THE PACIFIC NORTHWEST RESEARCH STATION BIODIVERSITY INITIATIVE: SCOPING OUT THE CHALLENGES IN MANAGING FOR BIODIVERSITY

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ABSTRACT—The USDA Forest Service Pacific Northwest Research Station's Biodiversity Initiative seeks to determine the types of science tools needed by natural resource professionals to meet diverse and complex biodiversity goals. During the scoping phase of this Initiative, we asked a broad cross-section of people whose work involves managing for biodiversity, from state and federal agencies to private forestry companies and environmental groups, what their priority needs, challenges, and concerns were for the region's biodiversity conservation. We report here the results of our scoping phase and discuss how we intend to address the issues raised. The main biodiversity management challenges included a lack of a common definition of biodiversity, lack of standardized policy to implement biodiversity management objectives, uncertainty about disturbance effects, lack of a monitoring framework, conflicting social and economic values, and difficulty in finding relevant data and information. The products most frequently requested included a central clearinghouse for biodiversity information and resources, various information products, quantification of social and economic values of biodiversity, monitoring guidance, and computer models. By including the viewpoints of diverse clients and emphasizing collaboration, the Biodiversity Initiative supports informed natural resource management for the long-term sustainability of a wide range of resources.

Key words: biodiversity, management, monitoring, information needs, resource managers, Pacific Northwest, PNW Research Station

In 2004, the USDA Forest Service's Pacific Northwest Research Station (PNW Station) launched a Biodiversity Initiative as a mechanism to integrate knowledge across disciplines and to create a new understanding of biodiversity management approaches. Recognizing that biodiversity is a natural and cultural asset, the PNW Station has identified the conservation of biodiversity as a principle goal. Since almost all forest management activities can affect biodiversity in some way, this Initiative was created to support informed management decisions. Habitats of focus in the Initiative are the forests and rangelands of Oregon and Washington. We have 2 primary objectives: 1) to learn from the diverse natural resource stakeholders in Oregon and Washington what major challenges they face in managing for biodiversity, and 2) to develop a set of priority management tools or products in direct partnership with interested collaborators. Here, we address the 1st objective by providing the results of our scoping process, in which we gathered information through conversations and workshops. From these findings, we have identified priorities to be developed as products of the Initiative.

Besides beginning the process of developing information products that will give managers more options, another goal of the scoping process was to create a feedback loop between research and management. Ultimately, we hope to forge partnerships, open communication channels, and begin defining how biodiversity can reap a range of economic, social, and ecological benefits.

METHODS

In our scoping phase, we 1st asked for individual input from approximately 100 people involved in natural resource management in Oregon and Washington. These stakeholders included a diverse cross-section of individuals from state and federal land management agencies, timber companies, conservation organi-

zations, local governments, tribal councils, university extension services, and the private small woodlot sector, among others. We asked the following questions:

- How do you construe the term biodiversity and what role does it play in your work?
- What current sources of information on biodiversity are available and do you find them adequate?
- What types of informational products on biodiversity would be most useful and how should that information be presented?
- What challenges or obstacles exist for transferring biodiversity information from research to management?

Second, 4 interactive workshops were held in both eastern and western Oregon and Washington. The workshops also enlisted a wide variety of people and organizations, similar in affiliation to conversation partners from the earlier scoping phase, and posed the same questions. However, these workshops differed from the one-on-one conversations due to their group environment, in which diverse social worlds and perspectives intersected to shape discussions about the complexities of biodiversity. The number of participants at each workshop averaged 14. Discussion formats included both large groups and smaller break-out sessions of about 5 people. The workshops were run by a professional facilitator who guarded against the imposition of a single viewpoint on the rest of the group and who encouraged open discussion of what inevitably involved conflicting concerns.

These workshops also expanded on information gathered during the initial scoping conversations. In particular, we asked what tools the research community might be able to provide to managers, how we might coordinate with established biodiversity programs, and how to understand the trade-offs inherent in multiple-objective management. Throughout the discussions, to avoid confining participants to a particular conception of biodiversity, we deliberately did not provide an "official" definition of the term. Rather than put words into their mouths, we wanted participants to voice concerns using their own definitions and ideas of biodiversity as it relates to their work.

RESULTS

Participants throughout the scoping phase commented on a wide range of challenges they face as they negotiate multiple goals involving biodiversity. Many of these challenges defy easy categorization and are difficult to address with specific information products; however, the purpose of the workshops was to hear as many perspectives as possible from divergent natural resource sectors, and to seek common concerns. The broad array of issues and information needs that emerged provided background that lent important context during the process of exploring ideas for relevant science products. Some of these challenges extend beyond the research capacity of the PNW Station, while others might be more easily framed and handled with information products. To tease these possibilities apart, we broadly categorize below some of the most commonly-heard challenges identified by workshop participants.

Main Challenges

Lack of Common Definition, Understanding.— One thing that quickly became clear during the workshops was the difficulty participants had defining "biodiversity". Short for "biological diversity", the term is understood in a general sense to refer to the extent and variability of organisms and ecosystems on the planet (Wilson 1997). Biodiversity is an inherently vague concept and is often discussed in highly conceptual language. It not only includes a wide palette of life forms as well as ecosystem processes, but also spans many overlapping scales, from genetics to species to landscapes. The level of complexity rises even further with the inclusion of interactions between natural and social systems, not to mention the ever-changing sets of interactions as these systems evolve. In designing this Initiative, we took biodiversity to mean all the discrete "ingredients" of the living world (genes, species, populations, and ecosystems), the processes that drive and link these elements, and their overall ecological and economic functions and benefits.

Scientists can salvage meaning from the vagueness of this concept by analyzing biodiversity at different levels of organization, from ecosystem down to gene (Wilson 1997). But in the context of management, it becomes more difficult to address fundamental elements in

isolation. Participants at our workshops expressed confusion as to how to make management decisions that attend to the interrelated levels and scales of biodiversity. For example, if a manager were to concentrate on biodiversity at the level of genetics, larger questions arise. What about maintaining genetic flow through corridors? As 1 participant pointed out, an understanding of genetics should be applicable at the landscape scale for a full range of ecological provinces.

In addition to confusion arising from the complexity of levels and scales, participants acknowledged frustration that no common language is being spoken. This became self-evident in the workshop setting where stakeholders from a range of backgrounds representing a multiplicity of concerns attempted to establish a firm basis for communicating with each other about biodiversity. Some participants made a case for the necessity of everyone working from the same definition or from a shared vision of biodiversity management, saying that without this nothing can be accomplished as a group. Others emphasized the need to accept ambiguity and simply acknowledge the presence of many definitions. In conclusion, there was an underlying sense that "biodiversity"—without any further clarification—is too vague to be a useful term for management. Many grappled with the overwhelming "largeness" or complexity of the issue and sought a way to standardize or define at least some parameters of biodiversity so that managers, the public, and policymakers might understand each other on the subject.

Lack of Explicit, Standardized Policy for Managing Biodiversity.—Currently there are no clear, comprehensive objectives set through legislation that direct the management of biodiversity for diverse stakeholders. Managers are left to puzzle over disparate goals to try to achieve the best outcomes for social, ecological, and economic conditions. Among the different ownership patterns, agency objectives, and management approaches on the landscape, it is difficult to attain a level of consistency in land use decisions. This lack of coherence leaves many resource professionals questioning whether they have a clear and predictable mandate to manage for biodiversity.

Workshop participants frequently returned to the difficulty of managing for biodiversity when there are so many different approaches and guidelines in effect. In general, government agencies, advocacy groups, and industry all operate according to different principles and objectives. Inconsistencies exist among the different types of government agency: multiple-use land management agencies routinely accept greater risk to biodiversity over a shorter period, while regulatory agencies usually opt to minimize risk over a longer period (Thomas 1999). At our workshops, industry representatives and small private forestland owners in particular disparaged the regulatory tangles that reflect a lack of coherent policy, in part because this unpredictability leaves them uncertain as to future impacts on their ability to run their businesses. They also mentioned that some policies, laws, and regulations can actually create "reverse" incentives that discourage biodiversity management even as other policies are intended to promote it.

Also, many people expressed dissatisfaction with the tendency of policy to focus on single species (for example, the Endangered Species Act), which they felt oversimplifies biodiversity. Others found fault with this type of policy for a different reason: it can be hard to get answers at the species level because as the resolution of genetic analysis gets finer, the consensus on how to classify discrete units for management will continue to change.

A central question that came from these discussions was: given the confusion of managing in mixed landscapes with little cross-agency collaboration, how does a manager prioritize biodiversity goals? Trying to gain a broader, more holistic context for one's actions was identified as a major challenge. Still, many participants felt that in spite of the inevitable range of management approaches, it would be worthwhile to strive for cross-jurisdictional biodiversity conservation strategies in order to attain some level of consistency in land use decisions on a mixed landscape. One participant summed up the issue by saying that a paradigm shift is needed to recognize the dynamic nature of ecosystems and to manage accordingly.

Uncertainty About Disturbance Effects on Biodiversity.—When studying an initial set of conditions in an ecosystem, ecologists can begin to broadly define and predict the trajectories of succession. However, disturbances such as for-

est fires, disease, insect pests, or timber harvest can cause sudden changes to these trajectories, triggering instabilities that can result in chaotic behavior and unpredictable consequences (Gunderson 1999). How does one manage for biodiversity within a natural disturbance regime? And how does one do this when the frequency, scale, and intensity of disturbance is uncertain?

Biodiversity management can be either active or passive, depending on specific desired outcomes. Thus, practitioners are faced with trying to understand and include both natural and unnatural disturbance dynamics in their plans and objectives. Some of the specific examples that raised questions at our workshops were:

- Certain habitats in early seral stages are difficult to maintain or restore, such as oak savannas or meadows. How does one compare natural early seral stages to stages after clearcutting, grazing, or burning?
- Invasive species are a threat to biodiversity and ecosystem stability. How do different disturbances impact the susceptibility of an area to invasives? How can managers better understand community resistance, competition with native species, and eradication options?
- What are the trade-offs between long- and short-term management objectives? If a certain ecologically important habitat is at risk for severe fire, should a fuel treatment be implemented even if it disrupts habitat in the short-term?
- What are the impacts of salvage logging, restoring fire regimes, grazing, or recreation on biodiversity?
- Climate change has been identified as the major threat to biodiversity. What are some potential impacts, and how will climate change scenarios play out in the short- and long-term?

Participants acknowledged the necessity of confronting uncertainty in a systematic manner, and expressed the need to build an integrated understanding of options based on a broader assessment of the impacts of disturbance effects on biodiversity. This understanding comes through active learning and through constant infusions of distilled and timely information.

Monitoring.—How does a manager know when his or her goals are being met? Devising a protocol for measuring biodiversity goals requires monitoring—an intimidating and complex effort to undertake. Attempting to inventory and monitor any aspect of biodiversity means dividing it into discrete, measurable elements. This is very information intensive. And in reducing biodiversity to particularities that can be quantified over time, the relevancy of the information becomes highly dependent on local conditions (Norton 1998). Besides spanning spatial and temporal scales, biodiversity is composed of different levels of ecological organization: genetic, species, ecosystem, and landscape. At each level, attributes of biodiversity can be assessed—for example, at the genetic level, genetic diversity; at the species level, abundance and density of species; at the ecosystem level, richness and diversity of species, guilds, and communities; and at the landscape level, habitat types (Wilson and others 1996).

Because of the complexities inherent in the various levels and scales of biodiversity, coherent monitoring strategies are hard to come by (see Gaines and others 1999 for a synthesis document that provides an approach and examples for developing biodiversity monitoring strategies).

In addition, managers are confronted with a variety of spatial and temporal scales. Much discussion at our workshops revolved around the lack of a standardized process for monitoring and the fact that no one even knows exactly what to measure in the 1st place. Some of the issues raised were: What would be good indicators? Indicators can provide metrics for a decision framework, but does monitoring for indicator species "work"? Research has suggested that using indicator species to test management standards can be problematic, particularly when using any forest vertebrate species, because each 1 has unique adaptations, responses to local conditions, and resource niches (Morrison and others 1992). On the other hand using a coarser filter, such as monitoring shrub-steppe habitat, allows only a broad view that may miss important detail. The working assumption behind the broader approach is that keeping track of a habitat type means keeping track of a system that supports a whole host of species. This approach has seldom been

tested and may not often be valid (Marcot and others 1994).

In sum, the workshops exposed a clear wish for specific guidance on monitoring, measuring, and assessment.

Social and Economic Considerations.—Much of the challenge in presenting biodiversity to a wide public without being reductive lies in the fact that different constituencies frame it in entirely different contexts. For some people, biodiversity has intrinsic value and should be protected independently of human values. Others emphasize biodiversity's utilitarian or economic value (Norton 2000). Those who make a living directly from forest or range resources were concerned about their livelihoods and insisted that the biggest restriction they face in managing for biodiversity is money. There are projects and goals they would like to work on (such as stream bank restoration), but the economic return is not there. In reply, some workshop participants suggested a system of compensation, where dollar values are assigned to biodiversity "services" (such as carbon sequestration capacity, species richness, or soil health) to help private landowners integrate biodiversity management into their business plans. This model of "natural capitalism" recognizes the critical dependence between the production of human-made resources and ecological well-being, and has been gaining international attention (Hawken 1997). This type of system would provide incentives for private landowners to meet biodiversity goals with positive motivation, as opposed to current "command and control" regulations. As a rule, most of the workshop participants found the negative associations surrounding certain biodiversity terms and policies to be a serious impediment to management and wondered whether biodiversity could be presented in a positive way regarding economic impacts.

Biodiversity suffers a certain amount of tension from being simultaneously a scientific concept and a social cause (Takacs 1996). This tension complicates policy formulation because competing values (recreation, species richness, conservation, jobs, wildlife habitat, and development) can paralyze action and create resistance or divisiveness. While a consensus on the importance of protecting biodiversity continues to grow, there is little agreement as to why or for what end, because humans have different ideals, preferences, and needs (Norton 2000). Again and again workshop participants agreed that barriers to biodiversity management are more social and economic than biological. Given this, participants wondered how biodiversity can be made relevant to the public in a way that doesn't reduce the many values humans derive from it to a single type. How can divisiveness be avoided? All agreed that effective communication is crucial, and many people remarked on the need for a common currency in reporting on biodiversity to the public. Using a unified message would be useful in promoting a cohesive vision of the values of biodiversity and would also help to establish accountability.

To address these topics, some participants hoped that this Initiative could begin to quantify some of these social and economic issues while also integrating local and traditional knowledge, perhaps by partnering with local groups such as conservation districts, watershed councils, or tribal agencies. This might allow the initiative to tap into the resilience and social capital available through local networks and collective choice.

Difficulty in Finding Information and Data.—Although information on the many facets of biodiversity is abundant, it is not clear how it can be pulled together and made useful and available. When asked where they currently go to find information on biodiversity, workshop participants responded with a scattered array of sources, including: scientific literature, publicly available biodiversity databases, university extension services, and in-house agency data collections.

The scattered nature of biodiversity information arises from the vast number of species, populations, and ecosystems involved, coupled with continuing interactions between these factors. But informational complexity also arises from problems of communication and coordination among agencies, kinds of data, and varieties of storage mechanisms for data. For a biodiversity information infrastructure to be accessible and effective, it must manage these complexities and deliver information to a wide array of users (Schnase and others 1997). The lack of communication and cooperation between the many groups dealing with biodiversity was seen as an impediment to good management.

Biodiversity Initiative Products

One of the primary goals of the Biodiversity Initiative is to deliver products that can reach intersecting social worlds *and* satisfy the information requirements of each. Many products were requested at the workshops, but there was not always a comfortable fit between the products requested and the capabilities of this Initiative. We have therefore narrowed down the list of potential products based on available resources and client interest. To the extent the resources of this Initiative can be applied, we are working on the following issues.

Central Web-based Clearinghouse for Biodiversity Information and Resources.—In answer to the information management challenge, we will facilitate the development of a single point of access listing information and resources related to biodiversity (see Kagan 2006). It could include updated lists of current literature, databases, relevant websites, and a "who's who" list of researchers, agencies, and groups working on biodiversity issues, including potential speakers who could make presentations to the public, schools, or at conferences. Also helpful would be information on funding sources and available grants. It could be a repository of spatial data and could also include information on individual species, such as their natural history, geographical range, and distribution.

Syntheses of Specific Biodiversity Topics.—We will systematically compile information on a variety of issues related to biodiversity management. The following specific information needs were mentioned at the workshops:

- Corridors—for example, what functions might they serve and what widths are optimal?
- Individual species—for example, their natural history, abundance, and risk status
- Issues specific to the eastside of the Cascade Range: range management, invasives, fragmented habitat, habitat degradation, successional changes, fire, sage grouse
- Highlights of on-the-ground success stories, especially any that show link between economics, social, environmental health, and biodiversity
- Case studies or models of projects
- Information on how to propagate an endangered plant
- A synthesis of Survey and Manage Program findings
- Genetic information on organisms in the PNW region
- Summaries of across-scale tools for biodiversity enhancement (snag retention, leave trees, buffers, using fungus to create dead trees, instream wood, variable density thinning, watershed designs, landscape trade-offs) (see Carey 2006a, 2006b)

Information on the Effects of Disturbance on Biodiversity.—In the interest of exploring the possibilities of using active management as a tool to reach biodiversity goals, participants requested the following information:

- Effects of thinning on species groups or landscape conditions
- Impacts of prescribed fire and fire suppression on wildfire
- Impacts of salvage logging
- Impacts of recreation
- How different disturbances affect an area's susceptibility to invasive species (see Delach 2006)
- Ecological consequences of grazing, particularly in riparian areas
- General trade-offs involved in active management on disturbance-based ecosystems (see Carey 2006a)

To address some of these issues, we have begun planning for 2 regional conferences: 1 on the impact of invasive species on biodiversity, and 1 on integrating biodiversity into the management of Northwest forests.

Development of Monitoring Metrics and Assessment Tools.—More specific guidance on monitoring, measuring, and assessment is needed. A review is provided by Beever (2006). While we recognized the enormity of this task and lack the resources to tackle the formulation of an entire monitoring module, there are areas where we feel significant progress could be made. The Initiative would likely take on a facilitative role in this respect and could create opportunities for collaboration with various agencies to explore these issues, such as hosting client workshops or overseeing cooperative efforts. Another starting point could be defining uniform standards for data collection of specific variables so data from all sources could be smoothly integrated.

Quantification of Social and Economic Values.—Social and economic concerns are intertwined with biodiversity management. Participants asked for assistance quantifying some of these values. Private landowners asked for information about existing incentive programs that would provide resources for biodiversity management. Some sectors requested a credit system that would recognize the contributions of different ownerships to an overall management strategy. A common understanding is needed of areas that provide important elements of biodiversity, such as riparian areas or habitat of listed species. Regarding all the product requests having to do with social and economic concerns, participants made clear the need to continually remind audiences of the benefits of biodiversity to society and to avoid a narrow or adversarial focus.

Our approach to these requests will involve creating a small workgroup to explore in more detail the information and products needs of small woodlot owners. Possible products may include workshops and short synthesis publications. In addition, we have planned a synthesis on the types and availability of traditional knowledge relating to biodiversity management in the Pacific Northwest.

Discussion

Biodiversity is linked to concerns over ecological stability, social and economic values, and genetic resources and has become associated with politically controversial matters in the Pacific Northwest, such as endangered species in old-growth forests. In some cases, biodiversity has become a divisive factor in deciding how to manage ecosystems for multiple values (Norton 1998). The many challenges inherent in managing for biodiversity extend across agency jurisdictions, land ownerships, and legal authority, and they involve a complex array of species composition, biological processes, and contingent interactions. Because of its considerable scope, it acts as an "umbrella" issue that impacts many different groups, which is why this Initiative took care to enlist the input of a wide variety of people and organizations. One thing remains constant across this range of practitioners: dealing with these issues requires thorough and reliable information based on current scientific findings and writings. That's where our Biodiversity Initiative has the potential to achieve results.

We seek to extract additional meaning from existing scientific, social, and economic data by combining information from a variety of sources and then delivering this "focused" information to biodiversity stakeholders. The connection between the generation of information and its use by those "on the ground" would not be possible without effective communication, in part because results mean different things in different disciplines (Star and Griesemer 1999). For example, if someone publishes a paper about herbivory on a post-fire landscape, it will be read against various perspectives and backgrounds and interpreted accordingly in light of botany, soil erosion, post-fire management, forest regeneration, policy implications, or ungulate species distribution. This requires researchers (or anyone disseminating information) to translate these meanings across a range of audiences. We face the task of aligning products with diverse client needs by working to understand anticipated applications for our outputs and by directly asking clients early in the process what types of information products they prefer. In our scoping phase for the Biodiversity Initiative, many information gaps were revealed and identified as roadblocks to management. Since the workshops ended, we have met with a science advisory group and a representative group of clients to begin honing the possibilities for products based on what would be most appropriate for various audiences. Information requests could be fulfilled using a combination of succinct 2-page fact sheets, longer in-depth syntheses, web products, workshops and field trips, or even regional or national conferences.

Although 1 of the main goals of this initiative is to cater to the individual needs of diverse groups of people, the initiative also recognizes the need for cooperation to reduce duplication of effort, to facilitate the sharing of information, and to tackle larger issues than what small groups working in isolation could do. The diversity of viewpoints of participants from different social worlds reflects a fascinating phenomenon: the functioning of a mixture of values with a shared need for information, with only partly overlapping definitions. The way in which a diversity of viewpoints coexists with cooperation has immediate consequences for

managing information (Star and Griesemer 1999). This has been 1 of the central lessons we have learned in the Initiative's scoping process.

The Initiative hopes to deliver information in such a way as to address these issues of complexity and coordination. One way we attend to them is by paying particular attention to collaboration. Effective collaboration requires credibility and good instincts for balancing the tensions of competing sets of concerns in multiscaled approaches. We will regularly check back with clients to make sure we are on a suitable trajectory, which will provide us with an adaptive feedback loop. The challenges brought up by our workshop participants are not likely to be resolved in the near future, so 1 test of the durability of our collaborations will be whether we can create partnerships with a lifespan beyond the 2-y time frame of this Initiative. Bearing that in mind, the Biodiversity Initiative proposes to use information and collaboration as a bridge to begin standardizing interfaces between different disciplines in an attempt to make progress toward integrative science and successful biodiversity management.

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