Integrating Climate Change Considerations into Forest Management Tools and Training

Linda M. Nagel[1], Christopher W. Swanston[2], and Maria K. Janowiak[3]

Abstract—Silviculturists are currently facing the challenge of developing management strategies that meet broad ecological and social considerations in spite of a high degree of uncertainty in future climatic conditions. Forest managers need state-of-the-art knowledge about climate change and potential impacts to facilitate development of silvicultural objectives and prescriptions that are flexible and enhance ecosystem resistance and resilience. Existing approaches also must be infused with adaptive techniques and strategies. We are working on a project that will help address these needs for forest management. Specifically, our objectives are to: (1) provide training on the ecological impacts of climate change to forestry professionals; (2) incorporate current understanding of species and forest responses to climate change into silvicultural strategies that meet management objectives while encouraging adaptation to changing climate conditions; (3) provide decision support tools to guide forest management planning under climate change; and (4) integrate climate change adaptation strategies into Forest Service silvicultural education and implementation. We describe the incorporation of training and tools from the larger project into the USDA Forest Service silviculture certification program, and report on lessons we have learned about the process attendant to the design and implementation of climate change training for land managers.

Keywords: climate change, forest management, NASP, silviculture certification, uncertainty

In: Jain, Theresa B.; Graham, Russell T.; and Sandquist, Jonathan, tech. eds. 2010. Integrated management of carbon sequestration and biomass utilization opportunities in a changing climate: Proceedings of the 2009 National Silviculture Workshop; 2009 June 15-18; Boise, ID. Proceedings RMRS-P-61. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 351 p.

[1] School of Forest Resources and Environmental Science, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931; lmnagel@mtu.edu.

[2] Northern Research Station, USDA Forest Service, 410 MacInnes Dr., Houghton, MI 49931; cswanston@fs.fed.us.

[3] Northern Institute of Applied Carbon Science, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931; mjanowiak02@fs.fed.us.

Introduction

Evidence for global climate change is unequivocal, as is the implication that human activity has caused substantial rises in greenhouse gases that are contributing to the earth's changing climate (IPCC 2007). Temperature, precipitation, and other climate variables are expected to continue changing worldwide, with substantial implications for the composition and function of terrestrial ecosystems (Kirilenko and Sedjo 2007). In the United States, forestland covers 33 percent of the land surface (Smith and others 2004) and provides extensive ecosystem services. Managers of these lands are seeking information and direction to create flexible and adaptive management approaches that balance the need to manage forests today for multiple objectives with the reality that future climatic conditions are uncertain.

An abundance of information is available about global climate change and how to promote forests that are able to adapt, but the mechanisms to combine and apply this information to specific situations are less common. This leads to a great need for educating land managers about climate change, its uncertainties, and the importance of incorporating both into silvicultural prescriptions.

Our approach to this complex issue centers on a combination of education and problem-solving exercises. We first educate participants about state-of-the-art climate change science and the potential ecophysiological responses of forests. We then facilitate problem-solving by engaging critical thinking skills so that approaches and strategies are developed from the ground up, building on local knowledge and experience of participants.

This overall approach provides participants with fundamental information on likely climate change impacts on forests, and arms them with a structure for incorporating these considerations into future management strategies. A common criticism of continuing education training is that the information gained often lacks practical application and does not strengthen attendee's ability to solve complex, real-world problems largely due to a one-way flow of knowledge (Salwasser and others 1990). The approach we outline here does not instill a one-size-fits-all solution, but rather builds in mechanisms and tools for further creative problem-solving to generate approaches to complex problems relevant to local forest types. This acknowledges that every situation confronting land managers is unique (i.e., forest plans, vegetation types, stand conditions, conflicting objectives) and requires management strategies particular to those conditions.

As part of a larger project funded by the USDA Forest Service Global Change Program aimed at providing advanced training in climate change science to land managers within the USDA Forest Service, we extended a training module geared toward forest management in the context of an uncertain climate future to the contingent of agency silviculturists in training for certification. Silviculture is an interdisciplinary practice used to manage for multiple objectives at a variety of scales with the local-level (stand), the scale at which on-the-ground actions (prescriptions) are implemented. Silviculture is recognized as a leading discipline within the forestry profession for implementing science-based practices, and leads the forestry profession by setting standards in continuing education and training (Graham and Jain 2004). The National Advanced Silviculture Program (NASP) is the current silviculture certification program within the USDA Forest Service. The program contains four core training courses led by academic institutions, and a fifth local area module developed specifically for expertise in a given forest type. Each course consists of a variety of topics taught by experts in their respective fields with the goal of preparing silviculturists to design prescriptions that meet the Minimum National Standards for Silviculturist Certification (Forest Service Handbook 2005). We incorporated a climate change module into the most recent NASP class, with these overall goals: 1) provide the latest scientific information about climate change and forest ecosystem responses; 2) develop a mindset for silviculturists to think about climate change considerations as part of decision making in forest management; and 3) develop a list of general forest management strategies that are applicable across national forests in the context of an uncertain climate future. The process implemented and outcomes achieved from this module are described below.

Educational Process

Context

The two-week Ecological Systems Course of NASP is the first course of the certification program, and is conducted at Michigan Technological University, Houghton, MI. A pilot four-hour climate change module was integrated into the third cohort of NASP (May 2009) as a new and essential component of the curriculum, and represents a logical and appropriate place to begin incorporating the complex issue of climate change into formal silviculture training. The module was

presented at the beginning of the second week, with the students already having several hours of basic forest ecology, geology, landforms, soils, hydrology, tree physiology, and disturbance ecology.

Approach

The process implemented during the climate change module consisted of a modified version of approaches utilized during an initial Silviculture Workshop geared toward Region 9 silviculturists held in fall, 2008 (Janowiak and others, unpublished paper). The pedagogical approach utilized components of the learning cycle (Allard and Barman 1994) through participatory engagement on the topic (fig. 1). To begin, the class was presented with a brief overall introduction of the topic at hand, and given a description of the goals for the climate change module in the context of NASP.

Inform and educate—To provide a sound and consistent scientific basis for building discussion, the first hour of the module consisted of a presentation of climate change science and forest response followed by an extensive question and answer session (fig. 2). The presentation covered several topics central to climate change issues in forest management. It included an overview of climate change science (observations, mechanisms, and predictions), the global carbon cycle, distribution and density of forest carbon, and how climate change affects forest ecosystems including benefits and deleterious effects on forest productivity. Uncertainty surrounding climate change and forest response was emphasized as material was presented, encouraging students to synthesize and evaluate information at higher levels of learning (Bloom 1956). To help students prepare for this topic and to provide context for climate change as it affects silviculture prescription development, three papers were assigned as pre-work: Birdsey and others 2006, Millar and others 2007, and the USDA Forest Service Strategic Framework for Responding to Climate Change (2008). The goals here were twofold: 1) to inform and educate participants about climate change providing a common level of understanding; and 2) to address misconceptions and skepticism that may be present among the group about climate change as a pervasive and real issue facing forest managers.

Engage—The goal of the first learning activity (fig. 1) was to generate interest, enable active participation, and begin the flow of problem-solving ideas by posing this question to the group: *What new or altered considerations does climate*

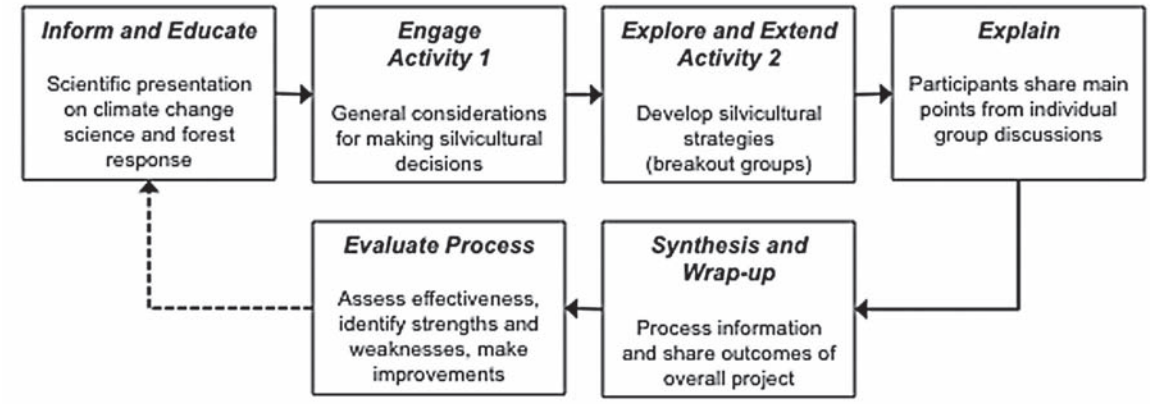

Figure 1—Modified learning cycle used in the climate change module of the Ecological Systems Course of the National Advanced Silviculture Program (NASP).

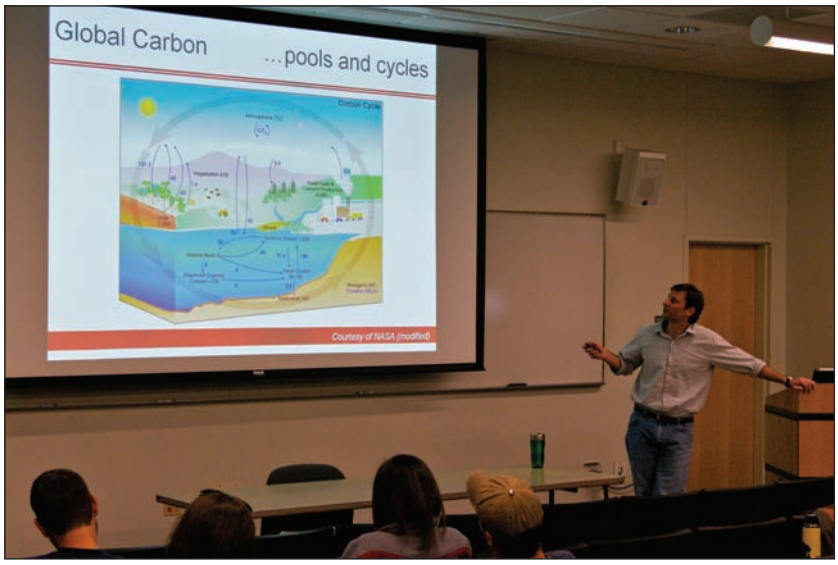

Figure 2—Presentation of climate change science and forest response. Photo credit: Jill C. Witt.

change bring to the process of making silvicultural decisions and devising strategies? Each person was given large sticky notes to write down individual thoughts, and then asked to share these ideas with the group by bringing them forward and posting them onto the whiteboard in the front of the classroom. As facilitators, we then guided the participants through a re-organization of ideas under broad themes that emerged from the group (fig. 3). This exercise actively engaged each participant and facilitated sharing of many individual ideas. The goal was not to seek full agreement or consensus among the group, but rather to generate a list of considerations that would help trigger discussion for the next exercise.

Explore and extend—The second activity involved brainstorming silvicultural strategies that could be used to sustain forests and reach management objectives. Each person was given a set of maps (fig. 4) representing projected change in

Figure 3—Responses to the question for Activity 1: *What new or altered considerations does climate change bring to the process of making silvicultural decisions and devising strategies?* Photo credit: Jill C. Witt.

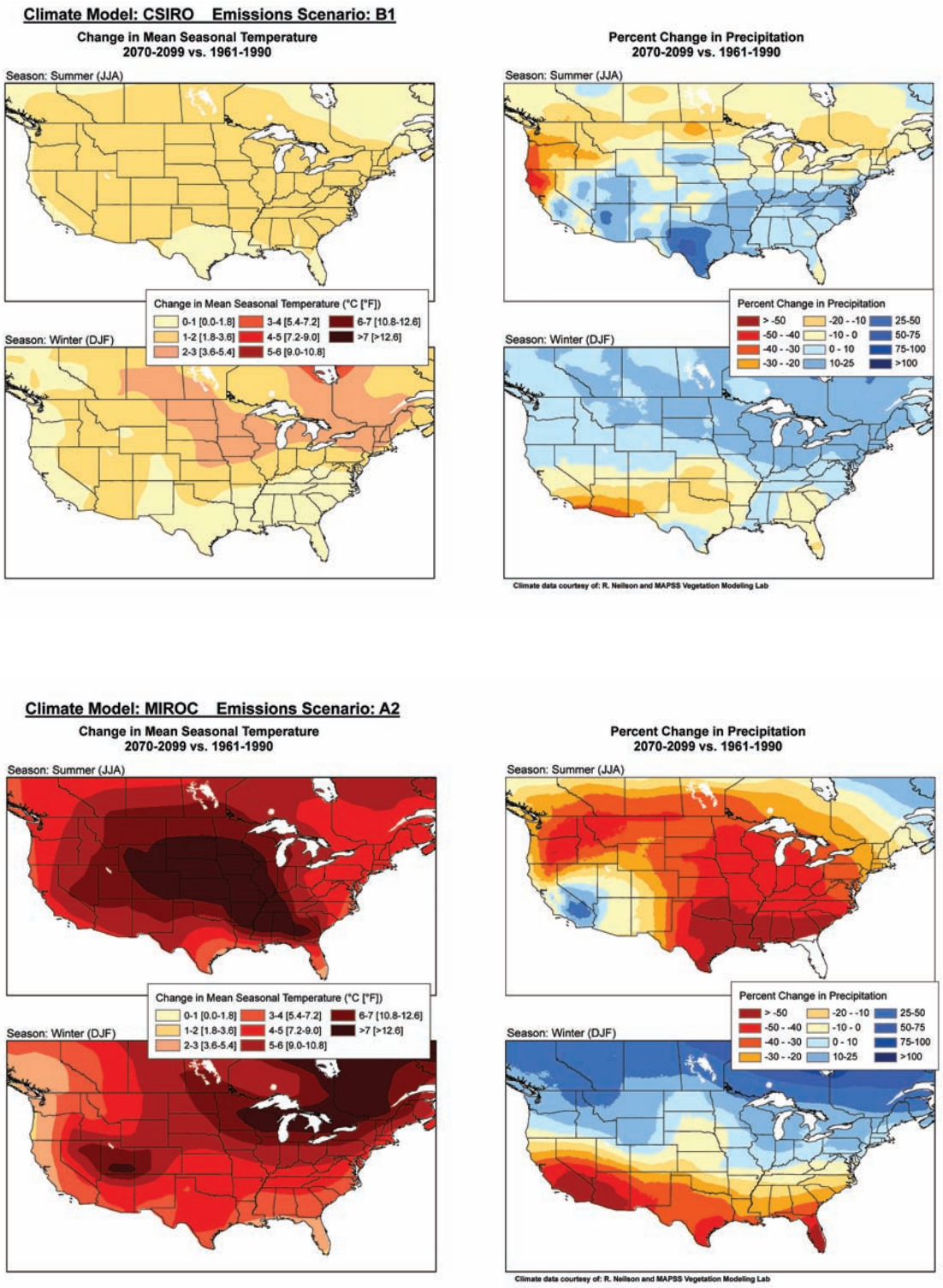

Figure 4—Climate change scenarios used for the activity to develop silvicultural strategies for forest management in the context of an uncertain climate future. The maps represent projected change in temperature and precipitation for the US using two climate models and emissions scenarios. Top: Projections using CSIRO global climate model and low (B1) emissions scenario represent a lesser degree of change in temperature and precipitation at the end of the century. Bottom: Projections using MIROC global climate model and high (A2) emissions scenario represent a greater degree of change in temperature and precipitation at the end of the century. Map data courtesy of R. Neilson and the MAPSS Vegetation Modeling Lab.

precipitation and temperature for summer and winter months at the end of the 21st century across the United States based on different emissions scenarios developed by the IPCC (2007). For simplicity and due to time constraints, two extremes (low model sensitivity and low emissions, high model sensitivity and high emissions) were used to frame the discussion. The class (32 participants) was then divided into five breakout groups by region or location consisting of five to eight people focused on common forest types in order to bring together similar experiences and to facilitate regionally oriented dialog specific to these two extremes.

The groups were instructed to address the following question given the range of uncertainty depicted by the different climate projections: *What silvicultural strategies may be helpful or necessary to sustain our regional forests in the face of climate change?* Each group was given a flipchart, an easel and markers, and the groups were relocated to a large open area conducive to group discussions outside the classroom. Each group chose a note-taker who recorded main points of the discussion on the flipchart. The groups were instructed to summarize five or six key points onto one flipchart page that would then be shared with the class by a volunteer spokesperson.

We acted as facilitators during this process, observing groups during their discussion to work through the overarching question. We deliberately avoided providing feedback or giving direction during these small group sessions. This enabled the participants to independently identify and grapple with complex issues, it encouraged open sharing of ideas, and resulted in the group framing their own problems and solutions. This exercise helped make climate change a real issue by forcing participants to extend and apply what they know conceptually about climate change to localized regions, and further required them to invoke local expertise and experience at the forest- and stand-level in order to develop practical strategies to address the issue.

Explain—The groups reconvened in the main classroom, and volunteer spokespersons shared a summary of the main ideas generated through the small group discussions with the full group. Their summary flipchart pages were posted on the board in the front of the room, and commonalities and unique ideas were identified. Participation from the entire group was encouraged during this process. This exercise allowed for a distillation of many different ideas that were discussed, provided an opportunity for individuals to practice organizing and presenting information, and exposed participants to general management issues from across different regions of the country.

Synthesis and wrap-up—The penultimate stage of the module was a synthesis of the day's activities and a brief description of how this module fit into the larger climate change project. Results from the initial Silviculture Workshop (Janowiak and others, unpublished paper) were shared, highlighting the many similarities to the ideas generated by the NASP participants during the current module. Final wrap-up comments were made emphasizing these broad concepts: 1) we know climate is changing, therefore we must be proactive in our approach to forest management; 2) there is no *single* shiny new silvicultural tool to use against climate change; instead we must be creative in developing silvicultural prescriptions and management approaches that are flexible and adaptive; and 3) continuing to practice sustainable forest management is our best approach toward addressing the uncertainties of climate change and other complex issues.

Evaluate process—We were interested in how effective our approach toward educating and training were for this group, so we implemented a survey at the end of the module to obtain feedback from the participants. We asked for comments on the information presented and activities conducted during the module. Participants were also asked to identify to what extent they had thought about this topic before, to what extent it has been discussed on their district or forest, if they thought they would incorporate ideas related to climate change into their management activities, and if their perceptions have changed during the module. We also asked them to identify the most and least useful parts of the module.

Outcomes

One of our main questions was whether this approach would be effective in helping participants develop silvicultural problem-solving skills to address the issue of climate change. We believe the process used in this module was highly effective at achieving our goals. The high response rate among the group, and the content of those responses on the evaluations, gave us positive evidence that our approach was effective at communicating climate change science and arming participants with a model structure for silvicultural strategy development. Some common themes are described below.

Feedback

Overall, the level of material presented was deemed appropriate for the audience, though many respondents desired more time, more in-depth information, and more activities for this topic within the overall curriculum of the two-week course. The detailed up-to-date information presented at the beginning of the module was often mentioned as a strength because it was clearly articulated with very useful graphics. The hands-on activities were highly rated and thought to be very effective at getting people to really think about the topic. The activities were consistently identified as a major strength of the module.

This reaction is in line with our overall experience with conducting training workshops and seminars: providing a detailed yet concise summary of climate change science is an essential component of educating land managers. But ultimately the most beneficial part of the process is the discussion generated and ideas shared within small groups. Our experience in this module was that the individual groups were reluctant to end their discussions and move to the final synthesis stage back in the classroom. It is clear that both components are necessary, but this finding reinforces the value and effectiveness of interactive teaching strategies that ultimately result in better learning and application of knowledge and skills (McNeal and D'Avanzo 1997).

Answers to the question *"To what extent have you thought about this topic before?"* ranged from "a lot" to "not very much. " Most people indicated they had thought about climate change, and active measures were being taken in some locations. Many faced limitations to incorporating climate change-oriented concepts and approaches into forest management plans from colleagues, and some perceived resistance to the idea across interdisciplinary boundaries as well. Time constraints and pressure to address other issues (i.e., restoration, invasive species) were also cited as major limitations to directly dealing with climate change in everyday activities. Several also mentioned that current forest plans were not developed in ways that allowed management flexibility in the face of climate change.

Conversely, carbon footprint reduction was identified as a positive step many local offices are taking. It was also pointed out that many of the silvicultural strategies currently implemented are geared toward increasing forest health and sustainability, which indirectly addresses many concerns regarding climate change. An overwhelming majority indicated that they would be incorporating ideas related to climate change into future management activities.

There was a mix of "yes" and "no" answers to the question of whether the module changed the respondent's perceptions about climate change. Many people responded that their understanding was enhanced and that they now feel more prepared for dealing with the issue on their forests. Some identified that climate change felt less overwhelming following the module. Though diminishing throughout the day, some skepticism remained within the group, largely surrounding the use of climate change models. There was appreciation for the overall approach in that silvicultural possibilities were elucidated and solutions were not dictated, recognizing that every situation is different. There was also a call for presenting this information to broader audiences.

Summary

As evidenced by the theme of this workshop, climate change is a real issue that must be confronted by land managers, and the USDA Forest Service is in a strategic position of opportunity to lead this charge. Education and training are necessary and pertinent first steps to move forward within the agency and beyond. The training module we described was effective at communicating state-of-the-art climate change science, and the hands-on activities successfully engaged participants into developing silvicultural strategies that will contribute to sustainable forest management in the context of an uncertain climate future. Feedback we received from participants is informative for improving content for future NASP sessions, including building in additional time for the topic of climate change. This ground-up approach to education and problem-solving, and the interactive flow of knowledge between academic, research, and management sectors, may serve as a model for future climate change training programs as well as for programs dealing with other contemporary issues of great importance facing natural resource managers.

References

Allard, D.W.; Barman, C.R. 1994. The learning cycle as an alternative method for college science teaching. BioScience 44(2): 99-101.

Birdsey, R.; Pregitzer, K.; Lucier, A. 2006. Forest carbon management in the United States: 1600-2100. Journal of Environmental Quality 35: 1461-146.

Bloom, B.S. 1956. Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc.

Forest Service Handbook, National Headquarters (WO) Washington, DC. FSH 2409.17: Silvicultural Practices Handbook. Chapter 8: Silvicultural Examinations, Prescriptions, and Evaluations. Effective Date: 01/18/2005. 19 p.

Graham, R.T.; Jain, T.B. 2004. Past, Present and Future Role of Silviculture in Forest Management. In: Shepperd, W.D.; Eskew, L.G. (Compilers). Silviculture in Special Places: Proceedings of the National Silviculture Workshop, Grandy, CO. RMRS-P-34. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. pp 1-14.

Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Janowiak, M.K.; Swanston, C.W.; Nagel, L.M.; Palik, B.J.; Twery, M.J.; Bradford, J.B.; Webster, C.R.; Parker, L.R.; Hille, A.T.; Johnson, S.M. Silvicultural Decision-making in an Uncertain Climate Future: A Process to Explore Considerations, Strategies, and Approaches. Unpublished paper on file at: U.S. Department of Agriculture, Forest Service, Northern Research Station, Houghton, MI. 29 p.

Kirilenko, A.P.; Sedjo, R.A. 2007. Climate change impacts on forestry. Proceedings of the National Academy of Sciences of the United States of America. 104(50): 19697-19702.

McNeal, A.P.; D'Avanzo, C., eds. 1997. Student-active science: models of innovation in college science teaching. Proceedings on the NSF sponsored conference on Inquiry Approaches to Science Teaching held at Hampshire College, June 1996. Saunders College Publishing. 490 p.

Millar, C.; Stephenson, N.L.; Stephens, S.L. 2007. Climate change and forests of the future: managing in the face of uncertainty. Ecological Applications 17: 2145-2151.

Salwasser, H.; Cross, G.H.; Sidle, W.B. 1990. Continuing Education for Biologists: the Forest Service Program. Transactions of the North American Wildlife and Natural Resources Conference. Volume 55: 144-153.

Smith, W.B.; Miles, P.D.; Vissage, J.S.; Pugh, S.A. 2004. Forest Resources of the United States, 2002. General Technical Report NC-241. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 137 pp.

USDA Forest Service Strategic Framework for Responding to Climate Change, Version 1.0. October 2, 2008. 21 p.

The content of this paper reflects the views of the authors, who are responsible for the facts and accuracy of the information presented herein.