Characteristics of Barred Owl (*Strix varia*) Nest Sites in Manitoba, Canada

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During 2009 and 2010, nine Barred Owl (*Strix varia*) nest sites were located in Manitoba, Canada, and data on nest trees, nest structure, and nest site habitat were collected. Nests were located in a variety of tree species, including Balsam Poplar (*Populus balsamifera*), Paper Birch (*Betula papyrifera*), Trembling Aspen (*Populus tremuloides*) and Burr Oak (*Quercus macrocarpa*). All nests were in tree cavities, and the majority of nests were in dead trees (67%) and had lateral openings (67%). Habitat surrounding nest trees and estimated canopy cover were highly variable. Diameter at breast height of nest trees, cavity width, and cavity depth were consistent and were determined to be the most reliable indicators of nest suitability for breeding Barred Owls. We conclude that the distribution of nesting Barred Owls is influenced more by availability of suitable nest sites than by nest tree species or nest site habitat.

Key Words: Barred Owl; *Strix varia*; habitat; nesting; raptor; Manitoba

Introduction

Barred Owls (*Strix varia*) nest in a variety of natural and anthropogenic structures (Robertson 1959; Shackleford 1996; Houston 1999), but are considered to be primarily cavity nesters (Mazur *et al.* 1997a, 1997b). They use tree cavities created by other birds, disease, rot, and/or tree damage (Mazur *et al.* 1997a; Vaillancourt *et al*. 2009). Because of its reliance on large diameter trees for nesting, the Barred Owl is considered an indicator species of forest health (McGarigal and Fraser 1984). The availability of nest sites limits its distribution, population size, and density (Robertson and Rendell 1990).

As a highly adaptable species (Robertson 1959; Shackleford 1996), the Barred Owl persists in some habitats that have been altered by human activity (Kelly *et al*. 2003; Houston 1999). However, nesting requirements must be met in order for avian populations to be maintained (Robertson and Rendell 1990). The Barred Owl's nesting requirements are poorly documented throughout most of its range (North America) (Mazur *et al*. 1997a), and specifically in Manitoba (Holland *et al*. 2003).

Across its range, the Barred Owl uses forest types along a gradient from hardwood to mixedwood to softwood forests (Nicholls and Warner 1972). Hardwood forests are rare throughout a large portion of its northern range, leaving only mixedwood and mostly boreal forests (Duncan and Kearns 1997). The link between large cavity-nesting species and mature stands of mixedwood forests is known (McGarigal and Fraser 1984; Potvin *et al*. 2000; Hodson 2003; Payer and Harrison 2003).

Barred Owl management and conservation by the government in Manitoba and elsewhere will be more effective if we understand which factors create suitable Barred Owl habitat within various mature mixedwood stands. Our objectives were to locate Barred Owl nest sites in Manitoba, Canada, and collect data on nests, nest trees, and nest site habitat. Describing these factors will contribute to hypotheses about nest and habitat selection in this species and the limits to their distribution in Manitoba and elsewhere.

Study Area

Research was conducted from February 2009 to September 2010 within the southern portion of Manitoba, Canada (49°0.0'N to 53°52.7'N and 95°9.2'W to 101°44.2'W). This area consists of prairie pothole, boreal hardwood transition, boreal taiga plain, and boreal softwood shield regions (Zoladeski *et al*. 1995). Predominant tree species in the study area were White Spruce (*Picea glauca*), Black Spruce (*Picea marinana*), Tamarack (*Larix laricina*), Jack Pine (*Pinus banksiana*), Trembling Aspen (*Populus tremuloides*), Balsam Poplar (*P. balsamifera*), and Paper Birch (*Betula papyrifera*). Southern Manitoba lacks major topographic changes; however, small shifts in elevation, along with the abundance of wetlands and waterways, create a highly variable habitat (Zoladeski *et al*. 1995).

Methods

Barred Owl nest sites were located using nocturnal audio surveying and diurnal audio playback with passive observation during the breeding season (February – June in 2009 and 2010) (Frith *et al*. 1997; Whiklo 2011). Survey transects were laid out in areas based on Barred Owl detection data obtained from the Manitoba Nocturnal Owl Survey (JRD, unpublished data; *op. cit.* Duncan and Kearns 1997) and historical accounts, and

transects were also laid out in suitable habitat adjacent to known areas of Barred Owl activity. In total approximately 1321 km of transect lines were surveyed in 2009 and 2010. Survey locations were situated 1.6 km apart along survey transects where playback of Barred Owl vocalizations were used to elicit responses (Whiklo 2011). Areas where Barred Owls were detected during nocturnal surveys were searched during daylight for active nests.

Nest trees were categorized as live or dead, and tree species, the height of the nest above ground, and diameter at breast height (DBH) were recorded. Diameter at breast height was calculated by measuring the circumference of the tree and then calculating the diameter: $D = C/\pi$. Cavity height (distance from the lowest point inside the nest to the highest point inside the nest), cavity width (distance from the furthest right-hand point inside the cavity to the furthest left-hand point inside the cavity), and cavity depth (distance inside the cavity perpendicular to cavity width) were measured; nest type (cavity, stick, other) and cavity orientation (lateral or apical) were also recorded.

Habitat within a 30 m circular plot surrounding the nest trees was categorized using Manitoba Forest Inventory classifications (Zoladeski *et al*. 1995), and the percentage canopy cover was estimated (Whiklo 2011). All measurements are reported as mean and standard deviation (SD).

Results

A total of nine Barred Owl nests were located in 2009 and 2010 within a 25 000 km^2 rectangle in southeastern Manitoba. All nests were cavity type structures; six were lateral cavities and three were apical cavities (Table 1). Six nest trees were dead and three were living (Table 1). Five nests were found in Balsam Poplar, two in Paper Birch, one in Trembling Aspen, and one in Burr Oak (Table 1). The mean nest height above ground was 7.7 m (SD 2.6). The mean diameter at breast height of nest trees was 49.2 cm (SD 18.9). The mean cavity height was 71.8 cm (SD 46.9), the mean cavity depth was 42.1 cm (SD 33.0), and the mean cavity width was 27.3 cm (SD 5.4) (Table 2).

Four nest trees were located in Balsam Poplar mixedwood (V1) stands, two in Black Ash (*Fraxinus nigra*) hardwood (V2) stands, one in a White Spruce/Balsam Fir (*Abies balsamea*) (V21) stand, one in a Miscellaneous Hardwood (V3) stand, and one in an area that could not be classified due to a lack of living trees (a pond created by an American Beaver, *Castor canadensis*) (Table 1). The mean estimated canopy cover was 42.8% (SD 27.2) (Table 2).

Discussion

There are a considerable number of studies that examine one or more aspects of the nest site structure, the nest tree species, and/or the habitat associated with the nest sites of the Barred Owl (Nicholls and Warner 1972;

TABLE 1. Data for nine Barred Owl (*Strix varia*) nest sites in Manitoba, Canada (2009 to 2010).

Owl nest site	Nest tree species	Nest tree status	Nest type	Manitoba forest classification[1]
Cow Moose Lake (Barred Owl 4)	Balsam Poplar	Dead	Lateral cavity	V1: Balsam poplar hardwood and mixedwood
Watson P. Davidson Wildlife Management Area (Barred Owl 5)	Paper Birch	Dead	Apical cavity	V1: Balsam poplar hardwood and mixedwood
Stead (Barred Owl 11)	Balsam Poplar	Dead	Lateral cavity	V1: Balsam poplar hardwood and mixedwood
Otter Falls (Barred Owl 20)	Balsam Poplar	Dead	Lateral cavity	N/A*
Nutimik Lake (Barred Owl 27)	Balsam Poplar	Live	Lateral cavity	V2: Black ash (White elm) hardwood
West of Woodridge (Barred Owl 31)	Balsam Poplar	Dead	Apical cavity	V21: White spruce/Balsam fir shrub
East of Piney (Barred Owl 36)	Paper Birch	Dead	Apical cavity	V1: Balsam poplar hardwood and mixedwood
Contour area (Barred Owl 55)	Trembling Aspen	Live	Lateral cavity	V2: Black ash (White elm) hardwood
Dencross (Barred Owl 56)	Burr Oak	Live	Lateral cavity	V3: Miscellaneous hardwoods

*Habitat was determined to be unclassifiable according to Manitoba forest classifications due to lack of living trees.
[1] Zolandeski *et al.* (1995)

TABLE 2. Further data for nine Barred Owl (*Strix varia*) nest sites in Manitoba, Canada (2009 to 2010).

Owl nest site	Nest tree diameter at breast height (cm)	Height of the nest above the ground (m)	Cavity height (cm)	Cavity depth (cm)	Cavity width (cm)	Canopy cover (%)
Cow Moose Lake (Barred Owl 4)	43.1	4.5	68.8	26.4	27.8	30
Watson P. Davidson Wildlife Management Area (Barred Owl 5)	42.9	7.4	24.9	32.9	29.4	35
Stead (Barred Owl 11)	50	10.2	156.0	127.0	24.5	60
Otter Falls (Barred Owl 20)	39.7	6.4	121.1	22.8	26.1	0
Nutimik Lake (Barred Owl 27)	56.2	12.1	67.9	35.9	35.9	70
West of Woodridge (Barred Owl 31)	33.7	5.8	11.4	22.3	21.5	75
East of Piney (Barred Owl 36)	33.3	5.4	42.0	29.8	21.2	5
Contour area (Barred Owl 55)	48.7	7.6	102.2	30.8	35.1	50
Dencross (Barred Owl 56)	95.5	9.9	52.2	51.0	24.0	60
Mean (SD)	49.2 (18.9)	7.7 (2.6)	71.8 (46.9)	42.1 (33.0)	27.3 (5.4)	42.8 (27.2)

Haney 1997; Mazur *et al*. 1997a, 1997b; Postupalsky *et al*. 1997; Winton and Leslie 2004; Olsen *et al*. 2006; Grossman *et al*. 2008; Singleton *et al*. 2010) and general Barred Owl habitat associations (McGarigal and Fraser 1984; Booth and Harrison 1997; Mazur *et al*. 1998; Hamer *et al*. 2007; Russell 2008). These studies vary considerably, as described in more detail below, in the way study areas were selected, in the size and habitat fragmentation of the study areas, and in the size and measurement of nest habitat plots. However, there is less variation in the way nest trees and nest sites were measured.

This variation in methodology limited our ability to compare results; nevertheless, some Barred Owl nest site characteristics were consistent across studies.

Nest type

In contrast to other studies (Mazur *et al.* 1997a; Postupalsky *et al*. 1997; Olsen *et al*. 2006), all nests ($n = 9$) located in the study were in tree cavities (Table 1). Mazur *et al*. (1997a) reported that 5 of 15 Barred Owl nests (33%) in the study in the boreal forest of Saskatchewan were in structures other than tree cavities; in witch's broom (the dense branching caused by *Arceuthobium* spp. in a White Spruce tree), in Red Squirrel (*Tamiasciurus hudsonicus*) nests, or in stick nests. In a study in the boreal mixedwood forest in Alberta (Olsen *et al*. 2006), 9 of 10 nest sites (90%) were in tree cavities (one Barred Owl nested in a stick nest). In Michigan, in hardwood (deciduous) and mixed forest habitat, Postupalsky *et al*. (1997) described 13 of 57 nests (23%) as being open sites, including hawk (Red-shouldered Hawk (*Buteo lineatus*) or Broad-winged Hawk (*Buteo platypterus*) and Northern Goshawk (*Accipiter gentilis*)) stick nests, a ground nest, a flat area in the fork of a Yellow Birch (*Betula alleghaniensis*), and a nest platform intended for Great Horned Owls (*Bubo virginianus*); the remainder were in tree cavities ($n = 26$) or nest boxes ($n = 18$).

The likelihood of finding an open Barred Owl nest in Manitoba would presumably increase with increased effort and sample size. However, it is noteworthy that, even though Barred Owls are known to use artificial open nests (Olsen *et al*. 2006), none were found nesting on a cumulative total of 2527 natural and/or artificial open stick platform nests in a variety of habitats checked for raptors over a 27-year period (1984–2010) in the same 25 000 km^2 study area in southeastern Manitoba (Duncan 1992; JRD, unpublished data).

The aforementioned studies (Mazur *et al.* (1997a), Postupalsky *et al*. (1997), and Olsen *et al*. (2006)) varied considerably in the way the study areas were selected or described, in the size of the study areas, in the methods used to find nests, in the forest habitat composition/fragmentation, and in other quantified ways (i.e., prey density, human disturbance). For example, this study was larger (~25 000 km^2) with varied habitat, the study described in Mazur *et al*. (1997a) was conducted within a 3 874 km^2 national park, the study described in Olsen *et al*. (2006) was a 800 km^2 predetermined area, and two study areas (28 km^2 and an undefined larger area) were studied in Postupalsky *et al*. (1997).

Smaller fragmented study areas or isolated protected areas (i.e., national parks) may vary in terms of the availability of cavity nests, the prey density, the forest habitat, and/or intra and interspecific competition, resulting in the variation observed in the proportion of nest type use by breeding Barred Owls. How these factors affect the availability of suitable cavity nest sites and the proportion of Barred Owls using open nest sites is unknown. However, the propensity of Barred Owls for cavity nests likely results from natural selection; Barred Owls nesting in cavities experience greater reproductive success than those that use open nests (Postupalsky *et al*. 1997).

Nest cavity characteristics

Given the importance of nest cavities to Barred Owl reproduction, we recorded a series of measurements. Cavity height and depth ranged widely (height ranged

from 11.4 to 156.0 cm and depth ranged from 22.3 to 127.0 cm) with high standard deviations, whereas cavity width was remarkably consistent (21.2 to 35.9 cm) (Table 2), despite the variation in nest tree species and status (live or dead) (Table 1). Cavity depth varied the most, perhaps as a result of the variable and sometimes advanced stages of tree decay, e.g., the nest site near Stead (Table 2). Postupalsky *et al*. (1997) recorded a similar mean cavity width (26.9 cm, range 18–44, $n = 25$), but did not report cavity depth measurements (as defined in this study) or standard deviations. Nest cavity measurements were not reported in other studies.

Nest tree diameter at breast height

Mean diameter at breast height of nest trees in this study (49.2 cm, SD 18.9) was consistent with that reported in other studies. Mazur *et al*. (1997a) recorded an average diameter at breast height of 47.4 cm (SD 12.8, $n = 15$), despite recording considerably higher values for the height of nests from the ground (13.3 m, SD 4.1) than this study (7.7 m, SD 2.6) (Table 2). Olsen *et al*. (2006) recorded an average diameter at breast height of 51.6 cm (SE 4.3), along with a relatively intermediate nest height above ground (10.4 m, SE 2.1).

There were relatively large differences in many nest tree variables among these studies (e.g., nest tree height, nest height, proportion of cavity nest structures, and nest tree species); therefore, the similarities in the diameter at breast height of nest trees suggest it is a valid and practical indicator of Barred Owl nest tree suitability.

Nest tree species, percentage canopy cover, and forest stand composition

Barred Owls nested in four hardwood tree species in this study (Table 1), and this variation was similar to that found in other studies. Mazur *et al*. (1997a) reported Barred Owl nests in both softwood (coniferous) and hardwood tree species, including White Spruce ($n = 5$), Trembling Aspen ($n = 5$), Balsam Poplar ($n = 4$), and Paper Birch ($n = 1$). Olsen *et al*. (2006) documented Barred Owl nests in fewer tree species in a smaller study area: Balsam Poplar ($n = 8$) and Trembling Aspen ($n = 2$). Barred Owls use a variety of nest tree species, live or dead, and they readily breed in artificial nest boxes placed in a variety of trees (Postupalsky *et al*. 1997). It is therefore unlikely that Barred Owls choose a nest site based on tree species per se.

High percentage forest canopy cover has been cited as a determining factor in Barred Owl selection of breeding habitat, possibly because it provides solar insulation (Nicholls and Warner 1972; Haney 1997; Winton and Leslie 2004; Grossman *et al*. 2008), but the influence of forest canopy may depend on the size of the area that was measured. In this study, canopy cover was measured within a 30 m circular plot centered on the nest tree, and it did not appear to influence Barred Owl nest tree habitat use: more than half the sample had a canopy cover of ≤50% (Table 2).

Mazur *et al*. (1997b) used a similar small-scale plot (11.3 m radius) with the nest tree at the centre, and reported a somewhat higher mean percentage cover of 57% (SD 17); this was not significantly different from random plots. Other studies reported yet higher percentage canopy cover within larger Barred Owl home ranges: 96% (SE 1.1) (Haney 1997), 62.8% (Winton and Leslie 2004), utilized "dense" cover disproportionately (no values given) (Nicholls and Warner 1972), >66% (Grossman *et al*. 2008), and >56% (Singleton *et al*. 2010).

Forest stands within the 30 m circular plots (centered on nest trees) were classified as one of three types of stands: hardwood and mixedwood, softwood shrub, or unclassified (American Beaver pond) (Table 1). This variation in nest habitat use is reflective of the great variety of forested areas over the considerable North and Central American range of the Barred Owl, from swamps and riparian areas to upland regions (Mazur and James 2000). This variation of forest stand nesting habitat use suggests that the Barred Owl is a forest habitat generalist.

Management of forests for Barred Owls

Strong selective pressure on Barred Owls appears to have resulted in their propensity for nest cavities in trees. Observed higher reproductive success in cavity nests implies nest site selection for cavities by this species (Postupalsky *et al*. 1997). This conclusion is supported both by our results and by those of others, in which the most consistent nest characteristics and nest habitat characteristics reported are the width of the nesting cavity and the diameter at breast height of the nest tree. Other Barred Owl nest habitat characteristics discussed herein vary considerably across the range of the Barred Owl. Apart from its effective dependence on suitable nest tree cavities, the Barred Owl is otherwise generally considered a forest habitat generalist (Mazur and James 2000).

The persistence of Barred Owl populations depends on the maintenance of forests with trees with a minimum diameter at breast height capable of producing cavities large enough for this large cavity-nesting species (Haney 1997). Knowledge of ecological factors and processes that promote the formation of suitable nest tree cavities is also critical to the maintenance of Barred Owls in a managed forest environment.

Barred Owls are associated with water (Mazur *et al*. 1997b; Hamer *et al*. 2007), mature or "old-growth" forest stands (McGarigal and Fraser 1984; Mazur *et al*. 1998), and mixedwood or hardwood stands (Booth and Harrison 1997; Mazur *et al*. 1997b; Russell 2008).

The role and importance of heart rot in hardwood species in the formation of nest cavities, as well as the role of snags in an ecosystem, are well documented (Thomas *et al*. 1979; Witt 2010). Barred Owl nest cavities found in this study were natural and had resulted from damage to and decay of the tree. These cavities

were not readily attributable to excavation by primary cavity nesters.

Cavities not created by primary cavity nesters are often created by tree decay and rot (Bunnell *et al*. 2002). Fungal rot is prevalent in older and/or larger stands of trees (Witt 2010) and has positive effects for both primary and secondary cavity nesters (Bunnell *et al*. 2002). Higher levels of moisture and humidity, factors found at sites within close proximity to water, increase the rate of decay in trees (Jackson and Jackson 2004). In Manitoba, hardwood species decay at a higher rate than most softwood species: annual losses of hardwood species to decay are double that of softwood species (Brandt 1995).

Barred Owl conservation would benefit from the development and use of a standard methodology to characterize nest sites and nesting habitat. Standard methodology would allow the results from studies across this species' range or through time to be compared. We also recommend that tree species composition, diameter at breast height, and ecological forest decay indicators be developed and used to identify priority Barred Owl habitat conservation areas where forest habitat loss affects the viability of local Barred Owl populations.

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