

Workshop Approach for Developing Climate Change Adaptation Strategies and Actions for Natural Resource Management Agencies in the United States

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ABSTRACT

Concrete ways to adapt to climate change are needed to help land-management agencies take steps to incorporate climate change into management and take advantage of opportunities to balance the negative effects of climate change. Because the development of adaptation tools and strategies is at an early stage, it is important that ideas and strategies are disseminated quickly to advance thinking and practice. Here, we offer an example of a successful workshop, focused on National Forests in the United States, which allowed quick dissemination of ideas and strategies for climate change adaptation in resource management through an interaction between scientists and managers. We share both the process used in the workshop and the outcome of facilitated dialogue at the workshop. By presenting concrete adaptation methods and showing the value of a focused scientist–manager dialogue, we hope to motivate the US Forest Service and other natural resource agencies to emulate our approach and begin the process of adapting to climate change.

Keywords: climate change, adaptation, forest management

Sadowski 2008), and biological diversity (Heller and Zavaleta 2009). Recent information on climate change adaptation for natural resources provides general adaptation strategies (Millar et al. 2007, Joyce et al. 2008, Innes et al. 2009). Only a few sources contain information on adaptation to climate change that is relevant and usable for natural resource managers from a tactical or operational perspective (Ogden and Innes 2007a, 2007b, 2008). Now that most land managers have accepted that climate change is real and of great concern, more concrete ways to adapt to climate change are needed to help managers take the first steps to incorporate climate change into management and reduce the negative effects of climate change on natural resources.

The US Forest Service administers over 78 million ha of land in 155 national forests and 20 national grasslands across the United States. The US Forest Service also advises and cooperates with private and state forest-

Climate change presents a major challenge to natural resource managers both because of the magnitude of potential effects of climate change on ecosystem structure, process, and function, and because of the uncertainty associated with those potential ecological effects. Furthermore, managers lack operational strate-

gies to aid in adaptation to climate change. In emerging literature on climate change adaptation, much of the focus has been on conceptual issues (Hansen et al. 2003), potential actions by governments and municipalities (Intergovernmental Panel on Climate Change 2007, Snover et al. 2007), individual resources (Slaughter and Wiener 2007,

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land managers and the international community. The National Forest System encompasses a wide range of different ecosystems and much of the country's terrestrial biodiversity. In addition to biodiversity, other ecosystem services provided by the National Forest System include water, timber, and fiber (provisioning services); recreational, aesthetic, and spiritual benefits (cultural services); regulating services that affect climate, floods, and water quality; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Millennium Ecosystem Assessment 2005). Climate change will likely impact all these ecosystem services provided by national forests. The US Forest Service is responsible for restoring, sustaining, and enhancing forests and grasslands while providing and sustaining benefits to the American people. Because of these responsibilities, federal scientists and land managers are tasked with reducing the negative effects of climate change on ecosystem function and services, while promoting and enabling beneficial aspects (US Forest Service 2008, 2009). Timely implementation of strategic and tactical adaptation options, with an emphasis on practical approaches that can be applied within the broader context of sustainable resource management, will be critical to meet both goals (Innes et al. 2009).

Resource managers are expected to incorporate science and climate change adaptation practices into planning, and they have the skill and local knowledge to do so but have limited exposure to rapidly changing scientific advances on climate change and related impacts. Scientists have technical knowledge but often a poor understanding of management and regulatory, policy, and collaborative social processes for resource planning and decisionmaking. A clear need exists for these two groups of specialists to work together to develop and implement applied adaptation projects. However, lack of formal relationships and differences in work culture, time frames, and communication styles have limited this dialogue at all scales. In addition, with climate change, there is an overwhelming amount of information that managers are trying to absorb, a very steep learning curve with climate change science, and little time for learning given managers' many responsibilities.

Here, we offer an example of a successful workshop process that allowed quick dissemination of ideas and strategies for climate change adaptation in resource management

through an interaction between scientists and managers. This interaction serves as an example of what might be done to promote collaboration between scientists and managers in climate change adaptation. In addition, because the development of adaptation tools and strategies is at an early stage, it is important that ideas and strategies are disseminated quickly to advance thinking and practice. Thus, our objectives were to describe and evaluate the process used in the workshop, the educational product, and the outcome of the facilitated dialogue of the workshop. In addition to describing the outcomes of interactions between scientists and land managers, the ideas discussed here build on existing principles of adaptation to climate change, such as the US Climate Change Science Program Synthesis and Assessment Product 4.4 (Joyce et al. 2008), Millar et al. (2007), and Bosworth et al. (2008), by providing concrete and tactical ways for resource managers to adapt to climate change.

The Workshop Process

We convened a workshop with a novel format to develop Web-based educational materials on climate change and management options for adapting to climate change in the US Forest Service and natural resource management agencies in general. The workshop was organized as a retreat at a remote long-term ecological research station in the central Oregon Cascade Mountains (the H.J. Andrews Experimental Forest). There, scientists and resource managers participated together in the final review of the course materials and took part in intensive discussion on climate change adaptation. We chose a workshop format because other studies have reported that managers do not have sufficient time to read refereed journal articles (one form of scientific outreach), and workshops provide opportunities to transfer information and facilitate interaction between managers and scientists (Schmoldt and Peterson 1991, Barbour 2007, Youngblood et al. 2007). The workshop not only served to transfer climate change science and adaptation information, but also gave managers the opportunity to ask the "so what" question when presented with climate change science information and heightened the managers' participation in vetting current adaptation strategies. In addition, a workshop process seemed appropriate to address the issue of climate change adaptation, because multiple workshop participants can

bring different expertise and perspectives on complex problems (Schmoldt and Peterson 2000). Finally, a workshop environment promotes two-way learning, where managers not only learn new science, but the scientists involved learn from managers about real-world science applications. We believe this event was significant because of the process used, group of people assembled, depth and usefulness of ideas generated, and quality and value of products delivered.

The workshop was conducted over a 3-day period and was focused on two specific goals: (1) to develop and videotape a coordinated lecture series and related discussions on climate change, ecosystem response, and resource management to develop a multimedia, Web-based educational module and (2) to promote focused dialogue on climate change and management within a select group of resource managers and scientists and to capture the lessons learned from these interchanges. Organizers developed a list of relevant topics for the course, and then 12 key scientists from the US Forest Service and other federal agencies with expertise on the topics and contextual experience were invited to develop talks to address these topics for videotaping. Themes for the talks were climate variability and projections, ecological responses to climate variability, and management responses to climate variability. Lectures were targeted for land managers in the western United States. Many of the talks were based on previous presentations, so coordination, review, and vetting were well advanced.

A group of 20 natural resource specialists and managers with expressed interest in climate change issues were invited to serve as reviewers and discussants for the workshop. After rehearsal talks were given by the scientists, both scientists and managers discussed the talks and provided critical review to improve relevance, clarity, and accessibility of the lectures. Discussions (along with general logistics) were managed by a designated facilitator, and three recorders took notes throughout the discussions. After each talk, respondents (scientists and managers) were also asked to develop questions and commentary that were used during formal videotaping. The questions and commentary were developed to be representative of what other managers might ask or comment on in response to the lectures. Based on critiques and comments, scientists then revised their talks and delivered the revised talk the following day for formal videotaping. Subse-

quent to the workshop, continuing critique, review, and revision of the videotaped lectures ensued. The final products from the workshop have been developed into educational modules for a Web-based short course (Furniss et al. 2009). The final short course product is described in more detail in the Results section.

In addition to producing videotaped lectures, we held a half-day facilitated discussion session during the workshop to take advantage of the diverse group assembled and thereby advance thinking on issues related to incorporating climate into resource management. These discussions were focused on two main questions: (1) How can climate science be directly incorporated into resource management? (2) How can the uncertainty of future climate change and effects be evaluated and managed? Small breakout groups of scientists and managers brainstormed answers to a given question, and then discussion of ideas with the entire group followed. A facilitator guided discussions, ensured that they remained on topic and within allotted time periods, and promoted input by everyone in the group. Three recorders took notes during the discussions and consolidated information after the workshop. Ideas that seemed to have group agreement were retained. The concepts and tactical approaches produced during this workshop provide concrete tactics to incorporate climate change science into resource management. The ideas and approaches conveyed by participants during the workshop are described in the Results section.

Workshop Results

The Web-Based Short Course Product

The H.J. Andrews Climate Short Course for Resource Managers (Furniss et al. 2009) is an online package (also available on DVD) with video lectures and interactive quizzes on climate and implications of climate change for management of national forests and grasslands. The short course was developed to be consistent with the goal of the larger Climate Change Resource Center website (US Forest Service 2010), which is to communicate current science on climate and climate change relevant to the most pressing questions faced by national forest and other resource managers. Course materials are grouped under three headings, physical climate information and climate change background, ecological

responses to climate, and management options in the face of changing climates. The first four presentations set the stage for the course by providing background information on past climates, climate variability, and future projections of climate and ecological response. The next set of four presentations gives information on the ecological consequences of climate change. The last set of six presentations is focused on management responses to climate variability.

The format of the short course allows managers to go through the materials as time allows and at their own pace; video lectures can be stopped and started at any point. Quizzes provide a way for managers to test their knowledge and reinforce key ideas. In addition, literature citations and links to additional information on the Climate Change Resource Center website allow managers to further delve into topics of interest.

Scientist–Manager Dialogue during Short Course Production

The development process for the short course (live peer review of lectures) led to provocative discussion among the participating scientists and managers. Managers had a number of fundamental questions about climate change after the first set of talks on past climates, climate variability, and future projections of climate and ecological response, such as, “If climate undergoes wide swings naturally, why should we be concerned about current climate change?”; “Are there past analogs to current changes in climate that can help us to understand what will happen with current climate change?”; and “Given what we know about climate cycles such as the El Niño Southern Oscillation and the Pacific Decadal Oscillation, can we better predict resource conditions with human-induced climate change?” The appropriate role of historical range of variability in management triggered a stimulating discussion. In general, managers have limited experience with climate models, and there were a number of questions about climate models such as, “What is the availability of climate predictions for the site or local scale and how reliable are they?” and “Attribution of climate change to humans relies on very complex models that do not include all the processes that determine climate. Can we trust these models? How do we derive what is useful from these complicated models?” There were also a number of questions about how to incorporate climate change into management such as, “Many

management decisions are short duration and site-specific. How should these climate change predictions influence management decisions?”; “How can we manage in the face of all this uncertainty associated with future climate change?”; and “Scientific papers sometimes have opposing and contradictory results. How do we take this information and use it in our land management?”

Talks on the ecological consequences of climate change led to questions such as, “How do I know what the intrinsic sensitivities are in my landscape?”; “How do you define ecosystem collapse?”; and “Shifts in native species with variation in climate brings into question the definition of an invasive species. At what point does a generalist that is adapting well to climate change become an invasive species?” There was also great interest in the third group of talks focused on carbon. Questions raised after these talks included, “We are getting requests to calculate carbon sequestration at the project scale. What scale is appropriate to calculate carbon sequestration—the project scale or the national scale?”; “How should we consider carbon in planning a precommercial thinning project?”; and “At what scale should we calculate our carbon fluxes?”

Many of the more challenging questions raised during the short course production, particularly on incorporating climate change into management and dealing with uncertainty, were further discussed in the facilitated dialogue that followed production (described later). Other questions highlighted gaps in information and areas where more investigation is needed. Thus, the scientist–manager dialogue during the workshop helped to underscore important questions for scientists to address in the future. Iterations of this type of workshop would help to further facilitate two-way scientist–manager dialogue and the adaptation process.

Facilitated Discussion Outcomes: Tangible Ways to Incorporate Climate Change Science in Resource Management

The background information provided by the lectures prepared workshop participants for in-depth discussion on climate change adaptation. Many ideas from participants in the facilitated dialogue focused on how climate change science can be institutionalized in agencies involved with the management of natural resources, such as

the US Forest Service and the US National Park Service. US Forest Service resource managers and scientists have dealt with a number of major challenges over the last few decades, including a major transition from emphasis on production of timber and commodities to ecological restoration and management for biodiversity. Workshop participants thought that these past challenges leave the agency well prepared for the shift in thinking required to meet the challenge of climate change. Institutionalization will involve incorporating climate change into many aspects of agency planning and process, and several of these aspects were suggested by workshop participants. For example, if climate change is institutionalized, it will be more fully considered in the national forest planning process, at all stages of project development, and in work prioritization, funding prioritization, hiring decisions, and staff performance reviews. In addition, incentives can be created to promote advances in addressing climate change and reducing vulnerability to climate change.

Education was suggested to be critical in increasing awareness of and promoting problem solving related to climate change. It was noted by managers that climate science needs to be made "less scary." Several ideas for climate change education methods for land managers were proposed during the workshop. For example, exposing resource managers to climate change science, promoting dialogue, and creating opportunities for education will help managers to be aware of the best available science, understand concepts associated with climate change science, acknowledge and accept uncertainties associated with future climate projections, and incorporate climate change into routine management activities.

Managers in particular thought that educating the public on climate change will have multiple benefits for natural resource agencies. Many managers at the workshop described litigation and appeals as barriers to implementation of active land management. Educating the public on climate change would promote understanding of the steps that state and federal land-management agencies can take to address climate change, thus promoting support for these actions and helping to avoid costly litigation. In addition, education could increase public cooperation with land-management agencies and could help agencies to meet management goals. For example, engaging landowners adjacent to fire-prone public lands

will assist efforts to reduce wildfire hazard and severity.

Workshop participants agreed that scientists will play a key role in helping managers deal with climate change by providing the best available information on climate change science and the ecological effects of climate change to inform management decisionmaking. Scientists can also encourage managers to think more scientifically, i.e., to base their decisions on high-quality literature, understand and disclose assumptions and limitations, subject their work to critical review, and take an experimental approach and monitor results. Managers, in turn, can help scientists be more practical, tune their scientific inquiries to the most relevant problems, and focus on solutions and the applicability of findings. Thus, it was suggested that iterative interactions and dialogue between scientists and managers, and forums for doing so, will be critical to incorporating climate change into natural resource management. Multiple ways to promote scientist–manager interactions were suggested, including iterative small meetings and informal discussions within communities of practice (e.g., water resources and vegetation management). Manager information needs can be determined with the use of surveys (e.g., Ogden and Innes 2007b). Science delivery can be enhanced by commissioning technical communication teams for natural resource agencies. Scientists and managers can also share information with others on successes and failures in climate change adaptation via the Internet and at professional meetings.

In addition to collaboration between scientists and managers, workshop participants indicated that collaboration among agencies, organizations, and stakeholder groups will help facilitate adaptation to climate change. Collaboration among stakeholders has become more common with management of large landscapes. Although collaboration among stakeholder groups often requires increased time and effort by managers initially, developing common plans and shared visions of resource management can result in saved time and financial resources over the long term and more innovative and, ultimately, more effective strategies in the face of climate change. For example, management for species such as ungulates and carnivores with home ranges larger than any single agency's ownership can be improved through collaboration among stakeholders (Baron et al. 2008,

Heller and Zavaleta 2009). Collaboration can also be expanded to a united climate change outreach program, such as the proposed US National Climate Service, that provides information on climatology, predictions of climate change effects, planning tools, and tutorials.

Many plant species will be subjected to increasing stress in a changing climate, and some species and genotypes may be unable to adapt to rapid warming. Workshop participants agreed that genetic stock that is better adapted to climatic conditions of the future will be more resilient and also increase overall ecosystem resilience. For these reasons, it will be imperative that natural resource agencies reassess genetic resources (e.g., seed availability and nursery stock) with climate change in mind. Participants suggested that agencies may want to put more existing resources into state and federal nursery programs, expand germplasm collections (seed and pollen), restore germplasm archives (many seed storage units have been closed), and include broader representation of diverse provenances. In addition, experimentation to determine the best provenance and species mixes to plant after disturbance in different locations can help to increase plant community resilience to both climate change and the disturbance regimes of the future.

Increased disturbance will almost certainly be associated with a warmer climate in many locations. For example, area burned by wildfire (McKenzie et al. 2004) and subjected to bark beetle outbreaks (Hicke et al. 2006) is expected to increase significantly across the western United States. Likely because many managers already deal with natural disturbance, managers were accepting of ideas related to management for disturbance. Workshop participants proposed that disturbance be incorporated into natural resource planning, rather than being treated as an anomaly, to facilitate timely and effective management actions when disturbance events occur. Participants suggested that using past extreme events and response to those extreme events as a context may help to structure thinking and improve response to future events. In addition, management activities that reduce the severity of disturbance, such as reduction of hazardous fuels in fire-prone forests, may help to reduce ecosystem vulnerability to a warmer climate. Fuel reduction activities are already conducted in many locations in the western

United States and thus would be relatively easy to implement.

Facilitated Discussion Outcomes: Tools and Methods to Evaluate and Manage Uncertainty

Dealing with uncertainties associated with the magnitude of changing temperature and precipitation and the magnitude and nature of ecological effects of climate change is one of the biggest challenges for land managers facing a changing climate. The many types of uncertainties can be overwhelming and delay adaptive responses. Several managers at the workshop described difficulties they have in thinking about climate change because of the uncertainties in model projections of future climate and ecosystem response. The second part of the facilitated dialogue, summarized later, was focused on tools and methods to evaluate and manage uncertainties associated with climate change in natural resource management.

To incorporate uncertainty into management, workshop participants suggested that scenarios be developed to bracket a credible range of potential future climates and ecosystem conditions. Managers could work to develop associated strategies for dealing with those ranges of future conditions. Commonalities among scenarios and associated management strategies could be a focus to determine which management practices would be the most robust to varied future conditions. For example, even if precipitation projections vary among scenarios, if summer rainfall stays relatively low in the western United States, warmer temperatures will lead to reduced summer soil moisture. Thus, managers may want to develop adaptation strategies that will help forests be more resilient to summer drought, such as forest thinning.

Participants thought that keeping an open mind is also going to be important for managers in dealing with uncertainties of climate change. Receptivity to climate change science on the part of managers, as well as willingness to explore relevant questions that produce management-relevant information on the part of scientists, will be necessary for climate change science to be incorporated into management (Jones et al. 1999, National Research Council [NRC] 2009). Even with the use of the best available science, it was suggested that periodic failures will be an inevitable part of dealing with climate change. Structuring management targets so that they could be reached in

multiple ways is one way to avoid frequent failure. However, periodic failures will be an important component of active learning as climate change effects are realized.

Managers were also concerned about risk, or exposure to the chance of loss (Kerns and Ager 2007), associated with climate change. It was suggested that, as a simple first step, both risks to ecosystems and risks associated with taking the wrong management path can be identified by asking "what if...?" during planning and project development. For example, what if natural regeneration failures occurred after increased summer drought? Would artificial regeneration activities increase regeneration without having other unintended consequences?

However, it was pointed out that there are more robust risk analysis tools that can be used when time and resources allow (see examples in Kerns and Ager 2007, Brekke et al. 2009, and NRC 2009). These tools can be used to quantify or approximate the likelihood of ecological changes, such as species, population, or habitat loss or gain, or streamflow increases and decreases. Risk analysis tools can also be used to evaluate tradeoffs associated with different management decisions and prioritize management actions. It was suggested that adding employees or functions that aid in risk assessment could help managers use these tools to incorporate risk into management.

Workshop participants widely agreed that increasing the resilience of ecosystems or increasing the ability of an ecosystem to accommodate climatic changes and return to desired conditions after disturbance (Millar et al. 2007) is one way to prepare for an uncertain future. Some managers expressed frustration with continuous suggestions to increase the resilience of the ecosystems they manage without being given any concrete ideas as to how to increase resilience. Therefore, several ways to increase watershed and ecosystem resilience to climate change were suggested. For example, it was suggested that using a portfolio of management approaches and practices, much like a stock portfolio, can help managers to "hedge their bets," increase the diversity of outcomes on the ground, and thus increase ecosystem resilience. Increasing the diversity of vegetation structures across large landscapes can help to increase ecosystem resilience to climate change. Diversifying seed banks and plantings (within and across species) could increase resilience by reducing the likelihood of forest stand failure. Several actions could

also be taken to increase watershed resilience and maintain water quantity and quality, such as protecting riparian forests and restoring wetlands and floodplains.

Many workshop participants suggested that reducing the effects of already existing nonclimatic stressors on ecosystems, such as landscape fragmentation and invasive species, will also increase ecosystem resilience to climatic changes. Managers were quick to point out that climate change is not the only issue they must deal with, and because of financial and time constraints, climate change may be a low priority for some natural resource managers (Moser and Luers 2008). However, it was suggested that embracing integrated ecosystem-based management and sustainable resource management in general, in which climate change is one of many stresses considered, could help alleviate current constraints on allocation of time and effort for managing climate change effects.

Discussion

Adaptation options generated during the workshop are consistent with the more general climate change adaptation strategies outlined in recent reports, including the strategies of promoting ecosystem resilience (Dale et al. 2001, Spittlehouse and Stewart 2003, Millar et al. 2007, Blate et al. 2009, Joyce et al. 2009), reassessing genetic resources (Smith and Lenhart 1996, Parker et al. 2000, Noss 2001), promoting education and awareness about climate change (Smith and Lenhart 1996, Spittlehouse and Stewart 2003, Moser and Luers 2008), and facilitating effective communication between scientists and managers (Baron et al. 2008, Joyce et al. 2008, Moser and Luers 2008). However, many of the ideas produced during the workshop were more specific and would thus affect resource management more directly than the general ideas that dominate current adaptation literature. These more concrete ways to adapt natural resource management to climate change were developed as a result of the workshop approach that allowed for direct engagement between scientists and managers in a "retreat" setting. Several other studies have shown that workshops that include both scientists and managers can be successful for brainstorming and problem solving in natural resources (e.g., Schmoldt and Peterson 1991, Schmoldt and Peterson 2000, White 2004, Youngblood 2007), and the recent report on "Informing Decisions in a Changing Cli-

mate” by the NRC (2009) calls for direct engagement between scientists and users of scientific information for effective climate change decisionmaking. The workshop we conducted was an efficient method for communicating climate change science to managers and an effective way for scientists to learn about what information is most useful to managers. In addition, the lecture series served as a foundation by providing education and review of vulnerabilities to climate change, which then allowed for more in-depth thoughts and discussion on adaptation. As found in other studies (e.g., Schmoldt and Peterson 1991), asking specific questions and conducting a facilitated discussion led to more productive dialogue on adaptation. Breakout groups during the facilitated discussion were also effective in promoting interaction between scientists and managers and generating adaptation ideas. This workshop can serve as a model others can follow for future development of climate change adaptation options for natural resource management. Iterations of this type of workshop may also lead to better-informed adaptation actions by natural resource agencies (NRC 2009).

The workshop also resulted in efficient development of online education materials for use by natural resource managers. The workshop approach allowed managers to critique presentations and ask questions to make the material more relevant to them. We believe this led to the development of a high-quality educational product. The quality of the lectures, and a user-friendly interface, seem to be contributing to the positive reception of the online and DVD short course produced from the workshop. In addition to being available on the Web, DVDs of the short course were produced and distributed to hundreds of national forest offices across the United States. Hundreds of DVD versions of the short course were also made available at the United Nations Climate Change Conference in Copenhagen in December 2009. Although reception of the short course has generally been positive, some managers requested more guidance on how to use the short course, perhaps because they did not have sufficient time to listen to all of the video lectures and wanted to choose only a few. Adding different pathways through a short course, with some less time-intensive options, may be a way to avoid this problem in the future. However, climate change is an issue that is going to require expenditures of time and effort by

natural resource specialists to become educated and effectively address climate change.

The success of a workshop such as the one we conducted depends on a number of factors. First, managers must be engaged and open-minded to provide useful critique and ideas. Invited scientists must be carefully selected to ensure that credible and relevant science is presented. Coordination of lectures requires careful planning and organization, as well as knowledge of relevant issues. Extracting useful ideas from a group of workshop participants requires careful planning and facilitation of discussions (Schmoldt and Peterson 1991). In addition, skilled discussion recorders are necessary for workshop outcomes to be summarized and effectively communicated.

Although more concrete adaptation ideas were generated during the workshop, many ideas were general in nature. This is likely because both scientists and natural resource managers are still in relatively early stages in development of adaptation plans. More specific and tactical approaches to climate change adaptation will likely come with more in-depth and place-based analyses of climate change impacts, vulnerabilities, and related management options.

Conclusions

Adaptation to climate change presents organizational and cultural challenges in addition to ecological ones. Many ideas that emerged in the workshop with natural resource managers and scientists focus on institutional changes that need to occur for successful adaptation. Even if good scientific information and financial resources are available, regulations (e.g., US Endangered Species Act), policy (e.g., forest harvest restrictions), and litigation (e.g., lawsuits from advocacy groups) can prevent or reduce the effectiveness of proposed adaptation activities. This will be a significant challenge for the implementation of adaptation on public lands.

Finally, with the possible exception of legislation being considered by the US Congress, the US Forest Service and other federal agencies that manage natural resources in the United States currently do not have a mandate for developing adaptation plans or a framework through which adaptation can be accomplished. It is challenging to motivate a geographically dispersed workforce, already stretched by heavy workloads, to expand their management and planning responsibilities to include climate change. In

the meantime, leadership is being provided by individual national forests in which managers have volunteered to develop adaptation plans (e.g., Joyce et al. 2008, Littell et al., in press) and by ad hoc efforts such as the workshop described here. By showing the value of a focused scientist–manager dialogue in developing educational information and adaptation options, we hope to motivate national forests and other natural resource agencies to emulate our approach and start the process of adapting to climate change.

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