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Will ecosystem management supply woodland caribou habitat in northwestern Ontario?

David L. Euler

Faculty of Forestry, Lakehead University, Thunder Bay, Ontario P7B 5E1, Canada (David.Euler@lakeheadu.ca).

Abstract: Ecosystem management is emerging as an important concept in managing forests. Although the basic conceptual idea is not new, important defining principles are developing that elucidate some of the specific attributes of ecosystem management. These principles include: the maintenance of all ecosystems in the managed forest, the emulation of natural disturbance patterns on the landscape and the insurance that structure and function of forested ecosystems are conserved. Forest management has an impact on woodland caribou (*Rangifer tarandus caribou*), although the presence of wolves (*Canis lupus*) and moose (*Alces alces*) in the same northern ecosystems also affects the caribou-forestry interaction. Specific management for caribou as a featured species has been proposed, based on managing large landscape blocks. Ecosystem management would also produce habitat in a manner that might accomplish the goal of conserving woodland caribou as well as maintaining other important ecosystem functions.

Key words: forest management, wildlife, biodiversity, ecological management.

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Purpose

The purpose of this paper is to briefly review the concept of ecosystem management and to consider how ecosystem management might affect woodland caribou (*Rangifer tarandus caribou*) habitat in Northwestern Ontario. The idea in this paper is a management hypothesis which must be tested before it is implemented. Establishing management hypotheses is a vital step in effective resource managment policy.

Meeting the needs of wildlife in forest management

A major problem faced by forest managers concerns how to deal with the complex and varied needs for maintaining wildlife habitat. Traditionally, management agencies have concentrated on a few commercially valuable species. The assumption behind this approach is that these species have economic value and if managed carefully can be sustained for long periods of time.

As concern for forest health increases in the public mind, more species get added to the management list of interest. Kimmins (1995) has reviewed the stages of forest management and terms the current stage "social forestry". In this stage, more species of plants and animals, both commercially valuable or as indicators of forest health, are added to the list that managers must accommodate.

In Ontario, the progression from commercially important species to species of broader interest is well underway. White-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*) dominated managers' thinking for the last several decades. However, as more people become interested in forest management, and value other wildlife species, managers have had to expand their concern to include a larger number of wildlife species.

As the list of wildlife species of concern to managers gets longer, the complexity of management increases dramatically. Ontario management policy now mandates that several species be "featured" in forest management plans. In Northwestern Ontario, white-tailed deer, moose, American marten (*Martes americana*) pileated woodpecker (*Dryocopus pileatus*) osprey (*Pandion haliaetus*) great blue heron (*Ardea herodias*) bald eagle (*Haliaeetus leucocephalus*) black

bear (*Ursus americanus*) and woodland caribou are all supposed to have habitat provided in forest management plans. As well, pressure is mounting for managers to conserve biodiversity, meet sustainability certification requirements and address habitat needs for additional wildlife species such as wood warblers.

The complex and sometimes contradictory habitat requirements of wildlife species leads to a virtually impossible task. No forest manager, however skilled, can develop a forest management plan that explicitly deals with habitat needs of all wildlife species. The best that can be accomplished, if an individual species is "featured", is to provide habitat for that featured species. Some benefits will accrue to non-featured species, but these are byproducts of the main goal.

Woodland caribou in northwestern Ontario

In Northwestern Ontario, attempts to develop and implement specific habitat management for caribou (Racey *et al.*, 1991) have been frustrating. The large scale logging disturbances needed to eventually create extensive tracks of old forest are difficult for the public to accept. The issue of wood supply and caribou habitat is also difficult to reconcile. Other criticism is based on caribou and moose partitioning their habitat (Cumming, 1996), thus avoiding the predator pit problem espoused by Bergerud (1983).

Rather than focusing directly on woodland caribou habitat, and continuing to contribute to the piecemeal approach to managing wildlife habitat, the more general ecosystem management approach might be more successful. Although a general approach does not explicitly provide habitat for any species, it may provide the best opportunity to meet the needs of a variety of wildlife species, while conserving biodiversity and meeting the objective of sustainability. Ecosystem management should also provide for the needs of woodland caribou.

The emerging concept of ecosystem management

The Crown Forest Sustainability Act in Ontario and policy documents of the Ministry of Natural Resources (e.g. Ontario Forest Policy Panel, 1993) have outlined Ecosystem Management as the new policy in forest management. As outlined by Carey & Curtis (1996) ecosystem management should help conserve biodiversity, maintain viable populations of wildlife and meet reasonable needs for human use of forest products.

The concept of ecosystem management of natural resources is gaining prominence with natural resource management agencies and in the literature of forest management (Gerlach & Bengston, 1994; Slocombe 1993). Although recent discussions have increased its profile, the fundamental idea was envisaged several decades ago. Grumbine (1994) listed Aldo Leopold and Victor Shelford as "visionary ecologists" who began advocating the ecosystem concept in natural resources management in the 1930's and 1940's. Even though ecosystem management is not a new idea, implementing it in forest management is new. The present intensity of timber harvest and the concern for maintaining healthy forests has prompted development of new approaches to forest management (Kimmins, 1995).

There is no universally accepted definition for ecosystem management, although the core idea expressed by nearly everyone is similar. Ecosystem Conservation, New Forestry and Natural Landscape Management all convey the essential elements of a comprehensive approach to forest management. For this paper, the term ecosystem management will be used, as it seems to be used most often in the literature.

Grumbine (1994) summarized much of the ecosystem management literature and defined ecosystem management. His definition is: *"Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."* The U.S. Forest Service has been developing policy on ecosystem management for some time (Salwasser & Tappeiner II, 1988) and in 1992 adopted ecosystem management as a policy for the Service. The definition accepted there was *"The use of an ecological approach to achieve multiple-use management of the national forests and grasslands by blending the needs of people and environmental values in such a way that the national forest and grasslands represent diverse, healthy, productive and sustainable ecosystems."* (Salwasser, 1992).

Principles of ecosystem management

The fundamental principles of ecosystem management are still evolving, with some important ideas evident in all approaches to this management technique. The principles of ecosystem management

listed by Grumbine (1994) include: a hierarchical context, appropriate ecological boundaries, adaptive management and managing for integrity of ecosystems. Kimmins (1995) spoke of the need to maintain ecosystem health and integrity, retain old-growth stages, use low disturbance harvesting systems, and above all else, protect biodiversity. Booth *et al.* (1993) emphasized the need to maintain a continuing supply of all natural forest ecosystem types, the importance of basing forest management on sound knowledge of forest science, and the need to address a diverse range of interests in planning.

While the principles of ecosystem management are still evolving, the universal goal of ecosystem management is to sustain the integrity and health of ecosystems, while meeting society's need for a sustainable supply of forest products, and other forest attributes to which social and cultural values are attached.

Characteristics of ecosystem management

The emerging paradigm in forestry clearly includes concern for both conservation of biodiversity and sustainable harvest of forest goods and products. Conservation of biodiversity and sustainable harvest represent conceptual ideas that are important but difficult to measure. However some goals and objectives of ecosystem management are measurable and these should give guidance to managers who are implementing the concepts.

Grumbine (1994) found that most of the discussion of ecosystem management focused on five main goals.

1. Maintain viable populations of all native species in situ.
2. Represent within protected areas, all native ecosystem types across their natural range of variation.
3. Maintain evolutionary and ecological processes (i.e. disturbance regimes, hydrological processes, nutrient cycles, etc.).
4. Manage over periods of time long enough to maintain the evolutionary potential of species.
5. Accommodate human use and occupancy within these constraints.

These goals represent a fundamental change from the goal of providing goods and services to humans to the maintenance of the integrity of ecosystems. Success is measured by the fact that ecosystems continue to evolve and change, but are not subject to degradation by human activity. The integrity of the forest itself is more valued than the monetary value of the goods and services that are supplied by the forest.

Ecosystem management and caribou habitat in northern Ontario

Changes in policy occur slowly. As the Ontario Ministry of Natural Resources moves from Featured Species Management to Ecosystem Management some different results can be expected in the forest. Would a forest managed under Ecosystem Management support woodland caribou populations in Northwestern Ontario?

Woodland caribou in Ontario

Woodland caribou habitat has been discussed extensively in many papers, (e.g. Cumming & Beange, 1993; Cringan, 1957; Darby & Pruitt, 1984). Predation and its impact on woodland caribou and moose has also been the subject of intense discussion and speculation, (e.g. Bergerud, 1983; Seip, 1991; Cumming, 1996). While these are important topics, they would not be the major concern in an ecosystem approach to managing northern forests. Instead, managers would consider how to maintain the natural ecosystems in the forested areas of concern. The assumption is that if natural ecosystem processes are conserved, and woodland caribou have evolved historically under those conditions, they have the best opportunity to continue to exist and remain healthy, under these same natural conditions.

Maintaining ecological processes

There are, of course, many ecological processes in any ecosystem. Predator-prey relationships, decomposition of organic matter, disturbance events of several kinds, such as fire or wind storms are all normal parts of ecosystem process and function.. However, only a few basic processes can be affected by forest management as keys to an ecological approach.

The key ecosystem processes that can be manipulated by foresters, in most cases, are:

– Use of logging to mimic the patterns that fire, wind, and insects create on the landscape,

– Managing selected attributes of biodiversity to ensure that biodiversity is conserved in the management processes,

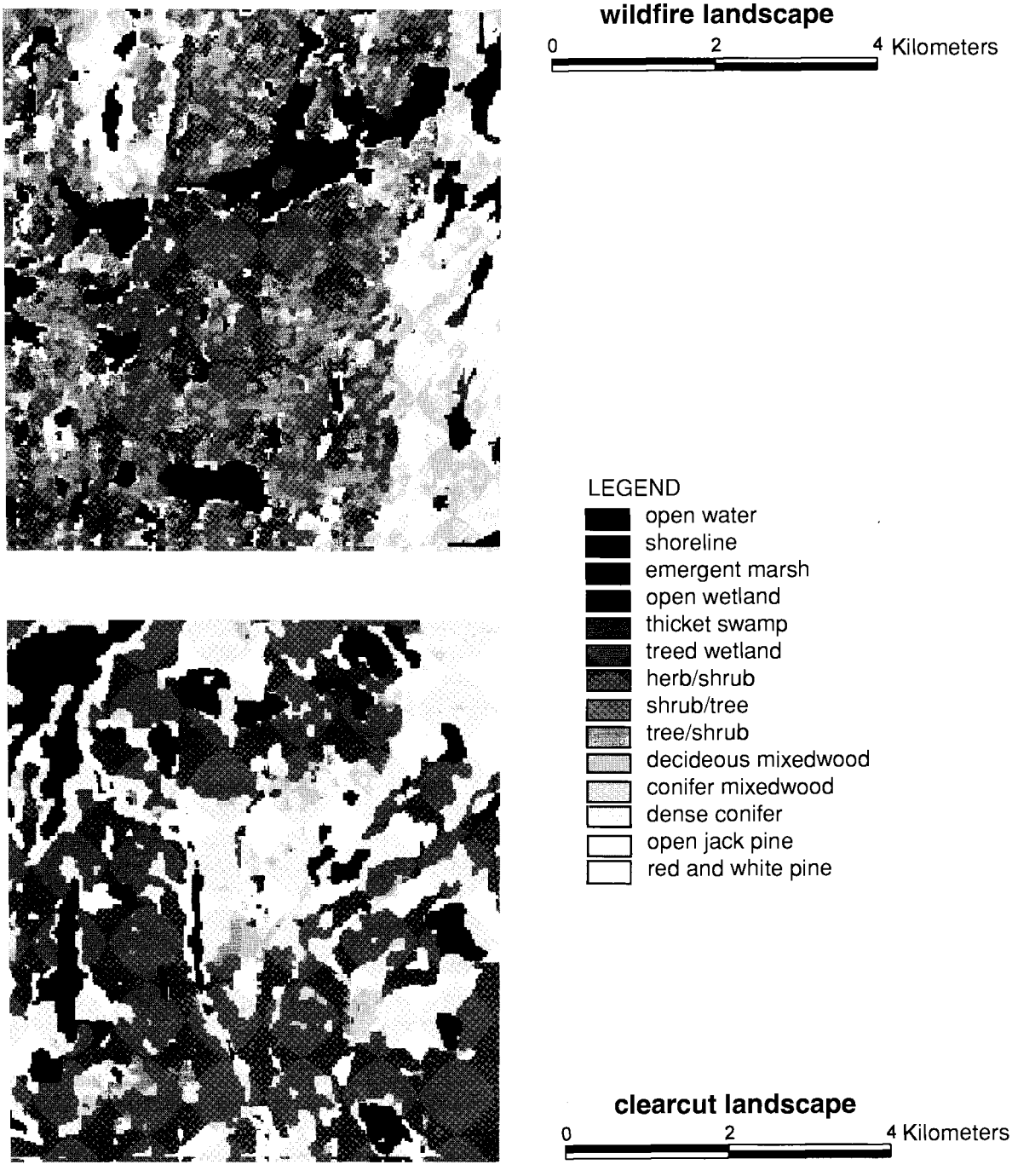

Fig. 1. Illustration of the different landscape patterns between a clear-cut and wildfire (Gluck & Rempel, 1996).

– Maintaining the age class distribution of commercial tree species similar to natural evolution of forests.

Mimic the pattern

The distribution of plant species on the landscape is important to wildlife species living there. If the

pattern on the landscape after logging is similar to the natural disturbance pattern, then wildlife species and biodiversity conservation goals have the best chance of being achieved. While the pattern left by logging cannot duplicate exactly the pattern left by natural disturbance events, it should be as similar as possible.

Gluck & Rempel (1996) compared the structural characteristics of post-wildfire and clear-cut landscapes in the Boreal forest near Dryden Ontario. They found that the clear-cut landscape tended to have larger, less dense patches than the wildfire, the patches in the clear-cut were more irregular in shape with greater amounts of edge and core areas than those in the wildfire, whereas the wildfire had more interspersion between patch types at the broader scales, Fig. 1.

Under ecosystem management, the size of clearcuts is important, and the size of wildfires is a useful guide to planning the size of clearcuts. Li *et al.* (1996) found that the size of wildfires was quite variable, and did not always follow a particular mathematical distribution. A common pattern of wildfire size distribution, in Northwestern Ontario, based on a 10 km by 10 km area, is illustrated in Fig. 2. Hunter (1993) found a similar pattern in eastern Canada. Fig. 2 describes a useful guide in developing logging plans that are consistent with the idea of ecosystem management.

With the advent of remote sensing, GIS systems and models of disturbances, (e.g. ON-FIRE as described in Li *et al.*, 1996) forest harvest plans that mimic the pattern of natural disturbances are within the reach of most forest managers. If practiced over 80 to 100 year rotations, and at the scale of a large area such as Northwestern Ontario, ecosystem management should contribute to maintaining the normal ecological processes that were present before major human exploitation of the forest started. This in turn should provide the habitat caribou need to remain healthy.

Selected aspects of biodiversity

The concept of biodiversity has come to mean all the aspects of life in ecosystems. The species present, the interaction among species, the genetic variability, indeed virtually any component of an ecosystem can contribute in some way to the idea of biodiversity. Forest management may change the biodiversity of the landscape or it may not, depending on the harvest techniques used.

Under ecosystem management the goal should be to maintain the diversity of the managed area reasonably close to the diversity present before management began. This goal is both scale and time dependent and must be considered at relatively large scales. However, the diversity maintenance goal is a practical and realistic way to measure the impact of logging on the landscape and assure the public that forest management is consistent with biodiversity conservation (Carey & Curtis, 1996).

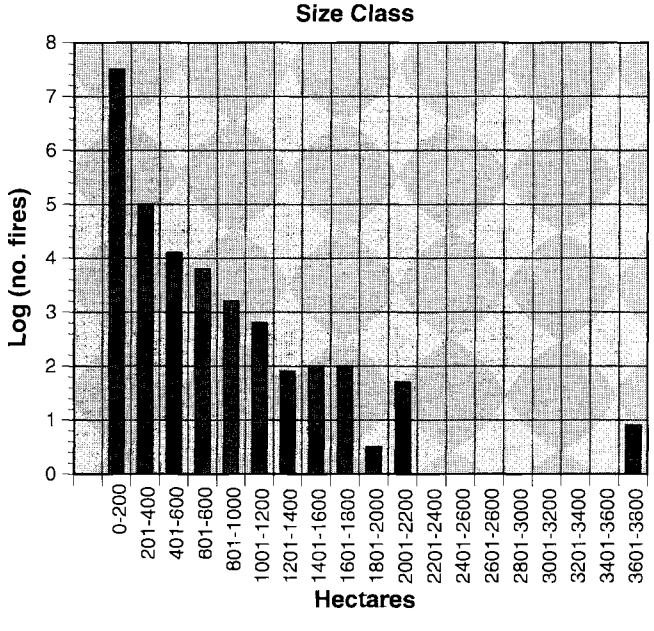

Fig. 2. Size distribution of wildfires in Northwestern Ontario (from Li *et al.*, 1996).

Baker (1993) describes how one aspect of diversity can be measured in areas disturbed by wildfire. Although Baker did not compare the wildfire landscape to a logged landscape, it would not be hard to do that comparison. In Baker's example, from the Boundaries Waters Canoe Area in northern Minnesota, he used patch age to calculate, using Shannon's index, the diversity of patch ages on the landscape. He demonstrated how fire suppression increased the patch age diversity of the landscape over the presettlement forest. The idea that fire suppression would increase some measures of diversity of the

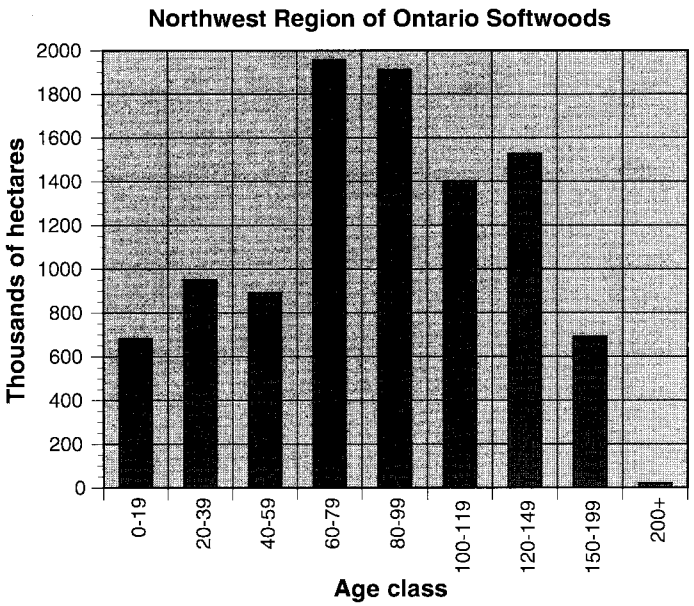

Fig. 3. Age class distribution of softwood trees in Northwestern Ontario.

landscape may seem counter-intuitive, and illustrates the importance of actually measuring the impact of major human activities on the landscape.

Managing age classes of trees

The third area that forest managers manipulate in the process of logging and fire suppression is the age class structure of commercial trees. As with the other goals of ecosystem management, the goal is to try to approximate the age distribution that has evolved in the boreal forest.

In an unmanaged and unlogged boreal forest, with forest fires unsuppressed, average disturbance frequency is usually in the range of 70 to 100 years. Van Wagner (1978) proposed that the resulting age class distribution is exponential. Boychuk *et al.* (1995) reviewed theoretical age class distributions in the Boreal Forest and concluded that the exponential model was common, although significant variations can occur. The age class distribution is not fixed, and will vary depending on scale and climatic factors. However, in virtually every case in Boychuk *et al*'s data a larger area of the forest is in younger age classes and less is in older age class. Forested boreal ecosystems, evolving in a disturbance environment, typically show age class distributions with considerably more area in younger rather than older forests.

The managed boreal forests of Ontario, in contrast, are dominated by older age classes. For example, in a status report from the Ontario Ministry of Natural Resources (Ontario, 1994) the following analysis is given:

In terms of age structure, Ontario's forest are dominated by mature and overmature forests; fully three quarters of the province's productive forest are over forty years old. The age class distributions of Ontario's forests result from 77 years of organized forest fire control in the north and 250 years of post-colonial settlement in the south. Forest fires disturb an average of 80 000 hectares of managed forest every year. In the pre-suppression (pre-settlement) era approximately 700 000 hectares of forest were consumed by fire. If one adds the area harvested each year (170 000 hectares) to the average area burned, the total area affected is 250 000 hectares. This represents less than 40% of ave-

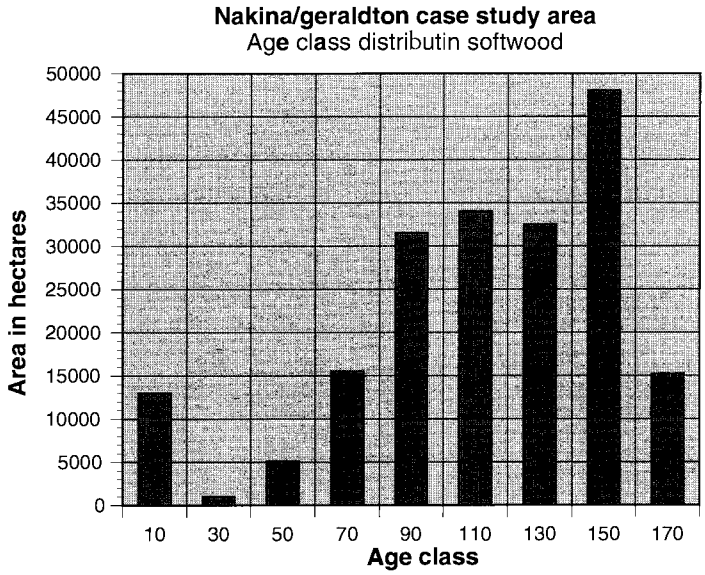

Fig. 4. Age class distribution of commercial tree species from the Nakina management unit in Northwestern Ontario.

rage area disturbed annually in Ontario's forests before European settlement.

Figs. 3 and 4 illustrate typical examples of this distribution.

To change the age classes distribution of commercial tree species towards a more evolutionary pattern, Boychuk *et al.* (1995) provide some useful guidelines. The goal is fewer trees in older age classes than is there now, met either by less fire protection or selective logging.

Affects on woodland caribou habitat

A Boreal Forest area managed under ecosystem management would have large scale disturbances, sometimes dozens of square kilometers in size. Old forests would be relatively rare; perhaps 5 to 10% of the landscape would be in these old stages. The landscape would not be as diverse, because most human activities tend to increase the diversity of the landscape, (e.g. Baker, 1993; Gluck & Rempel, 1996). Wide spread management for moose and other popular game animals that respond to edges and disturbed areas, has left a more fragmented forest than that which evolved under fire, insects and wind storms. The net result would be a forest with attributes that resemble the forest that evolved before people began to intensively manage the area. Because caribou evolved under these conditions it seems logical that the habitat portion of woodland caribou management would be satisfied by this approach.

The next step should be to use computer models of forest management and develop a specific example of how the landscape would change following an ecosystem management strategy. Gooding & Van Damme, for example, (1996) used a computer model to compare hauling costs of wood harvested in both conventional and ecosystem management regimes. The same approach would be beneficial in studying the potential impact of ecosystem management on caribou habitat.

Summary and conclusions

Moving from a featured species approach to ecosystem management is a difficult process that will be hard for many people to accept. There is a strong bias to search for specific solutions to problems encountered by selected species. When any wildlife species is considered endangered, whether it is bald eagles or woodland caribou, there is a strong impetus to develop specific solutions to the specific problem. The problem with the species by species approach is that the palate of individual problems accumulates to such a degree that it becomes impossible to solve in any realistic sense. In Ontario, for example, there are some 30 or 40 "guidelines" that managers are supposed to follow in developing forest management plans. In addition, there are several criteria for measuring sustainability that managers are supposed to include. The net result is that managers, no matter how sincere or hardworking, cannot follow the sometimes contradictory, sometimes obscure, guidance from these documents. In response, they build plans based on the particular biase they bring to the planning process.

In ecosystem management, a few basic principles are followed that provide the best opportunity to maintain viable populations of all species on the landscape, that will conserve biodiversity at the appropriate levels, and will sustain the fundamental processes that are important to ecosystem function. In that scenario, the needs of woodland caribou would seem to be protected to the best possible degree.

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