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The Pacific Northwest Research Station's Biodiversity Initiative: Collaborating for Biodiversity Management

Peter Nelson, Rachel White, Randy Molina

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Authors

Peter Nelson is a graduate student, College of Forest Resources and Evans School of Public Affairs, University of Washington, Box 352100, Seattle, WA 98195. **Rachel White** is a science writer and **Randy Molina** is a research botanist, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 620 SW Main St., Suite 400, Portland, OR 97205.

Abstract

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The Pacific Northwest Research Station launched a Biodiversity Initiative to assist natural resource professionals in integrating complex biodiversity concepts into natural resource management processes. We canvassed clients from various affiliations to determine the main challenges they face in biodiversity management, to define their information needs, and to understand how best to deliver biodiversity information within a collaborative framework. The biodiversity management challenges that emerged included (1) the lack of well-defined biodiversity management policies, (2) understanding and quantifying the interaction effects between a number of factors (e.g., disturbance types, management practices) and biodiversity, (3) the lack of applied biodiversity monitoring strategies, (4) difficulty in locating and accessing biodiversity information, and (5) balancing conflicting values relating to biodiversity. We also list the biodiversity information product needs of clients, as well as preferred technology transfer methods, and we discuss the future direction of the Biodiversity Initiative.

Keywords: Biological diversity, natural resource management, biodiversity information, information needs assessment, resource managers, Pacific Northwest.

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Introduction

In summer 2004, the Pacific Northwest Research (PNW) Station launched a Biodiversity Initiative as part of the mission of the Focused Science Delivery (FSD) Program (see sidebar). The goal of the initiative is to provide synthesized and policy-relevant biodiversity information products to FSD clients and other information users. This goal will be achieved in two phases. The initial scoping phase, reported in this document, involved working collaboratively with diverse clients and stakeholders to identify biodiversity management challenges and to assess biodiversity information needs. This scoping phase informed the direction of the second phase of the initiative, in which management tools and information products are being developed to assist clients in meeting their biodiversity management challenges. We discuss the impetus and background for the initiative and then describe the results from our scoping phase. We also provide a framework for setting priorities and implementing product development for the initiative.

Biodiversity is an overarching concept, and thus acts as a crosscutting theme in natural resource management, spanning technical and social realms.

Why a Biodiversity Initiative?

The concept of biodiversity is increasingly applied as a factor of interest and analysis in natural resource management. Biodiversity is an overarching concept, and thus acts as a crosscutting theme in natural resource management, spanning technical and social realms. If biodiversity can be construed as the variety of life and the processes that shaped them, and biodiversity management can be understood as value-based human interactions with those organisms and processes, we quickly realize that we are dealing with a vast and complex topic area. The interaction between biological and social complexity makes biodiversity management a formidable challenge. Essentially we are discussing the application of a conceptual framework to the grounded realm of natural resource policy and management. And although the term "biodiversity" is increasingly found in resource management scenarios and issues, we struggle with the application of the concept. The Biodiversity Initiative seeks to help bridge this gap; to make conceptual information on biodiversity topics available for practical application in management scenarios.

Scope and Direction of the Initiative

To capture the breadth and depth of biological and social issues surrounding biodiversity management, the Biodiversity Initiative focused on meetings with

The mission of the Focused Science Delivery Program is to enhance the usefulness of scientific information. High-quality research already exists, but often in a scattered array of sources. We pull together isolated pieces of information and synthesize them into a whole conceptual framework. We work closely with a wide variety of clients, and promote partnerships and collaboration. By compiling information specific to clients' needs, we hope to strengthen decisionmaking processes by ensuring that policy decisions are based on an integrated body of thought. Finally, we strive to identify ways to increase cooperation among researchers, political leaders, management specialists, and the public as they search for solutions to complex resource management problems.

a diverse range of clients and stakeholders in Oregon and Washington (including federal and nonfederal land managers, private landowners, forestry practitioners, scientists, and other natural resource professionals) to determine the range of challenges faced in managing for biodiversity and the information tools and products needed to meet those challenges. The initiative has sought input from diverse clients with a wide variety of viewpoints to promote mutual learning and understanding of the issues. We summarize client and stakeholder input from these meetings and synthesize that input into two main sections: (1) primary biodiversity management challenges and (2) requested biodiversity information products and technology transfer methods.

Since the initial scoping activity, the Biodiversity Initiative has focused on developing working groups of collaborators and partners who will determine the final products and work toward their completion. We realize that managing biodiversity is a huge topic area with many interested clients, each with unique information needs. A critical first step is working with our partners is to pare down an overwhelming list of information needs to a priority set of tools and products that resonate with a cross section of clients and can be accomplished within the initiative's timeframe (through 2006). Our progress in this vein is presented here.

We also recognize that information needs and tools for biodiversity management will continue well beyond the program's timeframe. We hope that many of the new working groups and partnerships will continue once they have gained significant foothold and realize the benefits of collaboratively provided, policy-relevant biodiversity information. Thus, the initiative will make a significant effort to facilitate the building of lasting partnerships and collaboration among the diverse set of stakeholders.

What Is Biodiversity?

Short for "biological diversity," the term was formally introduced during the first National Forum on BioDiversity in Washington, D.C. 1986 (Wilson 1997). In a technical and empirical sense, biodiversity refers to the diversity of life in all its forms and all its levels of organization, from fungi to western red cedar, from microbes to mountain lions. Biodiversity includes an intricate array of ecological patterns, processes, and contingent interactions. The complexity of biodiversity makes it a conceptual entity—virtually impossible to define in its entirety—yet it has emerged as an important issue in the conservation, management, and legislation of natural resources (McIntosh 2002).

According to Noss (1990), "A definition of biodiversity that is altogether simple, comprehensive, and fully operational (i.e., responsive to real-life management and regulatory questions) is unlikely to be found." Noss suggested that instead of attempting to restrict the term via definition, we should construct a "characterization of biodiversity that identifies the major components at several levels of organization." Such a construct conceptualizes biological diversity within a nested biological hierarchy that ranges in order from genes, to species, to biotic communities or ecosystems, to landscapes. As genes make up the details of a species, species make up the details of biotic communities and so on. In this sense, biodiversity implies a holistic conceptual framework that stands in contrast to more traditional "species-by-species" or "element-by-element" approaches of viewing the natural world and interpreting natural phenomena (Noss 1990).

To consider the variations and interactions among this hierarchy, Noss incorporated three ecosystem attributes: composition, structure, and function. Composition refers to distinct species, populations, or communities. Structure refers to patterns or physical arrangements of systems across a landscape, for example habitat complexity in the form of snags and down logs in a forest

Randy Molina

Coral fungus (*Ramaria araiospora*). Fungi provide just one example of the variety and complexity of life forms, and play an integral role in ecosystem processes, such as nutrient cycling and decomposition.

stand. Function refers to the processes that shape compositional and structural attributes, such as natural disturbances, gene flow, and nutrient cycling. Table 1 illustrates the relations between the nested biological hierarchy and the three ecosystem attributes.

Noss' conceptual biodiversity framework encourages a comprehensive approach to biodiversity management and helps highlight the relationships between the component parts. In addition, and relevant to this assessment, a conceptual framework of biodiversity can provide guidance in highlighting and categorizing information needs as well as assisting in biodiversity program implementation (e.g., in determining which attributes of an ecosystem should be monitored) (Peck 1998).

Methods

We employed two information gathering approaches in the client scoping phase by combining independent conversations with select clients (and small groups of clients), and structured, interactive workshops attended by representatives of diverse client groups. We chose to conduct a combination of individually based conversations and workshops to provide a diversity of interaction environments. Each format provides unique strengths in terms

Table 1—Compositional, structural, and functional biodiversity at multiple biological hierarchies

Biological level of organization	Ecosystem attributes		
	Structural	Compositional	Functional
Landscape	Landscape pattern	Landscape types	Landscape processes
Ecosystem	Habitat structure	Communities, ecosystems	Interspecific interactions
Species	Population structure	Species, populations	Demographic processes
Genetic	Genetic structure	Genes	Genetic processes

Source: Noss 1990.

of information gathering. For example, whereas individual conversations allow for detailed discussions of client information needs, workshops provide opportunities for group interaction and more synergistic idea generation. Throughout our interactions with clients, we deliberately refrained from providing an "official" definition of biodiversity. We opted to leave clients free to use their own conception of the term as they encounter it in their work.

Individually Based Conversations

Seventy-eight informal conversations were conducted with 99 individuals via telephone or in person with clients from a variety of sectors involved in natural resource management.[1] Clients were selected based on (1) existing relationships with the FSD Program and other Biodiversity Initiative partners and (2) a "snowball" approach that allowed participating clients to recommend additional relevant stakeholders for participation. These selection methods allowed us to interact with a broad range of clients and stakeholders from a network of individuals involved in Pacific Northwest biodiversity management issues. We felt that the conversations constituted a fair representation of the range of biodiversity management issues within a stakeholder network, and allowed us to gather enough information to put forward meaningful and useful information products.

Clients and stakeholders represented the following sectors: (1) industrial private forest-land owners, (2) nonindustrial private forest-land owners, (3) timber-related interest groups, (4) timberland investment groups, (5) conservation-oriented interest groups, (6) federal (Bureau of Land Management and

[1] For logistical reasons, some conversation sessions included multiple clients from a single sector.

Forest Service) managers and natural resource specialists (i.e., biologists and ecologists) at the forest and district levels as well as within the regional or state offices, (7) members of Oregon and Washington "Biodiversity Councils," and (8) individuals from state-level natural resource management agencies in Oregon and Washington (e.g., Washington Department of Natural Resources, Oregon Department of Forestry, and Washington Department of Fish and Wildlife).

Conversations were generally unstructured to allow clients freedom to articulate their specific interests and issues regarding biodiversity management. In addition, we sought more focused information on the following topic areas in order to better understand clients' biodiversity management challenges and information needs:

- Use, definition, and perception of the term biodiversity
- Views on the role and importance of biodiversity in natural resource management
- Consideration of the most important issues relating to biodiversity and natural resource management
- Current sources and use of information on biodiversity management in daily work and decisionmaking
- Descriptions of current biodiversity information needs
- Knowledge of research activities and products by U.S. Forest Service PNW Station scientists relating to biodiversity management
- Informational and organizational impediments to accessing and applying biodiversity information for decisionmaking
- Relationships of federal managers with nonfederal stakeholders with regard to biodiversity management

Although the primary objective of the workshops was to hear the management challenges and information needs from diverse clients, a secondary objective was to promote mutual learning among clients by encouraging active listening to divergent viewpoints on the issues.

Extensive notes were taken during conversations with clients and subsequently analyzed to identify and characterize common themes and issues. Those common themes and issues are discussed below.

Workshops

Four workshops were held, two each in Oregon (Bend and Eugene) and Washington (Wenatchee and Olympia). We purposely chose locations on the east and west sides of the Cascade Range to explore potential regional differences in terms of management challenges and geographically unique biodiversity information needs. Although the primary objective of the workshops was to hear the management challenges and information needs from diverse clients, a secondary objective was to promote mutual learning among clients by encouraging active listening to divergent viewpoints on the issues. Thus,

we invited clients who could represent many of the viewpoints that had been articulated in our previous, individually based discussions. Fifty individuals representing 25 organizations from the sectors noted above participated in the four workshops. We do not view these 25 organizations as inclusive of all interest groups or stakeholders involved in biodiversity management issues. However, we felt that it was a fair representation of the range of interests that would allow us to gather the needed information to meet the objectives of the scoping phase.

Randy Molina

Workshops provided a forum for a wide variety of clients to voice the challenges they face in managing for biodiversity, and to brainstorm ideas about what types of information products would be most useful to them.

A professional facilitator conducted the workshops and provided a nonadversarial environment for all clients to articulate their biodiversity management challenges and information needs. Participants were informed in the beginning that the workshops were not intended as forums to debate issues, but instead were a means to gather information and promote partnerships to address biodiversity management challenges and solutions. Workshops addressed four primary questions: What are the main challenges you face in managing for biological diversity? Where do you currently obtain your science resources on biodiversity management? What information and specific management tools do you need to meet the challenges you noted? and How can we best work together to develop these products and continue to share information on biodiversity management?

An informal voting exercise was conducted at the end of each workshop to help identify priority biodiversity information products from a list of topics generated throughout the session. Notes were taken throughout the meetings on flipcharts and by independent recorders. We summarized notes in terms of common themes and issues across all the workshops and integrated them with the results from the individually based conversations. Those common themes and issues are discussed below.

Results and Discussion

This section summarizes and discusses the results of our individually based discussions and workshops, and is divided into two main sections: (1) primary biodiversity management challenges and (2) requested biodiversity information products and preferred technology transfer methods.

Clients articulated a range of challenges associated with biodiversity management. We broadly categorize the most frequently cited challenges in this section as follows:

- The lack of well-defined biodiversity management policies, including:
  - Biodiversity mandate in federal land management policies
  - Biodiversity mandate in private land management policies
- Understanding and quantifying the interaction effects between a number of factors (i.e., disturbance types, management practices) and biodiversity. These factors include:
  - Resource management practices
  - Invasive species
  - Fire, forest health, and postfire logging
  - Restoration activities
- The lack of applied biodiversity monitoring strategies
- Difficulty in locating and accessing biodiversity information
- Balancing conflicting values relating to biodiversity

Challenge 1: Lack of Well-Defined Biodiversity Management Policies

There are currently no clear policy mandates that direct the management of biodiversity. This was a frequently cited biodiversity management challenge. Public and private forest managers face a variety of federal, state, and local land management policies (i.e., statutes, regulations, planning documents) that refer to the identification, conservation, or maintenance of biological resources; yet there is no explicit mandate for “biodiversity management”

per se. Across the mosaic of ownerships, landowners establish different management objectives and goals for their lands ranging along a gradient from the production of primarily economic goods to complete preservation of ecosystems. Variation in land management goals and objectives leads to variation not only in the types of problems and decisions managers encounter, but also a diversity of information needs and decision-support tools (i.e., program evaluation and monitoring tools).

In addition, land management philosophies are changing and becoming more complex than they were a generation ago as science begins to probe and unravel the interactions between human and ecological systems (Thomas 1999). This socioecological complexity has an impact on laws, regulations, court decisions, and public perceptions. The lack of policy coherence on biodiversity management leaves resource professionals to puzzle over disparate strategies for achieving social, ecological, and economic conditions.

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Biodiversity mandates in federal land management policies—
Certain federal statutes and accompanying regulations contain provisions that pertain, albeit somewhat indirectly, to biodiversity management. Clients frequently cited both the National Forest Management Act (NFMA), and, less frequently, the Endangered Species Act (ESA) as providing some guidance as to biodiversity policy. Yet these statutes do not explicitly compel federal managers to conduct biodiversity management per se—instead, they tend to focus on the species level within the biological hierarchy.

Congress passed the ESA in 1973 to strengthen the government's ability to protect imperiled wildlife and the habitat on which they depend.[2] Although it represents a landmark in natural resource policy, it embodies a species-by-species approach that may now seem outdated (Norton 1998). In the years since the passage of the ESA, an emphasis on habitats, ecosystem dynamics, and complex interactions has substantially expanded our understanding of the complexity of managing for natural resources (Norton 1998). Indeed, many clients expressed dissatisfaction with single-species oriented policies, saying these strategies oversimplify or even contradict the conceptual principles of biodiversity management. Protecting individual species remains important, but recognition that species exist within and interact with larger systems and interconnected communities also has become important.

[2] Endangered Species Act legislation can be accessed at http://www.fws.gov/endangered/ESA.html.

Stuart White

Blue grouse (*Dendragapus obscurus)*. Although protecting individual species is still important, effective biodiversity management recognizes that each species exists within a larger ecosystem in connection with many other species and processes.

The statutory requirements of the NFMA mandate the Forest Service to provide for a diversity of plant and animal communities within a multiple-use framework.[3] As such, NFMA provides management safeguards for species at risk of extinction or extirpation on Forest Service land. The diversity requirements of NFMA (along with ESA and other statutes) were a fundamental policy component in the debate over the conservation of late-successional forest ecosystems and appropriate levels of federal timber harvest in the Pacific Northwest in the 1990s (Robbins 2004).[4] The Northwest Forest Plan (NWFP) sought to resolve that debate over competing values by balancing commodity production with the conservation of forest ecosystems.[5] The conservation strategies of the NWFP could be construed as de facto biodiversity management in that various attributes of ecosystems and species were addressed at

[3] National Forest Management Act legislation can be accessed at: http://www.fs.fed.us/emc/nfma/index1.html.

[4] NFMA, the primary statute governing the administration of national forests, mandates the assessment of forest lands and the development of a resource management plan based on multiple-use, sustained-yield principles for each unit of the National Forest System. In December 2004, the Forest Service released a final rule on NFMA that shifts conservation emphasis from a species focus to an ecosystem focus. For more information on the new NFMA rule see http://www.fs.fed.us/emc/nfma/index2.html.

[5] Northwest Forest Plan documents and related information can be accessed at: http://pnwin.nbii.gov/nwfp.html.

several spatial scales. The NWFP ecosystem approach is notable for its creation of expansive landscape-scale reserve networks, its advocacy for adaptive management schemes, its social and ecological monitoring frameworks, and for its encouragement of interagency cooperation and planning. Also included in the NWFP was a key provision that charged agency managers with evaluating the site-level impact of management activities on rare and little-known species associated with late-successional forests. The survey and manage program was cited by some clients as a valuable contributing factor to a more comprehensive biodiversity management strategy found in the NWFP.[6]

Biodiversity mandates in private land management—
We learned that clients from the industrial and nonindustrial private forestland sectors consider (1) state forest practices acts and rules (2) forest management certification programs and (3) Habitat Conservation Plans (authorized under the ESA) as providing policy direction on biodiversity management issues.[7] As is the case with federal lands, various regulations and programs for private land address disparate elements of biodiversity, but there is no explicit, comprehensive biodiversity management policy mandate.

States differ in the extent of their regulatory programs, with the Pacific Northwest demonstrating the most extensive reliance on comprehensive forest practices laws (Moffat and Cubbage 2001). Yet, although state forest practice regulations are tending to become more complex for landowners, these regulatory frameworks tend to focus on traditional strategies to conserve resources such as soil, water, and wildlife. In Washington state, for example, debate continues over proper regulation of logging as it relates to northern spotted owl (*Strix occidentalis caurina*) habitat and the economic costs of setting aside riparian buffer zones. Comprehensive biodiversity planning, for the most part, has not entered state forest practices policies.

Forest management certification programs may be emerging as the most pertinent sources of explicit direction on biodiversity management. Landowners and timber companies can seek certification through several independent organizations such as the Forest Stewardship Council (FSC) or the

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[6] The survey and manage program was removed from the NWFP in March 2004.

[7] Authorized under the ESA, Habitat Conservation Plans are agreements between landowners and the federal government in which landowners agree to conservation measures in exchange for a permit to "take" listed species in connection with economic activity. Thus, the biodiversity components of Habitat Conservation Plans mimic those of the ESA policy mandate, cited above.

Sustainable Forestry Initiative (SFI).[8] Certification establishes a chain of custody and assures consumers of compliance with various forest stewardship standards and stipulations, at times including provisions for the conservation of forest biodiversity. For example, an SFI objective regarding biological diversity states that participating landowners shall: "Manage the quality and distribution of wildlife habitats and contribute to the conservation of biological diversity by developing and implementing stand- and landscape-level measures that promote habitat diversity and the conservation of forest plants and animals including aquatic fauna" (SFB 2004).[9] As we will discuss in later sections, determining whether management activities are contributing to the conservation of biological diversity is no simple task, and greatly depends on what aspects of biodiversity one chooses to measure. In addition, the SFI objective serves as a good example of how management strategies choose to focus on select biodiversity attributes at select spatial dimensions.

Private forest owners and timber companies enter into these planning activities for social and regulatory purposes. Certification and associated biodiversity conservation measures can demonstrate publicly the compatibility of corporate management activities with publicly valued ecological goals. Secondly, corporations may see certification and Habitat Conservation Plans as an opportunity to attain greater management flexibility than under traditional regulatory frameworks (Loehle et al. 2002). But as our clients pointed out, the benefits of undertaking such planning activities are not always clear, especially in terms of financial return. Entering certification programs or Habitat Conservation Plans can be expensive and difficult to develop and implement. In addition, confusion has built up around the fact that biodiversity requirements differ between certification programs, and that these programs do not always match up with state regulatory guidelines (Moffat and Cubbage 2001). These problems are sufficiently pervasive as to potentially thwart biodiversity planning efforts.

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[8] For information on the FSC see http://www.fscus.org/. For information on the SFI see http://www.aboutsfi.org/.

[9] See http://www.aboutsfb.org/generalPDFs/SFBStandard2005-2009.pdf.

Tom Iraci

Private forest owners may join a forest certification program to demonstrate publicly the compatibility of their management activities with ecological goals.

Challenge 2: Understanding and Quantifying the Interaction Effects Between a Number of Factors and Biodiversity.

Much of the challenge in incorporating biodiversity into management and planning lies in understanding the complex relationships between disturbance processes and biodiversity. Our clients discussed anthropogenic and "natural" forces as factors that impact biodiversity. Many of these conversations can be summed up as: "What is biodiversity? How are we impacting it? And, how do we quantify that impact?"

Forest management practices—

We learned that many clients do not have a clear idea of the interaction effects between forest management practices and biodiversity. This ambiguity is certainly driven by the above discussion on conceptual complexity and biodiversity policy mandates–absent a mandate, a manager, landowner, or practitioner may not consider biodiversity as an element of concern in resource management decisions. That being said, clients articulated a need for policy-relevant information on the appropriate role of active management in the conservation, restoration, or maintenance of biodiversity. The answers are largely unknown and immensely complex. Natural resource issues tend to be systems problems—complex and unpredictable, with multiple causes—and tend to span both natural and social spheres (Holling et al. 1998). Whether the

impact of a management action, such as timber harvest or grazing, poses a "threat" to biodiversity is unknown unless one has adequate information, including the capacity to assess the status of biodiversity prior to the management action. Thus, questions concerning the impacts of active management on biodiversity essentially become monitoring, experimental, or prediction/forecasting questions. A state employee involved in timber harvest programs captured this sentiment: "We need clear information on the risks of managing for simple (forest) structure and short rotations, and the effects on soil productivity and (biodiversity)." And because of the inextricable link between social and ecological values inherent in active management, interdisciplinary modes of inquiry into the combined systems of nature and humans are needed to gain enough information to formulate policy (Holling et al. 1998).

Invasive species—

We found that clients are challenged in understanding and quantifying the interaction effects of native species and biodiversity. Invasive species may have negative impacts on native biodiversity and ecosystem stability. Many invasives possess adaptations that allow them to be superior competitors; and they have been known to impact such ecosystem functions as productivity, soil fertility, disturbance regimes, nutrient cycling, and decomposition (Peck 1998). Resource managers face information challenges regarding community resistances, competition with native species, eradication options, and how different disturbances impact an area's susceptibility to invasives.

Steve Sutherland

Spotted knapweed (*Centaurea maculosa* Lam.). Resource managers need more information on how invasive species affect biodiversity, and what can be done about them.

Fire, "forest health" and postfire recovery—
According to clients from all sectors, significant uncertainty surrounds the relationship between wildfires, fire management practices, and elements of biodiversity. Information deficits were noted in the following management areas: fuels management/reduction, postfire logging, and fire suppression. And although many managers and practitioners were cognizant of departures (structural, compositional, and functional) from historical fire conditions, many were uncertain how these changing ecological conditions affect the complex components and elements of biodiversity.

For private landowners with commercial management goals, pressing issues of "forest health" overlap with biodiversity questions, particularly on drier landscapes east of the Cascade Range crest. Many clients manage their lands under the premise that uncharacteristically large or severe fires pose a threat to forest biodiversity, yet there are vast information gaps in this topic area. When asked what issues "biodiversity" brings to mind, a member of an east-side collaborative management group said: "Concern over fires, forest health and fuels reduction." According to this participant, collaborative decisionmaking groups need biologically relevant definitions of "forest health" along with cogent and usable explanations of how various fire management practices affect biological diversity. For example, how can managers develop effective fuels treatment plans that incorporate relevant information on the impacts to biological resources?

As mentioned above, some clients viewed "biodiversity management" as a potential threat to "forest health," particularly if it meant adopting a "hands-off" (no active management) approach. In managing for pest and disease outbreaks or reducing the fire susceptibility of a forest stand, managers believed there may be tradeoffs between levels of biodiversity and amounts of "risk," often expressed in terms of possible economic loss. We found that managers are seeking usable information on the appropriate balance (the range of costs, benefits, and tradeoffs) between maintaining or restoring natural ecological processes and managing for other values including timber. Managers are looking to science to help explain and synthesize the differences between "natural" and "unnatural" disturbance events in terms of their impacts to biodiversity. A participant who works on the dry forests in Washington gave voice to these types of questions:

> We have changed natural forest structure and composition. There are consequences in fire behavior associated with these changes. What are the appropriate structures, proportions and

Managers are looking to science to help explain and synthesize the differences between "natural" and "unnatural" disturbance events in terms of their impacts to biodiversity.

> arrangement of forests? What are the ranges of carrying capacities for a particular plant association? What are the appropriate species and stocking levels for those sites? What should landscape succession look like? We need a better way to infer what direction we are heading.

Practitioners need current high-quality information about disturbance dynamics as they work to achieve an effective balance between biodiversity management and active management.

Clients indicated that they are also lacking pragmatic and usable information on the impacts of postfire logging on elements of biodiversity, particularly in areas of high biological and social value such as late-successional and old-growth forest stands. In many of these cases, the questions revolved around how the removal of burned material would impact structural, compositional, and functional elements of those stands and landscapes. An Oregon conservation advocate said, "In terms of on-the-ground issues, salvage logging, particularly within legacy rich young stands, is critical. These stands are rare at the landscape scale and are being converted to a common habitat type." Certain structural elements are commonly cited as important for biodiversity including cavity trees, coarse woody debris, spatial heterogeneity in the overstory and understory, and legacies (Carey 2003), yet many of these studies have been conducted in wet, less fire-prone forest types, making their applicability to dry forest types uncertain. On a postfire landscape, a manager proposing a salvage logging operation may not have the appropriate (or relevant) information to justify potential impacts to these habitat elements. Federal managers expressed the concern that they do not have the proper tools to understand and prioritize these types of complex decisions. One participant said, "How have we changed the system? How will it respond? If you stay within the range of natural variability, the system will function. How do you translate these issues to the 'frontlines' (i.e., to managers in the field)?"

Restoration activities—

Clients described challenges that accompany efforts to restore biodiversity within forest systems. Managers are challenged in their attempts to design silvicultural prescriptions that will restore various elements of biodiversity to forest stands and landscapes. In some cases, the restoration objective is not always clear—for example, how does a manager address the variability ranges for specific biodiversity attributes? Any restoration target will fluctuate within a range, and defining an appropriate range is a tricky and subjective

process (Peck 1998) that can be better informed by science but not necessarily "solved." One manager captured the sentiment of those involved in emerging biodiversity management questions: "How do we restore habitat types to achieve landscape diversity? How do we restore late-successional forests? We have a lot of learning to do." Still, results from experimental manipulations of forest stands have been promising. Research has shown that intentional landscape management can provide a strategy for restoring ecosystems and conserving biodiversity (Carey 2003). The key is to conduct relevant research and then to provide that information to those seeking to implement strategic restoration efforts across forested landscapes.

Tom Iraci

Results from experimental manipulations of forest stands have shown that careful landscape management can help restore ecosystems and conserve biodiversity.

Challenge 3: The Lack of Applied Biodiversity Monitoring Strategies

Many managers echoed a familiar sentiment when attempting to implement biodiversity management strategies, "How do we know if our goals are being met? How do we know what to measure?" We found that managers feel that they lack sufficient tools and information including biodiversity management standards (goals and objectives), benchmarks for establishing trends or assessing ecosystem condition, and effective biodiversity monitoring tools.

Biodiversity monitoring allows managers to assess the effectiveness of biodiversity conservation strategies and measure their performance. Biodiversity monitoring has been tangentially emphasized under federal land management plans such as the NWFP, and is relevant across all land ownerships and sectors. A regional Forest Service employee familiar with NWFP monitoring explained the gap in biodiversity monitoring information, as follows:

> We are doing a lot of things that would be considered as biodiversity monitoring. What is missing is the overall framework. We need to make biodiversity concrete. Ecosystems are complicated. We need to break it down into pieces. We don't know enough to monitor all the pieces. We need to say: "this is what we think constitute all the elements of biodiversity" and develop that framework, from genes to communities to landscapes.

Clients outside the federal sector also cited the need for flexible and effective biodiversity monitoring strategies. A state employee with a natural resource agency in the state of Oregon said: "What we are looking for in the big picture is a coarse-filter/fine-filter approach with indicators that allow us to look at all species, not just a selected subset . . .Where are the holes in the big picture?"

The "big picture" includes numerous biological components arrayed and layered throughout multiple spatial and temporal scales. Many of our scoping conversations revolved around (1) the lack of a standardized process and set of tools for biodiversity monitoring and (2) uncertainty as to the most appropriate spatial scale for monitoring biological phenomena. How should managers select reasonable biodiversity indicators? Can indicators be used to assess ecosystem functionality? What is the utility and potential role of habitat surrogates? Our conversations and workshops left many of these types of questions unanswered, and exposed a clear need for specific guidance on biodiversity measuring, monitoring, and assessment systems.

Challenge 4: Difficulty in Locating and Accessing Biodiversity Information

In terms of data management, managers relayed that there were no consistent standards across management units and between agencies, making biodiversity management and information sharing a challenge. Data and other types of information on the vast range of biodiversity elements could be

considered patchy at best. The existing data and information are housed in a scattered array of sources and expressed in differing metrics. When asked where they currently seek information on biodiversity topics, clients listed a wide range—from the peer-reviewed scientific literature, to an assortment of publicly available databases, to university extension services, to in-house corporate or agency data sources.

The complex nature of biodiversity information comes from the underlying intricacies of the biological elements and processes involved in its expression—all of which continually evolve and interact. The biological informational complexity is compounded by the complexity of human systems used to manage it. The mechanisms used to organize, store, present, and deliver data and information can be nearly as diverse as the ecological components they seek to document and explain. In addition, biological data can involve conflicts of interest, or can get mired in political or commercial entanglements (Schnase et al. 1997). The lack of cooperation between various agencies was identified at our workshops as being a hindrance to managing for biodiversity. For an information system to be useful and effective, it must efficiently manage complexity while delivering information within an accessible framework.

Challenge 5: Balancing Conflicting Values Relating to Biodiversity

We found that the social dimension of biodiversity presented challenges for clients as they sought to balance often competing sets of values. We heard that the concept of biodiversity has become a "conservation tool" that is used in polarizing debates over natural resource management decisions. A timber sale planner on a national forest stated: "We hear the term biodiversity from (interest) groups. The term has a sociopolitical meaning. It drives agendas." Another participant put it bluntly: "Biodiversity management shuts down forests, period." Although these statements are difficult to interpret, it is clear that the term biodiversity can connote powerful reactions in certain stakeholders. Where biodiversity management is understood as the equivalent of "no active management," it becomes a threat to other social values.

Biodiversity management attracts a certain amount of conflict by being both a scientific concept and a social cause for conservation (Takacs 1996). Debate over often competing activities such as public lands recreation, resource use and jobs for people, the preservation of wildlife habitat or endangered species, or commercial development are infused with social values and can create resistance or divisiveness in natural resource and biodiversity

management. Therefore, although the idea of consciously managing for biodiversity is evolving in our natural resource professions, there is dispute over why or how to accomplish this, given widely varying human ideals, preferences, and needs (Norton 2000). This variation in values adds complexity to management and complicates the formulation of policy.

Mark Reid

Social debate over how land should be used—for recreation, preservation of wildlife habitat, or commercial development, for example—can cause divisiveness in natural resource and biodiversity management.

We found that many clients from the private sector are interested in the possibility of creating market-based economic incentives to meet society's demand for biodiversity values. For example, landowners could receive compensation for creating monetized units of biodiversity in the form of tax credits. Yet creating market-based biodiversity incentive systems is certainly both theoretically and pragmatically challenging, particularly the pricing of biodiversity values. One participant involved in creating biodiversity market incentives asked: "How do you monetize the biodiversity values that you are creating (through forestry)? What are the appropriate metrics for creating a market?" The limiting factor, common to many biodiversity challenges, lies in identifying practical and effective ways to characterize, measure, and catalog elements of biodiversity.

For clients representing the commercial forestry sectors, biodiversity management was often construed as a constraint on economic objectives.

Private landowners also told us that, given the vast range of biodiversity elements, different components of biodiversity should be provided by different landowners according to their management objectives. For example, landowners with economic management emphases could provide biodiversity values associated with managed forests. One private timberland manager captured the tone of these discussions:

> We must deal with [biodiversity] within legal, political, and social contexts. We need to understand the tradeoffs, and the values that managed lands contribute to biodiversity conservation. People [disregard the role that] intensively managed lands [play in] protecting rare species, species sites, and species diversity. There is a much larger role for intensively managed stands than can be understood by scientists, conservationists, and the public.

Emerging research is beginning to look at the contribution of managed lands to the maintenance and conservation of biodiversity. A number of clients named this research area as their primary biodiversity information need. One method of delineating the role of managed lands in resource management is through the use of Habitat Conservation Plans, in which small landowners have developed rating systems that recognize the value of different forest management strategies in terms of biodiversity conservation. Yet there remains a need for policy-relevant scientific information on the contributions managed lands make to overall biodiversity. Nonindustrial private landowners are unsure as to where they stand in the evolving resource management trend toward biodiversity management—they recognize that small private forest lands, in sum, provide a rich vein of biodiversity, particularly through recent policies that have set aside riparian areas and listed species habitat. Yet they are fearful that biodiversity management could threaten them commercially. One participant said, "Private landowners are confused by the term biodiversity. What does this mean in terms of new rules, new restrictions? For fiber producers, does this mean we will need to do an inventory of all plants and animals?"

Larger private landowners share the same concerns over the implications of biodiversity management. For the private forestry sector, the dilemma revolves around how they can contribute to biodiversity conservation while surviving in the forestry business. For example, landowners and researchers associated with the Sustainable Forestry Initiative are conducting studies and

compiling information to assess how industrially managed lands contribute to biodiversity conservation. At this time, an effective and usable set of biological criteria to make this assessment is lacking. And for private landowners, whose livelihoods can depend on the resources in these forests, biodiversity management must be made practical for it to be effective.

Workshop participants frequently stated that barriers to biodiversity management are more social and economic than biological. To address this, some clients requested that the Biodiversity Initiative begin to quantify some of these social and economic values. Ideally this would also involve integrating local and traditional knowledge—perhaps by partnering with local groups such as tribal agencies, watershed councils, or conservation districts—which would allow the initiative to tap into the social capital available through grassroots networks.

One of the main goals of the Biodiversity Initiative is to devise, develop, and deliver products that will be accessible to diverse social worlds and fulfill the information requirements of each.

Information Product Needs

One of the main goals of the Biodiversity Initiative is to devise, develop, and deliver products that will be accessible to diverse social worlds and fulfill the information requirements of each. Several information products were repeatedly requested during our information-gathering phase, although there was not always a comfortable fit between the products requested and the capabilities of this initiative. Therefore, based on available resources, client interest, and opportunities for collaboration, we have condensed the list of requested products to those the initiative may effectively address.

Central Web-Based Clearinghouse for Biodiversity Information and Resources

To address the challenge of information management, many people requested a single point of access to biodiversity information and associated resources. This point of access, which would most likely be Web based, could include the following types of resources and information:

- Current biodiversity literature, databases, and Web sites
- A master list of institutions, researchers, agencies, and groups working on biodiversity issues
- Information on funding sources and available grants
- Species and population information (natural history, geographical range, distribution, rare and lesser known species, species viability, species-habitat associations)
- Spatially explicit data on community/ecosystem condition and trends

Syntheses on Specific Biodiversity Topics

Clients, particularly managers involved in implementing biodiversity management strategies, requested summarized and synthesized information on a variety of biodiversity management topics. The following information need areas were mentioned:

- Natural history, abundance, and risk status of various species
- Genetic information on organisms in the Pacific Northwest
- Information on how to propagate endangered plants
- A synthesis of survey and manage program findings
- Summaries and syntheses of existing biodiversity literature, research topics, and research activities
- Summaries of broad areas of agreement and disagreement on critical biodiversity topics
- Interim reporting on biodiversity research efforts, prior to publication
- Syntheses of biodiversity conservation and management strategies
- Issues specific to the east side of the Cascade Range: range management, invasive species, fragmented habitat, habitat degradation, successional changes, fire, sage grouse
- Highlights of on-the-ground success stories, especially those that show relations among economics, social issues, environmental health, and biodiversity
- Case studies or models of projects

Information on Disturbance Effects

Clients expressed the need for concise, reliable, and policy-relevant syntheses on disturbance-biodiversity interactions including, but not limited to:

- Invasive species
- Fire—historical range of variability; identification of fire-associated species; the impacts of suppression, prescribed burning, and postfire logging (salvage) on measurable/observable elements of biodiversity
- Effects of thinning and other silvicultural methods on biodiversity elements including species groups and landscape condition
- The implications of "no management" for elements of biodiversity
- Mitigating the stressor effects of logging on elements of biodiversity
- Using silvicultural methods to restore particular elements of biodiversity (i.e., developing late-successional characteristics)
- Socioeconomic/biological tradeoffs involved in active management within disturbance-based ecosystems

Development of Monitoring Metrics and Assessment Tools

Clients are seeking specific scientific guidance on biodiversity monitoring, measuring, and assessment techniques. The Biodiversity Initiative planning team acknowledges the capacity challenge in formulating such a complex and multilayered monitoring module and currently lacks the resources to take this on. However, smaller steps can be taken, and the initiative could take on a facilitative role in this respect. Some examples of potential starting points include:

- Cataloging, summarizing, and analyzing existing biodiversity monitoring systems and strategies
- Generating and defining specific indicators for biodiversity monitoring
- Creating opportunities to collaborate with various agencies to explore issues involving monitoring and assessment, such as hosting client workshops or fostering cooperative efforts
- Creating tools that assist in the development of metrics for measuring, assessing, and monitoring biodiversity
    - Customize those tools to proper spatial scales
    - Customize those tools for different land ownerships
- Provide analyses and evaluation of how the NWFP and other federal land management plans are performing in terms of biodiversity management

Implementation Tools

Clients are seeking information products that will support the implementation of biodiversity planning and management strategies. This includes frequent requests for the following types of information subjects:

- Existing templates and case studies of applied biodiversity management
- Tools that allow managers to assess the efficacy of existing biodiversity strategies with benchmark strategies
- Implementing the “fine/coarse filter” biodiversity management approach; analyze the effectiveness of the survey and manage program as a biodiversity management approach; provide biodiversity conservation strategies and recommendations for the NWFP area; discuss a replacement for the fine-filter survey and manage approach; address biodiversity management within the Special Status Species Program
- Provide specific decision-support tools for national forest planning that address biodiversity management

Quantification of Social and Economic Values

As discussed above, social and economic concerns are intertwined with the technical aspects of biodiversity management. Clients requested information products and support in designing and quantifying variables associated with these values. They asked specifically for:

- Focused information on "market-based" (nonregulatory) biodiversity conservation programs
- Information on the economic aspects and benefits of biodiversity
- Traditional biodiversity knowledge or conservation methodologies outside the conventional scientific literature
- Tools and models that are able to quantify the biodiversity value of different land ownerships

Technology Transfer Methods

We found that clients prefer a variety of information products and delivery methods including the following.

Workshops, Field Trips, or Panels

Managers and practitioners believe face-to-face interactions with scientific information providers provide them with the opportunity to hear summaries and interim reporting on biodiversity studies. Direct interaction with researchers is particularly useful because managers often seek information on timelines that are shorter than the typical schedule of research, printing, and dissemination of research results. Clients also believe that face-to-face interactions allow researchers to interact with one another to discuss and indicate where there are issues of agreement as well as disagreement on biodiversity management issues.

Traditional Printed Materials

Many clients favored the access and utility of written materials and requested biodiversity literature in a variety of published formats including peer-reviewed scientific and professional journals, *Science Findings*, *Science Updates*, and General Technical Reports. Some clients requested more simplified information products such as brochures, fact sheets, posters, and children's education materials.

Models and Decision-Support Tools

Computer models can be useful in addressing single or multiple species, for projecting disturbance regimes, or in decision support. The following types were requested:

- Conceptual ecological and socioeconomic evaluative planning models (see the Coastal Landscape Analysis and Modeling Study[10])
- Risk assessment tools, methods, protocols, and approaches for biodiversity management
- User-friendly, effective, habitat models relating to the status of biodiversity
- Models associated with dead wood management as it relates to biodiversity management (such as DECaid[11])

Biodiversity Management Implementation Tools

Many clients requested decision-support tools to facilitate and improve the implementation of biodiversity management strategies. These tools include such things as biodiversity monitoring protocols, "biodiversity management" (i.e., taxonomic) checklists, model user guides, and NEPA biodiversity checklists and prioritization schemes for biodiversity restoration activities. Also requested were summaries of biodiversity definitions as well as conceptual portrayals of biodiversity.

Initiative Direction

In February 2005, we held a biodiversity workshop with invited speakers to synthesize several of the issues presented above. Proceedings of review articles from this workshop will be published in the journal *Northwestern Naturalist* in 2006.[12]

Another product of the workshop was a poster, shown at a biodiversity conference in France in April 2005. Our coordinated scoping and comprehensive vision of biodiversity appears novel worldwide. Advances made by the PNW Station Biodiversity Initiative will likely be of great interest to developing global programs.

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[10] See http://www.fsl.orst.edu/clams/.

[11] See http://wwwnotes.fs.fed.us:81/pnw/DecAID/DecAID.nsf.

[12] This should be one of the first products available from the initiative.

In April 2005, we held a followup workshop to present the results of our scoping activities to a representative group of clients and stakeholders to solicit input on a set of potential collaborative activities and products. It is important to realize that the PNW Station does not have the capacity to take on each of the managerial challenges and related products. The major objective of this followup workshop was to select some key focus areas for product development. After considerable discussion, the clients agreed to pursue the following issues.

Small Woodlot Owner Concerns

This client group, which includes nonindustrial private landowners, is diverse and experiences unique challenges associated with biodiversity management. Given the thousands of potential constituents, it is important to work closely with representative groups or associations as well as with the Oregon and Washington State Extension Services. Our strategy is to convene a small workgroup to explore more closely the biodiversity information and product needs of this client group and, most importantly, decide on a strategy to develop and disseminate information. We anticipate possible workshops and short synthesis publications uniquely catered to meet their needs.

Central Clearinghouse or Web Portal for Biodiversity Information

This product, which would collect, classify, and distribute biodiversity information, was requested at all client workshops. We have organized a workgroup to examine this need, with Oregon State University's Institute for Natural Resources (http://inr.oregonstate.edu/) taking the lead. The major objective of the institute is to deliver science information to Oregon's leaders and publics to help inform decisions on management of the state's natural resources. The institute also houses Oregon's Natural Heritage Program. Thus, the institute is uniquely suited to lead the effort for a biodiversity information clearinghouse. The workgroup will explore potential ways to organize and frame biodiversity information and then actively seek collaboration among the dozens of groups involved in biodiversity management projects in Oregon and Washington to ensure widespread participation and usefulness.

Monitoring

Developing biodiversity monitoring approaches and strategies represents a difficult challenge for practitioners involved in biodiversity management. Biodiversity management objectives vary widely among clients, often differing substantially in scope and scale. We will convene a workgroup to discuss common interests and share information on current biodiversity monitoring activities, particularly by Oregon and Washington state agencies. The workgroup will explore the development and use of biodiversity monitoring approaches. It will also consider if multiple groups with multiple management objectives could operate under one biodiversity monitoring framework. Collaboratively understanding how various ownerships, from private to state and federal, contribute to present (and future) regional biodiversity is an opportunity worth pursuing.

Collaboratively understanding how various ownerships, from private to state and federal, contribute to present (and future) regional biodiversity is an opportunity worth pursuing.

Workshops, Conferences, and Syntheses

We are in the beginning stages of identifying key issues around which to organize additional biodiversity workshops and syntheses products. As we work to build collaborative partnerships and capacity we expect our list of biodiversity products to grow. At this time we are planning two major regional meetings in 2006 to deal with many of the disturbance-biodiversity interaction concerns voiced by our clients. One workshop, hosted by the University of Washington, Department of Urban Horticulture, will focus on the impact of invasive plant species on the biodiversity of Oregon and Washington. A second, organized through Oregon State University, will examine crosscutting themes of a variety of social, economic, and ecological factors (e.g., fire, thinning, climate change, and disease) in relation to biodiversity management. This conference will emphasize the availability of management tools and showcase on-the-ground examples of managing to meet different biodiversity objectives in Pacific Northwest ecosystems. Proceedings will follow from each meeting so that the information will be available to a wide audience of professionals and the public.

We have also embarked on four synthesis products to meet several major information needs. One piece will articulate biodiversity within a conceptual framework. This includes providing clear, concise sets of key definitions along with a list of potential indicators or surrogates for use in biodiversity monitoring. As our scoping process revealed, defining and conceptualizing biodiversity and related principles of biodiversity management is essential for

effective communication and successful information transfer. A second synthesis will provide guidelines to managers and researchers on the use of citizen volunteers to help in the actual monitoring of biological resources, including biodiversity. Such inclusion of and participation by the public provides excellent opportunities for developing shared visions of biodiversity goals and ownership of management outcomes. A third synthesis will summarize the main outcomes and results from the survey and manage program. Many valuable ecological and practical management lessons were learned from this regionwide conservation program, and results will be important to the Forest Service and Bureau of Land Management programs for sensitive and special status species. To further address the management challenges brought forth from the survey and manage program, a fourth synthesis will explore in detail alternative approaches for the conservation of rare or little-known species. This book synthesis will have chapters on issues of species rarity, the unique challenges of little-known species, social and economic aspects of conservation management, legal considerations, setting goals and objectives, descriptions of various approaches (e.g., fine- and coarse-filter approaches, and combinations thereof) including their strengths and weaknesses, management implementation considerations, and finally a process to help managers select an approach (or approaches) to meet their conservation objectives.

Tom Iraci

The demand for natural resources, whether for economic or social gain, means a balance must be struck between biodiversity objectives and maintaining values desired by the public.

Concluding Remarks

As our results indicate, the challenges of managing for biodiversity are numerous and complex. Many of the challenges come from different perceptions among publics about what "biodiversity" means and how the word itself is used in a social or political context. Much of the complexity derives from the daunting number of taxa, their interactions, and the functions they perform in our diverse array of ecosystems. We know that we cannot measure and monitor all organisms and ecosystem processes, so we are left to find a set of indicators or surrogates that will provide meaningful information about the large set of biodiversity attributes we seek to maintain. The demand for use of our natural resources, whether for economic or other social gain, means a balance must be struck between managing these resources to meet biodiversity objectives and maintaining values desired by the public. We hope our Biodiversity Initiative will provide an impetus to facilitate mutual understanding of our biodiversity goals and develop long-term partnerships to see them through. Progress and results of the initiative will be posted at the PNW Station Web site (http://www.fs.fed.us/pnw/).

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Pacific Northwest Research Station

Web site	http://www.fs.fed.us/pnw
Telephone	(503) 808-2592
Publication requests	(503) 808-2138
FAX	(503) 808-2130
E-mail	pnw_pnwpubs@fs.fed.us
Mailing address	Publications Distribution Pacific Northwest Research Station P.O. Box 3890 Portland, OR 97208-3890

U.S. Department of Agriculture
Pacific Northwest Research Station
333 S.W. First Avenue
P.O. Box 3890
Portland, OR 97208-3890

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