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BARRED OWL HOME RANGE AND HABITAT SELECTION IN THE BOREAL FOREST OF CENTRAL SASKATCHEWAN

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ABSTRACT.—We assessed Barred Owl (*Strix varia*) home range and habitat selection in the boreal forest of central Saskatchewan from 1993 to 1995 using radio telemetry (11 females and 4 males). Breeding, nonbreeding, and annual home-range sizes averaged 149, 1,234, and 971 ha, respectively. Breeding and nonbreeding home ranges overlapped entirely for all but two owls. Relative to habitat composition at random areas, Barred Owl breeding home ranges had greater proportions of old (80+ years) mixedwood forest, and nonbreeding home ranges contained greater proportions of old and mature (50 to 79 years) mixedwood and deciduous forest. Both breeding and nonbreeding home ranges contained low proportions of young (<50 years) forest and treed muskeg. Breeding home ranges contained higher proportions of old mixedwood than nonbreeding home ranges. Habitats used for foraging and roosting differed from the proportions of habitat available within the study area. During the breeding period, Barred Owls strongly selected old mixedwood, with lesser selection for mature mixedwood and deciduous forests. Similarly, in the nonbreeding period, old mixedwood was selected most strongly, with lesser selection for mature mixedwood and mature and old deciduous forests. During the breeding period, owls used habitats in proportion to their availability within home ranges, with the exception of young mixedwood forest, which was selected against. Owls selected old mixedwood within their nonbreeding home ranges and avoided young and coniferous forests, treed muskeg, open areas, and water. *Received 22 May 1997, accepted 13 February 1998.*

THE BARRED OWL (*Strix varia*) is widely distributed in North America, ranging throughout the United States east and north from Texas, across Canada to southeastern Alaska, and south to northern California (Johnsgard 1988). The occurrence of Barred Owls in boreal and western montane forests of Canada and the United States is believed to have resulted from range expansion within the past 100 years (Houston 1959, Taylor and Forsman 1976, Boxall and Stepney 1982, Sharp 1989). This range expansion has brought the Barred Owl into contact with the Spotted Owl (*Strix occidentalis*) in the northwestern United States, where hybridization has occurred (Hamer et al. 1994).

Throughout their range, Barred Owls inhabit a variety of forest types. Numerous authors have suggested that Barred Owls require old forests (Elody and Sloan 1985, Bosakowski et al. 1987, Laidig and Dobkin 1995, Haney 1997, Mazur et al. 1997a). In contrast, the Barred Owl was not considered to be an old-forest obligate by Marcot (1995). In the boreal forest, Barred Owls are associated specifically with old forest (Boxall and Stepney 1982, Dunbar et al. 1991, Van Ael 1996, Mazur et al. 1997a). However, specific habitat selection has not been well quantified in this habitat type. Our objectives were to quantify home-range size and habitat selection by Barred Owls year-round in the boreal forest of central Saskatchewan. Specifically, we wanted to determine whether the Barred Owl is an old-forest obligate within the boreal forest.

STUDY AREA AND METHODS

The research was conducted from May 1993 to April 1995 within the southern boreal forest of Saskatchewan, Canada (53°55'N, 105°55'W). The study area (ca. 400,000 ha) encompassed the Prince Albert Model Forest, including a portion of Prince Albert National Park. The dominant tree species in the

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study area included trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), black spruce (*Picea mariana*), tamarack (*Larix laricina*), jack pine (*Pinus banksiana*), and balsam fir (*Abies balsamea*). Elevations ranged from 490 to 698 m. The topography is gently rolling, interspersed with numerous lakes and creeks. The climate is boreal continental, with an average annual precipitation of 401 mm (281 mm as rain and 120 mm as snow). January and July temperatures averaged −19.7 and 17.6°C respectively, with annual extremes of −48.3 and 36.1°C (Environment Canada Parks 1986). Approximately half of the study area was being commercially harvested for wood pulp and lumber during our study period.

Radio telemetry.—Barred Owls were captured throughout the year, with most (78%) being caught during the breeding period (April to August). Owls were located through call playback surveys. Several capture techniques were used, including mist nets, a hand-held net, and a noose pole in conjunction with a mounted Barred Owl or with live mice as bait.

Captured owls were classed as adults (>2 years) by the lack of buffy tips on the rectrices (Carpenter 1992). Sex was determined from body mass (females being ca. 25% heavier; Johnsgard 1988), presence or absence of an incubation patch, and vocalizations (Elderkin 1987). Owls were banded with United States Fish and Wildlife Service aluminum leg bands and fitted with backpack style radio transmitters (AVM Electronics). Harnesses were constructed of teflon ribbon, with two strands of nylon-coated braided cable running through the ribbon (see Duncan 1987). The adjusted harness sat immediately next to the owl's skin, ensuring normal thermoregulation. The radio transmitter and harness weighed 32 g, which is about 3.5% and 4.6% of the average body mass of female and male Barred Owls, respectively. Radio transmitters emitted a signal at a rate of 60 beats per minute, with the signal detectable up to 10 km if the receiver was on the ground. Transmitter battery life ranged from 8 to 12 months.

Radio-tagged owls were located through signal triangulation or by direct observation. Triangulation was achieved using a five-element Yagi antenna mounted on a vehicle or held by a person on the ground. The direction of the signal to the nearest degree was read from a compass rosette mounted on the inside of the truck roof. The actual direction (azimuth) was determined relative to the orientation of the truck. In the case of the hand-held Yagi, the azimuth of the signal was read from a compass. Accuracy of the telemetry equipment was estimated to be within 4° of the actual signal azimuth. At least three strong directional signals were recorded and plotted onto 1:50,000 topographical maps or 1:25,000 forest inventory maps. The signal directions were then entered into the computer program Locate II (Nams 1990), which calculated the estimated owl location and surrounding error polygon. Estimated owl locations with error polygons larger than 10 ha were not used in analyses.

TABLE 1. Habitat classification by cover type and stand age in a 400,000-ha study area of boreal forest of central Saskatchewan.

Habitat type	Stand age (yrs)	% of study area
Young deciduous	<50	2.8
Mature deciduous	50 to 79	5.5
Old deciduous	80+	5.1
Young mixedwood	<50	4.4
Mature mixedwood	50 to 79	3.3
Old mixedwood	80+	14.3
Young coniferous	<50	5.9
Mature coniferous	50 to 79	12.5
Old coniferous	80+	8.5
Treed muskeg	—	18.8
Open	—	11.5
Water	—	7.6

Radio-tagged owls were relocated on average every five days, with locations being recorded at least two days apart. Owls were located during the day and the night, thereby providing foraging and roosting locations. Only one location was used for times that owls were on nests.

Home range.—Home-range sizes were calculated for breeding (1 April to 31 August), nonbreeding (1 September to 31 March), and annual periods. Home-range size was calculated by the 95% minimum convex polygon (95MCP) range estimator using the computer program Home Range (Ackerman et al. 1990). Home-range asymptote was determined for all three periods.

Habitat classification and selection.—The 1993 versions of the existing forest inventories for Prince Albert National Park (Padbury et al. 1978) and the Saskatchewan Northern Provincial Forest (Lindenas 1985) were used to classify the available habitat into 12 types (Table 1). Forest stands were classified according to cover vegetation and stand age. Young stands were defined by a relatively short period since the last fire or harvest (<50 years). These stands were densely stocked, with competition among saplings for light and nutrients. Woody material remaining from the forest stand prior to disturbance was apparent. Mature stands were 50 to 79 years past the last disturbance, with an even-age composition and even canopy closure. Old stands (80+ years) were those typically past current harvest rotations. Typical of these stands were large dead and dying trees, creating gaps in the canopy and downed woody material.

In terms of species composition and general characteristics, deciduous habitats contained a mix of trembling aspen, balsam poplar, and white birch

(<20% coniferous trees). Mixedwood habitats contained a combination of trembling aspen, balsam poplar, paper birch, white spruce, black spruce, jack pine, and balsam fir (≥20% coniferous, ≥20% deciduous). Coniferous forest was dominated by white spruce, black spruce, jack pine, tamarack, and balsam fir (<20% deciduous). Treed muskeg was composed of black spruce and tamarack and was characterized by excessive soil moisture and retarded tree growth. Open habitats included cut and burned areas, flooded land, sand, clearings, and open muskeg.

The proportional composition of Barred Owl home ranges (95MCP), 706-ha circular buffers (n = 100) to serve as surrogate home ranges, and the entire study area were then calculated based on the 12 habitat types. Additionally, the habitat type for each owl location (owl habitat use) was tabulated, representing foraging and roosting locations. Owl locations with an associated error polygon of no more than 4 ha were included in habitat-selection analyses. Habitat selection was analyzed separately for the breeding and nonbreeding periods.

Habitat selection was evaluated at three levels: (1) proportional habitat composition in owl home ranges versus random home ranges, (2) proportional habitat composition at owl locations versus availability in the entire study area, and (3) proportional habitat composition at owl locations versus availability within owl home ranges. We used two statistical analyses to compare methods. The first compared observed versus expected habitat use based on habitat availability. Statistical tests were Mann-Whitney U-tests, chi-square goodness-of-fit tests, and Bonferroni confidence intervals.

The second analysis was based on Aebischer et al. (1993), who noted that in analyses of habitat use, avoidance of one habitat type can lead to an apparent preference for another habitat type, an outcome they referred to as "unit sum constraint." They proposed that habitat comparisons include a ratio of two habitat types so that selection for one type is assessed relative to selection for all other types. This is referred to as a log-ratio compositional analysis (hereafter "log-ratio analysis"). The analysis uses a Kruskal-Wallis test to assess differences between observed and expected habitat selection based on a matrix that ranks the importance of habitat types.

Home-range composition.—The habitat composition of Barred Owl breeding and nonbreeding home ranges was compared with the habitat composition of 100 randomly placed surrogate home ranges. Habitat composition data from owl home ranges was not normally distributed. Differences in habitat composition were tested with nonparametric Mann-Whitney U-tests and log-ratio analysis. Differences between Barred Owl breeding and nonbreeding home range habitat composition were tested with a Mann-Whitney U-test.

Owl habitat use and study area composition.—Habitat selection based on owl locations was compared with that expected based on the proportion of available habitat within the entire study area (Table 1). The habitat class "water" was not included in analyses of owl habitat use because water is not used by Barred Owls. Chi-square goodness-of-fit tests were applied to determine whether owls used habitats in proportion to their availability (Neu et al. 1974, Byers et al. 1984). In order to determine which habitat types were being selected, Bonferroni confidence intervals (α = 0.05) were constructed (Neu et al. 1974, Byers et al. 1984). Log-ratio analysis was also performed, with proportional owl habitat use representing habitat use and the study area habitat composition representing available habitat.

Owl habitat use and home-range composition.—Bonferroni confidence intervals were constructed (α = 0.05), and log-ratio analysis was performed to determine the importance of habitat types. Proportional owl habitat use again represented habitat use, and proportional home range (95MCP) habitat composition represented available habitat. In log-ratio analysis, habitats that were absent from a large proportion (70%) of owl home ranges were removed from the analysis because these were not available habitat for the majority of owls (Aebischer et al. 1993). Five habitats were removed during the breeding period: young deciduous, old deciduous, young mixedwood, young coniferous, and treed muskeg. Analysis of nonbreeding home ranges did not include three habitats: young deciduous, young mixedwood, and young coniferous.

RESULTS

We captured 15 adult Barred Owls (11 females and 4 males). On average, owls were tracked for 3.4 months during the breeding period ($\bar{x}$ = 21 locations per owl) and for 5.5 months during the nonbreeding period ($\bar{x}$ = 35 locations per owl). In total, we obtained 270 locations during the breeding period and 455 locations during the nonbreeding period.

Home range.—Barred Owl home ranges averaged 148.6 ± SD of 111.6 ha for the breeding period, 1,234.0 ± 630.7 ha for the nonbreeding period, and 970.6 ± 406.7 ha annually (Table 2). Home ranges reached asymptotic size at approximately 20 locations for breeding and nonbreeding periods and 40 locations for the annual period. However, home ranges for the annual period appeared to increase somewhat after 40 locations and reached a second asymptote at approximately 62 locations (Fig. 1). Breeding home ranges were calculated with as few as 12

TABLE 2. Size of Barred Owl breeding, nonbreeding, and annual home ranges calculated by the 95% minimum convex polygon estimator. Numbers of radio locations used for home-range calculations are in parentheses.

Owl	Sex	Home-range size (ha)		
		Breeding	Nonbreeding	Annual
Beaverglen	Male	91.4 (12)	1,403.5 (27)	1,766.8 (39)
Shady Lake	Male	363.5 (35)	2,010.5 (39)	808.7 (64)
Hillcrest	Male	66.7 (19)	1,181.2 (41)	1,184.2 (62)
Birch Bay	Male	—	728.9 (39)	—
Birch Bay	Female	101.9 (14)	—	—
Beartrap	Female	—	1,000.8 (29)	—
Paignton	Female	106.0 (19)	573.4 (38)	583.4 (58)
Heart Lakes	Female	129.0 (18)	1,573.3 (24)	873.9 (42)
Candle Lake	Female	50.0 (16)	610.9 (30)	600.1 (52)
Prospect	Female	55.7 (30)	689.1 (42)	—
Spruce River	Female	341.8 (32)	1,086.5 (36)	1,374.3 (71)
Summit	Female	38.1 (36)	588.8 (28)	572.9 (72)
Whelan Bay	Female	144.8 (18)	1,917.1 (35)	—
Waskesiu	Female	—	2,678.4 (33)	—
Whiteswan	Female	294.3 (21)	—	—

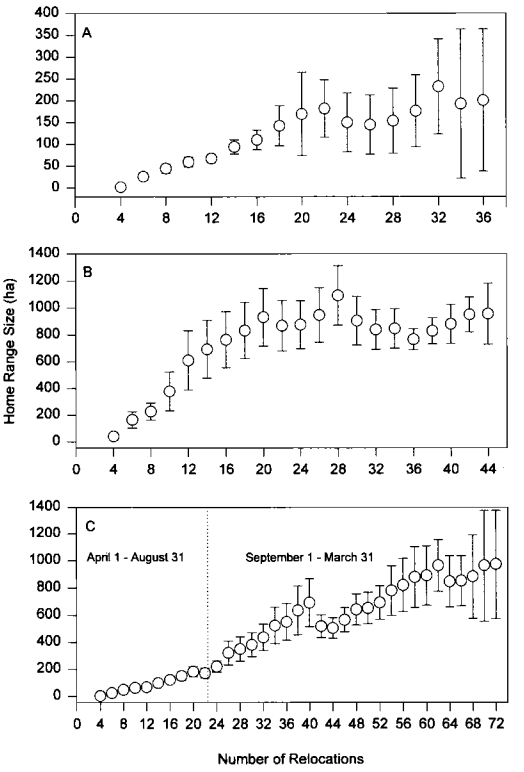

FIG. 1. Relationship between the number of radio locations and Barred Owl home-range size (95% minimum convex polygon) for (A) breeding period (1 April to 31 August; n = 12 owls), (B) nonbreeding period (1 September to 31 March; n = 13 owls) and (C) year-round (n = 8 owls). Values are $\bar{x} \pm$ SE.

locations and as many as 36 locations (Table 2). Given the approximate asymptote of 20 locations for breeding home range calculation, breeding home ranges calculated using fewer than 20 locations likely underestimated the actual home-range size.

Both breeding and nonbreeding home ranges were calculated for 10 owls. The breeding home ranges of eight of these owls were contained entirely within their nonbreeding home ranges. Breeding home ranges of the remaining two owls, which were females, did not overlap at all with their nonbreeding home ranges.

Home-range composition.—Barred Owl breeding home ranges and random home ranges differed significantly in habitat composition for 7 of the 12 habitat types (Table 3). Barred Owl breeding home ranges contained significantly higher proportions of old mixedwood forest and lower proportions of young forest and treed muskeg than did the random home ranges. Barred Owl nonbreeding home ranges and random home ranges differed significantly in proportional habitat composition for five habitat types (Table 3). Barred Owl nonbreeding home ranges contained significantly higher proportions of old and mature mixedwood and deciduous forest, and significantly lower proportions of treed muskeg and open areas, than did the random home ranges.

Based on log-ratio analysis, Barred Owl breeding and nonbreeding home range habitat composition differed significantly from that at

TABLE 3. Percent composition ($\bar{x}$, with SD in parentheses) of breeding (n = 12) and nonbreeding (n = 13) Barred Owl home ranges, breeding (n = 12) and nonbreeding (n = 13) Barred Owl radio locations, random surrogate home ranges (n = 100), and the entire study area. Home ranges calculated by the 95% minimum convex polygon estimator.

Habitat type	Owl home ranges		Owl radio locations		Random home ranges	Study area
	Breeding	Nonbreeding	Breeding	Nonbreeding		
Young deciduous	0.1 (0.3)[a]	1.2 (3.0)	0.5 (1.7)[c]	0.5 (1.2)[c]	2.7 (7.4)	2.8
Mature deciduous	10.7 (17.3)	14.2 (28.8)[a]	8.7 (12.4)[c]	11.9 (25.2)[c]	5.4 (13.8)	5.5
Old deciduous	1.9 (4.5)[b]	8.9 (12.6)[a]	1.6 (3.3)[c]	5.4 (5.4)[d]	5.0 (12.0)	5.1
Young mixedwood	0.1 (0.2)[a]	0.9 (2.3)	0 (0)[c,d]	0.2 (0.8)[c]	4.3 (8.5)	4.4
Mature mixedwood	6.7 (14.4)	12.1 (15.1)	4.9 (9.6)	14.1 (18.8)[c]	3.3 (6.3)	3.3
Old mixedwood	56.7 (29.3)[a,b]	29.8 (23.9)[a]	66.4 (28.0)[c]	56.0 (31.0)[c,d]	14.3 (17.8)	14.3
Young coniferous	0 (0)[a]	1.5 (4.2)	0 (0)[c]	0.4 (1.1)[c,d]	5.8 (12.9)	5.9
Mature coniferous	5.1 (9.8)[a]	7.6 (10.5)	6.5 (13.2)[c]	5.0 (7.8)[c,d]	12.4 (14.9)	12.5
Old coniferous	4.2 (8.6)[a]	5.3 (4.8)	5.1 (9.2)[c]	2.7 (4.7)[c,d]	8.5 (11.8)	8.5
Treed muskeg	2.1 (5.6)[a,b]	6.0 (8.8)[a]	2.1 (6.1)[c]	2.0 (3.2)[c,d]	18.7 (19.5)	18.8
Open areas	5.6 (6.1)	5.1 (5.2)[a]	3.6 (4.7)[c]	1.6 (2.3)[c,d]	11.5 (12.8)	11.5
Water	6.5 (9.0)	7.1 (8.7)	—	—	7.5 (14.8)	7.6

[a] Significant difference (Mann-Whitney U-test $P < 0.05$) between owl home range composition and random home range composition.
[b] Significant difference (Mann-Whitney U-test $P < 0.05$) between owl breeding and nonbreeding home range composition.
[c] Significant difference (Bonferroni confidence intervals) between owl radio locations and composition of the study area.
[d] Significant difference (Bonferroni confidence intervals) between owl radio locations and home-range composition. Comparisons are breeding to breeding and nonbreeding to nonbreeding.

random home ranges (breeding, $H = 22.36$, $P = 0.008$; nonbreeding, $H = 21.79$, $P = 0.010$). During both breeding and nonbreeding periods, old mixedwood forest was ranked the highest, and young forest and treed muskeg received the lowest ranks (Table 4).

TABLE 4. Numeric ranks for Barred Owl habitat selection based on proportional habitat composition of owl home ranges versus that of random surrogate home ranges, and proportional owl habitat use (radio locations) versus proportional habitat composition of the entire study area. The higher rank number corresponds to greater selection for a habitat type. Home ranges calculated using the 95% minimum convex polygon estimator.

Habitat type	Owl versus random home ranges		Owl use versus study area	
	Breeding	Nonbreeding	Breeding	Nonbreeding
Young deciduous	3	2	4	5
Mature deciduous	8	7	8	7
Old deciduous	4	8	5	8
Young mixedwood	2	1	1	0
Mature mixedwood	7	10	9	9
Old mixedwood	11	11	10	10
Young coniferous	0	0	0	2
Mature coniferous	6	4	3	6
Old coniferous	5	5	7	4
Treed muskeg	1	3	2	1
Open areas	10	9	6	3
Water	9	6	—	—

Habitat composition of breeding home ranges differed significantly from that of nonbreeding home ranges for three habitat types (Table 3). Breeding home ranges were composed of lower proportions of old deciduous and treed muskeg, and higher proportions of old mixedwood than were nonbreeding home ranges.

Owl habitat use and study area composition.—Based on goodness-of-fit tests and log-ratio analysis, Barred Owls did not use available habitat in the study area at random during the breeding ($\chi^2 = 578.35$, $P < 0.001$, df = 10; $H = 39.03$, $P < 0.001$) or the nonbreeding ($\chi^2 = 760.79$, $P < 0.001$, df = 10; $H = 50.06$, $P < 0.001$) periods. Compared with available habitat in the entire study area (Bonferroni confidence intervals), Barred Owls selected old mixedwood forest most strongly and mature mixedwood and deciduous forest to a lesser extent, and avoided young forest, coniferous forest, treed muskeg, and open areas during both the breeding and nonbreeding periods (Table 3). Similarly, log-ratio analysis for the breeding and nonbreeding periods revealed that Barred Owls selected old mixedwood forest most strongly, followed by mature mixedwood, and avoided young forest and treed muskeg (Table 4). Barred Owls did not use habitats in different

proportions during the breeding versus the nonbreeding period (Table 3).

Owl habitat use and home-range composition.—Log-ratio analysis revealed that Barred Owl use of habitat in the breeding and nonbreeding periods was not significantly different (breeding, $H = 1.12$, $P = 0.891$; nonbreeding, $H = 11.66$, $P = 0.070$) from that expected by habitat availability within the breeding and nonbreeding home ranges. According to Bonferroni confidence intervals during the breeding period, Barred Owls used all habitat types in proportion to availability within their home ranges except for young mixedwood, which was avoided (Table 3). During the nonbreeding period, Barred Owls selected more old mixedwood forest and less old deciduous, young coniferous, mature coniferous, old coniferous, treed muskeg, and open areas relative to availability (Table 3). The proportion of the home range in old mixedwood habitat was significantly negatively correlated with breeding home-range size ($r_s = -0.56$, $P = 0.054$) but not with nonbreeding home-range size ($r_s = -0.21$, $P = 0.482$).

Discussion

Home range.—Barred Owls in the boreal forest of Saskatchewan maintained relatively small breeding home ranges that expanded during the nonbreeding period. A nonbreeding home range typically included the breeding home range within its boundary. During the breeding period, Barred Owl home-range size was similar to that reported for Michigan (Elody and Sloan 1985) but less than half that reported for Washington (Hamer 1988). In this study, nonbreeding and annual home ranges averaged eight and six times larger, respectively, than breeding home ranges. Hamer (1988) found that annual home-range size ($\bar{x} = 644$ ha) was about twice that of breeding home-range size for Barred Owls in Washington. Nicholls and Fuller (1987) reported an average home-range size of 273 ha for Barred Owls in Minnesota, but they did not distinguish the period of the annual cycle. The nonbreeding and annual home-range sizes that we report are the largest recorded for the species. During the breeding and nonbreeding periods, male and female home ranges were similar in size (Table 2), which supports Hamer's (1988) findings from Washington.

Barred Owls are thought to be limited by nest-site availability (Devereux and Mosher 1984). The inclusion of breeding home ranges within larger nonbreeding home ranges is thought to protect the relatively scarce nest site (Lundberg 1979). However, prey availability is probably the major factor determining home-range size (Schoener 1968, Lindstedt et al. 1986). This would suggest that prey availability is lower during the nonbreeding period.

Habitat selection.—Barred Owls avoided young forest, coniferous forest, and treed muskeg and seemed to prefer old and mature mixedwood forest. Breeding home ranges contained high proportions of old mixedwood forest. Barred Owls nest primarily in tree cavities, which occur in live trees or within the broken tops of snags (Devereux and Mosher 1984). In the boreal forest of western Canada, old mixedwood forest contains the highest density of large (>40 cm dbh) trees and snags relative to other forest types (Lee et al. 1995). In our study area, Barred Owls nested ($n = 15$) in large trees and snags that averaged 47 cm dbh (Mazur et al. 1997b). Therefore, old mixedwood forest is a critical source of nest trees for Barred Owls in this region.

The proportion of home ranges in old mixedwood was negatively correlated with the size of breeding home ranges but not with nonbreeding home ranges. Breeding home ranges contained higher proportions of old mixedwood that nonbreeding home ranges, further emphasizing the importance of this habitat type during the breeding period. The continued use of old mixedwood forest during the nonbreeding period may have been in response to high prey availability.

Prey availability is an important factor in habitat use (Morris 1987), and roost sites also may play an important role. Barred Owls strongly selected old mixedwood forest for hunting and roosting, and selected mature mixedwood and deciduous forest to a lesser extent. Old mixedwood forest is structurally complex, with a high diversity of potential prey species of Barred Owls (McDonald 1995, Roy et al. 1995, Schieck and Nietfeld 1995). The Barred Owl is considered a generalist predator (Johnsgard 1988). Prey species include arthropods, fish, amphibians, mice and voles, larger rodents such as squirrels and hares, and birds up to the size of grouse (Marks et al. 1984, Elderkin

1987, Johnsgard 1988, K. M. Mazur unpubl. data). A relatively open understory and low density of trees may be important for ease of hunting by Barred Owls (Nicholls and Warner 1972, McGarigal and Fraser 1982). These characteristics are typical of old mixedwood forests in the boreal forest.

Barrows (1981) suggested that Spotted Owls select roost sites based on microclimates that are favorable for thermoregulation. Chesterman and Stelfox (1995) found slight differences in air temperature of young, mature, and old mixedwood forest stands in the boreal forest of western Canada. Old stands typically were warmer during the day in winter and cooler during summer. Thus, habitat characteristics that influence microclimate also may influence selection of old mixedwood forest by Barred Owls.

Different methods of analysis of habitat selection yielded quite similar results. Old mixedwood forest was ranked or selected highest regardless of which method was used (Tables 3, 4). A discrepancy occurred in the analysis of proportional habitat composition compared with random surrogate home range habitat. The analysis using log-ratio analysis resulted in open areas and water ranking second and third highest during the breeding period, and open areas third highest during the nonbreeding period. Given the small proportional values for these habitat types in owl home ranges compared with random home ranges, it seems unlikely that these habitats are as important as indicated by their rank. Overall, the use of log-ratio analysis provided no further insight into habitat selection by Barred Owls than detected through other methods faced by a unit sum constraint.

Barred Owls in our study area exhibited strong selection for mature and old forests, particularly old mixedwood forest (cf. Boxall and Stepney 1982). Barred Owls maintained large nonbreeding home ranges, the largest recorded for the species. As a predator with large areal and specific habitat requirements, the Barred Owl is likely to be sensitive to habitat changes. Therefore, timber management practices that ensure a continuous supply of old mixedwood forest are essential for the survival of Barred Owls and other species occurring in this forest type in the boreal forest.

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