Landscape Features and Characteristics of Great Gray Owl (Strix nebulosa) Nests in Fragmented Landscapes of Central Alberta

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Abstract.—Forest fragmentation through timber harvesting, agricultural clearing, and other industrial activities is increasing on the Canadian landscape. This study was conducted in order to gain an understanding of habitat requirements for breeding Great Gray Owls (Strix nebulosa) in the forest fragments of central Alberta. I examined landscape and nest site characteristics around Great Gray Owl nests in these fragmented landscapes. Data were collected by owl banders who surveyed the study area by vehicle. When a Great Gray Owl was observed, the forest patch was searched until a nest site was located. Information on nest tree, vegetation, and nest type was recorded to identify basic characteristics of the forest fragment containing the nest. Using aerial photographs and a digital planimeter, the size of the forested fragments, the edge/area ratio, the distance from the nearest forest patch and the percent of forested land in a 1.15 km radius circle were measured. Similar information was collected from randomly selected areas to determine general habitat availability. Of 19 nests studied, all were located in mixed-wood forests; 17 nests were stick nests; two were in stumps. All nests were located in poplar trees (Populus spp.). Of the available habitat, there was a trend for owls to be located in larger forest patches, areas with a greater percent of forested area in the home range, and forest patches with less edge in relation to area. Although forest edge is an important component of Great Gray Owl habitat, it is evident that the amount of forested area adjacent to the edge is equally as important for the nesting of this species.

Industrial forest harvesting, clearing of forested land for agricultural purposes, and oil and gas exploration are activities that contribute to increasing the amount of fragmentation in Canada's boreal forest. Apart from the obvious structural change in the forest, very little is known about the avian communities that inhabit these newly created fragments and residual forest patches.

Studies have been conducted for owl species in fragmented landscapes (Redpath 1995); however, few projects have looked specifically at Great Gray Owl (Strix nebulosa) biology in fragmented northern forests. It is known that Great Gray Owls tend to nest in older, mixed-wood forests of Alberta (Oeming 1955); however, the landscape features of the nesting area are not well described. Several studies have suggested that certain features such as bogs and wetter areas are often associated with Great Gray Owls in the boreal forests of Canada (Duncan 1992, Harris 1984, Nero 1984), but this habitat association has never been documented in Alberta.

My objective was to summarize information obtained from several years of owl banding in Alberta, to characterize landscape features of owls in fragmented forests. The aims of this study were:

- *To determine the minimum patch size used by Great Gray Owls in Central Alberta.*

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- To measure landscape characteristics surrounding Great Gray Owl nesting areas.
- To test whether or not edge plays a significant role in habitat selection by Great Gray Owls.
- To identify the characteristics of Great Gray Owl nests in Alberta (forest type, nesting tree utilized, nest type).
- To measure the reproductive success of Great Gray Owls breeding in landscapes fragmented by agriculture.

METHODS

The data used in this study were obtained from the Alberta Natural Resources Service, incorporating Great Gray Owl nesting records that were recorded by banders in central Alberta between 1990 and 1995. The banders (Ray Cromie and Trevor Roper) annually conduct raptor surveys to locate hawk and owl nests, and compile this information for the Alberta Natural Resources Service.

The survey technique used by the banders to obtain this data involved driving along selected roads until a Great Gray Owl was observed. The roads were selected based upon their proximity to patches of fragmented forest. There was a selection bias towards older mixed-wood stands, as the banders preferred to survey roads adjacent to patches of older mixed-wood forests. The roads were driven between 1 to 15 times, with an average of 10 times for each road. Over 3,000 km were traveled between January and March each year. Roads in the survey were concentrated around Fort Saskatchewan, but covered areas as far north as Smith, as far south as Rocky Mountain House, as far east as Edson, and as far west as Lamont. All of the roads were located in central Alberta.

The survey area encompassed a variety of different agriculturally fragmented landscapes. These landscapes typically contained remnant patches of forests, scattered among cleared fields (used for grazing and agricultural crops) and towns. The forest patches in the area were largely composed of boreal forest vegetation, including Picea mariana (black spruce), Picea glauca (white spruce), Populus balsamifera (balsam poplar), and Populus tremuloides (trembling aspen) as the dominant tree species.

When an owl was observed, its location was recorded on a map. If an owl, or a pair of owls, was detected at the same location more than once, or if an owl or pair of owls was recorded near a forest patch in March, the forest patch was searched intensively until a nest site was located. When a nest was found, its location was marked on a map and basic nest information (including legal land location, nest type, and nesting tree) was recorded. Nests were revisited to determine the reproductive success (determined by the number of chicks successfully reared to banding age).

Using aerial photographs of the nest areas, information was collected on landscape characteristics. The size of the woodland patch in which the nest was located was determined by tracing this patch with a digital planimeter (PLANIX 7, Tamaya & Company Ltd). Any barrier (road, water, buildings, clearing) was considered to be an obstruction to the forest, and the patch measurement did not extend beyond those barriers. To measure the amount of edge in relation to the size of the forest patch, the perimeter of the nest patch was measured and divided by the area of the patch. This was recorded as the edge/area ratio. The stand type was also interpreted from the aerial photograph as mixed-wood (a forest containing both Picea spp. and Populus spp.), pure coniferous (a forest consisting mostly of Picea spp.), or pure deciduous (a forest consisting mostly of Populus spp.) by using a stereoscope. An estimate of tree density within the stand was also estimated as less than 25 percent, 26-50 percent, 51-75 percent, or greater than 75 percent.

Other landscape characteristics were studied by looking at land features found within a 1.15 km radius of the center of the nest patch. A 1.15 km radius was selected based upon a description by Craighead and Craighead (1956) which suggested that Great Gray Owls travel over an area that can be as large as a circle 2.3 km diameter around the nest. Although this maximum range size from the Wyoming area is rather large, it is likely to be appropriate for the boreal forest of Alberta, as other northern owls (such as the Barred Owl, Strix varia) have been noted to have larger range sizes in Canada (James et al. 1995). Within this radius of the nest, the following features were recorded: number of other forest patches, sizes of other

patches, proximity of other patches to the nest patch, and percentages of different land types (agriculturally cleared land, forested land, oil and gas, bogs, bare soil).

To compare the Great Gray Owl nest site locations with the available habitat, forest patches were selected randomly along the banders' transect routes. This was done by laying a numbered grid over the aerial photographs and using a randomly generated number to select a forest patch. The same data were collected for the nest patches.

The forest type and vegetation density of patches containing nests were compared to available habitat using a G-randomization test. The other landscape variables were compared using the Mann-Whitney U test. The values for edge/area ratio were tested for their correlation with the percent of forest in the home range by pairing the nest site values with the available habitat values that had the same percentage forest in the home range (Wilcoxon signed rank test). Non-parametric tests were used because of the non-normal distribution of the data.

RESULTS AND DISCUSSION

Landscape Features Associated with Great Gray Owl Nests

Bogs, oil and gas development, water, and buildings were detected at very low frequencies in the radius of both the nest sites and the randomly selected areas and were therefore not tested for in the statistical analysis. Studies of Great Gray Owl habitat in Manitoba (Duncan 1992, Nero 1980) and Saskatchewan (Harris 1984) have shown an apparent preference for nesting sites adjacent to muskeg or bog areas. No apparent association between Great Gray Owl nests and bogs or muskegs was found in central Alberta study area. This could be explained by the bias towards surveying mixed-wood stands; however, it is important to note that few bogs and muskegs were recorded in the available habitat (bogs were only detected in three of the randomly selected areas, and in these areas, composed less than 10 percent of the landscape). A more likely explanation is that bogs and muskegs were not associated with Great Gray Owl nests in central Alberta because they were not available in the area.

A possible theory that could explain why owls may be found near muskegs in some Canadian landscapes and in mixed-wood forests in other areas (such as in central Alberta) is the fact that Great Gray Owls require clearings for foraging. These clearings often can appear in the form of low growing shrubs (as seen in a muskeg) or in the form of grassy agriculturally cleared fields. The documented dependency of Great Gray Owls on muskegs may be overly specific. A more correct statement would be that Great Gray Owls are dependent upon clearings, which contain available small prey.

Numerous studies indicate that many owls are dependent upon prey availability for their continued survival and reproductive success (Adamick et al. 1978, Korpimaki 1984). The Great Gray Owl is no exception. Mice and voles make up a very large portion of the Great Gray Owl's diet (Bull et al. 1989a, Duncan 1992, Mikkola 1983, Oeming 1955). The habitat requirements of the common voles in Alberta (such as Microtus pennsylvanicus) are open, grassy meadows (Smith 1993). This explains why, in Alberta, nests of the Great Gray Owl are located in close proximity to clearings such as a grassy field created through agricultural fragmentation.

The size of the forest patch in which Great Gray Owl nests were located was significantly larger in size when compared to the available patches (table 1). In the areas where Great Gray Owls were found to occur, there were also significantly greater amounts of forested area, and larger forest patches adjacent to the actual nesting patch (table 1). In the agriculturally fragmented landscapes of central Alberta, Great Gray Owls appear to be found more frequently in larger patches of forest, surrounded by other forest patches. This is consistent with Great Gray Owls in Oregon, where nest sites were always located in forested areas (Bull and Henjum 1990).

Forest Edge

There was a trend for owls to be located in areas with lower edge/area ratios ($P = 0.06$, table 1). To isolate the effect of edge from overall amount of forest cover, edge/area of forest cover ratios for nest sites were paired with randomly selected areas of the same percentage forest cover. There was no significant difference (Wilcoxon; $n = 17$, $z = -0.355$, $P = 0.72$). This would indicate that the edge/area is highly correlated with the percentage of forest cover.

Table 1.—Summary statistics of landscape features for forest patches containing Great Gray Owl (Strix nebulosa) nests and available habitat throughout the study area in central Alberta. Descriptive statistics (sample size, median, and range) are listed for each variable. Mann-Whitney tests were performed on the variables, and the results indicate that forest patch size, size of nearest forest patch, and percent of forested land in the owl's range were significantly different for the owl nest sites when compared with the available habitat (significance at P < 0.05).

	Nest patch		Available habitat			
Variable	**N**	**Median (Range)**	**N**	**Median (Range)**	**U test statistic**	**P-value**
Forest patch size (ha)	19	29.6 (10.8-119.7)	38	17.8 (1.0-233.0)	482.5	0.04
Edge/area ratio for forest patches	19	81.7 (38.4-255.6)	38	107.4 (25.4-500.0)	250	0.06
Size of nearest forest patch (ha)	19	25.6 (5.6-280)	38	19.8 (0.0-145.0)	475.5	0.05
Distance from nearest forest patch (m)	19	40 (15.0-330.0)	35	40 (15.0-2580.0)	263	0.2
Percent of forested area in the home range	19	55 (17.0-95.0)	38	32.5 (5.0-90.0)	494.5	0.02

Great Gray Owls have often been considered an edge dependent species, as they mostly hunt in open areas adjacent to forest patches (Hilden and Helo 1981, Mikkola 1983, Winter 1986). Great Gray Owls show a preference for edge environments, which allows them to hunt in the cleared environments where their microtine prey is often found. In my study, the owls all nested in a fragmented environment where there was a great deal of edge produced by agricultural fragmentation. In addition to quantitative data, Great Gray Owls were visually recorded by the owl banders to be actively foraging on the edges of forest patches. These results suggest that in a fragmented environment, there is a preference for areas with a greater amount of forest area, thus having less edge. In an agricultural landscape, it is the forested area that is in demand, not the edges. Although further studies are necessary, I would speculate that this may be the reverse in a forested landscape, where edge is in demand, not the forest.

A possible explanation for the greater use of areas with less edge by Great Gray Owls in this study is that avian predators often take advantage of edge environments. Northern goshawks (Accipiter gentilis) and Great Horned Owls (Bubo virginianus) frequently prey on juvenile Great Gray Owls (Duncan 1987, Nero 1980). Logically, it would be to the benefit of the Great Gray Owl to select nest sites in forested areas with a minimal amount of edge.

Nest Characteristics

All of the nests were found in mixed-wood forests (N = 19), which was significantly different from the available habitat (68 per cent mixed-wood, 18 percent pure coniferous, and 13.2 percent pure deciduous; G_{ran} = 11.27, P = 0.002). This observation is consistent with Oeming (1955), where mixed-wood poplar stands were noted to be the dominant forest type used by Great Gray Owls in Alberta.

All of the nests were located in poplar trees (Populus spp.), with 17 out of 19 nests in P. tremuloides and two in P. balsamifera. Of these 19 nest trees three were dead, and one was dead with a broken top, the rest of the trees were live (table 2). Of all nests, 17 were in stick nests and two were on stump nests (a nest located on the tree with a broken top).

Table 2.—Summary of information collected on 19 Great Gray Owl (Strix nebulosa) nest sites in central Alberta from 1990-1995. The maximum, minimum, and mean number of chicks produced are summarized at the bottom of the table.

Nest number	Nest tree *	Nest type	Chicks fledged
			Number
1	Bp	stick nest	2
2	Pt	stick nest	2
3	Pt	stick nest	3
4	Pt	stick nest	3
5	Pt	stick nest	3
6	Bp(broken top)	stick nest	3
7	Pt	stick nest	2
8	Pt	stick nest	2
9	Pt(dead)	stump nest	3
10	Pt	stick nest	2
11	Pt	stick nest	1
12	Pt	stick nest	3
13	Pt	stick nest	1
14	Pt(dead)	stump nest	3
15	Pt	stick nest	2
16	Pt(dead)	stick nest	3
17	Pt	stick nest	1
18	Pt	stick nest	2
19	Pt	stick nest	2
		Maximum	3
		Minimum	1
		Mean	2.26

* Two nest tree species were noted:
Bp - *Populus balsamifera*
Pt - *Populus tremuloides*

Tree density in the nest patches used by owls was greater than in the available landscape. All of the nests (N = 19) were found in forests with tree densities greater than 50 percent (31.6 percent were in forests of 51-75 percent densities, 68.4 percent were in forests of 76-100 percent densities), which was significantly different from the available habitat (26.3 percent in forest densities of 26-50 per cent, 31.6 percent in densities of 51-75 per cent, 42.1 percent in forests with densities of 76-100 percent; $G_{ran} = 9.756$, $P = 0.01$). In general, owls were often located in relatively dense mixed-wood stands which contained poplar trees with stick nests, stumps, or cavities suitable for nesting.

Reproductive Success

All 19 of the owl nests sampled produced young. The mean number of young fledged per nest was 2.3 (SD = 0.75), with a maximum of three chicks, and a minimum of one chick (table 2). This is consistent with studies in Oregon which had a mean number of young per successful nest of 2.3 (Bull et al. 1989b), and Finland which had 2.4 (Mikkola 1983). Reproductive success (as measured by the number of chicks fledged per nest) of Great Gray Owls in the agriculturally fragmented landscape of central Alberta does not seem to be measurably different from populations described elsewhere.

CONCLUSION

The effects of forest fragmentation on raptor species is poorly researched. Great Gray Owls are a species which require open areas for foraging, and thus forest fragmentation is seemingly a necessary landscape feature for this animal. However, in fragmented landscapes (such as central Alberta) the amount of edge available for foraging may not be as important as the amount of forested area available for nesting. As fragmentation of forests continues (e.g., by agricultural and timber industries), it will be increasingly important to ensure that mature forest patches are retained in the landscape for nesting of species such as the Great Gray Owl.

The status of the Great Gray Owl across North America is uncertain due to the lack of knowledge pertaining to this species (Hayward 1994). In Alberta, increasing pressure is being placed on forest raptors due to intense forest harvesting in the boreal forest. Industrial forest companies are attempting to manage forests based on ecological and wildlife principals (Weldwood 1990, Alberta Pacific Forest Products 1995), but without baseline biological data on key species such as the Great Gray Owl, it will be difficult to successfully implement and monitor management strategies. To conserve species such as the Great Gray Owl, a greater knowledge base must exist for this species. To maintain the species native to the boreal forests of North America, it will be essential for forest managers and researchers to share ideas and work together to implement management

plans. Monitoring the long-term effects of different fragmentation patterns on wildlife species is a critical aspect of forest planning, if ecological and wildlife components are to be maintained.

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