness Act. This all suggests that wilderness designation and traditional wilderness stewardship contribute to mitigation efforts, but there appears to be little potential to further mitigation efforts by changing time-tested approaches to wilderness designation and stewardship.

### **Facilitated Adaptation**

There is substantial consensus that the Earth’s climate is changing in response to greenhouse gases, that climate change will alter ecosystems and, ultimately, influence the ecological services that ecosystems provide. Some climatic, ecological and ecosystem service responses are highly likely. It is widely believed that temperature will increase,

snow pack will decrease and melt earlier, the frequency and severity of disturbances (e.g. flooding, fire and outbreaks of forest pests and disease) will increase, and many plant and animal species will attempt to migrate, typically to higher elevations and toward the poles (IPCC 2007a,b, c). Other responses are more uncertain. Some places are likely to see increased precipitation, while other places are likely to see decreases in precipitation (IPCC 2007a). Many responses will undoubtedly be complete surprises.

Climate change is expected to adversely affect critically important values and ecosystem services provided by the national forests and wilderness. Climate change could reduce the ability of ecosystems to provide such basic services as food, fresh water, fiber and genetic resources. It could reduce the ability of ecosystems to provide regulating services associated with water, air, erosion, pests and disease and natural hazards, as well as cultural services such as aesthetics, recreation and spiritual and religious values (MEA 2005). Of the many services and related values that are threatened by climate change, those most significant for wilderness ecosystems are probably (1) the provision of fresh water, (2) natural hazard regulation, particularly fire, and (3) the conservation of biodiversity. Any Forest Service strategy to effectively adapt to climate change and minimize adverse effects on ecosystems services and values must include wilderness lands if the strategy is to be effective

Water. Climate change in western mountains is projected to decrease snow pack, cause more winter flooding, and reduce summer stream flow, thereby decreasing critically important water supplies (IPCC 2007c). Forests provide nearly two-thirds of the freshwater in the 48 conterminous states (Stein et al. 2005). National forests and grasslands are the single largest source of drinking water in the United States; in western states they provide more than 50% of the water supply (USDA Forest Service 2000). Most national forest headwater watersheds are located in wilderness, making protection of wilderness water quantity and quality particularly important.

Given that climate change will reduce the supply of water, it is imperative that wilderness be managed such that the quantity and quality of water flowing from wilderness is not diminished further by other human activities. Adverse effects on wilderness watersheds are most likely to be caused by livestock grazing, activities that facilitate the spread of invasive species, recreation, mining activities and fire management practices that increase the likelihood of catastrophic wildfire (e.g. fire suppression often increases the long-term risk of catastrophic wildfire). Each of these activities has the potential to contribute to increased soil erosion and sedimentation and some add other pollutants to water. Actions to minimize the impacts of grazing, invasives, recreation and mining on water quality in wilderness must be a significant part of the overall Forest Service climate change adaptation strategy, as are efforts to appropriately manage the long-term risk of catastrophic wildfire (see below).

Fire. Warmer temperatures, reflected in longer growing seasons, drier soils and drier fuels have already been implicated in an increase in the frequency, intensity and size of wildfires (Westerling et al. 2006, IPCC 2007c). Longer, more severe fire seasons will likely affect fire management capabilities and effectiveness. Climate change adds to

concerns about increased fuel loadings from 70 years of fire suppression that have increased the risk of catastrophic fire, particularly in lower elevation and drier forest areas (Keane et al. 2002). As the risk of catastrophic fire increases, so does the risk to fire lives and property, the cost of fire fighting, smoke pollution, soil erosion and its adverse effects on water quality—risks that are also exacerbated by the enlarging wildland-urban interface.

With climate change, then, it is more important than ever to move beyond exclusive reliance on traditional fire suppression to fire management policies that better balance the short and long term risks associated with fire. In wilderness, wildland fire use is the preferred means of reducing combustible biomass because more intensive means (e.g. raking and piling of surface fuels, thinning of trees and other silvicultural treatments) are both less appropriate and more prohibitively expensive given the vast remote acreages involved. But many believe that wildland fire use will need to be augmented by prescribed burning and silvicultural cuttings that may have to be repeated a number of times (Keane et al. 2002). Adaptation strategies must include more resources and incentives for allowing fires to burn within or into wilderness, as well as consideration of prescribed burning and silvicultural treatments, even though these are actions that compromise the untrammled quality of wilderness character.

Biodiversity Conservation. With “medium confidence,” the IPCC (2007b) estimates that 20 to 30% of plant and animal species are likely to be at an increased risk of extinction if increases in global average temperatures exceed 2.7 to 4.5° F. Biological diversity is also likely to be further reduced by the spread of invasive species, many of which respond favorably to warmer temperatures and rising levels of atmospheric carbon dioxide (Ziska 2003). Loss of biodiversity, resulting from climate change, will be inversely related to the ability of species to either adapt to new conditions (“adaptation in place”) or move to environments where they are better adapted (“migration”). Adaptation in place will most likely be facilitated by maximizing genetic diversity and minimizing threats other than climate change. Successful migration will be dependent on “viable source populations and habitats, destination refugia and large-scale connectivity in the form of migration corridors or stepping stones between sources and destinations” (Taylor and Figgis 2007). The fragmentation of landscapes is a significant barrier to migration; it can also contribute to reductions in genetic diversity. This suggests that one key to minimizing the adverse effects of climate change on biodiversity is integrating management across large landscapes, to maintain and maximize diversity and to maintain, enhance and possibly assist the migration of species. Regional coordination and managing the matrix are as important to biodiversity conservation as appropriate management within protected areas such as wilderness (Hannah et al. 2002, CCSP 2008).

### **Integration of Wilderness Within the Forest Service**

Traditionally, the divide between wilderness lands and other lands managed by the Forest Service has been precipitous. Forest Service staff who are not funded by “wilderness” dollars seldom venture into wilderness or expend resources on its management. Conversely, the “wilderness” staff within the Forest Service have often adopted a fortress mentality—drawing a line around wilderness to defend it against the onslaughts of the

rest of the agency. This divide, along with the meager resources available to the “wilderness” staff, has always been a problem but it is one of the most substantial barriers to an effective Forest Service response to climate change.

If it is to respond effectively to climate change, the Forest Service can no longer ignore wilderness to the degree that it has in the past. Almost one in every five acres of the Forest Service is designated wilderness. Wilderness lands are disproportionately critical to an adaptation response to climate change. They provide some of the most important and threatened ecosystem services, such as fresh water and natural hazard regulation. They provide undisturbed corridors and elevation gradients in an otherwise fragmented landscape, contain important potential ecological refugia and provide valuable genetic reservoirs. Finally, they provide the best natural laboratories for gaining increased understanding about how best to sustain ecosystems and their human services into the future.

The boundaries between wilderness and surrounding lands must be made more porous if ecosystems are to respond appropriately to climate change. This will require change within the “wilderness” staff as well as elsewhere in the Forest Service. Appropriate management of designated wilderness will only be possible with the availability of resources more commensurate with wilderness acreage and need, along with more access to the time and resources of all Forest Service staff. Wilderness managers need to work with other Forest Service staff to develop large-scale strategies for effectively responding to climate change and managing other threats (Cole 2007). This will require compromise between such competing values as biodiversity conservation and the desire to leave nature alone (Cole 2000), conflict that is exacerbated by climate change.

### **Evolving Wilderness Stewardship Goals**

Climate change will force a reassessment of wilderness stewardship goals and objectives. In the past, goals have stressed natural conditions—usually considered to be either (1) those that would exist in the absence of modern, technological humans or (2) past conditions (within a range of historic variability) (Cole et al. 2008). But with climate change it is not feasible or desirable to attempt to maintain conditions in an unaffected or historic state, because “natural” conditions (as traditionally defined) will be “out-of-sync”—poorly adapted to future climates (Harris et al. 2006). Further guidance will be needed to articulate the wilderness values we will strive to sustain into a future that will be unprecedented and unpredictable. This guidance is necessary for wilderness managers to make good decisions about where and when to intervene in ecological processes and what the desired outcomes of interventions are.

Climate change will make wilderness stewardship more difficult. It fundamentally compromises the degree to which wilderness functions as a refuge from the effects of expanding civilization. It also exacerbates other ecological problems such as:

- Amplifying the adverse effects of fragmentation by increasing the need for some species to migrate.
- Increasing invasions by undesirable species that are better adapted to disturbed areas and climatic shifts.

- Greater problems with outbreaks of insects and disease.
- Enhanced risk of catastrophic wildfire, leading to attempted fire suppression, ultimately leading to further exacerbation of fire risk, insect and disease problems and other attributes of unhealthy forests.

Reassessment of stewardship goals for wilderness might best be undertaken in concert with efforts to better incorporate wilderness management within the entire Forest Service and across large landscapes, as discussed above.

### **Increased Understanding Derived from Wilderness Laboratories**

The foundation needed to implement the Forest Service’s global change strategy is dependent on an increased understanding of ecosystems and how they can be sustained for future generations (Powledge 2008). Large undisturbed landscapes that can serve as natural laboratories, controls and benchmarks are critical to increased understanding. Wilderness often provides the best available natural laboratories. For example, many of the lessons learned about wildland fire use—now being applied outside wilderness—were first learned in wilderness. Similarly, much of our knowledge about past climates—useful in learning how to adapt to change—has come from old trees, wood and pollen cores that increasingly can only be found on undisturbed wilderness lands. Long-term studies of species distributions—also best studied in wilderness landscapes—will be critical to understanding how species can adapt to change.

In a recent peer review of Forest Service research programs, Turner et al. (2007) concluded that “research in wilderness ecosystems should be a key component of any national climate change research program. High-elevation and high-latitude systems already have been identified as extremely vulnerable to effects of global climate change. Changes in the biota and in ecosystem processes and services must be understood in the absence of the myriad factors that confound attribution of cause and effect in more human dominated landscapes.” The difficulty of stewarding wilderness given rapid climate change, the importance of proper wilderness stewardship to adaptation, and the scientific value of wilderness—as the lands where we will learn much about mitigation and adaptation to climate change across all forest lands—all suggest an urgent need for increased scientific and monitoring attention to wilderness lands. More information is needed about what is there and how its attributes are changing and adapting.

### **References**

- CCSP (U.S. Climate Change Science Program). 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC, USA, 873 pp. <http://www.climatechange.gov/Library/sap/sap4-4/final-report/sap4-4-final-report-all.pdf>.
- Cole, David N. 2000. Paradox of the primeval: ecological restoration in wilderness. *Ecological Restoration* 18:77-86.

- Cole, D.N. 2007. Scaling-up the minimum requirements analysis for big wilderness issues. *International Journal of Wilderness* 13(1): 8-12.  
<http://leopold.wilderness.net/pubs/599.pdf>.
- Cole, D.N.; L. Yung; E.S. Zavaleta; G.H. Aplet; F.S. Chapin III; D.M. Graber; E.S. Higgs; R.J. Hobbs; P.B. Landres; C.I. Millar; D.J. Parsons; J.M. Randall; N.L. Stephenson; K.A. Tonnessen; P.S. White and S. Woodley. 2008. Naturalness and beyond: protected area stewardship in an era of global environmental change. *The George Wright Forum* 25:36-56. <http://leopold.wilderness.net/pubs/642.pdf>.
- Hannah, L.; G.F. Midgley and D.Millar. 2002. Climate change-integrated conservation strategies. *Global Ecology and Biogeography* 11: 485-495.
- Harris, J.A.; R.J. Hobbs; E. Higgs and J. Aronson. 2006. Ecological restoration and global climate change. *Restoration Ecology* 14: 170-176.
- IPCC (Intergovernmental Panel on Climate Change). 2007a. Summary for policymakers. In: *Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S. Solomon; D. Qin; M. Manning; Z. Chen; M. Marquis; K.B. Averyt; M. Tignor and H.L. Miller, eds. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. [http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1\\_Print\\_SPM.pdf](http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_SPM.pdf).
- IPCC (Intergovernmental Panel on Climate Change). 2007b. Summary for policymakers. In: *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry; O.F. Canziani; J.P. Palutikof; P.J. van der Linden and C.E. Hanson, eds. Cambridge, UK: Cambridge University Press: 7-22. <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf>.
- IPCC (Intergovernmental Panel on Climate Change). 2007c. North America. In: *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry; O.F. Canziani; J.P. Palutikof; P.J. van der Linden and C.E. Hanson, eds. Cambridge, UK: Cambridge University Press: 617-652. <http://www.gtp89.dial.pipex.com/14.pdf>.
- Keane, R.E.; K.C. Ryan; T.T. Veblen; C.D. Allen; J. Logan and B. Hawkes. 2002. Cascading effects of fire exclusion in the Rocky Mountain ecosystems: a literature review. General Technical Report. RMRS-GTR-91. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 24 p. [http://www.fs.fed.us/rm/pubs/rmrs\\_gtr091.pdf](http://www.fs.fed.us/rm/pubs/rmrs_gtr091.pdf).
- MEA (Millennium Ecosystem Assessment). 2005. *Ecosystems and human well-being: synthesis*. Washington, DC: Island Press. 137 p.  
<http://www.millenniumassessment.org/documents/document.356.aspx.pdf>.
- Powledge, F. 2008. Climate change and public lands. *Bioscience* 58: 912-918.
- Stein, S.M.; R.E. McRoberts; R.J. Alig; M.D. Nelson; D.M. Theobald; M. Eley; M. Dechter and M. Carr. 2005. Forests on the edge; Housing development on America's private forests. Gen. Tech. Rep. PNW-GTR-636. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.  
[http://www.fs.fed.us/pnw/pubs/pnw\\_gtr636.pdf](http://www.fs.fed.us/pnw/pubs/pnw_gtr636.pdf).

- USDA Forest Service. 2000. Water and the Forest Service. FS-660. Washington, DC.  
<http://fs.fed.us/pub/water/water.pdf>.
- Taylor M. and P. Figgis. 2007. Protected areas: buffering nature against climate change ~ overview and recommendations. In: Protected areas: buffering nature against climate change. Proceedings of a WWF and IUCN World Commission on Protected Areas symposium, 18-19 June 2007, Canberra. M. Taylor and P. Figgis, eds. Sydney, Australia: World Wildlife Fund-Australia: 1-12.  
<http://wwf.org.au/publications/cc-report.pdf>.
- Turner, M.G.; D.H. Anderson; G.H. Aplet; C.P. Dawson; J.G. Dennis; B.R. Noon and J.B. Waide. 2007. Report to USDA-Forest Service Research and Development: External peer review panel for the wilderness research program area. Unpublished report. 23 p.  
[http://fsweb.wo.fs.fed.us/rd/spas/3\\_Wilderness%20Review\\_Final%20Report.pdf](http://fsweb.wo.fs.fed.us/rd/spas/3_Wilderness%20Review_Final%20Report.pdf)
- Westerling, A.L.; H.G. Hidalgo; D.R. Cayan and T.W. Swetnam. 2006 Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 313: 940-943.
- Ziska, L.H. 2003. Evaluation of the growth response of six invasive species to past, present and future carbon dioxide concentrations. *Journal of Experimental Botany* 54: 395-404.