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Biodiversity in the Context of Management and Conservation of Forest Resource

Ji Hong Kim[1*], Jong Kyu Lee[1], and Joon Soon Kim[1]

[1]*College of Forest & Environmental Sciences, Kangwon National University, Chuncheon, 200-701, Korea*

ABSTRACT : Biodiversity, referring to the variety and abundance of species, their genetic composition, and the communities, ecosystem, and landscapes, is essential to maintain healthy and productive forests, and to provide useful hedge against the future uncertainties in conditions of the environment and natural resources. To realize the long-term sustainability for forest production of goods and services is dependent upon maintaining and enhancing the biodiversity in the forest ecosystem. Because we can not always recognized which portion of biodiversity is essential to maintain the stability and sustainability of the natural system, conserving biodiversity is even unconditionally important. Even though the activities of forest resource management may have a variety of negative impacts on biodiversity by modification of the natural ecosystem into economically effective artificial ecosystem, forest professionals have been developing intelligent scheme to coexist management and conservation. However, conservation of biodiversity must be a complex problem encircled by ecological, economical, and social considerations. There seems to be no such a simple and easy solution. Strategies for ecologically deliberated forest resource management, which could play an important role to conserve biodiversity, were discussed.

Keywords : Loss of biodiversity, Biodiversity values, Forest resource management, Conservation of biodiversity, Silvicultural system

Introduction

The United Nations declared 2010 to be the International Year of Biodiversity. It is incitement for every life on earth and of the value of biodiversity for lives of human beings, whose fate is closely associated with biodiversity, the enormous variety of other plants, animals, and microorganisms, the places they live and their surrounding environment all over the world. Because they all are essential part of nature.

Since the forest is fundamental cradle of the biodiversity, one of the current issues that may have the greatest impact on forest resource management and the forests of the future is the conservation of biodiversity. Forest deterioration and habitat destruction, resulted in loss of biodiversity, have received growing concern throughout the world since 1980s (May, 1988; Wilson, 1988). This loss may have significant economic, social, and ecological consequences. These considerations reflect increasing demands on natural systems for sustainable earth where human should depend on.

While the loss of individual species catches the attention, it is the fragmentation, degradation, and outright loss of forests and other ecosystems that poses the gravest threat to biodiversity. Forests are home to much of the known terrestrial biodiversity, but about 45 percent of the Earth's original forests are disappeared, cleared mostly during the past century. Despite some regrowth, the world's total forests are still shrinking rapidly, particularly in the tropics. Up to 10 percent of coral reefs - among the richest ecosystems - have been destroyed, and one third of the remainder face collapse over the next 10 to 20 years. Coastal mangroves, a vital nursery habitat for countless species, are also vulnerable, with half already gone (SCBD, 2009b).

The loss of biodiversity often reduces the productivity

* Corresponding author: (E-mail) kimjh@kangwon.ac.kr

of the forest ecosystem, thereby shrinking nature's basket of goods and services, from which we constantly draw. It destabilizes the forest ecosystem, and weakens their ability to deal with natural disasters such as floods, droughts, and hurricanes, and with human-caused stresses, such as pollution and climate change. Already, we are spending huge sums in response to flood and storm damage exacerbated by deforestation. Such damage is expected to increase due to global warming.

Biodiversity seems to provide a scientific foundation for widespread desires to conserve natural ecosystems, and is viewed as an obstruction to forestry as economical activity and other natural resource development projects. While the adequate maintenance of biodiversity in the forest often requires an extensive network of ecological reserves which exclude human modification, its conservation does not always prohibit the use of resources. Forests are increasingly considered as valuable reserves in which large tracts can be managed to conserve biodiversity. Public organization and policy have to include biodiversity in the planning process, and monitor and evaluate the effects of implementing any forest plan on biodiversity (Lee and Choo, 1992). In order to achieve these tasks, it is essential for forest resource managers to understand the basic concept of biodiversity, to recognize the value (Namkoong, 1991; Burton et al., 1992), and to develop the strategies in forest resource management (Probst and Crow, 1991), so as to maintain and enhance the biodiversity in forest ecosystems.

Concept of Biodiversity

Recently a lot of articles on forestry and the environment have cited biodiversity as one of the most important issues associated with the conservational point of view. However, a variety of definitions have been proposed for the concept of biodiversity. All of them attempt to capture basically the same idea with a little differences in clarity and conciseness. Perhaps the most generally cited and reasonably accepted definition for forestry profession comes from Task Force Report on biodiversity in Forest Ecosystem (SAF, 1991) : "Biodiversity refers to the variety and abundance of species, their genetic composition, and the communities, ecosystems, and landscapes in which they occur. It also refers to the variety of ecological structure, functions, or processes at all of these levels. Biodiversity occurs at spatial scales that range from local through regional to global"

SAF (1991) has suggested three components of diversity in forest related sectors: composition, structure, and function.

Compositional diversity includes the commonly recognized species diversity, as well as genetic and ecosystem diversity. Maintaining genetic diversity is critical to maintaining species diversity, and maintaining diverse ecosystems provides the habitats necessary for conserving diverse species.

Structural diversity pertains to the spatial arrangement of physical units. At the stand level, structural diversity can be characterized by the number of strata within the forest, for example, overstory canopy, subcanopy, shrubs, herbaceous plants. At the landscape level, structural diversity can be measured by the distribution of age classes in a forest or the spatial arrangement of different ecosystems.

Functional diversity represents variation in ecological processes, such as nutrient cycling or energy flow. This is the most difficult component to measure and understand.

It is important to keep in mind that the three components are mutually linked and each individual level, system, and ecological attribute are interrelated. Changes in compositional and structural diversity result in changes in ecological processes. In addition, genetic diversity and genetic management systems have direct influence on species, stand, and community (Namkoong, 1991).

Biodiversity is often considered, especially within the forest management community, as simply a list of species present at a location. The term can also be used in the context of providing habitats for species of some particular value of interest to people, and in this sense biodiversity is a good produced by the ecosystem. While biodiversity encompasses both these latter meanings, it is actually a broader term intended to encompass various

measures of the full richness of life on Earth.

As defined by the Convention on Biological Diversity, "biological diversity" means the variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, among species, and of ecosystems (SCBD, 2009b). Allen and Hoekstra (1992) defined biodiversity even more broadly to include the variety of life at multiple scales of ecological organization, including genes, species, ecosystems, landscapes, and biomes.

Biodiversity might be considered in terms of specific components that are particularly relevant to forest ecosystems and equate them with the scale at which they are classified and mapped by humans. In so doing, we can refer to standard metrics including genetic diversity and species richness that relate to the dominant plant and animal species that characterize a given forest ecosystem. We also refer to terms that describe the vegetation structure (height, density, and complexity) and age (SCBD, 2009b).

Forest Resource Related Values of Biodiversity

Biodiversity is the term given to the variety of life on Earth and the natural patterns it forms. The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life of which we are an integral part and upon which we so fully depend. It is the combination of life forms and their interactions with each other and with the rest of the environment that has made Earth a uniquely habitable place for humans. Biodiversity provides a large number of goods and services that sustain our lives. Among those, goods and services provided by ecosystems are summarized as provision of food, fuel and fiber; provision of shelter and building materials; purification of air and water; detoxification and decomposition of wastes; stabilization and moderation of the Earth's climate; moderation of floods, droughts, temperature extremes and the forces of wind; generation and renewal of soil fertility, including nutrient cycling; pollination of plants, including many crops; control of pests and diseases; maintenance of genetic resources as key inputs to crop varieties and livestock breeds, medicines, and other products; cultural and aesthetic benefits; and ability to adapt to change.

The value of biodiversity related to the forest is a emerging issue that has received widespread attention. Some categories of value can be concerned to the biodiversity, including economic value, existence value, spiritual value, and conservation value.

Forest management sorely for the timber resources without regarding biodiversity seriously under-utilizes economic potential of the forest. It is well known that vital resources associated with human life such as foods, fibers, medicinal drugs are derived from plants, animals, and microbial species in the forest. A variety types of recreation and aesthetic appreciation of forest landscape provide pleasure and relaxation to people and contribute to economy. The economic and cultural survival of many people depends largely on the retention of significant areas of forest having diverse composition and structure. The sustainability of various form of economic harvesting is basically dependent on the overall diversity of species from which to choose. The number of major commercial species in forestry are limited, therefore new plant varieties may have to be developed using biotechnology as well as traditional genetic methods. Also, intangible forest resource production, such as that of water, wildlife, recreation, esthetics should be achieved by the diversity of that from community through ecosystem to landscape.

Ecologists have been increasingly aware that maintaining biodiversity is essential to productive and healthy ecosystem. Various kinds of plants, animals and microorganisms facilitate energy flow, nutrient cycling, decomposition, and many other ecological processes. Diversified forest community is closely related to the trend and process of forest succession (Odum, 1969; Bazzaz, 1975). Also, Biodiversity may play a indirect role to measure efficiency, stability, and maturity by which the forest community is characterized (Loucks, 1970). Forest vegetation and animals have influence on the forest composition and regeneration

through a multiplicity of species interactions, such as competition, herbivory, and population regulation of other species. Biodiversity offers alternative food chains, biological pest and insect control, and improved silvicultural options.

Several studies have established that resilience in ecosystems is related to the biodiversity in the system and the capacity that it confers to maintain ecosystem processes (Loreau, 2000; Hooper et al., 2005; Drever, et al., 2006; Bodin and Wimen, 2007). Most ecosystem processes are controlled by, or are the result of, biodiversity. However, not all species are necessarily equally important in maintaining these processes (Diaz et al., 2003) and there is some redundancy at multiple levels within most ecosystems (Hooper et al., 2005).

Functional groups are assemblages of species performing similar functional roles within an ecosystem, such as pollination, production, or decomposition, hence providing the ecosystem with a level of redundancy. As discussed further below, functional diversity is not necessarily correlated with species richness (Hooper et al., 2005). Functional species that dominate ecosystem processes are not inevitably the most numerous species in the system (Diaz et al., 2003), and it is important to understand which species are contributing most to maintaining the flows of goods and services if management or protection is an objective.

Under changed conditions, however, species that had a limited or no functional role may become functionally dominant, hence buffering the ecosystem against large changes and conferring resilience; that is, passengers can become the drivers. This variable response has also been termed ‘functional response diversity and is critical to ecosystem resilience. Loss of functional species in the absence of redundancy has negative consequences for the ecosystem to the point of ecosystem collapse. Hooper et al. (2005) insisted a clear need for continued research into the relationship between species richness and ecosystem stability.

A major problem with valuing biodiversity is that of the benefits are intangible, which is difficult to be in monetary terms. The maintenance of ecosystem stability and balance is an important aspect of conserving biodiversity for which a value can hardly be calculated (Probst and Crow, 1991). In addition, because we can not always acknowledged which individual species is necessary to maintain ecosystem stability and sustainability, nor which species may be economically useful to mankind in the future, conserving biodiversity is even unconditionally important (Burton et al., 1992).

Biodiversity and Forest Resource Management

Forest biodiversity all around the world has shown steady and serious decrease at alarming rate. Key publications such as the Millennium Ecosystem Assessment and the Red List of Threatened Species indicate that a large and increasing number of forest ecosystems, populations and species are threatened globally or being lost due to the loss and degradation of forest habitats, and that this reduction of forest biodiversity will be aggravated by the effects of climate change. Forests are home to the largest number of threatened species of any other type of land use. It is assumed that numerous, but not yet scientifically described, species are presently being lost together with forest habitats (SCBD, 2009a).

Forest resource management can have a variety of negative impacts on biodiversity, particularly when carried out without management standards designed to protect natural assets. Human activities that threaten biodiversity are mainly caused by modification of the natural ecosystem into economically effective artificial ecosystem and by abuse or misuse of the natural ecosystem. Much of the diversity is being lost through adoption of simplified production systems that specialized in a single species, and through non-sustainable exploitation of resources and environmental pollution from industrial development. It is natural, therefore, that the impact of various forestry operations on forest ecosystems has been the subject of much controversy surrounding “development and conservation”.

Unsustainable forest operations and other pressures on

forest resources can lead to forest degradation and permanent losses in biodiversity. Globally, over half of the temperate broadleaf and mixed forest biome and nearly one quarter of the tropical rain forest biome have been fragmented or removed by humans (SCBD, 2009a). The public often criticizes forest management activities and think them as negative impact to many organisms dependent on the forest for their survival. However, the public desire to produce goods and services from forests where a number of forest management activities, such as timber harvesting and road construction, should involve. The increasing demands for the forest commodities and our expanding knowledge of the importance of maintaining biodiversity in the forest ecosystem pose difficult challenges to forest managers. Forest professionals may be asked to evaluate the impacts of their management activities on biodiversity.

Timber harvesting is one of the most blamed events that can reduce biodiversity among forest management activities. However, it should be noticed that not all kinds of harvesting methods would have unfavorable influences on biodiversity. Unless forest habitats are destructed, fragmented, or isolated by the logging operations, the impact can be decreased at minimum level. It means that an individual activity which impacts on the biodiversity must be evaluated on the level of regional landscape. A possible impact of harvesting practices on biodiversity is more likely related to spatial and timing arrangement of their application itself than of the practices themselves.

For example, clearcutting obviously causes enormous changes to the forest environment with detrimental consequences to many organisms both flora and fauna (Gove et al., 1992). Because of this reason, clearcutting has often been the target of environmental issues concerned with forestry. Nevertheless, the effects of clearcutting is somewhat variable for the diversity. When clearcutting is applied at a less extensive scale and in appropriate time arrangement, the practice can help to maintain or even enhance biodiversity (Swindel et al., 1984).

Niese and Strong (1992) studied the comparative analysis for various cutting systems in northern hardwood forests in Lake States of America, in terms of both economic return and tree species diversity. They reported that overall diversity was higher in clearcutting and shelterwood system sample plots than those of control after 40 years of management. Boyle (1991) has also pointed out that maintaining species diversity for birds and other fauna requires a continuing supply of forest ecosystems in various successional stages, which can be provided by clearcutting by patch. Consequently, the impact of clearcutting is not a simple reduction in species diversity, but rather a different effect, with some old-growth dependent species of plants and animals being lost from the system, presumably until suitable environmental conditions are restored.

Forest regeneration is another important practice associated with maintenance and conservation of biodiversity. It is related to the future composition and variety of forest vegetation species and genotypes, furthermore to the diversity of community and ecosystem. Regeneration practices that may impact on biodiversity include establishing stands with a few species and a limited range of genotypes in large scale of forest tract, and continually harvesting high-graded forest trees with natural regeneration in the selection system. The practice of timber removal by selecting trees with high rate of growth, good form, and/or resistance to insect and disease could impacts on the biodiversity of the subsequent forest by reducing variety of genotypes. Consequently, the adaptability of forest stand to changing site conditions may be reduced, which may influence long-term productivity and diversity of forest ecosystem. When timber harvesting changes the seed source on the site by removing inherent genotypes, the second-growth forests that arise from natural regeneration have reduced genetic diversity. Continual harvesting of high-graded trees reduces genetic variation (Guries, 1982) as well as may reduce species diversity in mixed stands (Smith, 1986). Deliberated stand regeneration plans should be established with careful evaluation for the potential impact that limit biodiversity. And the practice which can help to overcome the difficulty should be employed in forest regeneration.

In addition to the timber harvesting and forest regeneration, the other forest management practices necessary to achieve the benefits from forests include forest road construction, disease and insects control, fire management, forested watersheds management, regulation of forest recreation activities, wildlife management, etc. These practices also have both positive and negative effects on biodiversity in the forest ecosystem The effects are more or less the function scale, spatial arrangement, and application timing of management activities. Integration of forest management activities over long-term planning and extensive areas is essential to maintain and enhance biodiversity in forest ecosystems. Professional foresters should consider their application of management activities from the perspective of the regional landscape. It will be difficult to conserve biodiversity without understanding long-term and regional effects of specific practices on the basis of fundamental knowledge of ecological structure and function of the forest. They should recognize the importance of their operational activities in the context of a mosaic of forest age classes and mixed species stands, diversity of inherent tree species, variety of wildlife life-forms, and special habitat areas over a relatively extensive areas, that is, on landscape level (Oliver, 1992).

Conservational Scheme of Biodiversity

Conservation of biodiversity in forest resource management must be a complex task surrounds a variety of ecological, economical, and social considerations. With the current and prospective intensity of forest resource management, the impact of human modification on biodiversity in forest ecosystems has become a convincing concern. Therefore, it is essential to examine and evaluate existing and planned forest management activities to accomplish balancing economic development and biodiversity. We have to keep in mind that piecemeal approaches may result in over-simplification, frustration, and new unanticipated problems. Since individual situations of forest resource management require information and coordination corresponding to specific site conditions, management objectives, and economic considerations. Application of some general strategies can help to maintain and enhance biodiversity in the planning processes of forest resource management.

Plans for managing forests should include strategies to use the regional perspectives and to handle beyond the boundaries of specific ownership of forestlands (SAF, 1991). The pattern of forest ownership may affect the potentiality to achieve biodiversity purpose. Also different ownerships can contribute to the purpose in different ways. The objectives of landowners must be involved in consideration of any landscape level biodiversity conservation plan. We need to coordinate actions of forest owners, users and managers across landscapes to best ensure the maintenance of sufficient high quality connected habitat for species. Also it is necessary to promote collaboration between research organizations and forest management bodies to develop silvicultural knowledge and practices. Develop and expand networks of field practitioners (SCBD, 2009a). In consequence, it is important to include conservational purpose of biodiversity in public forest planning and policy formulation which encourage private landowners to play a key role to achieve the purpose.

Large-scale planted forests can provide a forest matrix within which areas of high conservation value can be protected and managed. We had better to encourage the establishment of representative natural forest within the plantation estate and, where possible, the restoration of natural forests on appropriate sites (SCBD, 2009a). It is essential to plan and manage over large areas of forestlands, that is, systems management at a landscape scale, emphasizing the maintenance of ecological integrity rather than stand-by-stand approach when considering biodiversity. To achieve a large unfragmented diversified ecosystem, relatively large suitable areas must be managed under coordinations (Franklin and Forman, 1987; Oliver, 1992).

The country land of South Korea consists of a distinctive mix of ecosystems and mosaic of forest landscape. The forest ecosystems are described as unstable complexity of a variety of plant and animal species and communities in a variety shifting successional stages. Forestlands

dominated by human activity are characterized by a modified land use history, mainly by unplanned and undeliberate logging operations, increased proportions in early successional stages. They have been simplified in structure and composition, and fragmented in habitat linkage (Kim, 1992). Increased emphasis on biodiversity in forest resource management will require greater attention to maintaining in these forests across diverse landscape. These undesirable conditions are less likely to occur under the intensive and rational forest resource management unless conscious decisions are made in the planning process.

Effective maintenance without miscarriage for biodiversity begins with considerate inventories of all biological resources in the forest ecosystem (Dallmeier, 1992). The concept of forest inventory should expand to include not only biological elements but also physical site conditions in planning process. All managers of natural resources should have a personal commitment to improve their knowledge of those resources and their variability. Foresters can facilitate the collection of data on the forest vegetation, wildlife, soils, physiography, distribution and attribute of forest communities, forest succession, biomass, productivity, and forest hydrology. The similarities and differences exhibited by these inventories should be noticed, and how they might change under alternative management prescriptions. Monitoring problem species and ecosystem is another important point. Encourage biology specialists to sample remote areas and those tentatively scheduled for harvesting. Preparation should be made to adjust the boundaries of management unit and to protect unique plots of biodiversity. Even though to catalogue all biodiversity is not possible, every contribution to this information base will help the decision of biodiversity management.

Forest management should emphasize multiple species of crop trees both within stands and among stands in others. It means to become ecosystem management instead of single species or tree management. Species differences in rates of growth and development may discourage forest managers from establishing mixed species stands, but Smith (1986) has suggested procedures for managing the stratified mixture of multiple species. In addition to the species composition, forest managers may wish to mange different stands for a variety of canopy structures. Retaining various structures within a stand will contribute much to ameliorate the habitat for many old-growth tree species and wildlife. Implementing a diversity of stand management schemes helps to create a structural and functional diversity of forest vegetation types across the landscape, including the full spectrum of ecological assemblages from early successional to old-growth forests. Managing for longer rotations is another useful practice that could achieve the old-growth forest and biological objectives (Norse, 1990). Where stands are managed only to the culmination of mean annual growth, they have merely begun to open up and to hold various understory vegetation. Longer rotation allow many more species to recolonize, filtering in to occupy specific microenvironment and niches.

Conclusion

Maintaining and enhancing biodiversity is dealing with all aspect of forest resource management. An apparent reason to conserve biodiversity is to guarantee sustainable productivity of forest resources and to refine our environment for present and future generations. Conserving the biodiversity as primary goal serves to remind us that forest resource managers should recognize to manage ecosystem and landscape, not just stands of trees. Forest resource managers should have been playing a key role in understanding and conservation of global diverse biological resources. The long-term ability of forest ecosystems to sustain the valuable commodities and non-commodities that we expect to them may depend on this biodiversity.

Ecological research and monitoring systems (including long-term monitoring plots) should be facilitated with the aim of providing useful guidance on forest dynamics, regeneration and genetic diversity of valuable tree species. It is essential to collaborate to collect, synthesize, analyse and share data on forest biodiversity based on permanent forest plots, inventories and other sources and make these

accessible to forest planners, forest managers and other stakeholders. The forest managers have to try to minimize the risk of invasive species and eradicate those that become established, and to develop management systems that favour natural processes and preferably plant native species that enhance the productivity and resilience of the forest. Planted forests should be managed in ways that benefit biodiversity, both within the planted forest itself and in areas of natural forest that are retained within the planted forest landscape. In order to achieve the overall objectives, we need to improve ecological knowledge to ensure that forest management enhances or maintains biodiversity and ensures forest functions such as pollination, seed dispersal and nutrient cycling. Areas of forest and other habitats that provide important ecological functions should be identified and measures taken to ensure their protection.

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