Міністерство освіти і науки України
Науково-методичний центр вищої освіти
Національний лісотехнічний університет України

ISBN 5-7763-2435-1

НАУКОВИЙ ВІСНИК

Проблеми створення Екологічної Конституції Землі

Випуск 16.8

Львів - 2006

ЗБІРНИК НАУКОВО-ТЕХНІЧНИХ ПРАЦЬ

НАУКОВИЙ ВІСНИК: Проблеми створення Екологічної Конституції Землі. – Львів: НЛТУУ. – 2006, вип. 16.8. – 184 с.

Збірник публікує науково-технічні праці співробітників вищих навчальних закладів України, науковців з-за кордону, а також спеціалістів лісового і деревообробного комплексу, присвячені різним аспектам освітянських проблем та наукових досліджень, передового досвіду і впровадження у виробництво здобутих результатів.

Призначений для наукових працівників, аспірантів, інженерів галузі, викладачів вищих закладів освіти, коледжів і технікумів, студентів старших курсів.

Рекомендовано до друку Вченою Радою НЛТУ України (*протокол №8 від 05.10.2006 р.*). У збірнику вміщено статті, підготовлені авторами на підставі їх виступів на другій Міжнародній науковій конференції "Екологічна Конституція Землі як економіко-правова основа глобальної стратегії сталого розвитку і екологічної безпеки планети" (Львів, 28-29 вересня 2006 р.).

Адреса редакції:
79057, м. Львів-57, вул. Ген. Чупринки, 103/54, НЛТУ України
Тел.: (032)239-06-95, 239-06-74 **E-mail:** nv@forest.lviv.ua **Web:** www.nv.westua.com

УДК 330.15 Доц. Вільям Кітон – факультет довкілля і природних ресурсів ім. Рубенштейна, Університет Вермонту, США

РОЛЬ ЗЕМЕЛЬ ЛІСОВОГО ФОНДУ ТА МОДЕЛІ МЕНЕДЖМЕНТУ СТАЛОГО ЛІСОВОГО ГОСПОДАРСТВА: ПІВНІЧНО-АМЕРИКАНСЬКІ ПЕРСПЕКТИВИ

Лісові екосистеми забезпечують людство життєво важливими екологічними послугами. Таким чином, міжнародні угоди щодо екологічної сталості, такі як Екологічна Конституція Землі, повинні містити норми, в яких йдеться про охорону лісових екосистем. На сьогодні важливою проблемою є збереження та забезпечення сталого розвитку лісів. У цій статті аргументовано переконання, що для досягнення цієї мети недостатньо лише заповідних територій, як таких, а необхідним є стале ведення лісового господарства на незаповідних ландшафтах. Висвітлено новітні напрацювання в галузі сталого лісівництва, охоплює такі моделі, як матричний менеджмент і ведення лісового господарства, що наслідує відновлення екосистем після стихійних явищ. Цей підхід створить основу для сталого веденню лісового господарства, заснованого на сучасному науковому знанні динаміки природних стихійних явищ. Підґрунтям такого підходу є переконання, що лісівничі заходи, які найбільш точно повторюють динаміку природних екосистем, найкраще зможуть забезпечити надання широкого спектра благ і послуг і водночас зберегти біорізноманіття. Таким чином, згадані моделі будуть доповнювати природно-заповідні мережі, у сукупності з ними гарантуючи сталий розвиток екосистем на різних просторових рівнях, охоплюючи цілі ландшафти та біорегіони.

На прикладах із США та Канади наведено стратегії стимулювання сталого ведення лісового господарства. Вони передбачають, залежно від форми власності на землю, регуляторні, стимулюючі, ринкові підходи, а також підходи, які враховують інтереси місцевого населення. Сучасні тенденції у лісокористуванні та глобальне зниження цілісності лісових екосистем загалом роблять майбутнє сталого лісівництва непевним. З метою забезпечення безперервних можливостей для сталого ведення лісового господарства рекомендується застосування широкого кола природоохоронних механізмів, зокрема матричних підходів і ведення лісового господарства, що наслідує відновлення екосистем після стихійних явищ.

William S. Keeton[1] – Rubenstein School of Environment and Natural Resources

Role of Managed Forestlands and Models for Sustainable Forest Management: Perspectives from North America

Forest ecosystems provide a host of critical environmental services to humanity. Thus, international agreements on environmental sustainability, such as a Global Environmental Constitution, must include provisions safeguarding forested ecosystems. At issue is how best to conserve and sustain forests. In this paper I argue that protected areas, while essential, will not accomplish this goal without sustainable forest management on the unprotected landscape. Recent developments in the field of sustainable forestry are reviewed, including models such as matrix management and disturbance-based forestry. These provide a framework for sustainable forest management based on recent scientific advances in our understanding of natural disturbance dynamics. The fundamental premise is that forestry practices that most closely approximate natural ecosystem dynamics will best provide a wide range of ecosystem goods and services while also conserving biological diversity. These models, therefore, will compliment protected area networks, collectively ensuring ecosystem sustainability at multiple spatial scales, including entire landscapes and bioregions. Strategies for promoting sustainable forest management are reviewed using examples and case studies from the United States and Canada. These include regulatory, incentive,

---

[1] William S. Keeton, Ph.D., is an Associate Professor of Forest Ecology and Forestry (william.keeton@uvm.edu)

market, and community based approaches, differing in applicability with land tenure context. Current trends in the forest products industry and global declines in forest ecosystem integrity in general render the future of sustainable forestry uncertain. Greater use of a broad range of conservation mechanisms is recommended to provide continued opportunities for sustainable forest management, including matrix and disturbance based approaches.

Introduction

Forest ecosystems are vital to global environmental quality, economic well-being, and humanity's future. Forestlands today account for only 30 % (or 3.9 billion hectares) of the world's land area, yet they harbor close to 90 % of known terrestrial species. Forestlands also provide critical ecosystem services, such as production of harvestable timber and non-timber resources, hydrological regulation, pollination vectors, and erosion control. Approximately 46 % of the carbon stored in the terrestrial biosphere is sequestered in forests, representing a major influence on global carbon cycles and climate processes. With such profoundly important ecosystem services at stake, multi-lateral agreements and conventions addressing environmental sustainability must include provisions safeguarding the long-term integrity of forest systems world wide. These principles are thus highly relevant to the Global Environmental Constitution proposed in these proceedings.

For decades the best way to sustain forest ecosystems, while also providing a broad range of ecosystem goods and services, has been the subject of debate. Conservationists favored the establishment of large, comprehensive protected area networks as a foundation for ecological sustainability, arguing this carried the least risk to species survival (Noss and Scott 1997). Other constituencies preferred forest management strategies stressing active vegetation manipulation (i.e. silvicultural management). Under this approach, sustained production of harvestable resources was the primary objective, with ecological objectives derived as a by-product of scientifically informed planning (Oliver 1992). More recently, ecosystem management models (see Grumbine 1994, Yaffee 2002) have bridged this ideological divide, viewing protected areas and actively managed forestlands as complimentary approaches if coordinated at landscape or regional scales (Keeton and Aplet 1997, Poiani et al. 2000). Not every ecosystem good or service (ecological or commercial) can be provided on every hectare; this requires a mosaic of differently managed forest stands or patches. But the relative mix of protected areas versus managed forestlands necessary to achieve broad sustainability objectives remains contentious in many regions of the world. Arriving at a desirable mix will always involve trade-offs between different economic and ecological objectives, values, and interests.

How much of the landscape can be realistically and justifiably allocated to protected areas? And perhaps even more importantly, on the remaining actively managed landscape, what forest management practices should be employed and how can these be encouraged? Clear direction on these questions must comprise a key element of future international environmental agreements, such as a Global Environmental Constitution. Providing guidance as a matter of international policy will be challenging. It must be adaptive to evolving models of sustainable ecosystem management as well as geopolitical context and local community involvement. In this paper I discuss several evolving models intended to guide sustainable forestry on managed forestlands, with the assumption that these would be used in conjunction with protected areas approaches. Examples and case studies from the United States of America and Canada are presented. These showcase several interesting and innovative ideas in sustainable forest management, with the explicit recognition that there is no universal "one size fits all" solution. Recent developments in North America may provide a perspective relevant to efforts elsewhere in the world.

The role of sustainably managed forestlands in an uncertain future

If 19th and 20th century conservation models were concerned primarily with the establishment of protected areas, such as flagship national parks, wilderness areas, and biological reserves, what will conservation look like in the next century? Reserves will always be a critical element of sustainable ecosystem management (Noss and Scott 1997, Lindenmayer and Franklin 2002). But ecologically-based stewardship of managed forestlands will assume a much greater role than it has in the past. The world's human population, currently 6.7 billion, is predicted to reach 9.2 billion by 2050 (UNPD 2007). Global demand for forest products, currently about 1.6 billion cubic meters per year, has been relatively constant over the last two decades, due to non-wood substitutes, recycling, and more efficient processing of raw wood (Sedjo 2005). Demand is protected to increase moderately (e.g. 5 to 10 %) over the next decade, due in large part to explosive economic growth and increased wood importation in China (White et al. 2006).

With these trends and increasing rates of per capita consumption, forested landscapes will face increasing pressures over the coming century. Every year 14.6 million hectares of forest are lost worldwide, and 1.5 million hectares of natural or semi-natural forest are converted to plantations (WWF 2002). These changes will be superimposed on the effects of other anthropogenic stressors, such as atmospheric pollution, spread of exotic species, and global climate change. Some effects likely will be experienced unevenly throughout the world, such as changes in forest productivity associated with global climate change (Aber et al. 2001). In this context – with human-caused stress in forest ecosystems felt ever more broadly and intensively – relying on protected areas alone to safeguard forest ecosystems will no longer be realistic or scientifically defensible, especially if these become islands in otherwise compromised landscapes. Careful, ecologically-sensitive, adaptive, scientifically-based management of the unprotected landscape (i.e. those areas outside of core ecological reserves) will be essential to sustain forest ecosystems.

There are several reasons why this is likely. Perhaps foremost among these is the fact that managed forestlands will continue to comprise the majority of the forested landscape. About 10 % of the world's major biomes are currently protected in formally established protected areas following international guidelines, such as IUCN's six category classification system. And this number is not likely to surpass 15 % for the foreseeable future. Moreover, only about 8 % of forests worldwide are included in strictly protected areas (IUCN category I), and this number varies considerably region to region. For instance, only 1.7 % of the forested area across 26 European countries is strictly protected (Parviainenet al 2000). Consequently, the vast majority of terrestrial biodiversity will continue to depend, either in part or in full, on habitat provided by lands outside of core protected areas (Lindemayer and Franklin 2002). We cannot count on core reserves alone to do the job. For example, the majority of species diversity in the U.S. is not sufficiently represented within existing federal protected areas to ensure long term population viability (Grumbine 1990, Scott et al. 2001).

Current conservation goals advocated by international organizations (e.g. IUCN, WWF) may be inadequate to protect biodiversity. By one estimate, 50 % of tropical taxa are predicted to go extinct within several decades even with significant increases in tropical forest protection (Soule and Sanjayan 1998). Half of the world's terrestrial species will remain at high risk of extinction even with 10-12 % of every major ecosystem type protected (Soule and Sanjayan 1998). Moreover, biodiversity is protected unevenly, with certain taxa and ecosystem types left more susceptible to risk than others. For example, there is a consistent bias towards high elevations and the least productive soils found in protected area systems (Scott et al. 2001). Protection varies dramatically by forest type around the world. For example, whereas about 27 % of broadleaf evergreen forests have some degree of protection (IUCM categories I-V), far less deciduous broadleaf (4 %) or evergreen needleleaf (7 %) forest is similarly protected (World Conservation Monitoring Center 2007).

Alternatives have been proposed to help address these problems. For instance, expanding protected area systems to include comprehensive representation of ecosystem diversity is a frequently advocated approach (Noss and Scott 1997). This is the basic premise behind the U.S. Gap Analysis Program and similar efforts elsewhere; these have identified high priority areas for inclusion within protected area systems. However, by one estimate core reserves would need to cover 30 to 75 % of most geographic regions to encompass adequate representation of all ecosystem types (Solomon et al. 2004). Expansion of protected area networks to this level is unlikely in many regions of the world. Thus, survival for many if not most species will continue to depend on the unprotected landscapes.

Another alternative is to focus new protected areas establishment on so-called "hotspots of biological diversity," which are areas of exceptionally high species richness and endemism. Protecting hotspots is efficient in terms of biodiversity return per unit area protected because one third of terrestrial plant and animal species are confined to less than 2 % of the Earth's surface. Some 25 hotspots have been identified globally, representing 1.4 % of the Earth's land surface (Myers et al. 2000). These areas alone contain 35 % of vertebrate species within four major groups and 44 % of the world's vascular plant species. Yet most hotspots currently have no formal protection.

Despite opportunities for improving protected areas coverage, managed forestlands will comprise the largest proportion of terrestrial biodiversity. Moreover, it is these lands that will sequester the vast majority of carbon in the terrestrial biosphere, produce clean water, and provide the ecosystem services upon which life and humanity depend in many regions of the world. The challenge lies in developing sustainable forest management approaches for the unprotected (or less fully protected) forest lands that balance economic and ecological objectives. Kolm and Franklin (1997) in their book, *Creating a Forestry for the 21st Century*, described this problem as follows: "If 20th century forestry was about managing individual forest stands, simplifying stand structure, and providing timber, 21st century forestry will be defined by understanding and managing complexity, providing a wide range of ecological goods and services, and managing across broad landscapes."

In North America a widely held view is that past management approaches have not been adequate to sustain a full array of biodiversity and ecosystem functions (Committee of Scientists 1999). New approaches are needed, although it is important to recognize that management history (i.e. harvesting intensity, extent of scientifically-based planning, adequacy of biodiversity conservation, etc.) has been highly variable, depending on ownership, region, silvicultural systems employed, degree of conflict over ecological vs. economic outputs, etc. Past approaches on the federally owned National Forest System in the United States were generally output driven (Yaffee 1994), focusing, for instance, on achieving a desired harvest level, intensity of recreational use, etc. Ecologically sustainable approaches, by contrast, would begin with an assessment of the capacity of the ecosystem to sustain a variety of uses over time within biological and ecological constraints. Only once sufficient attention is given to providing sufficient habitat for native organisms, for instance, would it be possible to determine an acceptable level of timber harvest. In the late 1990 s former U.S. President Bill Clinton appointed a committee of top forest scientists and economists, charged with developing recommendations for sustainable forestry on federal lands. They determined that a fundamental reversal in forest management was necessary, described as follows:

> "Sustainability ...has three aspects: ecological, economic, and social...the sustainability of ecological systems is a necessary prerequisite for strong productive economies, enduring human communities, and the values people seek from wildlands. We compromise human welfare if we fail to sustain vital, functioning ecological systems. It is also true that strong economies and communities are often a prerequisite to societies possessing the will and patience needed to sustain ecological systems (Committee of Scientists 1999)."

The Committee's recommendation, while still not fully adopted on federal forestlands, represented a revolutionary way of thinking. No longer would the federal government specify a given output level required of a national forest (e.g. harvestable timber volume based on a maximal sustained yield model), then leave it up to the forest managers to figure how to meet this objective. Instead, forest management would start with an understanding of the capacity of an ecosystem to produce goods and services – biological, ecological, commercial, etc. Only then could output targets only be established, within these constraints and to the extent they did not impair biodiversity or ecosystem functioning. At the same time, however, it was recognized that commitment to ecosystem protection was a choice not likely to be made by peoples and communities, particularly in impoverished regions of the world, struggling to meet the basic necessities of life. Thus, sustainable economic development must occur concurrently with development of the social and economic capital necessary for investments in ecosystem protection.

Matrix management

As the dominant element of the landscape, managed forestlands will have a controlling influence on ecological processes, such as biological connectivity and watershed functioning. It will of course also be the primary source for production of ecosystem goods and services upon which society depends. Because this "patch" or dominant landscape element surrounds and occupies the critical intervening areas between protected areas and intensively developed areas, such as cities, rural residential, and agricultural land, forest scientists now describe this middle ground as the "matrix". It can include both private and publicly owned lands, of any parcel size, so long as these are allocated primarily to natural resource management, conservation, or open space of some kind. Lindenmayer and Franklin (2002) identified five critical roles for the matrix. These are:

1. "supporting populations of species,
2. regulating the movement of organisms,
3. buffering sensitive areas, and
4. maintaining the integrity of aquatic ecosystems, and
5. providing for the production of commodities and services."

In the U.S., Canada, and other countries (e.g. Australia), recognition of the importance of the matrix has given rise to a new approach called "matrix" management. Matrix management incorporates concepts that have evolved along with the field of conservation biology. For instance, Lindenmayer and Franklin (2002) identify "maintenance of suitable habitat at multiple spatial scales" as an "overarching" goal of matrix management, stressing the importance of providing well-distributed habitats, including both large core habitats and smaller habitat islands within more intensively managed areas. Habitat is seen as an 'emergent' property of ecosystems, with certain habitat attributes (e.g. large trees, downed logs) provided at fine scales (e.g. within stands) and other attributes (e.g. large, unfragmented patches) provided at coarser scales (e.g. multiple stands, landscapes, watersheds, bioregions). According to Lindenmayer and Franklin's framework, five principles must be followed in order to achieve the overall goal. These are:

1. "maintenance of stand structural complexity,
2. maintenance of connectivity,
3. maintenance of landscape heterogeneity,
4. maintenance of aquatic ecosystem integrity, and
5. risk spreading, or the application of multiple conservation strategies."

The first principle recognizes that intensive or industrial forestry practices usually simplify stand structure resulting, for example, in less complex vertical complexity in the forest canopy, less horizontal variation in stand density, and lower densities of key habitat elements like large dead trees and downed logs (Franklin 1992, Swanson and Franklin 1992, Franklin et al. 1997). Thus, an alternative is to promote greater structural complexity (e.g. vertically differentiated canopies, higher volumes of coarse woody debris) in actively managed stands (Hunter 1999, Keeton 2006), reflecting a broader diversity of stand development stages (as consistent with stand dynamics specific to individual forest types). This may benefit those organisms not well represented in simplified stands, provided sufficient habitat is provided across multiple stands to support viable populations (McKenny et al. 2006).

Maintaining biological connectivity in managed forest systems is essential for the persistence of viable populations of organisms (Harris 1984, FEMAT 1993).

Thus, the second principle of matrix management involves strategies, such as terrestrial and riparian corridors, retention of well distributed habitat blocks and structures to provide "stepping stones," and other approaches, that allow organisms to disperse, migrate, access resources, and interact demographically. Maintaining a diverse landscape (principle three) supports an array of ecological functions while also increasing ecosystem resilience to disturbance and stress (Perry and Amaranthus 1997).

Principle four relates to minimizing deleterious forest management effects on surface waters and watersheds. Scientists have documented important ecological interactions between riparian forests and aquatic ecosystems (Ward et al. 2002, Naiman et al. 2005, Keeton et al. 2007 b). Thus, delineation of riparian buffers, riparian forest restoration, ecologically informed forest road management, and other best management practices for watershed protection are essential elements of matrix management (Gregory et al. 1997, Stuart and Edwards 2006).

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

Disturbance-based forestry

Matrix management principles are well grounded in the science, but like any model, will be challenging to implement when balancing competing objectives. Managers will face difficult questions: like how much is enough? How much of a particular type of habitat or ecosystem function should be provided by matrix management? Should this be a static or a dynamic, ever changing mix of habitats?

Some answers are provided by recent silvicultural developments in the U.S. and Canada, often referred to as "disturbance-based forestry" (Mitchell et al. 2002, Seymour et al. 2002). Disturbance-based forestry and matrix management are complimentary; the former offers guidance on implementing the latter. The idea is that an understanding of natural disturbance dynamics can help us develop low risk, ecologically friendly forestry practices. Keeton (2006) summarizes this as follows:

> *"Sustainable forestry practices across managed forest landscapes contribute to the maintenance of biological diversity and ecosystem functioning. The challenge lies in determining the mix of management approaches – including type, timing, intensity, and spatial configuration of silvicultural treatments – necessary to achieve sustainability objectives. One possibility is to focus on the architecture of individual forest stands and their spatial arrangement, with consideration given to the aggregate representation of multiple structural (or habitat) conditions at landscape scales. Patch and successional dynamics associated with natural disturbance regimes provide a useful guide for designing this type of structure or disturbance-based approach. A recommendation is to manage for currently under-represented structures and age classes on some portion of the landscape."*

An implicit assumption in these approaches is that forest management will be ecologically sustainable – i.e. has greater likelihood of providing viable habitats for a full range of native species – if it maintains or approximates ecosystem patterns and processes associated with natural disturbance regimes and successional processes (Aplet and Keeton 1999). This bounded range within which attributes of ecosystem structure and function vary over time and space has been termed the "historic range of variability" (HRV, Landres 1999). According to this line of thinking, if HRV represents the conditions under which organisms evolved and have adapted, then species will have the greatest likelihood of survival if similar conditions are provided through management. There are examples of sustainable forest management plans based on reconstructions of HRV (e.g. Cissel et al. 1999, Moore et al. 1999). Yet HRV based approaches are difficult to implement. To begin with, the feasibility of quantifying HRV for a given landscape varies greatly depending on data availability and modelling requirements (Parsons et al. 1999). There is the added difficulty of finding appropriate historical reference periods (Millar and Woolfenden 1999). Secondly, forest managers must determine whether HRV offers a realistic target for management. A further consideration is the extent to which conditions within the HRV are compatible with contemporary management objectives, altered ecosystem conditions and dynamics attributable to land use history, changing climatic conditions, etc. Despite these limitations, HRV provides an informative benchmark or reference for understanding landscape change (Aplet and Keeton 1999).

Disturbance-base forestry has largely developed along two lines of investigation in moist temperate and boreal regions of North America. The first is developing silvicultural practices that more closely approximate natural disturbance patterns, scales, and frequencies (Mladenoff and Pastor 1993, Seymour et al. 2002) and related regional stand age class distributions (Lorimer and White 2003). Natural disturbance return intervals inform harvesting frequency (rotation or entry cycle) and disturbance sizes (or extent) guide the scale of individual harvest units. In the northeastern U.S., for instance, small group selection methods (a form of uneven-aged silviculture), practiced on an entry cycles of several decades or more, best approximate the fine scale, high frequency disturbance regime of the region's temperate deciduous and mixed hardwood-conifer forests. Seymour et al. (2002) developed a "comparability index" that depicts the correspondence between a range of silvicultural systems and natural disturbance scales and frequencies. Some of these disturbance-based methods are being experimentally tested (e.g. Seymour 2005, Keeton 2006).

The second area of work in disturbance-based forestry is focused on ecosystem recovery following disturbances and long-term processes of stand development (Franklin et al 2002). This has included a growing appreciation for the role of biological legacies in ecosystem recovery following moderate to high intensity disturbances (Keeton and Franklin 2005). Biological legacies are "the organisms, organic materials, and organically-generated patterns that persist through a disturbance and are incorporated into the recovering ecosystem" (Franklin et al. 2000:11). Disturbance-based silvicultural systems developed in the western U.S. and Canada are designed to provide ecological functions similar to those associated with biological legacies. Examples include the "variable retention harvest system" (Franklin et al. 1997) and other retention systems (Marshall and Curtis 2005, Beese et al. 2005); these systems retain biologically significant elements of stand structure (e.g. large live and dead trees) following regeneration harvest. Structures are retained in varying densities/volumes and in different spatial patterns (e.g. aggregated vs. dispersed, Franklin et al. 1999, Aubry et al. 1999). Retention schemes can mimic the landscape level patterns (e.g. greater tree survivorship within riparian areas) created by natural disturbances, such as forest fire (Keeton and Franklin 2004).

An extension of this research has investigated effects of natural disturbances in mediating late-successional stand development (Abrams and Scott 1989, Lorimer and Frelich 1994). The objective is to develop silvicultural systems that provide a broader range of stand development stages, including old-growth habitats and associated functions (Franklin et al. 2002, Keeton 2006). These systems accelerate rates of stand development in young, mature, and riparian forests through under-planting, variable density thinning, crown release, and other methods (FEMAT 1993, Berg 1995, Singer and Lorimer 1997, Harrington et al.. 2005). Both these and retention forestry are prescribed as elements of the Northwest Forest Plan, a bioregional plan for federally owned forests in the U.S. Pacific Northwest (FEMAT 1993). As another example, an approach called "Structural Complexity Enhancement" has been experimentally tested in northern hardwood-conifer forests in the northeastern United States. This system accelerates late-successional forest development through a variety of unconventional silvicultural techniques, some of which approximate fine-scale natural disturbance effects (Keeton 2006).

Strategies for promoting sustainable forest management

Strategies for promoting ecologically-based forest management, including matrix management and disturbance-based forestry, will vary by geographic region, land tenure context, and other factors. In the U.S. a variety of strategies are employed. These range from regulatory approaches on publicly owned lands, such as federal forests in the Pacific Northwest region, to incentive-based approaches on landscapes dominated by private lands, such as in the eastern U.S.

Forest management in the U.S. is conducted under a set of federal and state laws regulating many aspects of forest and environmental management on public and sometimes private lands. These laws incorporate some elements of sustainable forest management, such as consideration of multiple resource values (i.e. "multiple use"), safeguards for threatened and endangered species, planning procedures, and watershed protections. However, the degree to which these laws have resulted in ecologically sustainable management has been the subject of considerable debate (see Grumbine 1990, Yaffee 1994, Davis et al. 2001). Laws such as the National Forest Management Act of 1976 are focused primarily on activities at the individual administrative unit level (e.g. a national or state forest). For this reason more holistic, trans-boundary, landscape level projects, for instance applying matrix management principles, have not occurred in a consistent manner nationally. Rather they have responded to regionally-specific issues, such as the need for a comprehensive plan to conserve old-growth forests in the U.S. Pacific Northwest. Thus, these projects are often implemented through regulatory development and administrative (or agency) authority granted by the statutes (laws or acts of Congress).

Regulatory approaches in the U.S. Northwest have included creation of a bioregional reserve system and delineations of "matrix" lands where disturbance-based forestry methods, such as retention forestry, are required. Such "top down" style approaches are possible, in this case, because over two thirds of the forest land is publicly owned. Large, federally controlled landscapes can be managed holistically under a unified, governmentally orchestrated plan. Application of matrix management principles has also occurred in a number of other regions with significant amounts of public land. These include, for example, the Sierra Nevada Range in California, the Greater Yellowstone Ecosystem in the northern Rocky Mountains, and the southern Appalachian Mountain region of the southeastern U.S.

In regions of the country, such as the northeastern U.S., dominated by privately owned lands and smaller forest parcel sizes other approaches are necessary (on an individual owner by owner basis) to achieve the same landscape level objectives. Matrix management objectives are thus achieved (indirectly, not explicitly) through a combination of limited conservation land acquisition, land-use review and regulation (varying greatly by state and locale), and incentive based programs. The latter include property tax relief for open space conservation and sustainable forest management. One such program in the state of Vermont is the "Current Use Value Appraisal Program." This assesses property tax rates based not on the residential or commercial development potential of a parcel of land – as is the case generally – but rather based on its "current use" as actively managed timberland. There are similar programs in other northeastern U.S. states, including New York, New Hampshire, Massachusetts, and Maine. Other programs, such as the federal "Forest Legacy Program," offer limited funding for private landowners who agree to keep forestlands in sustainable forest management and open space.

Conservation easements represent another tool frequently used to prevent forest lands from being split into smaller parcels (subdivision) and sold for real-estate development. Easements transfer development rights to a willing third party buyer, typically a public agency or a non-governmental organization (e.g. a land trust), while the original landowners retain other property rights (e.g. timber, minerals, access, etc.). In a few cases, lands sold under conservation agreements have included deed restrictions requiring sustainable forest management practices. Growth (i.e. development) management planning around rapidly expanding suburban and exurban areas has become another indispensable tool to conserve forestland and manage forest fire threats (Theobald 2003, Keeton et al. 2007 a).

Market-based mechanisms are also used to promote sustainable forest management. In North America there is widespread interest in forest certification systems, including frameworks developed both by the Forest Stewardship Council (FSC, a non-governmental organization) and the Sustainable Forestry Initiative (an industry sponsored program). Initially it was hoped that certified wood products would earn a premium in the marketplace, but this has been slow in coming. However, certification has given producers special access to buyers (e.g. institutions, environmentally motivated corporations, etc.) looking for certified products, making certified forests, mills, and distributors more competitive in these cases. According to Foster et al. (In press), "over 67 million hectares of forest land (approximately 16-22 % of total commercial forest land) in North America have been certified to FSC standards, and the FSC certified area worldwide has tripled over the last six years." Green labeling, such as the "Made in Vermont" label, offers another instrument for earning a premium, accessing niche markets, and gaining a competitive edge.

Developing markets for environmental services and amenities, such as water and recreational use, have great potential in terms of providing financial incentives for sustainable forest management. These can create market value for ecosystem services that currently have none. Foremost among these at present are rapidly developing "cap and trade" carbon markets. While the U.S. is not currently a signatory to the Kyoto agreement on climate change, voluntary carbon credit trading, such as the Chicago Climate Exchange, is growing and includes some timber companies as participants.

A final promising trend in North America is the increasing interest in community-based forestry. These efforts take different forms, but generally share the objective of enhancing community participation in and benefits from local forests. Examples include establishment of town forests, forestry cooperatives involving multiple small ownerships, community sort yards, efforts to stimulate locally based value-added manufacturing, leases granting communities limited management authority over local public lands (Canada only), and others. Community-based initiatives accomplish three primary things. First, they increase awareness of values provided by local forests, thereby stimulating public support for forest conservation and sustainable (often small scale) forest management. Second, they help return more of the economic benefits derived from forests directly to the community. And third, they provide strength in numbers. Multiple landowners, in effect, pool their resources and coordinate (to some degree) management across a larger area. This gives participants access to market opportunities not readily available to individuals. If conducted under a set of agreed upon standards, it also generally results in lower impact forestry practices and better provision of ecological values. Hence the opportunity for matrix management and disturbance based forestry through community forestry.

Globalization is reshaping the forest products industry, and with it the nature of sustainable forest management. In recent years there has been large scale divestiture of industrial timberlands in the northern hemisphere and reallocation of investments and capital to the southern hemisphere, primarily for establishment of high yield plantations, often utilizing exotic species (Franklin 2003). As industrial timberland is placed on the real-estate market, or acquired by shareholder groups (e.g. Timberland Investment Management Organizations) interested primarily in short term profit making, the ability of unprotected forestlands to contribute to sustainable forest management objectives becomes increasingly uncertain. In this context, application of incentive, market, and community based strategies will be even more important for keeping forestland in open space, habitat, and sustainable productive use. Without expanded use of these conservation mechanisms, sustainable management of the matrix will rapidly decline as an option.

Recommendations for the Global Environmental Constitution

This paper has discussed the critical values provided by ecologically-based forest management. Recently developed models, such as matrix management and disturbance-based forestry, offer possible options for achieving sustainable forest management objectives globally. A variety of regulatory, incentive, market, and community-based tools are available for promoting the implementation of these models more broadly. This review makes evident a number of recommendations for multi-lateral environmental agreements, such as a Global Environmental Constitution, designed to safeguard the world's forested ecosystems. These are as follows.

1. Recognize the critical importance of forests in global environmental sustainability, ecosystem functioning, and biological diversity conservation.
2. Recognize the fundamental ecological limits (ecosystem capacity) of forest ecosystems to sustain resource values; manage forests with the goal of providing wide array of ecosystem goods and services within these constraints.
3. Manage forests for ecological complexity, rather than employing conventional approaches that simplify ecosystem structure and function.
4. Implement holistic forest management strategies that integrate protected areas based conservation approaches with sustainable management of "matrix" lands.
5. Develop and implement matrix management approaches, including disturbance-based forestry practices, appropriate to different forested regions, forest types, and natural disturbance regimes.
6. Utilize, enhance, and provide support for mechanisms (regulatory, incentive, market, and/or community-based) that promote sustainable forest management on both public and privately owned lands.

Acknowledgements

The author is grateful to the Trust for Mutual Funding for funding international exchanges between the United States and Ukraine that led directly to development of this paper. Funding for portions of the literature review was provided by the USDA National Research Initiative, the Northeastern States Research Cooperative, the Vermont Monitoring Cooperative, and the USDA McIntire-Stennis Forest Research Program.

References

1. Aber, J., R.P. Neilson, S. McNulty, J.M. Lenihan, D. Bachelet, and R.J. Drapek. 2001. Forest processes and global environmental change: predicting the effects of individual and multiple stressor. BioScience 51: 735-751.

2. Abrams, M.D. and M.L. Scott. 1989. Disturbance mediated accelerated succession in two Michigan forest types. Forest Science 35: 42-49.

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

4. Aubry, K.B., M.P. Amaranthus, C.B. Halpern, J.D. White, B.L. Woodard, C.E. Petersen, C.A. Lagoudakis, and A.J. Horton. 1999. Evaluating the effects of varying levels and patterns of green-tree retention: experimental design of the DEMO study. Northwest Science 73: 12-26.

5. Beese, W.J., B.G. Dunsworth, and N.J. Smith. 2005. Variable-retention adaptive management experiments: testing new approaches for managing British Columbia's coastal forests. Pages 55-64 *in:* C.E. Peterson and D.A. Maguire (eds.). Balancing ecosystem values: innovative experiments for sustainable forestry. USDA Forest Service General Technical Report PNW-GTR-635.

6. Berg, D.R. 1995. Riparian silvicultural system design and assessment in the Pacific Northwest Cascade Mountains, USA. Ecological Applications 5: 87-96.

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

8. Davis, L.S., K.N. Johnson, P.S. Bettinger, and T.E. Howard. 2001. Forest Management (4th Edition). McGraw Hill, Boston, MA.

9. (FEMAT) Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: an ecological, economic, and social assessment. USDA Forest Service, Portland, OR.

10. Foster, B. C., D. Wang, and W.S. Keeton. In press. A post-harvest comparison of structure and economic value in FSC certified and uncertified northern hardwood stands. Journal of Sustainable Forestry.

11. Franklin, J.F. 1992. Scientific basis for new perspectives in forests and streams. Pages 25-72 in: Naiman, R.J. (Ed.). Watershed management: balancing sustainability and environment change. Springer-Verlag, New York, NY.

12. Franklin, J.F. 2003. Challenges to temperate forest stewardship – focusing on the future. Pages 1-10 in: D.B. Lindenmayer (ed.). Towards Forest Sustainability. CSIRO Publishing.

13. Franklin, J.F., D.R. Berg, D.A. Thornburgh, and J.C. Tappeiner. 1997. Alternative silvicultural approaches to timber harvesting: variable retention harvest system. Pages 111-140 in: K.A. Kohm and J.F. Franklin (eds.). Creating a Forestry for the 21st Century: The Science of Ecosystem Management. Island Press, Washington, DC.

14. Franklin, J.F., D. Lindenmayer, J.A. MacMahon, A. McKee, J. Magnuson, D.A. Perry, R. Waide, and D. Foster. 2000. Threads of continuity: ecosystem disturbance, recovery, and the theory of biological legacies. Conservation Biology in Practice 1: 8-16.

15. Franklin, J.F., L.A. Norris, D.R. Berg, and G.R. Smith. 1999. The history of DEMO: an experiment in regeneration harvest of northwestern forest ecosystems. Northwest Science 73: 3-11.

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

17. Gregory, S.V. 1997. Riparian management in the 21st century. Pages 69-86 *in* K.A. Kohm and J.F. Franklin (eds.). Creating a forestry for the 21st century. Island Press, Washington, DC.

18. Grumbine, R.E. 1994. What is ecosystem management? Conservation Biology 8: 27-38.

19. Grumbine, R.E. 1990. Viable populations, reserve size, and federal lands management: a critique. Conservation Biology 2: 127-134.

20. Harris, L.D. 1984. The Fragmented Forest. University of Chicago Press, Chicago, IL.

21. Harrington, C.A., S.D. Roberts, and L.C. Brodie. 2005. Tree and understory responses to variable-density thinning in western Washington. Pages 97-106 *in:* C.E. Peterson and D.A. Maguire (eds.). Balancing ecosystem values: innovative experiments for sustainable forestry. USDA Forest Service General Technical Report PNW-GTR-635.

22. Hunter, M.L. Jr. (ed.). 1999. Maintaining Biodiversity in Forested Ecosystems. Cambridge University Press, Cambridge, UK.

23. Keeton, W.S. 2006. Managing for late-successional/old-growth forest characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235:129-142.

24. Keeton, W.S. and G.H. Aplet. 1997. Ecosystem Management in the Interior Columbia River Basin. The Wilderness Society, Seattle, WA.

25. Keeton, W.S. and J.F. Franklin. 2004. Fire-related landform associations of remnant old-growth trees in mature Douglas-fir forests. Canadian Journal of Forest Research 34: 2371-2381.

26. Keeton, W.S. and J.F. Franklin. 2005. Do remnant old-growth trees accelerate rates of succession in mature Douglas-fir forests? Ecological Monographs 75: 103–118.

27. Keeton, W.S, J.F. Franklin, and P.W. Mote. 2007 a. Climate variability, climate change, and western wildfire with implications for the suburban-wildland interface. Pages 229-257 in: A. Troy and R. Kennedy (eds.). Living on the Edge: Economic, Institutional and Management Perspectives on Wildfire Hazard in the Urban Interface. Advances in the Economics of Environmental Resources, Vol 6. Elsevier Sciences, New York, NY.

28. Keeton, W.S., C.E. Kraft, and D.R. Warren. 2007 b. Mature and old-growth riparian forests: structure, dynamics, and effects on Adirondack stream habitats. Ecological Applications 17: 852-868.

29. Kohm, K.A. and J.F. Franklin (eds.). 1997. Creating a Forestry for the 21st Century. Island Press, Washington, DC.

30. Landres, P.B., P. Morgan, and F.J. Swanson. 1999. Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications 9: 1179-1188.

31. Lindenmayer, D.B. and J.F. Franklin. 2002. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach. Island Press, Washington, DC.

32. Lorimer, C.G. and L.E. Frelich. 1994. Natural disturbance regimes in old-growth northern hardwoods, implications for restoration efforts. Journal of Forestry 92: 33-38.

33. Lorimer, C.G. and A.S. White. 2003. Scale and frequency of natural disturbances in the northeastern U.S., implications for early-successional forest habitats and regional age distributions. Forest Ecology and Management 185: 41-64.

34. Marshall, D.D. and R.O. Curtis. 2005. Evaluations of silvicultural options for harvesting Douglas-fir young-growth production forests. Pages 119-126 *in:* C.E. Peterson and D.A. Maguire (eds.). Balancing ecosystem values: innovative experiments for sustainable forestry. USDA Forest Service General Technical Report PNW-GTR-635.

35. McKenny, H.C., W.S. Keeton, and T.M. Donovan. 2006. Effects of structural complexity enhancement on eastern red-backed salamander (*Plethodon cinereus*) populations in northern hardwood forests. Forest Ecology and Management 230: 186-196.

36. Millar, C.I, and W.B. Woolfenden. 1999. The role of climate change in interpreting historical variability. Ecological Application 9: 1207-1216.

37. Mitchell, R.J., B.J. Palik, and M.L. Hunter. 2002. Natural disturbance as a guide to silviculture. Forest Ecology and Management 155: 315-317.

38. Mladenoff, D. J. and J. Pastor. 1993. Sustainable forest ecosystems in the northern hardwood and conifer forest region: concepts and management. Pages 145-180 *in* G.H. Aplet, N. Johnson, J.T. Olson, and V.A. Sample (eds.). Defining Sustainable Forestry. Island Press, Washington, DC.

39. Moore, M. M., W.W. Covington, and P.Z. Fulé. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. Ecological Applications 9: 1266-1277.

40. Myers, N., R. A., Mittermeier, C.G. Mittermeier, G. A. B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

41. Naiman, R. J., H. Decamps, and M.E. McClain. 2005. Riparia: Ecology, Conservation, and Management of Streamside Communities. Elsevier/Academic Press, San Diego, CA.

42. Noss, R.F. and J.M. Scott. 1997. Ecosystem protection and restoration: the core of ecosystem management. Pages 239-264 in: M.S. Boyce and A. Haney (eds.). Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources. Yale University Press, New Haven, CT.

43. Oliver, C.D. 1992. A landscape approach: achieving and maintaining biodiversity and economic productivity. Journal of Forestry 90(9): 20-25.

44. Parsons, D.J., T.W. Swetnam, N.L. Christensen. 1999. Uses and limitations of historical variability concepts in managing ecosystems. Ecological Applications 9: 1177-1178.

45. Parviainen, J.W. Bucking, K. Vandekekhove, A. Schuck, and R. Paivinen. 2000. Strict forest reserves in Europe: efforts to enhance biodiversity and research on forests left for free development in Europe. Forestry 73: 107-118.

46. Perry, D.A. and M.F. Amaranthus. 1997. Disturbance, recovery, and stability. Pages 31-56 *in* K.A. Kohm and J.F. Franklin (eds.). Creating a Forestry for the 21^{st} Century. Island Press, Washington, DC.

47. Poiani, K.A., B.D. Richter, M.G. Anderson, and H.E. Richter. 2000. Biodiversity conservation at multiple scales: functional sites, landscapes, and networks. Bioscience 50: 133-146.

48. Scott, J.M., F.W. Davis, R.G. McGhie, R.G. Wright, C. Groves, and J. Estes. 2001. Nature reserves: do they capture the full range of America's biological diversity. Ecological Applications 11: 999-1007.

49. Sedjo, R.A. 2005. Future trends in U.S. forestry in a global context. Presentation to the Global Markets Forum, Orlando, Florida, February 15-17, 2005.

50. Seymour, R.S. 2005. Integrating natural disturbance parameters into conventional silvicultural systems: experience from the Acadian forest of northeastern North America. Pages 41-49 *in:* C.E. Peterson and D.A. Maguire (eds.). Balancing ecosystem values: innovative experiments for sustainable forestry. USDA Forest Service General Technical Report PNW-GTR-635.

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

52. Singer, M.T. and C.G. Lorimer. 1997. Crown release as a potential old-growth restoration approach in northern hardwoods. Canadian Journal of Forest Research 27: 1222-1232.

53. Solomon, M., A.S. Van Jaarsveld, H.C. Biggs, and M.H. Knight. 2004. Conservation targets for viable species assemblages? Biodiversity and Conservation 12: 2435-2441.

54. Soule, M. E., and M.A. Sanjayan. 1998. Conservation targets: do they help? Science 279: 2060-2061.

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

56. Swanson, F.J. and J.F. Franklin. 1992. New forestry principles from ecosystem analysis of Pacific Northwest forests. Ecological Applications 2: 262-274.

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

58. (UNPD) United Nations, Population Division. 2007. World Population Prospects: The 2006 Revision. Available online at http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm.

59. Committee of Scientists. 1999. Sustaining the People's Lands: Recommendations for Stewardship of the National Forests and Grasslands into the Next Century. United States Department of Agriculture, Washington, DC.

60. Ward, J. V., K. Tockner, D.B. Arscott and C. Claret. 2002. Riverine landscape diversity. Freshwater Biology 47: 517-539.

61. White, A., X. Sun, K. Canby, J. Xu, C. Barr, E. Katsigris, G. Bull, C. Cossalter, and S. Nilsson. 2006. China and the Global Market for Forest Products: Transforming Trade to Benefit Forests and Livelihoods. Forest Trends, CIFOR. Seattle, WA.

62. World Conservation Monitoring Center. 2007. Data available online at http://www.unep-wcmc.org/wdpa/.

63. WWF (World Wide Fund for Nature). 2002. Forests for Life: Working to Protect, Manage, and Restore the World's Forest. World Wide Fund for Nature, Gland, Switzerland.

64. Yaffee, S.L. 2002. Experiences in ecosystem management: ecosystem management in policy and practice. Pages 89-94 in: Ecosystem Management: Adaptive, Community-Based Conservation, G.K Meffee, L.A. Nielsen, R.L. Knight, and Dennis A. Schenborn (eds.). Island Press, Washington, DC.

65. Yaffee, S.L. 1994. The Wisdom of the Spotted Owl: Policy Lessons for a New Century. Island Press, Washington, D.C.

УДК 336.2

Доц. Г.С. Гулик – НЛТУ України, м. Львів

ЕКОНОМКО-ПРАВОВЕ ПОЛЕ ОРГАНІЗАЦІЇ НАЦІОНАЛЬНОЇ СИСТЕМИ ПРИРОДОКОРИСТУВАННЯ У КОНТЕКСТІ ПІДГОТОВКИ ЕКОЛОГІЧНОЇ КОНСТИТУЦІЇ ЗЕМЛІ

Розглянуто складові елементи системи організації процесу природокористування в Україні. Регулювання природокористування зумовлене необхідністю збереження життя і природної спадщини для майбутніх поколінь та забезпечення сталого соціально-економічного розвитку суспільства.

Ключові слова: природокористування, сталий розвиток, навколишнє природне середовище, екологічне право.

Assist. prof. H.S. Gulyk – NUFWT of Ukraine, L'viv

Nature management background in Ukraine

Key elements of Ukrainian nature management system have been considered in the paper. Regulation of nature management is stipulated by necessity to safe life and nature heritage with sustainable development for next generations.

Keywords: nature management, sustainable development, natural environment, environmental law.

Ідея Екологічної Конституції Землі передбачає інтеграцію в цьому глобальному правовому акті найбільш прогресивних ідей, механізмів та інструментів регулювання природокористування, закладених у національному екологічному праві усіх країн світу.

У правовому полі України сучасні основи законодавчого регулювання та організації природокористування були закладені Верховною Радою України у законі України "Про охорону навколишнього природного середовища" від 25 червня 1991 р. №1264-XII [1]. Цей закон увібрав у себе набутий зарубіжний та вітчизняний досвід щодо забезпечення функціонування економічного механізму природокористування і став основою для подальшого розвитку еколого-економічної системи управління природоохоронною діяльністю