Ecosystem Fragmentation in Ontario: Using Corridors in Protected Areas Planning

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Abstract

Ecosystem fragmentation is the process whereby a continuous area of habitat is both reduced in area and divided into two or more sections. It is both a global and regional form of environmental degradation. The establishment and retention of protected corridors is a method by which to address this threat to biological diversity. Corridors are a legitimate consideration in the ecological sciences and should be applied in the planning of protected areas in Ontario.

Introduction

The loss of natural environment and the fragmentation of that which remains is a globally-significant issue. The United Nations Environment Programme (1997:1) concludes that globally:

> World-wide habitat loss and fragmentation, the lack of biological corridors, and the decline in biological diversity outside protected areas constitute primary threats to overall biodiversity.

The Ontario Ministry of Natural Resources (1994:12) states that:

> The natural landscapes of southern Ontario have been altered and fragmented since settlement to meet the need for economic and social development of the province.

Clearly, ecosystem fragmentation is both a global and regional problem. Ecosystem fragmentation in its various forms has been an important issue for over a century and remains a serious problem in Ontario (ECO, 2000). This environmental issue must be addressed by the responsible governments in Ontario (ECO, 2000). The fragmentation of terrestrial and aquatic ecosystems can be interpreted to be both a "provincial interest" and a component of "ecological systems" as outlined in of Ontario's Planning Act (Section 2).

The use of corridors in protected areas planning is a means to address this form of environmental degradation. In support of provincial planning policies, the Ontario Ministry of Natural Resources (2000:137) defines corridors as

> ...the naturally vegetated or potential re-vegetated areas that link or border natural areas and provide ecological functions such as habitat, passage, hydrological flow, connection or buffering from

adjacent impacts. They can occur across or along uplands, lowlands or slopes. Ravine, valley, river and stream corridors are further defined as landform depressions, usually with water flowing through or standing in them for some period of the year.

Ecosystem Fragmentation in Ontario

The concept of the ecosystem is central to biodiversity and its maintenance (Holdgate, 1996). Likens (1992, cited in Christensen *et al.* 1996:670) defines it as "a spatially explicit unit of the Earth that includes all of the organisms, along with all components of the abiotic environment within its boundaries." Ontario's variability of ecosystems have created habitat for more than 2,900 species of vascular plants, 160 species of fish, 80 species of amphibians and reptiles, 400 species of birds, and 85 species of mammals (OWWG, 1991).

The Ecological Society of America (Christensen *et al.* 1996) proposes that the ecosystem concept implies that (1) spatial and temporal scales are critical; (2) ecosystem function depends on its structure, diversity, and integrity; (3) ecosystems are dynamic in space and time; and (4) uncertainty, surprise, and limits to knowledge exist. Further, the fragmentation of ecosystems may occur at any or all of the interconnected levels of biodiversity: (i) genetic; (ii) population/species; (iii) ecosystem/community; and (iv) landscape (Hunter 1996). Partially due to this complexity, no single comprehensive study on ecosystem fragmentation in Ontario exists (Eagles and Wilkinson, 2000).

Delineation of Ecosystems

Similar types of flora are frequently used to outline the boundaries of ecosystems. Forest-dominated ecosystems are of particular significance to Ontario as they represent the primary land cover for 76% of the province (OFPP, 1993:24). The causes of forest fragmentation vary with the latitude of these zones. The southern-most areas were historically deforested for agricultural purposes and now face increased pressures from urbanization. The northern ecosystems, although relatively isolated from large human populations, have become fragmented typically by resource extraction such as forestry and mining.

Geologic zones are also used to define the boundaries of ecosystems. For example, the Niagara Escarpment Planning and Development Act is administered by the Niagara Escarpment Commission. The Act (Section 2) is intended to maintain a "continuous natural environment," signifying the need for a linked system of protected sites along the entire 725 km length of this geological feature. Other ecosystems based on significant geologic features have generated political discussion, but do not as of yet possess such legislative tools including some of the sensitive glacial moraine ecosystems found in the southern portion of the province.

Watersheds are also employed to delineate ecosystems. Ontario possesses a network of more than 250,000 lakes with an unmeasured quantity of rivers, streams, and creeks — more than any other political jurisdiction on the continent (Waino, 1991). The fragmentation of these ecosystems may be caused by the in-filling of creeks, the drainage of wetlands and the damming of rivers. Inordinate levels of chemical pollution may also render an ecosystem as fragmented (Hunter, 1996).

Assessing Ecosystem Fragmentation

Ecosystem fragmentation is the process whereby a continuous area of habitat is both reduced in area and divided into two or more fragments (Reed *et al.* 1996; Wilcove *et al.* 1986). Fragmentation can be caused naturally, such as by fire regimes or drought. Fragmentation can also be result of human activities, such as the construction of roads or deforestation. Wright (2000) observes that fragmentation is

> ...neither a negative nor a positive. Landscapes are inherently fragmented and connected. They are in a sense 'patchy'. Some of course are patchier than others. Key is of course when fragmentation (or conversely connectivity) is thrown out of wack with a range of variation that the system can not adapt to.

The idea of connectivity is important through the establishment of corridors to adjacent reserves or fragmented ecosystems to facilitate the movement and migration patterns of metapopulations (Smith and Hellmund, 1993). Lindenmayer (1994) suggests that the extent to which corridors are actually used by animals is influenced by a number of interrelated factors such as the:

- Particular species targeted for conservation;
- Attributes of the corridors themselves, such as width, length and vegetation type;
- Suitability of habitat in the area surrounding corridors;
- Spatial location of corridors in the landscape (e.g., on gullies vs. ridges);
- Type of logging operations and their intensity and pattern in areas surrounding corridors;
- Impacts of edge effects such as windthrow

The quantity and health (e.g., population viability) of indicator species is used to monitor the conditions of fragmented ecosystems, because of the narrow ecological tolerance(s) of these species. McLaren *et al.* (1998) have identified vertebrate wildlife indicators for monitoring the integrity of forest ecosystems types in Ontario. The urgency of adopting analyses of ecosystem fragmentation is demonstrated by five of the selected indicator species being listed as "species at risk" and vulnerable: Great Grey Owl (*Strix nebulosa*), Southern Flying Squirrel (*Glaucomys volans*), Woodland Caribou (*Rangifer tarandus caribou*), Spotted Turtle (*Clemmys guttata*), and Wood Turtle (*Clemmys insculpta*) (ROM and OMNR 2000).

Ecosystem fragmentation is increasingly being acknowledged in landscape planning. Fragmentation was recognized as a major problem in the Carolinian Canada program in southwestern Ontario, both in the identification of the key sites for conservation (Eagles and Beechey, 1985) and the subsequent research program (Allen *et al.* 1990). In southwestern Ontario, Pearce (2000) found that

> Forest cover in the study area has been reduced to 26% of the land surface in 6,989 patches ranging in size from 0.09 ha to 3345 ha. However, 75% of the patches are < 3 ha and only 7 patches (<1%) are larger than 1000 ha. Most (98%) of the forest patches have high forest edge/forest interior ratios with no functional forest interior (>300 m from the forest edge).

Clearly, in southwestern Ontario the forest fragmentation is severe. Unfortunately, such comprehensive studies are not typically available (ECO, 2000). Exceptions to this lack of data include studies by Balser (1991) and Friesen *et al.* (1995).

Planning for Protected Corridors

The connection of fragmented ecosystems through the retention and establishment of corridors is critical to the maintenance of ecological processes (Eagles 2000). The fragmentation of natural areas is generally composed of two elements: (1) reduction of the total amount of a habitat type, or perhaps of all natural habitat, in a landscape; and (2) apportionment of the remaining habitat into smaller isolated patches (Wilcove *et al.* 1986). Natural areas may also become "shredded" in that habitat still exists, but it is transformed into long, narrow strips; this degraded habitat can be seen in the bands of vegetation along creeks and along hedgerows which cross agricultural or urbanized areas (Feinsinger, 1997).

The protection of core areas has been recognized in land use planning in Canada for almost 30 years through the designation of ESAs (Environmentally Sensitive Areas), ANSIs (Areas of Natural and Scientific Interest), PSWs (Provincially Significant Wetlands) and SSSIs (Special Sites of Scientific Interest) in planning instruments such as Official Plans (Eagles, 1975). Provincial and national parks, as well as conservation authority property, also play an important role as core areas.

A combination of corridors, cores and buffer zones is known as "multiple-use modules" or a protected habitat network (Meffe and Carroll, 1997). A network of corridors may link individual reserves or "nodes" to a central protected area surrounded by buffer zones regulating human activities. The application of corridors is reflected in the Provincial Policy Statement (1996) (Section 2.3.3) issued under the Planning Act:

> The diversity of natural features in an area, and the natural connections between them should be maintained, and improved if possible.

Therefore, corridors are recognized in municipal planning in Ontario. For example, the Regional Municipality of Waterloo (1998:G-1) sets an important precedent in explicitly recognizing that ecosystem fragmentation is an "adverse environmental impact" and requires in its Official Plan (Section 4.1.4) that corridors be established. Indeed, the Ontario Municipal Board (2000) states that "environmental linkages and corridors are legitimate planning considerations that the Board must have regard to in any application."

Corridor Functions

Corridors are a significant element within an over-all protected areas strategy. Corridors are typically linear (i.e., shortest distance through appropriate ecosystem types) strips of protected land which link a variety of quality ecosystem types (Smith and Hellmund, 1993). The establishment of corridors is necessary for species as they:

- Allow for movement within the existing territory;
- Provide access to a wide range of habitat;
- Facilitate seasonal migrations of metapopulations;
- Allow for interactions between species such as predation;
- Facilitate the physical recolonization of degraded areas;
- Maintain the genetic diversity of populations

Protected corridors also provide security to individual populations of species which are highly sensitive to human activities. For example, the connectivity of the landscape is critical to the breeding, birthing, feeding, or roosting of many animal populations (Soulé, 1991).

Corridors are equally important for the maintenance and diversity of plant species. Plant populations move, albeit, over long time scales. Plant populations can often persist for lengthy times in isolated patches of appropriate habitat. However, they also require gene flow, immigration and emigration if the species is to maintain maximum levels of genetic adaptability and variance. Different species of plants have a variety of dispersal mechanisms and capabilities which must also be considered in the planning of protected corridors.

Fencerow Corridors

The "fencerow scale" corridor or "line corridor" links small habitat patches (e.g., woodlots) using narrow rows of vegetation (e.g., trees, shrubs) for the movement of small vertebrates such as mice, chipmunks, and birds (Noss, 1991). This type of corridor is composed entirely of edge limiting its usage to relatively tolerant or generalist species. Such consideration is important as a corridor with a high ratio of edge-to-interior is less resistant to deleterious impacts than a continuous landscape (Hunter, 1996). Additionally, due to its size constraints, the lower quantity of biota in this type of corridor allows for an increased risk of local extinction. For example, it is well-documented that birds inhabiting forest-farmland edges experience high levels of nest predation (Wilcove *et al.* 1986). Species with smaller body sizes are also susceptible to undue predation near forest and wetland edges by exotic species or feral domesticates such as cats (*Felis catus*).

Strip Corridors

The second type of corridor functions at the "landscape mosaic scale" and is termed a "strip corridor" (Noss, 1991). This type of corridor is generally broader and longer, connecting significant landscape features rather than small habitat patches. A variety of ecosystem types would be protected in such a design, as many species find homogeneous areas inhospitable. Species need a variety of landscape elements to provide for a range of needs that vary in space and time. For example, this type of corridor would include large strips of forests connecting otherwise separate reserves, riparian areas along streams, or habitats that follow the topography of the landscape (Meffe and Carroll, 1997). Medium-sized vertebrates would use such a corridor to facilitate their movement between areas of shelter, feeding, and birthing.

Regional Corridors

Corridors may be also used at the "regional scale" as part of a network or greater ecosystem plan (Noss, 1991). This corridor is the largest type, providing the greatest quantity of interior habitat. In connecting a network of reserves, wide corridors are necessary as many large mammalian species require interior habitat to travel (Harrison, 1992). This type of corridor possesses the highest quantity of interior habitat and, therefore, accommodates a greater range of species. However, despite the greatest suite of ecological benefits of the three corridor types, a regional scale corridor is extremely difficult to implement because of the likelihood of it crossing multiple political jurisdictions with different governing agencies; it may further be complicated by the broad range of stakeholders and a lack of adequate funding.

Suitability of Corridors for Target Species

The quality and effectiveness of corridors must be considered through explicit recognition of conservation objectives of the target species (Soulé, 1991). Further, the frequency of use of corridors is species-specific. Many species can only travel in a corridor with a precise environment that is suitable for that species. In general, a common observed pattern is that some animals tend to maximize their distance from human habitation (Wright, 2000). Some animals make extensive use of corridors for much of their movement, as with skunks preferring to use hedgerows and mink using stream valleys. Others use corridors on a seasonal basis, such as ungulates or canids which use frozen streams for travel.

The necessary width of corridors is species-specific. The necessary width of corridors is even arguably subspecies-specific, based on the specific local conditions; for example, the territorial movement of wolves (*Canis lupus*) in Alaska differs from those in Minnesota necessitating different minimum corridor widths for the same species (Harrison, 1992). Species which are wary of humans require the greatest width as the corridors facilitate both movement and security. Therefore, to adequately maintain the biodiversity of an area, it is necessary that a corridor be based on the tolerance of the species requiring the greatest width. Parks Canada (2000), in a generalized fashion, recommends different minimums of corridor width: 200m for low protection, 500m for moderate protection, and 1000m for high protection. However, these widths are dependent upon the species targeted for using the corridors and the quality of habitat within.

Conclusion

The fragmentation of terrestrial and aquatic ecosystems is a naturally occurring process. However, human activities may substantially alter the dynamics of an ecosystem. The fragmentation of Ontario's ecosystems is a growing problem. Planning efforts will prove increasingly difficult in the future if immediate action is not taken. Indeed, the Environmental Commissioner of Ontario (2000:139) recommends that the Province of Ontario and its responsible Ministries "assist municipalities to ensure that ecosystem fragmentation is adequately considered in land use planning decisions."

The remaining isolated patches of natural areas can be protected and rehabilitated through the use of a system of corridors and core reserves. In an analysis of the scientific studies of corridors, Beier and Noss (1998:1250) conclude that,

> Our review has shown that evidence from well-designed studies supports the utility of corridors as a conservation tool.... Therefore, those who would destroy the last remnants of natural connectivity should bear the burden of proof that corridor destruction will not harm target populations.

Linkages between ecosystems provide for biological diversity, which the Province has an obligation to conserve (EC, 1995). These areas possess complex dynamics which interact at the genetic, population, species and landscape levels. Knowledge from the ecological sciences must be adequately incorporated into protected areas planning to ensure of measures to maintain and restore natural connections. The scientific information exists to implement such conservation strategies. However, public support and inter-agency co-operation at the multiple levels of government are critical to the success of any such project.

Acknowledgments

The author wishes to thank Dr. Paul Eagles of the University of Waterloo and Dr. Paul Wilkinson of York University for comments on earlier drafts of this manuscript.

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