LANDSCAPE ECOLOGY, AVIAN INFORMATION AND THE REHABILITATION OF WILDLAND COMPLEXES IN THE GREATER TORONTO AREA

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ABSTRACT

It is proposed that land regeneration projects should consider the total landscape or landscape ecology of a site. This holistic approach would extend management plans that link the replacement of the vegetation component with returning habitats necessary for the faunal component. Furthermore, the pattern of land use or landscape fragmentation is important for the successful rehabilitation and ongoing management of the landscape. These concepts and their implications for planning will be addressed in this paper with specific reference to the rehabilitation of a wildland/wetland complex on the Black River, Georgina Township, located in the Greater Toronto Area (GTA). This unique landscape includes remnant old-growth forest and vulnerable avian species but is under increasing pressure of fragmentation from exurban development. The results of a habitat fragmentation study comparing bird populations and diversity between this site and several more human-modified complexes in the GTA will be presented.

Introduction

Within the Greater Toronto Area many of the most significant and extensive greenland features are located in the exurban landscape. Unfortunately, little is known of these countryside greenlands in the South Lake Simcoe Watershed and on the Oak Ridge Moraine since they have primarily been located in countryside landscapes, away from large populations and in the past there has been little need to concentrate on them. In the last decade however, the proliferation of residential estate development in these natural areas combined with aggregate extraction operations, landfill dumps, and large scale utility projects to service the metropolitan centres of Metro Toronto have had a devastating impact on the diversity and integrity of these countryside wildlands. If sound land use decisions and conservation, maintenance and rehabilitation of natural areas is to occur in the GTA in the future, improved methodologies and strategies for acquiring and integrating information on the floral and faunal species, in a rigorous and planned way, will have to be developed.

Even within the GTA where, compared to the rest of the province, past inventory and research work is quite extensive and documented, a reliable base of environmental information does not exist. Yet, a data base of this nature is vital for the development of strategies concerning landscape rehabilitation. This paper presents the preliminary results of an ongoing project, funded by the Ontario Ministry of Natural Resources, that addresses the lack of an information base and the effects of human disturbance on bird species uniqueness, diversity and type (eg. forest interior species) for several wildland complexes in the GTA. It is proposed that the level of human activity or disturbance and the pattern of land use will affect the survival success of species populations and will be reflected in the levels of unique and rare species, diversity and specifically indicator species groups of raptors, cavity nesters and neo-tropical migrants.

Fragmentation of Landscapes

Southern Ontario and especially the Greater Toronto Area (GTA), has seen the rapid decline of many land cover types such as old growth forests and wetlands that are important habitat-specific types for many floral and faunal species. Their loss to rural agriculture and open space urban sprawl has had a major impact on species diversity and populations through the loss of a continuous cover of forest, wetland and wildland areas. This has led to the dissection or fragmentation of the land creating a mosaic of land cover referred to as the landscape.

Fragmentation results in the decline of gene pools, the loss of species that only occur in large patches of uninterrupted habitat, the endangerment of low-density, wide-ranging species, and the invasion of alien species. As fragmentation increases, many more suitable habitats for human-adapted species dominate the landscape and it becomes increasingly less hospitable to natural wildlife communities (Harris and Gallagher, 1989; Wiens, 1989).

The survival of species in the landscape is affected by the pattern of the landscape and landscape heterogeneity. It is often the structure of an entire landscape mosaic rather than the size or shape of individual patches that is important. Under certain circumstances smaller patches or a combination of small patches may contain more species than large patches (Simberloff and Abele, 1982; Loman and Von Shantz, 1991). However, certain types of species, usually the rare or unique, are susceptible to extinction in increased habitat patchiness and fragmentation (Butcher et al., 1981; Conner and Rudolph, 1991).

The problem of loss of habitat in the global community, especially Amazonia, and the impact on neo-tropical migrants has been reported in recent years (Wiens, 1989; Askins et al., 1990). The reverse situation, loss of habitat for the breeding and migration of these birds in North America is only now being recognized as significant (Askins et al., 1990). However, it has been difficult to establish long-term evidence of this phenomenon since little information is available on the population trends and landscape space requirements of many species.

Baseline Information and Historical Landscapes

Landscapes and habitats are dynamic and ever-changing over time. Often, little is known about the previous composition of botanical and faunal assemblages in places, especially the pre-European settlement characteristics of specific locales. For many years, assumptions have been made that may be erroneous as in the case of the revision of the extent of the historical savannas in southern Ontario (Catling et al., 1992). In the GTA, this is especially difficult since much of the presettlement forest has been cleared. It is possible to reconstruct the forest canopy from surveyor's records (Gentilcore and Donkin, 1973) but this only provides an overview of the dominant tree species, especially those that were a desired timber resource. It does not provide insight into the changes or dynamics of the forest ecosystem, especially the plant/animal relationships within these forests.

To develop a rehabilitation strategy that considers the landscape, it is necessary to establish a starting point, specifically, baseline values for a site. The composition, structure and functions of the land components (eg. fields, forests, and population centres) for an area have to be determined at the scale of the landscape with the focus on the interactions between the different types of land components or units (Moss, 1983). This is a holistic or ecosystem approach and the basis of research in the field of landscape ecology (see Forman and Godron (1986) for a general review of landscape ecology). This approach recognizes the impact that the land use within a land unit has on the surrounding, geographically connected units. For example, in a riparian system, the river, floodplain, slope and upland forests all combine to control the transport of nutrients and movement of species in river corridors (Forman and Godron, 1986). Therefore, rehabilitation should not simply be the reforestation of an area but it should have as a goal the recovery of the landscape system with the aim of achieving a "healthy" landscape. Soule and Kohm (1989) noted guidelines need to be developed that will help diagnose when the critical processes of a managed landscape are beginning to malfunction. Research aimed at both understanding degraded ecosystems and enhancing their productivity and diversity is a priority.

Bird Species as Indicators of Ecosystem Stress

The state of the landscape can be assessed by measuring the quality and quantity of fauna present at a site. Species rarity or uniqueness and measures of diversity have been typically considered as defining the significance and therefore, value of an area usually within various levels of significance (eg. regionally, provincially and nationally rare). In practice, the presence of more species and uncommon species makes an area more valuable, a habitat of higher quality retains a greater number of species. Less common species are frequently found in remaining higher quality habitats with their uncommon status resulting from habitat loss or degradation. The loss of habitats that retain a larger diversity and unique species constitutes a greater impact (Cable et al., 1989). However, diversity by itself does not necessarily provide information on specific environmental stress. A high diversity may simply indicate a large number of species that are urban-oriented or edge species which are adapted to fragmented landscapes (Loman and Von Shantz, 1991). It is necessary to examine the details of the types of species that constitute the diversity. These can be considered as groups of indicator species or response guilds (Croonquist and Brooks, 1991) that are representative of a particular use, ecosystem, or management concern and changes in the population of these species will reflect the effects of management decisions (Soule and Kohm, 1989).

In this study, avian species have been used to measure the effects of fragmentation and disturbance. Cable et al. (1989) recommends the use of birds in habitat assessment because relative to other taxa, they are conspicuous, easy to identify, and they occur in nearly every habitat type, thereby minimizing field time. Several avian groups of indicators have been selected including raptors, cavity nesters and neo-tropical migrants. Raptors occupy the end positions of the food chain and thus are good indicators of disturbance. Also some species have habitat-specific nesting and foraging requirements such as the Red-shouldered hawk (*Buteo lineatus*) that are quite dependent on the landscape pattern (Bosakowski et al., 1992). The presence of cavity nesters provides an indication of the availability of dead wood or snags that are available for nest sites, foraging and perching platforms (Schreiber and deCalesta, 1992). As a forest matures and reaches the stage of "old growth" the presence of cavities in older trees and snags increases and therefore, this stage in forest growth should be considered as an important component in the management of forest ecosystems. Neo-tropical migrants are threatened both by the loss of their winter habitat in the tropics as well as the decline of suitable breeding sites in Ontario. Many of these species are dependent on large tracts of interior forest for successful breeding and are considered as area-sensitive. The fragmentation of forest cover into smaller woodlots is a possible cause of their declining breeding success.

Site Description and Research Methodology

The sites investigated include the Black River, Uxbridge Brook and Milne Park wildland/wetland complexes. The first two sites are in the Lake Simcoe basin on the north slope of the Oak Ridges moraine and the latter is found in the upper Rouge River system on the south slope of the moraine (Figure 1 shows the relative position of each site within the GTA). Each has a ponding or small lake either from man-made or natural riverine origin causing a significant impoundment of long-term presence.

These riverine/lake systems are experiencing varying levels of pressure from human activity, forming a continuum of disturbance allowing for the comparative analysis and establishment of baseline values. Although it is difficult to establish a natural baseline measurement to compare sites to the previously unaltered landscape, especially in this area of Southern Ontario, the Black River site is a good example of a relatively undisturbed forested riparian landscape, one of the few remaining in the GTA. This area is a dynamic natural wetland/wildland complex at the confluence of two small riverine systems. The area is particularly unusual in the GTA in that it is relatively unaccessible and has virtually no development on the shores of the river and much of the area around. However, some modest development pressures are increasing resulting in the fragmentation of the landscape from agriculture and urban influences. This site has relatively large sections of forest interior dissected in several locations by agricultural fields. The general pattern of this fragmentation is presented in Figure 2.

The Uxbridge Brook site, similar to the Black River in size and location, is a riparian system draining from the Oak Ridge Moraine northward to Lake Simcoe. The river has moderate wetland development at both ends of a natural lake basin. It is a rural site that is experiencing increasing disturbance from residential/cottage development around the lake and the establishment of a subdivision on the southeast uplands. The majority of the forest cover has been selectively removed for cottage lots and while there is still a complete tree canopy in places, the forest system has been for the most part replaced.

Finally, Milne Park, part of the Rouge River system, is found close to Toronto, within the urban community of the Town of Markham, and is situated in an area of extensive development. The pond is man-made and suffers greater disturbance than the other sites from the surrounding population centres and the use of the area for recreation. There are small pockets of forest remaining in the park but these only fringe the river and do not provide a continuous cover. There has been extensive removal of tree species and replacement with lawn and individual plantings typical of an urban park setting.

The status of the breeding birds for each site was determined over two seasons, 1992 and 1993, commencing in late May until mid-August. The species type, population size and breeding success was measured as well as species behaviour and their spatial utilization of the landscape, the movement of species within and between landscape units for various functions such as breeding and foraging. The initial results of species diversity, uniqueness and indicator groups will be presented in this report while behaviour and spatial patterns will be addressed in a later paper.

The sites were sampled primarily in the early morning when the majority of species were most active, from 6:00 until 11:00 am. However, every fourth sample period was scheduled in the evening, from 2:00 until 9:00 pm., to include those species more common at this time, such as Common nighthawk (*Chordeiles minor*). Approximately equal field hours, by foot and canoe, were conducted at all sites, with 100 hours of field time by a team of two at each site during each season.

The limited area of the study sites and size of the research team made it possible to cover all of one site during a research period and because of the fragmented nature of the sites, it was decided to sample the entire site rather than to limit the research to sample plots. This ensured that all unique and indicator species would be identified and that fragmented landscape components, that were smaller than a standard research plot, would not be ignored.

Results

Uniqueness and Rare Species

As mentioned, there are several levels at which the rarity of species are recognized. In Table 1, species rarity was considered at the national (Committee on the Status of Endangered Wildlife in Canada or COSEWIC), provincial (Ontario Rare Breeding Bird Project or ORBBP) and regional level (eg. Lake Simcoe Regional Conservation Authority (LSCRA) and Metro Toronto Regional Conservation Authority (MTRCA)). The greatest number of rare species was found at Black River and the lowest at Milne Park, showing a decline from the least to most disturbed site. At Black River, there was breeding evidence of Red-shouldered hawk, Least bittern (*Ixobrychus exilis*), and sightings of Eastern bluebird (*Sialis sialis*) and Cooper's hawk (*Accipiter cooperii*) all listed as vulnerable by COSEWIC (Cadman et al., 1987). There are also sightings and historical records (Harpley and Pollock, 1991) of Sedge wren (*Cistothorus platensis*), Hooded merganser (*Lophodytes cuclullatus*), and Caspian tern (*Sterna caspia*) recognized as rare by the LSCRA.

At Uxbridge Brook, there were only several unique species observed. These included breeding evidence of Red-shouldered hawk and sightings of Caspian tern and Black-crowned night heron (*Nycticorax nycticorax*), the latter is recognized as rare by the LSCRA. The only sighting of a nationally rare species at Milne Park was Caspian tern, although there were sightings of Great egret (*Casmerodius albus*) and Black tern (*Chlidonias niger*), both recognized

as rare by the MTRCA.

Diversity

The preliminary results indicate that the diversity of breeding birds is inversely related to the level of human disturbance, habitat loss and fragmentation. A comparison of species diversity, compiled over the two seasons, for the three sites is presented in Table 1. Black River, with more forest cover and less human activity, had the greatest avian diversity with 92 species recorded. Uxbridge Brook had a lower number identified (73 species) and the lowest diversity was found at Milne Park with 57 species identified. Especially noteworthy at this site are the lack of species sensitive to environmental stress.

TABLE 1
LOCATION AND NUMBERS OF RARE BIRDS AND SPECIES DIVERSITY

Common Name	Scientific Name	Location		
		Black River	Uxbridge Brook	Milne Park
Hooded Merganser [a]	*Lophodytes culcullatus*	1	-	-
Caspian Tern [abc]	*Sterna caspia*	2	2	3
Black Tern [bc]	*Chlidonias niger*	-	-	4
Great Egret [b]	*Casmerodius albus*	-	-	1
Least Bittern [abc]	*Ixobrychus exilis*	1	-	-
Red-shouldered Hawk [abc]	*Buteo lineatus*	1	1	-
Sedge Wren [c]	*Cistothorus platensis*	2	-	-
Total Diversity		92	73	57

a Committee on the Status of Endangered Wildlife in Canada
b Ontario Rare Breeding Bird Project
c Lake Simcoe Regional Conservation Authority/Metro Toronto Regional Conservation Authority

Indicator Groups

Raptors

There were a greater number of species of raptors found at the Black River site (a total of six species) than the other two sites although there were similar numbers at Uxbridge (five) (see Table 2). At Milne Park only Sharp-shinned hawk (*Accipiter striatus*) and Osprey (*Pandion haliaetus*)were observed. The other sites had records of Broad-winged hawk (*Buteo platypterus*), Red-tailed hawk (*Buteo jamaicensis*), Red-shouldered hawk, Osprey and Sharp-

shinned hawk and there were also sightings of Northern harrier (*Circus cyaneus*) at Black River.

The presence of Red-shouldered hawk supports the findings of Bosakowski et al. (1992) who observed that the species nests in areas of larger wetlands and closer to streams in forest areas with a greater proportion of coniferous and mixed forest which is typical of the Black River and Uxbridge Brook sites. Their findings also suggest that the species is area-sensitive.

TABLE 2
LOCATION AND POPULATION OF RAPTORS

Common Name	Scientific Name	Location		
		Black River	Uxbridge Brook	Milne Park
Sharp-shinned Hawk	*Accipiter striatus*	3	2	2
Northern Harrier	*Circus cyaneus*	2	-	-
Broad-winged Hawk	*Butei platypterus*	1	2	-
Red-tailed Hawk	*Buteo jamaicensis*	2	2	-
Osprey	*Pandion Haliaetus*	3	2	2
Turkey Vulture	*Cathartes aura*	2	-	-
American Kestrel	*Falco sparverius*	1	1	-

Cavity Nesters

Table 3 indicates that similar species of cavity nesters were observed at all sites, indicating a high presence and availability of cavities and snags. There are higher populations of most species at Black River, especially those more sensitive to disturbance, Wood duck (*Aix sponsa*), and fragmentation, Great crested flycatcher (*Myiarchus crintus*). Urban-related species such as the Downy woodpecker had similar populations throughout.

TABLE 3
LOCATION AND POPULATION OF CAVITY NESTERS

Common Name	Scientific Name	Location		
		Black River	Uxbridge Brook	Milne Park
Wood Duck	*Aix sponsa*	10	2	3
Yellow-shafted Flicker	*Colaptes auratus*	10	7	4
Downy Woodpecker	*Picoides pubescens*	3	4	2

TABLE 3

LOCATION AND POPULATION OF CAVITY NESTERS

Common Name	Scientific Name	Location		
		Black River	Uxbridge Brook	Milne Park
Hairy Woodpecker	*Picoides villosus*	1	0	2
Great Crested Flycatcher	*Myiarchus crinitus*	12	7	5
Tree Swallow	*Iridoprocne bicolor*	31	21	5

Neo-Tropical Migrants

Although there were many species found at the sites that could be included in this category, a small group of species have been compiled in Table 4 as a representative sample to highlight trends between sites. From the table, it is obvious that the number of species and their populations were lowest at Milne Park and greatest at Black River. Species such as Veery (*Catharus fuscescens*), Wood thrush (*Hylocichla mustelina*) and Scarlet tanager (*Piranga olivacea*) were not recorded during the two years at Milne Park. Other species, not listed in Table 4, that were also not found at Milne Park but did occur at the less-disturbed sites included Chestnut-sided warbler (*Dendroica pensylvanica*), Golden-winged warbler (*Vermivora chrysoptera*) and Alder flycatcher (*Empidonax alnorum*). Ovenbird (*Seiurus aurocapillus*), Wood thrush and Veery, had the greatest populations at Black River. These species are forest floor nesters, preferring sites of undisturbed forest interior which are more common at the Black River site.

TABLE 4

LOCATION AND POPULATION OF NEO-TROPICAL MIGRANTS

Common Name	Scientific Name	Location		
		Black River	Uxbridge Brook	Milne Park
Eastern Pewee	*Contopus virens*	6	6	2
Scarlet Tanager	*Piranga olivacea*	2	0	0
Veery	*Catharus fuscenscens*	9	2	0
Wood Thrush	*Hylocichla mustelina*	6	4	0
Red-eyed Vireo	*Vireo olivaceus*	9	4	0
Ovenbird	*Seiurus aurocapillus*	22	12	5

Discussion

For each of the avian measures there was an increase in values from the most fragmented and disturbed site, Milne Park, to the least, Black River. The number of rarities was higher at Black River, the diversity was almost double and for each indicator group, raptors, cavity nesters and neo-tropical migrants, the numbers and populations of species were greater. These results combine to highlight the impact that human activity and fragmentation has had on these sites. Milne Park, experiencing the pressures of urban development and recreation, has the lowest values, especially those of the indicator groups, emphasizing the environmental stress on the faunal component of the landscape at this site.

Uxbridge Brook, which could be considered as a transition site, with respect to disturbance, had values that were continually between the other two sites. Specifically, the numbers for raptors and cavity nesters were similar to those at Black River but the neo-tropical migrants were lower. This indicates that the main stress on this site is the loss of forest interior. The preservation of the older trees in the cottage residential area provides cavity sites while the surrounding agricultural fields and riverine forests provide sites for raptors but the removal of the forest and its increased fragmentation has reduced those species dependent on this habitat.

The results emphasize the importance of the Black River site and its usefulness as a baseline for avian breeding information. The second phase of this project will be to relate species behaviour of the indicator groups and rare species with their spatial use of the landscape. This information will be used to develop a rehabilitation strategy for the Black River complex to maintain and enhance the health of this landscape system.

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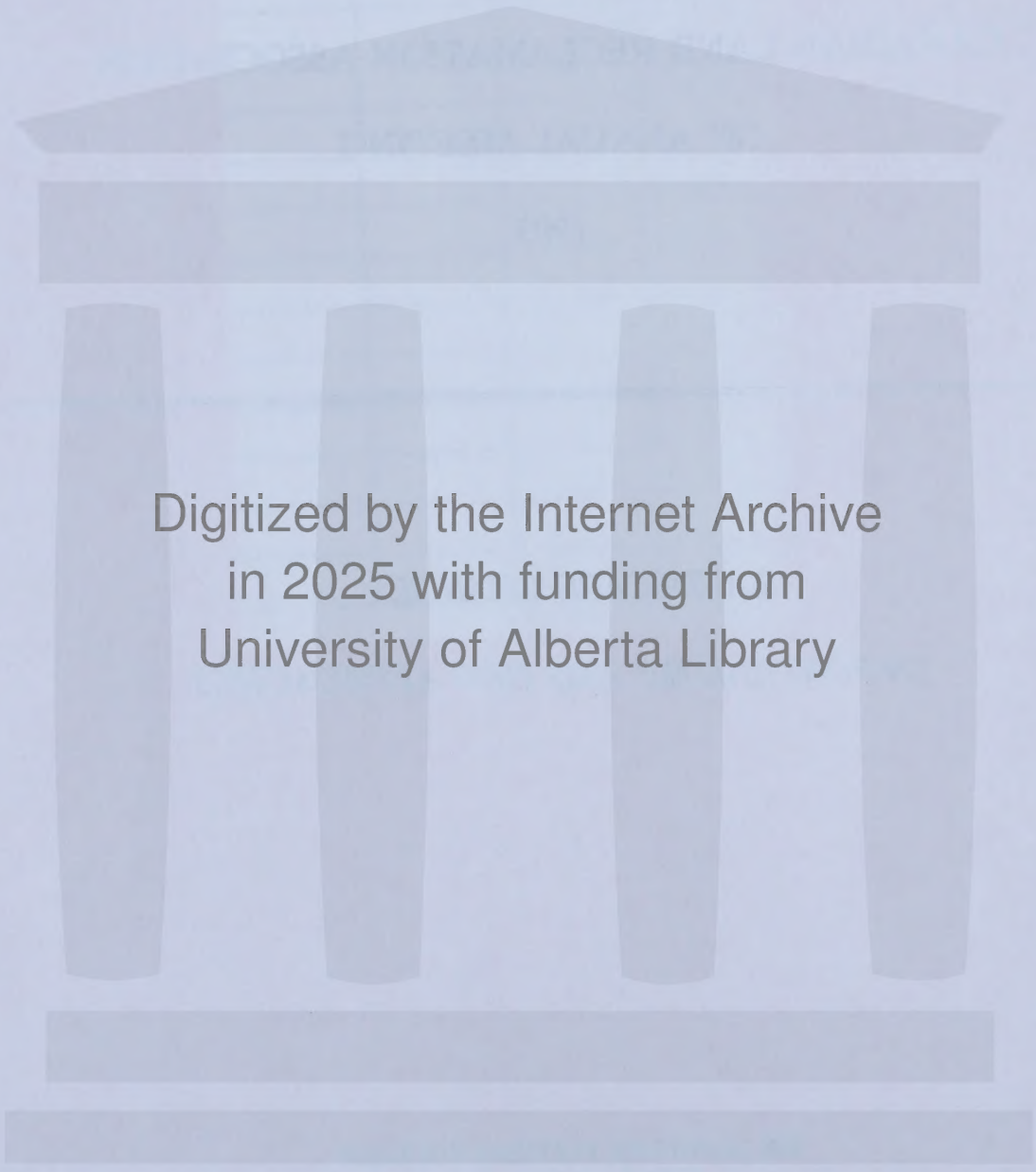

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