DISTRIBUTION AND RELATIVE ABUNDANCES OF BIRDS OF PREY IN DIFFERENT HABITATS IN THE WESTERN NEWFOUNDLAND MODEL FOREST

John W. Gosse and William A. Montevecchi

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Abstract

The main objective of the project was the collection of data on the diversity, abundance, and distribution of raptors in different aged balsam fir forest in the Western Newfoundland Model Forest (WNMF). The study was concentrated around in the old growth forests around Little Grand Lake, though surveys were also conducted at sites near Deer Lake, Cook's Pond, George's Lake, Gallants, and Stephenville Crossing. Raptor survey routes were established along forest access roads passing through different habitat types. These ranged from clearcuts (0-10 yr) in 1993 and 1994, silviculturally thinned areas (10-20 yr) in 1993, second growth forests (40-60 yr) and uncut old growth balsam fir forests in both years. Between 15 May and 11 August 1993, and 1 June to 14 August 1994, efforts were made to develop standardized study and survey methods, as well as to record habitat, feeding ecology and natural history data from birds of prey. Surveys involving playbacks of raptor vocalizations commenced at about 0600h for diurnal raptors and at about 2200h for nocturnal ones. Playbacks were made at 800 m intervals along forest roads. Raptors were detected by using playback vocalizations and by coincidental encounters. Nine species of raptors were recorded in the study area: Sharp-shinned Hawk (*Accipiter striatus*), Northern Goshawk (*Accipiter gentilis*), Rough-legged Hawk (*Buteo lagopus*), Osprey (*Pandion haliaetus*), Merlin (*Falco columbarius*), American Kestrel (*Falco sparverius*), Boreal Owl (*Aegolius funereus*), Great Horned Owl (*Bubo virginianus*) and Northern Hawk-Owl (*Surnia ulula*). Rough-legged Hawks, Ospreys, and Merlins were the most frequently sighted species. Results seem to support contentions that Northern Goshawks, Sharp-shinned Hawks and Boreal Owls inhabit old growth forests. Furthermore, old growth forests appear to contain a greater diversity of raptors than other habitat types. Rough-legged Hawks, mainly a tundra dwelling species, may have utilized clearcut areas for hunting. Merlins were sighted in all habitat types except old growth forests. Results from habitat mensuration will provide insight as to the specific habitat requirements of birds of prey within the Model Forest. Information on small mammal population dynamics for 1994 suggest that populations drastically declined (B.Adair, B.Sturtevant, pers. comm.) A dietary analysis of Sharp-shinned Hawk (*Accipiter striatus)* prey showed that the main prey evident at plucking posts were thrushes and warblers.

Introduction

Study of the distribution of birds of prey in different-aged forests within western Newfoundland is an important component of understanding wildlife and forestry interactions. Preservation of top level carnivores offer direct and incisive means with which to understand and maintain biodiversity in terrestrial ecosystems (e.g. Soule and Wilcox 1980; Frankel and Soule 1981). Raptors are vulnerable to both natural and human-induced perturbation (e.g. Poole 1989) and thus are valuable indicator species within boreal forest ecosystems. Throughout much of North America, habitat fragmentation has led to a general decline in the populations of forest raptors. More vulnerable species may include those that have narrow ecological tolerances, particularly if dependent on older seral stages, such as Northern Goshawks and Spotted Owls (see McCarthy *et. al.*). Conversely, other raptor species that prefer open or edge habitats (i.e. American Kestrels and Northern Hawk-Owls) may benefit from forest fragmentation.

Many factors interact to determine the populations and communities of raptors in any habitat. These vary from climate and vegetation to human alteration of habitat. In this respect, actions and events which change the habitat composition of a forest (e.g. timber harvesting and forest fires) will also influence the populations and community assemblages of raptors within it. This research will hopefully provide some insight into the factors which determine these raptor communities, and allow the development of forest management strategies which take these factors into account. It should also demonstrate the significance of raptors as indicators of the environmental health of Newfoundlands forested regions.

Study Objectives

Little is known about the diversity, distribution, and habitat associations of birds of prey in Newfoundland's boreal forests. For these reasons, research objectives were aimed at basic aspects of raptor study techniques and ecology:

1. To generate effective, standardized means to census birds of prey in the WNMF.

2. To study species diversity and the relative abundances of raptors in different aged forests and clearcuts within the WNMF.

3. To gain an understanding of the spatial and temporal distributions of raptors in the WNMF.

4. To develop density and population estimates of birds of prey.

5. To identify knowledge gaps with respect to Newfoundland raptors, and in doing so to develop research objectives for future studies.

Study Area, Methods and Materials

The study area for this project during the 1993 field season theoretically encompassed the entire WNMF (Figure 1), however most of the research effort was spent in the area of Little Grand Lake within the Pine Marten Study Area (PMSA) which is protected from forest harvesting. Much of this area is old growth balsam fir forest, however there are also many areas that were clearcut during the 1980s, before timber harvesting in the area was suspended. 8 to 14 July was spent in the Cook's Pond/Serpentine River area. Of particular interest in this area were clearcuts that were treated during the autumns of 1992 and 1993 with the herbicide glyphosate. In addition to Little Grand Lake and Cook's Pond, research trips were made to sites near Deer Lake (1, 4, 5 June, 13 July), Pasadena (10, 19 July, 10 August), Victoria Lake (3-5 July), Stephenville (20 July, 2 August), Gallants (7 July), and Corner Brook (19 July). Research in 1994 was conducted almost entirely in the area from the Trans Canada Highway (TCH) east to Little Grand Lake/Marten Pond, the secondary road from the TCH west to Spruce Brook, and at Cook's Pond (see Figure 1). These sites were largely located within old growth (80+ yr), second growth (30-60 yr), and clearcut areas respectively (see figures 1-4). Silvicultured (pre-commercially thinned) areas were excluded from consideration since the total land area of this habitat type in the Western Newfoundland Model Forest is essentially negligible. Sites were also investigated at Pasadena (27 June, 17, 22 July), Deer Lake (12 July, 3 August) and at Stephenville Crossing (8-11 August). Individual survey routes established at the above locations passed through a homogeneous habitat type and routes varied in length from 4.8 kilometres to 11.2 kilometres. Survey routes were reestablished in 1994 to ensure that distances surveyed in each habitat type were comparable. The distance surveyed in old growth, second growth, and clearcut areas in 1994

were 18, 16, and 16 kms, respectively. Furthermore, an equal number of surveys were conducted in each habitat type to provide a stronger experimental design to permit valid statistical comparisons of the abundances of birds of prey associated within each of the habitat types.

Vocalization broadcast surveys were conducted following the methods of Mosher *et al.* (1990) with some minor modifications. The focal species for 1993 were the Sharp-shinned Hawk, Northern Goshawk, Merlin, Boreal Owl, and Great Horned Owl. Equipment used for playbacks included a realistic vsc-2001 cassette recorder and a set of realistic portable minimus-0.6 speakers (83 db/1m). Broadcast stops were spaced at 800 m intervals measured using a vehicle oedometer. In those areas inaccessible by truck, an all terrain vehicle was used, and stop sites were assigned using 1:50,000 scale topographic maps and personal judgement. Upon arriving at each stop on a route, the observer would listen and/or look for raptors for 1 min. A series of six 20 sec playbacks of a single species' vocalizations, separated by 30 sec silent intervals, were then made over 5 min. Three vocalization segments were broadcast toward a randomly selected side of the road followed by three broadcast segments to the opposite side. The observer would then remain at the site for an additional 5 min to listen and look for raptors. Nocturnal surveys started at about 2200 h and diurnal surveys at about 0600 h.

Results from 1993 indicate that Merlins did not respond to conspecific vocalization playbacks, however incidental sightings were recorded. Playbacks for this species were not broadcast in 1994 when focal species were the Sharp-shinned Hawk, Northern Goshawk, Boreal Owl, Great Horned Owl, and the Northern Hawk-owl. In contrast to methods followed in 1993, nocturnal surveys involved broadcasting playbacks for both Boreal and Great Horned Owls during the same night. In the three habitat types surveyed, the vocalization playback of each owl species was broadcast at every second 800 m stop along the survey route. This method was also implemented for diurnal surveys. In this instance the playbacks for any individual species were broadcast at every third 800m stop along the survey routes. This method controlled for variations in weather conditions that may otherwise influence the detectability of the different raptor species when surveys are run on successive days. When sites of high raptor activity were located (i.e. prey remains or multiple sightings) efforts were made to locate nests and plucking areas. Several techniques were attempted including vocalization playbacks, concealed observations, and ground searches.

Habitat data were collected at sites of high raptor activity, such as around nests, roosts, plucking posts, and at 50 m and 400 m corresponding control areas. Data regarding stand structure, vegetation, snags, course woody debris (CWD), and a general description of the area were collected within an 11.3 m (0.04 ha.) fixed plot (see Mosher *et. al.*, 1987). The percentage of ground cover vegetation was estimated for the entire 0.04 ha. plot. The total number of snags (DBH > 10 cm) within the plot were counted. An index of course woody debris was measured by counting the number of dead fallen trees or limbs (diameter > 4 cm) along a 22.6 m random transect through the study plot. Tree species, diameter, height, and vigour were recorded for nest trees and plucking posts. Control sites were located by taking a random compass bearing and measuring the appropriate distance from the center of the raptor site. Additional habitat analyses were carried out at each 800 m stop along the 1994 survey routes. Fifty-eight 11.3 m habitat plots were measured at a distance of 50 m from a randomly

selected side of the road. Where survey routes followed lake shorelines, habitat measurements were made at a distance of 50 m from the shoreline. Equipment used for this work included a DBH measuring tape, Suunto altimeter, 50 m measuring tape, and a compass.

Samples of food remains were collected throughout the study period. These came in two forms: 1) regurgitated pellets of indigestible prey fragments, such as bone and fur, and 2) parts discarded by raptors prior to consumption. These include fur, large feathers, beaks, and appendages. Jawbones of small mammal prey were identified using a reference collection at the Newfoundland and Labrador Wildlife Division. Birds were identified by comparing collected feathers to those in a reference collection at Memorial University of Newfoundland.

Fig. 1

Western Newfoundland Model Forest
Indicating the 3 Main Study Sites

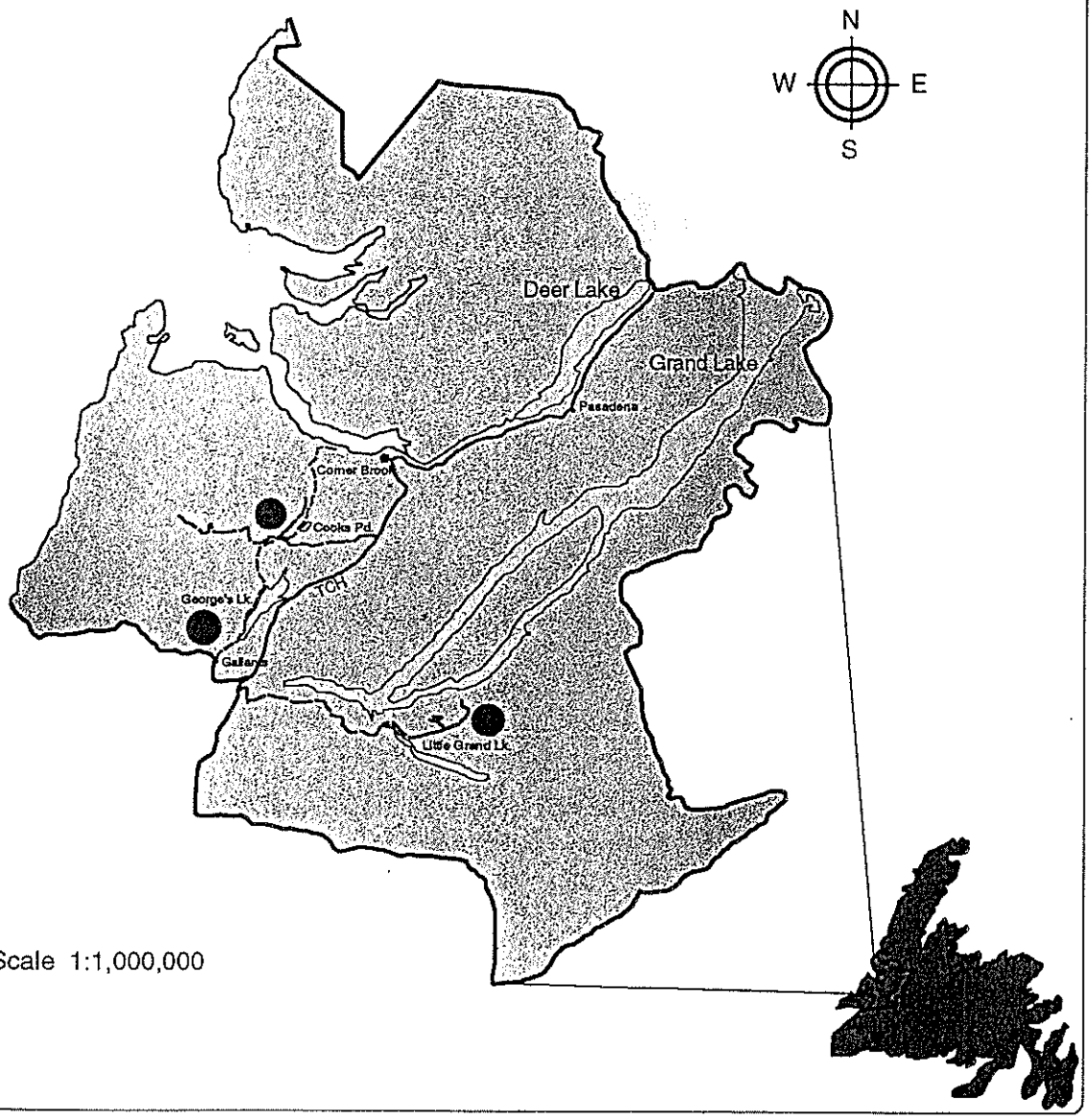


Figure 2 The Little Grand Lake study area indicating raptor survey routes 1-4. Areas of high raptor activity are depicted by bold typed letters.

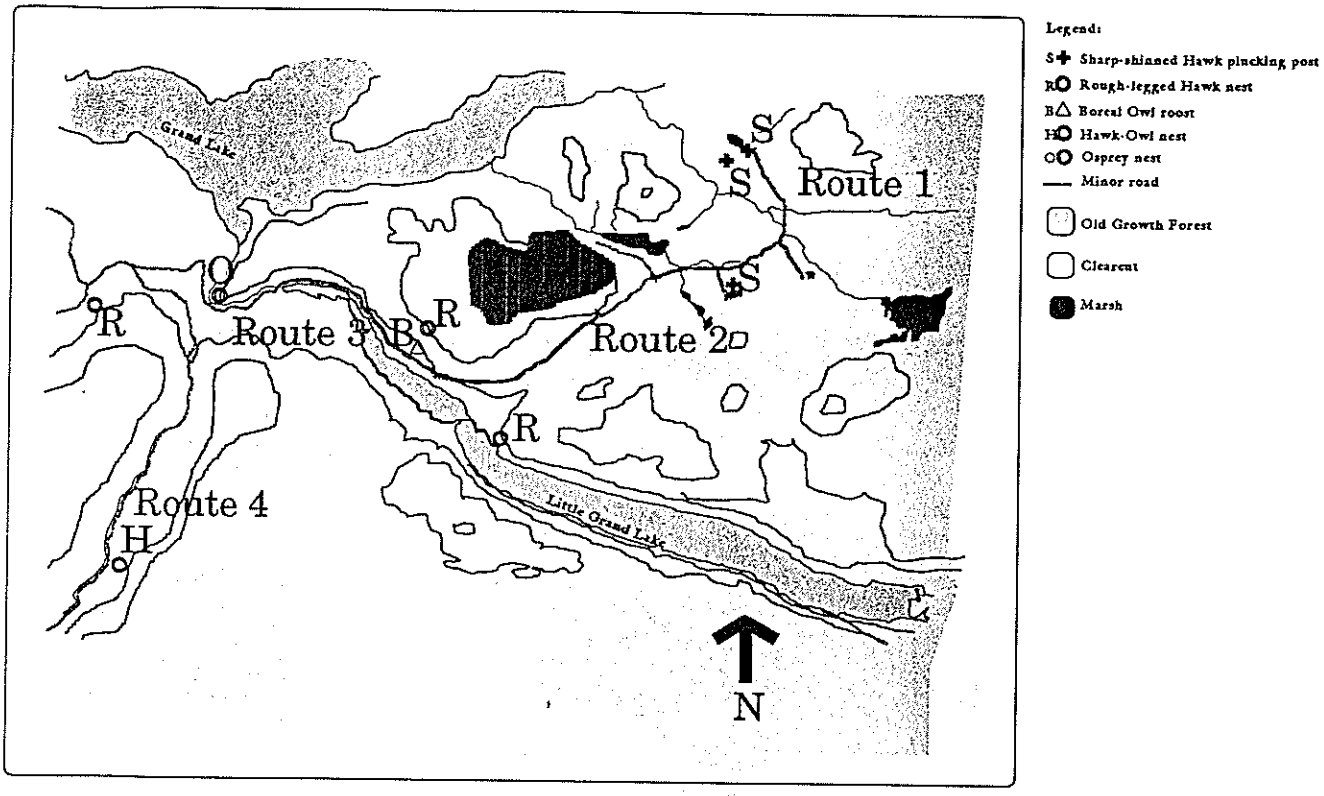
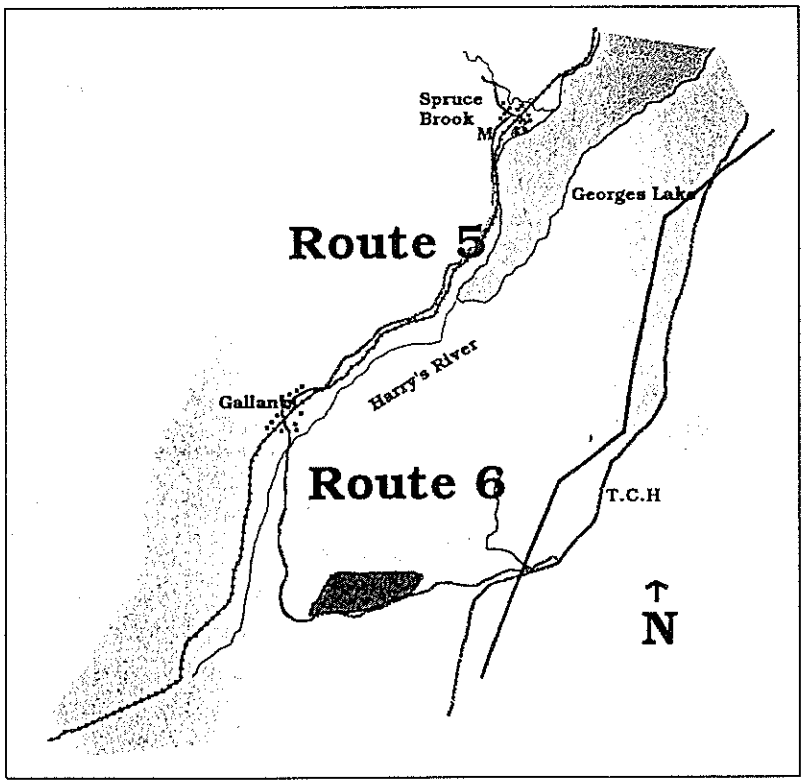


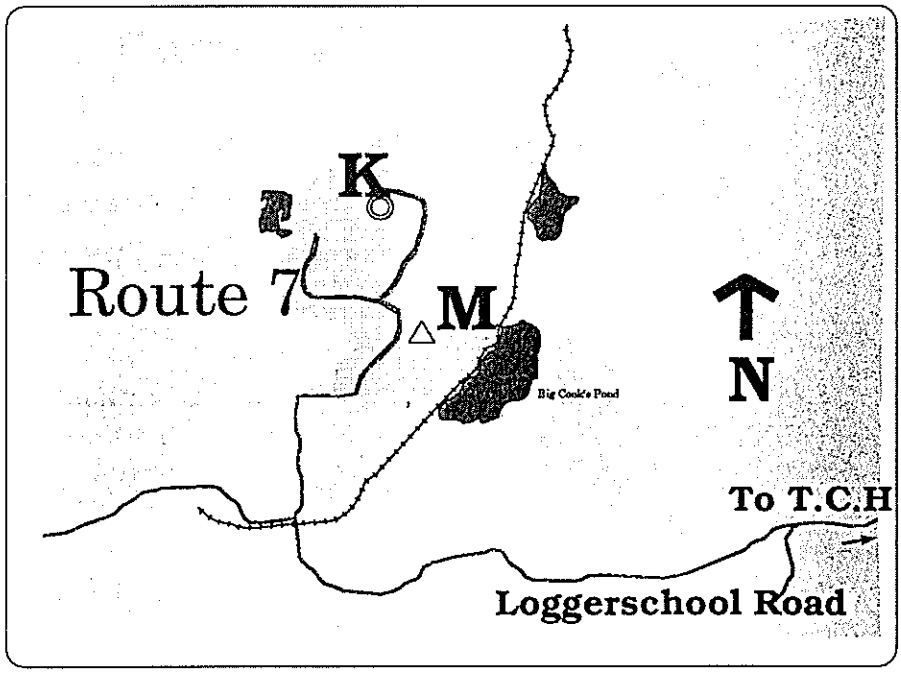
Figure 3 Raptor broadcast survey routes in second growth forests at Gallants and Spruce Brook



Legend:

- **M Merlin Nest**
- **Railway Bed**
- **Powerline**
- **Secondary road**
- **Houses/Cabins**
- **Second Growth**

Figure4. Raptor broadcast survey route in a clearcut at Cook's Pond, 1994.



Results

Broadcast Census Effectiveness

The survey methods used were not extremely successful. Most sightings were incidental, although definite responses were evoked on occasion. In 1993, only 3 of 94 raptors detected (3.2%) responded to conspecific vocalization playbacks. Two of these were by Boreal Owls and the other by a Sharp-shinned Hawk. In 1994, 9 of 105 raptors (8.6%) responded to playbacks, these were: Boreal Owls (1 occasion), Great Horned Owls (3 occasions), Hawk Owls (3 occasions), and Sharp-shinned Hawks (2 occasions). Increased success may have been attributable to improved audio equipment employed during 1994. It is notable that for each of the encounters throughout the study, a positive response to the playbacks was made during the initial 5 min of the broadcasting period.

Diversity and Abundance

Nine species of raptors were sighted between 24 May and 11 August, 1993 and 1 June to 14 August, 1994. The number of sightings for each species was determined by several factors, including relative populations in the study area, behaviour, and habitat preferences. For example, species that frequented clearcuts were more easily sighted than those which preferred wooded areas. In addition, vocal species (e.g. Rough-legged Hawks) were more easily located than quieter ones (e.g. Sharp-shinned Hawks, which are typically forest dwelling ambush predators). Finally, diurnal species were easier to detect than nocturnal species as the former can be sighted as well as detected from vocalizations. A summary of raptor sightings is listed in Table 1.

Table 1 Sightings of adult raptors in the Western Newfoundland Model Forest 1993-1994.

SPECIES	NUMBER OF SIGHTINGS (est.#individuals) 1993	1994	Total	FOREST HABITAT
Sharp-Shinned Hawk *Accipiter striatus*	13 (9)	15 (8)	28 (17)	Old second growth and uncut old growth forests
Northern Goshawk *Accipiter gentilis*	0 (0)	4 (1)	4 (1)	Uncut mature and old growth forests
Rough-legged Hawk *Buteo lagopus*	22 (18)	0 (0)	22 (18)	Open ground, clearcuts, cliff faces
Boreal Owl *Aegolius funereus*	8 (5)	1 (1)	9 (6)	Uncut mature forests and uncut old growth forests
Great Horned Owl *Bubo virginianus*	2 (2)	8 (4)	10 (6)	Old second growth forest
Northern Hawk-Owl *Surnia ulula*	10 (5)	14 (11)	24 (16)	Clearcuts
Merlin *Falco columbarius*	25 (14)	22 (16)	47 (30)	Clearcuts, old and young second growth, uncut mature and old growth forests
American Kestrel *Falco sparverius*	9 (8)	4 (4)	13 (12)	Clearcuts
Osprey *Pandion haliaetus*	5 (4)	35 (24)	40 (28)	Young second growth and uncut old growth forests near large water bodies

The habitat classifications in Table 1 are generalizations. Numbers of sightings include multiple sightings of individuals, but do not include nestlings. Table 2 reports the densities of raptors (species/ area surveyed) in different habitat type in each year. Figures are derived from the estimated number of raptors resident along survey routes. It is important to note, however, that figures may not be truly representative of second growth forests because of the low number of km surveyed. Clearcuts and commercially thinned areas had high densities of Rough-legged Hawks in 1993, American Kestrels in 1994, and Merlins for both years. Clearcuts were also selected as nesting sites by Northern Hawk Owls and American Kestrels. Neither site was extensively utilized by other species. Second growth forests at Victoria Lake in 1993 had densities of 0.1 birds/10.8 km^2 for Sharp-shinned Hawks, Great Horned Owls, and Merlins. Second growth forests surveyed near Gallants and George's Lake in 1994 had Great Horned Owl and Merlin densities of 0.13 and 0.25 birds/19.2 km^2, respectively. Results from surveys conducted in uncut old growth forests indicate that this habitat is utilized by a greater number of species than the other two habitat types. This forest type had a relatively high density of Sharp-shinned Hawks (1993 and 1994), Boreal Owls in 1993, and Merlins in 1994 (see Table 2) and also contained lower densities of Northern

edge of a stand of second growth and a gravel field cleared for cabin development. Outside of survey routes, Merlins were frequently sighted in several habitat types, including a pair inhabiting young second growht forest at Victoria Lake, a pair apparently hunting at the Stephenville airstrip, an adult in a suburban area (Pasadena), and Merlins foraging in pre-commercially thinned areas along the forest access road to Little Grand Lake. A second Merlin nest was found near the community of River of Ponds on the Northern Peninsula. The habitat surrounding this site was mainly composed of 30-50 yr black spruce and balsam fir with interspered bog patches.

American Kestrels (n=3) were sighted in a clearcut adjacent to route 7 (Cook's Pond) in both years. The nest cavity located in 1994 occurred in a large white birch snag approximately 150 m from the nearest forest edge. No nestlings were observed near the nest site. This pair was observed foraging in the surrounding clearcuts on numerous occasions. An active nest was also found in a clearcut near Deer Lake in 1993 (B. Mactavish, pers. comm.). American Kestrels were also recorded in clearcuts near Glide Lake and Copper Lake.

Nesting habitat of Ospreys at Stephenville Crossing was also investigated in 1994. No formal survey was conducted to estimate Osprey numbers in this area, however it is estimated that up to 20 pairs may be nesting in the immediate area (P. St. Croix, pers. comm.). Nesting sites based on historical records (P. St. Croix) were investigated to identify important habitat parameters. From 8 - 11 August, habitat data at 4 Osprey nests were collected. The general habitat consisted of second growth mixed forest in various succesional stages. Nests were typically erected in large spruce or white birch snags with top branches that allowed a structure for nest formation. One nest was erected at the top of a transmission pole. Several Osprey were also sighted at Little Grand Lake, George's Lake, and the Humber Valley. The nest previously occupied for the last decade at Lewaseechjeech Brook (Little Grand Lake) was apparently unoccupied in 1994.

Some data regarding the temporal distribution of raptors in the study area were collected. The Northern Hawk-Owls nesting near Deer Lake fledged 5 young on 27 June, 1993 (B. Mactavish pers. comm.). On 20 June, 1994, one nestling (two to three weeks old) was observed on a nest in a clearcut near Marten Pond and by 8 July had apparently fledged and left the natal area. At Glide Lake a pair of Hawk-Owls and one nestling were consistently sighted throughout June, 1994, and by 7 July the chick had fledged. Northern Hawk-Owls have a nestling period of 25 to 30 days and an incubation period of 25 to 30 days (Johnsgard, 1988), suggesting that egg laying began between 28 April and 8 May and that hatching occurred between 28 May and 2 June. Northern Hawk-Owls begin incubating when the first egg is laid. The 4 pairs of nesting Rough-legged Hawks observed in the area seemed to be relatively synchronous in their dates of hatching and fledging young. For the two nests in which fledging was observed, it occurred between 6 and 9 August, and hatching between 19 and 25 June. This gives a nestling period of 42 to 51 days. Johnsgard (1990) suggests that young Rough-legged Hawks do not leave the nest for at least 40 days, which compares well with our figures. Johnsgard (1990) also gives an incubation time of between 31 and 37 days, suggesting that laying occurred between 13 and 25 May. Three Merlin nestlings were first observed on the nest tree at George's Lake on 5 August, however fledging did not likely occur until one to two weeks later. Although accurate data are not available for other species, young American Kestrels nesting at Deer Lake left their nest between 13 July and 7 August, and young of both pairs of Sharp-shinned Hawks had left their nests by 26 July.

Habitat Requirements (1993)

For most species, habitat selection seemed to be as one would expect on the basis of the available literature. Work on prey species in different habitats, as well as studies of the feeding ecology of raptor species will help to better define habitat requirements. Table 3 summarizes the habitat types where different species of raptors were found.

Table 3 Habitat association of raptors in the WNMF, 1993-1994.

HABITAT TYPE	ASSOCIATED BIRDS OF PREY
CLEARCUT (0-10 yr) (also includes clearcuts treated with herbicides)	Rough-legged Hawk Northern Hawk-Owl Merlin American Kestrel
THINNED (10-20 yr)	Rough-legged Hawk Merlin
SECOND GROWTH (30-60 yr)	Sharp-shinned Hawk Great Horned Owl Merlin
UNCUT OLD GROWTH FOREST (80+ yr)	Sharp-shinned Hawk Northern Goshawk Boreal Owl Merlin Osprey

Table 4 Description of habitat variable abbreviations used in analysis of raptor nest-sites, plucking posts, roosts, and randomly selected control sites.

Habitat Variable Abbreviation	Description
Dens	Density of trees (>3 cm DBH)/0.04 ha plot
Dens<15	Density of trees <15 cm DBH
Dens>15	Density of trees >15 cm DBH
DBH	Diameter of tree at breast height
Dead	Dead merchantable and non-merchantable trees
Snags	Standing dead stems DBH>10 cm
Live	Live crown (>3 cm DBH)
CWD	Course woody debris. Includes fallen trees, limbs, and stumps.
Veg cover	Percentage ground cover of shrubs and woody plants
Bf	Balsam fir
Bs	Black spruce
Ws	White spruce
Wp	White pine
Wb	White birch
Yb	Yellow birch

Two areas of high Sharp-shinned Hawk activity were found. Both plucking areas were located in small clearings (50 x 30 m) within old balsam fir stands, where the trees were spaced at about 5 m apart and the canopy started approximately 6 m above the ground. The forest around both sites was often broken by small bogs. This seemed well suited to the hunting style of Sharp-shinned Hawks, which are ambush predators. Compared to control sites, plucking areas were characterized by fewer numbers of small (<15 cm DBH) dead balsam fir trees. There appeared to be a higher frequency of course woody debris (CWD) in the plucking areas (Table 5). In each case, after successful hunts, the birds returned to the small clearing, probably formed as a result of Hemlock Looper activity. Here the prey, usually a small bird or occasionally a rodent, was eaten. The hawks would perch on fallen trees, stumps and upturned roots where feathers, fur, beaks and entrails were removed from prey. Juveniles were seen around both clearings. It is possible that Sharp-shinned Hawks seek some sort of opening to use as a prey processing area.

Table 5 Habitat characteristics at Sharp-shinned Hawk (SSH) plucking posts and control sites in old growth forests within the WNMF. Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat Variable Abbreviation	SSH#1 Post	SSH#1 Ctrl	SSH#2 Post	SSH#2 Ctrl
Dens	57	139	37	106
Dens dead Bf<15	10	65	5	52
Dens dead Bf≥15	22	14	10	10
Dens live Bf<15	2	20	2	3
Dens live Bf≥15	11	32	19	36
Dens live Bs<15	10	1	0	0
Dens live Bs≥15	0	2	1	0
Dens live Wb≥15	2	3	0	5
% dead	56	58	15	62
% live	44	42	22	44
% Bf dead	71	60	100	100
% Bf live	29	40	95	87
% Wb dead	0	40	0	0
% Wb live	100	60	0	11
% Coniferous	96	95	100	95
% Deciduous	4	5	0	5
Dens snag	30	28	12	29
Dens snags <15 DBH	8	11	3	20
Dens snags ≥15 DBH	22	17	9	9
Total freq CWD	13	10	32	14
Veg Ground Cover	-	6	1	-

Boreal Owls were detected during nocturnal surveys on five occasions early in the field season (i.e. 25 May - 15 June). The owls were estimated to be within a distance of about 100 to 800 m from the point where vocalizations were broadcast. The habitat was predominantly old growth balsam fir forest with interspersed areas of low spruce and/or bog. Another Boreal Owl was detected in an old growth stand of mixed forest adjacent to Little Grand Lake. This owl was approached on eight occasions and was determined to use one of three trees as a roosting site. One of these trees in fact may have been its nesting site. This was a large white pine snag with a cavity at approximately 3.5 m from the ground. Most of the bark had been removed, however extensive decay of the wood had not begun. This tree was later climbed to investigate the possibility of a nest site, however the search was inconclusive. The second tree used as a roosting site was a large black spruce tree (DBH=32) with a dense canopy. The third site was a large white birch tree again with a dense canopy. All three trees were within approximately 100 - 200 m of a small bog. The habitat characteristics were determined for the roost in the black spruce tree and a randomly selected control site. The roosting site had an overall lower density of trees, however it had a greater percentage of live trees. The roosting site was also characterized by a greater number of large (>15 cm DBH) white birch trees (Table 6).

Table 6. Habitat characteristics of a Boreal Owl roosting site and control site located in an old growth forest at Little Grand Lake, WNMF. Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat Variable abbreviation	Boreal Owl Nest	Control
Dens	152	191
Dens dead Bf<15	34	91
Dens dead Bf≥15	4	8
Dens live Bf<15	59	46
Dens live Bf≥15	19	25
% dead	29	53
% live	71	47
% Bf dead	86	98
% Bf live	72	79
% Coniferous	87	98
% Deciduous	13	2
Dens snag	12	17
Dens snags <15 DBH	4	8
Dens snags ≥15 DBH	8	9
Total freq CWD	16	9
Veg Ground Cover	1	-

Clearcuts were frequently used by raptors. Most of these birds used a sit and wait hunting method, locating prey while perched in trees, which act as good vantage points. Of the 24 sightings of raptors (Merlins, American Kestrels, Northern Hawk-Owls, Rough-legged Hawks, and an Osprey) perched in clearcut areas, 15 were in birch, while the remainder were in spruce or fir. Birch are unsuitable as pulpwood, and so are often left standing in cut areas. Most of the sightings in spruce and fir were in those trees surrounding the cutblocks. Leaving birch and other trees standing within cutblocks seems to facilitate hunting and hence improve the quality of clearcuts as raptor habitat.

The Hawk-Owl nest area and control plot were located in an area that had previously been naturally burned. Although there were only a few snags in the 11.3 m radius nest and control plots, there were many snags (~10 cm DBH) and alder thickets in the general area. Ground cover vegetation was dense. The nest was on top of a broken off snag of DBH = 29 cm and a height of 6 m. The habitat characteristics are summarized in Table 7..

Areas of high Merlin activity were identified in second growth forests, clearcuts, thinned stands (<20 yr), and suburban areas. The Merlin roost and control site in the clearcut area was characterized by a few large residual white birch trees left standing by timber harvesting (Tables 8 and 9). Few live trees or snags remained and ground cover was dense and dominated by raspberry shrubs. Judging from the intensity of territorial behaviour exhibited by the Merlins it is believed that there may be a nest in one of the residual second growth stands within 500 m of the roost site. The Merlin plucking post in a second growth coniferous forest stand was characterized by a high percentage of live trees, particularly balsam fir and yellow birch. Few snags were present and the ground cover was approximately 65%.

The American Kestrel nest area contained a very low density of trees (Table 10). It is located within the burned area approximately 200 m from the Northern Hawk-Owl nest. Alder thickets and snags are numerous outside of the immediate 11.3 m radius plot. The nest cavity is found in a birch snag of DBH = 38.5 cm. The entrance hole is ~8 cm in diameter and is located 40 cm from the top of the tree.

Table 7 Habitat characteristics at a Northern Hawk-Owl nest and control site located in a clearcut/burned area near Deer Lake, WNMF. Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat Variable abbreviation	Hawk-Owl Nest	Control
Dens	12	20
% dead	75	55
% live	25	45
% Coniferous	58	80
% Deciduous	42	20
Total freq CWD	17	41
Veg Ground Cover	80	70

Table 8 Habitat characteristics of a Merlin roost and control site located in a clearcut area near Cooks Pond, WNMF. Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat Variable Abbreviation	Merlin Roost	Control
Dens	15	7
% dead	93	71
% live	7	29
% Coniferous	67	29
% Deciduous	33	71
Dens snags	3	3
Dens snags <15 DBH	0	3
Dens snags ≥15 DBH	3	0
Total freq CWD	46	23
Veg Ground Cover	75	85

Table 9 Habitat characteristics at a Merlin plucking post in a second growth forest stand near Gallants, (WNMF). Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat Variable Abbreviation	Merlin Plucking post	Ctrl1
Dens	125	75
% dead	12	32
% live	88	68
% Coniferous	72	90
% Deciduous	28	10
Dens snags	3	4
Dens snags <15 DBH	1	3
Dens snags ≥15 DBH	2	1
Total freq CWD	25	11
Veg Ground Cover	65	45

Table 10 Habitat characteristics at an American Kestrel nest and a control site located in a clearcut/burned site near Deer Lake, WNMF. Densities and percentages are recorded for 0.04 hectare plots. Frequency counts of CWD are recorded along 22.6 m transects.

Habitat variable abbreviation	Nest	Ctrl1
Dens	14	4
% dead	86	100
% live	14	0
% Coniferous	86	100
% Deciduous	14	0
Dens Snags	5	3
Dens snags <15 DBH	3	3
Dens snags ≥15 DBH	2	0
Total freq CWD	18	8
Veg Ground Cover	75	85

Table 12 Rough-legged Hawk food remains.

Species	Type and Quantity of Remains (Estimated # of individuals)
July 22/93	
Meadow Vole *Microtus pennsylvanicus*	9 jaws, 4 skulls, 1 tail (5)

Table 13 Northern Hawk-Owl food remains.

Species	Type and Quantity of Remains (Estimated # of individuals)
July 12/93	
Meadow Vole *Microtus pennsylvanicus*	3 skulls, 1 jaw (3)

Table 14 Species and estimated number of prey individuals taken by Sharp-shinned Hawks at three plucking posts near Marten Pond, 1993-1994.

Prey Species	Estimated # of individuals 1993	1994	Total
Thrush (*Catharsus* spp.)	8		
Warbler Species	7		
Downy Woodpecker (*Picoides pubescens*)	3		
Sparrow spp. (*Melospiza spp.*)	3		
White-throated Sparrow (*Zonotrichia albicollis*)	2		
Brown Creeper (*Certhia americana*)	1		
Mourning Warbler (*Opornis philadelphia*)	1		
Yellow-rumped Warbler (*Dendroica coronata*)	1		
American Redstart (*Setophaga ruticilla*)	1		
Meadow Vole (*Microtus pennsylvanicus*)	2		
Beetle (*Coleoptera spp.*)	1		
Total	30		