

**SCIENCE REVIEW OF THE UNITED STATES FOREST SERVICE  
DRAFT ENVIRONMENTAL IMPACT STATEMENT  
FOR NATIONAL FOREST SYSTEM LAND MANAGEMENT**

**Summary Report**



# RESOLVE

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**SCIENCE REVIEW OF THE UNITED STATES FOREST SERVICE  
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**Summary Report**

Science Reviewers\*:

Dr. John P. Hayes, *University of Florida*  
Dr. Alan T. Herlihy, *Oregon State University*  
Dr. Robert B. Jackson, *Duke University*  
Dr. Glenn P. Juday, *University of Alaska*  
Dr. William S. Keeton, *University of Vermont*  
Dr. Jessica E. Leahy, *University of Maine*  
Dr. Barry R. Noon, *Colorado State University*

\* Order of authors is alphabetical by last name

RESOLVE Staff:

Dr. Steven P. Courtney (Project Lead)  
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**RESOLVE** is a non-partisan organization that serves as a neutral, third-party in policy decision-making. One of RESOLVE's specialties is helping incorporate technical and scientific expertise into policy decisions. Headquartered in Washington, DC, RESOLVE works nationally and internationally on environmental, natural resource, energy, health, and land use planning issues. Visit <http://www.resolve.org> for more details. Contact RESOLVE at [info@resolve.org](mailto:info@resolve.org).

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## EXECUTIVE SUMMARY

The US Forest Service asked RESOLVE to coordinate an external science review of the draft Environmental Impact Statement (DEIS) for National Forest System Land Management Planning. The basic charge of the review process was to 'evaluate how well the proposed planning rule Draft Environmental Impact Statement (DEIS) considers the best available science.'

RESOLVE contracted with seven independent reviewers to review the DEIS. Reviewers were drawn from several areas of scientific expertise, and also had differing locales and past experience. Reviewers were vetted and interviewed before selection. Of the thirty potential reviewers who were considered, RESOLVE interviewed seventeen and ultimately selected seven reviewers.

Reviewers addressed three key questions on the DEIS, regarding scientific caliber, treatment of uncertainty, and comprehensiveness of the document. Reviewers were generally in agreement that the overall standard of scientific work in the DEIS was high. Reviewers did not substantively disagree with each other, so that USDA-FS may regard the reviewers as essentially in agreement regarding the DEIS.

Several reviewers identified areas for potential improvement of the document including missing subject areas (mostly small in scope) and missing literature.

Several reviewers highlighted monitoring design as a key issue.

Several reviewers discussed biological topics of concern, notably how to evaluate inherent capacity of the land, particularly in complex, changing systems. This is particularly difficult when considering cumulative effects.

Detailed reviewer comments are provided after the overview section.

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## THE PEER REVIEW PROCESS

RESOLVE is a non-profit that specializes in mediating and facilitating complex environment, health, and energy issues, and in helping individuals and organizations build their capacity to engage diverse interests in collaborative problem solving. RESOLVE's collaborative science program focuses on helping incorporate technical and scientific expertise into policy decisions. RESOLVE was contracted by the US Forest Service (USFS) to coordinate an external science review of the draft Environmental Impact Statement (DEIS) for National Forest System Land Management Planning. The basic charge of the review process was to 'evaluate how well the proposed planning rule Draft Environmental Impact Statement (DEIS) considers the best available science.'

The terms of the contract are set in the contractual document. They include the following:

- Selecting the science reviewers;
- Administering, organizing, leading, and managing the science review;
- Facilitating clarification discussion between the reviews and USFS Planning Rule team, as needed;
- Managing and producing a final report; and
- Maintaining an official record of the process.

RESOLVE maintains strong contacts with a network of technical experts and scientists with expertise in this area of research. In selecting scientists for this peer review process, we first approached scientists in our existing network with the required expertise. Further, we considered additional scientists recommended by those in our network. In selecting our reviewers, we had only two constraints: a reviewer could not be a USFS employee and must have no conflicts of interest. Following the dictates of our contract, we sought reviewers "who are respected in their field of expertise and are subject matter experts in the areas discussed in the DEIS," and during the selection process considered a group of reviewers with "expertise, diversity of science perspectives, independence, and ... no conflict of interest."

In selecting reviewers, we made the following explicit decisions:

- The DEIS indicated two divergent opinions related to watershed protection. We determined that this divergence was related to policy and not substantive science.
- We would actively look for reviewers that, collectively, have expertise in the following areas: climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring.
- Given the complex nature of climate change, we decided to have two reviewers with climate change expertise.
- In addition to the issues directly addressed in the DEIS, we felt that we needed a reviewer who was a monitoring expert as that was a large theme throughout Chapter 3. Also, we believed that forest threats was a significant enough issue that one reviewer should be a forest threat expert.

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We initially identified 30 individuals that appeared to meet the criteria of scientific expertise, appropriate experience, lack of conflicts of interest. From those 30, we winnowed the list down to seventeen scientists based on breadth of expertise and diversity. We approached these seventeen individuals about their willingness to participate in the science review. Not all scientists responded, and some were unable to meet the timelines of the project due to other commitments. Seven qualified scientists agreed to participate in the science review process.

The seven selected reviewers were:

Dr. John P. Hayes, *University of Florida*  
Dr. Alan T. Herlihy, *Oregon State University*  
Dr. Robert B. Jackson, *Duke University*  
Dr. Glenn P. Juday, *University of Alaska*  
Dr. William S. Keeton, *University of Vermont*  
Dr. Jessica E. Leahy, *University of Maine*  
Dr. Barry R. Noon, *Colorado State University*

All reviewers were qualified to participate and brought diverse knowledge and expertise to the issue. All were interviewed by Dr. Courtney of RESOLVE on their abilities, expertise, and potential conflicts. No serious problems were identified. All seven reviewers completed a conflict of interest statement derived from that used by the National Academies of Sciences. RESOLVE was confident in the ability of all the reviewers to fairly and objectively evaluate the DEIS.

Although not a formal requirement of the review process, RESOLVE sought (and obtained) reviewers with a diverse geographic representation and expertise.

Each reviewer was charged with reviewing Chapter 3 of the DEIS while considering the following three questions:

1. Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?
2. Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.
3. What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring.

All reviewers were instructed to only comment on the science in the DEIS, and were instructed to avoid comments on management or policy.

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All seven reviewers completed their reviews in a timely manner. RESOLVE staff read through the individual reviews and determined that each reviewer had met their obligations and completed a satisfactory review. RESOLVE staff also concluded that, while several review commented on policy-related science, no review commented on policy. Hence RESOLVE did not redact any portions of any review for being outside the charge of the task.

Following receipt of the reviews, RESOLVE distributed the reviews to the USFS Planning Rule team. The Planning Rule team posed three additional comments for RESOLVE.

*(1) Given that Dr. Keeton's review focused heavily on the context section, would he have focused more on the analytical sections of Chapter 3 if it had been clearer the context section was meant solely to provide background for the rest of the chapter?*

The USFS Planning Team ultimately determined to take Dr. Keeton's review as-is because other reviewers adequately addressed the analytical sections. The Planning Team acknowledged that the purpose of the context section should be made clearer in the text.

*(2) In Dr. Jackson's review, he referenced a "rich body of social science research" regarding "the beliefs and attitudes of public land grazers."*

The USFS Planning Team did not find any literature on this topic, and requested that Dr. Jackson provide some of the literature citations.

*(3) Dr. Noon provided a large body of information in his review but did not completely connect that information to recommendations for revisions to the DEIS.*

The USFS Planning Team decided to take the information Dr. Noon provided into consideration in conjunction with Dr. Hayes' review.

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## EVALUATION OF THE REVIEWS

The overall purpose of this section is to provide USFS with RESOLVE's assessment of the reviews themselves. The intent is to help the government decide on the scientific caliber of comments. For instance we will show whether any comment should be disregarded because the reviewers have exceeded their charge, or have made scientific errors, or are unfamiliar with the literature. Similarly, if reviewers disagree, then in this section we will highlight the disagreement, and provide RESOLVE's opinion on the scientific merits of the opposing viewpoints.

We will also discuss the overall response of reviewers to the primary framing questions of the review, so that USFS can assess the overall quality of their document, and whether there is a need for extensive revision, or for more modest changes in response to scientific peer review.

Finally, we will also provide USFS with our assessment of emergent themes (if any) from the reviewer's comments, and provide summaries of such areas. Again, the goal in this section is to render the reviews useful to the Service, and to point out any areas where substantive improvement may be warranted.

### *Quality of Reviews*

RESOLVE's assessment of the reviews, is that each reviewer performed adequately. While reviews varied greatly in length and breadth, this is partly a reflection of the subject areas of a reviewer's focus. There is more literature (and USFS did a better job of referencing it) in some subject areas than in others. Hence, we feel that all reviewers performed sufficiently well that USFS should take their comments seriously and as an indication of expert scientific opinion. We do not recommend excluding any reviewer's comments on the basis of scientific competency.

Similarly, reviewers did a good job of restricting their comments to technical as opposed to value-driven issues (e.g. policy). This is inevitably a difficult line to walk when the science under discussion is policy relevant (e.g. climate change, how to conduct monitoring, etc.). The reviewers did an excellent job of hewing to that line, and avoiding direct advice on management or policy. Hence RESOLVE does not recommend excluding any individual comment on the basis of falling outside the scope of the review, and we have not redacted any comment prior to submitting reviews to USFS.

Compared to other similar review efforts, we regard the overall caliber of the reviews as very high, most especially given the relatively short time frame for reviewers to read the materials and write their responses. We believe that this is a reflection of reviewers' engagement with this important issue, and their high level of expertise and commitment to public service.



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### ***Consistency and Disagreements in reviewers' comments***

Several reviewers overlapped in their areas of expertise. Indeed RESOLVE actively solicited opinions from more than one expert in some subject areas. This followed from our policy of seeking a representative spread of scientific comment on subjects with diverse opinion (following the National Academy guidelines).

Since we sought out more than one review in some subject areas (climate change, population biology, monitoring), we might reasonably expect that reviewers would disagree on some points. Hence it is important for RESOLVE to point out any such areas of disagreement and to provide our own evaluation as to which review is more accurate and useful.

However, in this review process, there were no substantive disagreements among reviewers. Although some reviewers have stronger emphases on particular points, there were no scientific areas where reviewers were diametrically opposed. Hence RESOLVE does not believe that there is a need to adjudicate any difference between reviewers.

To a great extent, reviewers were congruent in their evaluations. Where there were concerns, all or most reviewers shared them. Similarly, all reviewers agreed that the overall level of scientific effort shown by USFS was high. This consistency across reviews is not unique, but is unusual – usually reviewers disagree more than shown here. This should translate into increased certainty for USFS, in that there appears to be little diversity or uncertainty associated with these scientific reviews.

### ***Framing questions***

We framed questions for reviewers with three over-arching questions:

1. Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?
2. Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.
3. What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring.

Not all reviewers made explicit statements about the overall quality of the DEIS for each criterion, although each reviewer did address each issue (to greater or lesser degree) within the body of her or his comments.

#### ***Framing question 1: Overall scientific caliber.***

Without exception, the reviewers complimented USFS on a scientifically supported approach, which made good use of available literature. No reviewer thought that the Service had

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performed poorly, or that there were major scientific problems with the document. Reviewers did differ slightly in that Dr. Keeton felt that some material was introductory and not well explained; however as this material was essentially introductory to the process description, we do not regard his comments as reflecting on the more detailed analyses described later in the DEIS. Generally the overall tone of reviewers was congratulatory of the Service authors.

#### *Framing question 2: Uncertainty*

Not all reviewers addressed this framing question explicitly (as opposed to discussing it throughout their review). Of the four reviewers who did provide an overall evaluation of the treatment of uncertainty, two (Hayes, Juday) thought that the Service had done an excellent job, and that the DEIS provided a good treatment of uncertainty. Two other reviewers (Keeton, Leahy) were more nuanced, and found some areas where treatment of uncertainty could be improved. RESOLVE regards these differences among reviewers as reflective of their subject area of focus, and that the DEIS (while crafted with an overall high standard for addressing uncertainty) does have some areas where uncertainty could be addressed more explicitly.

#### *Framing question 3: Missing areas of discussion*

Not all reviewers addressed this issue in their overall summary evaluations, but all reviewers passed some comments in the body of their reviews. In general the overall assessment was that the Service had done a reasonably complete job in considering most relevant issues. However some reviewers did identify highlight additional areas that might warrant USFS attention (e.g. soils and climate change, road-building, aerosphere). Other reviewers provided extensive documentation to literature that is relevant to the discussion. It is RESOLVE's scientific assessment that some of this literature is useful background material, that may be appropriately reference, but that other areas (notably in the social science disciplines) may warrant further attention by the Service. Leahy's comments on economic analyses appear particularly pertinent.

### ***Important comments***

#### *Monitoring*

Many of the reviewers (Hayes, Noon, Jackson, Herlihy, Juday, Keeton) raised the issue of monitoring. The fundamental insight is that monitoring design is key to the successful implementation of the activities set out in the DEIS. Moreover, monitoring is a scientifically challenging exercise that (to be useful in adaptive management) must include careful consideration of the questions to be addressed, as well as which management triggers may be dependent on the results of monitoring. RESOLVE agrees with the overall thrust of the reviewers' comments, that monitoring is key, scientifically complex, and worthy of very careful attention both in the DEIS and specific plans. To the extent that monitoring guidance can be developed at a Service wide level, it is clearly the opinion of the reviewers that the DEIS should be as explicit as is feasible regarding the goals and practice of monitoring

#### *Inherent Capacity of the Land*

Both Keeton and Noon raised concerns about the difficulty of explaining and quantifying this concept. Not all reviewers shared this emphasis, but other reviewers (Hayes, Juday) did share some concerns about the use of biological concepts, and whether such use could be standardized. Reviewers with a biological background consistently emphasized the

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complexities of dealing with wildlife populations, and of taking an appropriately detailed approach that moved beyond simply indicator species approaches. Some reviewers also commented on the need to consider ecosystem processes rather than a focus on vertebrates (which may not always be good indicators of ecosystem health).

*Climate change and stability*

Several reviewers commented on climate change issues. Juday in particular emphasized the possibility for taking a broader perspective, beyond the simply ‘stressor’ approach. We agree that this may be a useful perspective for the Service.

Somewhat coupled to issues of climate change are more general issues of stability and change. Several reviewers commented on the dynamic nature of ecosystems, and of the necessity of having justifiable mechanisms to assess management against such changing backgrounds, and of incorporating cumulative impact assessment into such methods. These are challenging issues from a technical standpoint; to the extent that the DEIS can provide system-wide guidance, it will be useful for Service staff to have a coherent statement of how to deal with changing systems.

*Scale*

Several reviewers commented on issues of scale. This is relevant both for cross-ownership concerns, but also with regard to ecosystem and population processes that operate at very different scales in different locales. Again, to the extent that the DEIS can provide more explicit system-wide guidance on how to deal with such issues, the reviewers believe that it would be useful and give a more scientifically appropriate framework.

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## APPENDIX: REVIEWS

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. John P. Hayes, University of Florida*

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***Background and charge.***

This review was conducted at the request of RESOLVE to evaluate scientific aspects of the USFS Draft Environmental Impact Statement (DEIS) on the USFS Proposed Planning Rule published in the Federal Register on February 14, 2011. Specifically, this assessment addresses three questions posed by RESOLVE:

1. Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?
2. Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.
3. What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on diversity of plants and animal communities.

Accordingly, this assessment attempts to avoid judgment on the merits of the alternative selection, although does comment on the anticipated efficacy of the alternatives in achieving agency goals when that flows directly from limitations or characteristics of the underlying science and methodologies proposed. This assessment focuses on the preferred alternative, but addresses key aspects of other alternatives where appropriate.

***Scientific underpinnings of Alternative A with respect to diversity of plant and animal communities.***

Aspects of Alternative A pertinent to diversity of plant and animal communities are broadly and fundamentally linked to four science-based, foundational elements:

1. Use of an adaptive framework for management and planning, embedded in a strategy reliant on strong use of monitoring to create feedback loops for evaluation and modification of management actions;
2. A two-tiered conservation strategy focused on ecosystem diversity and species conservation, grounded in coarse- and fine-filter approaches to conservation;

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3. Planning embedded in the broader geographic and ecological context in which USFS lands occur, and the influences of that context on the conservation goals of those lands; and
  4. The dynamic nature of ecological systems and the changing environmental context likely to impinge on conservation goals.

Each of these elements will be examined separately in this assessment.

***1. Use of an adaptive framework for management and planning, embedded in a strategy reliant on strong use of monitoring to create feedback loops for evaluation and modification of the efficacy of management actions***

Contemporary science-based management and planning recognizes that uncertainties in responses of complex systems to management can create unpredictable responses and unintended outcomes. Moreover, it is widely recognized that best practices evolve through time, both in response to improved scientific understanding and as a consequence of dynamic and changing environmental contexts (e.g., broadscale changes in the landuse patterns, climate change, invasive species, pests, or pathogens).

Alternative A is based on use of an adaptive framework, which both uses scientific understanding as a foundation for actions and, in its most effective manifestation, is based application of scientific approaches to inquiry to provide feedback loops for modification of plans and actions. Use of an adaptive framework in the planning process is fully in line with current scientific understanding of most appropriate practices.

Efficacy of this adaptive framework is largely dependent on three factors: the elements subject to monitoring, the rigor and design of the monitoring program, and the manner in which monitoring information is used to modify plans and actions. In a well-designed, scientifically credible adaptive management plan all three elements are integrated and build from one another. The DEIS states:

*Measuring and monitoring key ecosystem characteristics related to composition, structure, function, and ecological connectivity along with a set of well-chosen focal species should provide timely information regarding the implementation and effectiveness of plan components related to plant and animal diversity and species viability.*

This statement is accurate only if monitoring is targeted to track specific ecological components that relate to the effectiveness of the plan to conserve plant and animal populations, and if there are explicit mechanisms for invoking plan modification when monitoring data indicate it is prudent to do so. The planning rule does not directly address rigor and design of the monitoring program, which is appropriate given the tremendous variation in conditions and locations for which the planning rule will be applied, and thus that degree of prescription is appropriately beyond the scope of the rule. The draft planning rule does, however, specify the elements subject to monitoring (albeit broadly) and the manner in which monitoring information is used to modify plans and actions in Section 219.12. Notably, some of the most significant differences between Alternatives D and E relate to approaches to monitoring.

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With respect to elements subject to monitoring, the preferred alternative directs monitoring to address three elements especially pertinent to diversity of plant and animal communities: the status of select watershed conditions (219.12[a][5][i]), the status of select ecological conditions (219.12[a][5][ii]), and the status of focal species (219.12[a][5][iii]). In addition, the preferred alternative provides general direction for use of the monitoring information in 219.12(d)(1), stating:

*The responsible official shall conduct a biennial evaluation of new information gathered through the unit monitoring program and relevant information from the broader-scale strategy... The evaluation must indicate whether a change to the plan, management activities, or monitoring program may be warranted based on the new information; whether a new assessment should be conducted; or that no amendment, revision, or administrative change is needed.*

While this latter section is identical in Alternatives D and E, Alternatives D and E provide additional elaboration on the elements subject to monitoring. Alternative D specifically links the elements subject to monitoring to the use of monitoring information in section 2219.12(a)(5)(ii), stating:

*The status and trends of ecological conditions within the planning area, including critical values for ecological conditions and focal species that trigger reviews of planning and management decisions to achieve compliance with 219.9(a)*

The lack of direct reference to triggers or thresholds for action based on monitoring data in Alternative A could jeopardize the scientific validity of the adaptive framework of the planning rule. Although Alternative A does not preclude meaningful application of the adaptive framework in planning, neither does it mandate its scientific validity or efficacy because of the broad, non-prescriptive guidelines provided in the planning rule. Explicit linkage to identification of triggers and thresholds, such as those proposed in Alternative D, would significantly strengthen the scientific integrity of Alternative A, and would facilitate appropriate selection of response variables to be monitored, and the metrics used for monitoring them.

## ***2. A two-tiered conservation strategy focused on ecosystem diversity and species conservation, grounded in coarse- and fine-filter approaches to conservation***

The two-tiered conservation strategy mandated through the planning process is consistent with current scientific understanding of the most practical and effective approaches to managing for the diversity of plant and animal communities, and reflects current literature and understanding. Through implementation of this planning process, the DEIS states that:

*Over time, as management activities are implemented to achieve the desired ecological conditions, habitat quantity would be expected to increase and habitat quality would be expected to improve for native species within the plan area.*

The expectation of increased habitat quantity and quality for *all* native species in the plan area is not scientifically credible, as increases in habitat quantity for some species will directly result

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in decreased availability for others (e.g., increasing habitat for late seral habitat specialists will directly reduce habitat quantity for species specializing on other seral stages). That aside, the basic strategy described in the DEIS is scientifically sound and consistent with current scientific thought.

Moving away from strategies based on Management Indicator Species (MIS; which would be implemented under Alternative B) to a more holistic framework reflects current understanding of flaws in use of the MIS approach as noted in the DEIS, and is an important step forward in this proposed planning rule.

### ***3. Planning embedded in the broader geographic and ecological context in which USFS lands occur, and the influences of that context on the conservation goals of those lands***

Consistent with current scientific understanding, the planning rule appropriately recognizes that effective conservation requires considerations at multiple spatial scales. However, the planning rule targets planning for diversity of plant and animal populations through sustainability of ecosystem diversity and species conservation in Sections 219.8 and 219.9 by strongly focusing on *the plan area*. While there are clearly pragmatic and efficiency reasons to focus planning at the scale of the plan area, current scientific understanding recognizes the critical importance of broader spatial scale patterns on viability of species, and similarly scientific understanding recognizes actions in one area often have profound impacts on the surrounding matrix of lands. Related to this, actions within one area manifest cumulative effects when replicated across the landscape or repeatedly through time. Such cumulative effects may not be anticipated or adequately accounted for when the planning exercise is not focused at a sufficiently broad spatial scale. Current scientific understanding stresses the importance of potential cumulative effects on viability and persistence of plant and animal communities. Explicit recognition of this phenomenon and inclusion of direct consideration of cumulative effects in the planning rule would strengthen the planning rule and bring it more fully into line with scientific understanding. Such consideration would likely be a component of Alternative L, but lack of in-depth evaluation or articulation of that alternative precludes assessment.

Current scientific understanding recognizes that biological populations transcend political and ownership boundaries, and that effective conservation strategies must engage conservation across boundaries. Despite this recognition, effective political mechanisms for implementing cross-boundary conservation strategies are problematic, especially on federal lands subject to regulatory constraints regarding involvement on non-federal partners on decision-making activities. The proposed planning rule calls for engagement and participation of a broad array of stakeholders in the planning process. Given regulatory constraints, the proposed planning rule appears to be structured to take best possible advantage of opportunities for engagement in a good faith effort to place the planning process in the broader context of the surrounding non-USFS landbase.

### ***4. The dynamic nature of ecological systems and the changing environmental context likely to impinge on conservation goals***

Consistent with current scientific understanding, the planning rule and DEIS recognize the importance of disturbance in maintenance of plant and animal communities. The dynamic



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nature of ecological systems, coupled with the rapid environmental change faced by USFS lands today, such as those resulting from climate change, unprecedented spread of invasive species, and emerging pathogens, create a considerable environmental uncertainty influencing the efficacy of a land management planning exercise. These uncertainties are generally well described in the DEIS and, as noted in the DEIS, constrain future options and certainty of planning. However, aspects of USFS planning and action also directly influence the likelihood that problems related to disease, invasive species, climate change, and other dynamic forces will be manifested on the landscape; USFS planning is not only constrained by these dynamic forces but also shapes their manifestation. Lack of recognition of this relationship in the DEIS or explicit consideration of these factors in the planning rule may be a shortcoming and does not fully reflect scientific understanding.

***Additional scientific issues and considerations not adequately considered in the draft planning rule***

The planning rule mandates consideration of ecological sustainability and encompasses many elements directly related to diversity of plant and animal communities in section 219.8. Aspects incorporated in the planning rule are laudable and encompass much of the scientific understanding on critical elements necessary for sustaining plant and animal communities. However, recent work has highlighted the importance of the aerosphere (the atmospheric envelope interfacing terrestrial and aquatic systems) and considerations related to aeroecology on sustaining populations (see Kunz et al., 2008, *Integrative and Comparative Biology* 48:1-11). Aeroecological considerations are particularly important for volant species, especially volant migratory species (including several species of arthropods, birds, and bats). Contemporary management on USFS lands can directly impact the region's aeroecological health. For example, wind development on USFS lands may directly impact species viability of migratory bats and other species. Although section 219.8(a)(1)(iii) does identify air quality, other elements impinging on diversity of plant and animal populations related to the aerosphere are not directly addressed in the planning rule.

Sections 219.4 and 219.7 address engagement of outside partners and approaches for plan revision. Neither of these sections specifically identifies engagement of the external (non-federal) scientific community as a directive in the planning process. While USFS and other arms of the federal government have significant scientific resources and capacity, the planning process would likely be strengthened and have increased credibility with direct engagement of the external scientific community. This engagement would also be, in and of itself, consistent with the adaptive framework that provides the foundation of the planning rule, and would help ensure incorporation of cutting edge information into the planning process.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. Alan T. Herlihy, Oregon State University*

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I was asked to provide a scientific review of the subject document with an emphasis on aquatic monitoring which is my area of expertise. Overall, I thought the general scientific basis of the document to be sound and current within my areas of expertise. In terms of monitoring, the general idea of using monitoring to inform decision making was well presented. However, there were no specifics about any kind of monitoring described in the chapter so I have no scientific comments about any of the monitoring.

**General Observations**

- There was a lot of redundancy and overlap among the different sections in Chapter 3. For example there were numerous places where there was a short discussion and a “see other section for details”. Also, the science was rather generic for a scientific audience. For a non-science audience the report seemed overly detailed. However, I know I’m only looking at one piece of the puzzle.
- The treatment of stressors seems very uneven. There’s a lot of discussion about climate change and roads for example but little or no mention about air pollution effects. Specifically I’m thinking of effects due to acidic deposition, mercury contamination to fish and other aquatics, and decreases in visibility (haze/ozone). I did a quick search and didn’t see the word mercury mentioned anywhere in the chapter. At first I thought this was due to the fact that the sources of these air-borne pollutants are generally not on USFS land and out of their control so there’s not much you can do about them. However there’s a whole section on climate change which is similar in nature (sources outside of USFS control).
- There were a fair number of “personal communication references”. That seems odd in a document like this and they are of little use for anyone trying to track down the basis of what was said. For example on p. 61, citing McNulty, pers. comm. for a definition of ecosystem resilience isn’t appropriate for a scientific document. Similarly, the use of unpublished papers and reports isn’t “scientific” (e.g. Potyondy and Geier, 2010; USDA Forest Service, 2002b). This may or may not be important for this document but from a scientific review perspective they are a detraction.

**Specific Comments**

p. 50: third line of last paragraph is missing a word.

p.55, top of page: Was it wise to not consider Alaska? Given its size, I’d guess that there’s a lot of USFS land there so it ought to be germane to this analysis.

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p. 67, aquatic stressors: some fairly large aquatic stressors aren't mentioned here. In particular, acidic deposition is a big problem in the Appalachians, fish stocking has a big effect on biotic integrity, and nutrient enrichment.

p. 67, first line, first paragraph: watersheds are in (not is in).

Table 1: the level of detail represented by this table seems much higher than that used in other sections.

p. 70, invasive species: invasive fish species are a widespread problem in streams and river of the U.S. that probably should be mentioned here (e.g., Lomnický et al. 2007, North American J. Fish. Management. 27:1082-1093).

p. 73, paragraph after table 2: I'm not sure what a "large-scale restoration project" is (how large is large-scale?). It says "examples may be found ...." in the text but they are not described. A short description of one would be useful.

p. 81, first paragraph: there's an extra "s." at the end of the paragraph.

p. 81, second paragraph: How are 12,000 sixth-code watersheds assessed to know that 30% of them are in good condition? Surely they were not all sampled? It's probably just because of my background but I'd be very interested in knowing how these "% in good condition" estimates are generated. I'm not convinced that there's a good basis for these numbers (also presented on p. 67). I'm sure it's too much detail to include in this chapter but specific numbers like these should be linked to something scientifically citable.

p. 81, third paragraph: I'm not sure I completely agree with the first sentence about the stability and high quality of wilderness areas. They're certainly some of the best quality water out there but they are not immune from human effects. Streams in Class I wilderness areas in the Appalachians have been acidified by acidic deposition. Surface waters in wilderness areas are also affected by N deposition (e.g. lake communities in the Front Range of Colorado – see Jill Baron's work). Mercury contamination in wilderness systems is also likely to be an issue especially for the human and wildlife consumption of large piscivorous fish (which is certainly an ecosystem service of these systems).

p. 87, second paragraph: I'm not familiar with the source of all the regional numbers like 90% of riparian conditions are good in Alaska. Again I'm not convinced that there's a good basis for these numbers given the scale of such an analysis (e.g. thousands of km of riparian zone to assess) and what is the definition of "good". The citation is for a congressional report that I have no way of accessing and I'm sure it doesn't contain the technical details anyway.

p. 102, last paragraph bullet header: It would be useful to know how many plans were reviewed to place the bullet text in context (e.g. is it three plans out of 100 reviewed relied on ... or three plans out of 10 reviewed?).

p. 104, last bullet: wording problem, this is not a sentence.

Figs 3,4,5: why 3 figures on this subject here? Level of detail on this topic seems out of place.

p. 147, second paragraph: The call out for Figure 5 is wrong. Figure 5 is about burros not forest harvest. I'm not sure what figure number is being referred to here. It doesn't seem to apply to figure 6 very well either.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. Robert B. Jackson, Duke University*

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I was charged with the task of reviewing Chapter 3 of the draft Environmental Impact Statement (EIS), particularly the sections on ecosystem restoration, watershed protection, diversity of animal and plant communities, climate change, and multiple uses. In addition to providing some history and perspective on the rule overall, I emphasize those sections in my review. Overall, I view the proposed new planning rule to be a substantial improvement compared to its predecessor(s). That positive assessment is based on the updated and improved quality of science that the rule and EIC incorporate and the many economic and environmental benefits that the new rule should provide.

The proposed new planning rule should substantially improve how our nation's Forest Service (FS) lands are used and managed. It provides a broader, more scientifically-current view of why these lands are important – for people, for other species, and for the water and additional resources we value. The new plan should also allow the Forest Service to do a better job of integrating its expertise, resources, and land holdings into a national and global network for monitoring environmental change. The plan and accompanying Environmental Impact Statement will help the Forest Service build on its history of land use, management, and stewardship to be more effective and responsive to the changing world around us.

The draft EIC and planning rule generally reflect the positive trend in the Forest Service towards improved protection, maintenance, and restoration of species and ecosystems at watershed and landscape scales instead of a historical emphasis on relatively small plots and reactive monitoring of problems (see, for instance, page 88 of the EIS). This new emphasis on larger-scale perspectives is also consistent with results and perspectives in the peer-reviewed scientific literature for the last decade or two. Its continued implementation should be helpful for people and other species that rely on our lands.

Overall, I believe that the information in the draft EIC and planning rule accurately reflects current scientific understanding as reflected in the peer-reviewed literature. For many reasons, some of them discussed below, options A, D, and E reflect current science *more completely* in my opinion than options B and C do. Implementing these former three options should make the forest service more nimble and proactive and better long-term stewards of our country's economic and environmental resources. The new planning rule and its impact as assessed in the EIC move the forest service farther along the spectrum to integrated watershed management that maximizes not just forest growth but also the diverse valuable services that lands provide. The new rule nudges the FS away from a more historical environmental emphasis on the environmental effects of resource extraction alone (recognizing that many FS employees have been leaders in ecosystem services and integrated stewardship). As the draft

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EIC and planning rule note, the new rule is needed “to ensure that plans will be responsive to the challenges of climate change; the need for forest restoration and conservation, watershed protection, and wildlife conservation; and the sustainable use of NFS lands to support vibrant communities.”

Given my overall positive assessment, there are some ways in which the science could be better incorporated into the EIS. One area of the draft EIS that does not reflect current scientific understanding of the peer-reviewed literature is the discussion of road building. On page 84, for instance, the EIC reads, “there is uncertainty in the literature regarding a direct cause-and-effect relationship of road density to erosion.” Other statements in the paragraph and document (e.g., page 98 of the EIS) are presented in a similar vein. While it is true that one can find examples in the literature where erosion is not positively related to road density, *on average* there is a scientific (and intuitive) relationship between more road building and maintenance linked to more erosion, at least in habitats vulnerable to erosion. Thus this section could more strongly reflect the benefits *on average* for road closings, erosion, and watershed protection. Reducing the extent of road building and restoring some existing roads should yield both economic and environmental benefits in many cases.

The new plan and EIS also take a varying approach to environmental monitoring, a topic of increasing social and scientific importance for the Forest Service (see, for instance, the section beginning on page 107 of the draft EIC). There are at least two ways that increased monitoring will be valuable for the forest service and for taxpayers that fund it. One is that increased monitoring of the condition of lands will allow the FS to be more informed and proactive in maintaining, preserving, and restoring valuable resources. The second way that increased monitoring reflects current science is that the FS can use data on its lands to monitor environmental change more thoroughly, including evaluating the current state and trends in climate change, wildlife diversity, the quality of water resources, and ecosystem services in general. Any planning option that does not acknowledge this responsibility is, in my view, outdated scientifically and a lost opportunity. The FS could do even more in monitoring.

Section on Diversity of Plant and Animal Communities (page 100 and beyond): The over-reliance on indicator species, usually vertebrates, in Alternative B and the lack of habitat management requirements in Alternative C in my opinion do not reflect more comprehensive and recent ecological and environmental research. Plan C also has a scientifically weak section on “Monitoring to Assess Effectiveness” that would lead to an incomplete and, likely, incoherent monitoring plan for the Forest Service as a whole.

Section on Climate Change (page 122 and beyond): The increased emphasis on using monitoring to detect climate change and using scenarios, management, and other tools to make lands more resilient to climate change is an improvement scientifically from the 1982 planning rule. Forest Service lands contain considerable carbon stocks that could be vulnerable to environmental change, climate-related and otherwise. The lands also provide opportunities to restore carbon stocks in a number of locations. As in some other sections of the EIS, the de-emphasis of climate and climate change in Alternatives B and C compared to A, D, and E are a lost opportunity for improving and maintaining forest service lands. Almost 30 years of new science in this area is poorly reflected in Alternatives B and C, neither of which adequately covers the importance of climate change or the opportunity that the Forest Service has to contribute to climate-change solutions. Alternatives A, D, and E also include a more flexible and

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nimble Adaptive Management approach that reflects current scientific understanding and that can incorporate ecological and socioeconomic data more rapidly into decision-making.

One scientific gap in the EIS in the Climate Change section is the lack of acknowledgement of monitoring soils for carbon storage to complement the emphasis (in the EIS and planning rule) on aboveground vegetation.

Another issue for consideration is how the FS will achieve the actual goals of making lands more resilient to climate change versus “simply” gathering more information. For instance, how will they incorporate best science into decisions about habitat connectivity and dispersal corridors? How can they maximize connectivity (where desirable) while minimizing economic costs?

Multiple Use Section: The lack of required inclusion of recreation into planning for Option B seems to me to be a scientific oversight, given the tens of millions of people that use FS lands each year. There is a rich scientific literature on recreation and economics from recent decades. The body of research emphasizes how important and valuable recreation is and highlights some of the conflicts that recreation sometimes has with conservation, water resources, and other valuable services. To ignore this information is a missed opportunity.

On page 143, a statement is made that “little is known about the size, distribution, and types of rangeland occupied by private ranches having Federal grazing permits or leases, or about the beliefs and attitudes of public land grazers.” If the first part of the statement is true, then the FS needs to collect better data on this topic. The second part, that little is known about the beliefs and attitudes of public land grazers, ignores a fairly rich body of social science research from the last few decades, recognizing that more research is needed.

Overall, I find the new planning rule and draft EIS to be well founded scientifically and a major advance compared with earlier rules. The authors, and the architects of the process that led to it, are to be commended. Some suggestions for improvement and some perspective on the inclusion of science into the five Alternatives are given above. I look forward to a future with even stronger Forest Service stewardship for our country.

### **Definitions**

The planning rule has some definitions that I believe are vague or will lead to confusion. Two in particular that should be clarified, either in that EIS or in the planning rule itself, are:

Health(y) – the degree of ecological integrity that is related to the completeness or wholeness of the composition, structure, and function of native ecosystems existing within the inherent capability of the land.

Resilience – the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.

I really have no idea what the definition of “health” means and believe that it is likely to be a source of confusion if left in this wording. For “resilience,” the term “reorganize” is problematic; I don’t understand what is implied there, either.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. Glenn P. Juday, University of Alaska Fairbanks*

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Note: In the response I have identified the document as “FS Planning Rule Draft EIS”, “planning rule”, or “FS Planning Rule”.

**Framing Question 1**

**Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?**

The FS Planning Rule Draft EIS presents accurate and up-to-date information about biodiversity resources and forest ecosystem disturbance in resource management, and particularly in the context of national forest management. A climate change element is woven into the discussion as one of several related and interacting factors that affect management and managed forest resources.

The literature cited in the FS Planning Rule Draft EIS makes effective use of significant synthesis and overview references related to the relevant topics in national forest management. Examples include grazing (Brown and MacDonald 1995, Curtin 2002), management disturbance regimes (Drever et al. 2006), riparian vegetation and water quality (Dosskey et al. 2010), biodiversity and ecosystem function (Hooper et al. 2005), monitoring and research on national forest plan implementation (Haynes et al. 2006), and several other topics.

The concepts of ecological function, stressors, ecological integrity, biodiversity, forest disturbance dynamics, and the fundamentals of climate change are defined and explained. While this is a lot to incorporate into a policy document that is offered to the public, these processes and factors are, in fact, the basis that Forest Service managers would be using to make not just individual decisions, but patterns of decisions that emerge in Land and Resource Management Plans. These concept are presented accurately in the EIS.

Climate change is a featured element of the FS Planning Rule Draft EIS, as stated in the third paragraph of the document (Summary, page i)

“A new planning rule is needed to ensure that plans will be responsive to the challenges of climate change; the need for forest restoration and conservation, watershed protection, and wildlife conservation; and the sustainable use of NFS lands to support vibrant communities.”

A vast research effort on the climate change topic has been carried out over the past two decades. In general, the published climate change literature has focused on (A) detecting or confirming that climate change is detectable - often in the early stages of the overall climate change research effort, (B) identifying single species distributions or specific habitats being altered by climate-related processes, (C) projecting or predicting future climate change and presumed future climate change

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effects, and (D) examining climate change influences on disturbance regimes.

Appropriately, the FS Planning Rule Draft EIS avoids getting into the primary climate change and climate change effects literature. Instead the document again relies on a number of synthesis and summary references. In terms of the applicability to the FS Planning Rule, the climate change literature of (A) above is implicit in a number of citations in the EIS, and the literature of (B) is not an appropriate focus for a rule that is to provide guidance to diverse planning situations across the nation for an extended period of time. The literature of (C) above is of some relevance, but has been affected by an overly speculative component in which the legitimate use of scenarios and models as tools of understanding and examination of sensitivity have been taken as literal predictions. The FS Planning Rule EIS has avoided an inappropriate citation or reliance on such literature, or use of the literature. One of the most relevant parts of the climate change literature for the proposed rule is (D), dealing with disturbance regimes, and appropriate citations are made.

Recommendation #1: Broaden the perspective on climate change beyond that of a “stressor” to ecosystems.

Climate change is presented in the FS Planning Rule EIS from an ecosystem-based and essentially place-based perspective. That is certainly appropriate for national forest planning, which is, of course, a place-based exercise for bounded properties. From this perspective it is natural enough to think of climate change exclusively as an extrinsic factor that arrives at the site and impinges on the existing ecosystem or resource.

“Two general perspectives have been expressed about whether climate change should be addressed in the rule. ... The second is that climate change is such a fundamental ecosystem stressor that the rule must explicitly address it.”

But this is not the only necessary perspective on climate change. During the last few decades of the 20th century when it began to emerge as a scientific topic of significance, climate change could accurately be said to have been a stressor. Now in places such as the Arctic and boreal regions, climate change is more than a “stressor.” Climate change is an established empirical phenomenon with a pervasive influence on the survival of organisms, and changes consistent with pervasive biome shift are confirmed (e.g. Beck et al. 2011).

Beck, P.S.A.; Juday, G.P.; Alix, C.M.; Barber, V.A.; Winslow, S.E.; Sousa, E.E.; Heiser, P.; Herriges, J.D.; Goetz, S.J. 2011. Changes in forest productivity across Alaska consistent with biome shift. *Ecology Letters*. doi: 10.1111/j.1461-0248.2011.01598.x

Especially during the presumed life of this rule, additional climate warming and change is very likely to be significantly more than a stressor, initiating large-scale shifts in ecosystem distribution on a global basis (e.g. Gonzalez et al. 2010).

Gonzalez, Patrick; Neilson, Ronald P.; Lenihan, James M.; Drapek, Raymond J. 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. *Global Ecology and Biogeography*, 19(6): 755–768. DOI: 10.1111/j.1466-8238.2010.00558.x

In the FS Planning Rule Draft EIS climate change is presented in the context of resilience and resistance. As long as climate change stays within limits, as it has in early stages of the phenomenon so far, then resilience and resistance are appropriate frameworks for dealing with the issues it will cause in the context of national forest planning. But there is very little reason to believe that there is some immediate upper limit to the climate change process now underway. Climate change at the



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level of wholesale biome shift, as has happened as recently as the beginning of the Holocene 12K years ago, replaces ecosystems, and resiliency has no application in that situation.

Recommendation #2: Add a broader perspective on climate change, involving more than issues of ecosystem resistance, resilience, and alteration of (familiar) disturbance regimes to the planning rule.

Recommendation #3: Add explicit statements and references on the contribution of species diversity to ecological function (e.g. Ecological Integrity and Resilience - pg. 61).

The rationale for elevating biodiversity to an overriding concern and directive in national forest management and management planning is partly based on the intrinsic regard for species themselves, but also is based on the case that diversity contributes to important ecological functions. The FS Planning Rule Draft EIS implicitly recognizes the latter point in a variety of places, such as the Figure 2 (Components of Biodiversity) and elsewhere. Even though aspects of the contribution of species diversity, alone, to ecological function are subject of lively debate, a number of direct experimental findings on the subject are available. In these experiments, greater species diversity leads to greater primary productivity, greater resilience and recovery following the stress of drought, greater efficiency of utilization of nutrient elements, less invasion by exotic species, and other effects. Some of these outcomes are stated goals of the FS Planning Rule. I suggest making this connection between species diversity and goals of planning explicit in the discussion. Doing so would close a gap in the circle of logic in the Draft EIS document. Appropriate support could be drawn from, among others, these references:

Tilman, D. 1999. The Ecological Consequences of Changes in Biodiversity: A Search for General Principles. *Ecology* 80 (5):1455-1474.

Tilman, D., Knops, J, Wedin, D., Reich, P., Ritchie, M., and E. Siemann. 1997. The Influence of Functional Diversity and Composition on Ecosystem Processes. *Science* 277: 1300-1302.

M. Loreau, S. Naeem, P. Inchausti, J. Bengtsson, J. P. Grime, A. Hector, D. U. Hooper, M. A. Huston, D. Raffaelli, B. Schmid, D. Tilman, D. A. Wardle. 2001. Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges. *Science* 26 October 2001: Vol. 294. no. 5543, pp. 804 – 808.

Recommendation #4: Clarify biodiversity concepts

Biodiversity has several operational definitions, and the uses and definitions of the terms and associated concepts in the early portion of the FS Planning Rule Draft EIS (pg. 56) are certainly acceptable and widely recognized. Yet on page 105 “biodiversity” is conflated with species diversity. I recommend a review for consistency in uses of “biological diversity”, “biodiversity”, and “species diversity”. In addition, there might be some places where the rationale for the planning rule and anticipated national forest plans could be specifically related to the maintenance of genetic diversity, specifically well-adapted ecotypes of widespread forest species. Some members of the public object to deliberate redundancy in certain national forest allocations for species based on a failure to grasp the essential role of genetic diversity in conferring survival advantage.

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### **Framing Question 2**

**Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.**

There are two ways that limitations and uncertainties need to be addressed in a document and process such as the FS Planning Rule Draft EIS. The first is the appropriate acknowledgement uncertainty that arises in applying the findings of the scientific literature. In my opinion the proposed FS Planning Rule Draft EIS does not appear to overinterpret the literature and generally respects the appropriate limits in the applicability of studies and findings. The second way is the uncertainty in management and planning that arises from the acquisition of new information and from changing circumstances on the ground, among users, or in Dealing with uncertainties and limitations in management planning is an integral part of the proposed rule. The FS Planning Rule is constructed so that two of the three stages of the continuous planning framework cycle explicitly involve uncertainty and limitations:

Alternative A (Proposed Action) (pg. iv)

The framework consists of a three-part learning and planning cycle:

...

2. Revise or Amend land management plans based on the need for change; and
3. Monitor to detect changes on the unit and across the broader landscape and to evaluate whether management actions produce desired outcomes.

Uncertainty is also dealt with explicitly in the context of climate change:

Climate Change (pg. 40)

*Alternative A*

... Uncertainties brought about by climate change would be addressed through a planning framework for adaptive management that includes 1) an iterative process of assessment, revising or amending plans, and monitoring, and 2) participation in all phases by managers, scientists, and the public.

I would rate the proposed planning rule EIS highly on this score.

### **Framing Question 3**

**What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring. Particular attention to climate change.**

Recommendation #5: Cite USDA Climate Change Science Plan and other collaborations in relationship to learning and monitoring functions highlighted as essential parts of the planning rule. It is apparent that the proposed FS Planning Rule, when implemented, will create a considerably increased demand for information. In fact, it will make information activities a larger and more integral part of the actual management of the national forests:

(pg. 17) "The proposed planning rule establishes an adaptive framework within which

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land managers and partners would work together to understand conditions on the land, develop land management plans to respond to existing and predicted conditions and needs, and monitor changing conditions and the effectiveness of projects and activities to provide a continuous feedback loop. The framework consists of a three-part learning and planning cycle: ...”

The FS Planning Rule Draft EIS describes an approach in which collaboration will be the principal strategy to achieve such goals rather than a significant change in the makeup of the national forest management workforce. Given the prominence of climate change as both a USDA Strategic Issue and a national forest framework planning issue, considerable expertise on the climate change issue will be needed to successfully carry out the planning rule.

Strategic Goal 2 of USDA’s Strategic Plan is:

“to Ensure Our National Forests and Private Working Lands Are Conserved, Restored, and Made More Resilient to Climate Change, While Enhancing Our Water Resources. “

The EIS would be strengthened by identifying essential contributors to implementing the planning rule. The USDA has developed a Climate Change Science Plan:

[http://www.usda.gov/oce/climate\\_change/science\\_plan2010/USDA\\_CCSPPlan\\_112910.pdf](http://www.usda.gov/oce/climate_change/science_plan2010/USDA_CCSPPlan_112910.pdf)

The USDA Climate Change Science Plan provides an important guide :

“... to enable clear and consistent consideration of current and potential investments in climate change science activities. This Science Plan presents an overview of the critical questions facing the Department’s agencies as they relate to climate change and offers a framework for assessing priorities to ensure consistency with USDA’s role in the Federal Government’s broader U.S. Global Change Research Program (USGCRP) and related efforts.”

In any event, clarifying the means of carrying out the proposed planning rule’s increased demand for climate change information is desirable. The sections on Transparency and Collaboration may be an appropriate place to do this.

**Recommendation #6: Resolve the tension or even contradiction between the projected effects of climate change or the lessons that can be drawn from actually experienced climate change versus the diversity mandate in NFMA.**

Perhaps the most serious issue in my opinion in the FS Planning Rule Draft EIS is the unresolved tension between the NFMA mandate to sustain the diversity of native species present at the beginning of the national forest land and resource management plan throughout the life the plan, versus the impending level of climate change which is likely to make environments no longer suitable for the survival of organisms that were typical of the recent past.

### **Diversity of Plant and Animal Communities**

People have differing opinions about the most appropriate way for the rule to provide guidance for maintaining plant and animal diversity and whether to contribute to the recovery of threatened and endangered species and maintain native species within the plan area...

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They state that the Forest Service, through its management actions, has a greater ability to influence the amount and quality of habitats than wildlife species, and that focusing on that aspect of ecological sustainability could provide the best opportunity for maintaining populations of all species in the plan area.

*Ecosystem Restoration in Current Plans (Page 71)*

Analysis of plans recently reviewed under the 1982 planning provisions shows that the historic range of variability was evaluated and used to identify approaches to restoration. Some qualify their reliance on historical conditions by taking into account ongoing and anticipated disturbances such as climate change or invasive species encroachment. Most of these plans identify restoration as a tool to enhance the resiliency of ecosystems in response to stressors and disturbances. Some units focused explicitly on habitat restoration as a tool to support specific species resiliency or to create habitat corridors to facilitate movement and migration of species.

The use of historic range of variability as a normative guide to the future seems to directly challenge the notion that climate change deserves to be a top-level concern. This apparent contradiction needs to be addressed in the FS Planning Rule and Draft EIS. There is one cited references that deals directly with this subject “The role of climate change in interpreting historical variability” (Millar 1999) but it is relatively old and needs to be supplements on such an important element of the proposed rule.

The challenge for forest management, given the scale, severity, and speed of climate change, is to supervise the response of the forest ecosystem to climate change. Some organisms are likely to successfully meet the challenges of migration and to do so relatively early in the process of change. In those cases, it is only necessary to verify the fact and then refocus resources on other species. The genetic diversity or potential of an individual, a population, or a species may not be appropriate for the new conditions and evolutionary adaptation will not be possible in the timeframe of rapid climate change. The concept of Assisted Migration has been developed to describe the feasibility and ethical issues of human intervention into the purposeful movement of species that have become displaced by a changing climate. The term “migration” is used 7 times in the document, but never quite in this context. The closest case would be the in the comments on Ecological Restoration - pg. 71.

Conceivably, Assisted Migration could fall within the scope of an Endangered Species Recovery Plan. This potential raises the interesting issue of how such actions would relate to the diversity mandate of NFMA.

**OVERALL CONCLUSION**

FS Planning Rule Draft EIS includes a competent and comprehensive review of the scientific literature relating to the intersection of biodiversity resources, forest planning and management, forest ecosystems and disturbance, and climate change impacts in the planning context. While I suggest that a few clarifications be incorporated, particularly clarifying the apparent logical inconsistency of basing planning processes and standards simultaneously on the goals of maintaining all native species as guided by the experience of historic variability while expecting and adapting to climate change and climate change effects beyond any historical experience, the proposed plan rule incorporates contemporary approaches and concepts of ecosystem management developed from new understanding of ecosystems in a way that appears to be valid and appears to meet a range of legal requirements.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. William S. Keeton, University of Vermont*

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**INTRODUCTION**

As requested, this review focuses on issues of restoration, climate change, watershed protection, and diversity of plants, though comments are provided on other topics. The review evaluates the strength of science underpinning the analytical framework used to evaluate management alternatives. For this reason, it concentrates on the sections of Chapter 3 that lay out the scientific concepts considered, rather than the application of these concepts to individual alternatives. Wherever possible the review suggests additional or alternative concepts, principles, findings, models, and citations that might enhance the overall presentation of the science in support of sustainable forest management on the National Forest System.

The review responds to the following specific questions:

1. Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?
2. Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.
3. What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring.

**GENERAL COMMENTS**

Central to the purpose of this chapter is to present the science required to effectively evaluate the range of management alternatives in the DEIS. At their core, these alternatives present a range of prescriptive vs. adaptive management approaches. Prescriptive approaches carry greater certainty in terms of precisely what kind of management will follow but are less able to respond to changing environmental conditions. Adaptive approaches can be ambiguous with respect to explicit management direction, yet reflect much of what the ecosystem management literature has been saying is needed to respond to global change and evolving social values and demands.

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Chapter 3 makes a very good attempt at laying out the basic concepts needed to evaluate the relative merits of these contrasting approaches. However, there is room for improvement in terms of providing specific indicators, benchmarks, and models that would help identify critical areas of uncertainty in the management alternatives. I recommend providing a more explicit scorecard or rating system that would allow the different alternatives to be evaluated against environmental criteria. There are several alternatives, but generally the analytical framework needs to be bolstered to better identify and compare the pros and cons of the management alternatives relative to environmental concerns, consequences, and indicators.

Overall the review of the field of conservation biology could be improved. Largely lacking is an in-depth discussion of important concepts from the conservation biology literature, including connectivity, core reserves, minimum dynamic area, metapopulations, and the relationship between biodiversity and ecosystem function.

Much of the foundational science text (pages 55-64) is somewhat jargon laden, introducing lots of concepts without delving into the concepts substantively or with direct linkage to management of the National Forest System. Here is an example: “While these three components (structure, composition, and function) of ecosystems are inseparable, any complete discussion of biological diversity must recognize the extraordinary diversity of ecological and evolutionary processes that far outnumber the compositional and structural elements because they include the evolution of every species, all the ecological interactions among species, and a myriad of ecosystem and genetic processes (Hunter 1999).” This is an unusual sentence. I have never seen this particular point argued in the literature, and it seems to incorporate circular reasoning. If structure, function, and composition are linked then how could one be any more important or numerous than the others? What does the term “inseparable” mean scientifically? The text would be stronger if it reviewed the actual empirical studies such concepts derive from, with less emphasis on synthetic textbooks like Hunter (1999).

Much of the initial scientific review (prior to page 64) seems poorly linked to actual issues relevant to National Forest Management. It mainly reviews basic concepts in ecology. I suggest beginning rather with the vast literature that has developed in the field of Sustainable Forest Management, then delve into the scientific underpinnings of that literature.

Recommended general sources to bolster this chapter:

Kohm, K.A. and J.F. Franklin (eds.). 1997. *Creating a Forestry for the 21<sup>st</sup> Century*. Island Press, Washington, D.C.

Lindenmayer, D.B. and J.F. Franklin. 2001. *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*. Island Press, Washington, DC.

Davis, L.S., K.N. Johnson, P.S. Bettinger, and T.E. Howard. 2001. *Forest Management* (4<sup>th</sup> Edition). McGraw Hill, Boston, MA. 804 pp.

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## SPECIFIC COMMENTS

### CONTEXT

#### *Dynamic nature of ecosystems*

Page 55. Stress rather that ecosystems are nested across scales, and are composed of mosaics of patches reflecting both geophysical influences and the interaction of disturbances with successional processes.

Page 56. The presentation of equilibrium dynamics is not clear. I suggest clarifying the old view, which held that ecosystems were constantly trying to recover towards a stable condition, and that disturbances were external to system. State clearly that this view is rejected under the current non-equilibrium model.

Page 56. This sentence is vague and irrelevant: “The concept of homogeneous states, or homeostasis, has been refined to explicitly recognize that ecosystems are dynamic, open systems that are subject to change due to disturbance regimes and other natural processes (e.g., natural senescence).” The text here seems mired in 1970s era systems theory, which has largely been abandoned as a useful way for understanding ecosystem dynamics. “Homogeneous states” has no contemporary definition or relevance. The concept of “homeostasis” has been largely rejected. The text would be better to describe non-equilibrium dynamics and contemporary models, such as natural range of variability, which is presented later and yet is at odds with concepts like homeostasis. My opinion is that these paragraphs on systems theory add little to the chapter; they provide little or no scientific foundation for evaluation of the management alternatives.

“Homeorhetic stability.” I have rarely if ever seen this term in the contemporary ecological literature. The text would be stronger if it steered clear of concepts of stability or explain why they have been rejected. The text does a poor job of reconciling these with contemporary views of ecology. They are largely NOT consistent. The review would be better if it focused instead on the vast literature on disturbance ecology and resilience, exploring topics such as disturbance-habitat interactions, successional dynamics, and the biodiversity-ecosystem function debate. The latter in particular is noticeably missing.

Sentence about Landfire seems odd. Why this particular example? There are hundreds of others. Need a citation for the Landfire case if you keep it.

Page 56. Last paragraph is poorly written. It seems just to throw around a lot of jargon. Biodiversity IS composition, so this sentence is redundant.

“The components interact to maintain biological diversity (Noss 1990).” This sentence does make sense. The text needs a better description of the science regarding maintenance of biodiversity. Need to describe all the key issues from the conservation biology literature. I note that a later section focuses on maintenance of species viability, so the authors will need to determine where best to present this material.

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This sentence doesn't make sense scientifically: "While these three components (structure, composition, and function) of ecosystems are inseparable, any complete discussion of biological diversity must recognize the extraordinary diversity of ecological and evolutionary processes that far outnumber the compositional and structural elements because they include the evolution of every species, all the ecological interactions among species, and a myriad of ecosystem and genetic processes (Hunter 1999)."

"Based in part on increased understanding of historical ecology and the perception that it provides of temporal scaling." I suggest adding greater detail on what you are referring to as "historical ecology" This is an large field of investigation. I suggest reviewing literature in particular on reconstructions of historical vegetation, land use change, shift in age class distributions, change in fire and insect disturbance regimes, and paleoecology. Provide a separate discussion of key concepts from the field of paleoecology (e.g. individualistic plant responses to past climatic changes) with implications for national forest management (e.g. the difficulty in predicting future vegetation shifts due to the likelihood of individualistic responses and thus resorting of species assemblages).

Page 58. The discussion of disturbance is a good start, but seems overly broad and general. One of most the important concepts to emerge from this field is "biological legacies." Biological legacies are "the organisms, organic materials, and organically-generated patterns that persist through a disturbance and are incorporated into the recovering ecosystem" (Franklin et al. 2000:11). Our understanding of these structures has had huge implications for sustainable forestry, such as development of retention forestry systems and disturbance-based silviculture, yet oddly this is missing from the discussion.

Please see:

Franklin, J.F., T.A. Spies, R. Van Pelt, A. Carey, D. Thornburgh, D.R. Berg, D. Lindenmayer, M. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbances and the structural development of natural forest ecosystems with some implications for silviculture. *Forest Ecology and Management* 155:399-423.

Franklin J, Lindenmayer D, MacMahon J et al (2000) Threads of continuity: ecosystem disturbance, recovery, and the theory of biological legacies. *Conservation Biology in Practice* 1:8-16

Other references for disturbance-based management:

Franklin et al. 2007. *Natural Disturbance and Stand Development Principles for Ecological Forestry*. USDA Forest Service General Technical Report NRS-19.

North, M.P. and W.S. Keeton. 2008. Emulating natural disturbance regimes: an emerging approach for sustainable forest management. Pages 341-372 in: R. Laforzezza, J. Chen, G. Sanesi, and T. R. Crow (eds.). *Patterns and Processes in Forest Landscapes - Multiple Use and Sustainable Management*. Springer, The Netherlands.

Seymour R, White A, deMaynadier P (2002) Natural disturbance regimes in northeastern North America—evaluating silvicultural systems using natural scales and frequencies. *Forest Ecology and Management* 155:357-367



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### ***Inherent capability of the land***

The chapter is rife with overly broad statements like: “Ecosystems are defined by interactions of biological and physical systems.” This reads like a brief summary of the entire field of ecology rather than a distillation of science specifically relevant to federal forest and grassland management. My main suggestion is to add a more sophisticated discussion of the science that is directly relevant to management. To do this, start each paragraph with a topic sentence that sets out one of the fundamental challenges facing management of the national forest system, such as biodiversity, roads, disturbances, invasive organisms, water, recreational impacts, and climate change. Then review all areas of the science relevant to those challenges, which would then set up a much better basis for evaluating the management alternatives based on their relative ability to address these challenges.

This section seems unlinked to its sub-title. A thorough review of intrinsic ecosystem capacity is a vitally important topic. In fact, the USDA Committee of Scientists (1999) said: *“Sustainability ...has three aspects: ecological, economic, and social...the sustainability of ecological systems is a necessary prerequisite for strong productive economies, enduring human communities, and the values people seek from wildlands. We compromise human welfare if we fail to sustain vital, functioning ecological systems.”* This statement recognizes that starting with an understanding of the fundamental capacity of ecosystems to sustain production of full range of ecosystem goods and services must be the basis for sustainable forest management, rather than starting with a preconceived output goal. However, the text in this section is about ecologically significant units (also an important topic), with an orphaned second paragraph about plant responses to climate change unlinked to either the section heading or the discussion of the National Hierarchy of Ecological Units. I suggest moving the current content and replacing it with a detailed discussion of ecosystem capacity.

### ***Historic Range of Variability***

This also is an important topic, and was featured prominently in the Committee of Scientists (1999) report. It would seem important, then, to revise more substantially our understanding of HRV gained in the last 12 years, both in terms of advantages and disadvantages as a guide for land management. The section would be improved by reviewing some of the many examples of management approaches based on HRV that have been developed over the last 15 years, for example at the H.J. Andrews Experimental Forest in Oregon.

This section touches on some of the key point, but also misses others. I present here an excerpt from Keeton (2007) where I attempted to review the most relevant aspects of the HRV debate for sustainable forest management:

*“An implicit assumption in these approaches is that forest management will be ecologically sustainable – i.e. has greater likelihood of providing viable habitats for a full range of native species – if it maintains or approximates ecosystem patterns and processes associated with natural disturbance regimes and successional processes (Aplet and Keeton 1999). This bounded range within which attributes of ecosystem structure and function vary over time and space has been termed the “historic range of variability” (HRV). According to this line of thinking, if HRV represents the conditions under which organisms evolved and have adapted, then species will have the greatest likelihood of survival if similar conditions are*

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*provided through management. There are examples of forest management plans based on reconstructions of HRV (e.g. Cissel et al. 1999, Moore et al. 1999). Yet HRV-based approaches are difficult to implement. To begin with, the feasibility of quantifying HRV for a given landscape varies greatly depending on data availability and modeling requirements (Parsons et al. 1999). There is the added difficulty of finding appropriate historical reference periods (Millar and Woolfenden 1999). Thirdly, forest managers must determine whether HRV offers a realistic target for management, considering the extent to which conditions within the HRV are compatible with contemporary management objectives, altered ecosystem conditions and dynamics attributable to land use history, and changing climatic conditions. Despite these limitations, HRV provides an informative benchmark or reference for understanding landscape change (Aplet and Keeton 1999).”*

From: Keeton, W.S. 2007. Role of managed forestlands and models for sustainable forest management: perspectives from North America. *George Wright Forum* 24(3):38-53.

This statement: “Fundamental to this approach is the concept of representation (Noss and Cooperrider 1994), which aims to maintain on the landscape those ecological conditions that represent all of the variety of ecosystems” – would be better in a section on reserve design theory, or competing views of ecosystem management (e.g. the reserves vs. active management debate. The citation is not a perhaps not the best one for this section. The concept of representation within reserves was not presented in the context of HRV.

This section is a good example of the kind of general review presented in this chapter that doesn’t really reach any conclusions. The reader is left wondering what the implications are for management and conservation on the National Forest System In this section, for example, can we conclude that HRV has something to offer as a benchmark for understanding long term changes in ecosystem structure and function, for comparison against contemporary conditions, or not? The reader will want to understand more clearly why the science is being reviewed and what the implications are.

An important point is not just that management could attempt to restore landscape dynamics to a condition within the HRV, but that we could move landscapes closer to HRV, even if full attainment is not possible (e.g. on highly altered or settled landscapes). Moreover, with climate change some aspects of HRV remain relevant, while others will change. But understanding how conditions have changed relative to historic benchmarks will always remain informative.

Page 60, 4<sup>th</sup> paragraph. It is not just “data quality” that is limiting, but also data availability. For instance, some of the most convincing examples of management approaches have been developed from reconstructions of HRV (e.g. Cissel et al. 1999) in systems where 1) fire regimes create highly dynamic fluctuations in ecosystem structure and function over time and space; and 2) these dynamics can be reconstructed reliably, for instance from fire scar records. In other systems, for instance those shaped primarily by fine-scaled wind disturbances (e.g. deciduous eastern forests), such reconstructions of disturbance history are often either not available or much more difficult to perform. My take on the literature is that HRV approaches work much better in western landscapes than in eastern landscapes, where land-use history is a much more important concept in many ways. Does this chapter have a section

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on the vast science exploring the profound influence of land-use history on eastern forests, such as the excellent work from the Harvard Forest group (e.g. numerous papers by David Foster and others)?

Other references:

Aplet, G.H. and W.S. Keeton. 1999. Application of historical range of variability concepts to biodiversity conservation. Pages 71-86 in: R. Baydack, H. Campa, and J. Haufler (eds.). Practical Approaches to the Conservation of Biological Diversity. Island Press, Washington, DC.

Cissel, J.H., F. J. Swanson, and P. J. Weisberg. 1999. Landscape management using historical fire regimes: Blue River, Oregon. *Ecological Applications* 9: 1217-1231.

### ***Ecological integrity and balance***

This section reviews basic ecological concepts while making few connections to actual management challenges facing the national forest system. It reads much like other broad synopses of concepts such as integrity, resilience, and resistance.

Last paragraph of page 61 alludes to the role of biodiversity in maintaining ecosystem resilience. However, it does not delve into the much larger debate about biodiversity and ecosystem function. Most research has shown that resilience is conferred by redundancy across and within functional groups of organisms. Suggest reviewing papers by D. Tilman, H. Mooney, and others. This debate is highly relevant to National Forest management, because a key issue has been whether, in order to maintain resilient, highly functioning ecosystems, we need to maintain viable well-distributed populations of as many species as possible, as opposed to just focal, rare, or ESA listed species. So this would be the perfect point in the chapter to provide a detailed scientific basis for evaluating the different management alternatives relative to this issue (see Naeem et al. 1999; Chapin et al. 1997).

Suggest removing the term “stable” (end of page 61). This still occasionally crops up in papers grounded in systems theory, but is deemphasized in the literature focused on ecosystem dynamics. What is a stable ecosystem? If they are dynamic, how can they be stable? Contemporary ecology views dynamic change as a process that organisms depend on. So are we talking about stability within a range of variation? Herein lies the debate in the literature. Better not to use this term.

References:

Naeem et al. 1999. Biodiversity and Ecosystem Functioning: Maintaining Natural Life Support Processes. *Issues in ecology* 4

Chapin III, F. S., B. H. Walker, R. J. Hobbs, D. U. Hooper, H. Lawton, O. Sala, and D. Tilman. 1997. Biotic control over the functioning of ecosystems. *Science* 277: 500-503.

### ***Stressors and their influence***

This section briefly introduces the concept of stressors and compounded stress interactions, but then quickly moves to the topic of climate change. As an alternative, I suggest using this

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section to explore the stressor-stress response framework adopted by many organizations and institutions, such as National Park Service's Northeast Temperate Forest Monitoring Network. A discussion of frameworks (like the "Pressure-State-Response" model) would provide the scientific basis for later portions of this chapter focused on adaptive management and monitoring.

Suggest changing this section to provide a thorough exploration of 1) stress interactions in ecosystems germane to the National Forest System, and 2) stressor-stress response monitoring frameworks. I also suggest adding a discussion of the interaction between the indirect (e.g. disturbance effects) and direct (e.g. physiological responses) effects of climate change. These are predicted to increase vulnerabilities for many species (see for example Franklin et al. 1991). Also mention the science showing increased vulnerabilities to climate related stresses where species occur at the margins of their tolerance ranges or competitiveness (see for example Beckage et al. 2008).

Reference:

Beckage, B., B. Osborne, D. G. Gavin, C. Pucko, T. Siccama, and T. Perkins. 2008. A rapid upward shift of a forest ecotone during 40 years of warming in the Green Mountains of Vermont. *Proceedings of the National Academy of Sciences* 105:4197-4202.

Franklin et al. 1991. Effects of global climatic change on forests in northwestern North America. *Northwest Environmental Journal* 7:233-254

### ***Management in the Face of Uncertainty***

This section provides a good overview of adaptive management. But a lot more could be said on this topic. There are many other models besides Walters and Holling (1990). That particular model seems somewhat dated given the tremendous development of thinking and implementation during the 1990s especially. I suggest incorporating one or two other frameworks for adaptive management. You can find an extensive bibliography for this topic at: [http://www.csun.edu/~vasishth/Adaptive\\_Mgmt-biblio.htm](http://www.csun.edu/~vasishth/Adaptive_Mgmt-biblio.htm)

Another very good synthesis of adaptive management theory, placed within the larger context of ecosystem management, is provided by Christensen et al. (2006). I suggest reviewing also Gregory et al. (2006).

Given the heavy reliance of the preferred management alternative on adaptive management approaches, the reader expects this chapter to provide a more substantial review of the full range of adaptive approaches, discussing pros, cons, and uncertainties. There is a substantial literature also on the social dimensions of this issue, including participatory processes. One specific model that I did not see reviewed is the Adaptive Management Area approach pioneered in the Pacific Northwest under the Northwest Forest Plan. This is unique, to my knowledge, in that it relies on "bottom-up" stakeholder processes to development management plans for the respective AMAs. It is a novel approach to public involvement, but has only worked well in some AMAs, not so well in others. Consequently, this case study could be used to highlight some of advantages and well as potential pitfalls/challenges associated with reliance on collaborative adaptive management.

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In the past decade other interesting adaptive approaches have been developed, with much of the innovation happening through public-private partnerships, such as Massachusetts's citizen-based coastal zone monitoring program. The USFS might consider incorporating elements of citizen based initiatives such as this. Also, I could find little mention here or later in the document of structuring adaptive management explicitly as experimentation, and the utility of wilderness, RNAs, and other special management areas as experimental controls in this context.

References:

Christensen et al. 1996. The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. *Ecological Applications* 6:665–691.

Gregory et al. (2006). Deconstructing adaptive management: criteria for applications to environmental management. *Ecological Applications* 16: 2411–2425.

## **ECOSYSTEM RESTORATION**

Page 66: “A stressor is generally associated with a departure from a reference condition that is primarily based upon the historical range of variability.” This is certainly one approach, but as the previous section acknowledges, it carries the uncertainty associated with trying to find historic time periods that remain analogous to present and future conditions in the context of global change. An alternative is to use vegetation simulation modeling to understand how baseline conditions may be changing. However, despite much work projecting vegetation change into the future, there is very high uncertainty regarding how this information could be used to establish “forward looking” reference conditions to guide restoration.

This section could be improved using a specific example of changing reference conditions. Consider using the example of climate related effects on fire regimes superimposed on past changes caused by fire suppression. The reference condition (or HRV) for fire restoration, in this example, is a moving target in some ways. See the following references:

Brown, T.J., B.L. Hall, and A. Westerling. 2004. The impact of twenty-first century climate change on wildland fire danger in the western United States: an applications perspective. *Climatic Change* 62: 365-388.

Keeton, W.S, J.F. Franklin, and P.W. Mote. 2007. Climate variability, climate change, and western wildfire with implications for the suburban-wildland interface. Pages 223-255 in: A. Troy and R. Kennedy (eds.). *Living on the Edge: Economic, Institutional and Management Perspectives on Wildfire Hazard in the Urban Interface*. *Advances in the Economics of Environmental Resources*, Vol 6. Elsevier Sciences, New York, NY.

McKenzie, D., Z. Gedalof, D.L. Peterson, and P. Mote. 2004. Climatic change, wildfire, and conservation. *Conservation Biology*: 18:890-902.

Mote, P. W., E. A. Parson, A. F. Hamlet, K. N. Ideker, W. S. Keeton, D. P. Lettenmaier, N. J. Mantua, E. L. Miles, D. W. Peterson, D. L. Peterson, R. Slaughter, and A. K. Snover. 2003. Preparing for climate change: The water, salmon, and forests of the Pacific Northwest. *Climatic Change* 61:45-88.

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Westerling, A.L., H.G. Hidalgo, D.R. Cayan, T.W. Swetnam. 2006. Warming and earlier spring increases western U.S. forest wildfire activity. *Science* 313: 940-943.

Page 66. Third paragraph should mention also invasive species as another major cause of change (it does appear later in bullet points). Arguably suburban-exurban development, rather than “urbanization,” are more important now in terms of ecosystem change. See references listed previously.

See also:

Drummond and Loveland. 2010. Land-use pressure and a transition to forest-cover loss in the eastern United States. *BioScience* 60: 286–298

Foster, D.R., B.M. Donahue, D.B. Kittredge, K.F. Lambert, M.L. Hunter, B.R. Hall, L.C. Irland, R.J. Lillieholm, D.A. Orwig, A.W. D'Amato, E.A. Colburn, J.R. Thompson, J.N. Levitt, A.M. Ellison, W.S. Keeton, J. D. Aber, C.V. Cogbill, C.T. Driscoll, T.J. Fahey, C.M. Hart. 2010. *Wildland and woodlands: a vision for the New England landscape*. Harvard University Press, Cambridge, MA. 36 pp.

### ***Stressors Associated with Changes to Aquatic Resources***

Need to give a source for the assessment and rating of watershed condition.

Mention also watershed impacts associated with invasives (e.g. Japanese knotweed).

More could be said about road impacts and the need for restoration. Here and elsewhere the document emphasizes sedimentation, which is important, but largely neglects effects on hydrology, such as timing and intensity of peak flows. I suggest incorporating more review of this topic. Modelling work has demonstrated linkages between road density, forest cover, and runoff during moderate rain-on-snow events, but runoff can be insensitive to these factors when the sheer volume of precipitation overwhelms other factors (Storck et al. 1998). Some studies (Jones and Grant 1996; Jones 2000) have found that peak (flood) flows are of greater magnitude in small watersheds downstream of areas with extensive clear-cutting and road networks, while others (e.g. Bowling et al. 2000) have not been able to confirm these statistical associations. The document needs to provide a better review of this issue.

The science of road restoration is complex. Decommissioning can include 1) gating, 2) replanting, 3) regarding to approximate original contour, and 4) all of the previous in tandem. The assessment should provide a basis for understanding 1) how these options differ, and 2) how the different management alternatives will address these options.

Road crossings, thermal barriers (caused by loss of riparian forest cover), and other impediments to fish passage (e.g. aquatic ecosystem connectivity) would seem like a critical watershed restoration issues for the document to evaluate, but I could find little discussion of these.

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References:

- Bowling, L.C., Storck, P., Lettenmaier, D.P., 2000. Hydrologic effects of logging in western Washington, United States. *Water Resources Research* 36, 3223-3240.
- Jones, J.A., 2000. Hydrologic processes and peak discharge response to forest removal, regrowth, and roads in 10 small experimental basins, western Cascades, Oregon. *Water Resources Research* 36, 2621-2642.
- Jones, J. A., Grant, G.E., 1996. Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon. *Water Resources Research* 32, 959-974.
- Storck, P., Bowling, L., Wetherbee, P., Lettenmaier, D.P., 1998. Application of a GIS-based distributed hydrology model for prediction of forest harvest effects on peak streamflow in the Pacific Northwest. *Hydrological Processes* 12, 889-904.

***Stressors Associated with Changes to Vegetation Composition and Structure***

In moist temperate North American forests, the most profound structural change has been the widespread simplification of stand structure resulting from 20<sup>th</sup> century forest management practices. This would be a good place to mention the vast science that has explored ecologically important elements of stand structure, such as canopy architecture, coarse woody debris, and horizontal heterogeneity (e.g. gap and non-gap patches). This is at the core of the forest management debates in the Pacific Northwest and other regions. Yet this idea does not seem clearly presented in this section. The text gives no indication that it has “learned” from this body of science assembled over the past 30 years. The chapter would be improved by clearly presenting the scientific basis for determining the relative merits of the management alternatives in terms of rectifying loss of stand and landscape scale structural complexity.

The other critical issue is the structural changes (e.g. shift from open canopied structure, to dense, multi-layered structure) in fire-suppressed forests historically associated with low intensity fire regimes. This is only briefly mentioned in the second to last paragraph (page 68), and the cause of the change is not clearly presented. Again, this seems to be given short shrift in terms of the vast literature on this topic.

As a reviewer I found myself wondering what the purpose was for the very brief review sections like this one. I was expecting a thorough analysis of these issues: their causes, consequences, and management implications. This would provide a more solid basis for evaluating the management alternatives. Skimming over critical issues like the two I just mentioned seems to achieve little.

***Stressors Associated with Changes to Landscape Patterns and Loss of Habitat Connectivity***

My comments on the last section apply here as well. There is a very large body science exploring simplification of the landscape scale structure associated with natural disturbance dynamics. Others papers deal directly with fragmentation and connectivity. Dispersed patch clear cutting and roads have been the primary causes of fragmentation on the National Forest System, but these are not mentioned explicitly. Associated with this is the literature proposing “matrix management” as a large-scale approach to reduce fragmentation and restore connectivity (see Lindenmayer and Franklin 2001).

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For a classic paper on this topic, see: Franklin and Foreman. 1987. Creating landscape patterns by forest cutting: Ecological consequences and principles. *Landscape Ecology* 1: 5-18.

For two highly germane and recent papers on changes in landscape structure and consequences for ecosystem functioning, see:

Rhemtulla, J. M., D. J. Mladenoff, M. K. Clayton. 2009. Legacies of historical land use on regional forest composition and structure in Wisconsin, USA (mid-1800s to 1930s to 2000s). *Ecological Applications* 19: 1061-1078.

Rhemtulla, J.M., D.J. Mladenoff and M.K. Clayton. 2009. Historical forest baselines reveal potential for continued carbon sequestration. *Proceedings of the National Academy of Sciences* 106: 6082-6087.

A recent US Forest Service assessment concluded that exurban sprawl and development is the single greatest threat to many forest ecosystems in the eastern US, particularly in the Southeast. The chapter could be significantly strengthened with respect to its presentation of this issue. It is imperative that the assessment provide a solid foundation for evaluating the management alternatives relative to this issue. Please see:

Theobald, D.M. 2003. Targeting conservation action through assessment of protection and exurban threats. *Conservation Biology* 17(6):1624-1637.

Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. *Ecology and Society* 10: 32.

USDA Forest Service. 2004. *Sprawl threatens forestry*. USDA Forest Service, Northeastern Area, State and Private Forestry, Newtown, PA.

### ***Stressors Associated with Loss of Natural (Historical) Fire Regimes***

This section provides a good overview of the topic. But it seems to concentrate on southern long-leaf pine systems, while giving less attention to western coniferous forests (e.g. Ponderosa pine and mixed-conifer). I suggest adding more material on changes in western forests. The literature has explored interactions between fire suppression, livestock grazing, and high grade logging in producing the elevated fire hazards we have today, but I only found fire suppression mentioned here. Synergistic interactions (vulnerabilities) between drought, fire, and insects are also very important and warrant discussion.

The table lists a “personal communication” for the statistics reported. This does not seem like a rigorous citation for a document of this importance. If the statistics are in a report or paper in preparation it would be preferable to cite that instead.

### ***Stressors Associated with the Spread of Invasive Species and Increased Incidence and Extent of Insect and Disease Outbreaks***

I found this section to be thorough, well written, and well cited at the intended level of presentation.



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### ***Ecosystem restoration in current plans***

- Invasive plant control and removal is another important restoration activity in current plans, e.g. on the Green Mountain National Forest. Often these projects are planned in collaboration with non-governmental organizations, like The Nature Conservancy, and community-based watershed alliances. More could be said of the critical role these partnerships play in initiating and pulling together the labor and funding for restoration activities.
- Riparian forest restoration (planting, thinning, woody debris additions, etc.) is a critically important activity on many National Forests. This should appear on your list under current plans.
- Some papers consider species reintroductions to be a type of restoration. This has clearly been an important activity on the National Forest System for decades.

### **WATERSHED PROTECTION**

#### ***Watershed Condition***

What have we learned from the system of “Key Watersheds” established in the Pacific Northwest under the Northwest Forest Plan? I suggest reviewing the literature on this topic and evaluating the pros and cons of adopting a similar approach more widely.

Much of the real watershed management action these days, particularly in the eastern U.S. where national forest lands are intermingled with state and private lands, occurs through partnerships with local communities and organizations. An example is the White River Partnership in Vermont (<http://www.whiteriverpartnership.org>). These have been instrumental in promoting a wide range of conservation and restoration activities. I found it strange that the document did not mention these initiatives or evaluate how these models could be expanded. The social science literature includes both case study and comparative analyses of these models. An example is:

Crow, S.M. and C.M. Danks. 2010. Why Certify?: Motivations, Outcomes and the Importance of Facilitating Organizations in Certification of Community-Based Forestry Initiatives. *Small-Scale Forestry*, 26

The text states (page 81) “Under all alternatives, wilderness areas would continue to serve as anchor points for sustained flow of ecosystem services, including clean water and high quality aquatic and terrestrial habitats.” However, it should be noted that the Wilderness Preservation System was not designed with this goal in mind. Implicit in this statement, however, is that unmanaged core reserves provide services distinct from managed areas. Since the wilderness system is primarily high elevation with relatively low biological productivity, and thus not representative of ecological diversity more broadly or low gradient, higher order riverine systems, this statement begs the question whether some of the alternatives recommend establishment of a more fully representative reserve system, such as the late-successional reserves established under the Northwest Forest Plan. The chapter might present the science both pro and con reserve establishment more fully.

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### ***Road system***

Top of page 84. It is not just the timing of flow that is affected by roads, but also the magnitude of flow. I believe the science has shown that road density, at small watershed scales, increases the frequency of high flows – and thus channel scouring, etc. -- after moderate intensity precipitation events. Please review the literature carefully on this point as it clearly has been a source of debate.

In steep montane systems, logging roads and associated landings, in conjunction with ridge line cabling practices, have been associated with slope failures, landslides, and debris torrents. I suggest reviewing the literature on this topic. This would seem like an important issue for the assessment to address.

Size, design, and maintenance of culverts are collectively another important issue facing the national forest system. Not sure I saw this mentioned.

One of the key issues facing the Forest Service is how to reduce the total mileage of the road system. As mentioned previously in this review, road decommissioning ranges from simple gating to complete restoration involving recontouring and planting. Clearly costs and benefits and subsequent uses vary widely with these alternatives. Therefore an important issue is how to plan and prioritize these activities. This seems worthy of mention in this section.

### ***Riparian area management***

Page 87. 1<sup>st</sup> paragraph. This paragraph over emphasizes the role of fire in riparian systems. The discussion overly simplifies, in my professional opinion, what is a very complex topic. The key point one can take from the literature in its totality is that there is a gradient of fire frequency and intensity in western riparian systems. Many papers (e.g. Turner et al. 1989, Camp et al. 1997, Keeton and Franklin 2004, and others) have shown that riparian areas, particularly moist temperate coniferous forests, have higher tree survivorship and thus act as refugia from high intensity fires. They rarely experience stand replacing fires. In these systems riparian buffers thus closely emulate natural disturbance effects. The document is incorrect in implying that scientists now think that fire is prevalent or important in many or most riparian areas. The real point is that some researchers working in systems with low to moderate severity fire regimes have shown reconstructed fire histories to be quite complex both spatially and temporally. This was an important finding, and has guided, for instance, innovations in forest planning in the Blue River watershed in Oregon (see Cissel et al. 1999, cited previously). The take home message is that fire behavior in riparian areas is highly variable. Sometimes riparian areas act as fire breaks, other times they funnel fires up slopes or are subject to partial mortality. Fire effects depend on the system and often specific weather conditions. I suggest revising this paragraph to further caveat that the importance of fire in riparian systems varies strongly along moisture and climatic gradients and that it is really only the drier, low to moderate severity fires regimes that have the behavior currently emphasized in this paragraph.

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References:

- Camp, A.E., Oliver, C.D., Hessburg, P., and Everett, R. 1997. Predicting late-successional fire refugia pre-dating European settlement in the Wenatchee Mountains. *For. Ecol. Manage.* 95: 63–77.
- Keeton, W.S. and J.F. Franklin. 2004. Fire-related landform associations of remnant old-growth trees in mature Douglas-fir forests. *Canadian Journal of Forest Research* 34: 2371-2381.
- Turner, M.G., Gardner, R.H., Dale, V.H., and O'Neill, R.V. 1989. Predicting the spread of disturbance across heterogeneous landscapes. *Oikos*, 55: 121–129.

This section might also mention that riparian buffer design, standards, and management varies widely across the U.S. (Lee et al. 2004), with major difference associated with ownership and region in particular. Therefore the management alternatives might consider a variety of riparian management models based on previous experience, not just on national forests. For instance, the Chesapeake Bay Program utilizes a three tiered or zoned buffer approach that has been adopted elsewhere in the world but to my knowledge is not employed on National Forests. This is one of many alternatives this document might evaluate. It is important for this document to provide a basis for understanding what specifically the alternatives call for in terms of riparian buffers, reserves, and or protections, particularly since type and intensity of management within buffers has varied so much in the past. A couple of good references to include in the review are Gregory (1997) and Naimen et al. (2005). The review might also acknowledge that riparian areas managed or protected for development of late-successional/old-growth structure are likely to provide exceptionally high quality low order stream habitats (Naimen et al. 2000, Keeton et al. 2007).

References:

- Keeton, W.S., C.E. Kraft, and D.R. Warren. 2007. Mature and old-growth riparian forests: structure, dynamics, and effects on Adirondack stream habitats. *Ecological Applications* 17: 852-868.
- Lee, P. C., Smyth, C., Boutin, S., 2004. Quantitative review of riparian buffer width guidelines from Canada and the United States. *Environmental Management* 70, 165-180.
- Gregory, S.V., 1997. Riparian management in the 21<sup>st</sup> century. In: Kohm, K.A., Franklin, J.F. *Creating a Forestry for the 21<sup>st</sup> Century*. Island Press, Washington, DC, pp. 69-86.
- Naiman, R. J., R. E. Bilby, and P. A. Bisson. 2000. Riparian ecology and management in the Pacific coastal rain forest. *BioScience* 50:996–1011.
- Naiman, R. J., H. Decamps, and M. E. McClain. 2005. *Riparia: ecology, conservation, and management of streamside communities*. Elsevier/Academic Press, San Diego, California

***Water quality***

Page 89. The text states “Some recently revised plans specify that State forestry BMPs should be implemented as plan guidelines and other plans specify that the state water quality standards should be used for protection of drinking water quality where appropriate.” It is important to state the some states, like Vermont, do not have true best management practices, but rather “acceptable management practices” that are only enforced if a violation is reported. The literature has shown that BMPs for water quality protection are highly variable state to

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state, and thus effectiveness is also highly variable. The review might evaluate which specific set of BMPs would provide adequate water quality protections, following for example Stuart and Edwards (2006).

Reference:

Stuart, G.W., Edwards, P.J., 2006. Concepts about forests and water. *Northern Journal of Applied Forestry* 23, 11-19.

## **DIVERSITY OF PLANT AND ANIMAL COMMUNITIES**

### ***Assumptions and Uncertainties***

Page 102. Statement about forest cover remaining stable. That has been the case in recent decades, however now it is turning the corner. Forest cover is declining in all six New England states for the first time in 150 years (see Foster et al. 2010). From Keeton (2007): "In the 1990's more than 80% of housing development was in rural areas (Heimlich and Anderson 2001); each year the U.S. loses almost 500,000 ha of forestland to the 'direct footprint' of development and other land conversions, and there is a much larger 'indirect footprint' that includes fragmentation effects (USDA Forest Service 2004)." I do not think stable forest cover should be assumed moving forward.

References:

Keeton, W.S. 2007. Role of managed forestlands and models for sustainable forest management: perspectives from North America. *George Wright Forum* 24(3):38-53.

Heimlich, R. E., and W. D. Anderson. 2001. Development at the urban fringe and beyond: impacts on agriculture and rural land. Agricultural economic report 803. Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

### ***Current Science***

One might add that the science has advanced not just in terms of biodiversity concepts and principles, but in also conservation design and practice. It might be useful to acknowledge this more directly.

### ***Maintaining Species Viability***

This is a scientifically awkward sentence: "Since many species occupy landscapes simultaneously and since the sum of species in an area is collectively termed biodiversity, the maintenance of biodiversity requires providing the sum of those species habitat conditions necessary for their survival across the landscape." It is a given that many species occupy the same landscape. This is a statement of the obvious, otherwise called an "ecosystem." Biodiversity is usually defined differently, as the diversity of life at all different levels of biological organization, including genes, populations, species, communities or ecosystems, and biomes.

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Page 105. First paragraph. This paragraph alludes to the debate about the relative merits of different conservation approaches and the uncertainty surrounding these. In their book “Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach,” Lindenmayer and Franklin propose a simple but logical solution, which they term “risk-spreading.” In short this means not putting all of your eggs in one basket. This might be an alternate (or perhaps complimentary) way to frame this part of the document. I have previously described risk-spreading as follows:

*From Keeton (2007): “Risk-spreading deals directly with the scientific uncertainty associated with over-reliance on any one forest management approach. For instance, if we are uncertain how sensitive species will respond to silvicultural treatments, it would be prudent to employ reserves in conjunction with active management. If it is uncertain whether we can control the spread of exotic species or restore fire regimes using reserve-based approaches alone, then active manipulations may also be necessary. Actively managed reserves offer an intermediate option (Figure 1). In short, uncertainty and risk are reduced if we employ multiple management and conservation strategies, addressing different spatial scales and applied to different portions of the landscape (Lindenmayer and Franklin 2002).”*

General feedback on this section: Most of the key concepts from the conservation biology literature are presented, but the writing composition could be improved to present these more clearly.

### ***Managing Ecological (Habitat) Conditions***

This section describes very general concepts only. One is left questioning how useful this type of narrative is in terms of establishing clear criteria by which the alternatives will be evaluated. Given the vast science on indicators of biodiversity conservation (see for example Ellison et al 2005; Schulte et al. 2006; Lindenmayer et al. 2000), the reader is left wondering why the chapter is not presenting a more scientifically robust analytical framework.

#### References:

Ellison et al. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. *Front Ecol Environ* 3: 479–486.

\*Lindenmayer, D. B.; Margules, C. R.; Botkin, D. B. 2000. Indicators of biodiversity for ecologically sustainable forest management. *Conservation Biology* 14:941-950.

Schulte et al. 2006. Evaluating the conceptual tools for forest biodiversity conservation and their implementation in the U.S. *Forest Ecology and Management* 232: 1–11.

\* This paper is cited elsewhere in Chapter 3.

### ***Monitoring to Assess Effectiveness***

This section provides a good discussion of the relative merits of different indicator approaches, such as indicator species, focal species, and guild-based approaches. More could be said about the importance of well distributed biodiversity for ecosystem functioning, and the relative ability of the different indicator approaches to accurately gauge maintenance and provision of

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ecosystem functions. In my professional opinion this area of science underpins much of the debate about the “viability rule” in current Forest Service regulations. Given the important policy discussion underway regarding this rule, the assessment should clearly lay out the foundational science describing what we know and do not know about diversity and function.

An alternative monitoring framework that would seem to fit better with this chapter’s emphasis on stressors is provided by the National Park Service’s “Vital Signs” program, a nation-wide monitoring initiative. This program differentiates between and provides a clear framework for monitoring: 1) stressors, 2) stress responses, and 3) management responses. It uses indicators for each of those three.

Composition based indicators include more than just species level indicators. Most papers stress the need to monitor landscape scale indicators as well, such as representation and distribution of community types, patch metrics, etc.

## **CLIMATE CHANGE**

### ***Scientific Findings about Climate Change***

This section provides a clear and unambiguous statement of the IPCC’s conclusion that the Earth’s climate is warming and that climate disruption is affecting both aquatic and terrestrial ecosystems. Noticeably missing, however, is recognition that the IPCC has also concluded with a high degree of certainty that the climate will continue to change under most emissions scenarios and that anthropogenic activities are the primary cause.

Also absent is a clear statement aligned with myriad recent papers (see for example, Ruddell et al. 2007, Birdsey et al. 2007, Ray et al. 2009, Nunery and Keeton 2010) that the nation’s forests have a critical role to play in helping to dampen the intensity of future warming by contributing to carbon sequestration and storage.

#### **References:**

- Birdsey, R.A. et al. 2007. North American Forests. In: King, A.W., Dilling, L., Zimmerman, G.P., Fairman, D.M., Houghton, R.A., Marland, G., Rose, A.Z., Wilbanks, T.J. (Eds.), *The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research Asheville, NC, USA*, pp. 117-126.
- Nunery, J.S. and W.S. Keeton. 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. *Forest Ecology and Management* 259:1363-1375.
- Ray, D.G., Seymour, R.S., Scott, N.A., Keeton, W.S., 2009b. Mitigating Climate Change with Managed Forests: Balancing Expectations, Opportunity, and Risk. *Journal of Forestry* 107, 50-51.

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Ruddell, S., Sampson, R., Smith, M., Giffen, R., Cathcart, J., Hagan, J., Sosland, D., Godbee, J., Heissenbuttel, J., Lovett, S., Helms, J., Price, W., Simpson, R., 2007. The role for sustainably managed forests in climate change mitigation. *Journal of Forestry* 105, 314-319.

### ***Threats to Ecological Integrity***

An important point, derived from paleoecological studies, is that every time the climate has changed in the past, plant assemblages have resorted themselves into new associations. Thus in the future we can expect ecosystems to not just shift geographically, but also to reform into new and perhaps novel species assemblages (see for example Delcourt and Delcourt; Webb et al. 2003).

The paleoecological literature has noted the importance, during past climatic fluctuations, of particular topographic positions that provided natural refugia where species persisted (Brubaker 1986, 1988). However, it is difficult if not impossible to predict which topographic positions might provide similar refugia in the future. Consequently several papers have suggested that conserved lands and protected areas should be expanded or designed to incorporate as much geophysical diversity as possible, providing a hedge against uncertainty. This seems like an important point to mention in this section.

There is evidence that climate change is already affecting fire activity (Westerly et al 2006, cited previously) and insect outbreaks. More could be said about interactions between predicted drought, fire, and insects (see Parson et al. 2001). These are synergistic interactions. Moreover, many ecologists predict that over the near term these indirect effects of climate change may be even more important than the direct effects of climate on plant physiology. This is because disturbances open forest canopies and reinitiate stand development, which is stage where seedlings are most sensitive to direct climatic effects.

Most models suggest that the greatest changes will occur as a result of multiple interacting anthropogenic stressors, including climate change. This point could be made more clearly. See Aber et al. (2001) and Ollinger et al. (2002).

#### References:

- Aber, J., R.P. Neilson, S. McNulty, J.M. Lenihan, D. Bachelet, and R.J. Drapek. 2001. Forest processes and global environmental change: predicting the effects of individual and multiple stressors. *BioScience* 51: 735-751.
- Brubaker, L. B. 1986. Responses of tree populations to climatic change. *Vegetatio* 67:119-130.
- Brubaker, L. B. 1988. Vegetation history and anticipating future change. Pages 41-60 in: J. K. Agee and D. Johnson (eds.). *Ecosystem Management for Parks and Wilderness*. University of Washington Press, Seattle, Washington.
- Delcourt and Delcourt. 1998. Landscape ecology: Relevant scales in space and time. *Landscape Ecology* 2:23-44.
- Ollinger, S. V., C. L. Goodale, K. Hayhoe, and J. P. Jenkins. 2008. Potential effects of climate change and rising CO<sub>2</sub> on ecosystem processes in northeastern U.S. forests. *Mitigation and Adaptation Strategies for Global Change* 13:467-485.

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Parson, E.A., P.W. Mote, A. Hamlet, N. Mantua, A. Snover, W.S. Keeton, E. Miles, D. Canning, and K. Gray Ideker. 2001. Potential impacts of climate variability and change on the Pacific Northwest. Chapter 9 in: National Assessment Synthesis Team (eds.). *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*. Cambridge University Press, Cambridge, U.K.

Webb et al. 2003. Climatically forced vegetation dynamics in eastern North America during the Late Quaternary Period. *Development in Quaternary Science* 1: 459-578.

### ***Threats to Social and Economic Conditions***

I found this section to be largely incomplete with respect to the myriad potential socioeconomic impacts identified in the literature. Noticeably missing is discussion of the threats that climate change play to municipal water supplies, ski areas leased on national forest lands, and commercial forestry (see Mote et al. 2003). The text also does not discuss one of the most important challenges facing the US Forest Service, which is the threat of increased fire hazards along the urban-wildland interface. For more information, please see the in depth provided by Keeton et al. (2007).

#### References:

Keeton, W.S, J.F. Franklin, and P.W. Mote. 2007. Climate variability, climate change, and western wildfire with implications for the suburban-wildland interface. Pages 223-255 in: A. Troy and R. Kennedy (eds.). *Living on the Edge: Economic, Institutional and Management Perspectives on Wildfire Hazard in the Urban Interface*. *Advances in the Economics of Environmental Resources*, Vol 6. Elsevier Sciences, New York, NY.

Mote, P.W., E.A. Parson, A.F. Hamlet, K.G. Ideker, W.S. Keeton, D. Lettenmaier, N. Mantua, E.L. Miles, D.W. Peterson, D.L. Peterson, R. Slaughter, and A.K. Snover. 2003. Preparing for climate change: the water, salmon, and forests of the Pacific Northwest. *Climatic Change* 61:45-88.

### ***Uncertainties about Climate Change***

This section could be significantly improved by adding more depth of discussion. Probably the most significant source of uncertainty pertains to emissions scenarios. It is worth noting that according to the most recent assessment global greenhouse gas emissions are currently exceeding and increasing faster than even the worst case scenario considered by the IPCC. The projections made by different GMCs certainly do differ and this is a major source of uncertainty. At the same time all models agree that some degree of climate change is certain. This point could be made more clearly.

In my opinion the most important source of uncertainty relevant to this assessment pertains to down-scaling global climate scenarios to regional and sub-regional scales. The preferred alternative relies heavily on adaptive management. However, a major source uncertainty that should be discussed in this section is that climate predictions are considered particularly imprecise at regional and sub-regional scales, making difficult the kind of climate forecasting required for effective adaptive forest management. There is large literature on this topic reviewed in IPCC reports. Despite this uncertainty some authors have suggesting that better



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use of climate forecasting, for instance predicting climate variability such as ENSO and Pacific Decadal Oscillation, could be conducted to inform adaptive management (McKenzie et al. 2004).

There are other important sources of uncertainty that could be considered. Climate change may influence both rates and pathways (e.g. successional dynamics) of future biomass development (Aber et al. 2001, Iverson et al. 2008). Whether these result in negative or positive effects on forest carbon storage potential will depend on many factors, including atmospheric CO<sub>2</sub> fertilization effects, intensity of warming and precipitation changes, extent of species range shifts, and interactions with other stressors, such as disturbances, disease, air borne pollutants, and land use (Ollinger et al. 2002, Beckage et al. 2008).

New References:

McKenzie, D., Z. Gedalof, D.L. Peterson, and P. Mote. 2004. Climatic change, wildfire, and conservation. *Conservation Biology*: 18:890-902.

Iverson, L., A. Prasad, and S. Matthews. 2008. Modeling potential climate change impacts on the trees of the northeastern United States. *Mitigation and Adaptation Strategies for Global Change* 13:487-516.

***Expected Conditions and Trends***

Given the large body of literature on the expected impacts of climate change, this section seems noticeably brief. It does not present the science on this topic.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. Jessica E. Leahy, University of Maine*

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This science review of Chapter 3 is focused on the use of science in “crafting the document, and in the analysis of alternatives,” according to the instructions. The instructions further requested reviewers to focus on the “technical merit of the analyses...technical perspective on the information upon which the decisions were based.” I have organized my comments, using page numbers, by three central questions.

**1. Does the information accurately reflect the current peer-reviewed scientific literature and understanding? If not, what is missing or incorrectly presented?**

In general, Chapter 3 does accurately reflect the current peer-reviewed scientific literature and understanding as it relates to applied social science or human dimensions of natural resources research. In many cases, however, I found statements to be written so broadly or generally that it was impossible to be incorrect. To answer Question #1, I have focused on areas that are missing scientific literature support, and suggested which literature may provide guidance. Citing these references, on top of the limited number of references (limited in scope, some outdated) currently in the chapter, will enhance this chapter. Additional specificity and the use of the scientific literature to “back up” these broad statements would greatly enhance the credibility, legitimacy and saliency of the analyses.

p. 55      An appropriate citation for the sentence, “Understanding and conserving these complex and dynamic ecosystems presents a challenge, particularly as environmental stresses intensify with projected changes in climate,” would be:

Cole, D. & Yung, L. (2010) *Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change* (Island Press. Washington, D.C. 287p.)

or

Hobbs, R.J., D.N. Cole, L. Yung, E.S. Zavaleta, G.H. Aplet, F.S. Chapin III, P.B. Landres, D.J. Parsons, N.L. Stephenson, P.S. White, D.M. Graber, E.S. Higgs, C.I. Millar, J.M. Randall, K.A. Tonnessen, and S. Woodley. 2009. Guiding concepts for park and wilderness stewardship in an era of global environmental change. *Frontiers in Ecology and the Environment* e-View. doi: 10.1890/090089; Online access: [www.esajournals.org/doi/abs/10.1890/090089](http://www.esajournals.org/doi/abs/10.1890/090089)

It appears that many of the concepts from this *Beyond Naturalness* are featured throughout Chapter 3. In fact, the editors are both USDA Forest Service researchers.

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However, it is never cited and there are missing components from this work. The following chapters are would contain relevant scientific information and additional references cited that could be included throughout Chapter 3:

Hobbs, Richard J.; Zavaleta, Erika S.; Cole, David N.; White, Peter S. 2010. Evolving ecological understandings: The implications of ecosystem dynamics. *In: Cole, David N.; Yung, Laurie, eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington DC: Island Press: 34-49.*

Stephenson, Nathan L.; Millar, Constance I.; Cole, David N. 2010. Shifting environmental foundations: The unprecedented and unpredictable future. *In: Cole, David N.; Yung, Laurie, eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington DC: Island Press: 50-66.*

Cole, David N.; Higgs, Eric S.; White, Peter S. 2010. Historical fidelity: Maintaining legacy and connection to heritage. *In: Cole, David N.; Yung, Laurie, eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington DC: Island Press: 125-141.*

Cole, David N.; Millar, Constance I.; Stephenson, Nathan L. 2010. Responding to climate change: A toolbox of management strategies. *In: Cole, David N.; Yung, Laurie, eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington DC: Island Press: 179-196.*

White, Peter S.; Yung, Laurie; Cole, David N.; Hobbs, Richard J. 2010. Conservation at large scales: Systems of protected areas and protected areas in the matrix. *In: Cole, David N.; Yung, Laurie, eds. Beyond naturalness: Rethinking park and wilderness stewardship in an era of rapid change. Washington DC: Island Press: 197-215.*

p. 58

In response to the sentence, “Without the perspective developed from historical ecology, understanding disturbance processes would not be possible,” the choice of relying on historic range of variability would be strengthened with the addition of:

Keane, R.E., P.F. Hessburg, P.B. Landres, and F.J. Swanson. 2009. The use of historical range and variability (HRV) in landscape management. *Forest Ecology and Management* 258:1025-1037.

Abstract: “This paper examines the past, present, and future use of the concept of historical range and variability (HRV) in land management. The history, central concepts, benefits, and limitations of HRV are presented along with a discussion on the value of HRV in a changing world with rapid climate warming, exotic species invasions, and increased land development. This paper is meant as a reference on the strengths and limitations of applying HRV in land management. Applications of the HRV concept have specific contexts, constraints, and conditions that are relevant to any application and are influential to the extent to which the concept is applied. These conditions notwithstanding, we suggest that the HRV concept offers an objective reference for many applications, and it still offers a comprehensive reference for the short-term and possible long-term management of our nation’s

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- landscapes until advances in technology and ecological research provide more suitable and viable approaches in theory and application” (p.1025).
- p. 71 There is limited discussion of the social and economic impacts associated with invasives in this section. In other areas of the chapters, there is limited discussion of the social and economic impacts of other environmental assessments. This would be an important aspect to include when describing the context.
- p.71 This page is one of the first times recreation is mentioned in the chapter. Should it be listed as a stressor earlier in the chapter? Are there other areas within the chapter where outdoor recreation should be addressed and included?
- p. 83 The chapter would benefit from a clarification on what is meant by “science-based road analysis.”
- p.124 This comment refers to a similar comment from page 71 on the lack of discussion about threats to social and economic conditions. Here Chapter 3 does discuss threats to social and economic conditions, but is too focused on only the impacts to recreation. The science this draws on is from Morris & Walls (2009) which is exclusively focused on outdoor recreation. The other citations such as Bloomfield (2000) and Irland (2001) are outdated. The CCSP 2008a report that is cited does not directly assess impacts to social and economic conditions.

An example of other social and economic conditions that could be impacted by climate change can be found here:

[http://climatechange.umaine.edu/files/Maines\\_Climate\\_Future.pdf](http://climatechange.umaine.edu/files/Maines_Climate_Future.pdf)

Unfortunately, I am not aware of any reports of this nature that directly concern NFS lands or the vibrant communities it wishes to sustain.

- p. 136 The discussion about residential development and population growth in counties adjacent to NFS lands highlighted what was the beginning of a striking lack of analysis on how the alternatives would impact adjacent local communities, many of which are rural and resource- or tourism-dependent.

An initial reaction would be to increase the discussion on amenity migration on page 136, but please do not interpret my comment as restricted to just the particular point of amenity migration. More broadly, the chapter should better address how the alternatives will affect communities of place, as well as community of interest, in terms of social and economic conditions. This may be beyond the scope of environmental impacts, but is critical to the sustainable use of public lands to support vibrant communities.

Amenity migration related citations that could be added:

Garber-Yonts, B. 2004. The economics of amenities and migration in the Pacific Northwest: review of selected literature with implications for national forest management. Gen. Tech. Rep. PNW-GTR-617. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 48 p.

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Charnley, S., McLain, R., and Donoghue, E. 2008. Forest Management Policy, Amenity Migration, and Community Well-Being in the American West: Reflections from the Northwest Forest Plan. *Human Ecology*, 36(5): 743-761. These authors concluded, "Our findings...demonstrate the importance of community-scale analysis for understanding the relation between land management policies, amenity migration, and community well-being" (p.761).

Kruger, L. E., Mazza, R., and Stiefel, M. (2008). Amenity Migration, Rural Communities, and Public Lands. In Donoghue, E. M., and Sturtevant, V. (eds.), *Forest Community Connections. Resources for the Future*, Washington, D.C., pp. 127-142. Note: This book would have additional sources of peer-reviewed literature that could be used to discuss the impact on the alternatives on communities adjacent to NFS lands.

p. 136 In addition to Johnson's science on African American visitors, it would be good include the science out of the PSW Research Station on Hispanic visitors. For example:  
[http://www.fs.fed.us/psw/publications/documents/psw\\_sp012/psw\\_sp012.pdf](http://www.fs.fed.us/psw/publications/documents/psw_sp012/psw_sp012.pdf)

p. 137 This chapter suggests that other planning frameworks will largely guide the outdoor recreation management of the NFS lands, so there will be little differences in impacts across the various alternatives. This may be a flawed logic if the other planning frameworks used the best available science. The use of the Recreation Opportunity Spectrum and Recreation Facility Analysis is rooted in outdated experience- and activity-based management. Many outdoor recreation land managers (including the Bureau of Land Management) now use the benefits-based management (BBM) approach. In this approach, a larger sphere of visitors and non-visitors would be considered. If the NFS lands used this best available science (BBM), then the alternatives could have different impacts due to the collaboration, focus on ecosystem services and dynamics, etc.

Here are relevant references for BBM:

Anderson, D., Nickerson, R., Stein, T., & Lee, M. (2000). Planning to Provide Community and Visitor Benefits from Public Lands. In W. C. Gartner & D. W. Lime (Eds.), *Trends in Outdoor Recreation, Leisure, and Tourism* (pp. 197-211). New York: CAB International.

Borrie, W., & Roggenbuck, J. (1995). *Community Based Research for an Urban Recreation Application of Benefits-Based Management* (No. GTR-PSW-156): USDA Forest Service.

Brown, P. (1984). Benefits of outdoor recreation and some ideas for valuing recreation opportunities. In G. Peterson & A. Randall (Eds.), *Valuation of wildland resource benefits*. (pp. 209-220). Boulder: Westview Press.

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Driver, B. L., Brown, P., & Peterson, G. (1991). *Benefits of Leisure*. State College, PA: Venture Publishing.

Driver, B. L., & Bruns, D. (1999). Concepts and uses of the Benefits Approach to Leisure. In E. Jackson & T. Burton (Eds.), *Leisure Studies: Prospects for the 21st Century*. State College: Venture Publishing.

Dustin, D., McAvoy, L., & Goodale, T. (1999). The Benefits Equation. *Parks and Recreation*, 32-37.

Fulton, D. (2001, July 6-8, 2000). *Integrating Social Information into Decision-making*. Paper presented at the Trout and the Trout Angler II, LaCrosse, WI.

Shin, W. S., Jaakson, R., & Kim, E. I. (2001). Benefits-Based Analysis of Visitor Use of Sorak-San National Park in Korea. *Environmental Management*, 28(3), 413-419.

Stein, T. (1997). *Understanding how rural community stakeholders value and benefit from natural landscapes*. Unpublished Dissertation, University of Minnesota, St. Paul.

Stein, T., & Anderson, D. (2002). Combining Benefits-Based Management with Ecosystem Management for Landscape Planning: Leech Lake Watershed, Minnesota. *Landscape and Urban Planning*, 60, 151-161.

Stein, T., Anderson, D., & Kelly, T. (1999). Using Stakeholders' Values to Apply Ecosystem Management in an Upper Midwest Landscape. *Environmental Management*, 24(3), 399-413.

Stein, T., Anderson, D., & Thompson, D. (1999). Identifying and Managing for Community Benefits in Minnesota State Parks. *Journal of Park and Recreation Administration*, 17(4), 1-19.

p. 156 It may be possible to find scientific support from some of the outdoor recreation effects, although there is not much in the literature. I would encourage additional "hunting." I found only this one reference:  
<http://www.wilderness.net/library/documents/320C.pdf>

p. 162 In each of the alternatives, the sub-sections on Collaboration and Resolutions could use more support from the peer-reviewed literature. The literature on "best-practices" within public involvement is extensive, and it is not clear what the authors of Chapter 3 are including or not including. One of the most glaring omissions is:

Frenz, I., Voth, D., Burns, S., & Sperry, C. (2000). Forest Service-Community Relationship Building: Recommendations. *Society and Natural Resources*, 13, 549-566.

Here is an additional list of missing citations about public involvement in forest planning (note: this list is not exhaustive):

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Shindler, B., Neburka, J., 1997. Public participation in forest planning: eight attributes of success. *J. Forest.* 95 (1), 17-19.

Davenport, M., Anderson, D., Jakes, P., and Leahy, J. 2007. "Reflections from USDA Forest Service Employees on Institutional Constraints to Engaging and Serving their Local Communities." *Journal of Forestry.* 105(1): 43-48.

Carroll, M.S. & Hendrix, W.G. (1992). Federally protected rivers: The need for effective local involvement. *Journal of the American Planning Association*, 58(3), 346-352.

Steelman, T. A., & DuMond, M. E. (2009). Serving the common interest in US forest policy: A case study of the Healthy Forests Restoration Act. *Environmental Management*, 43(3), 396-410.

Steelman, T. A. (2001). Elite and participatory policy making: finding balance in a case of national forest management. *Policy Studies Journal*, 29(2), 71-89.

Cheng, A.S. and K.M. Mattor. *In Press*. Place-based planning as a platform for social learning: insights from a national forest landscape assessment process in Western Colorado. *Society & Natural Resources*.

Cheng, A.S. 2007. Build it and they will come? Mandating collaboration in public lands policy and management. *Natural Resources Journal* 46:841-858.

Cheng, A.S. and K.M. Mattor. 2006. Why won't they come? Stakeholder perspectives on collaborative national forest planning by participation level. *Environmental Management*, 38:545-561.

Wellstead, A. M., R. C. Stedman and J. R. Parkins (2003). "Understanding the concept of representation within the context of local forest management decision making." *Forest Policy and Economics* 5(1): 1-11.

Buchecker, M., Hunziker, M., Kienast, F., 2003. Participatory landscape development: overcoming social barriers to public involvement. *Landscape Urban Plan.* 64, 29-46.

Moote, M., McClaran, M., 1997. Implications of participatory democracy for public land planning. *J. Range Manage.* 50, 473-481.

Moote, M., McClaran, M., Chickering, D., 1997. Theory in practice: applying participatory democracy theory to public land planning. *Environ. Manage.* 21 (6), 877-889.

Tuler, S., Webler, T., 1999. Voices from the forest: what participants expect of a public participation process. *Soc. Nat. Resour.* 12, 437-453.

White, S., 2001. Public participation and organizational change in Wisconsin land

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use management. *Land Use Pol.* 18, 341–350.

Halvorsen, K.E. 2006. Critical Next Steps in Research on Public Meetings and Environmental Decision Making. Invited Submission for *Human Ecology Review* on Public Participation. 13(2)150-160.

Halvorsen, K.E. 2003. Assessing the Effects of Public Participation. *Public Administration Review*. 63(5)535-543.

Halvorsen K.E., and M.E. Jarvie. 2002. Working and Lower Middle Class Women and Obstacles to Environmentally Related Public Meeting Participation. *Environmental Practice* 4(1)18-26.

Carr, D.S., and K.E. Halvorsen. 2001. An Evaluation of Three Democratic, Community- Based Approaches to Citizen Participation: Surveys, Conversations with Community Groups, and Community Dinners. *Society and Natural Resources* 14:107-126.

Halvorsen, K.E. 2001 . Assessing Public Participation Techniques for Comfort, Convenience, Satisfaction, and Deliberation. *Environmental Management* 28(2)179-186.

p. 171 While the literature mostly supports the notion that scenario planning can take longer amounts of time than traditional public involvement, the assumptions made about the planning time necessary to pursue scenario planning could be addressed through documentation from the mediated modeling literature, such as:

Kassa, H., B. Campbell, et al. (2009). "Building future scenarios and uncovering persisting challenges of participatory forest management in Chilimo Forest, Central Ethiopia." *Journal of Environmental Management* 90(2): 1004-1013.

Mendoza, G. A. and R. Prabhu (2005). "Combining participatory modeling and multi-criteria analysis for community-based forest management." *Forest Ecology and Management* 207(1-2): 145-156.

Mendoza, G. A. and R. Prabhu (2006). "Participatory modeling and analysis for sustainable forest management: Overview of soft system dynamics models and applications." *Forest Policy and Economics* 9(2): 179-196.

Suwarno, A., A. A. Nawir, et al. (2009). "Participatory modelling to improve partnership schemes for future Community-Based Forest Management in Sumbawa District, Indonesia." *Environmental Modelling & Software* 24(12): 1402-1410.

Vervoort, J. M., K. Kok, R. van Lammeren and T. Veldkamp "Stepping into futures: Exploring the potential of interactive media for participatory scenarios on social-ecological systems." *Futures* 42(6): 604-616.



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p. 173/4 There is a whole body of missing literature on trust in natural resources management, as well as procedural justice. There are several USDA Forest Service researchers who specialize in trust, include Pat Winter, Pam Jakes, and Sarah McCaffrey. The chapter should be clear to identify the multi-dimensional nature of trust, and that trust is composed of more than simply procedural justice (note: this list is also not exhaustive):

Hunt, L. and W. Haider. 2001. Fair and effective decision making in forest management planning. *Society and Natural Resources* 14: 873-887.

Cvetkovich, G., Winter, P., 2003. Trust and social representations of the management of threatened and endangered species. *Environ. Behav.* 35 (2), 286–307.

Davenport, M., Leahy, J., Anderson, D., Jakes, P., 2007. Building trust in natural resources management within local communities: a case study of the Midewin National Tallgrass Prairie. *Environ. Manag.* 39, 353–368.

Leahy, J. and Anderson, D. 2008. "Trust Meanings in Community-Water Resource Management Agency Relationships." *Landscape and Urban Planning.* 87: 100-107.

Höppner, C., Frick, J., Buchecker, M., 2007. Assessing psycho-social effects of participatory landscape planning. *Landscape Urban Plan.* 83 (2–3), 196–207.

Kramer, R., 1999. Trust and distrust in organizations: emerging perspectives, enduring questions. *Annu. Rev. Psychol.* 50, 569–598. (Note: not natural resources, but a key piece of literature on trust/distrust in organizations which applies to the USDA Forest Service).

Lawrence, R., Daniels, S., Stankey, G., 1997. Procedural justice and public involvement in natural resource decision making. *Soc. Nat. Resour.* 10, 577–589.

Lind, E.A., Tyler, T., Huo, Y., 1997. Procedural context and culture: variation in the antecedents of procedural justice judgments. *J. Pers. Soc. Psychol.* 73 (4), 767–780.

Smith, P., McDonough, M., 2001. Beyond public participation: fairness in natural resource decision making. *Soc. Nat. Resour.* 14 (3), 239–249.

Webler, T., Tuler, S., 2000. Fairness and competence in citizen participation: theoretical reflections from a case study. *Adm. Soc.* 32 (5), 566–595.

Winter, P., Palucki, L., Burkhardt, R., 1999. Anticipated responses to a fee program: the key is trust. *J. Leisure Res.* 31 (3), 207–226.

p. 173 Community capacity is indeed built through public involvement. Important peer-reviewed literature to cite are:

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- Payton, M.A., D.C. Fulton, and D.H. Anderson. 2005. Influence of Place Attachment and Trust on Civic Action: A Study at Sherburne National Wildlife Refuge. *Society and Natural Resources* 18:511-528.
- Leahy, J. and Anderson, D. 2010. "Cooperation Gets It Done: Social Capital in Natural Resources Management along the Kaskaskia River." *Society & Natural Resources*, 23(3):224-239.
- p. 178 The "best-practices" of engagement should be made clear and supported with literature. Without more information, these "best-practices" may or may not be supported by science.
- p. 179 "The use of Internet and other means" would be enhanced with a citation that discussed the prevalence of internet access and the preferred information source of the public. The only citation coming to mind is Mark Brunson's (Utah State University) work on family forest landowner information preferences which is not a good fit here.
- p. 180 A systematic table for this section would be helpful to evaluate the impacts across alternatives. Currently, it seems like different information is presented across the different alternatives.
- p. 181 Earlier in the chapter, the training of staff in scenario planning was mentioned. It would be good to be consistent across the alternatives in indicating whether or not additional training/skills would be needed. For instance, does the staff have the training and skills to complete the list itemized for Alternative E?
- p. 182 The paragraph that starts with, "Another concern about requiring a more standardized or prescribed process relates to the importance of the perceived sense of fairness, the sense that the process was fair." This paragraph needs more support. What evidence? There are several citations already listed that concern agency employees. I would recommend reviewing these and then revising the paragraph accordingly. There are some strong statements in this paragraph that are not necessarily supported by the literature.

**2. Based on the current peer-reviewed scientific literature and understanding: does the documentation on environmental effects adequately respond to levels of uncertainty and limitations? If not, please describe what is missing or incorrect, and how the documentation can be improved.**

Overall, the chapter does address uncertainty and limitations within its analysis of environmental effects. There are a few areas where the documentation can be improved. There are existing frameworks for decision support under uncertainty, but these are not considered within the chapter. I also had concerns about the "Efficiency and Effectiveness" section, which may not have adequately addressed uncertainty and limitations in those calculations.

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n.p.

I believe adding this peer-reviewed piece of literature to Chapter 3 would greatly add to its credibility in terms of how it has approached responding to uncertainty and limitations:

Schultz, C. (2008). "Responding to scientific uncertainty in U.S. forest policy." *Environmental Science & Policy* 11(3): 253-271.

Abstract: "Scientific uncertainty plays a significant role in forest policy and planning. Ecological complexity, the gap between science and policy, and public perceptions of science all contribute to the challenge of dealing with scientific uncertainty. This paper provides an overview of the role of scientific uncertainty in U.S. forest policy and an analysis of the requirements for responding to uncertainty under the National Forest Management Act, National Environmental Policy Act, and Endangered Species Act. The analysis includes a review of a broad range of literature and relevant statutory and regulatory language, along with several illustrative examples of case law. Findings include that all three laws allow for considerable agency discretion in cases of scientific uncertainty, and none prescribes a particular response to uncertainty. Approaches such as adaptive management may provide a way to proceed despite uncertainty, and while this approach represents something of a new paradigm in public land management, it is not incompatible with the current legal framework. The article concludes with recommendations, such as increased transparency and changes in the norms of judicial review, for increasing the accountability of decisions when uncertainty is involved. Also considered are other suggestions, such as peer-review, *Daubert* standards, and Bayesian inference techniques."

p.64

Chapter 3 encourages adaptive management as one way of responding to uncertainty ("Management in the Face of Uncertainty" section). The use of current peer-reviewed scientific literature and understanding in this particular section could be greatly enhanced. The USDA Forest Services' experiences with Adaptive Management Areas in the Northwest Forest Plan should be highlighted. For example, here are two references that could be included:

Shindler, B., Steel, B. & List, P. 1996. "Public Judgments of Adaptive Management: A Response from Forest Communities," *Journal of Forestry*, 94(6), 4-13.

Stankey, G., & Shindler, B. 1997. "Adaptive Management Areas: Achieving the promise, avoiding the peril. Gen. Tech. Rep. PNW-GTR-394. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

There are two pieces from the peer-reviewed literature that focus on lessons learned and ways of approaching adaptive management. These should be understood and incorporated into Chapter 3:

Lee, K. N. 1999. Appraising adaptive management. *Conservation Ecology* 3(2): 3.

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Abstract: “Adaptive management is appraised as a policy implementation approach by examining its conceptual, technical, equity, and practical strengths and limitations. Three conclusions are drawn: (1) Adaptive management has been more influential, so far, as an idea than as a practical means of gaining insight into the behavior of ecosystems utilized and inhabited by humans. (2) Adaptive management should be used only after disputing parties have agreed to an agenda of questions to be answered using the adaptive approach; this is not how the approach has been used. (3) Efficient, effective social learning, of the kind facilitated by adaptive management, is likely to be of strategic importance in governing ecosystems as humanity searches for a sustainable economy.”

and

Stankey, G., Bormann, B., Ryan, C., Shindler, B., Sturtevant, V., Clark, R., and Philpot, C. 2003. Adaptive Management and the Northwest Forest Plan: Rhetoric and Reality, *Journal of Forestry* 101(1): 40-46.

Abstract: “Adaptive management represents a process to use management policies as a source of learning, which in turn can inform subsequent actions. However, despite its appealing and apparently straightforward objectives, examples of successful implementation remain elusive, and a review of efforts to implement an adaptive approach in the Northwest Forest Plan proves the point. Barriers include an institutional and regulatory environment that stymies innovation, increasing workloads coupled with declining resources that constrain learning-based approaches, and a lack of leadership. The time is right to learn from experiences and consider alternatives.”

p. 65

Continuing within the “Management in the Face of Uncertainty” section, a sentence reads, “Adaptive management emphasizes management experience as a source of learning and employs an iterative process that links knowledge to action and action to knowledge.” The one citation included for social learning is outdated (from 1994). Fruitful replacements to read, incorporate, and cite would be:

Pahl-Wostl, C. & Hare, M. (2004). “Processes of Social Learning in Integrated Resources Management,” *Journal of Community & Applied Social Psychology*, 14(193-206).

Maarleveld, M. and Dangb’egnon, C. “Managing natural resources: A social learning perspective,” *Agriculture and Human Values*, 16: 267-280.

Muro, M. & Jeffrey, P. 2008. "A critical review of the theory and application of social learning in participatory natural resource management processes," *Journal of Environmental Planning and Management*, 51(3), 325-344.

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Schusler, T. M., D. J. Decker and M. J. Pfeffer. 2003. Social learning for collaborative natural resource management. *Society and Natural Resources* 15:309–326.

Furthermore, significant wildland fire research supports social learning activities and should be cited. These pieces of peer-reviewed literature would also include more detailed findings:

Toman, E., B. Shindler, and S. McCaffrey. 2008. Postfire communications: the influence of site visits on local support. *Journal of Forestry*, January/February:25-30.

Toman, E., B. Shindler, and M. Brunson. 2005. Fire and fuel management communication strategies: citizen evaluations of agency outreach activities. *Society and Natural Resources* 19:321-336.

Toman, E., B. Shindler, and M. Reed. 2004. Prescribed fire: the influence of site visits on citizen attitudes. *The Journal of Environmental Education* 35(3):13-18.

p.65

Continuing within the “Management in the Face of Uncertainty” section, the final sentence reads, “The approach assesses knowledge from a variety of sources and uses that knowledge to develop questions and hypotheses that can be tested, monitored and evaluated to better inform policy and management.” This sentence is missing a detailed discussion of forms of knowledge. Peer-reviewed literature on local ecological knowledge (LEK) and traditional ecological knowledge (TEK) should be included. While there are many to choose from, one often cited example would be:

Berkes, F., Colding, J., and Folke, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10:1251–1262.

Finally, knowledge-action links are well explored in the following articles:

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Giston, J. Jager, and R.B. Mitchell. 2003. Knowledge systems for sustainable development. *PNAS*. 100(14):8086-8091.

Van Kerkhoff, L., and L. Lebel. 2006. Linking knowledge and action for sustainable development. *Annual Review of Environment and Resources*. 31:445-477.

n.p.

This chapter does not explicitly discuss how, across all the alternatives, managers will make decisions about NFS lands in the face of uncertainty and limitations. There are a range of options that could be considered the best available science. Bayesian decision theory, a formal framework for risk and uncertainty that includes probabilities of outcomes, assessment error, risk attitudes, and welfare measures. These integrated assessment models can be calibrated against HRV and other historical data. It could work quite well for the

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NFS multiple uses, particularly the incorporate of welfare estimates. Example papers include:

Tomassini, L., R. Knutti, G.-K. Plattner, D. van Vuuren, T.F. Stocker, R.B. Howarth, M.E. Borsuk. Uncertainty and risk in climate projections for the 21st century: comparing mitigation to non-intervention scenarios. *Climatic Change*. In press.

Gerst, M.D., R.B. Howarth, M.E. Borsuk. 2010. Accounting for the risk of extreme outcomes in an integrated assessment of climate change. *Energy Policy*, 38: 4540–4548.

Another approach could be:

Kangas, J. and A. Kangas (2005). "Multiple criteria decision support in forest management--the approach, methods applied, and experiences gained." *Forest Ecology and Management* 207(1-2): 133-143.

Rauscher, H. M. (1999). "Ecosystem management decision support for federal forests in the United States: A review." *Forest Ecology and Management* 114(2-3): 173-197.

p. 158

I am very concerned about whether or not there is a source for the assumptions made in the efficiency and effectiveness calculations. Page 160 states, "...due in part to the reduced number of years anticipated to be needed for plan revisions." This assumption is not clearly explained, nor documented with literature. However, I am not aware of any research that looks at planning, inventory and monitoring costs as a function of planning process (note: this would make for a very interesting study). As it stands now, these assumptions -- beginning on page 158 and continuing through 160 -- do not seem justified. Why exactly would the planning time be reduced? As I suggest later, in response to Question #3, I would look at the time and costs of "successful" and "unsuccessful" plans revised under the 1982 planning rule (using criteria for success defined by the USDA Forest Service). Anecdotally, I am familiar with the White Mountain National Forest Plan. It exceeded the planning requirements, took 8 years to complete, and is largely looked at in the region as a success. Several of the alternatives are flexible and could easily result in revisions that take this long. If that is the case, then the cost estimates are incorrect. I would like to suggest a sensitivity analysis as a solution to this, since no known data exists on this. How sensitive are the costs should the plan revision times vary (e.g., instead of assuming 3 years, instead of the current 5, run the estimates using a range from 2-8 years).

p. 165

A discussion of the trends in costs to address post-decision appeals would be a good addition to support the assumptions with data. Is the cost of 3 & 2% increasing, decreasing, or constant over time?

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3. **What, if any, differing viewpoints should be included that are not mentioned in the DEIS regarding the effects of alternatives on climate change, restoration and resilience, watershed and water protection, diversity of plants and animal communities, sustainable use of public lands to support vibrant communities, forest threats, and monitoring. We recognize that this is a broad range of subjects; we have selected a group of reviewers that are each specialists in one or more of these areas. While you are welcome to address all of these areas, we recognize that some areas may fall outside your particular expertise. We particularly relying on you for review of the issue of sustainable use of public lands to support vibrant communities.**

After answering questions #1 and #2, there remain only two additional areas where the USDA Forest Service need to do more to consider or acknowledge different viewpoints on the alternatives and their impacts. The first includes the use of the representative revised plans as a basis for the baseline conditions and impacts. The second falls a bit outside my particular expertise, and include the use of HRV.

- p. 55            Much of the analysis throughout the chapter relies on the use of 9 representative plans created under the 1982 rule. The authors explain the process that was used to select these plans – the most recently revised plans from each region. However, there are alternative qualitative sample selection methods available to choose from. One sampling method that could be particularly useful for this analysis is a maximum variation sampling approach. This would call for evaluating the most and least “successful” plans from each region. Social and ecological criteria could be developed (e.g., numbers of appeals as a social criterion, and T&E species population as an ecological criterion). This approach to sampling should shed a different light on the analysis of alternatives later in the chapter. As one example, on page 176, the discussion of use of collaborative groups would be enhanced through the maximum variation sampling approach.
- p. 58            There is some debate about whether the “non-stationary property of system dynamics” reduces the need to understanding HRV due to shifting baselines. Chapter 3 does not address this differing viewpoint, but does defend the use of understandings from historical landscape ecology. My comment is not about that particular conclusion or decision, rather, it is about not fully acknowledge the debate on HRVs relevance given changing baseline conditions. This is acknowledged slightly on page 60 and 66 (“a reference ecosystem may not always be an appropriate goal”), but not cited.

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**USFS DRAFT PROGRAMMATIC EIS  
FOR NATIONAL FOREST LAND MANAGEMENT PLANNING  
SCIENCE REVIEW**

*Reviewer: Dr. Barry R. Noon, Colorado State University*

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The primary focus of my review comments pertain to section §219.9 of the Proposed Rules, “Diversity of plant and animal communities”. In addition, I make reference to the intersection of section §219.9 with sections §219.3, Role of science in planning, §219.6, Assessments, §219.8 Sustainability, and §219.12, Monitoring.

The authors of the DEIS and proposed rule demonstrate considerable understanding of the scientific literature relevant to maintaining plant and animal diversity of multiple-use landscapes. I found no major gaps in their knowledge of the literature. However, it was not always clear to me how the Forest Service would translate the often abstract and conceptual insights provided by the scientific literature into site specific recommendations for management actions. This true of the entire diversity-planning process beginning with selection of species of conservation concern, assessment of the status and population trends of these species based on unit-level monitoring data, and how the monitoring data would trigger changes in management practices. It may be that the Forest Service has put off developing detailed methods for each of these steps until Directives are developed for the planning rule.

The primary concern about the vagueness of the methods for conserving plant and animal diversity is that individual administrative units (e.g., 155 national forests) will each interpret the rule, and section §219.9 in particular, in a different way. This will lead to highly inconsistent and inefficient application of management practices to conserve plant and animal diversity. There is a fine balance between being overly prescriptive and allowing for too much local discretion. My sense is that the Forest Service generally favors local discretion over system-wide standards. Part of their argument is based on the belief that the science is too dynamic to be overly prescriptive in the alternatives. However, this is not true. Science is dynamic in the methods it employs to understand and manage ecological systems not in the objective to conserve these systems for future human generations.

Below, I divide my comments in to two specific sections. First, is a set of comments on the scientific foundation of the alternatives discussed in the DEIS. Second, is my summary of recent advances in the science of wildlife habitat ecology, species viability, and species-level monitoring that may be useful for the Forest Service to consider prior to adopting a final rule.

### **Specific Comments**

Below is a list of my comments/concerns applicable in varying degree to the plant and animal diversity provision in all five alternatives.

1. In practice, the biotic and abiotic elements and processes that characterize a species’ habitat are often poorly known. What is usually better known is the relation between



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the occurrence of the species on the landscape and the vegetation structure and composition in the neighborhood of these locations. As a result, designation of vegetation community types and their successional stages has often been used as a surrogate for a species' habitat (i.e., the coarse filter). Defaulting to vegetation type as a descriptor of a species' habitat has a long history in ecology. It has been driven largely by pragmatism—vegetation is much easier to measure and characterize than prey resources or nest sites, for example. The practice continues because detailed vegetation maps exist for most parts of the country based on either extensive ground-surveys or remotely sensed (e.g., satellite) imagery. However, it is important to keep in mind that vegetation is an assumed proxy for often more important, but more difficult to measure, resources. Some of the failure of vegetation-based habitat models to inform management and conservation may be due to breakdown of this assumption (Van Horne 2002). The coarse filter approach has significant limitations and will not be sufficient for many species.

2. The term “habitat” is used generically throughout the DEIS. When the term is used, it is my understanding that the authors had vegetation community types, and their successional stages (young, mature, old-growth), in mind. Habitat, of course, is a much more complicated concept (see my discussion below).
3. Based on (1), habitat becomes synonymous with the coarse filter approach to conserving plant and animal diversity. As a predictive tool, a conservation strategy focused exclusively on maintaining the attributes of the coarse filter is unlikely to provide habitat for all species of management responsibility (Noon et al. 2009).
4. The environment, including habitat, generally seems to be considered as a static concept. I do not think that enough attention has been given in DEIS to the dynamic nature of the environment and how this affects the achievement of management objectives. In general, the more dynamic the environment the more difficult it will be to achieve objectives and the greater the need for current monitoring data. Effective management decisions require knowledge of the current state of the environment.
5. The relationship between “ecosystem diversity” and “species conservation” is not clearly articulated in the DEIS or in alternative A. To some extent, all alternatives treat ecosystems and species as if they were distinct concepts. A look at any ecosystem diagram in any ecology textbook will likely be drawn as a box-and-arrows diagram. Importantly, the boxes, with labels such as primary producers, decomposers, primary consumers, secondary consumers, etc., are occupied by species of plants, animals, and bacteria. That is, species are the process-engines within ecosystems responsible for the transfer of matter and energy. The emphasis here is not on individual species names but on species' functional roles in ecosystems. This is a connection that could be more fully exploited via expanding on the focal species concept in the alternatives.
6. Following on (4), focal species may be a way to link the two key components of §219.9. Even though the focal species concept is generic, and not necessarily linked to a species' functional role in an ecosystem, many of the candidate categories of focal species are based on what species do in ecosystems.
7. The connections between sections §219.8 Sustainability and §219.9 are not well made in the DEIS or alternatives. Resilience, defined in the rule as the ability to absorb disturbance/perturbations without a significance loss of structure, function, or

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composition is directly linked to species diversity via the concept of functional redundancy. That is, ecosystems with functional redundancy, achieved by having many species with similar functional roles, are more resilient to disturbance (Naeem and Li 1997). (Note: what the Forest Service refers to as ecosystem resilience is sometimes called ecosystem resistance in the scientific literature. Resilience is defined as the time it takes an ecosystem to return to pre-disturbance state).

8. The concept of the “inherent capability of the plan area” is poorly defined in the DEIS. Since the inherent capability of the land area sets an upper limit to the Forest Service’s responsibility to conserve plant and animal diversity, it is very important that it be clearly defined and guidance be provided on its measurement. I understand what the Forest Service is trying to achieve by setting this limitation. That is, to limit its responsibilities in those cases where the occurrence or viability of a species will be outside of the control of the Forest Service.
9. The importance of maintaining a wide geographic distribution for a species’ viability is not adequately emphasized. One of the most important ways to increase a species viability (decrease is probability of extinction) is to maintain the species’ populations widely distributed across the landscape. This effectively decouples the temporal dynamics of local populations of a species and thereby decreases the probability that all local populations will decline synchronously. Maintaining the distribution of widely distributed species may require close coordination among administrative units.

### **Additional/Complimentary Perspectives on Enhancing the Role of Science in Species Viability and Monitoring**

Planning and managing for ecological sustainability should involve consideration of the following principles:

- Planning and management must focus on several scales of biological organization including ecosystems, communities, and individual species.
- Analyses must focus on appropriate geographic scales and include consideration of cumulative effects across ownerships.
- Analyses and management must take into account those factors that are within the control of the Forest Service and those that are not.
- The dynamic nature and variability of ecological systems across time and geography must be recognized when the status of systems is determined and goals for those systems are established.
- Uncertainty about how ecological systems work and respond to management must be recognized.
- Due to uncertainty, monitoring and adaptation are integral to responsible land management.

These principles were recognized by the Committee of Scientists in their 1999 report (COS 1999). Both the 2000 Planning Rule and the Forest Service Directives adopted pursuant to the 2005 Rule represent legitimate attempts to implement these principles.

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Beginning with the 1982 regulations, two requirements for assessments of plant and animal (biological) diversity have had a particularly contentious history within the Forest Service. These are the requirements to 1) monitor and 2) conduct viability assessments at the species level (Noon et al. 2003). The Forest Service has attributed the difficulties they experienced in trying to fulfill these requirements to inadequate funding and to the perception that these requirements exceed the agency's capabilities. Both of these constraints were recognized by the Committee of Scientists report (COS 1999); the Committee partially addressed them by recommending that most monitoring and viability assessments be limited to a small set of focal species. The Committee's argument was simple—it was plainly unreasonable and infeasible to assess the status, trend, and viability of all species, even if limited to vertebrate species. For example, the national forests within the Sierra Nevada ecosystem provide habitat for more than 500 vertebrate species, many with poorly known life histories and distribution patterns. Restricting assessment to a small (e.g., 10-20) set of species was meant to be pragmatic, to address the agency's requirements for conservation of biological diversity, to be within the capabilities of the agency, and to be based on the best available science (reviewed in Noon and Dale 2003).

The focal species concept has been incorrectly equated to the management indicator species (MIS) concept as it appears within the 1982 regulations. MIS were assumed to reflect the status and trends of a large number of unmeasured species (Landres et al., 1988). However, the concept that some species act as direct surrogates of others is untenable unless those species share similar population drivers (Cushman et al., 2010). The MIS approach, however, has merit in that it recognizes that the assessment of any complex system, such as an ecosystem, requires a surrogate-based approach. Focal species, in contrast, would commonly be selected on the basis of their functional role in ecosystems (e.g., species that serve keystone functions [Mills et al., 1993], act as engineers of ecological processes [Jones et al., 1994], indicate the action of key stressors [Caro and O'Doherty 1999], or strongly influence food webs via top-down control [Soule et al. 2005]). Noon et al. (2009) recently reviewed categories of focal species, methods to identify them, and how they may serve as surrogates for monitoring on federal public lands.

In the 2005 regulations, the Forest Service restricted its requirement to conserve biological diversity to a coarse-filter approach—that is, the remote monitoring of vegetation communities and their successional stages (also called cover types). However, the limitations of a coarse filter approach to infer species' distributions and status has been known for sometime (Noon et al., 2005). A recent review of the degree to which coarse-filter models can be used to infer animal occurrence concluded that "...the observed error rates were high enough to call into question any management decisions based on these models" (Schlossberg and King 2009:609). These authors went on to state that "...[coarse-filter] models oversimplify how animals use habitats, and the dynamic nature of animal populations" (Schlossberg and King 2009:609). The coarse-filter approach is a necessary component of the assessment of biological diversity but it is not sufficient on its own—it needs to be accompanied by some degree of direct species assessment (Noon et al. 2009).

Species level monitoring and viability assessments are much more feasible today than they were at the time of the Committee of Scientists' report (COS 1999) and the 2000 NFMA regulations. There have been significant advancements in the last decade in survey design, statistical methods, the ability to estimate species distribution patterns based on presence/absence data, and in obtaining estimates of animal abundance based on individual

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animal identities. Further, it is important to note that scientists within the Agriculture and Interior Departments have made many of these advances. Thus, the capability and understanding of state-of-the-art scientific methods relevant to monitoring and viability analysis reside within the federal agencies responsible for species conservation.

A recent significant advance in wildlife monitoring is based on use of presence-absence data which is relatively inexpensive to acquire, allows an exploitation of historical survey data, and can make use of recent advancements in genetic evaluation (e.g., MacKenzie et al. 2005). One variable estimated by occupancy models is the area occupied by a species, a measure of a species' spatial distribution. An example of its relevance to wildlife conservation is that the July 2005 issue of the *Journal of Wildlife Management* devoted a special section to the discussion and application of presence-absence sampling in wildlife monitoring (Vojta 2005) including an application to National Forest System lands (Manley et al. 2005). Temporal and spatial patterns in presence-absence monitoring data also allows inference to changes in animal abundance (MacKenzie and Nichols 2004), the single most important parameter that provides insights into likelihood of species persistence (Lande 1993).

Presence-absence monitoring can be based on real-time observation of a species at a survey site, or evidence that the species was at the survey location sometime in the recent past. One of the most significant advances in presence-absence monitoring takes advantage of the ability to confirm the presence of a species at a survey site based on its genetic signature (e.g., in hair or scat) (Waits 2004, Schwartz et al. 2006). If genetic markers are available, it is relatively straightforward to identify the sample by species on the basis of its DNA signature, and often to the individual level (Waits 2004). The ability to use indirect measures of presence for some species greatly increases monitoring efficiency and reduces survey costs.

These advances in survey methods (e.g., presence-absence models), detection techniques (e.g., genetic analysis), and changes in state variable from direct measures of demographic parameters (e.g., abundance, density, survival) to measures of area occupied have important applications to viability analyses. Traditional viability analyses have been based on estimates of demographic parameters including time series of abundance estimates, survival rates, and reproductive rates (Beissinger and McCullough 2002). Estimates of these parameters require extensive field surveys, frequent capture and marking of individual animals, are costly, and are available for only a small number of species. A consequence is that to require the Forest Service to conduct demographic viability analyses for all focal species is impractical.

In the planning rule and subsequent directives, it may be useful for the Forest Service consider indirect methods of viability analysis that take advantage of advances in the monitoring methods and techniques discussed above. These methods use area occupied (estimated from presence-absence data) as a measure of a species' geographic distribution within the survey area (e.g., one or more adjacent nation forests). Area occupied, the viability state variable, serves as a surrogate measure or index of the species abundance in the survey area. Surrogacy is justified on the basis of the well-established positive relationship between a species' abundance and its geographic distribution (e.g., Brown 1984, Gaston 1996). Further justifications for this approach are that methods have been developed to estimate abundance from occupancy data (Royle and Nichols 2003, Stanley and Royle 2005) and that measures of abundance have consistently been shown to be highly correlated to occupancy rates (Gaston et al. 2000, Zuckerberg et al. 2009). Justification for use of the viability index method is also based

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on the significant positive relation between a species' abundance and its probability of persistence (Lande 1993, Lande et al. 2003).

The proposed index of viability based on presence-absence data will be accompanied by greater uncertainty about a species true viability status than a demographically based analysis. This is inescapable. However, the index method may adequately address the agency's requirements for maintaining plant and animal diversity. Further, this approach meets the requirements for inclusion in the planning regulations:

- It is practicable.
- It is within the capabilities of the agencies to implement and interpret.
- It could serve as an early warning indicator of species imperilment prior to a need to consider as threatened or endangered.
- It has a strong scientific foundation.

### **Additional/Complimentary Perspectives on the Habitat and Viability Concepts**

Habitat is a spatial concept—habitat occupies space and has dimension of area. Habitat is a temporal concept—habitat has dynamics and changes through time. Habitat is a species-specific concept—by definition, no two species have exactly the same habitat requirements. Habitat is a multi-dimensional concept—habitat is characterized by multiple factors. Within a specific area, habitat is the collection of resources and environmental conditions needed to support survival and reproduction of the focal organism. Thus, habitat is a specific combination of both biotic and abiotic components and processes that allow occupancy of the environment by an organism. For the Forest Service to provide habitat to maintain diverse plant and animal communities over time will require that it manage multiple attributes of the environment at multiple spatial scales.

Abiotic components contributing to habitat include physical and chemical attributes of space such as temperature (mean, maximum, minimum); precipitation (form, amount, and temporal distribution); relative humidity; wind; elevation, exposure, salinity, and physical substrate (soil or rock type). Often, abiotic components are best distinguished as processes rather than discrete physical elements. For example, climate is a process that is characterized by attributes such as temperature and humidity that are not tangible elements.

Biotic components include living, or previously living, elements—that is, other species. For example, many imperiled species occupying old-growth forest ecosystems are associated with standing live, standing dead (snags), or fallen (logs) large trees. Typically, habitat is often described in terms of vegetation composition, vegetation structure (the physical architecture of the vegetation), and other biotic resources such as prey species or host plants. Note that the biotic and abiotic components that define a species' habitat are not independent. For example, precipitation and physical substrate largely determine the vegetation composition and structure of an area that may serve as habitat for a given species.

What defines habitat for a given species is a complex process influenced by the organism's morphological and physiological adaptations as influenced by its innate and learned behaviors (Block and Brennan 1993). A species' habitat requirements are subject to evolutionary change

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but usually only over time frames that are too long to be relevant to land management planning.

In simple terms, habitat is that area on the landscape needed for a species to be viable, that is, to reach a sufficient population size and geographic distribution so that its risk of extinction meets some predetermined recovery criterion (e.g., a 5% chance of extinction over the next 100 years). Implicit in this definition is a set of biological criteria that must be met by habitat. These criteria include:

- 1) The habitat provides the resources and physical conditions necessary for individual organisms to survive and reproduce. **[individual organism scale]**
- 2) The habitat is sufficiently extensive that it has a high probability of supporting a local population of sufficient size to incorporate natural and human disturbance events and not experience local extinction (at least over time frames established in the recovery criteria). **[local population scale]**
- 3) The habitat is sufficiently extensive at the scale of the target geographic range of the species (conditioned on recovered) that it is highly unlikely that all local populations will simultaneously experience extinction events. That is, the dynamics of local populations are asynchronous as a consequence of spatial redundancy of recovery habitat designations. **[geographic range scale]**

Land management planning with a goal of providing habitat for native species must address a species' habitat requirements at three spatial scales—individual, local population, and across its geographic range. The geographical range scale will require coordination of conservation efforts across administrative units.

For the land manager to be confident that (s)he is maintaining viable populations (e.g., 5% chance of extinction over the next 100 years), the characteristics of habitat that allow, on average, birth rates to exceed death rates must be identified. That is, habitat must be linked to the demographic processes of birth and survival at both the individual and population scales. Only habitat with the appropriate characteristics (see below) that allow for population growth (i.e., birth rates > death rates) will promote recovery and delisting. At the individual level this translates into habitat that allows for occupancy, survival, and birth (Hall et al. 1997). At the population level, this allows for the birth rate to exceed, on average, the death rate of the population (Chase and Leibold 2003).

Provisioning of habitat for species with complex life histories is a distinctive challenge. The issue here is that some species have specific, and distinct, habitat requirements dependent upon their life history stage or the time of the year. For example, consider a species that is migratory with distinct breeding and winter ranges. In this case, sufficient habitat for viability must include the requirements for successful breeding, migration, and survival on the wintering grounds.

The ability to relate demographic rates (birth and survival) to aspects of the environment is known for only a small number of species. Pragmatically, the Forest Service will have to restrict this level of assessment to a small number of focal species chosen according the procedures outline in Noon et al. (2009).

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APPENDIX: CURRICULA VITAE

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### **Academic Administration**

University of Florida

Department Chair, Department of Wildlife Ecology and Conservation, 2006 to present.  
Director, Ordway-Swisher Biological Station, 2006-present (Acting, 2006-2008).

Oregon State University

Associate Dean for International Programs, College of Forestry, 2005-2006.  
Program Coordinator, Cooperative Forest Ecosystem Research program, 1998-2004.  
Co-leader. Adaptive Coastal Oregon Productivity Enhancement (COPE) Program, 1992-1999.

### **Other Academic Appointments**

University of Florida

Professor, Department of Wildlife Ecology and Conservation, 2006 to present.

Oregon State University

Professor, Department of Forest Science, 2003 - 2006.  
Associate Professor, Department of Forest Science, 1998 - 2003.  
Assistant Professor, Department of Forest Science, 1992 - 1998.

University of Tennessee

Science Alliance post-doctoral fellow, Department of Zoology, 1990-1992.  
Faculty advisor: Dr. Gary F. McCracken.

### **Educational Background**

Ph.D., Ecology and Evolutionary Biology, Cornell University, 1990. Dissertation title: Biogeographic, systematic, and conservation implications of geographic variation in woodrats of the eastern United States. Research chairman: Dr. Milo E. Richmond.

M.S., General Studies - Biology, Southern Oregon State College, 1983. Thesis title: Forestry related aspects of the ecology of *Clethrionomys californicus* in southwestern Oregon. Research chairman: Dr. Stephen P. Cross.

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B.S., Wildlife Science, Oregon State University, 1978.

### **Semi-technical and Popular Publications**

2006. Walidien, D. L. and **J. P. Hayes**. Influence of alternative silviculture on small mammals. U.S. Geological Survey: Fact Sheet FS 2006-3100.
2004. **Hayes, J. P.** Wildlife considerations in modern forest management. *Western Forester* 49(4):1-3.
2004. **Hayes, J. P.** The truth about bats. *Northwest Woodlands*. Spring issue:16-17.
2004. Stoddard, M., **J. P. Hayes**, and J. Erickson. Influences of forest management on headwater stream amphibians at multiple spatial scales. U.S. Geological Survey: Fact Sheet FS 2004-3018.
2003. Arnett, E. B., and **J. P. Hayes**. Oregon flat-bottom bridge bat house study. *Bat House Researcher* 11(1):7.
2003. **Hayes, J. P.**, J. M. Weikel, M. M. P. Huso, and J. L. Erickson. Response of birds to thinning young Douglas-fir forests. U.S. Geological Survey: Fact Sheet FS-033-03.
1997. Weikel, J., and **J. P. Hayes**. Habitat selection by cavity-nesting birds in thinned and unthinned forests. *COPE Report* 10(3):2-6.
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1990. Lipton, J. and **J. Hayes**. Sea otters: A fatal conflict of interests. *World Magazine* 34:68-75.
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1989. **Hayes, J.** and J. Lipton. Black stripes or white stripes? *World Magazine* 30:56.
1989. Lipton, J. and **J. Hayes**. 'A species with a wing in the grave.' *World Magazine* 31:74-80.
1988. **Hayes, J.** and J. Lipton. Giraffes: a spectacular piece of evolution. *World Magazine* 19:64-72.
1988. Lipton, J. and **J. Hayes**. Hummingbirds; a colorful chorus. *World Magazine* 10:36-42.
1988. Lipton, J. and **J. Hayes**. Taking the bear by the tooth? *World Magazine* 9:62-66.

### **Presented Papers and Seminars**

(only first-authored presentations listed)

2009. Hayes, J. P. Conservation of bats in the 21st Century: A harbinger of broad-scale environmental crises? University of Central Florida Department of Biology seminar series (invited presentation).
2009. Hayes, J. P. Environmental tradeoffs: wind energy and wildlife. La Selva Biological Station lecture series (invited presentation).

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2008. Hayes, J. P. Wind energy and wildlife. University of Florida Department of Wildlife Ecology and Conservation seminar series.
2007. Hayes, J. P. Wind energy and wildlife: lessons learned and future directions (invited presentation). The Wildlife Society, Tucson, Arizona.
2007. Hayes, J. P. La vida silvestre y el manejo de bosques. (Invited presentation) INTA, Buenos Aires, Argentina.
2007. Hayes, J. P. Conserved forest lands: what, why, and for whom? (Invited presentation) Florida Chapter of the Society for American Foresters, Gainesville Florida.
2004. Hayes, J. P. Wildfire and wildlife (Invited presentation). Seoul National University, South Korea.
2004. Hayes, J. P., and S. Loeb. The influences of forest management on bat populations (Invited presentation). 2nd Bats and Forests Symposium and Workshop, Hot Springs, Arkansas.
2003. Hayes, J. P. Effects of wildfire and post-fire salvage on wildlife populations (Invited presentation). OSU Chapter of the Society of American Foresters. Corvallis, Oregon.
2003. Hayes, J. P. Effects of wildfire and post-fire salvage on wildlife populations. Workshop on Fire and Post-fire Salvage. Central Oregon Chapter of the Society of American Foresters. Bend, Oregon.
2003. Hayes, J. P. Monitoreo ecológico en bosques de alto valor de conservación (Invited presentation). WWF workshop on High Conservation Value Forests. Nicaragua.
2003. Hayes, J. P. Ecological monitoring in Neotropical forests managed for multiple resource values (Invited presentation). The Evergreen State College, Olympia, Washington.
2003. Hayes, J. P. Forest certification and ecological monitoring in Neotropical forests: academic visions and practical realities (Invited presentation). Oregon State University Department of Forest Science seminar series.
2002. Hayes, J. P. Dos caminos hacia un enfoque del manejo de ecosistemas en bosques del noroeste de los Estados Unidos. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica.
2001. Hayes, J. P. The influences of thinning on bird populations: an information-theoretic approach (Invited presentation). University of Washington College of Forest Resources seminar series.
2001. Hayes, J. P. Habitat ecology of bats in western coniferous forests: a review. The Wildlife Society, Reno, Nevada.
2001. Hayes, J. P. Biodiversity implications of transgenic plantations (Invited presentation). IUFRO symposium on Ecological and Social Implications of Transgenic Trees, Skamania Lodge, Washington.
2000. Hayes, J. P. Considerations in understanding the habitat ecology of vertebrates: examples from forests of the United States (Invited presentation). National Taiwan University, Taipei, Taiwan.
2000. Hayes, J. P. Managing for wildlife and biodiversity in forest ecosystems: Thoughts and approaches from the United States (Invited presentation). Sino-American Ecosystem Management Symposium, Taipei, Taiwan.
2000. Hayes, J. P. Forest management and bats in western coniferous forests: the current state of knowledge (Invited presentation). The Wildlife Society, Nashville, Tennessee.
2000. Hayes, J. P. La vida silvestre y el hábitat, ¿ pueden coexistir en los bosques del nor-oeste de los Estados Unidos? Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica.

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2000. Hayes, J. P. Desafíos al entender los efectos de la alteración del hábitat sobre la vida silvestre: Observaciones y perspectivas de los Estados Unidos. Programa Regional en Manejo de Vida Silvestre, Universidad Nacional, Heredia, Costa Rica.
2000. Hayes, J. P. Challenges and approaches to understanding the influences of forest management on wildlife. Department of Forest Science seminar series, Oregon State University, Corvallis, Oregon.
1999. Hayes, J. P. Practical and experimental considerations for designing and conducting field studies using Anabat Detectors (Invited presentation). American Society of Mammalogists, University of Washington, Seattle, Washington.
1999. Hayes, J. P. El manejo de bosques en el nor-oeste de los Estados Unidos - biodiversidad y silvicultura (Invited presentation). Instituto Nacional de Tecnológica Agropecuaria, Bariloche, Argentina.
1999. Hayes, J. P. Los efectos del raleo sobre la vida silvestre y el habitat en el nor-oeste de los Estados Unidos. Facultad de Agronomía, University of Buenos Aires, Argentina.
1999. Hayes, J. P., and J. M. Weikel. Avian community response to commercial thinning in the Oregon Coast Range (Invited presentation). Oregon Chapter of the Wildlife Society Annual meeting. Gleneden Beach, Oregon.
1999. Hayes, J. P. The effects of commercial thinning on wildlife (Invited presentation). COPE symposium: Forests and streams of the Oregon Coast Range: Building a foundation for integrated management. Corvallis, Oregon.
1999. Hayes, J. P. Ecology and management of bats (Invited presentation). COPE symposium: Forests and streams of the Oregon Coast Range: Building a foundation for integrated management. Corvallis, Oregon.
1998. Hayes, J. P. El manejo de bosques juvenes para mantener biodiversidad en el nor-oeste de los Estados Unidos: Los efectos de tala selectiva sobre la vida silvestre y el habitat (Invited presentation). Programa Regional en Manejo de Vida Silvestre, Universidad Nacional, Heredia, Costa Rica.
1997. Hayes, J. P. Vertical stratification of habitat use by bats in an old-growth forest. Wind River Canopy Crane Scientific Open House, Carson, Washington.
1996. Hayes, J. P. Temporal variation in bat activity and the design of echolocation monitoring studies. American Society of Mammalogists, University of North Dakota, Grand Forks, North Dakota.
1996. Hayes, J. P. Influence of forest management in riparian areas on bats in the Oregon Coast Range (invited presentation). Annual meeting of the Humboldt Chapters of the Wildlife Society and American Fisheries Society. Arcata, California.
1996. Hayes, J. P. Use of bat detectors to monitor bat populations. Oregon Chapter of the Wildlife Society Annual meeting. Gleneden Beach, Oregon.
1995. Hayes, J. P., and M. D. Adam. The influence of logging riparian areas on habitat use by bats in western Oregon (Invited presentation). The Bat-Forest Interaction Conference, Victoria, B. C.
1995. Hayes, J. P., and R. J. Steidl. Statistical power analysis in wildlife research (Invited presentation). The Wildlife Society, Portland, Oregon.
1995. Hayes, J. P., and S. P. Cross. Intra- and inter-specific variation in echolocation calls of bats in Oregon. American Society of Mammalogists, University of Vermont, Burlington, Vermont.
1995. Hayes, J. P. Riparian area management and bat populations (Invited presentation). Society for Northwestern Vertebrate Biology, Orcas Island, Washington.

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1994. Hayes, J. P., and P. Hounihan. Temporal variation in bat activity and its importance in the design of echolocation monitoring studies. American Society of Mammalogists, Smithsonian Institution, Washington, D. C.
1993. Hayes, J. P., and P. Hounihan. Spatial and temporal variation in bat activity in echolocation monitoring studies. North American Symposium on Bat Research, University of Florida, Gainesville, Florida.
1993. Hayes, J. P., M. Castellano, E. Horvath, and P. Hounihan. Mycophagy of Townsend's chipmunks (*Tamias townsendii*) in different aged forest stands in the Oregon Coast Range. American Society of Mammalogists, Western Washington University, Bellingham, Washington.
1992. Hayes, J. P., G. F. McCracken, S. Z. Guffey, F. Kriegler, and C. R. Parker. The impacts of hybridization on the genetics of brook trout in the Southern Appalachians. Society for Conservation Biology, Virginia Polytechnic Institute, Blacksburg, Virginia.
1992. Hayes, J. P. Genetics and the conservation of woodrats in the northeast. New York Natural History Conference, New York State Museum, Albany, New York.
1990. Hayes, J. P. and M. E. Richmond. Morphometric variability in woodrats of the eastern United States. American Society of Mammalogists, Frostburg State University, Frostburg, Maryland.
1989. Hayes, J. P. Patterns and causes of rarity in threatened and endangered mammals of the United States. Society for Conservation Biology, University of Toronto, Toronto, Canada.
1989. Hayes, J. P. Characteristics of rare mammals in the United States. American Society of Mammalogists, University of Alaska, Fairbanks, Alaska.
1989. Hayes, J. P., R. G. Harrison, and M. E. Richmond. Conservation implications of genetic variation in Allegheny woodrat populations. Northeast Fish and Wildlife Conference, Neville, New York.
1988. Hayes, J. P., R. G. Harrison, and M. E. Richmond. Biogeographic variation in mitochondrial DNA from woodrats in the eastern United States. American Society of Mammalogists, Clemson University, Clemson, South Carolina.
1983. Hayes, J. P. and S. P. Cross. Characteristics of logs used by deer mice (*Peromyscus maniculatus*) and western red-backed voles (*Clethrionomys californicus*) in southwestern Oregon. Northwest Bird and Mammal Society, Oregon State University, Corvallis, Oregon.

### Scientific Papers and Publications

- Accepted. Leuthold, N., M. Adams, and **J. P. Hayes**. Short-term response of Pacific giant salamanders to timber management in southwestern Oregon. *Journal of Wildlife Management*.
2011. Arnett, E. B., M. M. P. Huso, M. R. Schirmacher, and **J. P. Hayes**. Changing wind turbine cut-in speed reduces bat fatalities at wind facilities. *Frontiers in Ecology and the Environment* doi:10.1890/100103.
2010. Ober, H. K., and **J. P. Hayes**. Determinants of nocturnal Lepidopteran diversity and community structure in a conifer-dominated forest. *Biodiversity and Conservation* 19:761-774.
2009. Arnett, E. B., and **J. P. Hayes**. Use of conifer snags as roosts by females of three species of bats in western Oregon. *Journal of Wildlife Management* 73:214-225.
2009. Boland, J. L., **J. P. Hayes**, and W. P. Smith. Distribution of bats in southeast Alaska with emphasis on Keen's *Myotis* (*Myotis keenii*). *Northwest Science* 83:169-179.

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2009. Cahall, R. E., and **J. P. Hayes**. Influences of post-fire salvage logging on forest birds in the Eastern Cascades, Oregon, USA. *Forest Ecology and Management* 257:1119-1128.
2009. Frick, W. F., P. A. Heady III, and **J. P. Hayes**. Facultative nectar-feeding behavior in a gleaning insectivorous bat (*Antrozous pallidus*). *Journal of Mammalogy* 90:1157-1164.
2009. Frick, W. F., **J. P. Hayes**, and P. A. Heady, III. Nestedness of a desert bat assemblage: species composition patterns in insular and contiguous landscapes. *Oecologia* 158:687-697.
2009. **Hayes, J. P.**, H. K. Ober, and R. E. Sherwin. Surveying and monitoring bats. Pages 115-132, in Kunz, T. H., and S. Parsons (eds.). *Ecological and Behavioral Methods for the Study of Bats*, 2<sup>nd</sup> edition. Johns Hopkins University Press, Baltimore, MD.
2008. Frick, W. F., **J. P. Hayes**, and P. A. Heady, III. Island biogeography of bats in Baja California, Mexico: Patterns of bat species richness in a near-shore archipelago. *Journal of Biogeography* 35:353-364.
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2008. Ober, H. K., and **J. P. Hayes**. Influence of forest riparian vegetation on abundance and biomass of nocturnal flying insects. *Forest Ecology and Management* 256:1124-1132.
2008. Ober, H. K., and **J. P. Hayes**. Influence of vegetation on bat use of riparian areas at multiple spatial scales. *Journal of Wildlife Management* 72:396-404.
2008. Ober, H. K., and **J. P. Hayes**. Prey selection by bats in forests of western Oregon. *Journal of Mammalogy* 89:1191-1200.
2007. Committee on Environmental Impacts of Wind Energy Projects (Risser, P., I. Burke, C. Clark, M. English, S. Gauthreaux, Jr., S. Goodman, **J. P. Hayes**, A. Horvath, T. Kunz, L. Manuel, E. Lundtang Petersen, D. Strickland, J. J. R. Webb, R. Whitmore). *Environmental impacts of wind-energy projects*. The National Academies Press, Washington, D.C. 267 p.
2007. **Hayes, J. P.**, and S. Loeb. The influences of forest management on bats in North America. Pages 207-235, in M. J. Lacki, J. P. Hayes, and A. Kurta (eds.). *Bats in Forests: Conservation and Management*, John Hopkins University Press. 329p.
2007. Lacki, M. J., **J. P. Hayes**, and A. Kurta (eds.). *Bats in Forests: Conservation and Management*, John Hopkins University Press. 329p.
2007. Slauson, K. M., W. J. Zielinski, and **J. P. Hayes**. Habitat selection by American martens in coastal California. *Journal of Wildlife Management* 71:458-468.
2006. Stuart-Smith, A. K., **J. P. Hayes**, and J. Schiek. The influence of wildfire, logging, and residual tree density on bird communities in the northern Rocky Mountains. *Forest Ecology and Management* 231:1-17.
2006. Waldien, D.L., **J.P. Hayes**, and M.M.P. Huso. Use of downed wood for movement by Townsend's chipmunks (*Tamias townsendii*) in western Oregon. *Journal of Mammalogy* 87:454-460.
2005. Gomez, D. M., R. G. Anthony, and **J. P. Hayes**. Influence of thinning of Douglas-fir forests on population parameters and diet of northern flying squirrels. *Journal of Wildlife Management* 69:1670-1682.
2005. **Hayes, J. P.**, S. H. Schoenholtz, M. J. Hartley, G. Murphy, R. F. Powers, D. Berg, and S. R. Radosevich. Environmental consequences of intensively management forest plantations in the Pacific Northwest. *Journal of Forestry* 103:83-87.



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2005. Stoddard, M. A., and **J. P. Hayes**. Influence of forest management on headwater stream amphibians at multiple spatial scales. *Ecological Applications* 15:811-823.
2004. Finegan, B., D. Delgado, **J. P. Hayes**, and S. Gretzinger. El monitoreo ecológico como herramienta de manejo forestal sostenible: consideraciones básicas y una propuesta metodológica, con énfasis en Bosques de Alto Valor para la Conservación certificados dentro del marco del FSC (Ecological monitoring as a tool in sustainable forest management: general considerations and a proposed methodology emphasizing high conservation value forests and FSC certification; in Spanish). *Recursos Naturales y Ambiente* 42:29-42.
2004. Finegan, B., **J. P. Hayes**, D. Delgado, and S. Gretzinger. El monitoreo ecológico del manejo forestal en el trópico húmedo: Una guía para operadores forestales y certificadores con énfasis en Bosques de Alto Valor para la Conservación. (Ecological monitoring for forest management in tropical rainforests: A guide for forest managers and certifiers with emphasis on high conservation value forests; in Spanish). WWF Centroamérica, Costa Rica. 116 p.
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2004. Waldien, D. L., M. M. Cooley, J. Weikel, **J. P. Hayes**, C. C. Maguire, T. Manning, and T. J. Maier. Incidental captures of birds in small mammal traps: a cautionary note for interdisciplinary studies. *Wildlife Society Bulletin* 32:1260-1268.
2003. Aubrey, K. B., **J. P. Hayes**, B. L. Biswell, and B. G. Marcot. Ecological role of arboreal mammals in western coniferous forests. Pages 405-443. In Zabel, C. J., and R. G. Anthony (eds.). *Mammal community dynamics in coniferous forests of western North America: management and conservation*. Cambridge University Press.
2003. **Hayes, J. P.**, J. M. Weikel, and M. M. P. Huso. Response of birds to thinning young Douglas-fir forests. *Ecological Applications* 13:1222-1232.
2003. **Hayes, J. P.** Habitat ecology and conservation of bats in western coniferous forests. Pages 81-119. In Zabel, C. J., and R. G. Anthony (eds.). *Mammal community dynamics in coniferous forests of western North America: management and conservation*. Cambridge University Press.
2003. Stuart-Smith, A. K., and **J. P. Hayes**. Influence of residual tree density on nest predation of artificial and natural songbird nests. *Forest Ecology and Management* 183:159-176.
2003. Suzuki, N., and **J. P. Hayes**. Effects of thinning on small mammals in Oregon coastal forests. *The Journal of Wildlife Management* 67:352-371.
2003. Waldien, D. L., **J. P. Hayes**, and B. E. Wright. Use of conifer stumps in clearcuts by bats and other vertebrates. *Northwest Science* 77:64-71.
2002. **Hayes, J. P.**, and J. Hagar. Ecology and management of wildlife and their habitats in the Oregon Coast Range. Pages 99-134 in Hobbs, S. D., J. P. Hayes, R. L. Johnson, G. H. Reeves, T. A. Spies, and J. C. Tappeiner (eds.). *Forest and stream management in the Oregon Coast Range*. Oregon State University Press. 276 pp.
2002. Hobbs, S. D., **J. P. Hayes**, R. L. Johnson, G. H. Reeves, T. A. Spies, and J. C. Tappeiner, II. Moving toward sustainability. Pages 242-259 in Hobbs, S. D., J. P. Hayes, R. L. Johnson, G. H. Reeves, T. A. Spies, and J. C. Tappeiner (eds.). *Forest and stream management in the Oregon Coast Range*. Oregon State University Press. 276 pp.
2002. Hobbs, S. D., **J. P. Hayes**, R. L. Johnson, G. H. Reeves, T. A. Spies, and J. C. Tappeiner (eds.). *Forest and stream management in the Oregon Coast Range*. Oregon State University Press. 276 pp.

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2001. **Hayes, J. P.** Biodiversity implications of transgenic plantations. Pages 168-175 in Strauss, S. H., and H. D. Bradshaw, eds. Proceedings of the first international symposium on ecological and social aspects of transgenic plantations. [www.fsl.orst.edu/tgerc/iufro2001/eprocd.pdf](http://www.fsl.orst.edu/tgerc/iufro2001/eprocd.pdf).
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2001. Tuskan, G., and **J. P. Hayes**. Summary of breakout session 2B - biological context/biodiversity. Pages 203-204 in Strauss, S. H., and H. D. Bradshaw, eds. Proceedings of the first international symposium on ecological and social aspects of transgenic plantations. [www.fsl.orst.edu/tgerc/iufro2001/eprocd.pdf](http://www.fsl.orst.edu/tgerc/iufro2001/eprocd.pdf).
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2001. Weikel, J. M., and **J. P. Hayes**. Habitat use by snag-associated species: a bibliography for species occurring in Oregon and Washington. Oregon State University Forest Research Lab Research Contribution #33. <http://www.fsl.orst.edu/cfer/snags/bibliography.html>.
2000. Adam, M. D., and **J. P. Hayes**. Use of bridges as night roosts by bats in the Oregon Coast Range. *Journal of Mammalogy* 81:402-407.
2000. Arnett, E. B., and **J. P. Hayes**. Bat use of roosting boxes installed under flat-bottom bridges in western Oregon. *Wildlife Society Bulletin* 28:890-894.
2000. **Hayes, J. P.** Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. *Acta Chiropterologica* 2:225-236.
2000. **Hayes, J. P.**, and J. Gruver. Vertical stratification in bat activity in an old-growth forest in western Washington. *Northwest Science* 74:102-108.
2000. Larson, D. J., and **J. P. Hayes**. Variability in sensitivity of Anabat II bat detectors and a method of calibration. *Acta Chiropterologica* 2:209-214.
2000. Waldien, D. L., **J. P. Hayes**, and E. B. Arnett. Day-roosts of female long-eared myotis in western Oregon. *Journal of Wildlife Management* 64:785-796.
1999. **Hayes, J. P.** Allegheny woodrat / *Neotoma magister*. Pages 607-608, in Wilson, D. E., and S. Ruff, eds. *The Smithsonian Book of North American Mammals*, Smithsonian Institution Press, Washington, D. C. 750 pp.
1999. Carey, A. B., J. M. Calhoun, B. Dick, D. Jennings, K. O'Halloran, L. S. Young, R. E. Bigley, S. Chan, C. A. Harrington, **J. P. Hayes**, and J. Marzluff. Reverse technology transfer: obtaining feedback from managers. *Western Journal of Applied Forestry* 14:153-163.
1999. Humes, M. L., **J. P. Hayes**, and M. Collopy. Activity of bats in thinned, unthinned, and old-growth forests in the western Oregon. *Journal of Wildlife Management* 63:553-561.
1999. Waldien, D. L., and **J. P. Hayes**. A technique for capturing bats using hand-held mist nets. *Wildlife Society Bulletin* 27:197-200.
1999. Weikel, J. M., and **J. P. Hayes**. The foraging ecology of cavity-nesting birds in young forests of the northern Coast Range of Oregon. *The Condor* 101:58-66.
1998. Adam, M. D., and **J. P. Hayes**. *Arborimus pomo*. *Mammalian Species* 593:1-5.
1998. **Hayes, J. P.** Atlas of Oregon wildlife - Distribution, habitat, and natural history (book review). *Northwest Science* 72:150-151.
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1998. **Hayes, J. P.** An independent scientific review of Oregon Department of Forestry's proposed western Oregon state forests habitat conservation plan. Oregon Department of Forestry, Salem, Oregon. 323pp.

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1997. Barbour, R. J., S. Johnston, **J. P. Hayes**, and G. F. Tucker. Simulated stand characteristics and wood product yields of Douglas-fir forests managed for ecosystem objectives. *Forest Ecology and Management* 91:205-219.
1997. **Hayes, J. P.** Temporal variation in activity of bats and the design of echolocation-monitoring studies. *Journal of Mammalogy* 78:514-524.
1997. **Hayes, J. P.**, S. Chan, W. H. Emmingham, J. C. Tappeiner, L. Kellogg, and J. D. Bailey. Wildlife response to thinning young forests in the Pacific Northwest. *Journal of Forestry* 95(8):28-33.
1997. **Hayes, J. P.**, and R. J. Steidl. Statistical power analysis and amphibian population trends. *Conservation Biology* 11:273-275.
1997. McCracken, G. F., **J. P. Hayes**, J. Cevallos, S. Z. Guffey, and C. Romero. Observations on the distribution, ecology, and behaviour of bats on the Galapagos Islands. *The Journal of Zoology (London)* 243:757-770.
1997. Smith, J. P., R. E. Gresswell, and **J. P. Hayes**. A research problem analysis in support of the Cooperative Forest Ecosystem Research (CFER) Program. Forest and Rangeland Ecosystem Science Center Paper, Corvallis, Oregon. 92pp.
1997. Steidl, R. J., **J. P. Hayes**, and E. Schaubert. Statistical power analysis in wildlife research. *Journal of Wildlife Management* 61:270-279.
1996. **Hayes, J. P.** *Arborimus longicaudus*. *Mammalian Species* 532:1-5.
1996. **Hayes, J. P.**, and M. D. Adam. The influence of logging riparian areas on habitat use by bats in western Oregon. Pp. 228-237, in *Bats and forests symposium*, October 19-21, 1995, Victoria, British Columbia (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests Research Branch, Victoria, Canada. Working Paper 23. 292 pp.
1996. **Hayes, J. P.**, M. D. Adam, R. G. Anthony, and J. W. Witt. A comparison of the effectiveness of Sherman and modified Fitch live-traps for capture of small mammals. *Northwestern Naturalist* 77:40-43.
1996. **Hayes, J. P.**, M. D. Adam, D. Bateman, E. Dent, W. H. Emmingham, K. G. Maas, and A. E. Skaugset. Integrating research and forest management in riparian areas of the Oregon Coast Range. *Western Journal of Applied Forestry* 11(3):1-5.
1996. **Hayes, J. P.**, S. Z. Guffey, F. J. Kriegler, G. F. McCracken, and C. R. Parker. The genetic diversity of native, stocked, and hybrid populations of brook trout (*Salvelinus fontinalis*) in the Southern Appalachians. *Conservation Biology* 10:1403-1412.
1995. **Hayes, J. P.**, and M. D. Adam. The influence of logging riparian areas on habitat utilization by bats in western Oregon (abstract only). *Bat Research News* 36:26.
1995. **Hayes, J. P.**, E. G. Horvath, and P. Hounihan. Townsend's chipmunk populations in Douglas-fir plantations and mature forests in the Oregon Coast Range. *Canadian Journal of Zoology* 73: 67-73.
1994. **Hayes, J. P.**, and P. Hounihan. Field use of the Anabat II bat detector system to monitor bat activity. *Bat Research News* 35:1-3.
1994. **Hayes, J. P.**, E. G. Horvath, and P. Hounihan. Securing live traps to small diameter trees for studies of arboreal mammals. *Northwestern Naturalist* 75:31-33.
1993. **Hayes, J. P.**, and P. Hounihan. Spatial and temporal variation in bat activity in echolocation monitoring studies (abstract only). *Bat Research News* 34:111.
1993. **Hayes, J. P.** and M. E. Richmond. Clinal variation and morphology of woodrats of the eastern United States. *Journal of Mammalogy* 74:204-216.
1992. **Hayes, J. P.** and R. G. Harrison. Variation in mitochondrial DNA and the biogeographic history of woodrats (*Neotoma*) of the eastern United States. *Systematic Biology* 41:331-344.

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1992. McCracken, G. P., **J. P. Hayes**, S. Z Guffey, C. Romero, and J. Cevallos. Variation in the echolocation calls of *Lasiurus cinereus* and *L. brachyotis* on the Galapagos Islands (abstract only). *Bat Research News* 33:66.
1991. **Hayes, J. P.** How mammals become endangered. *Wildlife Society Bulletin* 19:210-215.
1987. **Hayes, J. P.** The positive approach to negative results in toxicology studies. *Ecotoxicology and Environmental Safety* 14:73-77.
1987. **Hayes, J. P.**, and S. P. Cross. Characteristics of logs used by western red-backed voles (*Clethrionomys californicus*) and deer mice (*Peromyscus maniculatus*). *Canadian Field-Naturalist* 101:543-546.
1986. **Hayes, J. P.**, S. P. Cross, and P. W. McIntire. Seasonal variation in mycophagy by the western red-backed vole, *Clethrionomys californicus*, in southwestern Oregon. *Northwest Science* 60:250-257.
1979. deCalesta, D. S., and **J. P. Hayes**. "Frightening devices" prevent bird damage. *Pest Control* 47:18-20.

### **Manuscripts Submitted**

In review. Leuthold, N., **J. P. Hayes**, and M. Adams. Response of Pacific giant salamanders and tailed frogs to threat of predation under differing sediment levels. Submitted to *Freshwater Biology*.

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## ALAN T. HERLIHY

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Department of Fisheries & Wildlife  
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### EMPLOYMENT AND EDUCATION

Senior Research Professor, Oregon State University, 2007-  
Senior Research Associate Professor, Oregon State University, 2000-2007  
Senior Research Assistant Professor, Oregon State University, 1991-2000  
Research Assistant Professor, Utah State University, 1987-1991

Ph.D., Environmental Sciences, University of Virginia, 1987  
M.S., Environmental Sciences, University of Virginia, 1984  
B.A., Chemistry, Northwestern University, 1981

### PROFESSIONAL ACTIVITIES AND HONORS

Primary technical contributor to the aquatic effects section of the National Acid Precitation Assessment Program's final report (Integrated Assessment) and State of Science/Technology Report 9 (Current Status of Surface Water Acid-Base Chemistry).

Had the technical lead for developing indicators of chemical condition, and coordinating the stream pilot surveys for EPA's Environmental Monitoring and Assessment Program.

Analysis team/co-author for EPA's EMAP Western Stream Pilot and Office of Water's National Wadeable Streams Assessment and National Lakes Assessment.

Principal Investigator on over \$4,000,000 of sponsored research

EPA STAA awards for journal articles, 2007, 2008, 2009; Letter of Commendation from EPA Administrator Lee Thomas for contribution to National Surface Water Survey, 1989; Oregon State University's Oldfield/Jackman Team Award, 2001

### SELECTED PUBLICATIONS (from 87 peer-reviewed journal articles and 6 book chapters):

Herlihy, A.T., and J.C. Sifneos. 2008. Developing nutrient criteria and classification schemes for wadeable streams in the conterminous USA. Journal of the North American Benthological Society 27:932-948.

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- Herlihy, A.T., S.G. Paulsen, J. Van Sickle, J.L. Stoddard, C.P. Hawkins, and L.L. Yuan. 2008. Striving for consistency in a national assessment: the challenges of applying a reference condition approach at a continental scale. Journal of the North American Benthological Society 27:860-877.
- Gitelman, A., and A.T. Herlihy. 2007. Isomorphic chain graphs for modeling spatial dependence in ecological data. Environmental and Ecological Statistics 14:27-40.
- Peterson, S.A., J. Van Sickle, A.T. Herlihy, and R.M. Hughes. 2007. Mercury concentration in fish from streams and rivers throughout the Western United States. Environmental Science and Technology 41:58-65.
- Rosfjord, C.H., K.E. Webster, J.S. Kahl, S.A. Norton, I.J. Fernandez, and A.T. Herlihy. 2007. Anthropogenically driven changes in chloride complicate interpretation of base cation trends in lakes recovering from acidic deposition. Environmental Science and Technology 41:7688-7693.
- Van Sickle, J., J. Baker, A. Herlihy, P. Bayley, S. Gregory, P. Haggerty, L. Ashkenas, and J. Li. 2004. Projecting the biological condition of streams, under alternative conditions of human land use. Ecological Applications 14:368-380.
- Eshleman, K.N., D.A. Fiscus, N.M. Castro, J.R. Webb, and A.T. Herlihy. 2004. Regionalization of disturbance-induced nitrogen leakage from mid-Appalachian forests using a linear systems model. Hydrological Processes 18:2713-2725.
- Waite, I.R., A.T. Herlihy, D.P. Larsen, N.S. Urquhart, and D.J. Klemm. 2004. The effects of macroinvertebrate taxonomic resolution in large landscape bioassessments: example from the Mid-Atlantic Highlands, USA. Freshwater Biology 49:474-489.
- Sullivan, T.J., J.R. Webb, K.U. Snyder, A.T. Herlihy, and B.J. Cosby. 2007. Spatial distribution of acid-sensitive and acid-impacted streams in relation to watershed features in the Southern Appalachian Mountains. Water Air Soil Pollution 182:57-71. doi: 10.1007/s11270-006-9320-x.
- Whittier, T.R., S.G. Paulsen, D.P. Larsen, S.A. Peterson, A.T. Herlihy, and P.R. Kaufmann. 2002. Indicators of ecological stress and their extent in the population of Northeastern Lakes: a regional-scale assessment. Bioscience 52:235-247.
- Herlihy, A.T., D.P. Larsen, S.G. Paulsen, N.S. Urquhart, B.J. Rosenbaum. 2000. Designing a spatially balanced, randomized site selection process for regional stream surveys: the EMAP mid-Atlantic pilot study. Environmental Monitoring and Assessment 63:95-113
- Herlihy, A.T., J.L. Stoddard, and C.B. Johnson. 1998. The relationship between stream chemistry and watershed land-cover data in the mid-Atlantic region, U.S. Water Air and Soil Pollution 105:377-386.
- Herlihy, A.T., P.R. Kaufmann, M.R. Church, P.J. Wigington, Jr., J.R. Webb, and M.J. Sale. 1993. The effects of acidic deposition on streams in the Appalachian Mountain and Piedmont region of the mid-Atlantic United States. Water Resources Research 29:2687-2703.
- Baker, L.A., A.T. Herlihy, P.R. Kaufmann, and J.M. Eilers. 1991. Acidic lakes and streams in the United States: the role of acidic deposition. Science 252:1151-1154.
- Herlihy, A.T., P.R. Kaufmann, and M.E. Mitch. 1991. Chemical characteristics of streams in the Eastern United States: II. Sources of acidity in acidic and low ANC streams. Water Resources Research 27:629-642.

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## ROBERT B. JACKSON

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<http://www.biology.duke.edu/jackson>

### EDUCATION

B.S. Chemical Engineering Rice University, 1983  
M.S. Plant Ecology Utah State University, 1990  
M.S. Statistics Utah State University, 1992  
Ph.D. Plant Ecology Utah State University, 1992

### SELECTED PROFESSIONAL & TEACHING EXPERIENCE

Nicholas Chair of Global Environmental Change, Duke University (2007-present)  
Director, National Institute for Climate Change Research, DOE, southeast region (2005-present)  
Director, Duke University Global Change Center (2004-present)  
Professor, Department of Biology, Duke University (2003-2007)  
Associate Professor, Department of Biology, Duke University (2001-2002)  
Director, Duke University Program in Ecology (2002-2006)  
Assistant Professor, Department of Biology, Duke University (1999-2000)  
Assistant Professor, Department of Botany, UT Austin (1995-1998)  
DOE Distinguished Postdoctoral Fellow for Global Change, Stanford Univ. (1993-1994)

### SERVICE & AWARDS

#### **Awards and Offices Held (Recent)**

Fellow, American Geophysical Union (2008)  
Vice President for Science, Ecological Society of America (2007-2010)  
President, Biogeosciences Section, American Geophysical Union (2004-2006)  
ISI Highly Cited (ISIHighlyCited.com, 2004-present)  
President, Physiological Ecology Section, Ecological Society of America (2000-2002)  
Presidential Early Career Award in Science and Engineering, NSF (1999)  
Ecology and Ecological Monographs, Special Features Editor (2001-2006)

### ***REFERRED PUBLICATIONS: Total = >150***

#### **Publications related to this project (limit 5)**

DC McKinley, M Ryan, R Birdsey, C Giardina, M Harmon, L Heath, R Houghton, RB Jackson, JF Morrison, BC Murray, DE Pataki, KE Skog 2011 A synthesis of current knowledge on forests and carbon storage in the United States. ***Ecological Applications***, in press.  
Shao, G, L Dai, JS Dukes, RB Jackson, L Tang, J Zhao 2011 Increasing forest carbon sequestration through cooperation and shared strategies between China and the United States.

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*Environmental Science and Technology* 45:2033–2034.

Galik, CS, RB Jackson 2009 Risks to forest carbon offset projects in a changing climate. *Forest Ecology and Management* 257:2209-2216.

Jackson, RB *et al.* 2008. Protecting climate with forests. *Environmental Research Letters* 3: 044006, doi:10.1088/1748-9326/3/4/044006.

Finzi, AC *et al.* 2007 Increases in nitrogen uptake rather than nitrogen-use efficiency support higher rates of temperate forest productivity under elevated CO<sub>2</sub>. *Proceedings of the National Academy of Sciences USA* 104:14014-14019.

#### **Other Significant Publications (limit 5)**

Manzoni, S, RB Jackson, JA Trofymow, A Porporato 2008 The global stoichiometry of litter nitrogen mineralization. *Science* 321:684-686; DOI: 10.1126/science.1159792.

Jackson RB, EG Jobbágy, R Avissar, S Baidya Roy, D Barrett, CW Cook, KA Farley, DC le Maitre, BA McCarl, B Murray 2005 Trading water for carbon with biological carbon sequestration. *Science* 310:1944-1947.

Jackson RB, WH Schlesinger 2004 Curbing the U.S. carbon deficit. *Proceedings of the National Academy of Sciences, U.S.A.* 101:15827-15829; doi:10.1073/pnas.0403631101.

Gill, RA, HW Polley, HB Johnson, LJ Anderson, H Maherali, RB Jackson 2002 Nonlinear grassland responses to past and future atmospheric CO<sub>2</sub>. *Nature* 417:279-282.

Sala, OE *et al.* 2000 Global biodiversity scenarios for the year 2100. *Science* 287:1770-1774.

#### **Additional Collaborators (previous 48 months)**

Albertson J Duke University, Barros A Duke University, Canadell, J CSIRO, Australia, Currie, W University of Michigan, DeLucia, EH University of Illinois, Dickinson, RE University of Arizona, Finzi, A Boston University, Harley, P NCAR, Boulder, Lichter, J Bowdoin College  
Monson, RK University of Colorado at Boulder, Parton, W Colorado State University, Paruelo, J University of Buenos Aires, Pritchard, S College of Charleston, Randerson, J UC Irvine, Sala, O Brown University, Schimel, J University of California at Santa Barbara, Torn, M University of California at Berkeley, Wilkinson, MK UC Boulder, Zak, D, U Michigan

#### **Synergistic Activities**

Science Advisor, National Public Radio Program "Earth and Sky"

Created and maintain the homepage for the Physiological Ecology Section of the Ecological Society of America (<http://www.biology.duke.edu/jackson/ecophys>).

Initiated and raised all funds for the "Janus Award", an annual undergraduate fellowship to encourage the study of an environmental problem from diverse perspectives; 1999's first recipient traveled down the Nile River to examine water use and water policy in Egypt.

Authored book: Jackson, RB 2002 *The Earth Remains Forever*, University of Texas Press.

Authored children's books: Jackson, RB 2006 *Animal Mischief*, Boyds Mills Press; *Weekend Mischief*, 2009, Boyds Mills Press, in press.



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## GLENN P. JUDAY

Professor of Forest Ecology  
University of Alaska Fairbanks  
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### Education:

B. S., 1972, Purdue University  
Ph.D., 1976, Oregon State University

### Courses:

NRM/GEOG 464 - Wilderness Management  
NRM/BIO 277 - Introduction to Conservation Biology  
NRM 697 - Ecology for Regional Resilience and Adaptation Program  
NRM 397/697 - Tree-ring Analysis

**Research Interests:** Tree-ring studies, Biodiversity under forest management systems, Climate change assessment, Climate change and forest growth, Structure of old-growth forest ecosystems, Old-growth forest ecology, Natural controls of biodiversity, identification of elements of natural diversity, Wilderness and natural area management, Forest development and ecosystem life history, Fire and climate change, Long-term environmental monitoring

### Examples of Research Support:

“The Potential of Lodepolge Pine as a New Crop Tree in Alaska.” USDA. \$53,672. 2001-2003  
Co-Principal Investigator (one of 4; Dr. Roseann D-Arrigo, Principal Investigator) “Response of Pacific Northwest and Alaskan Forests to Recent Multiple Environmental Changes” (3-year term, 06/2002 to 06/2005; totaling \$ 142,897. Source: U.S. Department of Energy, subcontract through Columbia University)

Co-Principal Investigator (one of 6; Dr. Terry Chapin, Principal Investigator) in project “Regional resilience and adaptation: Planning for change. Integrative Graduate Research, Education, and Training (IGERT) Program National Science Foundation.” (4-year term, 09/2001 to 09/2005; totaling \$ \$2,620,100. Source: National Science Foundation)

Co-Principal Investigator 06/2000 to 10/2004; F.S. Chapin & 23 others; “Interaction of multiple disturbances with climate in the boreal forest: Bonanza Creek LTER.” National Science Foundation. \$2,800,000

Co-Principal Investigator 10/01/2002 to 9/30/2003; G. Weller; “ACIA – Arctic Climatic Impact Assessment.” National Science Foundation and International Arctic Research Center. \$19,500.

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Co-Principal Investigator. 10/01/2001 to 9/30/2004; C.E. Lewis; "Birch sap – more than a tonic." USDA Special Grants. \$49,538.

Principal Investigator. 06/2002 to present. "Relationship of Tree Growth and Climate Variability in Alaska: Patterns, Controls, and Strategies for Management." USDA McIntire-Stennis Program. Funding varies annually.

10/2000 to 10/2003. Head of Graduate Advisory Committee for Martin Wilmking. "Ecosystem Integrity in Interior Alaska's National Parks." Canon Corporation & National Parks Foundation (Science Scholars Program). \$75,000

09/1999 to 09/2000. Supervisory Co-PI "To identify, prepare, catalog, and store mammal, bird, plant, and archeological specimens from NPS areas in Alaska: Dendrochronology of Wrangell – St. Elias National Park SBB samples. National Park Service (through UA Museum) CA 9910-6-9034 Amendment #5. \$12,500

02/1999 to 08/2000. Principal Investigator. "AFES 99-20. Calibration of SKOG (Spruce Killed Or Growing) -a forest disturbance and regrowth model for land management." UA Natural Resources Fund (Competitive). \$20,780

10/1998 to 10/1999. "AFES 98-24. Dendrochronological studies of National parks in Alaska." U.S. Geological Survey, Biological Research Division. \$33,719.

Supervisor. "AFES 98-10. Chena River Lakes Resource Information Projects FY98." U.S. Department of the Army, Corps of Engineers. \$25,000.

07/1998 to 02/2000. Co-Principal Investigator (with F.S. Chapin III PI and others). "AFES 92-28R10. Schoolyard LTER, Bonanza Creek LTER." National Science Foundation. \$12,616.

07/1998 to 02/2000. Co-Principal Investigator (with F.S. Chapin III PI, R. Boone, and others). "AFES 92-28R8. Creation and upgrade of voucher specimen collections for the Bonanza Creek LTER." National Science Foundation. \$50,000 (total project ); \$15,000 (my portion)

06/1998 to 06/1999. Faculty mentor for V. Barber. "AFES 98-52. Confirming recent climatic stress on white spruce through stable isotope analysis of tree-rings." International Arctic Research Center (Government of Japan). \$4,995.

05/1998 to 05/2000. Principal Investigator (with F.S. Chapin III PI, and 28 others). "AFES 98-36. Interaction of multiple disturbances with climate in Alaskan boreal forests." National Science Foundation. \$1,400,000.

04/1998 to 05/ 2001. Participating Scientist (R. Motyka, J. Freymueller PI). "GI 98-45. Uplift and Seismicity in Northern Southeast Alaska: Tectonic Stress or Glacial Unloading?" National Science Foundation. \$368,887.

11/1997. Principal Investigator. "AFES 97-29. Study of recent climatic stress in white spruce caused by global warming through stable isotope analysis: confirming and clarifying effects for forest policy." University of Alaska Natural Resources Fund competitive). \$26,205.

### **Examples of Publications:**

Wilmking, M., Juday, G.P., Ibendorf, J, and Terwilliger, M. (in review). Modeling spatial variability of treeline white spruce growth responses to climate change – outlook for two national parks in Alaska. [Global and Planetary Change].

Chapin, F. S., III, T. V. Callaghan, Y. Bergeron, M. Fukuda, J. F., Johnstone, G. Juday, and S. A. Zimov. (in review) Global change and the boreal forest: Thresholds, shifting states or gradual change? [Ambio].

Wilmking, M., Juday, G.P., Barber, V., and Zald, H. (conditionally accepted). Recent climate warming forces contrasting growth responses of white spruce at treeline in Alaska through temperature thresholds. [Global Change Biology].

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- Juday, G.P. (Lead Author), Barber, V.; Vaganov, E.; Rupp, S.; Sparrow, S.; Yarie, J.; Linderholm, H. (Contributing Authors), Berg, E.; D'Arrigo, R.; Duffy, P.; Eggertsson, O.; Furyaev V.V.; Hogg, E.H.; Huttunen, S.; Jacoby, G.; Kaplunov, V.Ya. ; Kellomaki, S.; Kirilyanov, A.V.; Lewis, C.E.; Linder, S.; Naurzbaev, M.M.; Pleshikov, F.I.; Savva, Yu.V.; Sidorova, O.V.; Stakanov, V.D.; Tchebakova N.M.; Valendik E.N.; Vedrova, E.F., Wilmking, M. (Consulting Authors). (accepted). Forests, Land Management, Agriculture, Chapter 14 In: Arctic Climate Impact Assessment. Arctic Council. Cambridge University Press.
- Barber, V.A., G.P. Juday and B.P. Finney. 2004. Reconstruction of Summer Temperatures in Interior Alaska: Evidence for Changing Synoptic Climate Regimes. *Climatic Change* 63 (1-2).
- Juday, G.P., Barber, V., Rupp S., Zasada, J., Wilmking M.W. 2003. A 200-year perspective of climate variability and the response of white spruce in Interior Alaska. Chapter 12 Pp. 226-250. In: Greenland, D., Goodin, D., and Smith, R. (editors). *Climate Variability and Ecosystem Response at Long-Term Ecological Research (LTER) Sites*. Oxford University Press.
- Ott, R.A., and G.P. Juday. 2002. Canopy gap characteristics and their implications for management in the temperate rainforests of southeast Alaska. *Forest Ecology and Management*. 159(3): 271-291.
- Rees, Daniel C., Juday, G.P. 2002. Plant species diversity and forest structure on logged and burned sites in central Alaska. *Forest Ecology & Management* 155 (1-3): 291-302.
- Barber, V.A., G.P. Juday, B.P. Finney. 2000. Reduced growth of Alaska white spruce in the twentieth century from temperature-induced drought stress. *Nature* 405: 668-673.
- Waide R.B.; Willig, M.R. ; Mittelbach, G.; Steiner, C.; Gough, L.; Dodson, S.I.; Juday, G.P.; Parmenter. R. 1999. The relationship between productivity and species richness. *Annual Review of Ecology and Systematics*. 30:257-300.
- Densmore, R.V.; Juday, G.P.; Zasada, J.C. 1999. Regeneration alternatives for upland white spruce after burning and logging in interior Alaska. *Canadian Journal of Forest Research* 29(4): 413-423.
- Jacoby, G.C., D'Arrigo, R.D., and G. Juday. 1999. Tree-ring indicators of climatic change at northern latitudes. *World Resources Review* 11(1):21-29.
- Ott, R.A., Juday, G.P., and T.E. Garvey. 1999. Conducting a landscape-level wind risk assessment on northeast Chichagof Island, southeast Alaska, and its potential use for forest management. Pages 202-210 In: *Proceedings of the Annual Meeting of the Society of American Foresters, 20 - 24 September, 1998*. Traverse City, Michigan.
- Juday, Glenn Patrick. 1998. Alaska Research Natural Areas: 4. Big Windy Hot Springs. Agricultural and Forestry Experiment Station Miscellaneous Publication 98-1. University of Alaska Fairbanks, Fairbanks, Alaska. 47 p.
- Malmstrom, Carolyn M.; Thompson, Matthew V.; Juday Glenn P.; Los, Sietse O.; Randerson, James T; Field, Christopher B. 1997. Interannual Variation in Global-Scale Net Primary Production: Testing Model Estimates. *Global Biogeochemical Cycles* 11(3):367-392.
- Jacoby, G. C., D'Arrigo, R. D. and Juday, G. P. 1997. Climate change and effects on tree growth as evidenced by tree-ring data from Alaska, Pages 199-206 IN *Sustainable Development of Boreal Forests*, Proceedings of 7th Conference of the International Boreal Forest Research Association, August 19-23, 1996 St. Petersburg, Russia, Federal Forest Service of Russia, Moscow (ISBN 5-7564-0151-2).
- Juday, Glenn Patrick. 1996 (on-line version issued Jan. 1996). Boreal Forests (Taiga) In: *The Biosphere and Concepts of Ecology*. Volume 14 *Encyclopedia Britannica*, 15th edition. pp. 1210-1216. [hardcopy version in printed and bound volume 1997]

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## WILLIAM S. KEETON

**ADDRESS:** Rubenstein School of Environment and Natural Resources  
343 George D. Aiken Center for Natural Resources  
University of Vermont  
Burlington, VT 05405 USA  
Phone: 802-656-2515 Email: [william.keeton@uvm.edu](mailto:william.keeton@uvm.edu)  
Website: [www.uvm.edu/envnr/wkeeton](http://www.uvm.edu/envnr/wkeeton).

### EDUCATION

2000 Ph.D. Forest Ecology. University of Washington, College of Forest Resources, Seattle, WA  
1994 M.E.S. Conservation Biology. Yale University. School of Forestry and Env. Science, New Haven, CT  
1990 B.S. Natural Resources. Cornell University, College of Agriculture and Life Sciences, Ithaca, NY

### CURRENT APPOINTMENTS

2007-present Associate Professor of Forest Ecology and Forestry. Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, VT.

2010-present Chair, UVM Forestry Program

2007-present Co-Chair, UVM Graduate Program in Forest and Wildlife Science

2010-present Board of Directors, Science for the Carpathians

2010-present Board of Directors, UVM Institute for Environmental Diplomacy (<http://www.uvm.edu/ieds>)

2001-present Lead scientist, Vermont Forest Ecosystem Management Demonstration Project

2005-present Lead scientist, University of Vermont Carbon Dynamics Laboratory ([www.uvm.edu/cdl](http://www.uvm.edu/cdl))

2005-present Fulbright Senior Specialist, U.S. Fulbright Scholarship Program

2005-present The Nature Conservancy, Vermont Chapter, Science Advisory Board

2009-present Co-Chair, Vermont Climate Collaborative, Agriculture, Forestry, and Waste Working Group

2009-present Vermont State Legislature, Biomass Energy Working Group

2007-present Vermont Monitoring Cooperative, Science Advisory Committee

2009-present New England Society of American Foresters, Chair of Silviculture Group

2009-present Belgian Research Programme for Earth Observation (STEREO II), Remote sensing of ecosystem impacts in mountain environments, Science Advisory Committee

2007-present Deputy Chair, Intern. Union of Forest Res. Organizations, Old-growth Forest Working Group

2009-present IUCN (World Conservation Union), Commission on Ecosystem Management

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**SELECTED PUBLICATIONS** (for a full list, please see [www.uvrn.edu/irsenriwkeeton](http://www.uvrn.edu/irsenriwkeeton))

- Keeton, W.S., A. A. Whitman, G.G. McGee, and C.L. Goodale. 2011. Late-successional biomass development in northern hardwood-conifer forests of the northeastern United States. *Forest Science* (in press).
- Keeton, W.S., P. Ange1stam, M. Baumflek, Y. Bihun, M. Chernyavskyy, S. M. Crow, A. Deyneka, M. Elbakidze, J. Farley, V. Kova1yshyn, B. Mahura, S Myk1ush, J. R. Nunery, 1. Solovity, and L. Zahvoyska. 2011. Sustainable forest management alternatives for the Carpathian Mountain region, with a focus on Ukraine. *Forum Carpaticum: Integrating Nature and Society Toward Sustainability*. Springer-Verlag
- Kuemmerle, T., P. O1ofsson, O. Chaskovskyy, M. Baumann, K. Ostapowicz, C.E. Woodcok, R. Houghton, P. Hostert, W.S. Keeton, and V.c. Radeloff. 2011. Post-Soviet farmland abandonment, forest recovery, and carbon sequestration in western Ukraine. *Global Change Biology*.
- Keeton, W. S., M. Chernyavskyy, G. Gratzer, M. Main-Knorn, M. Shpylchak, and Y. Bihun. 2010. Structural characteristics and aboveground biomass of old-growth spruce-fir stands in the eastern Carpathian Mountains, Ukraine. *Plant Biosystems* 144: 1-12.
- Nunery, J.S. and W.S. Keeton. 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. *Forest Ecology and Management* 259: 1363-1375.
- Kuemmerle, T., O. Chaskovskyy, J. Knorn, V.C. Radeloff, I. Kruhlov, W.S. Keeton, and P. Hostert. 2009. Forest cover change and illegal logging in the Ukrainian Carpathians in the transition period from 1988 to 2007. *Remote Sensing of Environment* 113:1194-1207.
- Foster, B.C., D. Wang, W.S. Keeton, and M.S. Ashton. 2010. Implementing sustainable forest management using six concepts in an adaptive management framework. *Journal of Sustainable Forestry* 29:79-108.
- Curzon, M.T. and W.S. Keeton. 2010. Spatial characteristics of canopy disturbances in riparian old-growth hemlock-northern hardwood forests, Adirondack Mountains, New York, USA. *Canadian Journal of Forest Research* 40: 13-25.
- Stovall, J, W.S. Keeton, and C.E. Kraft. 2009. Forest-stream interactions: Fine-scale spatial variability in late-successional riparian forests structure, light, and periphyton abundance. *Canadian Journal of Forest Research* 29: 2343-2354.
- Soloviy, I. and W.S. Keeton (eds.). 2009. *Ecological Economics and Sustainable Forest Management Developing a Trans-disciplinary Approach for the Carpathian Mountains*. Ukrainian National Forestry Univ. Press, Lviv, Ukraine. 416 pp.
- Warren, D.R., C.E. Kraft, W.S. Keeton, 1.S. Nunery, and G.E. Likens. 2009. Dynamics of wood recruitment in streams of the northeastern U.S. *Forest Ecology and Management* 58:804-813.
- Kucmmerle, T., O. Chaskovskyy, J. Knorn, V.C. Radeloff, J. Kruhlov, W.S. Keeton, and P. Hostert. 2009. Forest cover change and illegal logging in the Ukrainian Carpathians in the transition period from 1988 to 2007. *Remote Sensing of Environment* 113:1194-1207.
- Ray, D.G., R.S. Seymour, N.S. Scott, and W.S. Keeton. 2009. Mitigating climate change with managed forests: balancing expectations, opportunity, and risk. *10urnal of Forestry* 107(1): 50-51.
- Smith, KJ, W.S. Keeton, M. Twery, and D. Tobi. 2008. Understory plant response to alternative forestry practices in northern hardwood-conifer forests. *Canadian 10urnal of Forest Research* 38: 1-17.

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- Manaras-Smith, K., W.S. Keeton, T.M. Donovan, and B. Mitchell. 2008. Stand-level forest structure and avian habitat Scale dependencies in predicting occurrence in a heterogeneous forest. *Forest Science* 54:36-46
- Foster, B.C., D. Wang, and W.S. Keeton. 2008. A post-harvest comparison of structure and economic value in FSC certified and uncertified northern hardwood stands. *Journal of Sustainable Forestry* 26(3):1-21.
- North, M.P. and W.S. Keeton. 2008. Emulating natural disturbance regimes: an emerging approach for sustainable forest management. Chapter 17 in: R. Laforzezza, I Chen, G. Sanesi, and T. R. Crow (eds.). *Patterns and Processes in Forest Landscapes*. Vienna, Austria.
- Keeton, W.S., C.E. Kraft, and D.R. Warren. 2007. Mature and old-growth riparian forests: structure, dynamics, and effects on Adirondack stream habitats. *Ecological Applications* 17: 852-868.
- Keeton, W.S. 2007. Role of managed forestlands and models for sustainable forest management: perspectives from North America. *George Wright Forum* 24(3):38-53.
- Keeton, W.S. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. *Forest Ecology and Management* 235: 129-142.
- McKenny, H.C., W.S. Keeton, and T.M. Donovan. 2006. Effects of structural complexity enhancement on eastern red-backed salamander (*Plethodon cinereus*) populations in northern hardwood forests. *Forest Ecology and Management* 230: 186-196.
- Keeton, W.S. and J.F. Franklin. 2005. Do remnant old-growth trees accelerate rates of succession in mature Douglas-fir forests? *Ecological Monographs* 75:103-118.
- Keeton, W.S. and J.F. Franklin. 2004. Fire-related landform associations of remnant old-growth trees in mature Douglas-fir forests. *Canadian Journal of Forest Research* 34: 2371-2381.
- Mote, P.W., E.A. Parson, A.F. Hamlet, K.G. Ideker, W.S. Keeton, D. Lettenmaier, N. Mantua, E.L. Miles, D.W. Peterson, D.L. Peterson, R. Slaughter, and A.K. Snover. 2003. Preparing for climate change: the water, salmon, and forests of the Pacific Northwest. *Climatic Change* 61:45-88.
- Franklin, J.F., T.A. Spies, R. Van Pelt, A. Carey, D. Thornburgh, D.R. Berg, D. Lindenmayer, M. Harmon, W.S. Keeton, D.C. Shaw, K. Bible, and J. Chen. 2002. Disturbances and the structural development of natural forest ecosystems with some implications for silviculture. *Forest Ecology and Mgt.* 155:399-423.

#### **SYNERGISTIC ACTIVITIES:**

- Fulbright Senior Specialist*, U.S. Fulbright Scholarship Program. Fulbright Scholar advising Ukrainian agencies on forest carbon quantification and management in the Carpathian Mountain region.
- P.I.*: Global meta-analysis of temperate old-growth forests, focusing on carbon storage dynamics, 2008-present.
- P.I.*: USDA McIntire-Stennis Forest Research Program. 2008-2011. Evaluation of options for forestland owner participation in carbon markets: alternatives and institutional and economic constraints. - \$111,850.
- P.I.*: Northeastern States Research Cooperative. 2007-2010. Quantification of long-term forest carbon dynamics and net carbon storage under alternate forest management scenarios in the northern forest region. - \$50,000.
- P.I.*: Trust for Mutual Understanding. 2009-2010. Promoting conservation of ecosystem services, carbon market participation, and biodiversity in the eastern Carpathians and the northeastern United States. - \$25,000.

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*Co-PI:* Northeastern States Research Cooperative. 2007- 2010. Soil carbon and other quality indicators in managed northern forests. -\$100,000

*Professional activities:* Science for the Carpathians; Forest Guild Working Group on Climate Change and Forest Carbon; Green Mountain National Forest Climate Change Advisory Comm; Vermont Governor's Advisory Panel on Carbon Markets; VT State Legislature, Biomass Energy Working Group

**LANGUAGES:** English (fluent), German (proficient), French (basic), Ukrainian (survival)

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## JESSICA E. LEAHY

Assistant Professor  
School of Forest Resources, University of Maine  
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Telephone: (207) 581-2834, Fax: (207) 581-2875  
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### **EDUCATION:**

- Ph.D. Natural Resources Science & Management, Department of Forest Resources, University of Minnesota, St. Paul, Minnesota, 2005. Track: Economics, Policy, Management, & Society. Dissertation: "Community Benefits and Values Associated with U.S. Army Corps of Engineers Projects."
- M.S. Forest Resources, Department of Forest Resources, Oregon State University, Corvallis, Oregon, 2001.  
Minor: Environmental and Resource Economics. Thesis: "Effects of the Recreational Fee Demonstration Program on Backcountry Users in Grand Canyon and Everglades National Parks."
- B.S. Forest Recreation Resources, Department of Forest Resources, Oregon State University, Corvallis, Oregon, 1999. Option: Environmental Interpretation. Honors Senior Thesis: "Making Disturbance Ecology Research Relevant to Citizens."

### **SELECTED ACTIVE RESEARCH GRANTS (PI and Co-PI):**

- Stakeholder Research: Social Assessment of Biomass Harvests and Forest Bioproducts Industry in Maine
- The Forestry Community, Belief Systems and Consensus: Implications for Public Communication and Outreach
- Conflict Resolution through Trust and Relationship Building: Natural Resource Managers' Perceptions Sustainable Lake Management in Maine's Changing Landscape
- Building Demand for Maine's Certified Wood and Paper Products: Public Opinion and Market Research
- Forest Certification Knowledge and Attitudes Among Family Forest Landowners in Northern Minnesota

### **SELECTED RESEARCH PUBLICATIONS:**

- Leahy, J., Kilgore, M., Hibbard, C., and Donnay, J. "Family Forest Land Owners' Interest in and Perceptions of Forest Certification: Focus Group Findings from Northern Minnesota." Forthcoming in Northern Journal of Applied Forestry.
- Anderson, D., Wilhelm, S., Schneider, I, and Leahy, J.. "Proximate and Distant Visitors: Differences in Importance Ratings of Beneficial Experiences." Forthcoming in Journal of Park and Recreation Administration.
- Kilgore, M., Leahy, J., Hibbard, C., and Donnay, J. 2007. "Assessing Family Forest Land Certification Opportunities: A Minnesota Case Study." Journal of Forestry, 105(1): 27-33.



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- Kilgore, M., Leahy, J., Donnay, J., Hibbard, C., and C. Blinn. 2007. "Evaluating Logger Certification Attitudes and Preferences: A Minnesota Case Study." *Forest Products Journal*. 57(1/2): 84-90.
- Davenport, M., Leahy, J., Anderson, D., and Jakes, P. 2007. "Building trust in natural resource management within local communities: A case study of the Midewin National Tallgrass Prairie" *Environmental Management*, 39(3): 353-368.
- Davenport, M., Anderson, D., Leahy, J., and Jakes, P. 2007. "Reflections from USDA Forest Service Employees on Institutional Constraints to Engaging and Serving their Local Communities." *Journal of Forestry*, 105(1): 43-48.
- Johnson, R., Shelby, B., Brunson, M., and Leahy, J. 2005. "Socioeconomic Responses to Alternative Silvicultural Treatments." In C. Maguire & C. Chambers (Eds.), *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatments* (pp.88-103). Oregon State University Research Contribution #46. Corvallis, OR.
- Huppert, D., Johnson, R., Leahy, J., and Bell, K. 2003. "Interactions between Human Communities and Estuaries in the Pacific Northwest: Trends and Implications for Management." *Estuaries*. 26(4B): 997-1009.
- Leahy, J. 2001. "Public Recreation on Oregon's Family Forestlands." *Oregon Small Woodlands Association Update*. 20(5): 7.

**ORGANIZATIONS AND PROFESSIONAL AFFILIATION:**

International Union of Forest Research Organizations (Deputy, Nature Conservation and Protected Areas Working Group - 06.01.03), Society of American Foresters (Chair, Social and Related Sciences Working Group - New England SAF), International Association for Society and Natural Resources, National Association for Interpretation (Certified Interpretive Trainer)

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## BARRY R. NOON

Professor  
Department of Fish, Wildlife and Conservation Biology  
Graduate Degree Program in Ecology  
Colorado State University  
Fort Collins, CO 80523  
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### **Education:**

B.A. Biology, Princeton University, 1971  
Ph.D. Biology, State University of New York - Albany, 1977

### **Courses:**

FW 192 - Wildlife Inquiries  
FW 360 - Principles of Vertebrate Management  
FW 370 - Design of Fishery and Wildlife Projects  
FW 471 - Wildlife Data Collection and Analysis  
FW 580 - Analysis of Recovery Plans Under the Endangered Species Act  
FW 580 - Critique of the draft land management plan for the White River National Forest, Colorado  
NR 420 - Principles of Ecosystem Management  
EY 592 - Readings in Landscape Ecology  
EY 620 - Applications in Landscape Ecology

### **Professional Experience:**

8/97-present. Professor of Wildlife Ecology, Department of Fishery and Wildlife Biology, Colorado State University.  
10/95-7/97. Supervisory Research Ecologist, U.S. Forest Service, Redwood Sciences Laboratory, Arcata, CA.  
1/95-9/95. Chief Scientist, U.S. Department of Interior, National Biological Service, Washington, D.C.  
7/94-12/94. Supervisory Research Ecologist, U.S. Forest Service, Redwood Sciences Laboratory, Arcata, CA.  
8/93-6/94. Visiting Scholar, School of Forest Resources, University of Georgia, Athens, GA.  
7/87-7/93. Project Leader, U.S. Forest Service, Redwood Sciences Laboratory, Arcata, CA.  
9/81-6/87. Assistant and Associate Professor, Department of Wildlife Management, Humboldt State University, Arcata, CA.  
6/79-8/81. Research Wildlife Biologist, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

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**Professional Affiliations:**

American Ornithologist's Union; Elected Fellow  
Ecological Society of America; Applied Ecology Section; Statistical Ecology Section  
Society for Conservation Biology; Formerly Board of Governors; Assigning editor for the  
journal, Conservation Biology  
The Wildlife Society; Formerly Associate Editor for the Journal of Wildlife Management;  
Biometrics workgroup  
International Association of Landscape Ecologists

**Recent Honors and Awards:**

Aldo Leopold Leadership Fellow -- 2004-2005  
Senior Fulbright Scholar to India -- 2003-2004  
Milestone Publication Award from the U.S. Forest Service -- 2001  
Accommodaton for Government Service -- 1999  
Edward T. LaRoe III Memorial Award – 1997

**Publications (Since 1997):***In Press/Review:*

Sonderegger, D.L., H. Wang, W.H. Clements, and B.R. Noon. In press 2009. Using SiZer to direct thresholds in ecological data. *Frintiers in Ecology and the Environment*.  
Dickson, B.G., B.R. Noon, S. Jentsch, C.H. Flather, and W.M. Block. In press 2009. Multi-scale response of avifauna and their habitats to prescribed fire experiments. *Ecological Applications*.  
Brand, L.A., G.C. White, and B.R. Noon. In review. Avian species richness and community composition on the San Pedro River: Effects of habitat and hydrologic regime. *J. Applied Ecology*.  
Noon, B.R. In press. Old-growth forest as wildlife habitat. Pp xxx In: *Old Growth in a New World: Ecological and Social Perspectives on Forest Conservation in the Pacific Northwest*. T. Spies, and S. Duncan, editors. Island Press.

*Publications (1997-2007):*

Salafsky, S.R., R.T. Reynolds, B.R. Noon, and J.A. Wiens. 2007. Reproductive responses of northern goshawks to variable prey populations. *J. Wildlife Management* 71:2274-2283.  
Murphy, D.D., and B.R. Noon. 2007. Science and the private sector: Rules of engagement for scientist. *Conservation Biology* 21:25-28.  
Mudappa, D., B.R. Noon, A. Kumar, and R. Chellam. 2007. Response of small carnivores to rainforest fragmentation in souther Western Ghats, India. *Small Carnivore Conservation* 36:18-26.  
Wiens, J.D., R.T. Reynolds, and B.R. Noon. 2006. Juvenile movement and natal dispersal in an isolated population of northern goshawks. *Condor* 108:253-269.  
Wiens, J.D., R.T. Reynolds, and B.R. Noon. 2006. Juvenile movement and natal dispersal in an isolated population of northern goshawks. *Ecological Applications* 16:406-418.  
Noon, B.R., and K.S. McKelvey. 2006. The process of indicator selection. Pp. 944-951 In: Aguirre-Bravo, C. Pellicane, Patrick J. Burns, Denver P. and Draggan, Sidney, Eds. *Monitoring Science and Technology Symposium: Unifying Knowledge for sustainability in the Western Hemisphere*. Proceedings RMRS-P-42CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 990 p.

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- Noon, B.R., and J.B. Blakesley. 2006. conservation of the Northern Spotted Owl under the Northwest Forest Plan. *Conservation Biology* 20:288-296.
- Noon, B.R., N.M. Ishwar, and K. Vasudevan. 2006. Efficiency of adaptive cluster and random sampling in detection terrestrial herpetofauna in a tropical rainforest. *Wildlife Society Bulletin* 34:59-68.
- Hamer, T.L., C.H. Flather, and B.R. Noon. 2006. Factors affecting patterns in grassland species richness: the relative roles of grassland area, landscape, and prey. *Landscape Ecology* 21:596-583.
- Fleishman, E., R.F. Noss, and B.R. Noon. 2006. Utility and limitations of species richness metrics for conservation planning. *Ecological Indicators* 6:543-553.
- Brand, L.A., B.R. Noon, and T.D. Sisk. 2006. Predicting abundance of desert riparian birds: Validation and calibration of the effective area model. *Ecological Applications* 16:1090-1102.
- Blakesley, J.A., B.R. Noon, and D.R. Anderson. 2006. Site occupancy, apparent survival and reproduction of California spotted owls in relation to forest stand characteristics. *J. Wildlife Management* 69:1554-1564.
- Beissinger, S.R., J.R. Walters, K.G. Smith, J.B. Dunning, S.M. Haig, and B.R. Noon. 2006. Modeling approaches in avian conservation and the role of field biologists. *Ornithological Monographs* 59:1-56.
- Scherer, R.D., E. Muths, B.R. Noon, and P.S. Corn. 2005. an evaluation of weather and disease as causes of decline in two populations of boreal toads. *Ecological Applications* 15:2150-2160.
- Salafsky, S.R., R.T. Reynolds, and B.R. Noon. 2005. Patterns of temporal variation in goshawk reproduction and prey resources. *J. Raptor Research* 29:237-246.
- Noon, B.R., P. Parenteau, and S.C. Trombulak. 2005. conservation science, biodiversity, and the 2005 U.S. Forest Service Regulations. *Conservation Biology* 19:1359-1361.
- Noon, B.R., and D.D. Murphy. 2005. Management of Spotted Owls: The Interaction of Science, Policy, Politics, and Litigation. Pages xxx. In *Principles of Conservation Biology* (third edition). G. Meffe, M. Groom, and R. Carrol, eds. Sinauer Associates, Sunderland, Massachusetts.
- Cade, B.S., B.R. Noon, and C.H. Flather. 2005. Quantile regression reveals hidden bias and uncertainty in habitat models. *Ecology*. 86:786-800.
- National Research Council. 2004. Adaptive Management for Water Resources Project Planning. National Academies Press, Washington, D.C. (Noon is one of twelve authors).
- Noon, B.R. and B. G. Dickson. 2004. Managing the wild. *Frontiers in Ecology and the Environment* 9:496-497.
- Franklin, A.B., R.J. Gutierrez, J.D. Nichols, M.E. Seamans, G.C. White, G.S. Zimmerman, J.E. Hines, T.E. Munton, W.S. LaHaye, J.A. Blakesley, G.N. Steger, B.R. Noon, D.W.H. Shaw, J.J. Keane, T.L. McDonald, and S. Britting. 2004. Population dynamics of the California spotted owl (*Strix occidentalis occidentalis*): A meta-analysis. *Ornithological Monographs* 54. American Ornithologists Union.
- Dale, V. H., and B. R. Noon. 2004. What is a landscape and how is one studied? Pp. 11-14 In: *Proceedings From the Ridge—Considerations for Planning at the Landscape Scale*. USDA Forest Service Gen. Tech. Rpt. PNW-GTR-596.
- Beissinger, S.R., J.R. Walters, K.G. Smith, J.B. Dunning, S.M. Haig, and B.R. Noon. 2004. The use of models in avian conservation. *Current Ornithology*.
- Samson, F.B., F.L. Knopf, W. McCarthy, B.R. Noon, and others. 2003. Planning for population viability on Northern Great Plains national grasslands. *Wildlife Society Bulletin* 31:986-999.

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- Noon, B.R., D.D. Murphy, S.R. Beissinger, M.L. Shaffer, and D. DellaSala. 2003. Conservation planning and management of U.S. national forests. *Bioscience* 53:1217-1220.
- Ishwar, N.M., R. Chellam, A. Kumar, and B.R. Noon. 2003. The response of agamid lizards to rainforest fragmentation in the Western Ghats, South India. *Conservation and Society* 1:269-286.
- Cade, B.S., and B.R. Noon. 2003. A gentle introduction to quantile regression for ecologists. *Frontiers in Ecology and the Environment* 1: 412-420.
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## Steven P. Courtney

Dr. Steven Courtney is Director of RESOLVE's Science Program. He has worked as a scientist for 30 years, in both academia and since 1992 in resource-management. His technical background is in the sciences, and he has led several large-scale science programs regarding water, forests, and endangered species. He has also developed a strong program in facilitating communication between scientists and decision-makers, and on using multi-disciplinary approaches to complex ecosystem management decisions. He is an expert in the application of technical information in policy and management. A respected biologist with a solid reputation for mediating environmental disputes using an open, transparent process, Dr. Courtney is the solid choice to lead RESOLVE's science program. Dr. Courtney most recently worked as Vice President of the Sustainable Ecosystems Institute and as a Visiting Scholar at Stanford University.

### SELECTED MEDIATION CASES

**Peer Review and Science Advising Program** (1992-ongoing) Dr. Courtney has set up and administered a national program for science peer review and advising that serves many federal, state and tribal governments, as well as private and public benefit entities. Approximately 1000 scientists serve in this network.

**U.S. Forest Service Programmatic EIS** (2011) USDA-FS is in process of selecting a preferred alternative for an overall EIS process for all forest lands. This entails an independent scientific assessment of all technical aspects of the different alternatives.

**Taxonomy and Genetics of Wolves** (2010) Conservation and management decisions on wolves critically depend on understanding the identity of different populations. The US Fish and Wildlife Service sought independent scientific evaluation of the genetic status of different populations, ultimately leading to decisions on which populations require protection, and at what level (species, subspecies, DPS).

**Ecosystem versus Species Management** (2007-2010) Previously all endangered species were administered on a single-species basis. On his own initiative Dr. Courtney approached the USFWS with a proposal for a multi-species approach to crisis conservation cases such as those in Hawaii. This resulted in a policy change at the Department of Interior, and a multi-species listing/critical habitat approach that explicitly takes an ecosystem stance. The first such listing document, for Kauai forest systems was enacted by the Bush administration, and this innovative approach is now being extended under the current administration to other ecosystems.

**Rio Grande Ecosystem Recovery Planning** (2009-2010) The US Bureau of Reclamation is responsible (together with other agencies) for management of Rio Grands water flow regimes. This project entailed independent evaluation of the scientific basis for alternative options, based on the hydrology of the system, and effects on endangered species.

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**Northern Spotted Owl Recovery Plan Review** (2008) The Department of the Interior's proposed recovery plan for the Northern Spotted Owl drew criticism, with accusations of political interference, and congressional investigations. In response DOI asked Dr. Courtney to perform an independent and transparent evaluation. This evaluation successfully transformed the debate, and led to an approved Recovery Plan. The Oregonian newspaper editorialized: "heartening is the U.S. Fish and Wildlife Service's appointment of the independent scientist to lead this review. He is the widely respected biologist Steven Courtney....a perfect choice"

**USGS Missouri Programmatic Review** (2008) The Geological Survey requested an independent evaluation of all its research and outreach activities for one of its science centers. This review helped USGS to set priorities for future research and communication.

**Lahontan Cutthroat Trout Status Review** (2007-2008) The US Fish and Wildlife Service required mediation of the multi-state, multi-agency management of the Lahontan Cutthroat (the largest trout species). This involved listening and consulting with tribal governments, as well as many stake-holders regarding a diversity of interests, and led to the final issuance of a status review for this species (the first such assessment)

**Atlantic Salmon Hatchery Protocols, Production and Assessment** (2006) NOAA, USFWS and the state of Maine agencies were in disagreement over management of Atlantic Salmon hatcheries. The independent review team discovered that these differences were not (as previously thought) matters of scientific opinion, but of governance problems. The parties were able to agree on this perspective, and successfully moved to an adaptive management approach.

**Catfish Harvest Evaluation** (2006) The state of Missouri currently outlaws recreational hand-fishing, or 'noodling' for trophy catfish. This activity has resulted in human deaths, and is of questionable impact on catfish populations. Dr. Courtney negotiated with state and other biologists and with 'anonymous' illegal fishermen to evaluate impacts to catfish populations. Ultimately the state decided to retain laws outlawing the activity.

**Preble's Meadow Jumping Mouse Genetic and Taxonomic Review** (2006) The stakes in this project were very high. Protection measures for PMJM seriously restrict development in the Colorado and Wyoming front range. Different biologists had reached diametrically opposite conclusions regarding the status and even existence of PMJM. Dr. Courtney developed and led a team that determined the true taxonomic status of the mouse, leading to USFWS retaining protection measures in Colorado.

**Barred Owl Biology and Management** (2005) This highly emotive issue required analysis of the effects of one attractive native bird (the Barred Owl) on its endangered cousin (the Spotted Owl). Ultimately, through a series of workshops and discussions, involving animal welfare groups, conservationists, resource managers and others, the USFWS elected to start a trial program of shooting Barred Owls. Without Dr. Courtney's careful management of the process, this controversial and painful decision would probably have been impossible and would have been mired in litigation.

**Missouri River Pallid Sturgeon Review Program** (2004-2007) Pallid Sturgeon are a highly endangered species, which occupy the full length of the Missouri River. Hence management for the species affects numerous stake-holders (agriculture, shipping, water use, fishermen, conservation interests) and is administered by large numbers of agencies in 13 states. A solid and uniformly agreed scientific basis is essential for negotiation among these many interests.



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**Northern Spotted Owl Status Review (2004)** Prior to this project, all status reviews had been carried out by US government agencies. This scientific evaluation, led by Dr. Courtney, sought, through a transparent and completely impartial process, to perform the first comprehensive analysis of Spotted Owls. Initially met with distrust by the various parties, who had been warring for decades over the Northwest forest's most iconic species, this analysis now provides the benchmark for all status reviews carried out by USFWS. The findings of the status review finally ended the long period of litigation among timber interests, conservation groups, and the federal agencies, ultimately leading (after 16 years) to the first agreed Recovery Plan for the species.

**Everglades Avian Multi-Species Plan (2002-2004)** Everglades restoration entails coordination and negotiations between 35 state and federal agencies, two Indian nations, and numerous stakeholder groups (water users, agriculture, municipalities, conservation groups, fishermen, marine interests etc.). Against this backdrop, decisions must be reached on how to manage whole ecosystems, often requiring complex trade-offs between competing interests, and even between different endangered species that have opposite requirements. This created a management impasse, where there appeared to be no management options that were legally permissible. Dr. Courtney's leadership allowed participants to find the 'sweet spot' whereby conflicts were avoided, and restoration actions could move forward with general support.

**Headwaters Forest negotiations (1995-present)** The Pacific Lumber Company owned the last remaining stands of 1,000 year old redwood trees subject to logging. The company sought to liquidate these assets (valued at \$2.3 Billion). The federal and state governments sought to protect the forests under the Endangered Species Act and Clean Water provisions. The company sought compensation under the takings provision of the US constitution. This litigation took place against a backdrop of civil disobedience, that involved extensive years-long tree-sits, jailing of protestors, and even the death of one person. Dr. Courtney turned this situation around, and developed an open transparent joint fact-finding process that allowed complex negotiations to move forward. Ultimately the Headwaters grove was purchased by government for \$500 Million, and is now a permanent reserve. Other old-growth stands are protected by the current private landowners.

**Lower Columbia River Channel Deepening (2001)** Negotiations over deepening the Columbia river for navigation involved NOAA, USFWS, EPA, and the Army Corps, as well as numerous stakeholder interests, Tribal nations, and state agencies. Problems arose over the expected effects of deepening on salmon. These disagreements led ultimately to NOAA withdrawing its BiOp, leading to mutual recrimination and accusations of bad faith. Dr. Courtney and RESOLVE staff turned this situation around and through confidence building exercises, public workshops, and joint fact-finding before an impartial scientific panel, helped the parties to repair their relationships. Ultimately the science proved clear: channel-deepening would have little effect on salmon. NOAA issued a new favorable BiOp, and channel deepening has been funded and carried out by the Corps. The initial negotiations of the parties took 10 years before reaching a roadblock - the intervention and successful mediation took just 5 months to unlock the problem.



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Gutierrez, R. J., M. Cody, and S. Courtney. 2007. The invasion of barred owls and its potential effect on the spotted owl: a conservation conundrum. Biol. Invasions 9:181-196

#### **ON-LINE LINKS TO REPORTS**

Everglades Multi-Species Avian Ecology and Restoration Review

HYPERLINK "<http://sei.org/everglades/reports.htm>" <http://sei.org/everglades/reports.htm>

US Fish and Wildlife Service: Scientific Review panel for the Northern Spotted Owl

HYPERLINK "<http://sei.org/owl/home.htm>" <http://sei.org/owl/home.htm>

HYPERLINK "<http://sei.org/owl/finalreport/finalreport.htm>"

<http://sei.org/owl/finalreport/finalreport.htm>

Independent Science Review of the Pallid Sturgeon Assessment Program

HYPERLINK "<http://sei.org/sturgeon/population.htm>"

<http://sei.org/sturgeon/population.htm>

The Columbia River Channel Deepening Project.

HYPERLINK "<http://sei.org/columbia/home.html>" <http://sei.org/columbia/home.html>

Preble's Meadow Jumping mouse

HYPERLINK "[http://www.fws.gov/mountain-prairie/species/.../preble/Prebles\\_SEI\\_report.pdf](http://www.fws.gov/mountain-prairie/species/.../preble/Prebles_SEI_report.pdf)"

[www.fws.gov/mountain-prairie/species/.../preble/Prebles\\_SEI\\_report.pdf](http://www.fws.gov/mountain-prairie/species/.../preble/Prebles_SEI_report.pdf)

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## DEBBIE Y. LEE

Debbie Lee is a program associate in RESOLVE's Washington, DC office, where she assists in convening and facilitating consensus building and policy dialogues. Ms. Lee provides support in meeting logistics, communication with participants, agenda development, issue identification, and production of written materials. She has worked on a wide range of issues, including drinking water policy, agricultural biotechnology, watershed management, and children's environmental health.

She received a Master degree in Public Policy, with a specialization in Environmental Policy, and a Certificate in Ecological Economics from the University of Maryland, College Park. She received a Bachelor of Arts in History, Political Science, and Public Policy; and Certificate in Environmental Studies from St. Mary's College of Maryland, St. Mary's City, MD.

### SELECTED PROJECTS

**GeSI-EICC In-Region Sourcing (GEIRS) Stakeholder Panel.** (2010-present) The GEIRS stakeholder panel of the GeSI-EICC Extractives Work Group is a group of end-use companies, NGOs, and government agencies providing recommendations on supply chain tracing and certification schemes related to conflict minerals in the Democratic Republic of the Congo and the surrounding Great Lakes region of Africa.

**Continental Dialogue of Non-Native Forest Insects and Diseases.** (2010-present) The Continental Dialogue is sponsored by The Nature Conservancy. It is a group of from federal, state, and local agencies, industry, conservation groups, researchers, and land managers working together to address the introduction and spread of non-native and invasive forest pests. The Dialogue's activities are coordinated by a Steering Committee comprised of members representative of the overall Dialogue's participants.

**Acoustic Monitoring and Mitigation Systems: Status and Applications for Use by Regulated Offshore Industries.** (2009-present) This three-day technical workshop was held by the Minerals Management Service on the current status of acoustic hardware and software tools for marine mammal monitoring and mitigation as applied to offshore industries.

**Revised Total Coliform Rule Stakeholder Process.** (2009-present) The US EPA is holding annual public meetings up update stakeholders on the agency's revisions to the Total Coliform Rule, as promised in the Agreement in Principle of the Total Coliform Rule/Distribution System Advisory Committee.

**Produce Safety Project Stakeholder Discussion Series.** (2010) The Produce Safety Project of the Pew Charitable Trusts sponsored a series of meetings around the United States to help inform the anticipated FDA produce safety standard for the growing, harvesting and packing of fresh fruits and vegetables.

**Research and Information Collection Partnership.** (2009-2010) As per the Agreement in Principle of the Total Coliform Rule/Distribution System Advisory Committee, the EPA and the Water Research Foundation are partnering to develop a research agenda for drinking water distribution system issues. The Steering Committee holds regular conference calls and face-to-

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face meetings to advise the partners on the analytical framework used to determine the research agenda.

**Fairfax County Watershed Planning Process.** (2008-2010) Fairfax County, Virginia, developed watershed management plans for each of the watersheds within the county borders. RESOLVE supported the public involvement process in developing three of those plans: Accotink Creek, Nichol Run and Pond Branch, and Sugarland Run and Horsepen Creek watersheds. For each watershed, the county established a Watershed Advisory Group (WAG) to assist the Fairfax County Office of Stormwater Planning in developing watershed management plans. These WAGs met four to six times each over the course of a year. The county also held Public Issue Forums before and after the development of each watershed plan.

**EPA Small System Variance and Affordability Stakeholder Meeting.** (2009) The EPA held a public meeting on the agency's options to address small system variance and affordability. Stakeholders were asked to provide feedback to EPA on the revised national-level affordability methodology EPA intends to use in the development of future drinking water standards to determine if affordability-based variances can be made available to small drinking water systems.

**Children's Health Protection Advisory Committee (CHPAC)** (2007-2009). The 41-member Federal Advisory Committee was established by the EPA administrator to address environmental health issues related to children. Activities include coordinating the work of the RESOLVE team, preparing technical meeting summaries, designing agendas, communicating with participants, and preparing advance materials. The types of issues addressed by the Committee include the selection of existing EPA rules for reassessment, improvements to methods for setting reference doses that more effectively account for children, improvements in benefits assessment methods for regulatory impact assessments, and community outreach strategies.

**USDA Advisory Committee on Agricultural Biotechnology for the 21st Century (AC21).** (2007-2009) The federal advisory committee was convened to provide advice to the Department of Agriculture on the long-term impacts of biotechnology on agriculture and the work of USDA. AC21 developed reports that project future products of agricultural biotechnology, highlights key issues associated with these products, and make recommendations for how USDA can best prepare for these products. The Committee produced four consensus reports and one consensus letter.

**EPA Environmental Justice, Green Business, and Sustainability Assessment.** (2008) RESOLVE was hired by the US EPA Office of Environmental Justice to assess the current efforts at the nexus of environmental justice, green business, and sustainability, and possibilities for further action. As part of the assessment report, RESOLVE interviewed representatives from non-profit organizations and businesses around the country to develop case studies.

**EPA Advisory Committee on the Total Coliform Rule.** (2007-2008) The EPA established the Total Coliform Rule / Distribution System Advisory Committee (TCRDSAC) to achieve an agreement in principle about key concepts in a revised Total Coliform Rule, and future research on distribution system issues. A Technical Work Group was convened to assist the TCRDSAC with its work.

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## EDUCATION

- 2007 *Master of Public Policy, Specialization in Environmental Policy; and Certificate in Ecological Economics.* University of Maryland, College Park, MD
- 2005 *Bachelor of Arts, History, Political Science, and Public Policy; and Certificate in Environmental Studies.* St. Mary's College of Maryland, St. Mary's City, MD

## EMPLOYMENT HISTORY

- 2007-Present RESOLVE, Washington, DC, Program Associate
- August 2005-May 2007 University of Maryland School of Public Policy, College Park, MD, Graduate Assistant in Finance & Administration
- Summer 2005 and 2006 Barrie Day Camp, Silver Spring, MD, Nature Specialist
- 2002-2005 St. Mary's College of Maryland, St. Mary's City, MD, Environmental Studies Research Assistant

## PUBLICATIONS

- Debbie Lee. 2011. "Books review: exploring the dangers of daily life." Chinadialogue. Online. Available at <http://www.chinadialogue.net/article/show/single/en/4180-Books-exploring-the-dangers-of-daily-life>.
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