

# Forest Ecosystem Management in the Central Hardwood Region

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## Introduction

Considerable discussion over the past few years has focused on significant changes in the fundamental premises of the forestry profession. Various terms have been used to describe new approaches to managing forest resources; these include sustainable forest management, integrated resource management, new perspectives, and new forestry. The most recent and widely accepted term is ecosystem management.

Ecosystem management represents a change in the basic philosophy of forest management to a more holistic approach to the management of forested ecosystems. It requires foresters to work more closely with professionals in other fields. Some of these fields, such as wildlife biology, hydrology, and botany have established ties to forestry. Others, such as conservation biology and landscape ecology, have developed relatively recently and are making important contributions to the management of forested ecosystems at larger spatial scales.

The primary objectives of ecosystem management involve sustaining the long-term productivity and health of the total ecosystem and, in doing so, enhancing overall biological diversity. Greater management attention is paid to creating or maintaining appropriate ecosystem structure and species composition, which facilitates functioning of natural ecosystem processes. Ecosystem management shifts emphasis away from the production of commodities and toward a more integrated form of management where less attention is paid to what is removed from the land and more attention is paid to what is retained on the landscape.

Spatial boundaries of ecosystems vary depending on the processes or elements being considered.

For example, populations of herbaceous plants or salamanders might be effectively managed at the local woodlot scale, whereas managing for water quality typically requires examination of the entire watershed, and managing for wide-ranging mammals such as black bear often requires a regional approach. Ecosystem management can be defined as a tool for management of ecological processes over multiple spatial scales to achieve some desired future condition. The term "management" implies that people are an integral part of the ecosystem.

Even though management occurs across all scales, ecosystem management places a stronger emphasis on larger spatial scales than past management approaches have. Structures and patterns across entire landscapes are considered relative to how they affect ecosystem processes operating at landscape scales. Attention to longer time frames involve concerns for long-term sustainability of ecosystem productivity, recognition of the dynamic nature of both stand and landscape structure, and understanding the cumulative effects of management activities on biological diversity and ecosystem function.

While ecosystem management reduces the traditional emphasis on outputs, it also recognizes that production of commodities, including timber, remains an important consideration. For any new management approach to be successful, it must not only be ecologically sound, but it must be economically feasible and socially acceptable as well.

The wood products industry is an important part of the economy of the Central Hardwood Region, accounting for the harvest of over 600 million cubic feet of timber annually (roughly 3.5-4.5 billion board feet, 1991 figures) and supporting strong primary and secondary manufacturing



sectors. The United States currently imports between 5 and 15 percent of its annual domestic wood fiber needs; and as timber supplies from public lands throughout the country are reduced, it is likely that the demand for timber from this region will increase. Ecosystem management must address the demand for output production if it is to become accepted.

This paper is intended to provide professional foresters, and other land managers in the Central Hardwood Region, with general information concerning ecosystem management. It is important to recognize, however, that many gaps still exist in our knowledge of ecosystems, particularly at the larger spatial scales. Much of the conceptual material concerning ecosystem management is still evolving, and many of the basic scientific underpinnings have yet to be converted into application. Also, relatively little work on the development of the ecosystem management concept has been performed in, or is specifically related to, the Central Hardwood Region. We must, therefore, draw upon information developed in regions that often have little similarity to this region and decide if this information has applicability in the central hardwoods.

## Who Will Change?

The concept of ecosystem management evolved mostly from disputes over management of public lands, primarily National Forest lands. As such, the greatest immediate impact of ecosystem management will be felt by the public land management agencies where, in general, society has greater voice in setting management objectives and where centralized management facilitates local implementation of national or regional policies. Led by the U.S.D.A. Forest Service, federal agencies are adopting ecosystem management as their primary management approach on well over 100 million acres of forestland. Ecosystem management is also being adopted on several million acres of non-forestland administered by the U.S. Forest Service and other federal agencies.

In the Central Hardwood Region, public lands in federal ownership include national parks, fish and wildlife refuges, military installations, and national forests. Federal ownership in the region accounts for approximately 8 percent of all forestland. Located mostly in the southern portion of the region, these lands generally constitute the

largest remaining areas of contiguous natural habitat. Even though federal lands do not cover a large percentage of the Central Hardwood Region, they are and will remain important reservoirs for biotic diversity. It is unlikely, however, that adoption of ecosystem management on the majority of federal forestlands will significantly impact the overall management of forests throughout the region.

State lands, which are generally smaller but more evenly distributed in the Central Hardwood Region, are as important as federal lands, although they account for only about 2 percent of the forestland in the region. State parks, natural areas, fish and wildlife areas, and state forests provide the largest areas of contiguous natural habitat remaining in the northern part of the region. These lands are important to the long-term conservation of biota in the region, although their ecological value could be enhanced if their management were more closely integrated with the larger federal lands. State land management agencies, however, often have less flexibility than federal agencies in how they manage their lands, and state agencies have not committed to adopting an ecosystem management approach on their lands.

Nonindustrial private forestland (NIPF) owners are an important component of the Central Hardwood Region, holding nearly 90 percent of the forestland in the region. In many places, private forestlands constitute the major remaining pieces of natural habitat within landscapes of intensive agriculture or urban development. Their management will, therefore, play an important role in the application of ecosystem management in the region. In many respects, however, simply keeping these individual private woodlands in a forested condition is as important ecologically as the specific management approach used. Expanding forest patch sizes and providing connections across landscapes is frequently much more important than how individual stands are managed.

Ecosystem management certainly will have its greatest effect on management of public lands, but private landowners will also be affected, primarily because society's concern over management impacts on all lands is increasing. Public pressure to protect ecological values has resulted in the passage of both state and local land use regulations in areas throughout the country. Legislation has been introduced at the federal level, as well as



in some states, to ban the use of some forest management practices such as clearcutting. These attempts to limit the tools available to forestland managers have not yet been successful, but they illustrate the greater importance that society is placing on forestry issues.

Indirectly, NIPF landowners will be affected by market forces spurred by wide-scale adoption of ecosystem management on public lands. Annual timber harvests from national forests have dropped from nearly 13 billion board feet in 1987 to under 6 billion board feet in 1993, with further reductions expected. At the same time, demand for wood products continues to rise. This trend has resulted in increased pressure for wood supplies from other sources, primarily from privately owned forestlands. This will likely increase the visibility of activities on private lands and further focus public attention on how these lands are managed.

## Why Change?

Major change in any profession is painful. Many foresters, as well as other natural resource professionals, do not see the need to change to an ecosystem management approach. Professional forestry, after all, has served the nation well for the past 100 years. Even so, the change to ecosystem management represents what many consider a natural evolution in the forestry profession. Change on this scale is not unprecedented in professional forestry. The concept of multiple use, instituted at the end of the 19th century, was considered by many as a radical departure from forestry practices of the times.

The current changes facing the forestry profession are a result of many factors. Principal among them are changes in societal expectations and demands relative to the management of natural and semi-natural lands. The public no longer views forestlands solely as a source of commodity outputs. There has been a general increase in society's awareness and concern for environmental issues at the local, as well as national and global levels. This is largely related to the increased urbanization of the U.S. population. Fewer people are directly dependent on the land for their livelihood, or are immediately affected by resource management decisions. This is true in the Central Hardwood Region as well, where most people live in urban areas or do not derive income directly from the land base.

The change toward ecosystem management is also a function of the increasing amounts of information available concerning how ecosystems function and how they are impacted by management. It has become increasingly obvious that ecosystems provide many services and benefits in addition to supplying commodity outputs and recreational opportunities. We now have a greater appreciation for the tremendous complexity of structure and function contained in natural ecosystems, and the importance of maintaining as much of this complexity as possible in our management of these systems.

Contributing to the push toward ecosystem management are the perceived negative environmental impacts associated with forest management activities. In many instances these perceptions have not been warranted; frequently they have been promoted to advance various political agendas. However, there are many cases where concern over the impacts of forest management is justified. Much of this has resulted from using management approaches considered acceptable at the time of implementation, but which have since been shown to have undesirable consequences. For example, the use of small dispersed clearcuts, as well as group selection methods, for regenerating forests has been favored as a way of minimizing the impact of harvesting on the landscape. Recent findings show that these approaches may actually increase fragmentation of landscapes and could result in greater ecological impacts than approaches which aggregate harvest units. While these situations are inevitable in any field where the knowledge base continues to expand, it nonetheless dictates the need to modify approaches to incorporate new information.

## What Is Ecosystem Management?

Ecosystem management is a new approach to land management—one that places greater concern on the ecological values associated with natural systems, while at the same time recognizing the many demands society places on forests. Although new from a philosophical and conceptual standpoint, ecosystem management does not represent a new technology. The same set of tools used in traditional forest management are available for ecosystem management, with only a few new tools being added to the mix. The major change will be when and where the tools are used.



## Conserving Biological Diversity

Conservation of biological diversity is one of the primary emphases of ecosystem management. Biological diversity, or biodiversity, is the variety, abundance, and distribution of biological entities in a given area. It encompasses a variety of scales, from genetic variation within species to variation among ecosystems at the landscape, or even global scale. In general, however, conservation of biodiversity is concerned with maintaining the variety of species present within a defined area.

In many regions of the country, forest ecosystems contain some of the highest levels of natural biological diversity. Even in the Central Hardwood Region, where nearly all forests have in the past been subject to severe man-caused disturbance, the biodiversity contained in forest systems is generally greater than that of surrounding non-forest lands. If preservation of native biological diversity is to be a national environmental priority, then ecosystem based approaches to management must be incorporated on at least some portion of our forested landscapes.

Species evolution and extinction are natural processes which occur in all ecosystems. The rate of species loss worldwide, however, is accelerating as a direct consequence of increasing human demands on ecosystems, making it important to find ways to use natural resources without contributing to the loss of biodiversity. There are a number of ecologically important reasons to be concerned with biodiversity in forested ecosystems. Biodiversity is intimately linked to ecosystem structure and function, and therefore, is essential for the continued, long-term health and productivity of our ecosystems. Many "minor" species act as ecological indicators, providing insights about site characteristics and alerting us to potential environmental impacts.

In addition to the many ecological values that depend on the maintenance of biodiversity, there are important economic considerations. The many plant and animal species that occur in forested ecosystems are potentially important sources of foods, medicines, and gene pools for domestic crops and livestock. Managing for diversity also provides a hedge against changing economic or climatic conditions which could affect the profitability of management systems designed for current conditions.

Finally, along with the ecologic and economic considerations, there are important social factors concerning biodiversity. These tend to be more subjective, but are no less important to consider. An important reason for preserving biodiversity is that a substantial segment of society believe that species have intrinsic values unto themselves and are, therefore, worth protecting.

As part of ecosystem management, foresters will be expected to give greater consideration to biodiversity. It is widely recognized that retention of totally natural ecosystems will not be an option for most landscapes, and lands set aside in preserves will never adequately maintain current levels of biodiversity. Areas managed for the production of outputs, therefore, will be vital in the effort to conserve regional biological diversity. In many cases, however, this will require that resource managers modify their approaches. There also needs to be a greater understanding of the specific factors threatening regional diversity, as well as a greater appreciation for the importance of this issue.

Biodiversity is commonly measured at scales ranging from local (i.e., the stand) up through regional, to national or global. Management impacts to biodiversity are generally best addressed at the regional scale or above. It is less important to consider local presence or abundance of species that are common at the regional level. However, small sites with specialized characteristics (e.g., droughty soils, seeps, and cliffs) often provide critical habitat for many of the rare species found in a region, and are particularly important to consider in local management decisions.

Adequate consideration of biodiversity requires resource managers to accurately predict impacts of management activities on species survival. Unfortunately, biologists and ecologists lack adequate information to make these predictions using a species by species approach. Because most resource managers do not see, or are unable to recognize, all the individual plant and animal species they affect, an ecosystem-based approach to management of biodiversity is more likely to be successful. An ecosystem approach strives to maintain a variety of ecological communities across the landscape, thus providing a wide range of habitat conditions for as many different species as possible.



How should resource managers plan for long-term maintenance of biodiversity? At the local scale, placement and timing of activities are very important. Placement of skid trails and log landing should avoid extreme sites likely to harbor rare species. Application of herbicides should be timed to reduce impacts to non-target species. Unique or important structural features should be protected or maintained. At larger scales, attempts should be made at reducing the amount of fragmentation of landscapes, and at connecting areas of natural habitat through revegetation of cleared lands. Efforts should also be made to minimize the introduction of non-native species. The general objective is to produce landscapes with as much natural design and as many natural features as possible.

Human-dominated landscapes are frequently characterized by modified disturbance regimes, a preponderance of early seral conditions, high-contrast fragmented landscapes, and simplified structural diversity. In the Central Hardwood Region, all of these are true with the possible exception of simplified structural diversity. A long-term priority to reduce fragmentation in the region should include selected conversion of certain agricultural lands to natural vegetation, and obliteration of some roads currently located within the few remaining large, contiguous areas of forested landscape. Management of these areas provides a variety of habitats associated with interior forest conditions, and helps ensure the long-term survival of many of the native species of the region. Most of the responsibility for providing these conditions will fall to the public land-management agencies; although, adjacent private lands are also important in these forested landscapes.

## **Sustaining Long-Term Health and Productivity**

The second major area of emphasis for ecosystem management, and one linked to the conservation of biodiversity, is the sustainability of ecosystem productivity. Sustained productivity does not imply merely maintaining a sustainable yield of timber production. Ecosystem management is concerned with sustaining all parts of the forest system and allowing natural ecological processes to function to the fullest extent possible. Providing for sustained health and productivity of forested ecosystems requires management

activities designed to maintain much of the natural structural and compositional complexity. The operational focus of ecosystem management, therefore, is on management for structural diversity at both the stand and the landscape level. It assumes ecosystem functions and processes are closely linked to ecosystem structure, both physical and compositional.

In some regions of the country, creating greater stand-level structural complexity implies less use of even-aged management, and greater attempts at promoting tree species diversity. In the Central Hardwood Region, appropriate stand structural complexity and species composition can be attained with either even-aged or uneven-aged management. Stand-level management under ecosystem management, while still designed to achieve production of commodity outputs, should be tailored to minimize impacts to sensitive flora and fauna, soil and water resources, visual quality, and overall biodiversity. Silvicultural practices might attempt to more closely emulate patterns and effects of natural disturbance by retaining more residual biomass in the form of standing live trees, standing dead snags, and coarse woody debris (CWD) on the forest floor.

Snags and CWD serve several important ecological functions. They provide structural habitat characteristics for various plant and animal species, are potentially important in long-term nutrient cycling, and help minimize impacts to soil and water resources. Because of naturally high levels of tree species diversity in the Central Hardwood Region, maintaining canopy structural complexity should not be a problem in most instances. It will be more difficult to ensure adequate levels of standing dead and CWD are maintained within stands.

Stand-level manipulation is the principal means of achieving objectives in forest management; however, while stand-level management remains important in ecosystem management, the primary land unit of concern for planning and setting of objectives is the landscape. The ecosystem management approach recognizes that many important ecological processes operate at the landscape level, such as intraspecific gene flow, hydrologic cycles, movement of many wildlife species, and long-term dispersal of many plant species. Assuring that these processes are maintained requires attention to various elements of landscape structure such as average forest patch size, distribution



of patches, connectivity between patches (i.e. corridors), and degree of fragmentation as it relates to the amount of forest edge versus interior forest conditions.

Management at the landscape-level, particularly on public lands, will again attempt to emulate natural patterns and processes characteristic of the forest ecosystems of the region. In some areas this will include the reintroduction of fire, recognizing its role as an important disturbance agent in many natural ecosystems. Fire in the Central Hardwood Region has historically, beginning with Native Americans, been related to human activity. It is recognized, however, as an important factor in long-term survival of many plant communities such as prairies, savannas, barrens, and wetlands. Fire has also been an important factor in maintaining seral tree species in forest communities across the region.

Ecosystem management requires greater attention be given to the size and juxtaposition of treatment units on the landscape. In large, contiguous forest areas of the region, large patch size should be maintained for long-term provision of interior forest habitat conditions. Interior conditions are often limited on managed landscapes due to excessive fragmentation, thus reducing suitable habitat for some plant and animal species. Providing for larger patches can be accomplished by treating larger blocks in single entries, or by aggregating harvest units over 10-20 year periods to eventually form single, essentially homogeneous patches providing interior forest conditions.

In much of the Central Hardwood Region, forests and other wildland habitats occur as small patches within a matrix of agricultural land, and the potential isolation of species is a major concern. Even though specific features of individual patches are very important, it may be equally important for many of the plant or animal species utilizing them that there is some connection with other suitable patches on the landscape. As patches become more isolated and suitable corridors for movement between patches are not provided, the risk of localized extinction of sensitive species increases.

With ecosystem management, objectives are developed and decisions made based upon a predetermined Desired Future Condition (DFC) for the landscape. Determining the DFC requires cooperation between the various landowners on

the landscape. This is true wherever ecosystem management is attempted, but it is particularly critical in the Central Hardwood Region where landscapes are dominated by numerous NIPF landowners. A major challenge will be breaking down the ecologically meaningless boundaries that separate administrative units, agencies, or ownership's.

At an even larger scale, ecosystem management is concerned with the connectivity between landscapes, such as between large areas of forested lands separated by a predominantly urban or agricultural landscape. The character of the matrix separating these forested landscapes can be important in terms of movement of migratory wildlife, and the reintroduction of plant or animal species which may have become locally extinct.

It is important to recognize that ecosystems are dynamic and constantly changing, hence the importance of considering longer temporal scales in ecosystem planning. Our limited ability to accurately predict the long-term cumulative impacts of management means effective ecosystem management requires careful monitoring to determine if objectives continue to be met. This is one area where new tools and approaches need to be developed. Specific items to be monitored will be based on the objectives for the area, and effective monitoring will require that these objectives be expressed in quantitative terms. The existing landscape must also be assessed quantitatively, focusing on key indicators such as species richness, sensitive species health and abundance, landscape patterns, water quality, pollution levels, and aesthetic quality. Long-term monitoring determines whether management actions are achieving desired results and are moving the ecosystem closer to the DFC.

Monitoring is useful for determining if long-term objectives are being met. At the same time, ecosystem science is constantly developing new knowledge. "Adaptive management" is an important feature of ecosystem management in which long-term plans are designed with the flexibility to use the results of monitoring and new scientific information to update and modify plans. In the Central Hardwood Region, additional flexibility is required because landscape objectives will change through time as the objectives of individual landowners change, or as properties within the planning area change ownership.



## Implications of Ecosystem Management in the Central Hardwood Region

Ecosystem management affects all regions of the country differently. In the Central Hardwood Region ecosystem management will require greater changes in management at the landscape scale than at the individual stand scale because there has been less reliance in this region on intensive, single species, high production management. In the mixed hardwood forest types which predominate, the variety of tree species typically present, and their differential growth rates, promote stands with naturally high levels of structural complexity, even under even-aged conditions. There is little evidence suggesting stand-level silvicultural practices commonly used in the region pose any problems from the standpoint of structural complexity or biological diversity.

The typical management objectives of private landowners also will reduce the potential impact of ecosystem management in the region. Studies of NIPF landowners show that timber production typically is not the primary motivation for ownership. Timber harvest is often an objective, or a tool used to meet other objectives, wildlife habitat, aesthetic quality, and naturalness are typically more important to the private forest landowner.

Despite typical landowner objectives, NIPF lands in many areas of the central region historically are poorly managed; or more commonly, have not been managed at all. In many cases, the only "management" private lands receive is when trees reach merchantable size and the timber is sold. This often entails removal of only the largest, most valuable trees resulting in an overall decline in the economic value of the stand. Once the economic value has been exploited, there may be little incentive to maintain the stand in a forested condition. However, sound forest management, which often includes timber production, meets the multiple objectives of private landowners better than the typical exploitation of woodlands, and should be encouraged as part of ecosystem management, or any other approach.

## Obstacles to Ecosystem Management in the Region

There are several obstacles to wide-scale implementation of ecosystem management in the Central Hardwood Region. The most significant of these concern the pattern of land ownership in the region. Nearly 90 percent of all forestland is privately owned for nonindustrial purposes. The average forest property is small, generally less than 50 acres, and changes ownership often. This means that most landscapes of the size required for effective ecosystem management consist of dozens, and sometimes hundreds, of separate landowners.

Dealing with a large and diverse set of landowners requires incorporating a wide variety of individual objectives into coordinated long-term management strategies. Most owners are very protective of their private property rights, and many will be reluctant to cooperate if they perceive ecosystem management as an approach which requires that they relinquish autonomy over their own property. Also, most owners have no formal management plan or strategy for their land. In Indiana, for example, it is estimated that less than 20 percent of the acres harvested are under any kind of formal management or have received professional input. The big challenge for forest managers involves getting private landowners to practice scientific forest management of any kind, as much as getting them to consider ecosystem management.

Cooperation among private landowners in an ecosystem management program will be further hampered by the general lack of organized leadership among forest owners in the region. The majority of private forest landowners are not closely tied to organizations which exert much influence on their management decisions. Some landowners participate in various state and federal programs, such as Tree Farm and the Stewardship Incentive Program, but this involves a small proportion of the total number of forestland owners in the region. Organizational leadership must surface, along with new methods to encourage landowner participation, if ecosystem management is to work in the Central Hardwood Region.

Another obstacle to ecosystem management is the state of existing landscapes. The Central Hardwood Region is highly fragmented with a



general lack of large, contiguous, predominantly forested landscapes. Most of the fragmentation has resulted from the conversion of forestlands to urban and agricultural land uses. It is unrealistic to think that completely natural ecological systems could be restored to any significant portion of the region. For example, large, native predators are not likely to become reestablished. The lack of large areas of relatively natural habitat will make it difficult to fully utilize management regimes important to the long-term survival of many plant and animal species. Given the existing landscapes in the region, it is important to recognize that developed lands, both agricultural and urban, will often be part of the ecosystem mix.

## **Factors Favoring Ecosystem Management in the Region**

### **Landowner Objectives**

Despite obstacles to ecosystem management in the Central Hardwood Region, there are factors which favor adoption of the approach. As discussed earlier, the typical objectives of forest landowners may be more compatible with ecosystem management than with traditional approaches. Studies have frequently shown that maximizing revenues from timber is rarely the primary goal of private forest owners. As society in general becomes increasingly aware of environmental issues, we can expect that NIPF owners also become more concerned with the impacts of their management activities.

Timber production, while generally not the primary objective of NIPF landowners, is very often one objective. The ecosystem management approach provides for harvest of timber while at the same time protecting other values that concern many landowners. Even where timber production is a primary objective of the landowner, the ecosystem management approach can provide ways to accomplish this.

On public lands, management objectives can be just as varied. Particularly on state or locally owned lands, there is frequently a need to generate revenues to offset land management costs. There is also greater pressure from the public to provide aesthetically pleasing landscapes, recreational opportunities, and a variety of other goods and services. A primary feature of ecosystem management is the flexibility to incorporate the

wide range of management objectives specific landowners or management agencies may have.

### **Incentive Programs**

Incentive programs, sponsored by government agencies or private organizations, are designed to encourage landowners to put their lands under management to achieve some stated objectives. Frequently, the objectives are simply to keep the land in a forested condition and under professional management, with few restrictions on the personal objectives of the landowner. Incentives may include cost sharing for specific practices, direct payments to landowners, or reduced tax assessments on their forestland. Currently there are no programs designed specifically for ecosystem management; however, many existing programs could be used to encourage landowner cooperation in ecosystem management. Very likely there will be additional programs developed to promote ecosystem management as it becomes more visible nationally.

### **Value of Forest Products**

The forests of the Central Hardwood Region are important for many reasons, one of which is the generally high-value hardwood resource. Market forces often provide the means by which management objectives are met by providing the resources to implement forest plans. Currently, prices for timber are high, not just for traditionally high-valued oak and walnut, but also for other species. The reduction in available timber supplies in other regions of the country suggests that timber demand, and thus prices, will remain high. High demand favors use of new technologies, lowers utilization standards, and thus increases merchantability of a greater variety of forest products. As long as ecological objectives are adhered to, these favorable market forces can provide conditions conducive to implementing an ecosystem management approach.

## **Recommendations to Land Managers**

Ecosystem management is unlikely to have drastic impacts on land management in the Central Hardwood Region. There are, however, some recommendations that can be made to help managers incorporate elements of the approach. How these recommendations are applied will



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**Table 1. Stand-level strategies for implementation of ecosystem management in the Central Hardwood Region.**

- Maintain land in a forested condition.
  - Maintain or create structural and compositional complexity.
  - Utilize forest management practices which maintain economic value along with suitable structure.
  - Provide for adequate current and future levels of snags and coarse woody debris.
  - Minimize impacts to areas with unique site conditions through proper location of roads, log landings, and skid trails.
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depend largely on who the land manager is working for. Managers of public forestlands can include appropriate ecosystem management strategies into their long-term plans and implement them at the project level. Resource professionals dealing directly with private forestland owners can provide recommendations for how to use an ecosystem management approach as one possible choice for interested landowners.

Specific recommendations for incorporating an ecosystem management approach can be broken into stand-level and landscape-level strategies. At the stand-level (Table 1), the objective is to maintain structural and compositional complexity, which, in this region, is easily accomplished using a variety of silvicultural systems. If not enough standing dead or coarse woody debris is present to meet objectives, then actions can be planned to enhance current or future levels of these structures. Care should be taken to minimize impacts to areas of unique site conditions which provide

habitat for many rare or sensitive species, and which are often important in the functioning of various ecosystem processes.

At the landscape-level (Table 2), the primary objective for most areas of the region is to minimize and, if possible, reduce fragmentation. In areas consisting of large, unfragmented forest, managers should attempt to maintain large patch sizes by treating larger units or by aggregating smaller treatment units. Attempts should also be made to locate roads where they will not contribute to fragmentation. In landscapes which are currently fragmented, attempts should be made to minimize isolation of patches, enlarge patches through plantings of nonforested areas, and provide connections between patches utilizing riparian corridors, shelterbelts, and where possible, reforestation of select nonforested areas.

Another landscape-level objective is to create or

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**Table 2. Landscape-level strategies for implementation of ecosystem management in the Central Hardwood Region.**

- Increase the size of isolated forest patches in fragmented landscapes through afforestation of adjacent non-forest land.
  - Create connections or linkages between isolated wooded areas using riparian corridors, shelterbelts, and afforestation of select nonforested areas.
  - Minimize permanent clearings within existing large forest patches.
  - In unfragmented landscapes, utilize treatment units which maintain large patch size.
  - Maintain a mix of successional stages or structures within the landscape, including both early-successional (recently disturbed) and old growth stages.
  - Establish a workable monitoring program with quantitative criteria designed to measure progress toward meeting stand- and landscape-level objectives.
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maintain, to the extent possible, natural landscape patterns and structures by attempting to emulate historic disturbance regimes. In this region, that will include reintroduction of fire or use of management techniques which are intended to emulate the effects of fire. Ideally, this will result in landscapes containing mixtures of successional stages and structures, including late-seral and old-growth communities that are rare throughout most of the region, and which provide unique habitat characteristics for many plant and animal species. Primary responsibility for maintaining many of the rare or unique landscape structures will likely fall on the public land management agencies in the region. Private lands will be important in maintaining a balance of structures on the landscape.

## Summary

Ecosystem management represents an evolution in the philosophical approach of the forestry profession to the management of natural resources. It's an approach that places greater importance on the conservation of biological diversity and sustainability of long-term ecosystem health and productivity. While new approaches may result in minor modifications to traditional silvicultural practices, naturally high levels of structural and compositional diversity make stand-level activities a minor concern in the Central Hardwood Region.

The major challenge in the Central Hardwood Region centers on how to address landscape-level issues associated with ecosystem management. Highly fragmented landscapes and the predominance of NIPF landowners with a diversity of ownership objectives create difficulties in developing and implementing long-term landscape-level management plans. A high priority for ecosystem management in the region will be the development of new approaches to encourage cooperative planning across multiple ownerships. This will only be successful if NIPF landowners do not perceive that they are being asked to give up personal property rights.

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