Annotated Bibliography

Biodiversity and Sustainable Forestry

By:
Dr. Toral Patel-Weynand

For:
National Commission on Science for Sustainable Forestry

X. Annotated Bibliography – Part 1

Abramovitz, J. 1991. Investing in Biological Diversity: U.S. Research and Conservation Efforts in Developing Countries. World Resources Institute. Washington, DC.

In 1990, the Center for International Development and Environment of the World Resources Institute conducted a survey of US-based organizations to solicit data on biological diversity research and conservation activities undertaken in developing countries in 1989. In all, 1,093 projects active in 127 developing countries were analyzed, and the $62.9 million invested in these projects represented a 68 percent increase over funding in 1987. The US government and charitable foundations each contributed over one-third of the total funding, revealing a seven-fold increase in foundation spending since the last survey in 1987. Compared to the amounts devoted to such other worthy endeavors as mapping the human genome ($3 billion), and measured against the pressing need to conserve the planet's biological wealth for the benefit of current and future generations, the total amount invested by the US in global diversity is still very small.

Agee, J. and D. Johnson, eds. 1988. Ecosystem Management for Parks and Wilderness. University of Washington Press. Seattle, WA.

A group of 33 managers, scientists and planners met in April 1987 to discuss and develop an improved conceptual management approach for park and wilderness ecosystems. The focus of this approach was cooperative ecosystem management, which recognizes that most ecological problems, whether biological, social, or both, are often unconstrained by political boundaries. There is now a recognized need not only for active management within park and wilderness boundaries, but for refined goals and implementation of cooperative management with neighboring landowners. The purpose of this book is to indicate why a new vision is necessary and to discuss strategies for cooperative management. There will never be a single blueprint, a cookbook approach that will fit every park and wilderness situation. Unique legal, biological, and social situations guarantee that individualistic solutions be defined, and that those solutions remain flexible to incorporate new information and values within the intent of Congress.

Agee, J. and D. Johnson. 1988. Introduction to Ecosystem Management. In: Ecosystem Management for Parks and Wilderness (J. Agee and D. Johnson, eds.). University of Washington Press. Seattle, WA.

To develop an improved conceptual approach to managing change in park and wilderness areas, 33 scientists, planners, and managers gathered for a workshop on April 6-10, 1987. A working definition of ecosystem for this forum was agreed upon: an ecosystem is any part of the universe chosen as an area of interest, with the line around that area being the ecosystem boundary and anything crossing the line being input or output. The ecosystem concept can be applied to all lands, not just those managed for natural values. Four biological and social system properties of ecosystems underlie successful environmental assessments and have implications for management: 1) Ecological systems are continually changing; 2) There may be substantial heterogeneity in impacts from a particular action; 3) Systems may exhibit several levels of stable behavior; and 4) There is an organized connection between parts, but everything is not connected to everything else. Given the political boundaries of park and wilderness ecosystems and unavoidable and uncertain human influence, change will occur in these systems. Given this reality, a four-step approach can be used as a process to meet park and wilderness ecosystem goals:

1) define goals and measurable targets for ecosystem condition;
2) define the ecosystem boundaries for the primary components;
3) develop management strategies to achieve goals that transcend political boundaries; and
4) establish a program to assess the effectiveness of the management strategies in achieving the identified goals.

Agee, J. and D. Johnson. 1988. A Direction for Ecosystem Management. In: Ecosystem Management for Parks and Wilderness (J. Agee and D. Johnson, eds.). University of Washington Press. Seattle, WA.

Successful management for the future of parks and wildernesses will necessitate "Thinking Like An Ecosystem", recognizing that the ecosystem concept includes social as well as natural components. For park and wilderness areas, ecosystem management is a way to produce desired conditions and preserve future options. Several principles or characteristics of ecosystem management that have emerged are:

1) Cooperation and open negotiation are important to success.

2) Different agencies and neighbors have different mandates, objectives, and constituencies, to which interested parties must be sensitive.
3) Success should be measured by results – progress toward goals of component condition and ecosystem maintenance – not by amount or quality of coordination.
4) Threshold management goals are established by the park and wilderness legislation.
5) Clearly defined problems have a greater chance of being resolved.
6) Over the long term, ecosystem management must accommodate multiple uses at a regional scale and dominant or restricted use at the unit or site scale.
7) High quality information is necessary to identify trends and respond to them intelligently and deliberately.
8) Social, political, and environmental issues must be viewed in a system context, not as individual issues.
9) All management is a long-term experiment, and decisions are always made with less than complete information.

The transition to ecosystem management in parks and wilderness will involve a gradual shift in management thinking and behavior. Top priority issues in ecosystem management are:

1) What are the important research needs associated with ecosystem management?
2) What are the important general management, planning, and communications issues associated with ecosystem management?
3) What are the important challenges to ecosystem management in the areas of conflict resolution and cooperation?
4) What are the important limits and constraints to ecosystem management?

Alig, R. 2000. Where Do We Go From Here? Preliminary Scoping of Research Needs. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

Preliminary findings from the 2000 RPA Assessment (2000 Renewable Resource Planning Act Assessment) indicate that approximately 15-20 million acres of US forestland may be converted to urban and developed uses over the next 50 years if historical trends continue. Such land use conversions may further fragment or parcelize forests. Fragmentation resulting from changing land use patterns is becoming an increasingly important topic in the US, with concerns being raised about habitat protection, timber supply, and myriad other issues. Although some wildlife species need edge areas caused by fragmentation of forest cover, forest fragmentation has many potential consequences that include loss of biodiversity, increased populations of invasive and non-native species, changes in biotic and abiotic environments, "edge effects", and decreased or more costly natural resource availability such as in the case of timber management. While recognizing substantial variation in fragmentation processes and patterns across the country, the following topics need further research:

1) Develop more rigorous definitions, recognizing the changes in land use, land cover, and ownership can result in a variety of fragmentation.
2) Better document forest fragmentation and parcelization, and develop a long term database.

3) Investigate cases of any forest fragmentation considering both natural and human-related factors.
4) Consider possible suite of consequences of forest fragmentation, including ecological and economic and economic impacts of forest fragmentation.
5) Augment policy analyses to mitigate impacts and/or modify fragmentation trends.

Alig, R., B. Butler, and J. Swenson. 2000. Fragmentation and National Trends in Private Forest Lands: Preliminary Findings From The 2000 Renewable Resource Planning Act Assessment. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

From the 2000 Renewable Resource Planning Act Assessment (2000 RPA), preliminary findings indicate that approximately 15-20 million acres of US forestland may be converted to urban and developed uses over the next 50 years if historical trends continue, and such land use conversions may further fragment or parcelize forests. The US population is projected to grow by another 120 million people by 2050, with relatively fast growth rates in the key timber supply regions of the South and Pacific Northwest. In addition to the projected changes in the total area of forestland, the forest cover dynamics are projected to significantly change the composition of forests, especially in the eastern US. The largest projected forest cover changes result from intensification of forestry practices in the southern US, where the area of pine plantations is projected to increase by over 50% over the next fifty years. In addition to the changes in the biologic composition of forests, changing landowner demographics that include increasing numbers of owners and increasing management objectives will also impact the forests.

Almekinders, C. and W. de Boef, eds. 2000. Encouraging Diversity: The conservation and development of plant genetic resources. Intermediate Technology Publications Ltd, London, UK.

Since the early 1980s, plant genetic resources have become a very hot global political issue, and much has changed in the principle and concept of ownership of plant genetic resources. This book and the associated workshop organized in 1997 in Baarlo, The Netherlands, provides a comprehensive and comprehensible array of experiences and insights on the science, ethics, economics, politics, dynamics, and significance of plant genetic resources. Distinguishing features of the workshop and this book are that all of the participants and authors have actually done something about plant genetic resources, whether on the ground; in advocacy; in negotiations; in policy; in research; or in programs on conservation and use. Both the workshop and the book helped to articulate a community-centered Gene Management System model, which recognizes that tribal and rural farming communities have a long tradition of serving as custodians of genetic wealth, particularly landraces often carrying rare and valuable genes.

Altieri, M. 1999. The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems and Environment 74: 19-31.

Increasingly, research suggests that the level of internal regulation of function in agroecosystems is largely dependent on the level of plant and animal biodiversity present. In agroecosystems, biodiversity performs a variety of ecological services beyond the production of food, including recycling of nutrients, regulation of microclimate and local hydrological processes, suppression of undesirable organisms, and detoxification of noxious chemicals. It is argued that because biodiversity mediated renewal processes and ecological services are largely biological, their persistence depends upon the maintenance of biological integrity and diversity in agroecosystems.

Amoros, C., G. Bornette, and C. Henry. 2000. Environmental Auditing: A Vegetation-Based Method for Ecological Diagnosis of Riverine Wetlands. Environmental Management 25 (2): 211-227.

The management of riverine wetlands, recognized as a major component of biodiversity in fluvial hydrosystems, is problematic. Preservation or restoration of such ecosystems requires a method to assess the major ecological processes operating in the wetlands, the sustainability of the aquatic stage, and the restoration potential of each riverine wetland. A method of diagnosis based on aquatic macrophytes and helophytes is proposed. Plant communities are used because they are easy to survey and provide information about: (1) the origin of a water supply and its nutrient content; (2) effects of flood disturbances; and (3) terrestrialization processes. The method is demonstrated on five different river systems.

Atamuradov, H., G. Fet, V. Fet, R. Valdez, and W. Feldman. 1999. Biodiversity, Genetic Diversity, and Protected Areas in Turkmenistan. In Contested Issues of Ecosystem Management (P. Corona and B. Zeide, eds.). The Haworth Press. Pages 73-88.

The information is presented on the independent state of Turkmenistan as a rich depository of unique biodiversity. Biodiversity in Turkmenistan is well-studied compared to many adjacent areas due to unique historical and political circumstances. Diverse mountain vegetation of the Kopetdagh Range – a depository of plant genetic diversity – is characterized in detail. Endangered species of large mammals are listed and their current status is outlined. Suggestions are made for conservation of biodiversity in Turkmenistan.

Barnes, B. K. Pregitzer, T. Spies, and V. Spooner. 1982. Ecological forest site classification. Journal of Forestry 80: 493-497.

An ecological method of multi-factor site classification, operational in southwestern Germany for over 30 years, was applied on the Cyrus H. McCormick Experimental

Forest in the Upper Peninsula of Michigan. Strong inter-relationships were found among physiography, soils, and vegetation, and these factors were used simultaneously in the field to distinguish and map ecosystems that recur in the landscape. Such ecosystem units form the basis for intensive multiple-use management. The method illustrates an alternative to single-factor and component methods and indicates the trend toward integration of the important factors in classifying and mapping ecosystems. Ecological site classification has arrived in Europe and Canada, and its time will come in the United States. Because US foresters will need increasingly detailed understanding of ecosystems and reliable productivity estimates as management needs intensify, the techniques and outcomes of current component methods in the US will evolve over time to more and more resemble those of the ecological approach described here.

Barthlott, W. and M. Winiger, eds. 1998. Biodiversity: A Challenge for Development Research and Policy. Springer Verlag, Berlin, Germany.

Biodiversity – sometimes understood simplistically as "diversity of species" – is a specific quality of life on Earth whose dimensions and importance have just lately been fully realized. Biodiversity is spread unequally over the world; in fact, the main share of biological resources worldwide is harbored predominantly by the so-called developing countries in the tropics and subtropics. This volume presents the proceedings of a symposium organized by the newly-established North-South Centre for Development Research (ZEF) in Bonn on biodiversity.

Bass, S. and M. Muller, eds. 1999. Protecting Biodiversity: National Laws Regulating Access to Genetic Resources in the Americas.

Within the countries of North and South America are found some of the most diverse collections of flora and fauna in the world. Colombia alone carries over 50 thousand different plant species. This precious resource, however, is quickly dwindling. Pharmaceutical and biotechnology companies are tapping America's genetic resources at an ever-increasing rate, and habitat destruction has pushed many species to extinction or to the brink of extinction. This book addresses one of the most fundamental aspects of this important issue: the lack of adequate national laws regulating access to, and compensation for, the use of local genetic resources. This book is the first to compare such laws and policies ranging across a range of countries in both the industrialized and developing worlds, including Argentina, Canada, Colombia, Costa Rica, Paraguay, Peru, and the United States. It also presents legal viewpoints, conclusions, and solid recommendations for future action.

Bekkering, T. 1992. Using Tropical Forests to Fix Atmospheric Carbon: The Potential in Theory and Practice. Ambio 21 (6): 414-419.

Tropical forestry has over the past decade received increased attention in view of its supposed potential to contribute to a reduction of the greenhouse effect. Two forestry strategies are described to this end: forest conservation and expansion of the forest area. For both strategies a realistic maximum area to be preserved/planted is estimated. It is concluded that from the viewpoint of sequestering carbon dioxide, 15 countries have a major potential for forest conservation, whereas afforestation efforts should concentrate in 11 countries. However, even if current efforts are increased substantially, the contribution to reducing the carbon content of the atmosphere is moderate at best. It is not realistic to boost tropical forestry for the sake of sequestering carbon alone, but efforts should focus on more direct benefits.

Bernardi, G. 1996. Genome Dynamics and the Generation of Biodiversity. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and F., T. Younes, eds.) CAB International, Wallingford, UK.

Some years ago Wilson and co-workers proposed that the higher rates of karyotypic change (changes in the morphological characteristics of the chromosomes in a cell) and species formation of mammals compared to cold-blooded vertebrates was due to the formation of small demes (or groups), as favored by the social structuring and brain development of the former. Here, evidence is reviewed which indicates that mammals are more prone to karyotypic change and species formation than cold-blooded vertebrates because of their different genome organization. Similar evidence has also recently become available for birds. Although this different organization appears to be a necessary and, in all likelihood, a sufficient condition for the increased rates of karyotypic change and species formation found in mammals, it is still possible that social structuring and brain development may have played an additional accelerating role.

Bishop, R. 1993. Economic Efficiency, Sustainability, and Biodiversity. Ambio 22 (2/3): 69-73.

An economy can be both efficient and sustainable, but efficiency does not guarantee sustainability. The safe minimum standard (SMS) for biological diversity illustrates the practical steps that could be taken to increase the likelihood that the economy is sustainable. Extinction threatens sustainability because it may affect the stability of economically important ecosystems and it may entail losses of plants, microorganisms, and animals that would otherwise have become important resources in the future. The stated policies of the US and many other countries are consistent with the SMS.

Boot, R. and R. Gullison. 1995. Approaches to Developing Sustainable Extraction Systems for Tropical Forest Products. Ecological Applications 5 (4): 896-903.

There are few if any examples of the demonstrably sustainable extraction of either timber or non-timber forest products. Potential extraction systems for timber and non-timber forest products from tropical forests must be evaluated both in terms of their sustainability and their impact at the ecosystem level. The impact of forest product harvest on the demographics of the target species can be explored with the use of mathematical models and the maximum sustainable level of harvest identified. With this information, an economic analysis of the range of harvest intensities between zero and maximum sustainable yield can be conducted, with the goal of identifying the range of harvest intensities that are both sustainable and economically viable. This range of harvest intensities should then be analyzed in terms of its impact on the ecosystem, to avoid forest impacts that are unacceptably high.

Boyce, M. and A. Haney. 1997. Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources. Yale University Press. New Haven, CT.

Many Americans perceive that many environmental regulations do not make sense. Some laws appear to be inflexible and seem not to recognize the importance of humans as integral components of ecosystems. Ecosystem management is about developing sound stewardship for natural resources while recognizing the value of biological diversity in formulating strategies for the use of natural resources. Ecosystem management is about putting people on the land and doing so in a way that doesn't degrade the very resources upon those people depend. Sustainable resource use is possible and necessary to ensure the future of life on this planet. This book explores ecosystem management, a crucial blend of science and management that is setting the stage for responsible stewardship of natural resources for the twenty-first century.

Burger, J. 2000. Landscapes, tourism, and conservation. The Science of the Total Environment 249: 39-49.

One key aspect of global change is a decrease in ecological integrity as more and more landscapes are developed, leaving a mosaic of intact refuges and degraded patches that may not be sufficient for conserving biodiversity. While increases in human population and shifts in the distribution of people affect land use, the temporary movement of people can have major implications for conservation and biodiversity. Three examples are presented where recreation/tourism can enhance the conservation of land on a landscape scale, leading to habitat protection and biodiversity preservation: (1) Shorebirds often require a matrix of different habitat types during migratory stopovers, and ecotourism can serve as a catalyst for landscape scale protection of habitat; (2) Riparian habitats can serve as corridors to link diverse habitat patches, as well as serving as biodiversity hotspots; and (3) Remediation and rehabilitation of contaminated lands, such as those of the US Department of Energy, aimed at developing recreational activities on uncontaminated portions, can be the most economical form of re-development with no increase in human or ecological risk.

Butler, B., S. DiFazio, M. Duane, T. Neal, and M. Stoddard. 2000. Meeting Reports: Sustainability and Biodiversity of Tropical Ecosystems Symposium held at Oregon State University, Corvallis, OR on May 27, 1999. Environmental Conservation 27 (1): 82-83.

A major paradox in conservation is that amongst the countries of the world, biological wealth correlates poorly with economic wealth. That is, much biological diversity is concentrated in non-industrialized countries with large impoverished populations. This situation has historically created conflicts between the need for economic development to meet the basic needs of rapidly increasing populations and the desire to preserve the integrity of ecosystems and conserve biodiversity. To increase the awareness and understanding of the issues of sustainability and biodiversity in tropical ecosystems, the symposium was held to focus on the causes and consequences of, and solutions to, deforestation, and the nature of biodiversity. Although the biological and social systems differ amongst tropical areas, some common causes, consequences, and solutions exist.

Cassel-Gintz, M. and G. Petschel-Held. 2000. GIS-based assessment of the threat to world forests by patterns of non-sustainable civilization nature interaction. Journal of Environmental Management 59: 279-298.

The paper presents a novel transdisciplinary approach to investigate non-sustainable civilization-nature interactions in the context of global change. The approach rests on the decomposition of intricate dynamics of Global Change into problematic patterns of civilization nature interactions ('syndromes'). These syndromes of global change characterize endangering and risky developments of civilization-nature interaction and represent a baseline for measuring and indicating non-sustainability; in order to have sustainable development, it is necessary to have a far-reaching absence of syndromes. The syndromes encompass the core patterns of global change, e.g., soil degradation, climate change, threats to biodiversity or global deforestation. The approach is illustrated by an analysis of civilization-nature interaction patterns for global deforestation, because global forest ecosystems play an important role in the global carbon cycle and their importance to biological diversity.

Chen, J., J. Franklin and T. Spies. 1992. Vegetation response to edge environments in old-growth Douglas-fir forests. Ecological Applications 2(4): 387-396.

Forest edges created by dispersed-patch clear-cutting have become a conspicuous landscape feature in western North America, but the effects of edge on forest structure and function are still poorly understood. This paper describes the responses of stocking density, growth, mortality, and regeneration for three conifer species (Douglas-fir, western hemlock, and Pacific silver fir) from the clear-cut edge into the interior of old-growth forest patches adjacent to 10-15 year old clearcuts in southern Washington and central Oregon. Statistically significant effects were found along the edge (forest-clearcut boundary line) for each of the above variables, and depth-of-edge influence (the point along the clearcut-forest gradient at which a variable has returned to 2/3 of interior forest habitat condition) ranged from 16 to 137 meters. The amount of square forest patch affected by edge decreased as patch size increased and varied greatly with the depth-of-edge influence. With increasing concerns about organism and processes that require interior forest habitat, determining the area of residual forest influenced by adjacent clearcut is critical to current and future resource management. Responses of additional biological variables must be explored and information on edge phenomena should be extended to the scale of landscapes.

Christensen, N., J. Agee, P. Brussard, J. Hughes, D. Knight, G. Minshall, J. Peek, S. Pyne, F. Swanson, J. Thomas, S. Wells, S. Williams, and Henry Wright. 1989. Interpreting the Yellowstone Fires of 1988: Ecosystem responses and management implications. Bioscience 39 (10): 678-685.

The Yellowstone fires of 1988 were distinctive for the intensity and scale of public and media attention given them, for the great costs of their attempted suppression, and for the timely test they provided for the management philosophies, policies, and programs of parks and wilderness areas. Increasingly, wilderness management has emphasized the preservation of natural processes rather than simply the preservation of natural features, objects, or scenes. The subversive consequences of halting natural succession and the futility of trying to recreate a former scene over large areas are now recognized. The landscape embodies chance as well as mechanism; there are those who would argue that chance itself is a value, that the unpredictable is the essence of the wilderness experience.

Christensen, N., A. Bartuska, J. Brown, S. Carpenter, C. D'Antonio, R. Francis, J. Franklin, J. MacMahon, R. Noss, D. Parsons, C. Peterson, M. Turner, and R. Woodmansee. 1996. The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. Ecological Applications 6 (3): 665-691.

Ecosystem management is management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function. The following are fundamental scientific precepts for ecosystem management: (1) Spatial and temporal scale are critical; (2) Ecosystem function depends on its structure, diversity, and integrity; (3) Ecosystems are dynamic in space and time; and (4) Uncertainty, surprise, and limits to knowledge. Ecosystem management is not a rejection of an anthropogenic for a totally biocentric worldview. Rather, it is management that acknowledges the importance of human needs while at the same time confronting the reality that the capacity of our world to meet those needs in perpetuity has limits and depends on the functioning of ecosystems.

Connell, J. 1978. Diversity in Tropical Rain Forests and Coral Reefs: High diversity of trees and coral is maintained only in a nonequilibrium state. Science 199(24): 1302-1310.

The commonly observed high diversity of trees in tropical rain forest and corals on tropical reefs is a non-equilibrium state which, if not disturbed further, will progress toward a low-diversity equilibrium community. This may not happen if gradual changes in climate favor different species. If equilibrium is reached, a lesser degree of diversity may be sustained by niche diversification or by compensatory mortality that favors inferior competitors. However, tropical forests and reefs are subject to severe disturbances often enough that equilibrium may never be attained. Although tropical rain forests and coral reefs require disturbances to maintain high species diversity, it is important to emphasize that adaptation to these natural disturbances developed over a long evolutionary period. In contrast, some perturbations caused by man are of a qualitatively new sort to which these organisms are not necessarily adapted. Tropical communities are diverse, thus species populations are usually smaller than those in temperate latitudes, which increases the chances that such new disturbances will cause many species extinctions.

Costa, P. 1996. Tropical Forestry Practices for Carbon Sequestration: A Review and Case Study from Southeast Asia. Ambio 25 (4): 279-283.

In order to fulfill their commitments to the UN Framework Convention on Climate Change, the industrialized countries started searching for cost-effective alternatives for reducing their greenhouse gas emissions. This has led to a rising interest in forestry-based carbon (C) offsets. Tree planting or silvicultural treatments can be used to actively remove carbon dioxide from the atmosphere. Alternatively, conservation practices or improved forest management can be used to prevent or reduce current trends of carbon release from existing forests. In this paper, a series of carbon offset projects are described and, in particular, a project involving planting of degraded forests in Sabah, Malaysia is described in detail.

Costanza, R., W. Kemp, and W. Boynton. 1993. Predictability, Scale, and Biodiversity in Coastal and Estuarine Ecosystems: Implications for Management. Ambio 22 (2/3): 88- 96.

This paper looks at coastal and estuarine ecosystems in terms of their unique biodiversity characteristics and the implications of these characteristics for management. With the exception of coral reef and other reef communities, coastal and estuarine systems are generally low in species diversity. But, estuaries are typically dominated by strong aperiodic physical forces and are also characterized by a high degree of organism mobility. These characteristics point to a high degree of ecosystem resilience. The general hypothesis is that the biodiversity achievable in a system is a function of the predictability and scales of its physical environment. This hypothesis is consistent with the limited data on diversity in estuaries and other systems. Biological or species diversity is put in a systems context as a scale-dependent measure of an important system characteristic. In estuaries, it is the diversity of ecological processes, and in particular certain keystone processes, that are more critical and that should be the focus of management efforts.

Council for Agricultural Science and Technology (CAST) Task Force. 1999. Benefits of Biodiversity. CAST Task Force Report 133.

Productive and efficient agriculture, which is the foundation of modern successful societies, has depended on biological diversity and will be even more dependent on it in the decades and centuries ahead. The earth's biodiversity is the source of all livestock, of all crops and pollinators of crops, of the biological agents that control crop pests, of many agricultural pesticides and pharmaceuticals, and of numerous ecosystem services essential to agriculture, including the renewal of their fertility. Expanding human activities are threatening this biodiversity, and thus compromising the long-term sustainability, productivity, and stability of agriculture and society. Based on review and synthesis of the scientific literature, the Task Force made three broad recommendations and identified associated actions: (1) preserve biodiversity by preserving natural areas; (2) preserve diverse sources of plant and animal germplasm for future agricultural use; and (3) increase the effective use of diversity in agriculture.

Daily, G. and P. Ehrlich. 1994. Population Extinction and The Biodiversity Crisis. In: Biodiversity Conservation (C. Perrings, K. Maler., C. Folke, C Holling, and B. Jansson, eds.) Kluwer Academic Publishers, London, UK.

Since biodiversity encompasses diversity of life ranging from genetic, population and species levels to community and ecosystem levels, the decay of biodiversity at the species level addresses only part of the picture of the extinction crisis. The great emphasis given to the issue of species extinction is in part an historical artifact. Important as is the loss of species, it should not obscure the intimately related and equally important problem of the extinction of populations. The health of the human economic system depends as much or more on the maintenance of population diversity as it does on the maintenance of species diversity. It is not known and may never be known how much population and species diversity can be lost without severely impairing ecosystem services. The best policy guideline remains the "rivet popper" analogy: Society should no more assume abundant functional redundancy among populations and species and exterminate them ad lib than a pilot should pop rivets from the wing of an aircraft and sell them based on a similar redundancy assumption. Any other assumption amounts to taking a gigantic gamble with the future of civilization.

Danida. 1999. Evaluation: WWF Project to Support The Convention on Biological Diversity. Ministry of Foreign Affairs, Denmark.

The Convention on Biological Diversity (CBD), which came into effect in 1993, is an international treaty that provides a framework of actions required to conserve the wealth of the planet's biological diversity, to ensure its use is sustainable, and that benefits arising from its use are equitably shared. The World Wide Fund for Nature (WWF) developed the Project to assist selected countries in meeting their obligations as signatories to the Convention. The evaluators concluded that the Project has made a significant contribution to the CBD's promotion, and to the implementation of many Convention Article elements at the local, national, sub-regional, regional, and international levels.

DeGroot, B. 2000. Reconnecting the Environment. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

Wildlife and plants isolated on "islands" of habitat face problems that endanger their recovery or may even lead to their demise. Fragmentation of habitat is the most severe threat facing many species, and the parks and forests created to protect them are often nothing more than isolated land compounding these problems. State and federal forest managers are increasingly seeking ways to re-connect together "islands" of habitats caused by fragmentation to allow seeds and genes to be disseminated more freely for all species. One of these ambitious projects will provide wildlife connecting corridors from the Yellowstone Park in Wyoming all the way through Canada in to Alaska. In an example at the state level, Maryland's Department of Natural Resources has created a program called the "Green Infrastructure" to link together isolated parks and forests under its management. Its purpose is to identify what areas have the greatest concentration of biological diversity, and decide how best to connect them with corridors to ensure permanently protected conduits for the movement of plants and animals.

de Jong, W. 1997. Developing swidden agriculture and the threat of biodiversity loss. Agriculture, Ecosystems and Environment 62: 187-197.

Indonesia has the world's third largest area of tropical forest. These forests are treasured for their high biodiversity, a result of the country's unique geographic positioning, but also as an economically important natural resource. It is still a commonly held belief that swidden agriculturalists are responsible for about half of Indonesia's deforestation. In order to solve this problem, the country has defined a number of measures that attempt to convert swidden agriculturalists into sedentary cultivators. With an example of swidden agriculture from West Kalimatan, including its important forest management component, this paper demonstrates that further developing existing swidden agriculture – forest management components into these measures holds the potential to bring economic development to the region, while biodiversity is conserved.

Denno, R. and M. McClure, eds. 1983. Variable Plants and Herbivores in Natural and Managed Systems. Academic Press. New York, NY.

The causes of spatial and temporal variation in host plants and the effects of variable resources on herbivores are currently receiving the attention of ecologists, evolutionary biologists, and agricultural, forest, and urban entomologists. Host-plant heterogeneity viewed at several levels may be a key to disclosing how and why seemingly disadvantaged plants are so successful despite their herbivores. Understanding the dynamics of plant-herbivore relationships and applying this knowledge in agriculture and silviculture are the themes of this volume. However, unlike previous books, this one emphasizes the individual, population, species, and community responses of herbivores to plant variation rather than the detailed nature of the variation. These are theoretical questions that now excite basic scientists and also offere material to applied biologists that may prove instrumental in establishing new crop and pest-management programs.

Denno, R. and M. McClure. 1983. Introduction -- Variability: A Key to Understanding Plant-Herbivore Interactions. In: Variable Plants and Herbivores in Natural and Managed Systems (R. Denno and M. McClure, eds.). Academic Press. New York, NY.

Superficially, plants appear to be at a disadvantage when compared to their herbivores in both ecological and evolutionary time. The reproductive potential of many herbivores is incredibly high, which seemingly poses a major threat to their host plants. Furthermore, how plants with relatively long generation times and low recombination rates stay in the evolutionary arms race is not immediately clear. However, plants are abundant and remain largely intact despite their herbivores, which would seem to be an apparent paradox. One explanation may be that the seeming advantages enjoyed by herbivores may be countered in part by the inherent variation of their hosts at various scales and the predicament this poses for them. Because of the profound, potentially negative effects of plant variability on herbivore abundance, it is not surprising that the reduction of interplant variability by agriculturists and silviculturists elevates some herbivores to pest status. However, the tables might be turned on herbivores by manipulating or exploiting host-plant variability to reduce pest density.

di Castri, F. and T. Younes, eds. 1996. Biodiversity, Science and Development: Towards a New Partnership. CAB International, Wallingford, UK.

This volume summarizes the materials emerging from an International Forum called "Biodiversity, Science, and Development: Towards a New Partnership" held in September 1994 in Paris, France. The forum was organized in a rather unusual way. Instead of the traditional lecture approach most common to scientific congresses, only round tables with a few panelists were organized. After a general framework given by the moderator, panelists made short and provocative interventions stimulating the debate among themselves and with the numerous participants on the floor. Time was then provided for an open discussion that was summarized at the end by the moderator. This volume reflects the peculiar patterns of the Forum and the different sections take largely into account not only the initial statements of the contributors, but also incorporate the main features of the subsequent discussion.

di Castri, F. 1996. Opening Address of IUBS. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and T. Younes, eds.) CAB International, Wallingford, UK.

There is no concept as fundamental, yet at the same time as controversial and as little understood, as the concept of biodiversity. It is a fundamental concept, because biodiversity is life, it is the variety of living organisms at different levels of integration.

The diversity of genes which make up the germplasm of a population (genetic diversity); the diversity of species, which all together shape a given ecosystem (specific diversity); and the diversity of ecosystems, which in their fragmentation or inter-penetration constitute a regional landscape (ecological diversity). The new concept of biodiversity emerges precisely from the interlocking of and the interactions among these three diversities. Biodiversity also gives us a framework for managing renewable natural resources, whether it is in the view of conserving biodiversity or putting terrestrial (agriculture, forests, breeding) or aquatic resources to use. Because of daily human contact with biodiversity, there are many connections between biological diversity and cultural diversity, hence the diverse ways of life and value systems that govern human societies.

di Castri, F. and T. Younes. 1996. Introduction: Biodiversity, the Emergence of a New Scientific Field – Its Perspectives and Constraints. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and T. Younes, eds.) CAB International, Wallingford, UK.

This paper discusses the perspectives and constraints that need to be addressed to establish biodiversity as a new scientific field. The perspectives include biodiversity as: 1) the unifying factor within the science of biology; 2) the cornerstone for agriculture, animal husbandry, forestry and aquaculture utilization; 3) the source of information for understanding the diversity of landscapes and the diversity of populations necessary for land use and regional development; 4) fundamental in the new era of industrial applications; 5) the tool to establish a much-needed bridge within the social and cultural role; and 6) a pillar of human development where a new synthesis between globalization and diversity is achieved. The constraints that need to be addressed include: 1) the current status of taxonomy; 2) measuring biodiversity; 3) the current dichotomy between the diversity agenda and priorities of industrialized countries of the North and developing countries of the South; 4) misconceptions in educational institutes and media that biodiversity is intrinsically opposite to economy and development; and 5) dealing with biodiversity requires dealing with a complex system that exhibits with non-linear behavior with a lower degree of predictability. To face this unpredictability, two principles should be adopted: the precautionary principle to keep options open for the future, and the principle of flexibility to maintain an adaptive potential and to choose the "right" way when confronted with the unavoidable and sudden bifurcations and surprises in the years to come.

Doing, H. 1997. The landscape as an ecosystem. Agriculture, Ecosystems and Environment 63: 221-225.

Landscape in this paper is defined as "a complex of geographically, functionally, and historically interrelated ecosystems" (also: "organized land"). For its planning and management, mapping of geomorphological, hydrological, and climatic conditions is crucial to understand the ecological patterns. To warrant the landscape's sustainability, its ecosystems' multiple and interdependent functions should be carefully identified on macro-, meso-, and micro-level. It is argued that, whereas a natural ecosystem is homogenous, the landscape ecosystem is heterogenous, for example in a mosaic or zoned way. Like evolution in organisms, succession in ecosystems tends to develop toward increasing independence from environmental fluctuations. On the contrary, landscape ecosystems have increasingly lost their regional autonomy over the decades as external input technologies became favored.

X. Annotated Bibliography – Part 2

Drever R. 2000. A Cut Above: Ecological Principles for Sustainable Forestry on BC's Coast. The David Suzuki Foundation. Vancouver, BC, Canada.

The fate of coastal temperate rainforests of the central and north coast of British Columbia is in dispute. In March 2000, the David Suzuki Foundation organized a millenium conference called Turning Point, which involved all of the stakeholders in BC. At the close of the conference, the DSF committed to produce a set of science-based principles to guide forest managers towards ecological sustainability. The nine guiding principles described in this report are meant to guide human behavior in the forests of British Columbia. They are based on the understanding that protecting biodiversity and ecosystem integrity is fundamental to the long-term health and productivity of British Columbia's coastal temperate rainforests and its coastal communities. The nine principles are:

1) Make ecological sustainability the fundamental objective of forest management.
2) Use a hierarchy of scales when planning forest practices.
3) Establish a rate-of-cut that does not compromise the long-term ecological integrity of landscapes and watersheds.
4) Engage local communities and incorporate local knowledge in establishing decision-making processes in planning forest management.
5) Conserve all native species and their habitats within the range of natural variability.
6) Protect hydroriparian areas and functions.
7) Focus silvicultural systems primarily on what is retained rather than what is removed.
8) Incorporate ecological restoration of degraded landscapes, stands, and sites into forest management.
9) Acknowledge uncertainty and monitor the ecological consequences of forest practices.

Duelli, P., K. Obrist, and D. Schmatz. 1999. Biodiversity evaluation in agricultural landscapes: above-ground insects. Agriculture, Ecosystems and Environment 74: 33-64.

In agriculture, sustainability can be linked to ecological resilience. In view of present or imminent environmental changes in agricultural landscapes, the diversity of species and genotypes, particularly of potential beneficials and alternative prey, may become of increasing importance. However, the available methods and empirical data concerning species diversity of above-ground insects in agricultural landscapes do not yet allow comprehensive evaluation. Methods for optimizing the reliability and comparability of faunistic inventories are proposed. In general, organismal biodiversity is higher in less intensively cultivated habitats. Apart from the impact of biocides, variation in species diversity often depends on the biodiversity of the surroundings (mosaic landscape) rather than on differing management regimes. The focus on preserving or enhancing, but also in evaluating biodiversity in cultivated areas thus should clearly be on the landscape level.

Duinker, P. 1996. Managing Biodiversity in Canada's Public Forests. In: Biodiversity, Science and Development Towards a new Partnership (di Castri, F., T. Younes eds.) CAB International, Wallingford, UK.

Conservation of forest biodiversity is taking center stage on Canadian forest management and policy agendas at every turn. Forest users and managers are putting biodiversity into their goal statements, yet few have developed firm ideas as to how to translate the concepts into concrete targets, and then to design appropriate and implementable schedules of biodiversity-conserving actions. During this century, timber-management practices and harvest of forest fauna have been the most influential factors degrading forest biodiversity in Canada's publicly owned forests. Climate change is the most serious potential future threat, and careful timber-management practices the main means of maintaining or restoring forest biodiversity. The guidelines approach to forest biodiversity conservation is gradually giving way to an adaptive management approach using explicit forecasts of the expected behavior of elements of forest biodiversity under a management regime. A combination of the species-by-species approach and the ecosystem diversity approach starts with two key departure points: the approach must be simple, and among-stand diversity is the place to start. The following indicators/scales begin addressing forest biodiversity in management of public forests in Canada: 1) Among-stand diversity – composition and structure; and 2) Special species – habitat carrying capacities and population viability. Enlightened forest managers and stakeholders are unlikely to want to maximize biodiversity, but rather to get it approximately "right". Getting biodiversity "right" in most cases will mean trying to conserve it at "natural" levels, but this will be difficult to define precisely. Using the among-stand diversity and provision of habitats for special species management approaches, along with the guidance emerging in the literature and the concepts of hierarchy of diversities, forest managers and stakeholders in Canada can aggressively pursue sustainable forest development through biodiversity conservation.

Ehrlich, P. and G. Daily. 1993. Population Extinction and Saving Biodiversity. Ambio 22 (2/3): 64-68.

In the past decade, a great deal of attention has been focused on the problem of protecting endangered species. Indeed, for historical reasons, biodiversity has largely been discussed by biologists in terms of the diversity of species, leading economists and others to reasonably conclude that conserving Earth's species diversity is the crucial task before us. But the loss of species is only one aspect of the extinction crisis, and in many parts of the world may not be the most important facet of the decay of biological diversity (biodiversity). This paper examines the complementary issue of the extinction of populations, offers a preliminary assessment of its importance relative to the extinction of species, and examines relevant policy implications.

Fajvan, Mary Ann. 2000. Effects of the Harvesting Practices on the Sustainability of Non-Industrial Private Forests. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

Short-term economic gains are driving the exploitive harvesting practices of maturing, second generation hardwood forests. Harvesting, in the form of silvicultural treatments aimed at stand development and species composition is not being practiced, especially on private land. Harvesting practices that focus on a particular stand component (sawtimber trees of select species) significantly alter stand structure and impact ecological sustainability. Because most stands contain a single cohort, harvesting only the largest trees of a particular species leaves behind less diverse stands of low vigor. Vertical canopy stratification is altered and large gaps are irregularly interspersed with tree clumps. Sustainability of eastern hardwood forests depends on ensuring a diversity of species in the next generation. With diameter-limiting harvesting targeting the removal of shade-intolerant, overstory tress, a reduction in species diversity may occur.

Falk, D., C. Millar, and M. Olwell. 1996. Restoring Diversity: Strategies for Reintroduction of Endangered Plants. Island Press, Washington, DC.

The reintroduction of endangered plants is the theme of this book around which a variety of recovery efforts and restoration projects is described. One of the major challenges is linking restoration ecology to the main body of ecological theory. Ecological restoration and species reintroductions must be an integral part of conservation strategy. Opportunities for restoring biodiversity are everywhere, if only because damage is everywhere. Virtually all of the case studies described in this book are small restoration projects for individual rare species, which has been the state of the art. Will lessons from small-scale experiments transfer readily to regional experiments? The importance of context is also emphasized by the editors: "There can be no successful reintroduction of any organism, or restoration of any community, unless these individual efforts are part of healthy, intact, functioning, and diverse large-scale ecosystems."

FAO [Food and Agriculture Organization of the United Nations]. 1993. State of the World's Forests. FAO. Rome, Italy.

Forests are complex ecosystems capable of providing a wide range of economic, social, and environmental benefits. While forests and woodlands are now recognized as essential for human life, their benefits and services are valued differently by different people and different groups. Moreover, the numerous roles that forests are expected to play in local, national, and global development continue to change over time. These shifting and sometimes conflicting expectations create difficult policy challenges related

to both the forest sector and national development. This report synthesizes information from multiple FAO reports analyzing the state of forest resources and the role of forests in sustainable development to serve as background to the FAO's report to the Secretariat of the Commission on Sustainable Development.

FAO [Food and Agriculture Organization of the United Nations]. 1993. The challenge of sustainable forest management: What future for the world's forests? FAO. Rome, Italy.

This book grew out of the Tenth World Forestry Congress in 1991. The Paris Declaration called on the world's decision makers to raise awareness and inform the public so that forest issues could be better understood and appreciated. Greater public awareness by itself will not result in the management of forests on a sustainable basis. The public has to be involved in the debate and decisions on the development of systems of management for all types of land use. The requirements for sustainable forest management include not only the involvement of people but also the availability of appropriate techniques and adequate finance. In addition, ways must be found to solve or alleviate the many economic and social problems which, although arising outside the forests, have major impacts on the forest resource. This book is a contribution not only to increasing public awareness of the issues involved but also eventually to the implementation of sustainable forest management and of sustainable land use.

Fauvel, G. 1999. Diversity of Heteroptera in agroecosystems: role of sustainability and bioindication. Agriculture, Ecosystems and Environment 74: 275-303.

Heteroptera represent an important part of the global insect fauna in many crops, more on the basis of their numbers than biomass. From 50 to 100 species have been recorded in the most exhaustive censuses of fruit trees or low growing crops, about half of which are really important. The influence of the environment on the recolonization of cultivated plots by these families has been shown for fruit trees (apple and pear) and some low-growing crops (potatoes). Their sensitivity to ecological factors and to the secondary effects of phytosanitary sprays are features that make Heteroptera potentially good indicators of ecological change.

Frank, D. and S. McNaughton. 1991. Stability increases with diversity in plant communities: empirical evidence from the 1998 Yellowstone drought. OIKOS 62(3): 360-362.

The authors studied the hypothesis that species diversity of ecological communities contributes to stability. They found that stability of plant community species composition increases with diversity in grasslands of Yellowstone National Park. The authors noted that community diversity was attributed to spatial heterogeneity of the community, thus suggesting that pattern diversity may be a contributing factor to ecological stability.

Franklin, J. 1993. Preserving Biodiversity: Species, Ecosystems, or Landscapes. Ecological Applications 3 (2): 202-205.

Efforts to preserve biological diversity must focus increasingly at the ecosystem level because of the immense number of species, the majority of which are currently unknown. An ecosystem approach is also the only way to conserve processes and habitats (such as forest canopies, belowground habitats, and hyporheic zones) that, with their constituent species, are poorly known. Continued concern with species is essential, however. Landscape-level issues also need much greater attention. Designing an appropriate system of habitat reserves is one landscape-level concern. Understanding and appropriately manipulating the landscape matrix is at least as important to reserves issues, however, since the matrix itself is important in maintaining diversity, influences the effectiveness of reserves, and controls landscape connectivity.

Franklin, J., D. Perry, T. Schowalter, M. Harmon, A. McKee and T. Spies. 1989. Importance of ecological diversity in maintaining long-term site productivity. In: Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystems (D. Perry, R. Meurisse, B. Thomas, R. Miller, J. Boyle, J. Means, C. Perry, and R. Powers, eds.) Timber Press, Portland, OR.

Long-term site productivity is ultimately dependent upon ecosystem resilience – an ability to absorb stress or change without significant loss of function – and not simply soil properties. Forest ecosystems are faced with dramatic changes in climate, pollutants, and pests and pathogens. These uncertainties, coupled with our demonstrably inadequate knowledge of ecosystem function, strongly indicate management approaches which retain the genetic, structural, landscape, and temporal diversity critical to resilience. Current management emphases simplify forests. Alternative management programs that retain diversity, including schemes which accommodate early successional species, provide for coarse, woody debris, create mixed stands, protect streamside habitats, and provide for diverse and functional landscapes, are suggested. Foresters must manage to retain greater ecological margins in order to sustain long-term productivity and buffer against uncertainties.

Fry, G. 1991. Conservation in Agricultural Ecosystems. In: The Scientific Management of Temperate Communities for Conservation (I. Spellerberg, F. Goldsmith, and M. Morris, eds.) Blackwell Scientific Publications, London, UK.

The link between agriculture and landscape is very intimate. Without agriculture, many landscape types valued for their rich biological diversity, scenic qualities or cultural significance, would not exist. Such landscapes shaped by and dependent upon agricultural activity can be termed “cultural landscapes”. In Europe, threats to conservation interests on agricultural lands include intensification and specialization, abandonment of marginal farming areas to become scrub woodlands or non-native forests, consolidation of ownership, increased use of agrochemicals, drainage schemes that remove wetlands, and habitat loss and modification on semi-natural habitats. If public support for wildlife and landscape conservation continues to grow, even more conservation initiatives on agricultural land will be seen. For wildlife conservation, areas managed primarily for nature conservation can be considered the apex of a pyramid supported by the remaining semi-natural habitats in the countryside, which are further supported by the habitats on farmland. This can be translated into a conservation strategy that places the highest priority on safeguarding nature reserves and protected areas, accepts the need to conserve semi-natural habitats in the general countryside, and emphasizes the need to enhance wildlife habitats on farmland.

Gadgil, M. 1993. Biodiversity and India's Degraded Lands. Ambio 22 (2/3): 167-172.

"Ecosystem people" of the world subsist by producing or gathering a diversity of biological resources from their immediate vicinity. Their quality of life is intimately linked to the maintenance of modest levels of biodiversity in their own circumscribed resource catchments. Their resource base has been extensively degraded by pressures created by "biosphere people", i.e., the Third World elite and citizens of industrial countries, who can draw resources from all over the world and are thus indifferent to environmental degradation in the Third World. Because "ecosystem people" have a genuine stake in biodiversity maintenance in their immediate surroundings, it is important that conservation efforts include maintenance and restoration of at least modest levels of biodiversity throughout the Third World. Five initiatives are presented that would support the achievement of this goal in India.

Gerakis, A. and K. Kalburtji. 1998. Agricultural activities affecting the functions and values of Ramsar wetland sites of Greece. Agriculture, Ecosystems and Environment 70: 119-128.

Agricultural activities in the agroecosystems neighboring wetland ecosystems are considered a major threat to the latter in all Mediterranean countries. The threat was investigated in thirteen internationally important wetland sites of Greece. It was found that the Adamus' Wetland Evaluation Technique is useful even in the little studied Ramsar sites of Greece. The study concluded that the sustainability of wetland ecosystems depends to a significant degree on the sustainability of agroecosystems. The reverse is also true because wetlands provide irrigation water, crop pollinators, some frost protection, and predators of crop pests. Therefore, a national policy for the sustainable development of the soil, water, and genetic resources of Greece must integratively consider both these ecosystem types.

Goldsmith, F.B. 1991. The Selection of Protected Areas. In: The Scientific Management of Temperate Communities for Conservation (I. Spellerberg, F. Goldsmith, and M. Morris, eds.) Blackwell Scientific Publications. London, UK.

Over the last ten years, a shift has occurred from scientific criteria to more aesthetic or cultural ones for the selection of sites for nature conservation. There has been a shift from a single-purpose conservation towards identifying the differing objectives of different safeguarding operations, i.e., recognizing that some sites are for species protection whereas others are for some human purpose such as education. This can be particularly important in the urban context. The formal or "scientific" criteria have their role on the national and international scale but elsewhere the objectives of the exercise should be very carefully identified. If the purpose of the exercise is identified then the criteria are likely to be identified more readily. There are usually problems of scale and of measurement and it is important to recognize that these may affect the choice of criteria. Because organisms in nature reserves are isolated and often vulnerable, more emphasis needs to be placed on the matrix of the countryside. Simple and appropriate selection strategies that incorporate criteria that meet combined objectives should be devised. It may be better to consider "Heritage Areas" that recognize the importance of landscape, archaeology, history, culture, amenity, recreational, and educational use as well as nature. Such an approach would ensure greater public support and more effective protection for highly valued resources.

Gower, S., C. Grier, and K. Vogt. 1989. Aboveground production and N and P use by *Larix occidentalis* and *Pinus contorta* in the Washington Cascades, USA. Tree Physiol. 5(1): 1-11.

This study compared the aboveground net primary production (ANPP) and nitrogen (N) and phosphorus (P) use efficiencies of two conifers, the deciduous western larch (*Larix occidentalis* Nutt.) and the evergreen lodgepole pine (*Pinus contorta* Dougl. var. *latifola* Engelm.) in the Cascade Mountains of Washington. The study found that ANPP and production efficiency (ANPP/foliage mass) were similar in these species when needle longevity is taken into account. Western larch and lodgepole pine retranslocated 87 and 66% of foliage N and 66 and 78% of foliage P, respectively. At the stand level, N use efficiency of western larch was greater than that of lodgepole pine, whereas P use efficiency of lodgepole pine was greater than that of western larch. The efficient use of N, high specific leaf area, and low initial cost of foliage construction allow the western larch to overcome its deciduous nature and inhabit the relatively harsh forests of the Northern Hemisphere. Conversely, the greater needle longevity of the lodgepole pine enables it to overcome relative deficiencies in these factors.

Grier, C. and R. Logan. 1977. Old-growth *Pseudotsuga menziesii* communities of a western Oregon watershed: Biomass distribution and production budgets. Ecological Monographs 47(4): 373-400.

The primary objective of this study was to measure and compare biomass and production budgets of plant communities in the diverse habitats of a small watershed in the western Cascade mountains of Oregon. Living biomass, organic matter distribution, and organic matter production budgets were determined for plant communities dominated by 450-year old *Psuedotsuga menziesii* (Mirb.) Franco forests. Total tree biomass of the various communities was more related to past mortality than habitat differences. Biomass of standing dead trees and fallen logs was generally inversely related to aboveground tree biomass. Aboveground tree biomass increment was negative in all communities. Aboveground net primary production in the various communities was roughly proportional to standing biomass, and consisted entirely of detritus. Available evidence indicates larger peak biomass in seral *P. mensiesii* than in climax *Tsuga heterophylla* forests. These communities may be in the process of declining from seral peak to steady-state climax biomass.

Hartshorn, G. 1995. Ecological Basis for Sustainable Development in Tropical Forests. Annual Review of Ecology and Systematics 26: 155-175.

Unless sustainable development becomes much more prevalent in tropical forests, appreciable areas of unprotected tropical forests will not survive far into the twenty-first century. Sustainable tropical forestry must integrate forest conservation and economic development. Key ecological factors discussed here include: reproduction, natural regeneration, growth, ecosystem functions, and biodiversity conservation. Four models of sustainable tropical forestry are described: (1) the PORTICO company industrial timber operation in Costa Rica; (2) the Yanesha Forestry Cooperative operation in the Peruvian Amazon; (3) community-based production of non-timber forest products; and (4) locally controlled nature tourism.

Hawksworth, D. 1996. Microorganisms: The Neglected Rivets in Ecosystem Maintenance. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and T. Younes, eds.) CAB International, Wallingford, UK.

Microbes have existed for over 3.5 billion years: they shaped the Earth's atmosphere, first colonized land, combined to make cells, recycle elements, and mediate key life processes. Current knowledge gaps are immense: less than 5% of the fungi, bacteria and viruses on Earth have been named, and little is known of the range, ecological requirements, and roles of those that have. Although some ecological processes depend on a few microbial species, the extent to which there is real duplication of function is obscure; in any case, replication in any function increases resilience to perturbations. The roles of microorganisms in different ecosystems are diverse, but the communities most at risk from reductions in microbial diversity are those in extreme environments, the boreal and temperate forests, and the oceans. The current level of ignorance of most microorganism groups (the "microbial knowledge gap") has major implications for biodiversity conservation and sustainable use: microbially-mediated ecological processes should be monitored, the protection of undisturbed habitats is essential to microbial conservation, and consolidated international action is needed to provide the microbial data pertinent to ecosystem maintenance.

Heal, Geoffrey. 1999. Markets and sustainability. The Science of the Total Environment 240: 75-89.

Do markets lead us to make sustainable choices? If not, why not? And what would we need to do to remedy this? This paper takes a preliminary look at these questions. It identifies three categories of reasons why market choices may not be sustainable, related to valuation of the future, recognition of the benefits provided by environmental assets, and incorrect incentives. It gives examples of cases in which these problems have been corrected, and considers the scope for a more positive relation between market forces and conservation of the environment.

Heywood, V. (exec. ed.). 1995. Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press. Cambridge, UK.

Biodiversity represents the very foundation of human existence, but heedless actions are eroding this biological capital at an alarming rate. UNEP has played a key role in the development of the issues relating to biodiversity, and in this spirit commissioned the Global Biodiversity Assessment (GBA) project. Underlying this endeavor was an attempt to mobilize the global scientific community to analyze the present state-of-the-art knowledge and understanding of biodiversity and the nature of our interactions with it. The GBA is an independent critical, peer-reviewed scientific analysis of the current issues, theories, and views regarding the main aspects of biodiversity. The Assessment does not concern itself with the assessment of country-level or regional biodiversity.

Holdgate, M. 1989. Conservation in a world context. In: The scientific management of temperate communities for conservation. The 31st symposium of the British Ecological Society, South Hampton. (I. Spellerberg, F. Goldsmith and M. Morris, eds.) Blackwell Scientific Publications. Oxford, UK.

Ecology has a major contribution to make to the primary mission of the International Union for the Conservation of Nature and Natural Resources (IUCN) to create an enduring harmony between humanity and the natural environment that sustains our species, but in ways that go wider than the traditional roles of science. “Management” can be defined as human intervention in the dynamic processes which determine the composition of plant and animal communities, so as to maintain a particular desired pattern or series of processes. “Conservation” is here taken to be a wider process of sustainable management of renewable natural resources, as an essential foundation for the human future on this planet. Although the temperate communities are not great reservoirs of biological diversity, the scientific management of temperate communities for conservation is critical since the sustainable development of the temperate zones is essential for the human future, and the preservation of such diversity as they exhibit is important. Moreover, because these ecosystems are relatively well known, and their management receives greater resources than in most tropical areas, work here can be a valuable source of knowledge and methodology. In particular, such work can emphasize:

1) the value of detailed scientific insights obtained through the study of key elements in temperate ecosystems and species;
2) the value of temperate communities in their own right as components of global diversity and as valued features of the countries in which they occur;
3) the value of demonstrating in the temperate regions how human populations and demands can be brought into balance with ecosystems;
4) the use of temperate examples to demonstrate the management techniques available to implement strategies for conservation and sustainable development; and
5) the utility of ecology as a basis for both conservation for human use and conservation of the diversity of nature in its own right.

However, it is crucial that temperate zone ecologists are outward looking and involve themselves in the daunting problems of the tropical zones.

Holling, C. 1996. Biological Foundations for Sustainability and Change. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and T. Younes, eds.) CAB International, Wallingford, UK.

Perceptions, problems, and policies are formed as much by images of the world as by the world itself. The way key subcultures in the natural and social sciences view the world is converging around theories of change. Those theories rationalize the paradoxes of stability and instability, of order and disorder or of stasis and evolutionary change. The image of Nature Resilient as one in opposition to that of Nature Evolving is only apparent. The appropriate image is of Nature Resilient and Evolving, since both attributes of flexible persistence and of experimentation interact. Since those are the same apparent paradoxes inherent in the goal of sustainability and development, an avenue opens for directly relevant cooperation between critical parts of science and policy. Complex living systems need both stability and change. The first is provided by resilience – properties that allow a system to be subjected to external change and still persist in its basic operations and functions. Diversity of number of controlling species or entities, and diversity of those entities in space provide the enduring foundations for resilience. However, if that was all, such persistence would be stasis – systems doomed to repeat identical cycles on a wheel of determinism. Opportunity for novelty emerges because such cycles inexorably go through brief periods of disorganization and turbulence where unexpected events and novel combinations can seed a different future. Such experiments can be ever-repeated without persistent chaos for the whole because of the integrity provided by the hierarchical structure. The more these localized vulnerabilities sat one level start to connect with similar vulnerabilities at neighboring levels, the more turbulent and sweeping the possible transformations. Protecting and restoring the diversity of life is one of the foundations for sustainability. But sustainability is not just for ecological or social or economic reasons. Sustainability as a single goal and a single focus could lead to stasis and rigidity unless the opportunities are available for evolutionary change, i.e., for human development in its deepest sense of physical, intellectual, and spiritual well-being.

Hull M., R. Bruce, J. Johnson, and M. Nespeca. 2000. Forest Landowner Attitudes Toward Cross-Boundary Management. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

Ecosystem processes and function do not stop at political boundaries. Increased fragmentation of land ownership thus presents a challenge to ecosystem management goals. However, a fragmented ownership pattern need not produce a fragmented forest if landowners coordinate their management goals. This article focuses specifically on fragmentation occurring in forested landscapes in the Southern US. The land fragmentation in this region seems likely to continue, if not accelerate, in a market response to the increasing demand for and supply of forest ownership. Despite the concern about property rights and the old adage that good fences make good neighbors, findings suggest that forest owners will implement management practices that cross property boundaries and respond to the larger temporal- and spatial-scale issues of ecosystem management. Perhaps the most significant finding of this study is that so few landowners said unequivocally that they would not participate in such practices. It appears as if the landowners who currently don't engage in these practices would do so if policies were implemented and funded that provide the needed money, knowledge, and personnel to implement these practices well.

Hunsaker, C. 1993. New concepts in environmental monitoring: the question of indicators. The Science of the Total Environment, Supplement 1993: 77-95.

Current environmental issues such as declining biodiversity, sustainability of ecosystems, and global atmospheric change are manifestations of multiple stresses. The need to establish baseline ecological conditions as a reference for assessing future change has grown more acute with the increasing scale of environmental issues. This paper discusses the indicator framework for the United States Environmental Monitoring and Assessment Program, the linkage between indicator selection and successful assessment, and the status of indicator selection in 1992.

Huston, M. 1994. Biological Diversity: The coexistence of species on changing landscapes. Cambridge University Press, Cambridge, UK.

This review and synthesis of the patterns and theories of biodiversity provide a firm scientific basis for the study and management of the Earth's biosphere. Beginning with a practical definition of biodiversity and an overview of diversity patterns on Earth, the book develops a conceptual framework that extends traditional theories of species diversity to explain both the general patterns of diversity and the apparent exceptions to these patterns. Many of the major concepts in ecology are incorporated into the framework for understanding patterns of diversity on landscapes. Case studies apply the theories and models described.

Irwin, L. and T. Wigley. 1993. Toward an Experimental Basis for Protecting Forest Wildlife. Ecological Applications 3 (2): 213-217.

Social and economic debates over allocation of old-growth forests have spawned conservation strategies that are aimed at protecting sensitive wildlife species while allowing limited timber harvesting. The authors are interested in improving the scientific underpinnings for such conservation strategies, because doing so might both minimize costs of resource development and provide more reliable protection. In this paper, they discuss potential consequences from inductive inferencing systems, and conclude use of such soft systems could result in conservation strategies that fail to meet intended goals. Greater emphasis should be placed on hypothetico-deductive inferencing processes that vigorously apply adaptive management techniques. Such processes simultaneously test alternative landscape patterns and forestry options as rigorous management experiments, and thus could incrementally predicate forest policy upon an experimental basis.

Johnson, K., K. Vogt, H. Clark, O. Schmitz, and D. Vogt. 1996. Biodiversity and the productivity and stability of ecosystems. TREE 11 (9): 372-377.

Resolution of the relationships between the diversity of life forms occupying ecosystems and the behavior of those systems is a prime directive of ecological research. The problem ultimately encompasses all questions about how species coexist and how communities of populations influence ecosystem performance. Early theoretical discussions established the axiom that diverse, complex ecological communities are the most stable. Results of some field studies in the 1960s and 1970s began to challenge the universality of this paradigm. Theoretical advances based on mathematical modeling indicated that the nature of the species interactions, rather than species number alone, determines the stability of ecological systems. Recently, growing concern over the loss of biodiversity and new empirical evidence has prompted revisitation of the idea that species diversity enhances the productivity and stability of ecosystems.

Kareiva, P. 1994. Diversity begets productivity. Nature 368: 686-687.

The Ecotron at Silwood Park, Berkshire, UK consists of 16 environmental chambers, and have been used to replicate terrestrial communities that differ only in their biodiversity. Of the ecosystem processes observed, only productivity and respiration exhibited clear patterns with respect to the manipulation of biodiversity, with productivity increasing two- to three-fold as biodiversity was increased two- to three-fold. Studies of microcosms in Ecotron chambers will never replace field experiments or exploration of naturally occurring patterns, but does promise to provide an important counterpoint to the large-scale global monitoring and long-term data sets seen as necessary research tools for addressing global environmental concerns.

Keenan, R., D. Lamb, O. Woldring, T. Irvine, and R. Jensen. 1997. Restoration of plant biodiversity beneath tropical tree plantations in Northern Australia. Forestry Ecology and Management 99: 117-131.

Understory colonization by native species was assessed in timber plantations on the Atherton Tablelands in North Queensland, Australia (latitude 17^o S). The survey included 151 plots (each 78.5 m^2 in area) in plantation monocultures of the *exotic Pinus caribaea* and the natives *Araucaria cunninghamii*, *Flindersia brayleyana*, and *Toona ciliata* ranging in age from 5 to 63 years. On similar sites, *F. brayleyana* had a significantly greater number of colonizing species than *A. cunninghamii* which, in turn, were significantly greater in number than *P. caribaea*. Tree species richness and the number of species regarded as "late successional" increased significantly with age for the two species where a range of ages was measured. The distance from the rainforest to the plantation edge generally had little effect on the number of tree species. Between 80 and 90% of the tree species were primarily bird-dispersed. The implications of these results for conservation of biodiversity and ways of managing plantations to conserve this diversity are discussed.

Kennedy, A. and K. Smith. 1995. Soil microbial diversity and the sustainability of agricultural soils. Plant and Soil 170: 75-86.

Many world ecosystems are in various states of decline evidenced by erosion, low productivity, and poor water quality caused by forest clearing, intensive agricultural production, and continued use of land resources for purposes that are not sustainable. The biological diversity of these systems is being altered. Ecosystem functioning is governed largely by soil microbial dynamics, but little research has been conducted to quantify the beneficial relationships between microbial diversity, soil and plant quality, and ecosystem sustainability. Microbial populations and their responses to stresses have been traditionally studied at the process level, with little attention paid to responses at the community or organismal levels. Microbial communities, which also comprise complex interactions between diverse organisms, and their processes need to be examined in relation to not only the individuals that comprise the community, but the effect of perturbations or environmental stresses on those communities.

Kessler, W., H. Salwasser, C. Cartwright, Jr., and J. Caplan. 1992. New Perspectives for Sustainable Natural Resources Management. Ecological Applications 2 (3): 221-225.

The USDA Forest Service is taking a new direction in its research and management programs in response to changing views of land and natural resources. The changes reflect the complexity of society's concerns and expectations for national forest management, including biological diversity, ecological function and balance, product yields, social values, and the beauty and integrity of natural environments. The new direction involves a shift in management focus from sustaining yields of competing resource outputs to sustaining ecosystems. More than ever, management of public lands and resources requires knowledge about ecosystems, including relationships to human values, activities, and patterns of resource use.

Khasa, P. and B. Dancik. 1997. Sustaining Tropical Forest Biodiversity. In Sustainable Forests: Global Challenges and Local Solutions (O. Bourman and D. Brand, eds.). The Haworth Press.

Tropical forests are very rich in biological diversity and form an important economic and ecological resource. This biodiversity is of great value for communities living in or near these forests as a ready source of subsistence and cash income, and for the world at large as a source of tropical timber and non-timber products and a repository of genetic and chemical information. However, this biological complexity is diminishing rapidly. The main human (anthropogenic) actions causing loss of tropical forest biodiversity along with the strategies of management for forest biodiversity are analyzed. Not only is the biophysical component important in management for biodiversity, but the active participation and support of local people, the national government, and international cooperation as a whole, are essential for an effective and sustainable development of tropical forests.

Kimmins, J.P. 1999. Biodiversity, Beauty and the "Beast": Are beautiful forests sustainable, are sustainable forests beautiful, and is "small" always ecologically desirable? The Forestry Chronicle 75 (6): 955-960.

Biological diversity is our planet's inheritance from millions of years of evolution. The idea has developed that in western society that if something looks "nice", it must always be ecologically superior and better for biodiversity than something that is visually undesirable. There is also the idea, which appeals equally to our sensibilities, that there is a "balance of nature", that nature seeks and needs an equilibrium condition, and that change in this condition is bad. Ecosystem change and disturbance are seen as threats to both the survival of nature and to biodiversity. There is no evidence that such generalities are true, and lots of evidence they are not. The key message is that we should let knowledge of the ecological and biological diversity of forests, and the associated values we wish to sustain, play a major role in deciding how the many different kinds of forests in the world should be managed. Any one single forestry policy or management method must not be applied everywhere, and important aesthetic considerations must be balanced with the ecology of the values to be sustained.

Kohm, K. and J. Franklin. 1997. Creating a Forestry for the 21st Century: The Science of Ecosystem Management. Island Press. Washington, DC.

Over the past decade, a sea change has occurred in the field of forestry. A vastly increased understanding of how ecological systems function has transformed the science from one focusing on simplifying systems, producing wood, and managing at the stand-level to one concerned with understanding and managing complexity, providing a wide range of ecological goods and services, and managing across broad landscapes. This book is an authoritative and multidisciplinary examination of the current state of forestry and its relation to the emergent field of ecosystem management. Drawing upon the expertise of top professionals in the field, it provides an up-to-date synthesis of the principles of ecosystem management and their implications for forest policy.

Kuusipalo, J., J. Kangas, and L. Vesa. 1997. Sustainable Forest Management in Tropical Rain Forests: A Planning Approach and Case Study from Indonesian Borneo. Journal of Sustainable Forestry 5 (3/4): 93-118.

When planning for sustainable forest management, economic, environmental and social demands often conflict. Forest management in Southeast Asian tropical dipterocarp forests has been particularly biased to wards maximizing immediate economic return from extensive logging. This paper describes a case study within a rain forest logging concession in Indonesian Borneo. The study uses the Analytic Hierarchy Process method for resource allocation and priority setting to identify an optimal strategy which yields a sustained economic output from timber production, while at the same time being environmentally and socioculturally sustainable. Despite their relatively high costs, strategies involving selective harvesting combined to complete restoration of original dipterocarp stock in logged-over areas were superior in terms of economic, environmental, and social sustainability. Priorities set by local communities for the strategies to meet their socioeconomic and cultural needs coincide well with those ensuring the restoration and biodiversity.

Lancia, R., J. Gerwin, M. Mitchell, W. Baughman, and M. Bently. 2000. Avian diversity and productivity on an intensively managed, industrial forest in South Carolina: The Westvaco example. In: Proceedings of the Forest Fragmentation 2000 Conference: Sustaining Private Forests in the 21st Century (L.A DeCoster, ed.). The Sampson Group, Alexandria, VA.

Consolidated ownership of large tracts of forestland presents an opportunity to evaluate and to manage the effects of forest fragmentation. Forest fragmentation reduces the total area of contiguous forest and isolates to varying degrees the remaining forest patches. The potential threat to biodiversity is perceived as a consequence of direct loss of habitat for wildlife, increased predation and nest parasitism, interference with dispersal and introduction of non-native species. In the Southeast, about 20% of the forestlands are owned by the forest products industry. These industry-owned landscapes typically result in a diverse mixture of habitat types and spatial arrangements that could be managed more effectively for both protecting ecosystem functions and biodiversity and for producing timber supplies. For example, the Westvaco Corporation uses an Ecosystem-Based Multiple Use Forest Management System to provide fiber for its mills while maintaining, protecting, and enhancing ecosystem elements and functions on the approximately 500,000 acres it owns in the Coastal Plain of South Carolina. One aspect of this system is a network of corridors kept in pine or hardwood habitat that are two to four times the typical rotation length. These corridors are designed to protect and maintain water quality, wildlife habitat, visual quality, and biodiversity. Based on point counts, Westvaco's corridors, within a landscape context of managed pine with a hardwood component, provided habitat for many migrant and resident bird species. Landscape models gave insights into scales appropriate to evaluating habitat for a variety of species. In summary, large tracts of industrial forest offer the opportunity to manage forest fragmentation and landscape design, and thereby have great potential to conserve breeding habitat for birds.

X. Annotated Bibliography – Part 3

Lande, R. 1988. Demographic Models of the northern spotted owl. (*Strix occidentailis caurina*). Oecologia 75: 601-607.

In this study, analytical models were used to estimate the geometric growth rate of the northern spotted owl population and to predict the effect of future habitat loss and fragmentation on the equilibrium occupancy of suitable territory. No statistically significant difference was found between the annual geometric growth rate predicted by this study and that of a stable population or the approximate one percent annual decline estimated from long-term surveys. The analysis of territory occupancy revealed that in order to promote long-term persistence of the northern spotted owl population, the great majority of remaining old-growth forest may have to be conserved. The estimated minimum habitat requirement for the population is greater than that allowed in current management plans by the USDA Forest Service.

Leps, J., J. Osbomova-Kosinova and M. Rejmanek. 1982. Community stability, complexity and species life history strategies. Vegetatio. 50(1): 53-63.

The relationship between complexity and stability of biotic communities is a well known controversy in contemporary ecology. Until recently, many ecologists believed that increased community complexity, often expressed as "species diversity", begets greater community stability. However, this hypothesis seems to have lost ground during the last decade. This paper discusses the relationship between species diversity and stability (characterized by resistance to displacement and by the ability of an ecosystem to return to normal (i.e., resilience), after a period of stress). The positive correlation between diversity and resistance and the negative correlation between diversity and resilience in a field habitat stressed by drought is assessed, and there appears to be no causal relationship between diversity and these measures of stability. Resistance and resilience of the plant communities studied were determined primarily by life history strategies of the constituent species. The results of the study imply the validity of a "Gleasonian", population-centered explanation of succession within plant communities.

Lefort, M. and M. Chauvet. 1996. Biodiversity and Agriculture, Grasslands and Forests. In: Biodiversity, Science and Development, Towards a New Partnership (F. di Castri and T. Younes, eds.) CAB International, Wallingford, UK.

Agricultural, grasslands, and forestlands house ecosystems that play various roles well beyond production, which is their main function. These matters have been seldom studied because they were so obvious in pre-industrial agrosystems. The increase in environmental artificiality brought about by intensified and simplified farming reveals many difficulties related to the extinction of certain species or to the upsetting of certain ecosystem functions. There exists a real need for restructuring agricultural systems to reduce production uncertainties with respect to biotic and abiotic fluctuations; better integrate long-term environmental protection; and improve responsiveness to the very fast changes in agricultural markets and legislation. Systematic mowing of grasslands tends to make them more monospecific. Well tended grazing is far better for maintaining diversity of both plants (all species present get a chance to bear fruit) and animals (wildlife can coexist with the livestock). In forestry, silvicultural practices of the previous decades have also aimed for profitability with single species stands and uniform management (tillage, fertilization, tree work). These changes have decreased biological diversity and the adaptability of forests to respond to future uncertainties, particularly to major outbreaks of forest pests. Biodiversity conservation issues can be better integrated when managing timber production forests by including activities such as the following:

1) Key habitats should be preserved during harvesting so as to keep the heritage of natural forests.
2) Populations of key species should be preserved in priority because they determine the structure of the community, and the presence of other species.
3) Fragmentation of natural forests should be avoided because this creates barriers for gene flow.
4) Forests should be regenerated with native species, whose yield is often higher than that of exotic species in the long run.

It is important that research should find which parameters affect variability within the populations so that they can be better integrated into the management schemes. Similarly, a better understanding of the effects of natural perturbations on forest dynamics should help simulate them in silvicultural practice.

Loreau, M. 1998. Biodiversity and ecosystem functioning: A mechanistic model. Proceedings of the National Academy of Science, USA 95: 5632-5636.

Recent experiments have provided some evidence that loss of biodiversity may impair the functioning and sustainability of ecosystems. However, adequate theories and models to provide robust generalizations, predictions, and interpretations for such results are still lacking. Here, a mechanistic model of a spatially structured ecosystem in which plants compete for a limiting soil nutrient is presented. This model shows that plant species richness does not necessarily enhance ecosystem processes, but it identifies two types of factors that could generate such an effect: (1) complementarity among species in the space they occupy belowground and (2) positive correlation between resource use intensity and diversity. In both cases, the model predicts that plant biomass, primary productivity, and nutrient retention all increase with diversity, similar to results reported in recent field experiments.

Lugo, A., J. Parrotta, and S. Brown. 1993. Loss in Species Caused by Tropical Deforestation and Their Recovery Through Management. Ambio 22 (2/3): 106-109.

The loss of species as a result of deforestation and degradation of tropical forestlands is widely discussed. Models based on island biogeography theory are used to evaluate the relationship between species extinction and deforestation. The analysis shows that natural resiliency causes the models to overestimate the rates of extinction for given intensities of deforestation. There is an opportunity to couple natural processes with management activities to reduce species extinctions and restore species richness to degraded lands. As an example, we show how tropical monoculture tree plantations can foster diverse native forests in areas previously deforested.

Main, A. 1999. How much biodiversity is enough? Agroforestry Systems 45: 23-41.

This paper addresses the question of how much biodiversity is enough in the context of the concept of agriculture as a mimic of nature. Following an historical review of the likely origins of ecosystems, the currently accepted components of biodiversity, viz. genetic, species, and ecosystem, and their functional expression, are shown to be relevant to agriculture. Examples of adequate biological diversity are given and it is concluded that what constitutes enough biodiversity in an agricultural system is dependent on the goal in question and will be different depending on whether the aim is, for example, to increase yield stability or deal salinity, ground water levels, etc. The point is made that ecosystems and their composition are contingent in nature so the history of events, their frequency and intensity all need to be considered when interpreting the natural biodiversity present and thus determining what is enough in particular circumstances.

van Mansvelt, J., D. Stobbelaar, and K. Hendriks. 1998. Comparison of landscape features in organic and conventional farming systems. Landscape and Urban Planning 41: 209-227.

Four organic (biodynamic) farms coupled with conventional farms from their neighborhood in The Netherlands, Germany, and Sweden, and 3 organic farms and 4 conventional farms from the West Friesean region in The Netherlands were evaluated to compare their impact on landscape diversity. Presence of diverse land use types, woody elements (plantings), and visual elements (vertical and horizontal coherence, colors and forms) were analyzed. The results show that the diversity of landscapes and farming system was greater in organic farms. Also, all forms of coherence were found to be greater in organic farms. In terms of landscape diversity, the organic types of agriculture have a good potential for positive contributions to a sustainable agro-landscape management.

Marquis, R. and C. Whelan. 1994. Insectivorous birds increase growth of white oak through consumption of leaf-chewing insects. Ecology 75(7): 2007-2014.

This study analyzed the indirect effects of insectivorous birds on plant growth through consumption of leaf-chewing insects in a Missouri Ozark deciduous forest. Over a period of two years, insect numbers, leaf damage, and resultant plant growth for control saplings of white oak (*Quercus alba*) were compared to saplings caged to limit access by insectivorous birds but not herbivorous insects. In a third treatment, insecticide was sprayed on young white oak trees to determine the impact of the insect herbivores on plant growth in the presence of birds. As a result of differences in leaf area damage, caged plants produced one-third less total aboveground biomass compared to insecticide-treated plants, with control plants producing intermediate values. This is the first terrestrial ecosystem study to demonstrate a significant impact of insectivorous birds on plant growth. The results suggest that, over the long term, observed declines in North American populations of insectivorous birds may reduce forest productivity because of potentially higher numbers of leaf-chewing insects and the concomitant negative effect on plant growth.

McNeely, J., K. Miller, W. Reid, R. Mittermeier, and T. Werner. 1990. Conserving the World's Biological Diversity. IUCN, Gland, Switzerland.

Instead of nurturing the Earth's resources to provide benefits that can be sustained far into the future, too much of modern development is abusing nature to provide excessive benefits for a generation or two of humans. A new form of civilization based on the sustainable use of renewable resources is not only possible, but it is essential. This book suggests the principles and tools that are available for promoting the new civilization. These include community self-reliance, diversity in both nature and human cultures, economic systems that consider all costs and benefits of alternative actions, scientific research that is applied to the challenges of managing natural resources, and the use of modern information technology to ensure that decisions are based on full knowledge of the likely consequences.

McNeely, J. 1996. Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources. International Union for Conservation of Nature and Natural Resources (IUCN). Gland, Switzerland.

This document grew out of workshops held in San Jose, Costa Rica, on February 4-5, 1988 and Washington, DC on April 13, 1988. At these workshops, case studies were presented, concepts were discussed, and general approaches were agreed. The document, perhaps wrongly, takes as a starting point the current world economic system, and describes what can be done within that system to enhance the conservation of species and ecosystems. It offers pragmatic and immediate solutions to pressing problems which cannot wait until the world's economy is fundamentally reformed. A fundamental issue which remains to be solved is determining the optimal distribution of benefits from utilizing biological resources. Most of today's benefits from harvesting the forests, grasslands, wetlands, and seas flow to the global community at large. Relatively few benefits are provided to the local people who bear the bulk of the costs either of the impacts of over-exploitation or of abstaining from destructive harvesting practices.

Similarly, the greatest value in conserving biological diversity flows to the global community, while the cost of preservation falls on the comparatively few who seldom are provided any economic incentive to conserve the resource.

Menge, B. and J. Sutherland. 1987. Community regulation: variation in disturbance, competition, and predation in relation to environmental stress and recruitment. American Naturalist 130: 730-757.

This paper provides a general, conceptual framework to aid in answering two questions. First, do patterns of community structure respond predictably to variation in ecological processes (disturbance, competition, predation)? Second, does the importance of different ecological processes vary predictably in response to variation in environmental conditions (environmental stress and recruitment density)? The authors discuss the presumed relationship between the physical environment and food-web structure, describe the predictions of a model of community regulation that includes physical disturbance, predation, and competition as ecological processes, examine how the variation in recruitment affects the predictions of the model, outline the predictions of the model with respect to species diversity at the basal trophic level, and describe ways in which these predictions could be tested. The model applied assumes that mobile organisms (i.e., consumers) are more strongly affected by environmental stress than are sessile organisms and that food-web complexity decreases with increasing stress. This model predicts that when competition for space leads to exclusion and recruitment is high, the relationships between diversity and either predation or disturbance are distinct, not equivalent as is often assumed. The authors suggest that physical disturbance is distinct from predation (considered equivalent to, but distinct from, biological disturbance). The model should be applicable to both terrestrial and aquatic environments, with appropriate modification made for the relative importance of omnivory in terrestrial versus aquatic interaction webs.

Meurisse, R., W. Ypsilantis, and C. Seybold (tech. eds.). 1999. Proceedings: Pacific Northwest Forest & Rangeland Soil Organism Symposium (Held March 17-19, 1998 in Corvallis, OR). USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-461. Portland, OR.

Soil organisms have become a focus of attention for addressing issues of soil quality and health, and ecosystem sustainability. Land managers are challenged to ensure that their actions are beneficial to belowground organisms and processes in the long-term. Research about soil organisms, their populations, roles, and management effects is fragmented and often esoteric. The diversity of soil organisms is tremendous. The principal organisms include bacteria, actinomycetes, fungi, arthropods, nematodes, worms, insects, and mammals. In order to provide a "state-of-the-science" about soil organisms related to management, a symposium was convened to address soil organism functions and processes, management effects on soil organisms and processes, and describe some roles of soil organisms in restoration and applications for land management. The focus of the symposium was on Pacific Northwest forest and rangeland ecosystems.

Miller, K. 1996. Balancing the Scales: Guidelines for Increasing Biodiversity's Chances Through Bioregional Management. World Resources Institute, Washington, DC.

To conserve biodiversity more effectively, the geographic scales of conservation and development must be expanded to embrace whole ecosystems. Program processes must be changed to involve the broad array of people and institutions having a stake in the management of the region. Only by adopting this "bioregional" approach can natural resources be nurtured while giving local communities the chance to derive sustainable livelihoods. This practical book explores the lessons to be drawn from current experiments with bioregional approaches, and proposes sensible guidelines for policy-makers, and especially for practitioners, on making bioregional management work.

Miller, K. and S. Lanou. 1995. National Biodiversity Planning: Guidelines Based on Early Experiences Around the World. World Resources Institute, United Nations Environment Programme, and The World Conservation Union. Gland, Switzerland.

One-hundred and fifty-six governments made a statement at the Earth Summit at Rio de Janeiro in 1992: They are prepared to accept responsibility for conserving the full diversity of plant, animal, and microbial life in their countries, to begin using biological resources sustainably, and to seek the equitable sharing of benefits from biodiversity. Among the earliest steps taken by countries before Rio was initiating country studies to systematically assess their biodiversity. Based on a review of written case studies provided by 17 countries, this guide offers a method that "biodiversity planners" can use to initiate a national biodiversity planning process that builds upon country studies and other planning efforts. An illustrative seven-step biodiversity planning process is spelled out as a guide to those willing to make choices and get them implemented.

Minckler, L. 1980. Woodland Ecology. Syracuse University Press, Syracuse, NY.

This book describes the important contribution of woodlands to the environmental health of an area and the personal satisfactions and economic benefits the owner can derive from a well-managed forest environment. Emphasis is placed on providing woodland owners with an understanding of the ecological principles and human interests related to the total forest environment. The material in the book applies primarily to the eastern United States from the Great Plains to the Atlantic Ocean.

Montagnini, F., B. Eibl, L. Grance, D. Maiocco, and D. Nozzi. 1997. Enrichment planting in overexploited subtropical forests of the Paranaense region of Misiones, Argentina. Forestry Ecology and Management 99: 237-246.

Line enrichment experiments using native species of commercial value were established in overexploited forests in Misiones, Argentina on public and private lands. Ten timber species were tested, as well as *Euterpe edulis* (palmito) which can be harvested after 10-12 years for its heart of palm. Four to 7 years after planting, seven of the 10 species showed promising results as did the palmito. Though long-term results are required to document the potential for growth and quality of production for each species, results from the experiments can provide insights into the use of these species for enriching the overexploited and secondary forests in the region.

Munasinghe, M. 1993. Environmental Economics and Biodiversity Management in Developing Countries. Ambio (2/3): 126-135.

Reconciling and operationalizing the three main concepts of sustainable development – the economic, ecological, and sociocultural – poses formidable problems. Environmental economics and valuation can play a key role in helping to incorporate concerns about biodiversity loss into the traditional decision-making framework. Case studies from Madagascar and from Sri Lanka demonstrate that this approach can be used to eliminate projects with unacceptable impacts and to redesign others. Improving the incomes and welfare of local communities, especially poor ones, while simultaneously preserving physical and biological systems, offers opportunities for developing countries to pursue all three goals of sustainable development in a complementary manner.

Munro, N., and J. Willison, eds. 1998. Linking Protected Areas with Working Landscapes Conserving Biodiversity. SAMPAA, Wolfville, Nova Scotia, Canada.

This book represents the proceedings of the Third International Conference on Science and Management of Protected Areas held May 12-16, 1997 in Calgary, Canada. This meeting continued the tradition of bringing together researchers, managers, policy makers, non-governmental organizations, and decision makers to review and discuss contemporary issues of importance in the management of protected areas. The proceedings were pulled together and published by the Science and Management of Protected Areas Association (SAMPAA).

Naeem, S., L. Thompson, S. Lawler, J. Lawton, and R. Woodfin. 1994. Declining biodiversity can alter the performance of ecosystems. Nature 368: 734-737.

Communities of species and their associated biological, chemical, and physical processes, collectively known as ecosystems, drive the Earth's biogeochemical processes. Currently, most ecosystems are experiencing loss of diversity associated with the activities of human expansion, raising the issue of whether the biogeochemical functioning of ecosystems will be impaired by this loss of species. Current ecological knowledge supports a wide range of views on the subject, but empirical tests are few. Here the authors provide evidence from direct experimental manipulation of diversity over a wide range of magnitude, using multi-trophic level communities and simultaneous measures of several ecosystem processes, that reduced biodiversity may indeed alter the performance of ecosystems.

NCASI [National Council for Air and Stream Improvement]. 2000. Land Management Tools for the Maintenance of Biological Diversity: An Evaluation of Existing Forestland Classification Schemes. Technical Bulletin No. 800. NCASI. Research Triangle Park, NC.

One of the most important challenges facing forest managers in meeting wood production objectives while maintaining or enhancing wildlife and biodiversity. Forestland classification is one important tool that managers use to evaluate both wood growth potential and habitat conditions. Many different approaches to forestland classification are currently in use. Approaches vary in the information they represent and their usefulness for addressing objectives related to wildlife and biodiversity. This report evaluates existing forestland classification schemes in terms of their ability to monitor biodiversity and their relative cost to implement. The results of this investigation suggest that no one classification scheme is clearly superior for providing information relevant to the monitoring and maintenance of biological diversity. Combining existing classification schemes may be a useful and cost-effective method for providing this information. None of the existing systems for classifying forestland provide adequate information on stand structure, and many provide only marginal information on current forest composition. Structural information is needed by forest managers to monitor biological diversity at smaller scales because day-to-day management decisions are usually made, and always implemented, at the local level.

Noss, R.F. 1983. A regional landscape approach to maintain diversity. Science. 33(11): 700-706.

Land managers have traditionally assumed that achieving maximum local habitat diversity will favor diversity of wildlife. However, recent trends in species composition in fragmented landscapes suggest that a more comprehensive view is required for perpetuation of regional diversity. A regional network of preserves, with sensitive habitats insulated from human disturbance, might best perpetuate ecosystem integrity in the long term. A regional landscape approach to preservation should also recognize the importance of broad corridors connecting habitat islands. Species composition and abundance, not simple number of species, assume primary importance in the context of regional preservation. Native species are preferred over those exotic to the landscape and rare or reduced species over the widespread and superabundant. The pre-settlement landscape (allowing for natural dynamism) is the ideal condition against which contemporary diversity and composition are evaluated. Management of the land to achieve maximum critical habitat area and insulate species with high extinction probabilities is the most prudent approach to long-term conservation.

NRC (National Research Council). 1994. Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands. National Academy Press. Washington, DC.

Proper use and management of our nation's natural resources has been a challenge since European settlement of this country began. Rangelands and related resources were damaged during settlement by erosion and loss of habitats through inappropriate use and unintentional mismanagement. The current condition or quality of US rangelands has been described by some as the best condition in this century and by others, using the same data, as extremely abused and degraded. Given these confusing interpretations, the Board of Agriculture of the National Research Council convened the Committee on Rangeland Classification to examine the scientific basis of methods used by USG agencies to inventory, classify, and monitor rangelands. The Committee's report recommends that the principal purpose of rangeland assessment should be to assess rangeland health. Rangeland health should be defined as the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained. The minimum standard for rangeland management should be to prevent human-induced loss of rangeland health. The determination of whether a rangeland is healthy, at risk, or unhealthy should be based on the evaluation of three criteria: degree of soil stability and watershed function; integrity of nutrient cycles and energy flows; and presence of functioning recovery mechanisms. A national system to inventory and monitor rangelands should be based on the collection and analysis of data on changes in a minimum set of multiple indicators of rangeland health.

NRC [National Research Council]. 2000. Environmental Issues in Pacific Northwest Forest Management. National Academy Press. Washington, DC.

Congress asked the National Academy of Sciences to provide basic information to help guide future forest management in the region, and the National Research Council convened the Committee on Environmental Issues in Pacific Northwest Forest Management in 1993. The committee was charged to review: the information concerning the current state of knowledge of forest resources; definitions of old growth, including biological, economic, social, and physical amenities that old-growth provides; forest management practices and the effects on resources of the forests and the economic consequences of those practices; and the use of forest products from the region and the degrees to which products from other US regions could be substituted for them. Clear goals are essential to any effort to rationalize forest management in the Pacific Northwest, and the committee identified four goals that it believes lie at the heart of the issues in forest management in this region:

1) Sustain viable populations of indigenous species;
2) Maintain properly functioning ecological processes;
3) Meet human needs for forest commodities; and
4) Satisfy cultural and aesthetic values.

Conflicts arise among them as they are applied in specific circumstances because they cannot all be maximized or optimized simultaneously. Much of the disagreement regarding policies and protocols in forest management is associated with the relative priorities that should be assigned to each of these goals.

Orians, G. 1993. Endangered at What Level? Ecological Applications 3 (2): 206-208.

The functioning of the Endangered Species Act has been less effective than expected because remedial action is not triggered until populations are in serious trouble and because of the inadequacies of a species-by-species approach. These problems have stimulated interest in expanding the Act to protect endangered habitats, communities, and ecosystems. Such a development requires the existence of a generally agreed upon classification system for these larger ecological units. No such classification system exists, and developing one will be difficult and politically contentious.

Paoletti, M. 1999. Using bioindicators based on biodiversity to assess landscape sustainability. Agriculture, Ecosystems and Environment 74: 1-18.

Although not new, the use of bioindicators is an innovative approach for assessing various types of environmental mismanagement, including pollution, high input farming, inappropriate disposal of wastes, contamination, etc. This approach uses biological organisms and biodiversity as tools to assess ongoing situations in the environment. Bioindicator-based studies have the potential to make a major contribution to optimizing different farming systems, input practices, new crops, etc., and to influence political policies governing landscape management, urban and industrial area design, and landscape reclamation and transformation.

Parrotta, J., J. Turnbull, and N. Jones. 1997. Catalyzing native forest regeneration on degraded tropical lands. Forestry Ecology and Management 99: 1-7.

Forest clearing, forest degradation through human disturbance, and the deterioration of land productivity due to inappropriate agricultural practices is a major problem in the tropics. Restoration of ecosystem health and productivity has generally relied on abandonment of land and subsequent natural forest succession. In recent years, there has been consideration of management options to accelerate recovery and restore productivity, biodiversity, and other values. At a June 1996 Washington, DC symposium on the use of tree plantations to catalyze restoration of degraded forests and lands in the tropics, there was strong evidence that plantations can facilitate forest succession in their understories through modification of both physical and biological site conditions. Development and design of management options to assist this process are required, taking into account socio-economic realities, development priorities, and conservation goals.

Pasicolan, P., H. Udo de Haes, and P. Sajise. 1997. Farm forestry: an alternative to government-driven reforestation in the Philippines. Forest Ecology and Management 99: 261-274.

Under its Contract Reforestation Program between 1988 and 1992, the Philippine government borrowed heavily and paid people to plant trees on public land, with 25-year stewardship agreements to maintain them. Results of the first phase of implementation were poor, but on the same sites where problematic reforestation projects were assessed were found successful small tree farm holdings without government support. The study identified eight success conditions for spontaneous and sustainable tree growing at the farm level and made eight recommendations for government intervention to maximize program impact.

Pavlik, B. 1996. Conserving Plant Species Diversity: The Challenge of Recovery. In: Biodiversity in Managed Landscapes (R. Szaro and D. Johnston, eds.). Oxford University Press, New York, NY. pp. 359-376.

The present crisis of mass extinction, caused by population growth, technology, and resource consumption, is unprecedented in the short history of the human species and in the long history of this planet. Plants are bearing the brunt of this crisis, with nearly 20,000 taxa globally rare or threatened and as many as 60,000 facing extinction by the middle of the next century. The recovery of endangered plants, including the restoration of their critical habitats, might be the greatest challenge facing species-level conservation programs. This paper examines: (1) how small reserves can become more effective; (2) the importance of demographic monitoring; (3) the role of population viability analysis; and (4) recommendations for improving recovery efforts.

Pearce, D., and D. Moran. 1994. The Economic Value of Biodiversity. Earthscan Publications, London, UK.

This book grew out of an analysis of the kinds of economic values that are generated by conservation activity but which may well not be captured in the market place. The question was then re-framed to ask “Why does biodiversity disappear?” and how its economic value might be captured by various institutional mechanisms. The major conclusion of the work is that there is something wrong with the way actual economic decisions are made – for some reason, they fail to “capture” the economic values that can be identified for biological diversity. These economic failures lie at the heart of any explanation for the loss of biological diversity, and, if they can be addressed, there is a chance of reducing biodiversity loss.

Perrings, C., K. Maler, C. Folke, C. Holling, and B. Jansson, eds. 1994. Biodiversity Conservation: Problems and Policies. Kluwer Academic Publishers, Dordrecth, The Netherlands.

This book reports the more policy-oriented results of the Biodiversity program of the Beijer International Institute of Ecological Economics of the Royal Swedish Academy of Sciences. The program brought economists and ecologists together to consider where the problem in biodiversity loss really lies, what costs it has for society, and how it might best be addressed. The results are strikingly different from those reported in other works on the subject. Biodiversity loss matters for all ecosystems – not just the mega-diverse tropical forests. And it matters because it compromises the resilience and so the productivity of these systems. Biodiversity conservation requires the development of policies that change the behavior of resource users everywhere – not just in parks and reserves. The book is valuable reading for researchers and policy makers alike, since it canvasses options for the reform of park management, biodiversity conservation projects, property rights, tax, trade, and price regimes that are within the reach of governments everywhere.

Perry, D., M. Amaranthus, J. Borchers, S. Borchers, and R. Brainerd. 1989. Bootstrapping in Ecosystems: Internal interactions largely determine productivity and stability in biological systems with strong positive feedback. Bioscience 39 (4): 230-237.

Positive feedback is increasingly recognized as an important component of ecosystem dynamics. Within the constraints of resource supply or other environmental factors, the biological system characterized by strong positive feedback among its components is in many ways self-generating – its productivity and stability determined largely through its internal interactions. Systems characterized by strong, positive interactions among their components can be complex, productive, and quite stable under conditions to which they are adapted, but when key linkages are disrupted they are fragile and subject to threshold changes. In this article, recent work on one particular "bootstrapping" relationship – reciprocal interactions between plants and soils – is reviewed. Through close mutual interactions between plants and soil organisms, these ecosystems create the conditions that allow the systems to persist. Severing the close links between plants and soils has contributed to degradation of many ecosystems, and restoring these links is an important step toward rehabilitation.

Price, C. 1995. Economic evaluation of financial and non-financial costs and benefits in agroforestry development and the value of sustainability. Agroforestry Systems 30: 75-86.

Financial appraisal of agroforestry is not different in kind from appraisals applied to pure forestry. Existing techniques for valuing non-market effects may also be applied. Effects on hydrological and carbon fluxes might be less favorable than those of pure forests. In the confusing field of biodiversity valuation too, only limited and specific claims can be made for agroforestry. Agroforestry may offer a quantifiable value in short-term sustainability, and might meet recent economic definitions of long-term sustainable development, without encountering the full dangers to future generations embodied in conversion of natural to human capital.

Probst, J. and T. Crow. 1991. Integrating biological diversity and resource management: An essential approach to productive, sustainable ecosystems. Journal of Forestry 89(2): 12-17.

The authors define biodiversity drawing on the commonly cited technical definition. However, they state that the definition must encapsulate the three defining elements of diversity, i.e., genetic, species, and ecosystem. Since, biological diveristy occurs on local, regional, and global spatial scales, they view the term as something more than 'local species richness'. In addition, they discuss several concepts relating to biodiversity including spatial considerations, defining long-term variability for species, public benefits of biodiversity, and managing responsibilities. Based on this discussion, they make the following recommendation for sustaining and improving biodiversity:

1) Use a regional perspective when considering biological diversity.
2) Think beyond the boundaries of specific ownership when planning and managing.
3) Plan and manage over large areas rather than using a stand-by-stand approach. Consider the cumulative impact of individual projects on regional population and resources.
4) Emphasize multispecies and ecosystem management instead of single species and tree management.
5) Provide habitat sufficient to maintain species of concern (e.g.' large wide ranging mammals'), not just sufficient habitat to attract immigrants from more productive sources.
6) Maintain or create spatial patterns.
7) Conduct ecological surveys and inventories.
8) Monitor problem species and inventories.

Rodriguez, J. 2000. Impact of the Venezuelan economic crisis on wild populations of animals and plants. Biological Conservation 96: 151-159.

Because of the relatively well-defined starting date of Venezuela's current economic crisis (early 1983), it provides an ideal model for exploring the effect of worsening economic conditions on biodiversity use. The author focuses on changing harvest intensities of wood, wildlife and fish, by comparing harvest patterns prior to and after the onset of the economic crisis (pre- and post-1983). In general, the harvest of wood, wildlife and fish increased sharply after 1983 reaching previously unrecorded levels, growing at a higher rate than the human population. These harvest levels appear to be unsustainable. Although more than one mechanism may explain these results, most of the evidence suggests that contraction of the economy led to rising unemployment, causing the workforce to shift to natural resource exploitation as an alternative source of income and food.

Salwasser, H., J. Caplan, C. Cartwright, A. Doyle, W. Kessler, B. Marcot, and L. Stritch. 1996. Conserving Biological Diversity Through Ecosystem Management. In:

Biodiversity in Managed Landscapes (R. Szaro and D. Johnston, eds.). Oxford University Press, New York, NY.

This paper describes an ecosystem management approach to multiple-use management that features conservation of biological diversity integrated with other uses and values of wildlands. The approach evolved from a USDA Forest Service program known as New Perspectives for Managing the National Forest System. The authors discuss concepts and aims of multiple-use ecosystem management and New Perspectives, describe a goal-oriented strategy for conserving biological diversity, and give three examples of how goals for conserving specific aspects of biological diversity were integrated with ecosystem management on national forests in the United States. They conclude with a discussion of changes needed to further the development and implementation of ecosystem management as a process to improve relationships between humans and land.

Sandlund, O., K. Hindar, and A. Brown. 1992. Conservation of Biodiversity for Sustainable Development. Scandinavian University Press, Oslo, Norway.

In September 1990, 110 international experts in conservation biology and related fields of research and management met in Roros, Norway to participate at the International Conference on the Conservation of Genetic Resources for Sustainable Development. The Conference summarized the state of the art in conservation biology and analyzed the problem of biodiversity conservation from a wide array of perspectives. Genetic and ecological research forms the basis for an understanding of conservation. However, to achieve any long-term conservation of Earth's biodiversity, the scientific results must be implemented within a wider social, economic, and political perspective. This volume makes the information presented at the Conference available to a wider audience. The topics discussed here are of utmost relevance to all scientists, managers, and politicians who are engaged in the struggle to conserve and use the living natural resources of this planet in a sustainable fashion.

Schowalter, T. and P. Turchin. 1993. Southern pine beetle infestation development: interaction between pine and hardwood basal areas. Forest Science 39(2): 201-210.

Public demands for changes in forest practices are affecting tree species composition and age distribution of public forests. While these changes often are necessary to improve habitat for endangered wildlife species, effects on insect populations have been largely ignored. As a result, conflicts between requirements for wildlife protection and pest suppression have arisen. Over a period of two years in the Homochitto National Forest of southwestern Mississippi, this study evaluated the interactive effects of different forest structures, i.e., different southern pine/hardwood composition relevant to future management proposals, on southern pine beetle infestation development. This study provided experimental confirmation of the hypothesis that stand susceptibility to southern pine bark beetle infestation increases with pine basal area. Others have also demonstrated that reduced pine basal area inhibits bark beetle infestations. This study also demonstrated that competition from hardwoods apparently does not increase stand susceptibility to bark beetles. These results are consistent with the resource concentration hypothesis, which holds that the presence of non-hosts interferes with herbivorous insect dispersal and discovery of intermixed hosts, thereby reducing the probability that hosts will be discovered and attacked by herbivores. These results have direct implications for future forestry objectives. The study found that sparse pine and pine-hardwood stand structures were relatively less favorable to southern pine beetle infestation development. Prior to Euro-American settlement, such forests dominated by longleaf pine covered large portions of southern landscapes as a result of natural thinning by fire, insects, and pathogens. Thus, the thinning of current forests, together with conversion back to longleaf pine, should decrease stand favorability for southern pine beetle. Forests composed of scattered pines with or without hardwoods are also conducive to wildlife management goals, e.g., the red-cockaded woodpecker.

Schowalter, T., W. Hargrove, and D. Crossley, Jr. 1986. Herbivory in forested ecosystems. Ann. Rev. Entomol. 31: 177-196.

This paper reviews: 1) factors (abiotic, chemical defenses, physical defenses, nutrients, predation and parasitism, and forest structure) that influence herbivory primarily by foliage-consuming and sap-feeding insects in forested ecosystems; 2) tree responses to herbivory (the effect on individual trees, tree condition and response to herbivory); and 3) the impact of herbivory on forested ecosystems (nominal and short-term effects, effects on community development, effects on nutrient cycling, effects on forest uses). Based on this review, there emerges a recognized need for carefully designed long-term manipulative experimentation, especially since short- and long-term responses to herbivory are different or even opposite. They emphasize the need to utilize multivariate, factorial and discriminant techniques as opposed to classical scientific methods where all variables but one are held constant. Despite these problems, undeniable progress has been made toward understanding herbivory in forested ecosystems. The less-restrictive perception of herbivore/plant interaction as a mutualistic non-zero-sum game represents one example of such progress, as does the viewpoint that considers plants as heterogenous resources in time and space.

Schwartzman, S., A. Moreira, and D. Nepstad. 2000. Rethinking Tropical Forest Conservation: Perils in Parks. Conservation Biology 14 (5): 1351-1357.

According to some conservationists, large, pristine, uninhabited parks are the defining criterion of success in conserving tropical forests. Hence, they believe the removal of people from tropical forests is an essential step in the creation of successful parks and in the conservation of nature in the tropics. This approach fails to recognize forest residents and rural people in general as potent political actors in tropical forest regions and an essential component of the environmental political constituencies that are necessary for long-term conservation of tropical forests. In Amazonia and elsewhere, rural people are defending far bigger areas of tropical forest from unfettered deforestation than are parks. The establishment of pristine, tropical forests is an important conservation goal, but the exclusive pursuit of this goal undermines the broader objectives of conservation when it identifies forest residents and other rural people as the enemies of nature.

X. Annotated Bibliography – Part 4

Serageldin, I. and J. Martin-Brown. 1999. Partnerships for Global Ecosystem Management: Science, Economics, and Law. Proceedings and Reference Readings from the Fifth Annual World Bank Conference on Environmentally and Socially Sustainable Development (Held Oct. 6-7, 1997 in Washington, DC). The World Bank. Washington, DC.

Beginning in 1993, each autumn the World Bank Group has convened an international conference on a theme related to advancing environmentally and socially sustainable development. The theme for the 1997 conference was the scientific, legal, and economic requirements of global ecosystem management. Although international agreements are but one element of addressing global environmental issues – such as the loss of biodiversity, climate change, desertification, ozone depletion, and water degradation – they play a crucial role. It is essential that they reflect the best available scientific knowledge, that they embody the most sensible economic analysis to advance the most cost-effective means of achieving the desired results, and that legal arrangements responding to these agreements create a level playing field and opportunities for innovation in the marketplace. The main results of the conference presentations, workshops, and dialogues were: a better understanding of the roles and relationships among global systems regarding national sustainable development plans, national legislation, and macroeconomics; access to examples of best practice and innovative processes; contributions to the content of country development strategies; and assistance to development practitioners in better assessing the global connections of their work.

Seydack, A. 1995. An unconventional approach to timber yield regulation for multi-aged, multispecies forests. I. Fundamental considerations. Forest Ecology and Management 77: 139-153.

Sustainable harvesting here implies that similar amounts and types of products (dimensions, quality, species) continue to be harvestable at periodic intervals in perpetuity. Harvesting must therefore be organized in such a way that it remains within the renewable capacity of the forest system both in terms of growth as well as the success and type of regeneration. Coupled with the demands for environmental services and maintenance of biodiversity, this can only be achieved if harvesting remains spatio-temporally in accord with the natural disturbance regime. The yield regulation approach advocated here involves periodic mortality preemption through the selective harvesting of over-mature or senile trees proportional to species-specific turnover.

Shaw, C. and B. Eav. 1993. Modeling Interactions. In: Beetle-Pathogen Interactions in Conifer Forests (T. Schowalter and G. Filip, eds.). Academic Press. London, UK.

Integration of the material on the various interactions among bark beetles, pathogens, and conifers, particularly as it relates to predicting pest outbreaks and quantifying their impacts, would markedly enhance the information's utility for both forest managers and scientists. Computer models can meet this need by capturing in a set of mathematical equations the biological data along with the conceptual models used by forest managers dealing with these pests and scientists studying them. An important benefit of the modeling process is that it highlights the still inadequate understanding of many aspects of host/pest interactions. Since bark beetle and root pathogen interactions contribute to the dynamics of ecosystem structure, function, development and productivity, models for predicting bark beetle infestations and tree mortality have become an important tool for forest management. As the bark beetle infestations move across various ecosystems, there is an urgent need for forest management research to examine issues of forest succession, adaptation and health in terms of long-term sustainability, resilience and resistance of these ecosystems to disturbances that are both anthropogenic and natural. Consequently, the development of models that describe and predict bark beetle and pathogen epidemiologies and tree mortality, has become a major focus of attention. One example of such a model is the Western Root Disease Model, which is the first pest model in North America that deals with the interactions among root pathogens, bark beetles, and conifers. Such models can serve as valuable tools for use in short-term and long-term planning by forest managers.

Silver, W., S. Brown, and A. Lugo. 1996. Effects of Changes in Biodiversity on Ecosystem Function in Tropical Forests. Conservation Biology 10 (1): 17-24.

Changing land use patterns in the tropics have resulted in vast areas of damaged and degraded lands where biodiversity has been reduced. The majority of research on biodiversity has been focused on population and community dynamics and has rarely considered the ecosystem processes that are intimately related. A framework is presented for examining the effects of changes in biodiversity on ecosystem functions in natural, managed, and damaged tropical forests. Using a whole-ecosystem approach, the framework identifies key nutrient and energy cycling processes and critical junctures or pathways, termed interfaces, where resources are concentrated and transferred between the biotic and abiotic components of the ecosystem. The few available data suggest that functional diversity, and not just species richness, is important in maintaining the integrity of nutrient and energy fluxes. High species richness, however, may increase ecosystem resilience following disturbance by increasing the number of alternative pathways for the flow of resources.

Simberloff, D. 1976. Experimental zoogeography of islands: effect of island size. Ecology 57(4): 629-648.

A controlled experiment performed on 8 small mangrove islands constituted an exact test of several biogeographic hypotheses which had rested largely on unsatisfying statistical treatments. The results were consistent with a model which posits the islands as originally in a state of dynamic equilibrium between immigration and extinction, then re-equilibrating quickly when forced into an oversaturated condition. It was specifically demonstrated that: 1) species number increases with island size alone, independent of habitat diversity; 2) the increase with area is faster on separate islands than on increasing subsections of one island; 3) the area effect and the underlying dynamic equilibrium are not due only to an increased sample of transients and vagrants on larger islands; and 4) predictions of the effects of decreased area on species composition can be stochastic at best, not deterministic. It is clear that much of the dynamic equilibrium and its associated turnover in the system can be ascribed to individual species characteristics and the effects of a rigorous physical environment.

Slocombe, D. 1993. Environmental Planning, Ecosystem Science, and Ecosystem Approaches for integrating Environment and Development. Environmental Management 17 (3): 289-303.

Currently popular concepts such as sustainable development and sustainability seek the integration of environment and development planning. However, there is little evidence that this integration is occurring in either mainstream development planning or environmental planning. “Ecosystem approaches”, as developed and applied in ecology, human ecology, environmental planning, anthropology, psychology, and other disciplines, may provide a more transdisciplinary route to successful integration of environment and development. Experience with ecosystem approaches is reviewed, and a synthesis of desirable characteristics for a framework to integrate environment and development planning is presented as a guide for future work and a criterion for evaluating existing programs.

Smeding, F. and W. Joenje. 1999. Farm-Nature Plan: landscape ecology based farm planning. Landscape and Urban Planning 46: 109-115.

A procedure is presented for restyling the lay-out and management of farms in order to increase the biodiversity in the agricultural landscape as well as the sustainability of farming. The protocol for the development of an on-farm Nature Management Plan explicitly uses landscape ecology characteristics, local biotic and abiotic data and potential, as well as the farming system data and farmer’s personal interests. It may also enhance the farmer’s interest and understanding of agro-ecological pattern and process and induce a more conscious approach to elements of nature on the farm, which may be a start for ecologizing agricultural practice.

Smythe, K., C. Bernabo, T. Carter, and P. Jutro. 1996. Focusing Biodiversity Research on the Needs of Decision Makers. Environmental Management 20 (6): 865-872.

The project on Biodiversity Uncertainties and Research Needs (BURN) ensures the advancement of usable knowledge on biodiversity by obtaining input from decision makers on their priority information needs about biodiversity and then using this input to engage leading scientists in designing policy-relevant research. Decision makers articulated concerns related to four issues: significance of biodiversity; status and trends of biodiversity; management for biodiversity; and the linkage of social, cultural, economic, legal, and biological objectives. In response, scientists recommended six priority research areas and broad recommendations were developed for each area to provide direction for research planning and resource management strategies.

Soule, M. and K. Kohm, eds. 1989. Research Priorities for Conservation Biology. Island Press. Washington, DC.

Conservation biology is a recent response of the scientific community to a wave of global environmental change that threatens to extinguish a large fraction of the earth's biological diversity. Research in the natural resources field and overlapping disciplines has already provided important information and planning guidelines. Yet, humankind has hardly begun to appreciate the extraordinary complexity of ecological systems, much less develop strategies for their long-term protection. This book proposes an urgent research agenda designed to further understanding of the basic mechanisms that fuel and maintain biotic diversity and, ultimately, to increase the effectiveness of these preservation efforts.

Soule, M., ed. 1986. Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Inc. Sunderland, MA.

This objective of this work is to provide a synthesis of the scientific foundation for the protection and management of biodiversity. Another objective is the encouragement of communication among all sectors of the conservation community. Its 25 chapters are divided into six sections: Fitness and Viability of Populations; Patterns of Diversity and Rarity: Their Implications for Conservation; The Effects of Fragmentation; Community Processes; Threats and Management of Sensitive Habitats and Systems; and Dealing with the Real World. Although written for a broad audience, the chapters are authoritative and many contain new information and original theories and models relevant to *in situ* and *ex situ* conservation.

Soule, M. 1986. Conservation Biology and the "Real World". In: Conservation Biology: The Science of Scarcity and Diversity (M. Soule, ed.). Sinauer Associates, Inc. Sunderland, MA.

The ultimate test of conservation biology is the application of its theories in actual management situations in the "real world", which is the world "out there", the world of politics and economics, and all the vagaries of human nature associated with these areas. Dealing with emotionally and ethically complex material, such as the extinction crisis, often requires courage and the willingness to speak out in public regarding such matters.

Conservation biology has made significant strides recently, and much of value has been learned about the utility and limitations of island biogeography, about area effects, edge effects, genetic management, disease, the result of removals and introductions, endemicity, rarity, etc. Much of this information is already being applied in the design and management of natural areas, in captive breeding programs, and in other conservation projects. The principal social challenges in the years to come will be to strengthen: 1) the financial and institutional supports for conservation biology, in both research and educational roles; 2) the contacts with related, natural resource disciplines; and 3) contacts with the management community itself. Conservation biology is the biology of scarcity, and research into the problems of scarcity at various levels, from that of the local population, through the metapopulation, the entire species, to the community and the ecosystem, is needed. At the community level, one of the obvious problems is the question of community structure, and the relative weights of stochastic versus deterministic forces affecting such structure. The specific research questions with important consequences for creating more-informed biodiversity protection and management guidelines include:

1) What is community equilibrium?
2) Is it ever achieved?
3) Is it more or less likely to exist in humid tropics than elsewhere?
4) Are there multiple stable states or equilibria?

Southgate, D. and H. Clark. 1993. Can Conservation Projects Save Biodiversity in South America? Ambio: 22 (2/3): 163-166.

At the urging of environmental groups, bilateral and multilateral development agencies are trying to save biological diversity in Africa, Asia, and Latin America. There are few results to show so far, in part because most projects are barely under way. Unfortunately, there is little reason to expect major payoffs in the future. This paper contains a critical examination of donor agencies' efforts in South America and argues that the campaign is faltering for five reasons: (1) Too much concentration on the Amazon Basin; (2) Projects reflect wishful thinking about local communities' regard for natural ecosystems; (3) Many projects involve the transplant of national parks, a rich-country institution to an alien setting; (4) The strong link between renewable resource mining and economic activities in frontier areas is ignored; and (5) Complementarities between economic development and ecosystem conservation are not being exploited. A major thrust of the campaign should be to improve production, income, and employment in other areas, especially where agriculture is already well established.

Spies, T. and J. Franklin. 1996. The Diversity and Maintenance of Old-Growth Forests. In: Biodiversity in Managed Landscapes (R. Szaro and D. Johnston, eds.). Oxford University Press, New York, NY.

The contribution of old-growth forests to biological diversity has only become widely recognized in the last 10 years. Understanding the ecology of old-growth and maintaining its distinctive biological diversity requires a hierarchical perspective. The biological hierarchy used in this paper is the framework composed of genes, species and populations, ecosystems, and landscapes. Placing old-growth in a biological hierarchy provides a more unified concept of old-growth and demonstrates how human manipulations at one biological level can affect old-growth values at other levels. The objectives of this paper are to: (1) review the ecological perspectives on old growth at genetic and physiological, population and species, ecosystem, and landscape levels; (2) characterize some of the diversity in types of old growth; and (3) discuss options for the maintenance and restoration of old growth.

Spellerberg, I., F. Goldsmith, and M. Morris, eds. 1991. The Scientific Management of Temperate Communities for Conservation. The 31st Symposium of the British Ecological Society, Southampton 1989. Blackwell Scientific Publications. London, UK.

The first aim of this symposium was to acknowledge the achievement of the earlier symposium: “The Scientific Management of Plant and Animal Communities for Conservation”, held in 1970, and to show that much of value in temperate conservation science has been accomplished in the intervening years. The symposium succeeded in presenting a reasonably balanced picture of temperate conservation science within the context of global conservation problems, since many of the most pressing of these are in the tropics rather than the world’s temperate regions. One important objective in holding the symposium was to emphasize the importance of science, particularly ecological science, as a basis for conservation. Another important objective was to foster a “coming together” research workers and practical conservation managers. This volume will hopefully serve as a reminder of this important aspect of conservation and make a significant contribution to its literature.

Stinner, D., B. Stinner, and E. Martslof. 1997. Biodiversity as an organizing principle in agroecosystem management: Case studies of holistic resource management practitioners in the USA. Agriculture, Ecosystems and Environment 62: 199-213.

Holistic Resource Management (HRM) is a process of goal setting, decision making and monitoring which integrates social, ecological, and economic factors. Biodiversity enhancement is a fundamental principle in HRM and students are taught that biodiversity is the foundation of sustainable profit. In the HRM process, practitioners develop a holistic goal which includes: (1) quality of life values; (2) forms of production to support those values; and (3) landscape planning, which should protect and enhance biodiversity and support ecosystem processes of succession, energy flow, hydrological and nutrient cycling. An overview of the HRM model is presented and the results of 25 interviews with HRM farmers and ranchers from across the USA in which perceptions and experiences with respect to the role of biodiversity in the sustainability of their operations were explored. Of the people interviewed, 95% perceived increases in biodiversity and 80% perceived increase in profits from their land since HRM began influencing their decisions.

Swanson, T. 1997. Global Action for Biodiversity. Earthscan Publications, London, UK.

The Convention on Biological Diversity (CBD) contains numerous intellectual challenges for those seeking to implement its provisions. Many of its innovations are little more than good ideas remaining to be given practical application. This volume attempts to describe the fundamental nature of the global problem now before the international community and the basic nature of the international agreement that is required to achieve its solution. The problem remains to fill in the gaps of the Convention, and it is essential that this be done by means of international agreements of the most particularistic kind. This volume undertakes to set forth a bio-economic framework for analyzing the biodiversity problem so that protocols to continue the practical implementation of the CBD can be negotiated.

Szaro, R. 1996. Biodiversity in Managed Landscapes: Principles, Practice, and Policy. In: Biodiversity in Managed Landscapes (R. Szaro and D. Johnston, eds.). Oxford University Press, New York, NY.

Maintaining biodiversity requires attention to a wider array of components and larger landscape units in determining management options. The political process of developing biodiversity policy should be guided by three central principles: (1) efforts at maintaining biodiversity should be directed at maintaining the total biodiversity of the landscape for many generations; (2) diversity must be understood dynamically, in terms of healthy processes, rather than merely as a maintenance of current elements of the system; and (3) economic activities that complement and enhance, rather than oppose and degrade, ecological processes are to be preferred and encouraged.

Szaro, R. and D. Johnston, eds. 1996. Biodiversity in Managed Landscapes. Oxford University Press, New York, NY.

"Where do we go from here" is the question so far as dealing with biodiversity in management is concerned. Fulfilling this task requires understanding where we are in terms of knowledge and professional and public understanding of biodiversity. A logical first move is to synthesize the applicable information on principles and theory surrounding biodiversity. This book answers that need by bringing together and synthesizing relevant principles, practices, and policies for biodiversity conservation.

The Heinz Center. 1999. Designing a Report on the State of the Nation's Ecosystems: Selected Measurements for Croplands, Forests, and Coasts & Oceans. Ythe H. John Heinz III Center. Washington, DC.

This prototype report represents a framework for reporting ecological conditions and applies this framework to present information on Croplands, Coasts & Oceans, and Forests. Expert committees with representatives from industry, the environmental community, academia, and government developed this framework and selected items to report. These committees identified the most important ecological goods, services, or properties for each system, then searched for high quality data to describe their status. The prototype includes 12 ecosystem properties describing three broad aspects of each system: its basic dimensions; its provision of food, fiber, and other goods. and its physical, chemical, and biological condition. By using a consistent set of ecosystem goods, services, and properties, the framework allows comparisons among ecosystems while describing key elements of each ecosystem. In 2001, The Heinz Center will issue an expanded report covering all ecosystems of the United States.

Thomas, C. 1990. What do real population dynamics tell us about minimum viable population sizes? Conservation Biology 4(3): 324-327.

If the variability of an animal population can be established, the population size required to produce a negligible probability of extinction over a given time period can be estimated. Because extinction is probabilistic, the minimum viable population (MVP) size for each animal population must be estimated separately, after considering the characteristics of the population and the environment under scrutiny. Once established, MVP estimates can be used to design and manage reserves for focal species. Previous MVP guidelines have been based more on theory and models than on observations of natural population dynamics. When studies of population persistence and the dynamics of natural populations are examined, the conservative approach that emerges is to assume that a population will exhibit maximum variability: i.e., it will vary by three orders of magnitude. With this variability, a population geometric mean of must be 5,500 individuals to drop below 100 at a rate only once in 100 years. On the basis of empirical evidence, a population size of 10 is too small, 100 is usually inadequate, 1,000 is adequate for species of normal variability, and 10,000 should permit medium- to long-term persistence of most of the most variable birds and mammals. The geometric mean value of at least 5,500 may be a useful goal for the preservation of existing species in undivided habitat, and as a recovery target for smaller populations elsewhere. However, this guideline is no substitute for a thorough knowledge of the species and habitats under consideration. Populations that occupy habitat fragments that are far too small to hold thousands of individuals may still possess great conservation potential, particularly when populations are not completely isolated. When populations show average or low population variability and inhabit stable environments, mean values of 500 may be adequate for long-term persistence. Models and empirical evidence indicate that some populations can persist and recover at even lower levels for many years. However, it is often easier and less expensive to ensure that a large population does not become small than to ensure that a small population does not become extinct.

Thomas, J., J. Parker, R. Mowrey, G. Hanson, and B. Bell, eds. 1979. Wildlife Habitats in Managed Forest: The Blue Mountains of Oregon and Washington. Agriculture Handbook 553. USDA, Forest Service. Washington D.C.

Until just a few years ago, forest managers were not especially concerned with wildlife. However, forest managers are now under increasing pressure to account for wildlife in their management activities, particularly in land use planning. One must first start with a simple question: What do forest managers do that affects wildlife? They certainly do not manage wildlife directly; instead, they manage habitat and the forest manager alters wildlife habitat with every decision. Habitat is something a forest manager understands, controls, and can be held accountable for. The maintenance of appropriate habitat is the foundation of all wildlife management. Habitat, therefore, is the key to organizing knowledge about wildlife so it can be used in forest management. This book is the first major attempt to use such an integrated system to examine the impacts of forest management on terrestrial vertebrate fauna. This pioneering perspective is both theoretically sound and of immediate practical value. Application of this system has led to substantial improvements in the effectiveness of forest-wildlife planning in the Pacific Northwest's Blue Mountains.

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

This paper uses theory and experiments to explore the effects of diversity on stability, productivity, and susceptibility to invasion. A model of resource competition predicts that increases in diversity cause community stability to increase, but population stability to decrease. These opposite effects are, to a great extent, explained by how temporal variances in species abundance scale with mean abundance, and by the differential impact of scaling on population vs. community stability. Models of competition predict that greater plant diversity leads to greater primary productivity. This diversity-productivity relationship results both from the greater chance that a more productive species would be present at higher diversity (the sampling effect) and from better "coverage" of habitat heterogeneity caused by the broader range of species traits in a more diverse community (the niche differentiation effect). Both effects cause more complete utilization of limiting resources at higher diversity, which increases resource retention, further increasing productivity. In total, biodiversity should be added to species composition, disturbance, nutrient supply, and climate as a major controller of population and ecosystem dynamics and structure.

Tilman, D. and J. Downing. 1994. Biodiversity and stability in grasslands. Nature 367: 363-365.

One of the ecological tenets justifying conservation of biological diversity is that diversity begets stability. Impacts of biodiversity on population on population dynamics and ecosystem functioning have long been debated, however, with many theoretical explorations but few field studies. Here, a long-term study of grasslands is described which shows that primary productivity in more diverse plant communities is more resistant to, and recovers more fully from, a major drought. Results support the diversity-stability hypothesis, but not the alternative hypothesis that most species are functionally redundant. This study implies that the preservation of biodiversity is essential for the maintenance of stable productivity in ecosystems.

Tilman, D., R. May, C. Lehman, and M. Nowak. 1994. Habitat destruction and the extinction debt. Nature 371: 65-66.

Habitat destruction is the major cause of species extinctions. Dominant species are considered to be free of this threat because they are abundant in the undisturbed fragments that remain after destruction. Here we describe a model that explains multispecies coexistence in patchy habitats and which predicts that their abundance may be fleeting. Even moderate habitat destruction is predicted to cause time-delayed but deterministic extinction of the dominant competitor in remnant patches. Further species are predicted to become extinct, in order from the best to the poorest competitors, as habitat destruction increases. Because such extinctions occur generations after fragmentation, they represent a debt – a future ecological cost of current habitat destruction.

Tilman, D., D. Wedlin, and J. Knops. 1996. Productivity and sustainability influenced by biodiversity in grassland ecosystems. Nature 379: 718-720.

The functioning and sustainability of ecosystems may depend on their biological diversity. Elton's hypothesis that more diverse ecosystems are more stable has received much attention, but Darwin's proposal that more diverse plant communities are more productive, and the related conjectures that they have lower nutrient losses and more sustainable soils, are less well studied. Here, we use a well-replicated field experiment, in which species diversity was well controlled, to show that ecosystem productivity in 147 grassland plots increased significantly with plant biodiversity. Moreover, the main limiting nutrient, soil mineral nitrogen, was utilized more completely when there was a greater diversity of species. These results support the diversity-productivity and diversity-sustainability hypotheses. Our results demonstrate that the loss of species threatens ecosystem functioning and sustainability.

Turner, M., R. Gardner, and R. O'Neill. 1995. Ecological Dynamics at Broad Scales. Bioscience Supplement on Science & Biodiversity Policy: S-29 to S-34.

In response to environmental problems, such as global climate change, land-use change, habitat fragmentation, and loss of biodiversity, ecologists are expanding the scope and scale of their inquiry. Current trends in research and land management suggest that the broad-scale focus in ecology is likely to remain prominent for some time. In this article, we review issues associated with biodiversity at broad scales and suggest several important research needs. There are many studies of how landscape dynamics influence biodiversity, but the effects of variation in ecosystem processes on this relationship are often not considered. In addition, there are few studies of how biodiversity influences landscape pattern, a potentially important feedback. Similarly, there is detailed knowledge of how some species influence ecosystem processes, but the influence of the landscape and spatial variation on their interactions is poorly understood. Finally, the interactions between landscape dynamics and ecosystem processes are not well understood.

Ulgiati, S. and M. Brown. 1998. Monitoring patterns of sustainability in natural and man-made ecosystems. Ecological Modeling 108: 23-36.

By means of a systemic analysis of the relationships among components of a system's web, flows of energy and other resources converging to produce the output (biomass, biodiversity, assets, industrial products) can be evaluated on a common basis, i.e. the content of solar equivalent energy (hereafter, emergy). Indices and ratios based on emergy flows can be calculated and used to evaluate the behavior of the whole system. A new index of sustainability is also defined and applied to case studies. The trends of these indices provide useful information about the dynamics of economic systems within the carrying capacity of the environment in which they develop.

US MAB (U.S. Man and the Biosphere Program). 1995. Biosphere Reserves in Action: Case Studies of the American Experience. Department of State Publication 10241. Washington, DC.

The United States Man and the Biosphere Program (US MAB) fosters harmonius relations between humans and the biosphere through domestic and international cooperation in interdisciplinary research, education, biosphere reserves, and information exchange. US MAB utilizes UNESCO designated biosphere reserves as sites for promoting ecosystem management by incorporating a program of ecosystem protection with sustainable human use and development; documenting global change and biological diversity through monitoring, inventorying, and scientific research; and organizing regional cooperative institutions for resolving complex issues of multipurpose land use. The 12 case studies presented in this book represent only a few of the possible evolutions of a biosphere reserve in its efforts to reach out to the local and regional community. Some have had great success, while others consider their successes almost negligible. All document tremendous effort from many people to improve the communication among landowners, land managers, scientists, and any others interested in the health and well-being of the natural and human environment of the biosphere reserve.

Valpasvuo-Jaatinen, P. , S. Rekolainen, and H. Latostenmaa. 1997. Finnish Agriculture and its Sustainability: Environmental Impacts. Ambio 26 (7): 448-455.

The aim of the article is to describe Finnish agricultural structure and the state of the environment, as well as the environmental impacts of agriculture to surface and groundwaters; atmospheric emissions; rural landscape; and biodiversity; with special attention to fertilization, erosion, and pesticides. The objectives and structure of the Finnish Agri-Environmental Programme 1995-1999 are explained, and the implementation of the program is viewed through environmental goals and environmental impacts. Transition to sustainable agriculture in Finland is also discussed, followed by an assessment of sustainability and environmental risk analyses.

Vance, N. and J. Thomas, eds. 1997. Special forest products – biodiversity meets the marketplace. Sustainable forestry – seminar series; 1995 October-November; Oregon State University, Corvallis, OR. US Department of Agriculture 1997 Gen. Tech. Report GTR-WO-63; Washington, DC.

Although North American forests traditionally have been viewed as a source of wood and paper, a variety of profitable products are being discovered that come not only from trees, but from nonwoody plants, lichens, fungi, algae, and microorganisms. the northern temperate forests' abundant biotic resources are being transformed into medicinals, botanicals, decoratives, natural foods, and a host of other novel and useful products. These products are referred to as secondary, specialty, special, or nontimber forest products. Consumer forces, social climate, expanding global markets, and an increase in entrepreneuralism are contributing to a new interest in developing these products as a viable economic option, especially in communities have a vital relationship with forests. Species diversity, a biological attribute that contributes to the ecological stability of forests, takes on an economic value to those sourcing or "biodiversity prospecting" for natural products. A totally integrated model of ecosystem management or of sustainable forestry would include this kind of interaction.

Vandermeer, J., M. van Noordwijk, J. Anderson, C. Ong, and I. Perfecto. 1998. Global change and multi-species agrosystems: Concepts and issues. Agriculture, Ecosystems and Environment 67: 1-22.

Complex (multi-species) agroecosystems change rapidly as a result of farmers' decisions based on their perception of opportunities and constraints. Overall, the trend is still one of reducing complexity. This review addresses the dring forces as well as consequences of this change and discusses the hypothesis that complex agricultural systems are more dependable in production and more sustainable in terms of resource conservation than simple ones. Farmer decisions regarding planned diversity on the farm have consequences not only for harvested produce, but also for associated diversity and non-harvested components which may contribute to ecological sustainability.

Vogt, K., D. Vogt, H. Asbjornsen, and R. Dahlgren. 1995. Roots, nutrients and their relationship to spatial patterns. Plant and Soil. 168-169: 113-123.

Ecosystem sustainability and resilience after a disturbance may be regulated by processes occurring at smaller spatial scales. The matrix of different spatial environments are created by: 1) individual plants that accumulate higher concentrations of specific nutrients, trace elements, or defensive plant secondary chemicals and thereby modify the chemistry of their ecological space and/or rates of processes; 2) the presence of structures (e.g., coarse woody debris) that may buffer some micro-environments from disturbances by functioning as a hospitable environment or as a reservoir for mycorrhizal fungi to sustain them into the next phase of stand development; and 3) chemical changes in soils during soil development which may result in distinct soil chemical environments. This paper presents three case studies from temperate and tropical forest ecosystems which suggest the importance of studying plant growth and nutrient and trace element cycling by stratifying sampling to encompass the mosaic patterns of existing spatial variability within the ecosystem. the examples show how individual plant species are able to create ecologically distinct spatial environments because of their distribution patterns within the landscape, how nutrient transfers in roots respond to the chemical variations in the soil, and how roots and mycorrhizal fungi are able to maintain themselves in the mosaic of coarse woody debris remaining on a site after the elimination of aboveground tree biomass. The three case studies include a subtropical forest in a Tabonuco forest type in the Luquillo Experimental forest, Puerto Rico, H.J. Andrews Experimental Forest in Oregon, and in a mature *Abies amabilis* ecosystem on the western slopes of the Cascade Mountains in Washington.

Webb, E. 1997. Canopy removal and residual stand damage during controlled selective logging in lowland swamp forest of northeast Costa Rica. Forest Ecology and Management 95: 117-129.

Sustainable timber extraction through selective logging has been proposed as a method of forest management that can help curtail the rate of tropical deforestation. The paper reports canopy removal and stand damage estimates for a controlled selective logging operation in lowland swamp forest of northeast Costa Rica. Although absolute levels of residual damage during controlled logging were quite low, there was no conclusive evidence that total residual damage was relatively lower than intensity-adjusted estimates from uncontrolled tropical logging operations. In contrast, canopy removal during logging was lower relatively lower than that in two other neotropical studies. The results are discussed in the broad context of tropical forest management, and a conservative approach to tropical forestry increases the possibility of sustainable extraction of the resource.

Wells, M. and K. Brandon. 1993. The Principles and Practice of Buffer Zones and Local Participation in Biodiversity Conservation. Ambio 22 (2/3): 157-162.

Recognition is growing that the successful management of protected areas ultimately depends on the cooperation and support of local people. As a result, there has been a dramatic increase in financial support for projects attempting to link the conservation of biodiversity in protected areas with local social and economic development. Drawing on our recent analysis of 23 integrated conservation-development projects in 14 developing countries, this paper explores the challenges which have arisen in operationalizing two key concepts that lie at the heart of community-based conservation: first, buffer zones around park boundaries; and second, greater participation of local people in conservation and development. Important practical constraints which have so far limited the effective implementation of these two concepts are described.

Wendland, A. and K. Bawa. 1996. Tropical Forestry: The Costa Rican Experience in Management of Forest Resources. Journal of Sustainable Forestry 3 (2/3): 91-156.

An overview of the forestry sector in Costa Rica was undertaken to determine whether the existing management practices of timber resources hold the potential to meet the country's demands for timber in the immediate decades to come, and to identify changes that might be needed in the management of forest lands. Results indicate that the present management of Costa Rica's timber resources – both natural forests and plantations – does not hold the potential to meet the country's demands for timber for more than the next ten years without severe loss of its forests. Costa Rica, with its enlightened public administration system, vast technical and scientific knowledge about its forest ecosystem, and extensive assistance from international organizations, must succeed in articulating and implementing a sustainable forestry policy, otherwise prospects in the less fortunate tropical forests would be bleak.

Western, D., R. Wright, and S. Strum, eds. 1994. Natural Connections: Perspectives in Community-based Conservation. Island Press, Washington, DC.

This volume represents the proceedings of a workshop on community-based conservation held at Airlie, Virginia from October 18-22, 1993. The workshop sought to provide perspectives on why so many projects failed to succeed at reconciling human needs and conservation at the local level, despite proposals containing all the right words. The discussions revealed that most organizations appeared to pay lip service to the goal of involving local communities in conservation but, in reality, went about their business as usual. Most personnel had not resolved the problem of building local sustainability into their projects by strengthening local institutions in the developing world. The volume concludes with a summary of the lessons learned from the workshop.

Wilcove, D. 1993. Getting Ahead of the Extinction Curve. Ecological Applications 3 (2): 218-220.

Four steps to markedly reduce the rate of species loss in the United States are proposed: (1) Enact new legislation or an executive order requiring the Bureau of Land Management (BLM) and the US Fish and Wildlife Service to mainatain viable populations of all native vertebrates on BLM lands and wildlife refuges; (2) preserve representative examples of all the natural communities occurring on each national forest, BLM district, or national wildlife refuge; (3) develop a national initiative to protect freshwater biodiversity; and (4) reauthorize and strengthen the Endangered Species Act.

Williams, J. and G. Davis. 1996. Strategies for Ecosystem-Based Conservation of Fish Communities. In: Biodiversity in Managed Landscapes (R. Szaro and D. Johnston, eds.). Oxford University Press, New York, NY.

The increasing loss of genetic and species diversity is one of the world's most critical problems and as E.O. Wilson succinctly noted, that loss "is the folly that our descendants are least likely to forgive us." It is not surprising that our concerns for biodiversity traditionally have focused at the level of individual species, and that conservation needs or opportunities at the community level have seldom been considered. The escalating loss of species suggests, however, that additional conservation strategies are needed. The purposes of this paper are to describe a strategy that maintains aquatic community integrity and to characterize the ecosystem-based management approach necessary to maintain fundamental ecological processes across landscapes and seascapes.

Wilson, E.O., ed. 1988. Biodiversity. National Academy Press. Washington, DC.

The diversity of life forms, so numerous many have yet to be identified, is the greatest wonder of this planet. The biosphere is an intricate tapestry of interwoven life forms. The source of this book was the National Forum on Biodiversity held in Washington, DC on September 21-24, 1986. The book offers an overall view of the Earth's biodiversity and carries the urgent warning that mankind is rapidly altering and destroying the environments that have fostered the diversity of life forms for more than a billion years.

Woodley, S., J. Kay, and G. Francis. 1993. Ecological Integrity and the Management of Ecosystems. St. Lucie Press, Ottawa, Canada.

As society's dependence on resources wrought from ecosystems deepens and therefore, the stress under which those ecosystems are put increases, the need to assure ecological sustainability has become widely recognized. In 1988, the Parliament of Canada passed an amendment to the National Parks Act requiring that "maintenance of ecological integrity, through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan." Inclusion of the term "ecological integrity" as a legal responsibility has raised the problem of usefully defining the term in the context of National Park management. Does ecological science have the ability to provide useful measures of ecological integrity? Is there a useful process for incorporating value judgements within measurable ecological variables? This volume brings together individuals from a variety of backgrounds: academics, government policy makers, park managers, environmentalists, and diverse readers, all with a stake in ecosystem management, to address these questions.

van der Zon, T. (ed.). 1995. Biological Diversity: Sectoral policy document of Development Cooperation. Ministry of Foreign Affairs, Development Cooperation Information Department. The Hague, Netherlands.

Since the 1970s, biological diversity has been the focus of increasing attention in international policy on nature conservation and the environment. The concept of biological diversity arose out of the observation that an exponentially increasing number of species is threatened with extinction as a result of human activity. This sectoral policy document elaborates the objectives and broad policy lines for development cooperation on the basis of an analysis of the issue of the conservation of biological diversity and the sustainable use of biological resources. Priorities for action are also set, and the instruments required to implement policy are described. This document sets forth environmental policy for Dutch development cooperation in the area of biological diversity.