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Source: Northwestern Naturalist, 87(1) : 1-9

Published By: Society for Northwestern Vertebrate Biology

URL: https://doi.org/10.1898/1051-1733(2006)87[1:BCPHIT]2.0.CO;2

BIODIVERSITY CONSERVATION—A PLACE HOLDER: INTRODUCTION TO PAPERS IN THIS ISSUE

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ABSTRACT—Biodiversity conservation in the US Pacific Northwest is gaining new attention as large reserves are recognized as not being a panacea for protection of all rare species. In February 2005, a workshop at Oregon State University, held in conjunction with the joint annual meetings of the Society for Northwestern Vertebrate Biology and the Oregon Chapter of the Wildlife Society, focused on key topics of concern relative to the advancement of biodiversity conservation in the region. Articles in this issue of *Northwestern Naturalist* provide overviews of these topics. As an introduction, I describe the origin of conservation biology at another conference 25 y ago and 2 key developments occurring in intervening years—the definition of ''biodiversity'' and the need to advance and integrate several socioeconomic aspects of the discipline. Both of these developments support the concept of conservation biology as a ''place holder''.

Key words: conservation biology, biodiversity, socioeconomics

While ideally wholesome, biodiversity conservation has inherent elements of intangibility and complexity. Over a quarter of a century has passed since I attended the 1978 Conservation Biology Conference in San Diego, California, that was pivotal in launching Conservation Biology as a discipline (Soulé and Wilcox 1980) and later a professional society (Society for Conservation Biology 2005). From my tunnel vision at the time, this single event was a catalyst to the metamorphosis of conservation from an ethic to a biological discipline, inciting a kind of riot into academia to accept a discipline with a mission as a science. I've considered this metamorphosis similar to a ''punctuated equilibrium'' because unlike other divisions of biology that developed slowly over time, Conservation Biology emerged seemingly well developed, highly integrated, and mission-ready. Yet, 25 y later, we are still redefining the basic terms used to describe biodiversity and are constantly marketing the need for its conservation. In 1980, Thomas Lovejoy wrote, ''This reduction in the biological diversity of the planet is the most basic issue of our time.'' (page *ix* in: Soulé and Wilcox 1980). This basic issue is with us still, and in many ways seems only more acute. Has the discipline truly developed and progress been made in protection, maintenance, or restoration of biota?

Upon inspection, there is ample evidence that conservation biology has grown tremendously in a quarter of a century. The discipline is represented globally at hundreds of universities as departments or special programs. In application, worldwide efforts are underway to conserve both systems and species, and these are sponsored by governments as well as environmental interest groups. While originally conservation biology integrated biological disciplines, it has grown to be a well-accepted applied science closely aligned with socio-politico-economics. Today, conservation biology themes may be addressed in university programs in Environmental Studies, Geography, or Landscape Ecology, which may perform a semantic function to better integrate across social and biological sciences. However, full integration has been slow to achieve because biological and social sciences traditionally have been applied to conservation issues separately.

Some of the greatest strides in conservation have been made at local to regional scales—especially when legal regulations or directives for individual species or system preservation have met with mobilized entities addressing biological issues. For example, the restoration of bald eagle (*Haliaeetus leucocephalus*) populations has resulted in its proposed de-listing as threatened in the United States. This focused effort was backed by the Endangered Species Act (ESA), with a huge national constituency in place to implement basic biological research, monitoring, and restoration measures. In another example, in the US Pacific Northwest, 80% of western federal forests are now in a reserved status largely due to ESA-listed and sensitive biota such as the northern spotted owl (*Strix occidentalis*), marbled murrelet (*Brachyramphus marmoratus*), and anadromous fishes. Concern for these taxa forced a timber harvest gridlock upon the region, and a Presidential mandate was used to break this gridlock and protect forest health, wildlife, and waterways while producing a sustainable level of timber sales and non-timber resources (USDA and USDI 1993). In addition to the ESA, legal regulations applicable to the development of this ecosystem management plan included the National Forest Management Act, the Federal Land Policy Management Act, and the National Environmental Policy Act (USDA and USDI 1993).

In the Pacific Northwest, biodiversity conservation is gaining new attention as it becomes clear that the coarse-filter approaches of habitat-based protections such as large federal reserves are not a panacea for protection of all rare species (USDA and USDI 1994a, 1994b, 2000, 2001, 2004a, 2004b, 2004c). In forests, proposals recommending management of biodiversity in the matrix, that portion of the land prioritized for timber production, suggests a complementary approach to large reserves; together reserves and matrix management may better integrate production of multiple resources across landscapes (Cissel and others 1998; Shaughnessy and O'Neil 2001; Johnson and others 2002; Lindenmayer and Franklin 2002). Following this combined coarse-plus-fine filter theme, tools for stand-to-landscape scale, combined-species-and-commodity management are being identified (for example, McComb 2001; Lindenmayer and Franklin 2002; Olson and others 2002; Wessell 2005). Thus, a more unifying approach of multiple resource management across spatial scales appears to be developing and integrating the prior opposed dual approaches of commodity production and species-ecosystem management for conservation. As this process unfolds, the specific objectives and values to be attained by managing landscapes are being reassessed. New knowledge of species and systems function is being collated to ensure the best scientific information is used. From the perspective of biodiversity, those values needing protection, maintenance, and restoration are being redefined. Perhaps by its very nature, the complexity and relative novelty of conservation biology requires adaptive management, and there is a continuous need to spiral back to the beginning to synthesize new knowledge, renew interdisciplinary collaborations, redefine the mission, and readjust the path. We are at that point in the Pacific Northwest; rather than the black and white of reserves and managed lands, conservation biology is being ''ratcheted'' to a new level to integrate the gray where both sets of values are addressed together. With the merging of biological, social, political, and economic concerns, perhaps another step in the punctuated equilibrium of conservation biology has been made.

In February 2005, a Biodiversity Workshop was held at the joint annual meetings of the Society for Northwestern Vertebrate Biology and the Oregon Chapter of The Wildlife Society. The workshop was part of a scoping process underway by the Biodiversity Initiative of the US Forest Service, Pacific Northwest Research Station, to assess current challenges for biodiversity management in Oregon and Washington forests and rangelands (White and Molina 2006). Representatives from several government agencies, conservation institutions, universities, and private industries attended. Invited speakers and an open panel discussion at this workshop highlighted key biodiversity issues emerging in Oregon and Washington. Papers in this volume provide overviews of the following issues: 1) active versus passive management (Carey 2006a) and restoration approaches to manage bio-complexity (Carey 2006b); 2) invasive species (DeLach 2006); 3) modeling (Marcot 2006); 4) monitoring (Beever 2006); and 5) information management (Kagan 2006). There was consensus among both workshop speakers and participants that clarity was needed regarding the definition of biodiversity and that significant advances could be made to resolve conflicts relative to the sociopolitical aspects of biodiversity conservation. For a common understanding in the articles to follow, I briefly review these here. During the workshop, these issues were expanded upon by other speakers not represented in this special issue: George Stankey (USDA Forest Service) and Bruce Taylor (Defenders of Wildlife).

BIODIVERSITY

Biodiversity as a concept is multidimensional. The term is an abbreviated form of ''biological diversity'' (for example, Wilson 1988), and has come into use only within about the last 15 y. As a word, it is representative of a discipline that is still very much in development. Biodiversity has been used synonymously with species diversity, yet the abbreviated species-focus is only 1 portion of the concept as it is commonly used today. In the Global Biodiversity Assessment sponsored by the United Nations Environment Programme, Bisby (1995) characterized biodiversity by 3 disciplines: taxonomy, genetics, and ecology. These disciplines provide a reference system for all organisms, recognition of discrete forms, and acknowledgment of the roles of biota in larger systems. Similarly, the Society for Conservation Biology breaks biodiversity into 3 components: 1) all forms of life, bacteria to vertebrates; 2) all levels of organization of living things including genes, populations, species, communities, ecosystems, and landscapes; and 3) all interactions among life forms and organizational levels (Society for Conservation Biology 2005). Thus, in today's usage it often has both compositional and functional aspects (Callicott and others 1999). In composition, biodiversity is an inventory of life forms across biological scales of organization that includes genetic, species, community, habitat, landscape, and biome diversity. In function, biodiversity is integral to processes that maintain healthy ecosystems, including the biotic role in the maintenance of energy flow and air, water, and nutrient cycles. Together, simply, biodiversity is all variation of life forms and the ecological functions and processes they affect.

While these aspects each can be described and categorized, each has unknowns, and the sum is complex and difficult to measure. Hence biodiversity conservation is not a straightforward exercise. The intangibility of such conservation emerges when the composition or function of a system is not well known, and surrogates proposed to be in-lieu indicators of composition or function also seem insufficient. For example, in the US Pacific Northwest, managing landscapes for owls, murrelets, and fishes did not achieve biodiversity objectives for 300 other rare taxa closely associated with old-forest conditions (USDA and USDI 2000, 2001, 2004c). Yet, with adaptive management, new knowledge can be continuously applied to the issue, and in-lieu biodiversity management decisions can be placeholders until a more effective alternative is developed.

At every level of biological organization, there is imprecision in unit designation. While taxonomy appears precise, life form variants often grade continuously rather than categorically. For example, the delineation of distinct populations, evolutionarily significant units, or discrete population segments (for example, Moritz 1994; USDI and USDC 1996; Pennock and Dimmick 1997; Waples 1998) has not been broached for most species. At the next higher level, standards for species designations are not common among taxonomic groups. Phylogenetic patterns and scientific opinion varies (''lumpers or splitters''). Additionally, our knowledge of species is incomplete. New vertebrate species are described only occasionally, such as recent discoveries of a new primate in Africa (Jones and others 2005) and a new salamander in California (Mead and others 2005), while other taxa are very much biotic frontiers to be explored. Most estimates of numbers of undescribed species are in the millions. Furthermore, the compilation of known taxa locations across a landscape is steeped in unknowns. We have only begun to describe the world in which we live.

To strive to conserve biodiversity suggests maintenance of these knowns and unknowns, not only as discrete units but the diversity of assemblages in which they occur. The task is not merely to retain the species ''salad bar'' arrayed before us in their separate units as a classical zoo, but rather to retain the menu of mixes across broad spatial scales. The salad analogy is compelling at 1st, but falls short as a biodiversity analogue because, while the salad's components may have limited mixing because they are mostly discrete units, biota interact immensely, have ecological functions, and affect processes.

Ecological functions and processes affected by biota include their roles in altering air, soil, and water, and in transferring nutrients and energy. While the relationship between biodiversity and ecosystem services is not entirely known and may vary, some ecosystems appear particularly vulnerable to change, including arid, arctic, and island systems (Mooney and others 1995). Three examples illustrate we are gaining new understandings of species serving as ''engineers'' within ecosystems relative to their structure and function. First, the critical role of soil biota for ecosystem function is an active area of recent research (Wall 2004), with a call being made in 2002 for an international initiative for soil biodiversity conservation by the Convention of Biological Diversity, established among 152 nations at the 1992 Earth Summit in Rio de Janeiro (Convention of Biological Diversity 2002). In the northwest, soil biota are diverse, yet functions are not well understood (Moldenke 1999), and development of adequate standards for soil productivity and sustainability within harvested landscapes will require adaptive management as new information becomes available (for example, Page-Dumroese and others 1996). Second, the developing concept of reciprocal subsidies between aquatic-riparian systems, where the health of 1 part of the system requires inputs from the others, relies in part on biotic interactions cycling between these adjacent zones (Baxter and others 2005). With highly dendritic stream networks as occur in many forested watersheds of the Pacific Northwest (for example, USDA and USDI 1993), this process may play an important role in regional forest ecosystems. Lastly, Marcot and Vander Heyden (2001) categorized 85 key ecological functions of wildlife species, with a summary of patterns of vertebrate species from Oregon and Washington. These examples demonstrate that each taxon may serve a role for ecosystem structure and function, and webs of direct and indirect interactions between them and their environments are complex, and in many cases are only beginning to be understood.

Sociopoliticoeconomics

Like so many other things, Conservation Biology ultimately comes down to ''place''. While begun by an unprecedented integration of biological disciplines (Soulé and Wilcox 1980), conservation biology boils down to planning the management of places with biodiversity and ecological priorities (designing ''placeholders''). Hence, such land management necessarily also merges sociology, economics, and political science (for example, Noss and others 1997). This cross-discipline integration is a process not an outcome, which heightens the complexity of managing lands for multiple resources (for example, Clark and others 1999). Humans have a multitude of views of the values of ''place'' (Clark and others 1999), ranging from sentimental, familial, aesthetic, ethical, and philosophical to a range of functional values, which may include protection or production of both ecological and economic commodity resources. The challenges become intricate as our human influence on nature prevails in a mosaic of these eco-socioeconomic tradeoffs. As these are weighed with the biodiversity conservation task as a paramount value under consideration, the task itself can be hotly debated by our society of diverse values and goals. Conflicts in an area are inevitable when divergent priorities, philosophical to socioeconomic to ecologic, are voiced by stakeholders to that place. The scale of conflicts escalates when stakeholders view values of a place as a commons or a right. This becomes particularly acute when distantly situated people consider the resources of a far place to be theirs as well; air, water, land, and biota may be valued as such commons (Hardin 1968). Environmental groups and government agencies often act as local or regional representatives for such distant stakeholder publics. It is important to note that the result of integrated resource management across such diverse disciplines and values does not necessarily eliminate conflict (Clark and others 1999), but rather allows full consideration of all values during assessments and management decisions.

Effective tools to aid in conflict resolution relative to integrating multiple ecological and socioeconomic priorities for a place are a current biodiversity conservation need (Cowling and Pressey 2003). Tools which have gained some success in defraying conservation conflicts but warrant additional development include education, incentives, partnerships, land use changes, and adaptive management.

First, support of biodiversity conservation issues requires communication among all potential stakeholders. In particular, the public does not necessarily understand biodiversity and the rationale for its conservation. Private landowners of smaller holdings may need to be informed how their lands may contribute to biodiversity conservation goals for the larger landscapes in which they occur. Stankey and Shindler (2005) refer to this as fostering ''cultural adoptability'' or ''social acceptability'' for managing diverse biota and the processes they engineer. They emphasize that to be effective this is not a one-time, one-way information transfer of conservation tenets to the public, but is more of an iterative engagement process to continually place the new information into a series of contexts, priorities, and personal judgments (for example, related to socioeconomics, geography, aesthetics, ethics, utilitarianism). Personal relationships among educators and publics, and trust issues, arise in this process. Public education in this light is dynamic and educational processes warrant development for improved effectiveness. Innovative approaches include multi-way collaborative information transfer sessions between representatives of science, management, politics, and other stakeholders regarding rationale for and ramifications of biodiversity conservation. Such cross-discipline working groups may develop into partnerships (discussed below) relative to specific projects.

Second, incentives are the current catch phrase used to maintain stakeholders' interests in voluntarily contributing to a conservation-based resolution of conflicting priorities regarding how to manage a place (for example, Shaughnessy and O'Neil 2001). For example, development of compensations for landowners who voluntarily devote time, space, or resources to biodiversity conservation or ecological stewardship may reduce their conflicts for economic gain. Such compensations may be related to tax breaks, or they may include socioeconomic gains or regulatory relief for landowners based on a sustainability ''certification'' of their lands or commodities from their lands. Certification is becoming a preferred tool in many instances because it clarifies to landowners the standards and measures needed for conservation and sustainability, while it confirms to the public that these measures have been utilized.

Development of such incentives could be derived from local, provincial, state, federal, or international programs or policies. Programs have been developed to engage landowners in a voluntary participation of ecosystem management or sustainability approaches with biodiversity objectives. An extreme permutation of such policies would be to make them authoritative, where nonregulatory incentives develop into legal requirements. Yet, in the United States, a policy or legal framework for biodiversity management or general ecosystem conservation has not been well developed. Here, states have a strong role in the protection of their resident species, and state regulations addressing biodiversity are few and lack specificity (Defenders of Wildlife 1995). Again, adaptive management serves this sociopolitical aspect of conservation, as programs and regulations are continually under development, scrutiny, and change.

Third, partnerships among neighboring landowners or stakeholders can clarify individual roles for local to regional conservation. However, collaborations and partnerships rely on trust and compromise, which may be difficult to achieve with a highly charged conflict about place. Nevertheless, partnerships may spread the measures to contribute to biodiversity conservation among many stakeholders, reduce the measures needed to be addressed by single landowners, and facilitate conflict resolution. Large scale landscape management planning may do this. For example, in Oregon the Coastal Landscape Analysis and Modeling Study examined the tradeoffs among forest uses among neighboring landowners, which serves to clarify contributions of different lands to land use goals (for example, Spies and others 2002). However, in this example the time and effort to assess large scale priorities among scientists, managers, and policy makers is enormous, and the need for institutional support surfaces as a major hurdle to complete the task (Spies and others 2002). Land management partnerships at smaller scales may be more tractable to implement, but accomplishing all resource priorities in a smaller area may be more difficult, and if biodiversity conservation is not to be compromised, they may provide less opportunity to address other resource priorities. Clarification of land management objectives and partner roles for biodiversity objectives across spatial scales is needed (Clark and others 1999). Cross-discipline working groups of stakeholders should be assembled early in the development of a project and retained throughout (Cowling and Pressey 2003).

Change in land use is a 4th tool that may effectively address sustainability objectives. The creation of national parks and national forests in the United States are historical examples of this tool, used to set aside public lands for specified purposes. Within national forests, land allocations further partition areas for different objectives. With lands administered by the federal Northwest Forest Plan, several reserved and nonreserved allocations exist, including Late-Successional Reserves, Administratively Withdrawn Areas, Congressionally Withdrawn Areas, Matrix, and Adaptive Management Areas (USDA and USDI 1993, 1994b). Additional layers of land use guidelines in this Plan include Key Watersheds, Resource Natural Areas, Riparian Reserves, and Spotted Owl and Marbled Murrelet Management Areas. Land use changes also result from habitat conservation plans or habitat prioritizations developed by many stakeholders including government agencies, private and industrial landowners, and environmental institutions (for example, Noss and others 1997; Shaughnessy and O'Neil 2001). These approaches need not be solely reserve-based, where set-asides for conservation are as islands within a managed matrix. As I presented earlier, a mix of reserves and a matrix managed with biodiversity objectives has been proposed as an effective design to retain key habitats, species, and processes (Shaughnessy and O'Neil 2001; Lindenmayer and Franklin 2002; Wessell 2005). For example, land exchanges, acquisitions or conservation easements are other mechanisms that can serve biodiversity conservation, and have been implemented by land trusts working with local governments and some environmental groups. Finally, land use changes are inevitable as populations develop and urban areas spread into agricultural or unmanaged lands, and with these changes come corresponding sustainability implications (for example, Alig and Kline 2002). The value in changes of land use by any of these mechanisms is that they can directly address conservation objectives and provide clarity to managers and stakeholders regarding the products and values expected to result from each place on the landscape.

Lastly, adaptive management is the cornerstone of conservation biology, yet it is not always an integrated piece of the process relative to on-the-ground applications for species or systems management. It is an easy concept to understand but is remarkably difficult to implement, and as a process it also requires development to improve effectiveness. Stankey and others (2003) identified several impediments to successful adaptive management in the federal Northwest Forest Plan. For example, an adaptive management philosophy views land management as an experiment where change is expected, yet forestry is traditionally a prescriptive application of standards and guidelines set by regulations. Adaptive management requires assessments of conditions, monitoring with time, a learning-based process with iterative knowledge syntheses, and evaluations of management approaches. Management resiliency to respond to new information requires new types of programmatic flexibility. Assessment and monitoring alone are daunting tasks (Noss 1999), and for an entire ecosystem they require a huge capacity of expertise and funds. However, some examples of adaptive management attempts under the Northwest Forest Plan are apparent (Stankey and others 2003). In particular, the Survey and Manage program for rare and little known species was learning-based (USDA and USDI 2000). New information was compiled for species in 2 contexts: predisturbance surveys looked for occurrences of species prior to land management activities, and strategic surveys were implemented to fill critical gaps in species information. For each species in the program, an Annual Species Review was conducted to compile new information that was evaluated relative to the conservation status of the species by scientists and managers (separately), and, as warranted, changes in species status resulted from a 3rd level evaluation by policy makers (USDA and USDI 2004c). Adaptive management was also conducted programmatically via 2 Environmental Impact Statements changing regulatory standards and guidelines. The 1st resulted in broad changes to clarify the program for easier implementation in 2000 (USDA and USDI 2000). In 2004, socioeconomic priorities and program redundancies were cited as rationale to fold these rare species into the existing federal agency sensitive and special status species programs (USDA and USDI 2004a, 2004b), and the program was eliminated. However, it was reinstated in 2006 by court order, showing a judicial role in program adaptive management.

Further program changes are anticipated to resolve ongoing issues.

SUMMARY

Conservation biology has grown tremendously in 25 y. I use the analogy of punctuated equilibria to describe the steps I have seen in its development. Although conservation biology appeared to emerge fully fledged at the outset, it has been undergoing considerable change, with 2 steps of change described here. One step has been that the concept of biodiversity has developed into a multi-faceted composite of life form composition, structure, function, and processes. It is complex to describe and is filled with unknowns, which lends to management intangibility. In-lieu surrogates for this composite are used, such as indicator species or habitats, and adaptive management must be applied to refine these approaches as knowledge develops. In particular, as new species, systems, or knowledge of management effectiveness accrues, adaptive management is applied to ''ratchet'' conservation biology to a new level, altering approaches to increase efficacy. In this way, conservation biology is a discipline undergoing continual revision—but at any 1 time, the ratchet is stationary, as a ''place holder'', where existing knowledge has been applied despite gaps and uncertainties.

A 2nd step of its punctuated equilibria is that conservation biology has developed from a discipline with purely biological roots to 1 which heavily relies on the social sciences to design effective land management strategies for multiple resource objectives. The merging of biosociopoliticoeconomic approaches to managing places (literally, place-holding) has not been smooth, and perhaps we are yet ''midstep''. Most conservation or landscape assessments retain more than traces of independently conducted considerations (biological, sociological, economic, political) rather than a synthetic approach. When considered separately, they become trade-offs, and conflicts easily arise as resource priorities are debated. The social sciences are where conservation research and development needs to focus now in order to develop effective tools to resolve conflicts about clarifying and managing for diverse objectives and to merge social and biological science assessments. Biodiversity conservation planning needs to become a more seamless entity of natural and social sciences, and advances are needed to address areas with persisting conflicts. These include educational processes, incentives, partnerships, land use changes, and adaptive management.

These are among several topics of current discussion in the US Pacific Northwest, where biodiversity conservation issues have come to the forefront of land management. Papers in this issue review key topics that have been raised as paramount to understanding patterns of change in biodiversity and to designing approaches to biodiversity maintenance or restoration (White and Molina 2006). Advancement of biodiversity conservation in these particular areas is an identified need in the Pacific Northwest, to move the ratchet 1 more tic.

ACKNOWLEDGMENTS

I am grateful to G Stankey, K Vance-Borland, R Molina and R White for comments and discussion on an early draft of this manuscript.

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