The Future of Our National Forests
Enhancing Adaptive Capacity
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Dr. Joyce's research has focused on quantifying climate change impacts on ecosystems, wildlife habitat and forests and also on developing adaptation options for their management. She is a climate change specialist for Resources Planning Act assessments in the Forest Service charged with identifying and coordinating analysis of the potential effects of climate change on U.S. forests and rangelands. She has contributed to various publications and studies on the first synthesis of management options available for national forest managers incorporating climate change considerations. She received her Ph.D. from Colorado State University, and was recognized with the Forest Service Deputy Chief's Distinguished Science Award in 2010.

What have we read so far in this e-book? Ecosystems are changing in response to observed changes in climate, extreme events, and disturbances such as fire and insects. We read not only that these changes are occurring but that we should expect them to continue – changes in temperature; more extreme events; and more disturbances such as fire and insects that are not like the past. Key point: these changes in climate and ecosystems are now part of the environment in which resource management occurs.

Resource managers base decisions on experience, an ever-developing field of scientific information and the local climate. Imagine driving from Aspen in the mountains to Fort Collins on the northern plains of Colorado. The tree species change from spruce and fir trees to ponderosa pine and then to only grasses, no trees. The vegetation differences are the result of different climates. Resource management in the forests around Aspen is different when compared to the ponderosa pine forests in the foothills and even more so when compared to the grasslands outside of Fort Collins. Various kinds of resource management activities used in these ecosystems are influenced by the climate in these ecosystems, such as when and what types of logging occur, how and when areas are protected for animals breeding, when and what type of prescribed fire is used and what size the road culverts are.

We can think of these management activities as tools in a toolbox. These tools have been developed based on the experience of natural resource managers and research scientists and reflect the climate in a given area. Because the toolbox reflects the climate in each area, we might ask, "Are the current tools in the natural resource management tool box appropriate for managing our National Forests under climate change?"

Adapting to climate change typically has two goals: reducing the vulnerability of ecosystems and human communities; and enhancing the resilience of ecosystems. Let's look at the first goal: reducing the vulnerability of ecosystems and human communities. We would say that an ecosystem is vulnerable when it is unable to cope with the adverse effects of climate change. Scientists have established that, over a long period, ecosystems have adapted to a certain frequency and intensity of fire. Thick bark on ponderosa pines gives it the adaptive capacity



High-elevation spruce and fir trees in the White River National Forest, Ponderosa pine trees with an understory of grasses in the Pike San Isabel National Forest and grasses and forbs in the shortgrass prairie on the Pawnee National Grassland shortgrass prairie. Photo Credits: U.S. Forest Service

to withstand periodic surface fires. Climate change will likely alter the kinds of fires and how frequent they occur. Under that future, ecosystems that have evolved over time to be resilient to fire could now be vulnerable to these different fire regimes. Whether that happens in your area is a function of what is happening to climate in your area. Is the temperature changing? According to the Colorado Climate Report, the temperatures in Steamboat Springs, Grand Junction, and Montrose have warmed over the last 100 years. Understanding what the changes are in your area begins the conversation on how your ecosystem or community may be vulnerable.

What have we learned from past natural resource management and extreme weather events? Lake Tahoe in Nevada, noted for the clarity of the lake water, is surrounded by forests, some managed by the U.S. Forest Service. Winter storms are a regular part of the climate here. The standard practice when any vegetation management treatment is done is to have the erosion protection devices in place before winter storms begin, more specifically by Oct. 15. The erosion protection devices are a tool in the natural resource management toolbox. These winter storms can be very wet. In 2009, a winter storm was forecast in early October, the first of the season. All accounts pointed to this first storm being a large one. Indeed, it was. 3.2 inches of moisture fell on October 14, more than 3 times the average for that day based on 101 years of weather data from the Tahoe weather station. Key point: the date, October 15, reflected an understanding of when winter storms typically, normally, usually start. Instead of looking just at the calendar, now we might need to look at the forecast as well as the calendar, and in so doing begin to determine if the dates associated with our resource management need to be changed. Learning from experience and iteratively incorporating lessons into future resource management is adaptive management in its broadest sense.

Let's look at the second goal: enhancing the resilience of ecosystems to the changing climate. We would say that an ecosystem is resilient when the same plants and animals can return after a disturbance such as wildfire. Stresses such as air pollution, invasive species, and fragmentation of habitat can reduce the ability of an ecosystem to return after a disturbance. The goal of enhancing the resilience of ecosystems would mean an attempt by resource management to reduce these stresses — reduce air pollution, remove or reduce the invasive species, and attempt to reconnect habitat for wildlife.

Meadow Creek wildfire, White River National Forest, was managed for multiple resource objectives with the major one being improvement of wildlife habitat by creating diversity in the vegetative mosaic. Photo credit: USFS

We have to keep in mind that the changes will continue and that these changes are directional. Key point: the temperature is warming, yes it will be variable, but the trend is directional. What does directional mean? Think of a balloon. Press your finger into the balloon, just a little and then let go. The balloon returns to its original shape. Press your finger into the balloon again, further and further – this is directional change. The balloon can only withstand so much directional change. For ecosystems, directional change in temperature means that at some point, the plants and animals on the landscape we know today may not be the plants and animals that will be best suited, adapted, to that landscape under climate change. We are seeing changes on the landscape today where plants and animals are not returning to develop the type of ecosystem before the disturbance. Plants and animals are reactive in response to climate change; they do not anticipate. Humans can anticipate. Preparing for these events is a necessary step in enhancing our adaptive capacity and it is also our greatest challenge.

In the West, changes associated with climate are very likely to be abrupt — a major fire, a drought, an insect outbreak, or a combination. When these abrupt changes occur, it may be important to be ready with a strategy for facilitating the new ecosystem conditions. Here management must be flexible, perhaps experimental, and we must learn with every step we take. Even outside of these events, it may be necessary to anticipate. As we learn more and begin to understand that the plants best suited to our landscape will be different, we may to begin

managing transitions to these new ecosystem conditions. In these situations, managing for adaptation means promoting efforts that sustain desired long-term ecosystem functions, such as maintaining soil productivity and health, maintaining watershed health, hydrological cycles, promotion of native flora and fauna, and maintenance of amenities that human communities depend upon from the National Forests, even in the face of eventual loss of the plants and animals as we know them now in many or most areas.

Much scientific information is available. My colleagues and I have found the most successful way to weave this scientific information with the on-the-ground experience of natural resource managers is a science-management partnership. This partnership can take many different forms from a one-day workshop, to a yearlong arrangement.

This partnership provides a place to ask the question about whether we have the tools in the natural resource management toolbox to reduce the ecosystem vulnerabilities and to manage the ecosystems for resilience, and to begin the conversation about managing the transitions to novel and new ecosystems. The key point here is that it is not so much talking as it is listening. Through these conversations, new ways of looking at natural resource management emerge. Can current tools be used? Can current tools be applied in new ways? Do we need new tools?

National Forest resource monitoring and management; manager collecting water samples to monitor air quality in Colorado.
Photo Credit: Linda Joyce

Rather than thinking about climate change as a problem, we might envision this as a puzzle. Each of us has a piece of that puzzle and all of our pieces are needed in order to create the picture of the puzzle. We know part of that picture. Temperature is warming and will likely continue to warm. There will be more extreme events, and disturbances such as wildfire and insect outbreaks will be different from our historical past. The resource manager must begin to contemplate whether the current tools in the natural resource management tool box can still be used, could be used in a new way, and what new tools are needed. By studying new questions, it helps us understand how climate and ecosystems interact. Scientists have the responsibility to bring that new information into natural resource management.

The National Forest, as well as the National Park, the Bureau of Land Management and the National Wildlife Refuge, must look across the boundary lines. The bark beetle outbreak in Colorado has taught many local, state and federal agencies, as well as private landowners, that these altered disturbances do not stop at the property line. The magnitude of such a large-scale event requires a coordinated response across the landscape. The greatest challenge is anticipating these large-scale events, managing them and adapting to large-scale changes.

Prescribed fire on the Gunnison National Forest, Colorado.
Photo Credit: Dennis Garrison, U.S. Forest Service

The public must also be involved, and you can get involved in many ways. You can be the eyes on the landscape. You can be a volunteer observer in the CoCoRaHS network – the Community Collaborative Rain, Hail and Snow Network – measuring and mapping rain, hail and snow. This network aims to provide the highest quality data for natural resource management, education and research applications. Or you can be a volunteer observer of the National Phenology Network. What is Phenology? It is the recurring plant and animal

Forest Service Scientists Conduction Field Research. Photo Credits: Michael Kyan

life cycles, such as leafing out and flowering. Scientists know that these events are sensitive to climatic variation and change. Observers watch for when a flower blooms, or when insects emerge, or birds migrate. As an NPN observer, you can help scientists identify and understand environmental trends so we can better adapt to climate change, and share your concerns with natural resource managers and scientists.

Each of us has a piece of that puzzle and all of our pieces are needed in order to create the picture of the future of National Forests and enhancing our adaptive capacity.

Public Involvement on National Forest: Moving young seedling trees up steep slopes for planting. Photo Credit: Wendy R. Maguire

Nature watch migratory Bird day for kids. Photo Credit: Mary Cunningham