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I'm afraid to speak or move

for fear that all this wonderful beauty

will just vanish like a broken silence.

words of Anne of Green Gables (L.M. Montgomery)

University of Alberta

Barred Owl Habitat Use and Distribution in the Foothills Model Forest

by

Danielle Lisa Takats ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science

in

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Edmonton, Alberta

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University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **Barred Owl Habitat Use and Distribution in the Foothills Model Forest** submitted by **Danielle Lisa Takats** in partial fulfillment of the requirements for the degree of Master of Science, in Wildlife Ecology and Management.

Geoffrey L. Holroyd (Co-Supervisor)

James A. Beck, Jr. (Co-Supervisor)

Peter Kershaw

Victor Lieffers

December 17, 1997

Dedicated To

My Father, Josef Takats,

My Mother, Margaret Rose Takats

and My Kindred Spirits.

Thank you for your love and support.

Abstract

A two-year ecological study (1995 through 1996) was conducted on the Barred Owl (*Strix varia*) in the Foothills Model Forest (FMF) located in west-central Alberta. The Barred Owl was chosen for study because it is considered an indicator of old growth forest. Little information exists on the Barred Owl in Alberta. The purpose of this study was to investigate Barred Owl nesting, roosting, and foraging habitat use. Broadcast surveys were used to determine the presence and relative abundance of nocturnal owls. Data was collected in March, April, and May. Three hundred calls from six species of owls were recorded at 893 stops for a call rate of 0.34 calls per stop. Moon phase significantly affected the rate of owl calls. Owl call rate was significantly lower in the middle of the night (midnight to 3:59) compared to the early night (20:00 to 23:59) and early morning (4:00 to 7:59). During precipitation, low temperatures, and strong wind, fewer owls called spontaneously or responded to the playback calls. Owls responded significantly more during the two minute silent listening period beginning each 15 minute survey period than in subsequent listening periods after playback. Broadcast surveys, telemetry, and casual observations were used to record information on 42 territorial Barred Owls. Barred Owl density was determined to be 0.05 owls/km^2 and 0.04 owls/km^2 in 1995 and 1996 respectively. Six pairs of owls were investigated for nesting. They were found to nest in natural cavities of large diameter (mean dbh=74.0 cm) balsam poplar trees (*Populus balsamifera*). Barred Owls were found to use old mixedwood uneven-aged stands of white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and balsam poplar for nesting, roosting, and foraging. The Barred Owl is a generalist predator over its Foothills Model Forest range, and feeds on a variety of small mammal, bird, amphibian, and insect species. Some individuals were found to specialize on birds or microtines. They will opportunistically feed on certain species of prey when they are abundant. The Barred Owl can serve as a good indicator of old growth forests, particularly those associated with riparian areas. A draft habitat model, based on literature, was modified to include the importance of balsam poplar trees for nesting and the negative affects of openings associated with Great Horned Owl predation (*Bubo virginianus*) and anthropogenic disturbance.

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Chapter 1

Introduction

"The noisiest of the unseen witnesses around me were the owls, who pronounced their gloomy speeches with profound emphasis . . ."

-John Muir

1 Introduction

Raptors (also known as birds of prey) are an important group of birds to consider when managing for the well being of our environments. The position of birds of prey high on the food chain makes them valuable indicators of environmental health (Oliphant 1994). Birds of prey include Vultures, Kites, Eagles, Hawks, Ospreys, Falcons, Caracaras, and Owls.

Key issues that have affected and are still affecting raptors include toxins (e.g. DDT, carbofuran) and habitat loss. Examples of species that have been affected by anthropogenic changes in the environment in North America include: the Peregrine Falcon (*Falco peregrinus*) (Hickey 1969, Fyfe *et al.* 1976), the Bald Eagle (*Haliaeetus leucocephalus*) (Noble *et al.* 1993, Hunter and Baird 1994, Shutt 1994), the Osprey (*Pandion haliaetus*) (Ewins and Houston 1992), the Burrowing Owl (*Speotyto cunicularia*) (James and Ethier 1989, Kirk and Hislop in press, Wellicome 1997), the Swainson's Hawk (*Buteo swainsoni*) (Whelan 1996), the California Condor (*Gymnogyps californianus*), and the Spotted Owl (*Strix occidentalis*) (Gutierrez and Carey 1984, Gutierrez *et al.* 1984, Howie 1980). The Barred Owl (*Strix varia*) has recently been chosen as a management indicator in many forested North American landscapes (James 1993, James *et al.* 1995, Johnson 1987, McGarigal and Fraser 1985).

1.1 The Issue

Habitat destruction has accounted for bigger reductions in raptor and other wildlife populations than any other factor (Newton 1979). The establishment of extensive forestry operations in Alberta has raised the importance of sustainable management for biodiversity. Farr (1992) noted that forests managed primarily for fiber production undergo regional changes in vegetation patterns, particularly in the age class distribution of forest stands. Clearcutting practices have the ability to dramatically alter the forests by opening up the canopy and creating edge. Habitat fragmentation reduces and isolates resources (Redpath 1995). Understanding how forest-dwelling species depend on the forests, is a big step towards understanding and managing our forests in a sustainable way.

It is not unusual for some forest-dwelling wildlife species to exhibit specific affinities and adaptations for old or undisturbed forest environments (Marcot 1995). The Spotted Owl has been at the center of a debate over forest management in the Pacific Northwest for at least a decade (Thomas *et al.* 1993, USDA 1992, USDI 1990). Spotted Owls preferentially select old

growth forests for all their life requisites (Forsman *et al.* 1984, Guitierrez *et al.* 1984, Carey *et al.* 1990) and are scarce in second-growth forests (Carey *et al.* 1992). The Barred Owl and Spotted Owl are closely related to one another and are considered by some authors as a superspecies (American Ornithologists' Union 1983, Johnsgard 1988).

The Barred Owl was chosen for study because it has the potential to serve as an indicator of the presence of old growth forests in Alberta. Indicator species are measurable surrogates for environmental end points such as biodiversity. According to Noss (1990), an indicator should be sufficiently sensitive to provide an early warning of change.

Foresters usually consider old growth stands to be over-mature or decadent (Patton 1992). Older forests are usually targeted for harvesting because they contain large volumes of fiber, have insects and disease, and have slowed growth rates (low mean annual increment). The status of Canada's remaining old growth forests is of growing concern, because of the high rate of harvest (Ellis 1993).

There is no generally accepted definition of old growth forest (Hunter 1990). Old growth forests, as defined in this thesis, are characterized by large diameter trees (>35 cm dbh in Alberta), multilayered canopies, trees of a wide range of sizes and ages, and the presence of standing and downed dead woody material (Heinrichs 1983). These forests can be very dense to relatively open depending on the dominant trees. The canopy in coniferous dominated stands will be more closed while in deciduous-dominated stands will be more open. Old growth forests include climax forests, but do not exclude sub-climax or even mid-seral forests (British Columbia Ministry of Forests 1992). Dominant trees are close to or older than their age of physiological maturity, therefore the old growth stage can be reached at different ages depending on the site, the ecosystem type, and the dominant tree species (Duchesne 1994).

1.2 The Foothills Model Forest

As a part of Canada's Green Plan, the federal government established a network of model forests, that would serve as a testing ground for new economically and ecologically sound approaches to forest management. A model forest is defined as a working scale forest that is managed for a sustainable supply of timber, but must also integrate other important values such as water quality, biological diversity, wildlife habitat, community stability, and recreational, cultural, and/or spiritual values (Forestry Canada 1993).

The Foothills Model Forest is one of ten model forests that were established across Canada in 1992. The Foothills Model Forest's mission is "to develop and recommend an approach to sustainability and integrated resource management through research and technology by means of collaborative partnerships." These partners include Forestry Canada, Alberta Department of Environmental Protection, Weldwood of Canada, Alberta Environmental Training Center, Jasper National Park and Forestry Canada. The purpose and rationale of this study was to determine what key habitat features are important to the Barred Owl in the Foothills Model Forest and provide this information to forest managers to try to ensure populations of Barred Owls are maintained.

The Foothills Model Forest (FMF) is located in west-central Alberta (Figure 1-1) and includes the Weldwood of Canada Forest Management Area, William A. Switzer Provincial Park, the Cache Percotte Forest, and Jasper National Park. The Wilmore Wilderness Area was also recently added. The FMF total area is 2.3 million hectares and covers portions of the Foothills and Rocky Mountain Natural Regions. The Foothills Natural Region is divided into Lower and Upper Foothills Subregions. The Rocky Mountain Region is divided into three Subregions: the Montane, Subalpine, and Alpine (Beckingham *et al.* 1996).

This study was restricted to accessible areas in the Upper Foothills, Lower Foothills, Montane, and Subalpine Subregions. Lodgepole pine (*Pinus contorta*) and Engelmann spruce (*Picea engelmanii*) dominate the lower and higher elevations in the FMF (Table 1-1).

Table 1-1: Distribution of tree species among subregions in FMF (Strong and Leggat 1981).

Species	Scientific Name	Lower Foothills	Upper Foothills	Montane	Subalpine
Lodgepole Pine	*Pinus contorta*	D	D	D	D
White Spruce	*Picea glauca*	C	C	C	R
Engelmann Spruce	*Picea engelmanii*	X	R	X	C-D
Black Spruce	*Picea mariana*	C	C	O	R
Balsam Fir	*Abies balsamea*	O	O	X	X
Subalpine Fir	*Abies lasiocarpa*	X	X	R	C
Douglas Fir	*Pseudotsuga menziesii*	X	X	C	R
Aspen	*Populus tremuloides*	C	O	C	O
Balsam Poplar	*Populus balsamifera*	O-C	O	O	O
White Birch	*Betula papyrifera*	O	O	X	X
Tamarack	*Larix laricina*	O	O	O	X

D=dominant, C=common, O=occasional, R=rare, X=not present

Figure 1-1: Map showing the location of the Foothills Model Forest in west-central Alberta.

1.3 The Barred Owl

Ecologies of most owl species, particularly forest-dwellers, are still relatively unknown. The Barred Owl is widely distributed throughout North America, ranging from the East Coast to western Canadian provinces (American Ornithologists' Union 1983). It is found from the southern tip of Florida to southeastern Alaska.

There is little information available on the Barred Owl in western Canada except for British Columbia (Boxall and Stepney 1982). The Barred Owl is widely distributed in eastern and southern British Columbia, where it nests in natural cavities in living and dead trees. Only eight nests have been located in coniferous and mixedwood forests of Douglas fir, western red cedar, white spruce, and black cottonwood (now called balsam poplar, *Populus sp.*), usually near water (Campbell *et al.* 1990). The first records of Barred Owls in Saskatchewan were not made until 1955 (Houston 1959), and the first nest was not found until 1961 (Houston 1961). K. Mazur recently found 40 pairs of territorial Barred Owls during call surveys in the Prince Albert Model Forest, Saskatchewan (James *et al.* 1995).

The status of the Barred Owl is largely unknown in Alberta (Boxall and Stepney 1982). The first nest record for Alberta was in 1966 in Edmonton (Jones 1966) and Semenchuk (1992) reports only eight breeding records during the five year provincial bird atlas. They were found in the boreal forest region north of Edmonton, in the foothills/montane forests of western Alberta, and in Jasper National Park. Despite the recent sightings in the Wabasca region and a nest confirmed near La Crete in northern Alberta (Takats 1995), the Barred Owl is still considered rare in northern regions (McGillivray 1996).

The Barred Owl is a medium-sized owl with dark brown or brownish black eyes, a dull yellowish bill, no ear tufts, and a distinctive streaked pattern on the body. Horizontal dark brown streaks occur on the throat, separated by vertical streaks on the lower breast and flanks (Bent 1938, Johnsgard 1988). The tail, back, wings, and head are dark greyish-brown and barred heavily with white and/or buff. Greyish-white facial disks with a mixture of blackish brown and buffy white bars run concentrically around the eyes and the head is large and rounded. Supercilliary eyebrows and lores are dull grayish white or pale grayish (Figure 1-2). The Barred Owl is considered the most vocal of all the owls in North America (Semenchuk 1992). The typical call is a distinctive set of hoots, 'Who cooks for you, who cooks for you all'.

Figure 1-2: Photo of a Barred Owl showing the distinctive dark brown eyes and streaking on the chest. (photo by Stephen Glendinning)

Barred owl survival is dependent on the availability of food, areas for courtship and nesting, and sheltered perches for roosting (Nicholls and Warner 1972, Elody and Sloan 1985). The Barred Owl shows a strong association with mature and old growth forest types across its North American range (McGarigal and Fraser 1985). They have been found to have a close association with water (Bent 1938, Eckert 1974).

Average home range size of the Barred Owl varies from region to region. In Minnesota an average home range size of 229 ha (range 86 to 370 ha) was determined using radio telemetry (Nicholls and Warner 1972). Elody and Sloan (1985) reported that the average year round Barred Owl home range in Michigan was 282 ha, although during the summer months the home range averaged 118 ha. Hamer (1988) found that four pairs of owls in western Washington had a mean home range size of 905 ha. Bosakowski *et al.* (1987) reported a density of 0.07 pairs/km^2 in northern New Jersey, and Craighead and Craighead (1956) found the density of Barred Owls

in Michigan was 0.03 pairs/km^2. Barred Owl density and home range size in Alberta are unknown.

Owls do not build their own nests. Hollows in trees, old hawk and raven stick nests, and broken off trees (stubs) have been used by the Barred Owl (Bent 1938, Court, pers. comm., Mazur, pers. comm.). Stands with large diameter trees that are mature enough to provide natural cavities are preferred (Allen 1987). Little or nothing is written on pair bonding in this species (Johnsgard 1988).

Murray (1976) reported an average clutch size of 2.4 eggs from across the Barred Owl's range but that there may be increases in the average clutch size with increasing latitude. Bent (1938) found that the race *varia* had an average clutch size was 2.36 (range 2-4). One five-egg clutch in the National Museum may be the work of two females (Johnsgard 1988). The reported incubation time is 28 to 32 days in the United States (Dunstan and Varchmin 1985). Apfelbaum and Seelbach determined that the average number of nestlings was 2.02 (based on 55 broods). The young fledge in four to five weeks (Bent 1938). Roost sites are usually in thickly foliated trees 5 m or more above the ground (Duncan 1994, Voous 1988). There is little information on the life history of Barred Owls in Alberta.

Barred Owls are considered opportunistic feeders, or food generalists, and are known to prey on small mammals, birds, amphibians, reptiles, fish, and insects. Small mammals are the primary component of the Barred Owls diet (Bent 1938, Errington 1932, Earhart and Johnson 1970, Marks *et al.* 1984). Neither diet studies nor studies on roost and forage habitat have ever been conducted on the Barred Owl in Alberta.

1.4 Habitat Suitability Index Models

The goal of wildlife habitat modelling is to develop models that can be used to assess habitat relationships and to predict their sensitivity to perturbations. Habitat suitability index (HSI) models synthesize habitat use information into a framework appropriate for field application and are scaled to produce an index value between 0 (unsuitable habitat) and 1 (optimal habitat) (Allen 1987, Van Horn and Weins 1991). An assumption in HSI models is that there is a direct linear relationship between the HSI value and carrying capacity (USDA 1981). If this is true then, the models can further be used to predict current and future wildlife carrying

capacities for various management actions, by using a timber supply model to predict various future states of the forest (Beck and Beck 1995).

HSI models can be constructed from basic life history information or by modifying existing habitat models. A draft model was written for the Barred Owl (Olsen *et al.* 1995) based on a literature review and personal communications. The model is based on the assumption that reproductive habitat is the most limiting characteristic of year-round Barred Owl distribution. Models based on literature need to be validated and, if necessary, modified to perform adequately in the geographic area being evaluated (O'Neil *et al.* 1988).

1.5 Objectives

There are six objectives that will be covered in this thesis:

1. To determine the distribution and abundance of the Barred Owl in the Foothills Model Forest.
2. To determine what other owl species are found in the Foothills Model Forest and their relative abundance.
3. To test some of the environmental conditions affecting broadcast surveys, and provide recommendations for a standardized method during the breeding season.
4. To determine the habitat (nesting, roosting, and foraging) associated with the presence of the Barred Owl.
5. To determine the prey available to, and the prey selected by, the Barred Owl.
6. To validate, and if necessary, modify the Draft Habitat Suitability Index Model for the Barred Owl (Olsen *et al.* 1995).

1.6 Literature Cited

Allen, A.W. 1987. Habitat suitability index models: Barred Owl. U.S. Fish and Wildlife Service Biological Report 82. 17 pp.

American Ornithologists' Union. 1983. Check-list of North American birds, 6th edition. American Ornothologists' Union, Washington, DC. 877 pp.

Beck, J.A. and B.H. Beck. 1995. Integration of timber and wildlife habitat supply. Final report to Canada Alberta Partnership Agreement in Forestry. Forestry Canada Regional Development, Edmonton, Alberta. 110 pp.

Beckingham, J.D., I.G.W. Corns, and J.H. Archibald. 1996. Field guide to the ecosites of west-central Alberta. Natural Resources Canada, Canadian Forest Service, Northwest Region, Northern Forestry Center, Edmonton, Alberta.

Bent, A.C. 1938. Life histories of North American birds of prey. Dover Publications, Inc. New York, New York. Pp. 182-197.

Boxall, P.C. and P.H.R. Stepney. 1982. The distribution and status of the barred owl in Alberta. The Canadian Field-Naturalist 96(1): 46-50.

British Columbia Ministry of Forests. 1992. Toward an old-growth strategy. Public Review Draft.

Campbell, R.W., N.K. Dawa, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. (eds.). 1990. The birds of British Columbia. University of British Columbia Press, Vancouver, BC.

Carey, A.B., J.A. Reid, and S.P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon Coast Ranges. Journal of Wildlife Management 54:11-17.

Carey, A.B., S.P. Horton, and B.L. Biswell. 1992. Northern spotted owl: influence of prey base and landscape character. Ecological Monographs 62(2): 223-250.

Duchesne, L.C. 1994. Defining Canada's old-growth forests – problems and solutions. The Forestry Chronicle 70(6): 739-744.

Duncan, J.R. 1994. Barred owl habitat use literature review. Report to the Manitoba Raptor Foundation, Balmoral, Manitoba. 23 pp.

Dunstan, T.C. and T.E.M. Varchmin. 1985. Behavioral and physical development of barred owls, *Strix varia*. Proceedings of the Raptor Research Foundation Symposium on Nov 9-10 in Sacramento, CA.

Earhart, C.M. and N.K. Johnson. 1970. Size, dimorphism, and food habits of North American owls. Condor 72(2): 251-264.

Eckert, A.W. 1974. The owls of North America (north of Mexico). Doubleday and Co., Inc., Garden City, New York.

Ellis, L. 1993. Canadian old growth forests, a status report from Newfoundland to British Columbia. Canadian Parks and Wilderness Society. 42 pp.

Elody, B.J. and N.F. Sloan. 1985. Movements and habitat use of barred owls in the Huron Mountains of Marquette County, Michigan, as determined by radio-telemetry. Jack-Pine Warbler 63(1): 3-8.

Errington, P.L. 1932. Food habits of Southern Wisconsin raptors, Part 1 Owls. The Condor 34: 176-184.

Ewins, P.J. and C.S. Houston. 1992. Recovery patterns of ospreys, *Pandion haliaetus*, banded in Canada up to 1989. Canadian Field-Naturalist 106: 361-365.

Farr, D. 1992. Bird abundance in spruce forests of west central Alberta: the role of stand age. In Birds in the Boreal Forest by D.H. Kuhnke (ed.). Proceedings of a workshop held March 10-12 in Prince Albert, Saskatchewan. Forestry Canada. Pp. 55-62.

Forestry Canada. 1993. The state of Canada's forest 1992. Forestry Canada, Communications Division, Ottawa. Ministry of Supply and Services Canada. 112 pp.

Forsman, E.D., E.C. Meslow, and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs 87: 1-64.

Fyfe, R.W., S. Temple, and T.J. Cade. 1976. The 1975 North American peregrine falcon survey. Canadian Field-Naturalist 90: 228-273.

Gutierrez, R.J. and A.B. Carey. 1984. Ecology and management of the spotted owl in the Pacific Northwest. USDA. Forest Service, General Technical Report PNW-185.

Gutierrez, R.J, D.M. Solis, and C. Sisco. 1984. Habitat ecology of the spotted owl in north-western California: implications of management. Proceedings of the Society of American Foresters 1983. Pp. 368-373.

Hamer, T.E. 1988. Home range size of the northern barred owl and northern spotted owl in western Washington. MSc. Thesis, Western Washington University. 85 pp.

Heinrichs, J. 1983. Old growth comes of age. Journal of Forestry 81(12): 776-779.

Hickey, J.J. (ed.). 1969. Peregrine falcon populations: their biology and decline. University of Wisconsin Press, Madison, WI.

Houston, S. 1959. First records of the Barred Owl in Saskatchewan. Blue Jay 17(3): 94.

Houston, S. 1961. First Saskatchewan nest of barred owl. Blue Jay 19(3): 114-115.

Howie, R. 1980. The spotted owl in British Columbia. In Threatened and Engangered Species by R. Stace-Smith, L. Johns, and P. Joslin (eds.). B.C. Ministry of the Environment, Victora, B.C. Pp. 96-105.

Hunter, M.L. 1990. Wildlife, forests, and forestry. Regents/Prentice Hall, Englewood Cliffs, New Jersey. 370 pp.

Hunter, P. and D. Baird. 1994. The bald eagle in Ontario's Great Lakes basin. Bird Trends, Canadian Wildlife Service. Environment Canada, Ottawa, ON. Pp. 17-18.

James, P.C. 1983. Oldgrowth and owls: what have we learned. In Birds in the Boreal Forest: Proceedings of a Workshop Held March 10-12 in Prince Albert, Saskatchewan by D.H. Kuhnke, ed. Pp. 70-79.

James, P.C. 1989. Trends in the winter distribution and abundance of burrowing owls in North America. American Birds 43: 1224-1225.

James, P.C., K.M. Mazur, and S.D. Frith. 1995. The Barred Owl as an indicator of old forest and its role in long-term forestry planning. Annual Report. Saskatchewan Environment and Resource Management. 27 pp.

Johnsgard, P.A. 1988. North American owls: biology and natural history. Smithsonian Institution. 295 pp.

Johnson, D.H. 1987. Barred owls and nest boxes: results of a five-year study in Minnesota. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 129-134.

Jones, E.T. 1966. Barred owl nest record for Alberta. The Blue Jay 24: 140.

Kirk and Hislop. In press. Population status and recent trends in Canadian raptors: a review. Conservation Biology.

Marcot, B.G. 1995. Owls of old forests of the world. General Technical Report PNW-GTR-343. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 64 pp.

Marks, J.S., D.P. Hendricks, and V.S. Marks. 1984. Winter food habits of barred owls in western Montana. Murrelet 65(1): 27-28.

McGarigal, K. and J.D. Fraser. 1985. Barred owl responses to recorded vocalizations. Condor 87(4): 552-553.

McGillivray, W.B. 1996. A survey of summer birds in north-central Alberta. Alberta Naturalist 26(4): 75-77.

Muir, J. 1916. A thousand mile walk to the gulf. Houghton Mifflin Company, Boston, MA.

Murray, G.A. 1976. Geographic variation in the clutch sizes of seven owl species. Auk 93: 602-613.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, South Dakota. 399 pp.

Nicholls, T.H. and D.W. Warner. 1972. Barred owl habitat use as determined by radio-telemetry. Journal of Wildlife Management 36(2): 213-224.

Noble, D.G., J.E. Elliott, and J.L. Shutt. 1993. Environmental contaminants in Canadian raptors, Technical Report Series No. 91. Canadian Wildlife Service, Environment Canada, Ottawa, ON.

Noss, R.F. 1990. Indicators of monitoring biodiversity: a hierarchical approach. Conservation Biology 4(4): 355-364.

Oliphant, L. 1994. A report on results of national and regional ornithological surveys in Canada. Bird Trends 4:1.

O'Neil, L.J., T.H. Roberts, J.S. Wakely, and J.W. Teaford. 1988. A procedure to modify habitat suitability index models. Wildlife Society Bulletin 16: 33-36.

Olsen, B., L. Takats, B. Beck, and J. Beck. 1995. Barred Owl (*Strix varia*) breeding habitat: draft habitat suitability index model. In Habitat Suitability Index Models for 35 Wildlife Species in the Boreal Foothills of West-Central Alberta. Interim Report, Foothills Model Forest, Hinton, Alberta. 11 pp.

Patton, D.R. 1992. Wildlife habitat relationships in forested ecosystems. Timber Press, Inc. 392 pp.

Redpath, S.M. 1995. Impact of habitat fragmentation on activity and hunting behavior in the tawny owl, Strix aluco. Behavioral Ecology 6(4): 410-415.

Semenchuk, G.P.(ed.). 1992. The atlas of breeding birds of Alberta. Federation of Alberta Naturalists, Edmonton, Alberta. 371 pp.

Shutt, L. 1994. Environmental contaminants in Canadian raptors. Bird Trends, Canadian Wildlife Service, Environment Canada, Ottawa, ON. Pp. 26-27.

Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources, Edmonton, Alberta. Technical Report T/4.

Takats, D.L. 1995. Rare bird sightings in the boreal forest of northern Alberta. Alberta Naturalist 25(4): 79-81.

Thomas, J.W., M.G. Raphael, R.G. Anthony. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest: the report of the scientific analysis team. Portland, OR: Pacific Northwest Region.

USDA. 1981. Standards for the development of habitat suitability index models 103 ESM. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Release No. 1-81, 103-EMS-F-4. 105 pp.

USDA. 1992. Final environmental impact statement on management for the northern spotted owl in the National Forest. Forest Service, Portland, OR.

USDI. 1990. Endangered and threatened wildlife; determination of threatened status for the northern spotted owl; final rule. Fish and Wildlife Service, Portland, OR.

Van Horne, B. and J.A. Weins. 1991. Forest bird habitat suitability models and the development of general habitat models. U.S. Fish and Wildlife Service, Report 8. 31 pp.

Voous, K.H. 1988. Owls of the northern hemisphere. MIT Press, Cambridge, MA.

Wellicome, T.I. 1997. Status of the burrowing owl (*Speotyto cunicularia hypugaea*) in Alberta. Alberta Wildlife Status Report No.11. 21 pp.

Whelan, P. 1996. Swainson's still in trouble. Raptor Watch 10(2): 1. Hawk Watch International.

Chapter 2

Broadcast Surveys in the Foothills Model Forest, Alberta: The Abundance of Owls and the Effects of Environmental Conditions on Call Rate

"A moonlit lake by wood canoe,
Where grebes would dance and loons would wail.
A Barred Owl's low *who cooks for you*,
A frosted mug, with draft drawn ale."

-J. Butler (Winter Reflections on a Year Gone By)

2 Introduction

To effectively manage wildlife, knowledge of distribution, relative abundance and, if possible, density of the wildlife population is important (Mosher and Fuller 1996). Raptors are difficult to study in the field because they occur at low densities in most areas, tend to have large home ranges, are extremely mobile, often inhabit remote inaccessible areas, and can be secretive (Craighead and Craighead 1969, Pendleton *et al.* 1987). Owls are even more difficult than other raptors to study because of their nocturnal habits and their propensity to nest in inconspicuous places (McGarigal and Fraser 1985).

Fuller and Mosher (1987) describe a number of techniques for surveying raptors: road surveys, foot surveys, aerial surveys, boat surveys, and broadcast surveys. Broadcast surveys in avian censusing are used for the following applications: (1) nocturnal species (eg. Owls), (2) species found in inaccessible areas, (3) species with large territories, and (4) species with low or barely audible calls (Johnson *et al.* 1981). These surveys are one of the most widely used techniques to locate and census owls (Holt 1959, Fuller and Mosher 1981, Johnson *et al.* 1981, Smith 1987). Owls vocalize to communicate with their mates, to delineate territory, and to signal its occupancy (Nichols and Fuller 1987). They aggressively establish, maintain, and protect their spatial relationships (Gill 1990). Territorial defense is generally strongest at the start of the breeding season and subsides later (Newton 1979). Imitating or broadcasting tape recordings of owl vocalizations can invoke vocal responses and/or approach from many species of owls (Fuller and Mosher 1981, Duncan and Duncan 1993).

Location, habitat selection, and abundance indices of an owl population can be determined by recording the number and location of spontaneously calling individuals. Broadcasts can also be utilized to help locate nesting pairs, and increase detection rates (Bibby *et al.* 1992, Devereux and Mosher 1984, Fuller and Mosher 1987), particularly in forested areas where owls are difficult to detect. Response rates during broadcast surveys vary among owl species but can be as high as 82.4% in the Barred Owl (*Strix varia*) (Bosakowski 1987). There are few published references that measure effects of weather on owl censusing (Robbins 1981b). Environmental conditions such as wind velocity, precipitation, and temperature can directly affect owl call counts (Fuller and Mosher 1987). Time of day can also affect counts, for example up to 79% of records of Screech (*Otus asio*), Great Horned (*Bubo virginianus*) and Barred Owls during four hour Breeding Bird Surveys were clustered in the sunrise hour (Robbins 1981a).

Holroyd and Van Tighem (1983) documented the status of owl species in the Jasper area (Table 2-1). Semenchuk (1992) describes the distributions of the Great Horned Owl and Northern Saw-whet Owl as widespread and common, the Northern Hawk-Owl, Great Gray Owl, Boreal Owl, Burrowing Owl, Northern Pygmy Owl, Short-eared and Long-eared Owls as fairly common but restricted to certain parts of the province, and the Barred Owl as the rarest owl in the province. The Snowy Owl is a winter visitor to the province.

Table 2-1: Status and distribution of owls in Jasper National Park (Holroyd and Van Tighem 1983).

Species	Status and Distribution
Great Horned Owl (*Bubo virginianus*)	Uncommon year round resident.
Snowy Owl (*Nyctea scandiaca*)	Very rare visitor or migrant.
Northern Hawk-Owl (*Surnia ulula*)	Very rare resident.
Northern Pygmy Owl (*Glaucidium gnoma*)	Uncommon resident.
Burrowing Owl (*Speotyto cunicularia*)	Not recorded.
Barred Owl (*Strix varia*)	Rare resident.
Great Gray Owl (*Strix nebulosa*)	Very rare resident.
Long-eared Owl (*Asio otus*)	Not recorded.
Short-eared Owl (*Asio flammeus*)	Very rare visitor.
Boreal Owl (*Aegolius funereus*)	Rare resident.
Northern Saw-whet Owl (*Aegolius acadicus*)	Uncommon resident in spring/summer.

This paper describes the species and abundance of owls in the Foothills Model Forest, and evaluates some of the environmental conditions (i.e. moon phase, cloud cover, wind, precipitation, time of night, time of year, species of owl call used) that affect call rates in owls. The results were used to suggest some standard methods for conducting broadcast surveys.

2.1 Methods

2.1.1 Study Area

The Foothills Model Forest (FMF) is located in west-central Alberta, Canada, surrounding the town of Hinton, and includes the Weldwood of Canada Forest Management Area, William A. Switzer Provincial Park, the Cache-Percotte Forest, and Jasper National Park. Broadcast surveys were restricted to within 80 km of the town of Hinton, as it was not feasible to survey the entire

2.3 million ha of the FMF. This study area is dominated by Lodgepole Pine (*Pinus contorta*) throughout the Foothills Natural Region of the FMF. Trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white spruce (Picea glauca), black spruce (*Picea mariana*), and balsam fir (*Abies balsamea*) are common and Engelmann spruce (*Picea engelmanii*), and Douglas fir (*Pseudotsuga menziesii*) are uncommon. The forest stands range from young to old and are continuous to fragmented (naturally and anthropogenically).

2.1.2 Transects

Eberhardt and Thomas (1991) stated that the basic approach in descriptive sampling is to choose samples randomly. In 1995, ten-16 km transects were randomly located along roads within an 80 km radius of Hinton according to the following procedure (Figure 2-1):

- 100 townships (6x6 miles) were numbered 1 to 100 (each township had 36 sections),
- townships were randomly chosen, and sections within those townships were randomly chosen,
- if a road was present in the section, the direction the transect was laid was randomly chosen.

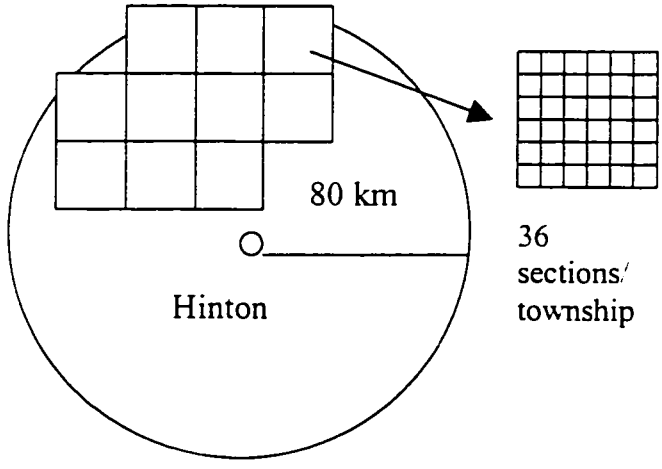


Figure 2-1: Layout of townships and sections randomly chosen for transect surveys.

In 1996, a second set of nine additional transects were set non-randomly (variable lengths), to cover more area and to include Jasper National Park (which joined the Model Forest in September, 1996). By using transects the range of habitats were sampled and large areas were covered efficiently (Fuller and Mosher 1987, Van Horne 1983). Transects were separated by at least 5 km and were spaced far enough apart so that calls could not be heard on more than one

transect (Anderson *et al.* 1979). The roadways that were used for surveys had variable widths (range of 15 to 75 meters).

Stearns (1947) and Smith (1978) recorded Barred Owl calling up to 0.8 km away and Bondrup-Nielsen (1978) found that Boreal Owls could be heard up to 1.5 km. Equally spaced broadcast stations were set along all of the transects at 1.6 km intervals, to reduce the chances of recording the same owls calling at different stations, but to ensure that few owls were missed. Roads had to be 4x4 truck accessible in winter and could not be major log hauling routes for reasons of safety for the researcher and improved detectability of owls.

2.1.3 Broadcast Surveys

Owl calls are a major courtship signal. Broadcast surveys were conducted during the owls' breeding season (March through May, 1995 and 1996) because call rate during the breeding season is significantly higher than in the non-breeding season (Bosakowski 1987). Transects were completed four times in 1995 and three times in 1996. It was determined that only one survey per month for three months was needed after reviewing the 1995 data and finding that only two additional owls were recorded with the fourth survey.

A Sony Mega Bass Sports ghetto blaster was used at half volume. This volume was chosen because it could not be heard at a distance of more than 600 meters (by the human ear). The blaster was slowly rotated continuously 360° during each 20 second broadcast, to ensure the sound traveled in all directions.

All stops began with a two minute listening period and ended with a five minute listening period. On the first 10 transects only Barred Owl taped calls were played. Tapes were made from a random combination of different Barred Owl call types: pair duetting, single female calling, single male calling (Voices of the New World Owls by Hardy, Coffee, and Reynard; Peterson Guide to Western Bird Songs; Peterson Guide Eastern/Central Birding By Ear; and the Alberta Owl Prowl by Beck and Beck). The two minute silent listening period was followed by a series of six 20 second Barred Owls broadcasts with one minute silent listening periods after each broadcast. The total survey time was 15 minutes for each station (2 minutes + 6 x 20 seconds + 6 x 1 minute + 5 minutes). If a call was heard but could not be identified in the 15 minutes, up to 10 additional minutes of listening was added (no more than this amount of time was added to ensure that a transect could be completed within the four hour night time interval).

On the second set of nine transects, broadcasts of three different owl calls (Barred Owl, Boreal Owl, and Great Gray Owl) were played in sequence, twice over and separated by one minute listening periods (Boreal and Great Gray Owl calls taken from Alberta Owl Prowl by Beck and Beck).

The sequence of conducting transects was determined randomly during three night time periods, 20:00 to 23:59, 0:00 to 3:59, and 4:00 to 7:59 (Mountain Standard Time was changed to Mountain Daylight Time in April). Counts were not usually conducted in inclement weather (heavy precipitation or strong wind), although if inclement weather started during the latter part of a survey route, the route was completed. Environmental conditions recorded at each stop included: start time of survey, time of response (according to the clock), temperature (°C), wind speed (Beaufort scale, used in Breeding Bird Surveys, see Table 2-2), precipitation (type-snow or rain and intensity-low, medium, or high), cloud cover (percent), moon phase (based on the calendar-new moon and eight quarters), moon visible or obscured by cloud at each station, and snow depth (centimeters).

All owl calls were recorded as follows: time of call, broadcast interval (8 listening intervals), owl species, direction and distance from the observer, and behavior type. Behavior types included: singing and not approaching, singing and approaching, silently approaching and singing, and silently approaching with no vocalization (Beck and Beck, 1988). A sample of a field datasheet is included (Appendix A). The locations of calling owls were recorded on maps, to reduce the chances of recounting the same territorial owl, and to aid in the interpretation of owl distributions (Fuller and Mosher 1987).

Table 2-2: Beaufort scale translations to wind speed and indicators.

Beaufort Number	Wind Speed in km/hr	Indicators of Wind Speed
0	Less than 2	Smoke rises vertically
1	2 to 5	Wind direction shown by smoke drift
2	6 to 12	Wind felt on face, leaves rustle
3	13 to 19	Leaves, small twigs in motion
4	20 to 29	Raises dust and loose paper; small branches move
5	30 to 38	Small trees sway; crested waves on inland waters

All data was entered into Microsoft Excel, and then imported into an SPSS (Statistical Package for the Social Sciences) for Windows (1996) package for analysis. Logistic regression

was performed on the variables: time of year, moon phase, moon visible, night time interval, cloud cover, and temperature, to test environmental effects on owl call rates. To test for interaction between moon phase and cloud cover, a logistic regression with a covariate was performed. Call rates were compared for precipitation and wind events, but no statistics were performed on the data because of low sample size. A comparison was made of the number of owls responding at different broadcast intervals, and the types of behavioral responses.

2.2 RESULTS

2.2.1 Calls

A total of 893 stops were completed during March, April, and May, 1995 and 1996. Six species of owls were recorded on the transect surveys (Table 2-3): Barred Owls, Boreal Owls, Great Gray Owls, Great Horned Owls, Northern Saw-whet Owls and Northern Pygmy Owls. A total of 300 calls from owls was recorded on the transect surveys, a rate of 0.34 calls per stop. Some owls responded on more than one survey, therefore, the total number of calls was more than the total number of territorial owls that was present (Figure 2-2).

The Boreal Owl was the most abundant owl recorded on these transects (128 calls), while the Northern Pygmy Owls and Great Gray Owls were the least abundant owls recorded (4 calls and 8 calls respectively). The Boreal Owl had a much lower call rate in the second year. Declines in call rates were also found for the Barred Owl and Northern Saw-whet Owl. Barred Owls, Boreal Owls, and Great Horned Owls had the highest territorial call rates (Figure 2-2). Great Grey Owls and Northern Pygmy Owls had very low call rates, however more were recorded from casual observations (Table2-4).

Calls and sounds from non-owl species were recorded at 16 stations and include: Wolves (*Canis lupus*), Coyotes (*Canis latrans*), Wood Frogs (*Rana sylvatica*), Boreal Chorus Frogs (*Pseudacris triseriata*), Northern Goshawk (*Accipiter gentilis*), Common Snipe (*Gallinago gallinago*), Common Nighthawks (*Chordeiles minor*), Gray Jay (*Perisoreus canadensis*), Common Loon (*Gavia immer*), and various unidentified species of waterfowl. Three other species of owls were recorded in the FMF, but not during broadcast surveys: Snowy Owl, Northern Hawk-Owl, and Short-eared Owl.

Table 2-3: Broadcast survey results showing the total number of calls from all species of owls in 1995 and 1996.

*Owl Species➡	BAOW		BOOW		GGOW		GHOW		NSOW		NPOW	
Transect ↓	**95**	**96**	**95**	**96**	**95**	**96**	**95**	**96**	**95**	**96**	**95**	**96**
Gregg Lake	8	8	7	1	0	1	4	5	2	0	0	0
Cold Creek	4	1	25	4	0	2	2	1	0	1	0	0
TriCreeks	2	1	6	0	0	0	4	4	5	2	1	0
Fish Creek	0	0	16	4	0	0	1	3	2	0	0	0
Pedley Road	1	1	3	0	1	1	3	2	4	1	0	0
WildHay Road	4	2	3	1	0	0	1	0	3	1	0	0
Medicine Lodge	1	0	15	9	1	0	2	8	0	6	0	0
Blackcat Ranch	10	6	4	0	0	0	2	0	1	3	0	0
Prest Creek	2	0	4	1	0	0	4	0	3	2	1	0
Lynx Creek	1	2	7	3	0	0	2	0	7	0	0	0
Sub-total	**33**	**21**	**90**	**23**	**2**	**4**	**25**	**23**	**27**	**16**	**2**	**0**
Paul's Road	-	0	-	4	-	0	-	0	-	1	-	0
Beaver	-	0	-	1	-	0	-	0	-	0	-	0
Mercoal	-	0	-	0	-	0	-	6	-	0	-	0
Cache Percotte	-	1	-	1	-	2	-	0	-	0	-	0
Q-road	-	0	-	0	-	0	-	1	-	0	-	0
Snaring	-	0	-	1	-	0	-	0	-	1	-	0
HW 93A	-	3	-	4	-	0	-	0	-	1	-	0
HW 93	-	0	-	1	-	0	-	0	-	1	-	1
Maligne	-	0	-	3	-	0	-	0	-	0	-	1
Sub-total	**-**	**4**	**-**	**15**	**-**	**2**	**-**	**7**	**-**	**4**	**-**	**2**
TOTAL	**33**	**25**	**90**	**38**	**2**	**6**	**25**	**30**	**27**	**20**	**2**	**2**
TOTAL (95&96)	**58**		**128**		**8**		**55**		**47**		**4**	

Table 2-4: Total number of the six species of owl recorded during the project, by all methods of observation.

*Owl Species➡	BAOW		BOOW		GGOW		GHOW		NSWO		NPOW	
Observation↓	**'95**	**'96**	**'95**	**'96**	**'95**	**'96**	**'95**	**'96**	**'95**	**'96**	**'95**	**'96**
First 10 transects	17	13	55	17	2	3	17	22	21	13	2	0
New transects	-	3	-	13	-	1	-	4	-	3	-	2
Casual observations	13	11	6	2	11	11	13	4	21	5	5	5
Total	**30**	**27**	**61**	**32**	**13**	**15**	**30**	**30**	**42**	**21**	**7**	**7**

*BAOW - Barred Owl, BOOW - Boreal Owl, GGOW - Great Gray Owl, GHOW - Great Horned Owl, NSWO -Northern Saw-whet Owl, NPOW - Northern Pygmy Owl

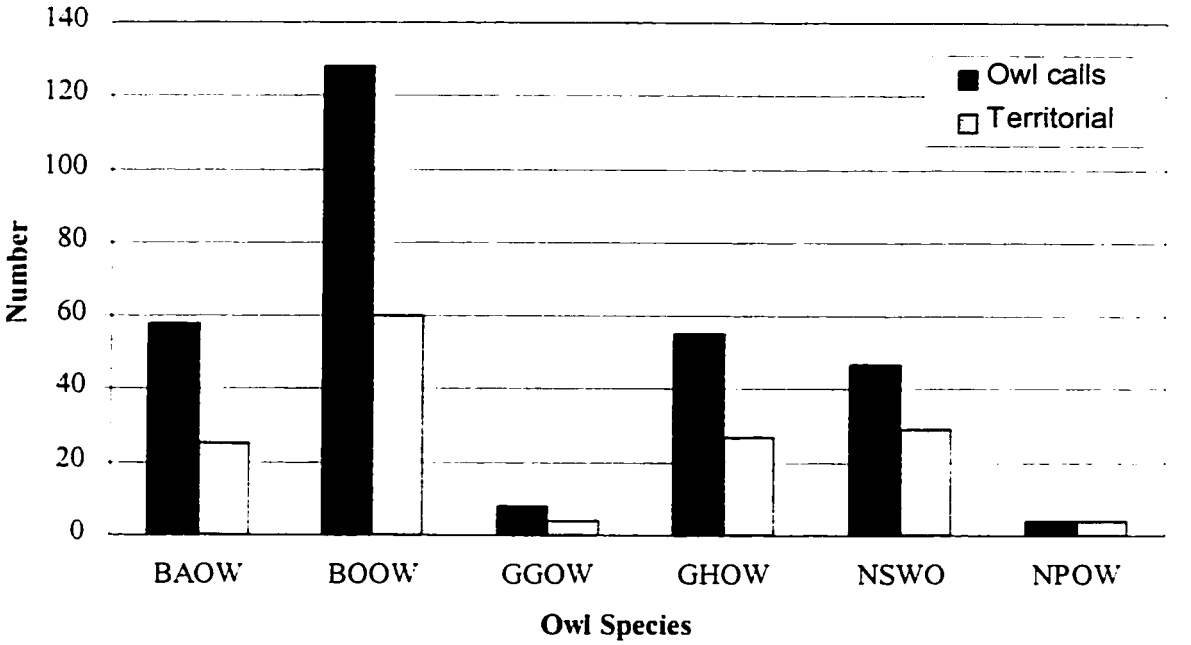


Figure 2-2: Graph showing total numbers of calls and total number of territorial owls recorded.

During 1996, I recorded 87 calls on the first ten transects (0.29 call rate), and 34 on the nine new transects (0.22 call rate). Call rate did not significantly increase (Logistic regression, Sig.=0.156) when the Great Gray and Boreal Owl calls were played in addition to the Barred Owl call, on the new transects. Seven test surveys were conducted in areas with three known Boreal Owls, to determine if they responded to Barred Owl broadcasts. When the Barred Owl call was played, three Boreal Owls that were calling spontaneously continued calling in all seven cases. Two Boreal Owls responded to the Barred Owl taped calls however, when a Boreal Owl call was played, the two Boreal Owls stopped calling on four different occasions. The Great Gray Owl call elicited responses from Great Gray Owls and Boreal Owls.

2.2.2 Environmental Conditions

Results from all transects were combined to test the effects of certain environmental conditions on owl call rates (call rate = number of owls that called/station). Overall, time of year did significantly affect the number of owl calls recorded (Logistic regression, Sig.=0.0246): 83 in March (28 percent), 118 in April (39 percent), and 99 in May (33 percent) (Table 2-5). April had the highest call rate in 1996 (0.43 calls/stop), but the lowest call rate in 1995 (0.16 calls/stop). Each species of owl had different peak calling months. Barred Owls hooted less in

March (13 calls) than in April (23 calls) and May (22 calls), whereas Northern Saw-whet Owls responded more in May (23 calls) than in March (7 calls) and April (17 calls). Boreal Owls called more in March (46 calls) and April (48 calls) than in May (34 calls).

Table 2-5: Number of owl calls recorded during each month in 1995 and 1996.

	March		April		May	
Species	1995	1996	1995	1996	1995	1996
Barred Owl	6	7	11	12	16	6
Boreal Owl	39	7	30	18	22	12
Great Gray Owl	0	1	0	4	2	1
Great Horned Owl	9	6	8	18	8	6
Northern Saw-whet Owl	5	2	5	12	17	6
Northern Pygmy Owl	1	0	0	0	1	2
Total	60	23	54	64	66	33
Month Totals	83		118		99	
% Calls Each Month	28		39		33	

Owl call rates varied significantly (Logistic regression, Sig.=0.0064) between night time intervals (Figure 2-3). Over all species of owls, time Intervals 1 and 3 had higher call rates than time Interval 2. Boreal Owls and Northern Saw-whet Owls had lower call rates in Interval 2, however, Barred Owls and Great Horned Owls had equal call rates in the three time intervals. Great Gray Owls responded more during time Interval 1 (50 percent of calls), while the Northern Pygmy Owl responded more in time Interval 2 (50 percent of calls).

Overall, more owls called in the initial two-minute silent period before the first broadcast than in any subsequent two minutes (43.7 percent) (Figure 2-4 and 2-5). In the two-minute silent listening period, 64.1 percent of Boreal Owl calls were recorded, whereas only 10 of the 58 Barred Owls (17.2 percent) were recorded. By the end of the fourth broadcast, most of the owl calls had occurred (88.7 percent). At the end of call Interval 5, 89.7 percent of the Barred Owls, 96.7 percent of the Northern Saw-whet Owls, and 83.6 percent of the Great Horned Owls had been recorded. All the Great Gray Owls and Northern Pygmy Owls had called by the end of call Interval 2. Boreal, Barred, and Great Horned Owls that called early in the broadcast sequence, usually (85 percent) continued to call throughout the entire 15 minutes that were spent at each station. Great Gray Owls and Northern Pygmy Owls did not call for more than a few minutes.

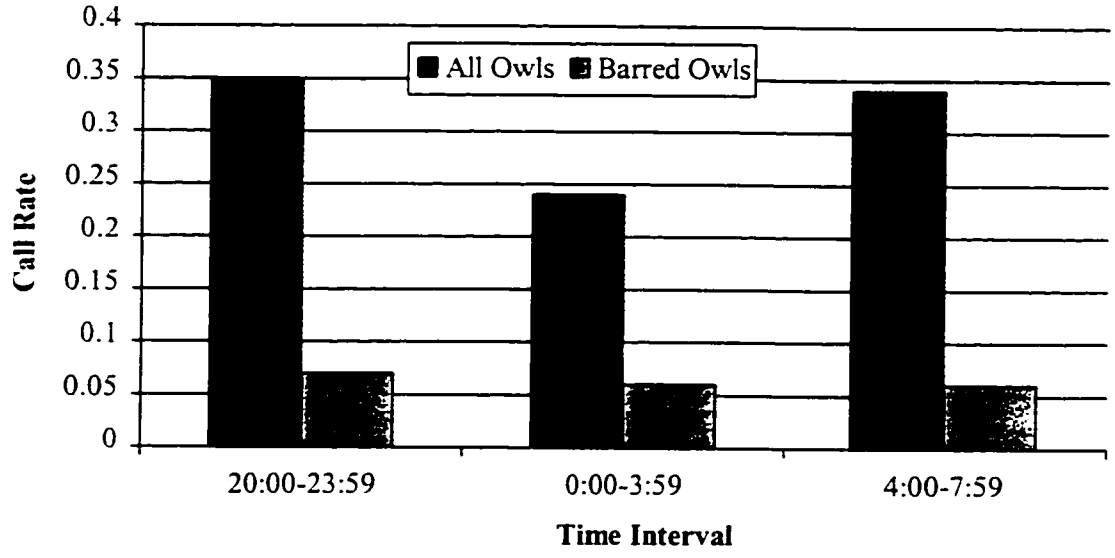


Figure 2-3: Overall call rate of all owls and Barred Owls at the different time intervals.

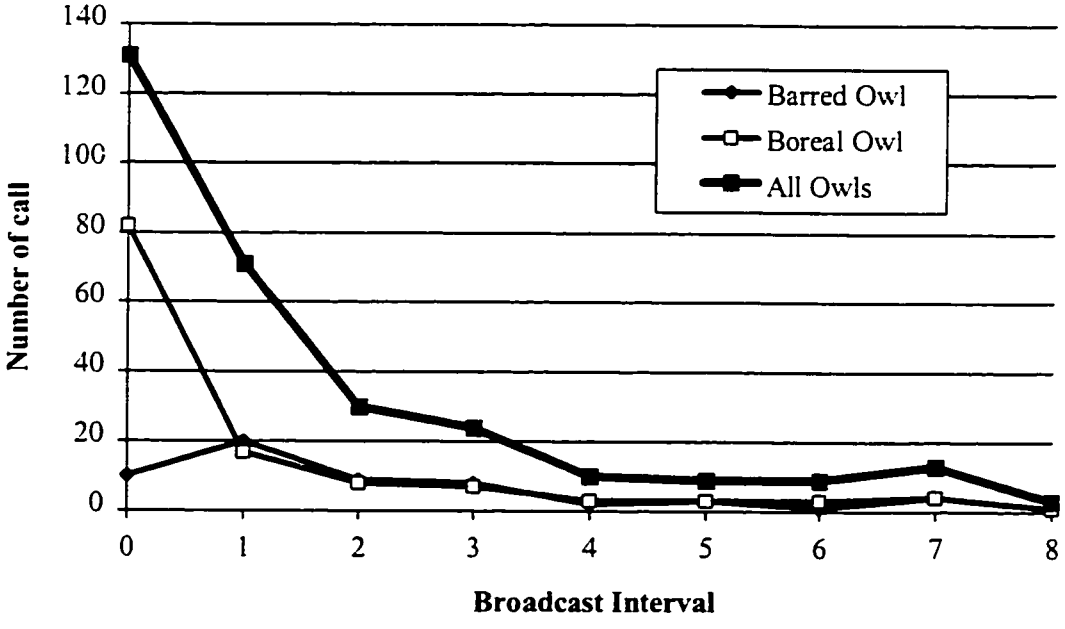


Figure 2-4: Number of new owls responding at different broadcast intervals (0=2 minute silent period, 1=after first broadcast, 2=after second broadcast, etc., 7=five minute listening, 8=10 minute listening).

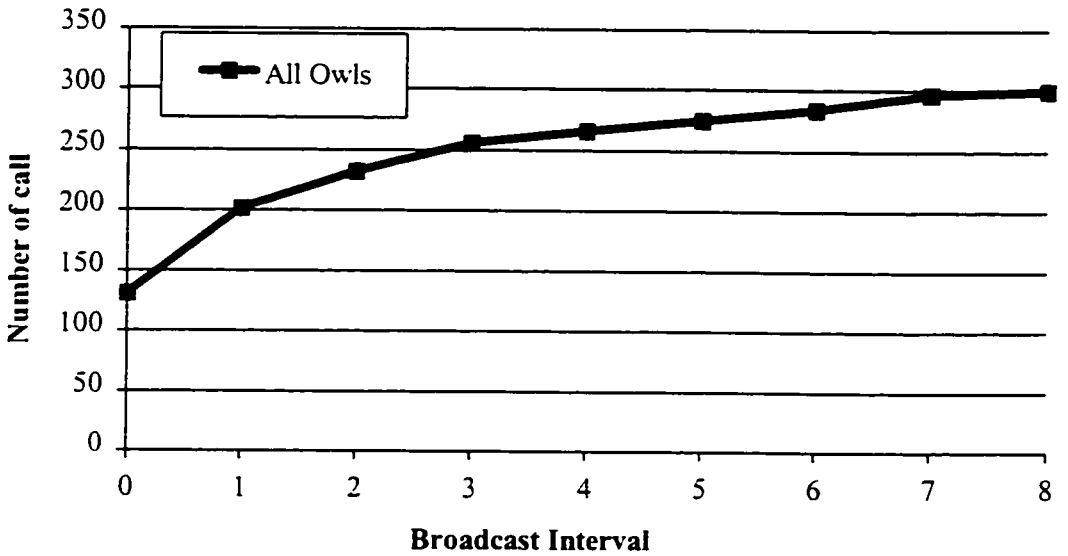


Figure 2-5: Cumulative number of new owls responding at different broadcast intervals (0=2 minute silent period, 1=after first broadcast, 2=after second broadcast, etc., 7=five minute listening, 8=10 minute listening).

Owls responded to the broadcasts in a variety of ways (Figure 2-6). Most of the owls (79 percent) responded by calling from distance. On 19 percent of the occasions, owls called and then approached. Nine owls were detected approaching silently. Only one Boreal Owl was detected silently approaching and singing. Great Horned Owls and Barred Owls were the only species recorded silently approaching and not singing. Northern Saw-whet (40) usually called from a distance but did not approach. Northern Pygmy Owls (4) and Great Gray Owls (8) did not approach on any occasions that were observed.

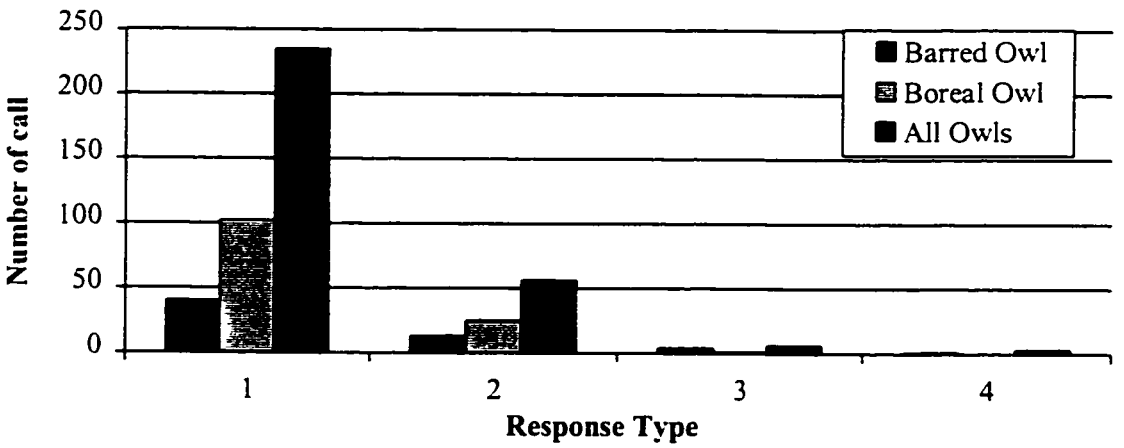


Figure 2-6: Owl responses to broadcast surveys (1=calls, does not approach, 2= calls, approaches, 3= silently approaches, calls, 4=silently approaches, no vocalization).

Owl broadcast surveys were conducted at temperatures ranging from -30 °C to +10 °C (Figure 2-7). Owls called at temperatures as low as -28 °C. The call rate increased with temperature, and was highest between -10 °C and +10 °C. The highest jumps in call rate occurred between –20 °C and –10 °C. Owl call rate dropped as wind speed increased (Figure 2-8). No owls were heard calling when winds exceeded Beaufort scale of 3 (over 19 km/hr).

Although most transects were not run during precipitation events, there were stops where precipitation was recorded. No owls were recorded calling during heavy precipitation events (Figure 2-9). Light snow had little effect on owl call rate, however moderate rain and snow did significantly decrease call rate. No owls were recorded calling during heavy precipitation events.

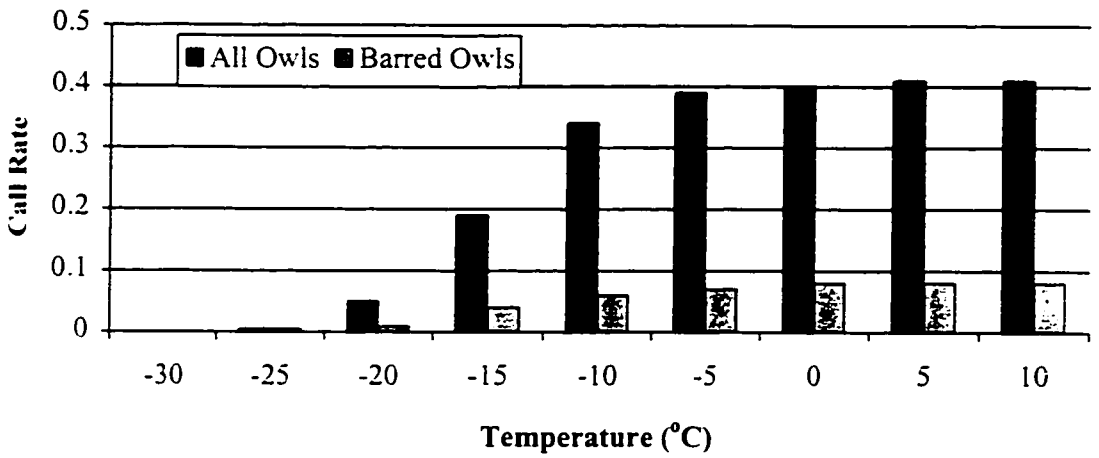


Figure 2-7: Call rates of all owls and Barred Owls as temperature increases (5 °C intervals).

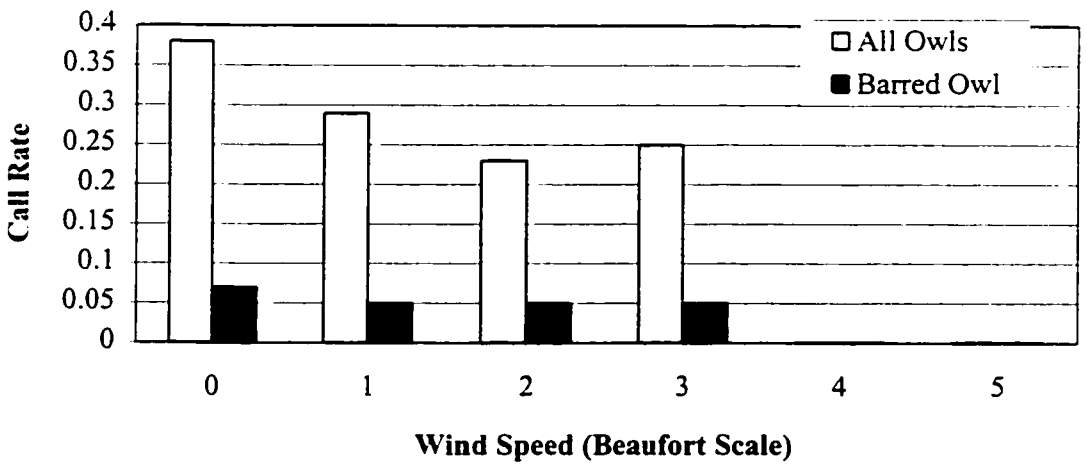


Figure 2-8: Overall call rate of all owls and Barred Owls at different Beaufort Scales.

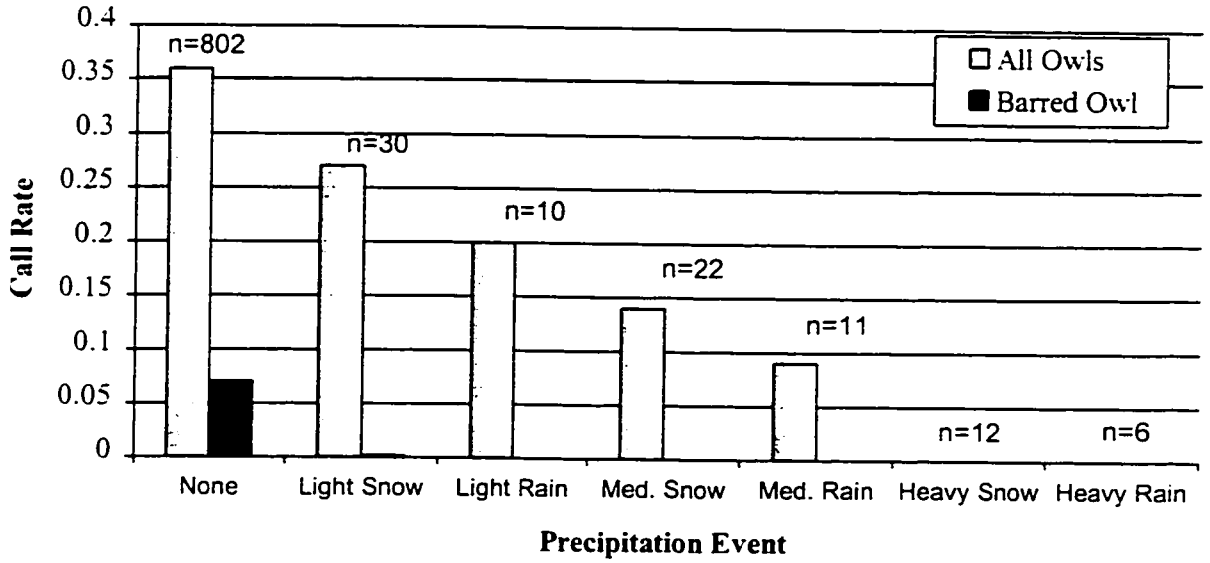


Figure 2-9: Overall call rates of owls in various amounts of precipitation (n=number of stops surveyed).

The moon phase had a significant effect on owl call rates (Logistic regression, Sig.=0.0025). Call rate was much higher at the full moon than the new moon, 0.42 and 0.16 calls/station respectively (Table 2-6). The highest call rate was recorded at an almost full moon. Cloud cover did not have a significant effect on call rate (Logistic regression, Sig.=0.5276). When moon phase and cloud cover were tested together as covariates, they significantly affected call rates (Logistic regression, Sig.=0.0249). Call rate was 0.40 when the moon was visible and 0.23 when the moon was not visible, therefore, the number of calls increased significantly when the moon was visible.

Table 2-6: Call rates during different moon phases.

*Moon Phase (x/8)	Call Rate
0	0.16
1	0.21
2	0.25
3	0.33
4	0.29
5	0.34
6	0.33
7	0.50
8	0.42

* Moon phase=0 is a new moon, moon phase=8 is a full moon.

2.3 Discussion

The most often overlooked avian species in censusing are the nocturnal owls (Johnson *et al.* 1981). A variety of techniques have been used to determine owl distribution and abundance. Researchers hope to produce density, or at least, relative abundance results (Skirvin 1981). Transect surveys, conducted during the night, were effective in determining distribution and relative abundance of four species of owls in the FMF: Barred, Boreal, Great Horned, and Northern Saw-whet Owls. This survey method has also been used in Manitoba (Duncan and Duncan 1993) and Ontario (Francis and Bradstreet 1997) to determine distribution and abundance of owls, in particular Barred, Boreal, and Northern Saw-whet Owls. Carpenter (1987) and Palmer (1987) also found that playback is an effective method for studying various species of owls.

Broadcast surveys were not effective for determining the abundance of Great Gray Owls (Table 2-2, 2-3 and Figure 2-2). Winter (1986) found that Great Gray Owls in the Sierra Nevadas, California readily responded to taped calls at almost any time and Brenton and Pittaway (1971) observed that Great Grays are visible primarily in early morning and late afternoon during the winter and early spring. Most of the Great Gray Owls recorded during this project were seen foraging during daylight hours along openings, and did not respond well to playback (Table 2-4). Under ideal conditions the calls of Great Grays can be heard 800 meters, although they often carry only about 500 meters (Mikkola 1983). The call stations were set 1.6 km apart, which may have contributed to a lower number of certain owl species being detected. As well, the owls may have moved further into the forest for nesting.

Broadcasts were also not effective for determining the abundance of Northern Pygmy Owls (Table 2-2 and Figure 2-2), and were heard calling during the day in many instances (Table 2-4). König (1968) found that the Eurasian Pygmy Owl called at dawn, dusk, and during the day, but rarely after dark. The Pygmy Owl has a smaller home range, is relatively secretive, and may not be found near roads, therefore it may not have been detected due to the spacing of the call stations.

McGarigal and Fraser (1985) had sampling periods that were 32 minutes long. They found that response rate of Barred Owls increased rapidly during the first 15 minutes and then leveled off. Francis and Bradstreet (1997) found that 56-65% of Boreal Owls were detected in the first

minute of listening time during broadcast surveys in Ontario. Most of the owl calls in this study (88.7%) were recorded within seven minutes, suggesting that stops can be shorter than 15 minutes. Many owls (43.7%) were calling spontaneously, before broadcasts were played.

Only Barred Owls increased their call rate after the first broadcast was played. Bosakowski *et al.* (1987) found that a longer period of time was needed to elicit a response from both members of a pair of Barred Owls. Many of the Barred Owls recorded on the transects appeared to be unmated. There is a possibility that longer time was needed at each stop, to encourage both the male and female to respond. Unmated owls may also respond better to broadcast surveys, as they may be still defending a territory and/or searching for a mate (Nowicki 1974, Cink 1975).

Using broadcasts of the larger owls is thought to inhibit the calling of smaller owls. McGarigal and Fraser (1985) found that using a Great Horned Owl call did not significantly affect the response of Barred Owls. Although I would caution against the use of the Great Horned Owl call, it appears using a large owl's (the Barred Owl) vocalizations was successful in eliciting calls from most of the common species of owls (Boreal, Great Horned, and Northern Saw-whet Owls) during the breeding season, in the FMF. Owls did not respond more when Great Gray Owl and Boreal Owl calls were utilized during the surveys, therefore using the Barred Owl call alone can elicit a high response rate from common owl species found in this area.

One must be careful when looking at the year to year variation of owls responding to the broadcast surveys. There are many environmental conditions that can affect call rate of owls, and may lead to conclusion that owl populations are declining. Palmer (1987) suggests that annual variation in numbers of owls calling may be linked to small mammal cycles, since this may be directly related to the fact that breeding may not occur if food supply is low. Throughout Alberta there was a small mammal population crash over 1995/96 (Pattie pers. comm.). As well, deep crusty snow conditions made foraging difficult for owls. This may account for the lower number of owls detected during 1996.

Call rates are found to be highest during the breeding season (Bosakowski *et al.* 1987). Great Horned Owls have a much earlier breeding season than the Barred Owls, and Northern Saw-whet Owls breed later than both these species (Johnsgard 1988). Extreme weather

conditions can inhibit calling, but as the breeding season progresses the birds can be affected less by weather (Armstrong 1963). The change in call rate due to weather can also contribute to the monthly variation in call rates. Temperatures would be colder in March than in April and May. Extremely low winter temperatures were found to inhibit the calling of Eastern Screech Owls in Wisconsin (Carpenter 1987), and Boreal Owls had reduced calling rate with colder temperatures (Bondrup-Nielsen 1978). Overall, this study found that call rate was highest at temperatures above −15°C (Figure 2-7 and 2-8), and therefore, surveys should not be run at temperatures below this temperature. Call rate remained relatively constant above this temperature, and therefore standardization of the data was unnecessary.

Environmental conditions directly affect owl vocalization rates in a number of ways. Owls do not respond well during heavy precipitation and high wind. Palmer (1987) found that the two factors that most affected Boreal and Saw-whet Owl calls were wind and precipitation. The single-most important weather variable influencing response to call playback was wind (Siminski 1976, Forsman 1983). Wind can directly affect the researcher's ability to hear owls calling and the owls' ability to hear the broadcast. As well, the wind may affect the ability of owls to fly or to detect prey (Smith 1987), therefore owl would not be actively moving around their territories to defend them. Robbins (1981b) also noted that, in poor environmental conditions, the total species observed might be near normal, but the number of individuals was reduced.

Cloud cover did not significantly influence either Boreal or Saw-whet owl calling activity during a study in Colorado (Palmer 1987). Mikkola (1983) found that Eagle Owls (*Bubo bubo*) called more on cloudless nights, whereas Hansen (1952) found the same trend with Tawny Owls (*Strix aluco*). The same results were found in the FMF. Cloud cover however affects whether the moon is visible or not, and in turn significantly affects call rate.

Moon phase can directly affect owl call rates (Armstrong 1963). O'Connor (1987) found that Boreal Owls were easier to detect during moonlit nights when they approached silently and did not vocalize. Northern Saw-whet Owls and Boreal Owls were heard calling more during a full moon phase than at any other time during a study in Colorado (Palmer 1987). The results of broadcast surveys in the FMF also showed that more owls called during the full moon phase (Table 2-6). The call rate follows an almost linear decline as moon phase decreases.

The sequence and time separations between calling vary dramatically in the literature, however, there seems to be some similarities. Many studies use a sequence of 20 seconds of song followed by listening period (Swengel and Swengel 1987, Duncan and Duncan 1993, Francis and Bradstreet 1997). This appears to be a good length of time for each call sequence, and allows the researcher time to listen for any owl call responses. The most important rule to follow is to set a standard sequence of calls and listening, to ensure transects and/or points can be compared to one another.

Finally, there is a definite possibility that many owls went undetected if they silently approached, and did not vocalize. It would be interesting to work with a known population of owls and test how accurate broadcast surveys are in predicting the relative abundance of the population. Another concern is disturbance of the owl's normal behavior. Broadcast surveys, although effective in surveying for owls increases the owl's risk of being preyed on, disrupts foraging and courtship, and can also draw females off their nests. This survey method should only be used for research purposes by trained people.

2.4 Suggestions for Standardized Breeding Season Surveys

1. A silent listening period of at least two minutes, before broadcasts, is recommended.
2. Run surveys: a half hour after sunset and before midnight, and/or after 04:00 until a half hour before sunrise to get the highest call rates from all owl species.
3. Repeat the survey routes three times, because owl calling activity is not constant between nights. Surveys should be run: in late March, in April and in early May, with a separation of about two to three weeks.
4. A minimum of seven minutes should be spent at each survey point. It is not necessary to spend more than 15 minutes.
5. The Barred Owl call will elicit responses from Great Horned, Boreal, Northern Saw-whet, and Barred Owls. A sequence of at least three 20 second duration calls should be played, each followed by one minute silent listening periods.
6. Transects are an excellent way to efficiently survey owls over large areas. Stations should be set a maximum of 1.6 km apart and no less then 0.8 km apart.
7. Information on the environmental conditions should be recorded at each stop. This information can be tested, to determine how environmental conditions affect call rates.

8. Surveys should not be run during temperatures below −15 °C and with winds higher than 3 on the Beaufort Scale.

9. Broadcast surveys can be used to survey Barred, Boreal, Great Horned, and Northern Saw-whet Owls, but other methods (e.g. daytime surveys) need to be used to survey other species that do not respond well to broadcasts.

2.5 Literature Cited

Anderson, D.R., J.L. Laake, B.R. Crain, and K.P. Burnham. 1979. Guidelines for line transect sampling of biological populations. Journal of Wildlife Management 43(1): 70-78.

Armstrong, E.A. 1963. A study of bird song. Oxford University Press, London. 335 pp.

Beck, B. and J. Beck. 1988. The greater Edmonton owl prowl. Alberta Naturalist 18(3): 97-100.

Bibby, C.J, N.D. Burgess, and D.A. Hill. 1992. Bird census techniques. Academic Press Inc., San Diego, CA. 257 pp.

Bondrup-Nielsen, S. 1978. Vocalizations, nesting and habitat preferences of the boreal owl (*Aegolius funereus*) in North America. MSc. Thesis, University of Toronto, Ontario. 158 pp.

Bosakowski, T. 1987. Census of barred owls and spotted owls. In: Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 307-308.

Bosakowski, T. R. Speiser, and J. Benzinger. 1987. Distribution, density, and habitat relationships of the barred owl in Northern New Jersey. In: Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 135-143.

Brenton, D.F. and R. Pittaway, Jr. 1971. Observations of the great gray owl in its winter range. Candian Field-Naturalist 85: 315-322.

Carpenter, T.W. 1987. Effects of environmental cariables on responses of Eastern screech owls to playback. In: Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 277-280.

Cink, C.L. 1975. Population densities of screech owls in northeastern Kansas. Kansas Ornithological Society 26: 13-16.

Craighead, J.J. and F.C. Craighead, Jr. 1969. Hawks, owls, and widlife. Dover Publications, Inc., NY. 443 pp.

Devereux, J.G. and J.A. Mosher. 1984. Breeding ecology of barred owls in the central Appalachians. Raptor Research 18(2): 49-58.

Duncan, J. and P. Duncan. 1993. Manitoba's nocturnal owl survey, progress report. Manitoba Department of Natural Resources, Wildlife Branch, Winnipeg, Manitoba. 20 pp.

Eberhardt, L.L. and J.M. Thomas. 1991. Designing environmental field studies. Ecological Monographs 61(1): 53-73.

Forsman, E.D. 1983. Methods and materials for locating and studying spotted owls. U.S. Forest Service General Technical Report, PNW-162. Portland, OR. 8 pp.

Francis, C.M. and M.S.W. Bradstreet. Monitoring boreal forest owls in Ontario using tape playback surveys with volunteers. In press for Proceedings of The Biology and Conservation of Owls of the Northern Hemisphere Conference held in Winnipeg, Manitoba, February, 1997.

Fuller, M.R. and J.A. Mosher. 1981. Methods of detecting and counting raptors: a review. In: Estimating Numbers of Terrestrial Birds by C.J. Ralph and J.M. Scott (eds.). Studies in Avian Biology 6. Pp. 235-246.

Fuller, M.R. and J.A. Mosher. 1987. Raptor survey techniques. In: Raptor Research Management Techniques Manual by B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird. National Wildlife Federation, Washington, D.C. Pp. 37-65.

Gill, F.B. 1990. Ornithology. W.H. Freeman and Company, New York, New York. 660 pp.

Hansen, A.L. 1952. Natuglens (*Strix a. aluco*) dogn-og ar Arsrytyme. Dansk Onr. For. Tids. 46: 158-172.

Holroyd, G.L and K. K.J. Van Tighem. 1983. The ecological (biophysical) land classification of Banff and Jasper National Parks, vol. 3, the wildlife inventory. Canadian Wildlife Service, Edmonton, Alberta. 691 pp.

Holt, J.B. 1959. Counting small owls at night. Audubon Mag. 6: 227-228.

Johnsgard, P.A. 1988. North American owls, biology and natural history. Smithsonian Institution, Washington, D.C. 295 pp.

Johnson, B.T., B.T. Brown, L.T. Haight, and J.M. Simpson. 1981. Playback recordings as a special avian censusing technique. In: Estimating Number of Terrestrial Birds by C.J. Ralph and J.M. Scott, eds. Studies in Avian Biology 6: Pp.68-75.

König, C. 1968. Vocalizations of Tengmalm's Owl (*Aegolius funereus*) and the pygmy owl (*Glaucidium passerinum*). Vogelvelt: 115-138.

McGarigal, K. and J.D. Fraser. 1985. Barred owl responses to recorded vocalizations. Condor 87(4): 552-553.

Mikkola, H. 1983. Owls of Europe. Buteo Books, Vermilion, SD. 397 pp.

Mosher, J.A. and M.R. Fuller. 1996. Surveying woodland hawks with broadcasts of great horned owl vocalizations. Wildlife Society Bulletin 24(3): 531-536.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, South Dakota. Pp. 13-17.

Nicholls, T.H. and M.R. Fuller. 1987. Territorial aspects of Barred Owl home range and behavior in Minnesota. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 121-128.

Nowicki, T. 1974. A census of screech owls using tape-recorded calls. Jack-Pine Warbler 52: 98-101.

O'Connell, M.W. 1987. Occurrence of the boreal owl in northeastern Washington. In: Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 185-188.

Palmer, D.A. 1987. Annual, seasonal, and nightly variation in calling activity of Boreal and Northern Saw-whet Owls. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 162-168.

Pendleton, B.A. Giron, B.A. Millsap, K.W. Cline, and D.M. Bird. 1987. Raptor management techniques manual. National Wildlife Federation, Washington, DC. 420 pp.

Robbins, C. 1981a. Effect of time of day on bird activity. In: Estimating Number of Terrestrial Birds by C.J. Ralph and J.M. Scott, eds. Studies in Avian Biology 6: 275-286.

Robbins, C. 1981b. Bird activity levels related to weather. In: Estimating Number of Terrestrial Birds by C.J. Ralph and J.M. Scott, eds. Studies in Avian Biology 6: 301-310.

Semenchuk, G.P. 1992. The atlas of breeding birds of Alberta. Federation of Alberta Naturalists, Edmonton, AB. 391 pp.

Siminski, D.P. 1976. A study of the great horned owls (*Bubo virginianus*) population density with recorded calls in northwestern Ohio. MSc. Thesis, Bowling Green State University, Bowling Green, Ohio.

Skirvin, A.A. 1981. Effects of time of day and time of season on the number of observations and density estimates of breeding birds. In: Estimating Number of Terrestrial Birds by C.J. Ralph and J.M. Scott, eds. Studies in Avian Biology 6: 271-271.

Smith, C.F. 1978. Distributional ecology of the barred and great horned owls in relation to human disturbance. MSc. Thesis, University of Connecticut, Storrs.

Smith D.G. 1987. Owl census techniques. In Raptor Research Management Techniques Manual by B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird. National Wildlife Federation, Washington, D.C

Steams, E.I. 1947. Notes on the abundance of the barred owl. Urner Field Observer 2:5-7.

Swengel S.R. and A.B. Swengel. 1987. Study of northern saw-whet owl population in Sauk County, Wisconsin. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 199-208.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47(4): 893 901.

Winter, J. 1986. The status, distribution and ecology of the great gray owl in California. MSc. Thesis, San Francisco State University.

APPENDIX 2-1: Sample data sheet used in the field for broadcast surveys.

Owling Transect Data Sheets

Date:_____ **Observer(s):**_____ **Transect:**_____

_____ _____

Time Interval: 1 2 3 **Visit :** _____

Owls Species	**Interval**	**Response Type**	**Tree Species**
BAOW-barred	0 first 2 minutes	1 sings, does not approach	Aw aspen
BOOW-boreal	1 after first broadcast	2 sings, approaches	Pb balsam poplar
NSWO-saw-whet	2 after second broadcast	3 silently approaches, sings	Bw paper birch
NPOW-pygmy	3 after third broadcast	4 silently approaches,	Sw white spruce
GHOW-great-horned	4 after fourth broadcast	no vocalization	Sb black spruce
GGOW-great gray	5 after fifth broadcast		Pl lodgepole pine
NHOW-hawk-owl	6 after sixth broadcast		Lt tamarack
LEOW-long-eared	7 five minute interval after		Fa subalpine fir
	8 ten minute interval beyond		

Point: 1 Start Time:_____ Temp.:_____°C Wind:_____ Prec.:_____

Cloud cover:_____% Moon phase:_____ Snow depth: _____

Time	Interval	Owl Species	Direction	Distance	Response	Comments

Point: 2 Start Time:_____ Temp.:_____°C Wind:_____ Prec.:_____

Cloud cover:_____% Moon phase:_____ Snow depth: _____

Time	Interval	Owl Species	Direction	Distance	Response	Comments

Chapter 3

Barred Owl Distribution, Density, and Habitat Use in the Foothills Model Forest

"An old growth forest!
Precious
Sophisticated
Complex
Uniquely irreplaceable."

-J. Butler, from "Execution of an Old Growth Forest" (1994)

3 Introduction

There have been numerous studies of Barred Owl habitat use in the United States (Apfelbaum and Seelbach 1983, Bosakowski *et al.* 1987, Devereux and Mosher 1982, Devereux and Mosher 1984, Dunstan and Sample 1972, Elody 1983, Elody and Sloan 1985, Hamer 1988, Laidig and Dobkin 1995, Leder and Walters 1980, McGarigal and Fraser 1984, Nichols and Fuller 1987, Nichols and Warner 1972). Most of the publications on Barred Owls in Canada are of single nest or sighting information (Allin 1944, Campbell 1973, Cartwright 1931, Dunbar *et al.* 1991, Grant 1966, Houston 1959, Houston 1961, Jones 1987, Preble 1941, Takats 1995, Takats 1996).

Some species of wildlife rely on certain characteristics of older forests. The Barred Owl (*Strix varia*) is considered to be dependent on older forests and can be considered an indicator species. Hunter (1990) defines an 'indicator species' as having such a narrow ecological tolerance that their presence or absence is a good indicator of environmental conditions. The purpose of this study was to better understand the ecology of the Barred Owl, and use this information to make some recommendations to the forest industry on how to manage for this species, and the habitat on which it relies.

Little information exists on the distribution, abundance, and habitat of the Barred Owl in western Canada (Kirk *et al.* 1994, Court pers. comm.). Only eight nests have been found in British Columbia (Campbell *et al.* 1990). Jones (1987) describes 16 records of Barred Owls in Alberta from 1953 through 1981. The first breeding record of the Barred Owl was in 1949 (Jones 1966). Boxall and Stepney (1982) report only eight confirmed nests in Alberta, and according the Boxall (1986) the Barred Owl is considered the rarest owl in Alberta. There is no information on the density of the Barred Owl in Alberta.

The Barred Owl is listed in the Status of Alberta Wildlife Report (Alberta Environmental Protection 1996) as a Yellow B species. The Yellow list contains sensitive species that are not currently known to be at risk of declining, but require special management to address concerns related to human-related changes to the environment. The 'B' designation includes species that are associated with habitats (e.g. old growth) or habitat elements may be, deteriorating.

Barred Owls are dependent on large remote forests with mature and old growth trees for nesting, roosting, and foraging (Eifrig 1907, Paris 1947, Elody 1983, Devereux and Mosher

1984. Elody and Sloan 1985. McGarigal and Fraser 1984. Bosakowski *et al.* 1987. Dunbar *et al.* 1991). and in Ontario. prefer tall hardwood forests that are vertically complex (Van Ael 1995). Oeming (1955) found Barred Owls were common in remote areas of undisturbed mature and old growth forest in Alberta. They avoid extensive clearings. open fields. and marshes (Nicholls and Warner 1972. Fuller 1979. Bosakowski *et al.* 1987), and can be preyed on by Great Horned Owls (*Bubo virginianus*) (Fuller *et al.* 1974. Laidig and Dobkin 1995. Court pers. comm.).

Barred Owls in the United States have been reported to nest in interior portions of expansive. mature woodland (Allen 1987). The typical Barred Owl nest is in a cavity in a large living or dead tree or in the top of a broken snag (Apfelbaum and Seelbach 1983). and a few nests have been reported in stick nests (Eckert 1974. Apfelbaum and Seelbach 1983).

The first nest reported in Saskatchewan was in a black poplar stub (balsam poplar). 6 m above ground in a cavity created by a partially broken off branch (Houston 1961). Price (1940) stated that Barred Owl nests were very hard to find and that he never found this species using an open nest. although he had tried for years to find one. In Alberta. two nests have been reported by Jones (1966) and Jones (1987). the first in a cavity 10 m up in a dead balsam poplar and another in a balsam poplar stump. 8 m above ground. Cavity use has also been recorded in Ontario (Allin 1944).

Little specific information exists on roosting and foraging habitat. Johnsgard (1988) describes Barred Owl habitat as densely foliaged (deciduous and coniferous) for daytime roosting. Foraging habitat is described as mature forests with large trees that provide clear unobstructed flight paths for hunting (Duncan 1994). Prey are more exposed where the understory vegetation is sparse (Elody 1983. Devereux and Mosher 1984). Fuller *et al.* (1974) found that Barred Owls used hunting perches 5-6 m in height.

3.1 Objectives

Johnson (1980) looked at habitat associations at three levels: the physical geographic range, the home range level, and the habitat components in that home range. These three levels are covered in this thesis chapter. The objectives were to:

1) Determine the distribution and abundance of the Barred Owl in the Foothills Model Forest.
2) Determine the general habitat associated with the Barred Owls' presence and its home range.
3) Determine specific habitat components associated with nesting, roosting, and foraging.

3.2 Methods

3.2.1 Study Area

The Foothills Model Forest (FMF) is located in west-central Alberta and encompasses the Weldwood of Canada Forest Management Area, William A. Switzer Provincial Park, the Cache Percotte Forest, and Jasper National Park (2.3 million hectares). The study efforts were restricted to an area within a radius of 80 km from the town of Hinton. Lodgepole pine (*Pinus contorta*) dominates the landscape in the foothills, while white spruce (*Picea glauca*), black spruce (*Picea mariana*), and trembling aspen (*Populus tremuloides*) are common at lower elevations, and balsam poplar (*Populus balsamifera*) and balsam fir (*Abies balsamea*) are uncommon. Douglas fir (*Pseudotsuga menziesii*) dominates in the mountains (Strong and Leggat 1981).

3.2.2 Distribution and Density

Broadcast surveys were used to locate owls in this forested landscape (McGarigal and Fraser 1985, Guetterman *et al.* 1991, Carey *et al.* 1992, Duncan and Duncan 1993). Surveys were conducted along ten 16 km transects in 1995 and 1996. Nine additional transects, of variable length, were surveyed in 1996. The surveys were conducted during Barred Owl breeding season (March through May). The ten transects in 1995 and 1996 had a two-minute silent listening period, followed by a series of six 20 second Barred Owl calls, each followed by a one minute silent listening period. The surveys ended with a five-minute silent listening period (refer to chapter two for more details). Boreal, Great Gray, and Barred Owl calls were played on the nine new transects in an effort to increase response rate of other species of owls. All Barred Owls that called were recorded and the distance and direction from the researcher was noted.

The distribution of the Barred Owl was determined from records on all 19 transects plus casual observations of owls by researchers working in the area and broadcast surveys were conducted in other locations apart from transects to increase the sample size. The density of owls was calculated by dividing the number of owls recorded on the first 10 transect surveys by the total area those 10 transects covered (10 transects x 16 km length x 2 km width = 320 km^2). This calculation assumed that all owls were responded during the broadcast surveys.

All species of raptors recorded on or near Barred Owl territories were noted, as these could be potential predators and competitors for food, territories, and nest sites.

3.2.3 General Habitat Use

Locations of owls that responded on transect surveys were plotted on Weldwood of Canada, Forestry GIS (Geographic Information System) vegetation maps based on distance and direction of all calls from the observer at a known location. The stand data associated with these locations was taken off of the AVI maps (Alberta Vegetation Inventory, Appendix E) and was ground truthed to ensure accuracy. Proudfoot *et al.* (1997) found no significant difference between the habitat associated with radiotagged owl locations and locations of owls responding to broadcasts. This method of determining general habitat use was used for Spotted Owls in Olympic National Park (Mills *et al.* 1993).

3.2.4 Specific Habitat Use

Telemetry

Nesting, roosting, and foraging sites were difficult to determine because of the Barred Owl's secretive nature. As well, continuous data on movements of owls are difficult to follow (Nicholls and Warner 1972). For these reasons, radio telemetry was used to help track owl movements. Live capture efforts were run from May through August, 1995, and from March through August, 1996.

A variety of methods were used to trap raptors (Meng 1971, Kenward *et al.* 1983, Bull 1987, Fuller and Mosher 1987, Bub 1991, Redpath and Wyllie 1994). Barred Owls were trapped with two mist nets suspended between poles and set in a V-shape on the territory of a Barred Owl (Nicholls and Fuller 1987, Bloom 1987). Nets were set in small openings where perches were available (Bub 1991), and where trees were dense to make it difficult to see the mist net. Ground vegetation was cleared from the area before nets were unfurled to ensure they did not get tangled and to prevent any injury to birds caught in the net. A mechanized Barred Owl decoy accompanied by taped calls was used to attract the Barred Owls to the mist nets (Court, pers. comm., Jacobs 1996).

In June, 1995 and 1996, two types of traps were employed, as owls no longer responded well to taped calls (Kenward *et al.* 1983, Redpath and Wyllie 1994). The first design, the drop-lid (Figure 3-1a), was divided into two sections, the lower section holding the bait and the upper section holding the raptor (Bloom 1987). The raptor entered the top section causing a trigger to

release the trap lid. The second design, the drop-door (Figure 3-1b) had three compartments, a center compartment to hold the bait, and two outer compartments to hold raptors. The raptor entered an outer compartment from the side and caused a trigger to release the sliding side doors (Kenward *et al.* 1983, Bub 1990). Traps were baited with Rock Doves (*Columba livia*), Brown-headed Cowbirds (*Molothrus ater*), or mice, and were checked every six to eight hours. The lure animals were fed and watered daily, and the traps were closed during inclement weather.

In May through July 1996, a Bal Chatri trap was used (Figure 3-1c). The Bal Chatri (Berger and Mueller 1959) is a wire cage with monofilament nooses affixed to the top and/or sides with a lure animal (feeder mouse) inside (Bloom 1987). The trap was set out when a Barred Owl was seen, and was monitored continuously during its use.

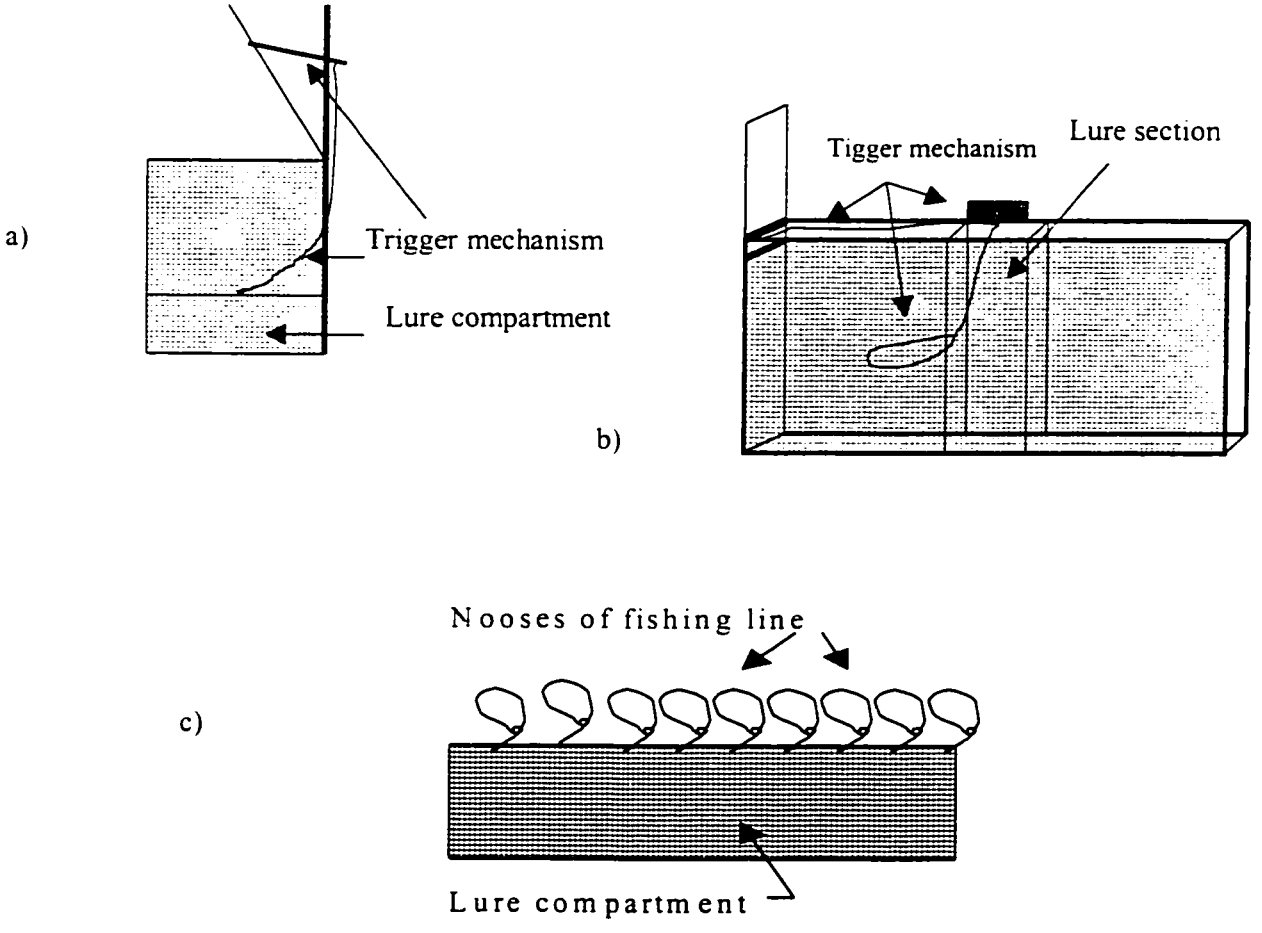


Figure 3-1: Sketches of different trap designs a) drop-lid, b) drop-door, and c) Bal Chatri.

Radio transmitters were affixed using a backpack harness style to Barred Owls that were successfully captured (Figure 3-2). Loops of Teflon passed from the corners of the transmitter and were crossed over the breast (Nichols and Warner 1968, Dunstan 1972, Kenward 1985). The area where the Teflon crossed on the breast was sewn together to prevent the straps from sliding up and down the breast. Although tail mount transmitters are preferable to backpacks (Dunstan 1973, Fuller and Tester 1973, Kenward 1978), they were not used because they would be shed in the fall, and telemetry in winter would not be possible. Transmitters had a battery life of 18 months, to ensure winter data could be collected, and to facilitate finding nests in two spring seasons.

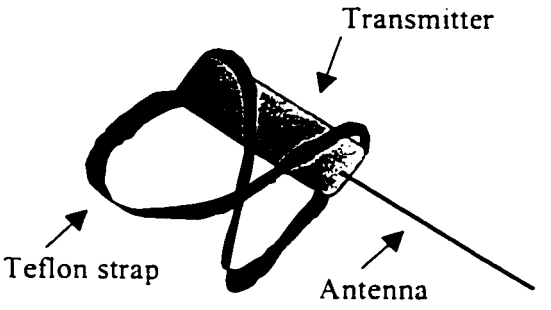


Figure 3-2: Sketch of backpack Transmitter with Teflon straps.

Using hand-held three element Yagi antennas (Amlaner 1980), researchers triangulated on radiotagged birds. Ideally successive bearings should be 60° apart (Springer 1979), but because this is extremely difficult to accomplish in this area with few roads, 20 ° was the minimum angle of separation chosen. Only one receiver package was available at most times, therefore bearings were not taken simultaneously. The maximum amount of time allowed to elapse between the three bearings was 10 minutes. Three or four bearings were plotted on orthophotos (Guetterman *et al.* 1991) and the center of the polygon was considered the location of the owl. The maximum size of an acceptable triangulation polygon was 2.5 ha. To check on the accuracy of triangulations, and to attempt to locate nest, roost, and forage sites, researchers walked in on radiotagged birds after a triangulation was taken (Guetterman *et al.* 1991).

Locations were taken randomly throughout the 18 months in an attempt to cover all times of the day and seasons. All locations that followed these criteria were used to determine the home range size of the Barred Owl. Call sites from transect surveys and casual observations in the field were also plotted on maps to help determine home ranges and general habitat use.

Stick Nest Searches

Since Barred Owls occasionally use stick nests (Bent 1961, Eckert 1974, Apfelbaum and Seelbach 1983), searches for stick nests were conducted in cooperation with a Northern Goshawk (*Accipiter gentilis*) study (Schaffer 1996). The first search method was an aerial survey by helicopter, which was suggested as an effective means for locating stick nests (Ethier 1995).

The second method involved intensive ground searches, by snowshoe, during February and March, 1996 (before leaf-out), and when possible throughout the snow-free season. Transect searches were conducted in 1 km^2 areas, in 1 km radii around three known Northern Goshawk nest sites, and in areas where goshawks, owls, and other stick nests had been sighted. Northern Goshawks are known to build multiple nests in close proximity to each other (within 0.8 km in Alaska) and will alternate between them (McGowan 1975, Reynolds *et al.* 1982, Duncan and Kirk 1994). While the Northern Goshawks are using one nest, other species of birds may take over the unoccupied nests.

Other Methods

Barred Owl habitat use was determined by other methods including:

1. Audio triangulation and walking in on owls that were calling spontaneously.
2. Casual observations in the field.
3. Nesting site records from bird watchers in Jasper National Park.

These methods were used during the day and night. Locations were classified as nesting, roosting, or foraging when possible. If nesting was suspected in an area, all possible nest trees were tapped in an attempt to flush the female. Trees with cavities were also climbed to investigate possible nesting.

3.2.5 Vegetation Surveys

Vegetation surveys were conducted at known Barred Owl nest, roost, and forage sites using a nested plot method modeled on Bibby and Burgess (1992), Timoney (1993), and Reynolds *et al.* (1980). Each nest survey had a 0.04 ha circular center plot and four 0.04 ha plots set in cardinal directions 30 m away (Figure 3-3). Roost and forage surveys had a similar layout for the first locations but it was determined that there was no significant difference between the center and surrounding plots, therefore only the center plot was surveyed for the remaining.

The nest/roost/forage tree was considered the center of the survey. Appendix 3-1 shows the specific information recorded on the center trees. Each plot had information recorded on trees in a 0.04 ha area, shrubs in a 0.004 ha area, and herbs in four 1 m^2 areas (average) (Figure 3-3). Tree characteristics that were recorded are listed in Appendix 3-2. Shrub species were placed in three separate height classes: < 1 m, 1-2.5 m, and >2.5 m. The percent cover of each species was recorded and the total shrub cover was determined. Each herb species was recorded for percent cover. The average height and total percent cover for herbs, grasses, and sedges/rushes was recorded. Ground cover was divided into the following categories: litter, mineral, moss, lichens/fungus, downed wood, and other (eg. water). The percent cover of each category was determined and the depth of the litter and moss was measured.

Logs were measured in the 0.04 ha plots (Appendix 3-2). The overall site characteristics of nest/roost/forage sites that were described include: site geographical position (macro and meso scales), surface shape, soil drainage, flood hazard, slope, aspect, canopy and subcanopy tree species, their heights and crown bases. Canopy closure can be best estimated by means of a spherical densiometer (Bessie 1995). A convex spherical densiometer was used at the five-meter mark in four cardinal directions at each plot. Three nests located on the Weldwood FMA were plotted on aerial photos, and stands were AVI typed by Weldwood staff.

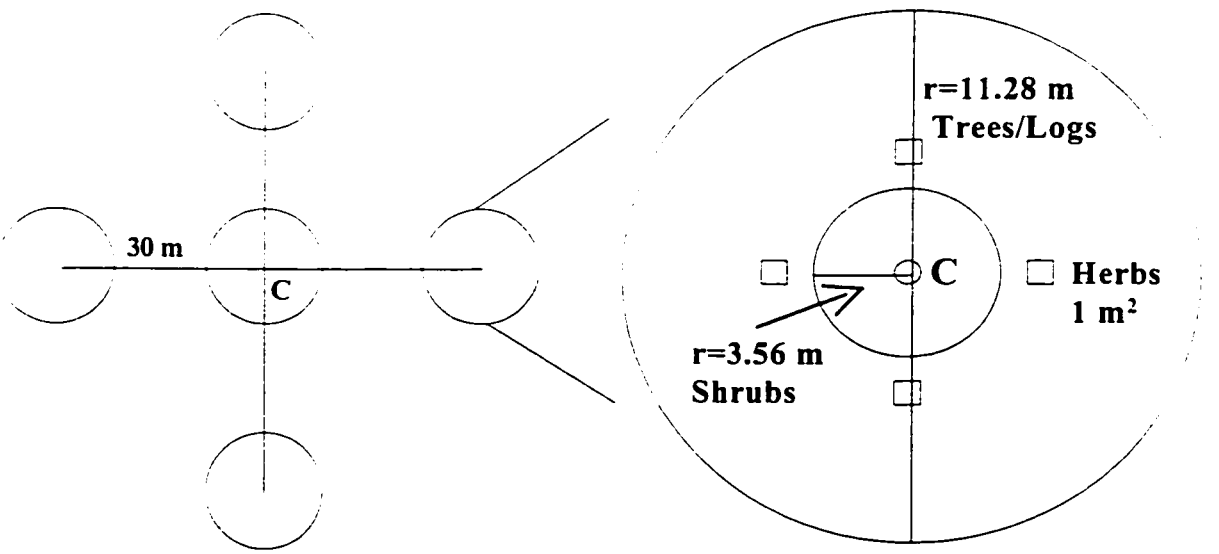


Figure 3-3: Plot layout for the vegetation surveys. Center plot with plots set in four cardinal directions. Each plot surveyed in trees in 0.04 ha, shrubs in 0.004 ha, and herbs in four 1 m^2 areas. C = nest/roost/forage tree.

3.2.6 Statistics

The average tree diameters of the six nests, seven roosts, and three forage plots of the Barred owls were compared to the surrounding average stand tree diameters to determine whether the nest plot was significantly different. A normality test for skewness and kurtosis was conducted on the tree diameters. The data were log-transformed and the means were compared using an independent samples t-test.

The average diameters of the Barred Owl nest stand trees were compared using an independent samples t-test, to determine if they were similar. The canopy closures determined for each of the plot's stands (5 plots in each of 6 stands) were compared to determine if there was variation between or among groups using an ANOVA.

3.3 Results

3.3.1 Distribution and Abundance

Seventeen territorial Barred Owls were recorded in 1995, on the ten transects (Table 3-1). Only 13 Barred Owls were recorded in 1996. During 1996, three more Barred Owls were found call surveys on the additional nine transects.

Barred Owl density was 0.05 and 0.04 owls/km^2, in 1995 and 1996 respectively (0.03 pairs/km^2). This density is much higher than what was expected, as there were few historic records of Barred Owls in the Hinton area. The Boreal Owl had a very high density in 1995 (0.17 owls/km^2), but dropped dramatically in 1996. Northern Saw-whet Owl numbers also dropped in 1996. Barred Owl and Great Horned Owl densities changed slightly from year to year. Barred Owls dropped and Great Horned Owls increased (from 0.05 to 0.06 owls/km^2).

Casual observations provided an additional 13 records of Barred Owls in 1995, and 11 in 1996 (Table 3-3). Many Great Gray Owls were recorded casually during the daytime. A dead owl was discovered and identified as a Great Gray Owl killed and partially eaten by a Great Horned Owl. As well, casual observations accounted for the majority of Northern Pygmy Owls that were found. Three additional species of owls were reported in 1996 from casual sightings: a Short-eared Owl (*Asio flammeus*), a Snowy Owl (*Nyctea scandiaca*), and two Northern Hawk-Owls (*Surnia alula*).

Table 3-1: The number of territorial owls responding on ten transects run March through May, 1995 and 1996.

*Owl Species→	BAOW		BOOW		GGOW		GHOW		NSWO		NPOW	
Transect↓	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996
Gregg Lake	3	3	5	1	0	0	2	2	2	0	0	0
Cold Creek	2	1	12	3	0	1	1	1	0	0	0	0
TriCreeks	2	1	3	0	0	0	3	2	1	2	1	0
Fish Creek	0	0	9	2	0	0	1	2	2	0	0	0
Pedley	1	1	2	0	1	1	2	2	3	1	0	0
WildHay North	2	1	3	1	0	0	1	1	3	1	0	0
Medicine Lodge	1	0	9	7	1	1	2	6	1	4	0	0
Blackcat Ranch	3	4	3	0	0	0	2	1	1	2	0	0
Prest Creek	1	0	3	1	0	0	2	3	2	1	1	0
Lynx Creek	2	2	6	2	0	0	1	2	6	2	0	0
Total	**17**	**13**	**55**	**17**	**2**	**3**	**17**	**22**	**21**	**13**	**2**	**0**

Table 3-2: The number of territorial owls recorded March through May, 1996 on new transects.

*Owl Species→ Transects↓	BAOW	BOOW	GGOW	GHOW	NSWO	NPOW
Cache Percotte	1	1	1	0	0	0
Paul's Road	0	2	0	0	1	0
Beaver	0	1	0	0	0	0
Mercoal	0	0	0	3	0	0
Q-Road	0	0	0	0	0	0
Pyramid/HW93 A	2	4	0	1	0	0
Snaring	0	1	0	0	1	0
HW 93	0	1	0	0	1	1
Maligne Road	0	3	0	0	0	1
TOTAL	**3**	**13**	**1**	**4**	**3**	**2**

* BAOW – Barred Owl, BOOW Boreal Owl, GGOW Great Gray Owl, GHOW Great Horned Owl, NSWO Northern Saw-whet Owl, NPOW – Northern Pygmy Owl

Table 3-3: Total number of the six species of owl recorded during the project, by all methods of observation.

*Owl Species➡	BAOW		BOOW		GGOW		GHOW		NSWO		NPOW	
Observation↓	'95	'96	'95	'96	'95	'96	'95	'96	'95	'96	'95	'96
First 10 transects	17	13	55	17	2	3	17	22	21	13	2	0
New transects	-	3	-	13	-	1	-	4	-	3	-	2
Casual observations	13	11	6	2	11	11	13	4	21	5	5	5
Total	**30**	**27**	**61**	**32**	**13**	**15**	**30**	**30**	**42**	**21**	**7**	**7**

* See bottom of Table 3-2 for codes.

Forty-two different territorial Barred Owls (10 females, 17 males, and 15 unknown sex) were recorded during the two years of this project (Appendix 3-4), seven were paired and the other 28 were single but may have had mates that did not respond to broadcasts. Twenty-six different territorial owls were recorded during broadcast surveys and 16 were recorded by casual observations. The distribution of Barred Owls, in the Foothills Model Forest, recorded during this project was clumped because of the distribution of suitable habitat (Figure 3-4).

Other raptors that were recorded on or near Barred Owl territories were: Northern Goshawk, Cooper's Hawk (*Accipiter cooperii*), Sharp-shinned Hawk (*Accipiter striatus*), Red-tailed Hawk (*Buteo jamaicensis*), Broad-winged Hawk (*Buteo platypterus*), Northern Harrier (*Circus cyaneus*), Osprey (*Pandion haliaetus*), Merlin (*Falco columbarius*) and American Kestrel (*Falco sparverius*). The Golden Eagle (*Aquila chrysaetos*) was also recorded on two occasions, but was probably migratory. Species found nesting on Barred Owl territories include the Northern Goshawk and the Red-tailed Hawk. Owl species found nesting on Barred Owl territories include the Boreal and Northern Saw-whet Owl. Great Horned Owls were not found on Barred Owl territories. The remains of a Great Gray Owl depredated by a Great Horned Owl were found near a Barred Owl territory.

3.3.2 General Habitat Use

Forty-five Barred Owl calling locations were recorded during the broadcast surveys (Appendix 3-3). Some owls called on more than one visit to each point during the surveys. If they called from a new stand, the information associated with that new stand was recorded. All of the associated forest stands had a white spruce component, and were predominantly mixedwood containing trembling aspen and balsam poplar. Black spruce and lodgepole pine occurred in only nine of the 45 stands.

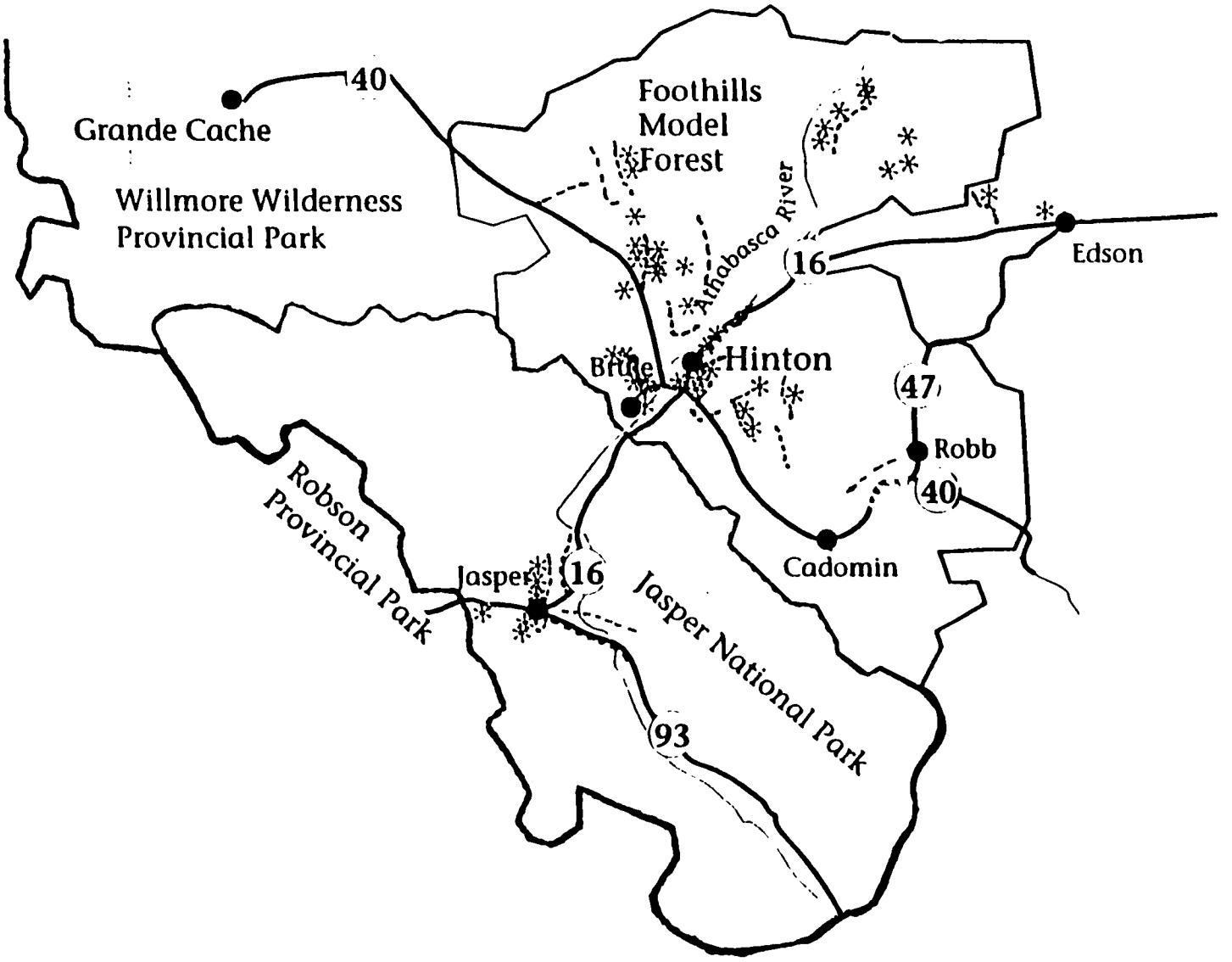


Figure 3-4: The distribution of forty-two territorial Barred Owls (based on broadcast surveys and casual observations). Dashed Lines indicate the transects where the 19 broadcast survey transects were located.

All the stands had a greater than 40 percent (B density) canopy closure (Figure 3-5). Thirty-seven of the 45 locations (82.2%) were found in C density stands (51-70% canopy closure). No Barred Owls were found calling from stands with lower than 35 percent canopy closure. The average stand height of each calling location was 22.9 m (S.D.=1.86), was always above 18 m, and was above 21 m in most cases (Figure 3-6).

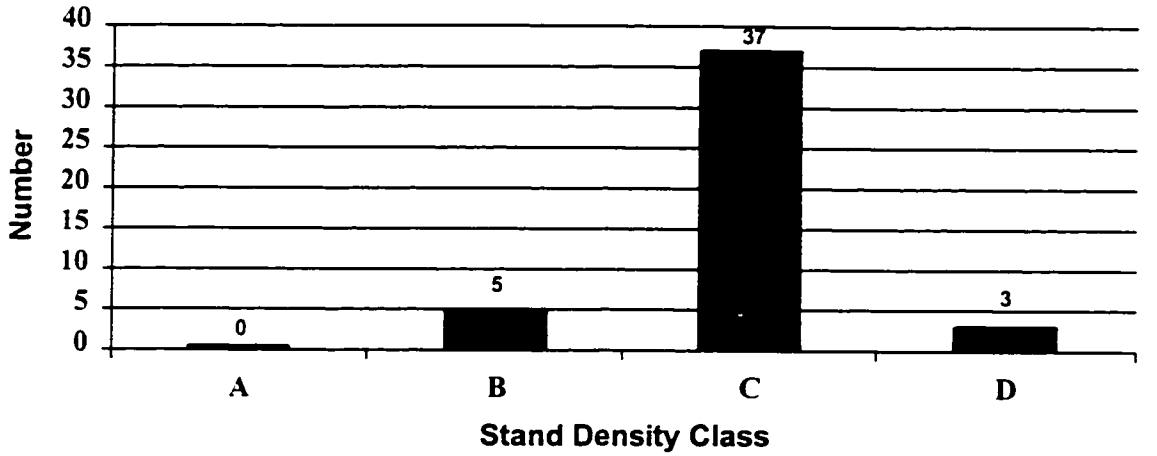


Figure 3-5: Stand density associated with owls recorded on the broadcast surveys. AVI density codes: A is 5-30%, B is 31-50 %, C is 51-70%, and D is 71-100% canopy closure.

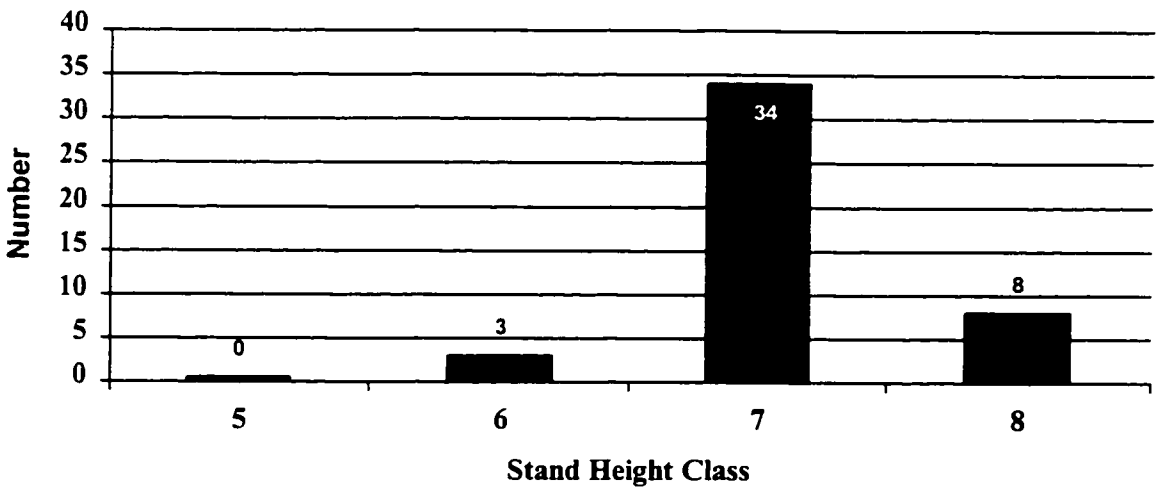


Figure 3-6: Average stand height associated with owls calling on the transect surveys. AVI height codes: 5 is 15.1 to 18.0 m, 6 is 18.1 to 21 m, 7 is 21.1 to 24 m, and 8 is 24.1 to 27 m.

3.3.3 Specific Habitat Use

Stick Nest Searches

On 17 April 1994, (before leaf flush) at 11:00h, four researchers and a pilot conducted an aerial survey north and west of the town of Hinton and searched for stick nests. The helicopter flew at 95 km/hr at an average height of about 65 meters above the ground. Twelve parallel transects were run east-west along the Athabasca River east of Hinton (total area covered 34 km^2). We then traveled to Fish Creek, Peppers Lake, and over the Athabasca Tower lookout towards Solomon Creek near Blackcat Ranch. No stick nests were located during the search effort. The helicopter was flown over an area containing a known stick nest, and the stick nest could not be located. Total flight time was just over 90 minutes. We observed one Canada Goose (*Branta canadensis*), one Common Raven (*Corvus corax*), and two adult Red-tailed Hawks.

Ground stick nest searches were conducted in the summer of 1995 and from February through May 1996, (before leaf flush). A total of 36 stick nests were located and investigated (Table 3-4a) in a total area of 2900 ha. The goshawk study surveyed additional areas, and found another 25 stick nests, but no owl nests were located (Table 3-4b). None of the 61 stick nests were used by Barred Owls, although four of the nests were located in Barred Owl territories. Over 80% of the stick nests were found in trembling aspen trees. Most of the stick nests were in deciduous trees (83.6%).

Stick nests were used by Common Ravens and five raptor species: Northern Goshawks, Red-tailed Hawks, Osprey, Great Horned Owls, and Great Gray Owls. The Great Horned Owl nest at R.C. Fliers had two young that fledged successfully. The pair could not be located in 1996, therefore no nest was found. Old Fort Point (1995) and Jasper Park Lodge (1996) each had Great Horned Owl nests with two young. Two young successfully fledged from Old Fort Point, while only one fledged from the Jasper Park Lodge nest. The same pair of owls could have occupied these two nests. The Obed area had two different Great Gray Owl nests in 1995 and 1996. The 1995 nest was depredated, possibly by a mammalian predator. Great Gray Owl nests were also recorded at Emerson Gaswell and Edson in 1995. Neither of these nests was reoccupied in 1996.

Table 3-4: Stick nest search results showing the: (a) area searched, number of stick nests, tree species, and nest occupant in the shared study, and (b) the Northern Goshawk study stick nest data (Schaffer pers. comm.).

Location	Total Area Searched (ha)	Number of Stick Nests	Tree Species	Nest Occupant (Year)
(a) Shared Surveys				
Blackcat nest	315	3	1 Aw	NOGO (1995)
			2 Aw	2 CORA (1996)
Paul's Road nest	315	4	1 Aw	NOGO (1994)
			1 Aw	NOGO (1996)
			1 Aw, 1 Pl	unoccupied
Grizzly nest	315	2	1 Aw	NOGO (1995)
			1 Aw	RTHA (1996)
R.C. Fliers	100	4	1 Aw	GHOW (1995)
			1 Aw	CORA
			2 Aw	unoccupied
Athabasca Ranch	100	6	2 Aw	2 CORA (1996)
			3 Aw, 1 Pl	unoccupied
Blackcat Ranch	70	1	1 Aw	unoccupied
Solomon Creek	410	0	--	----
WildHay Ridge	350	1	1 Pl	unoccupied
Gregg Lake	300	4	2 Aw	CORA (1996),
			1 Aw	BAEA (1995/96)
			1 Pb	NOGO (1996)
Cold Creek (1 km^2)	100	0	--	----
Cold Creek	40	1	1 Pl	unoccupied
Seabolt Creek Road	50	1	1 Aw	unoccupied
A16	85	0	--	----
Obed	100	3	1 Aw	GGOW (1995), RTHA (1996)
			1 Aw	GGOW (1996)
			1 Aw	unoccupied
Robb Road (km 23)	50	1	1 Aw	unoccupied
Emerson Gaswell	50	1	1 Aw	GGOW (1995)
Lynx	100	0	--	----
Pyramid Lake	100	1	1 Pl	OSPR (1996)
Jasper Park Lodge	20	1	1 Fd	CORA (1995) GHOW (1996)
Old Fort Point	20	1	1 Sw	GHOW (1995)
Edson	50	1	1 Aw	GGOW (1995)
Total	**2900**	**36**	**28 Aw, 5 Pl, 1 Sw,1 Fd, 1 Pb**	

Table 3-4: Stick nest search results (Con't.).

Location	Total Area Searched (ha)	Number of Stick Nests	Tree Species	Nest Occupant (Year)
(b) NOGO Study				
A road km 46.5		1	Aw	RTHA
		2	Aw	unoccupied
Marlboro		3	Aw	NOGO (1996)
		2	Aw	unoccupied
Medicine Lodge (nth block)		1	Aw	unoccupied
Medicine Lodge		1	Aw	RTHA
Gregg River Burn		2	2 Pl	2 CORA (1996)
South Jarvis Creek		4	4 Aw	unoccupied
D58		1	Aw	unoccupied
Lambert Creek		2	2 Aw	2 CORA (1996)
Round Lake (Obed)		2	2 Aw	2 CORA
East Cache/Graveyard		1	Aw	unoccupied
South of HW16/Hinton sign		2	2 Aw	unoccupied
HW 16 Right-of-way		1	Aw	unoccupied
A20		1	Sw	unoccupied
Peppers Lake Road		1	Aw	CORA (1996)
Total		**25**	**2 Pl, 1 Sw 22 Aw**	
Grand Total		**61**	**7 Pl, 2 Sw, 1 Fd 50 Aw, 1 Pb**	

Aw=trembling aspen, Pb=balsam poplar, Sw=white spruce, Pl=lodgepole pine, Fd=Douglas fir
RTHA=Red-tailed Hawk, CORA=Common Raven, NOGO=Northern Goshawk, GGOW=Great Gray Owl, GHOW=Great Horned Owl, OSPR=Osprey

The Blackcat Northern Goshawk nest was occupied in 1995. Two Barred Owl pairs had territories nearby, one pair to the north, and the other to the south. The Goshawk did not occupy the nest in 1996, and the pair of Barred Owls located south of it increased their home range to include the stick nest area.

Telemetry

Drop-lid and drop-door trapping were unsuccessful methods for catching Barred Owls. The traps were used for 6300 hours from June through August, 1995 in four areas: Fish Creek, Wild Hay Ridge, Lynx Creek, and Blackcat Ranch. In 1996, the traps were used for 1700 hours from June through July in the Blackcat area only. Species caught in the drop-lid traps (Table 3-5) during the two seasons included five raptor species: Northern Goshawk, Cooper's Hawk,

Sharp-shinned Hawk, Red-tailed Hawk, and Broad-winged Hawk (*Buteo platypterus*), and two non-raptor species: Gray Jay (*Perisoreus canadensis*) and Red Fox (*Vulpes vulpes*). One Northern Goshawk was caught in the drop-door trap. Most of the raptors were caught during June (early in their breeding seasons) and August (during migration), in locations where the traps were very visible. However, placing traps in visible locations made them susceptible to vandalism, and three traps were damaged beyond repair.

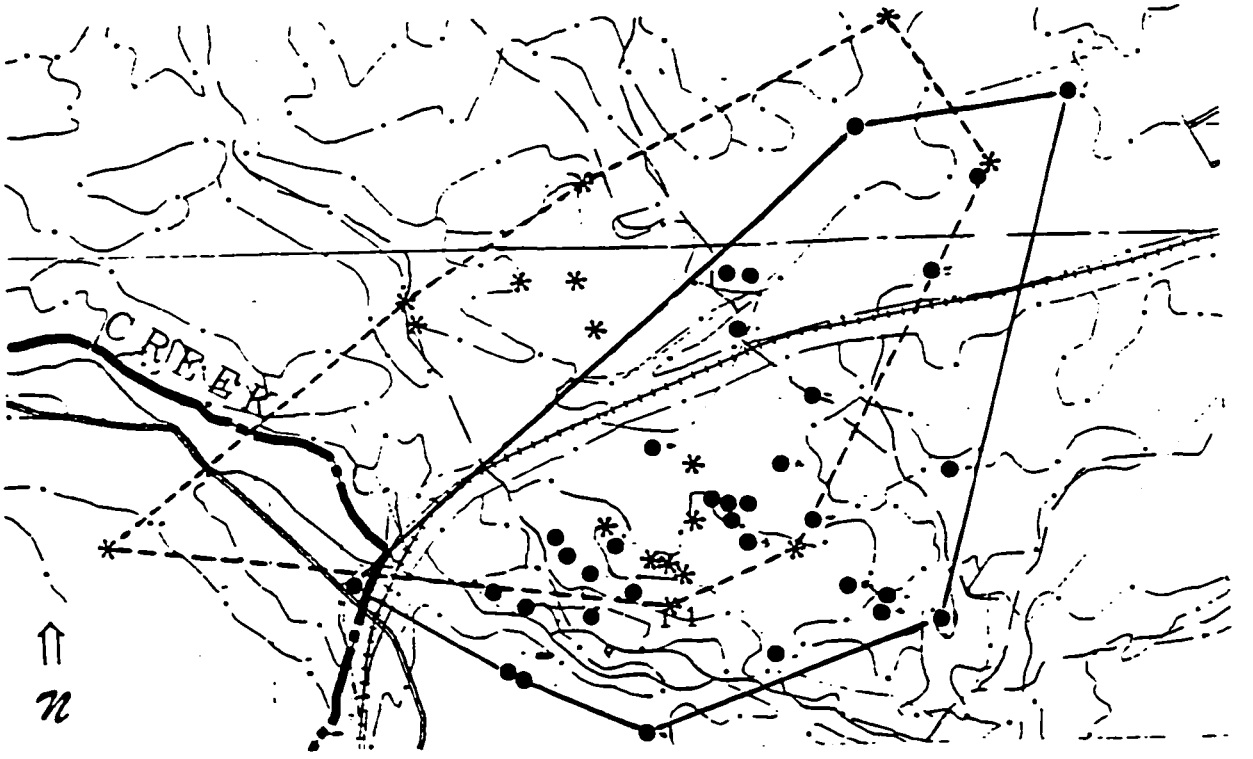
Table 3-5: Locations and dates of species caught in drop-lid traps.

Species	**Location**	**Date**
Northern Goshawk*	Wild Hay Ridge	June 29, 1995
Cooper's Hawk	Wild Hay Ridge	July 19, 1995
Cooper's Hawk	Blackcat Ranch	August 3, 1995
Gray Jay	Blackcat Ranch	August 4, 1995
Sharp-shinned Hawk	Blackcat Ranch	August 14, 1995
Red-tailed Hawk	Blackcat Ranch	August 16, 1995
Northern Goshawk	Blackcat Ranch	August 18, 1995
Red Fox	Blackcat Ranch	June 5, 1996
Cooper's Hawk	Blackcat Ranch	June 6, 1996
Broad-winged Hawk	Blackcat Ranch	June 6, 1996

*Caught in Drop-door trap

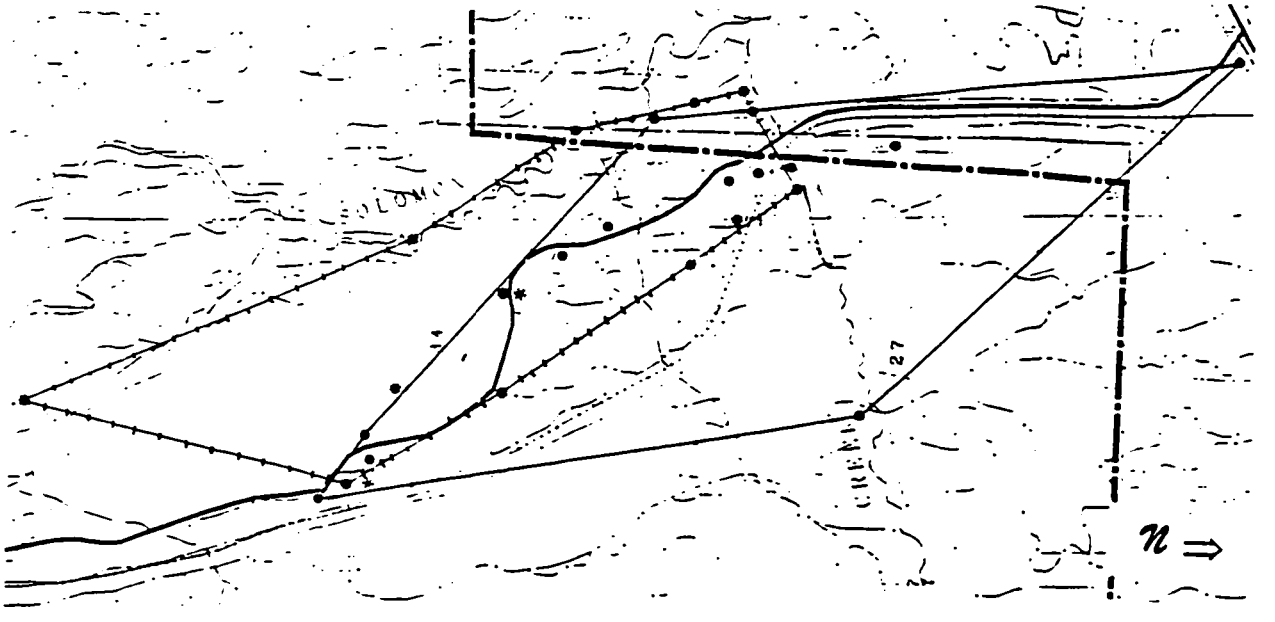
The Bal Chatri trap was used on six different trap nights but was not successful in trapping Barred Owls. On two occasions a male Barred Owl flew down onto the trap. The owl hit the trap six times, but did not get caught because it did not have its talons open. A Northern Goshawk was captured in 1996 using the Bal Chatri trapping method (Schaffer, pers. comm.).

Mist nests were used to capture one female Barred Owl on June 28, 1995 at 0:30 near Solomon Creek. An 18 month radiotag was affixed to the owl and over 100 radiolocations were taken from the capture date through October 21, 1996. Locations were plotted on GIS maps to estimate the home range size of the Solomon Creek female owl (Figure 3-7). Home range was determined to be 150 ha in summer 1995, 170 ha in winter 1995/1996, and 185 ha in summer 1996. Home range was also determined for a male Barred Owl at Blackcat Ranch, that had many calling and sighting records: 240 ha in summer 1995 and 155 ha in summer 1996 (Figure 3-8).



Scale - 1 : 15 000 Summer— (150 ha) Winter ----- (170 ha)

Figure 3-7: Home range of the radiotagged Solomon Creek female Barred Owl. Summer 1995 is shown with dots and solid line, winter 1995/1996 is shown with stars and dotted line.



Scale - 1 : 30 000 Summer 1995 — (240 ha) Summer 1996 — (155 ha)

Figure 3-8: Home range of the Blackcat male Barred Owl. Summer 1995 shown with dots and solid line. summer 1996 shown with stars and slashed solid line.

Nests

A total of six Barred Owl nest trees were located during this project, in the Foothills Model Forest (Table 3-6). One nest was found by walking in on the radiotagged Barred Owl at Solomon Creek on April 19, 1996 (Figure 3-9). The owl remained in the cavity until about June 11, and then abandoned the nest. During this time the female was fed by the male at the nest and was seen leaving and returning to the nest on two occasions. No young owls were observed.

Two nests were located by investigating trees containing cavities (in areas with pairs of owls): one on May 24, 1995 and one on July 27, 1996. The 1995 nest was abandoned and no young were ever observed. The 1996 nest had one confirmed young fledge successfully. Another nest was discovered when two young owls were seen fledging (June 21, 1996). Two other nests were found by birdwatchers in Jasper and both had two young fledge. All six Barred Owl nests were found in natural cavities of live balsam poplar trees. These trees had a wound, from a branch breaking off, on the tree where it could rot and create a natural cavity on the top or side of the main trunk.

The average diameter of tree used by Barred Owls for nesting was 74.0 cm (Table 3-6). Barred Owls selected one of the largest diameter trees in the stand (Figures 3-10a-f). The average nest tree height was 25.3 m and the average nest cavity height was 15.6 m. The nest plots had a significantly larger mean diameter than the surrounding stand (Tables 3-7 and 3-8) in five of the six stands. Only the Blackcat nest plot was not found to be significantly larger than the surrounding stand (Table 3-8). The average dbh of the nest stands were not significantly different from each other (P=0.031) and were located near water (streams, rivers) in all cases.

Table 3-6: Characteristics of Barred Owl nests (Pb=balsam poplar).

	TREE				NEST	
Nest	**Species**	**DBH (cm)**	**Height (m)**	**Crown Base (m)**	**Type**	**Height (m)**
Blackcat Ranch	Pb	61.8	19.0	11.2	cavity	10.4
Lynx Creek	Pb	74.5	26.4	15.0	cavity	15.3
Solomon Creek	Pb	69.1	23.4	19.2	cavity	16.8
Miette 1	Pb	71.1	27.3	17.1	cavity	17.0
Miette 2	Pb	82.7	28.9	17.3	cavity	17.3
Miette 3	Pb	85.0	27.0	11.7	cavity	16.8
Mean	-	**74.0**	**25.3**	**15.3**	-	**15.6**
S.D.	-	**8.7**	**3.6**	**3.2**	-	**2.6**

Figure 3-9: Photo of the Solomon Creek female Barred Owl flying into the nest cavity (top photo by Stephen Glendinning) and close up of nest cavity (bottom photo by author).

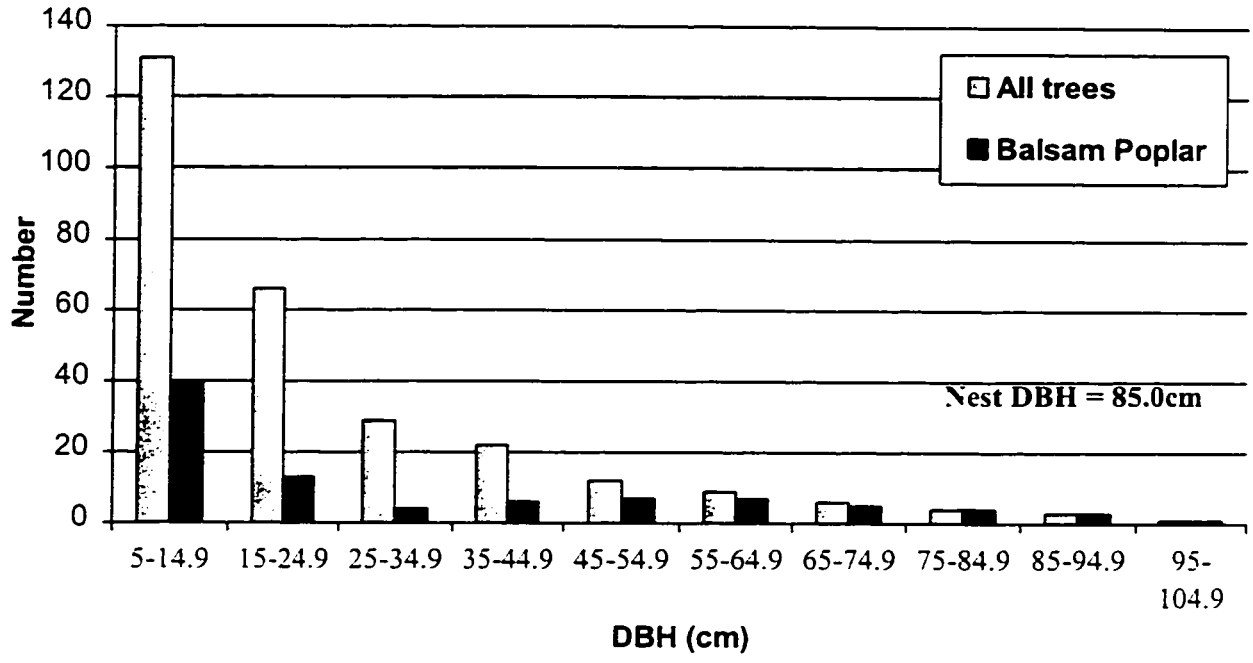


Figure 3-10a: Diameter of Miette 3 nest tree compared to diameters available in the stand.

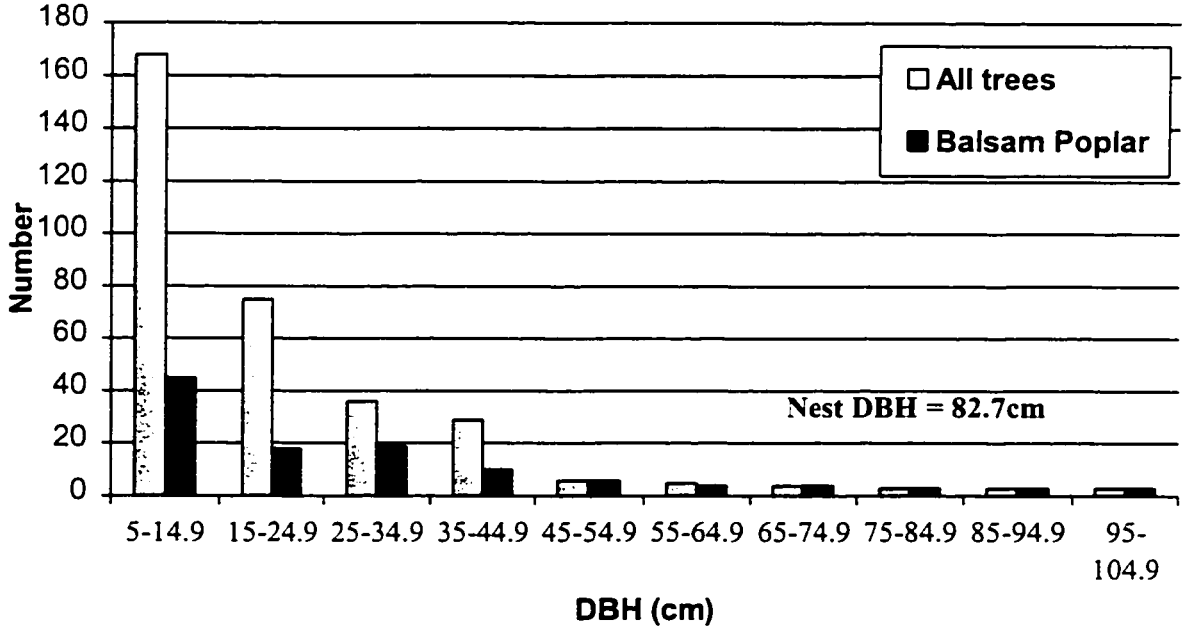


Figure 3-10b: Diameter of Miette2 nest tree compared to diameters available in the stand.

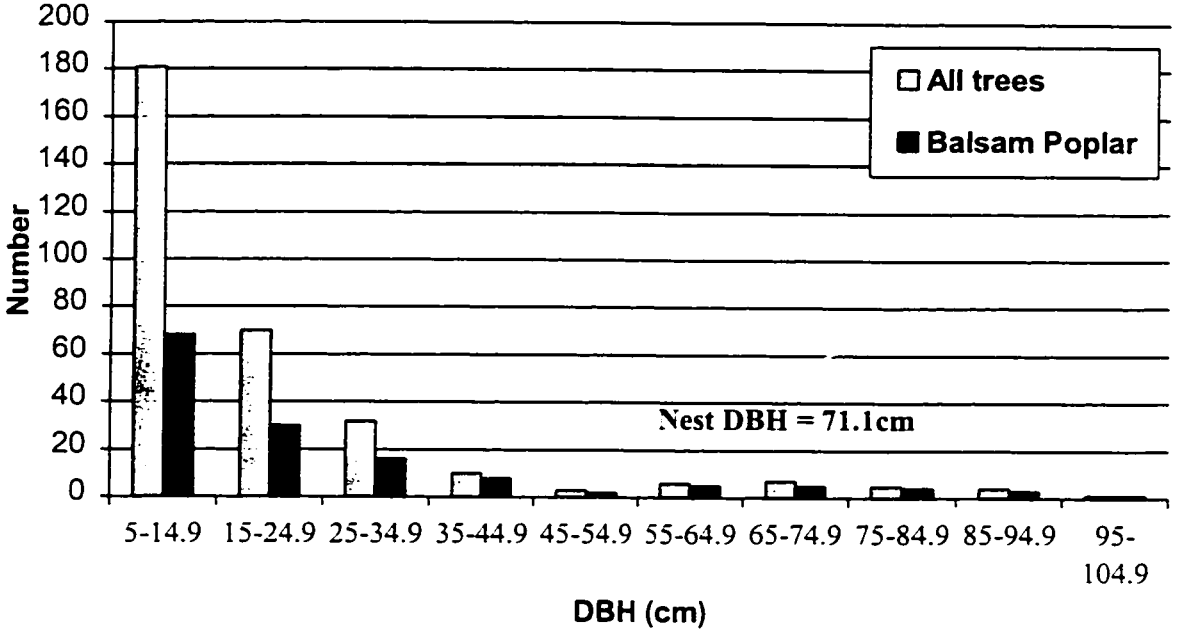


Figure 3-10c: Diameter of Miettel nest tree compared to diameters available in the stand.

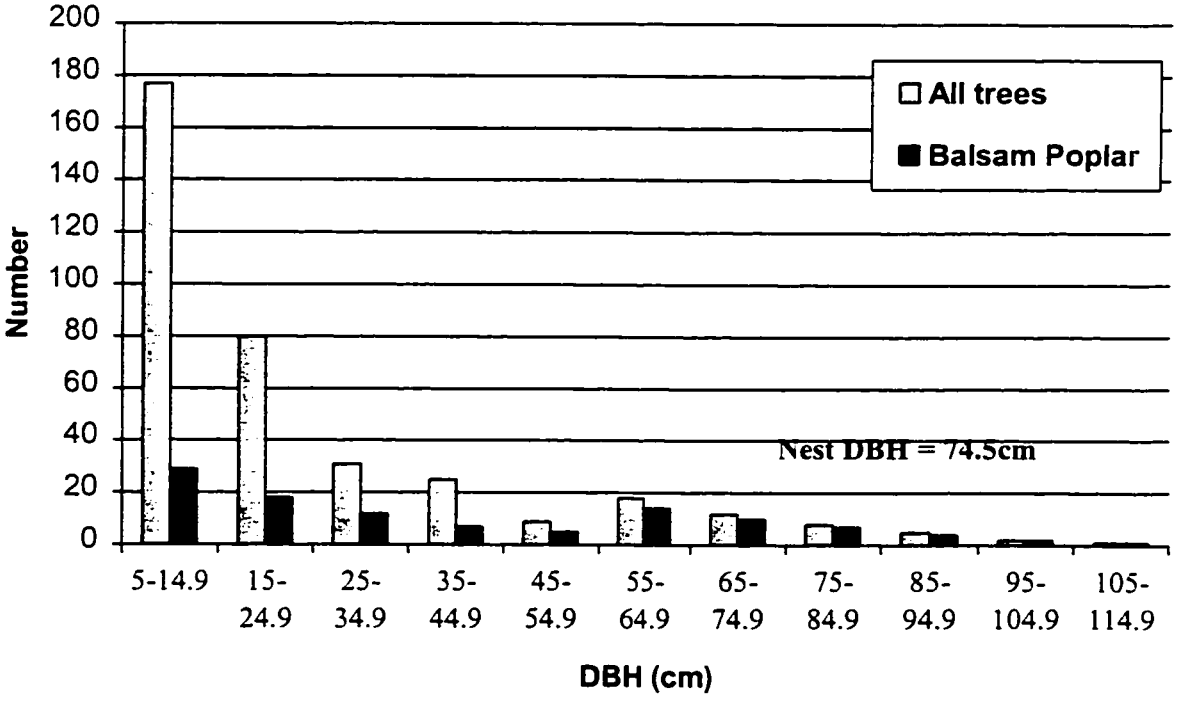


Figure 3-10d: Diameter of Lynx nest tree compared to diameters available in the stand.

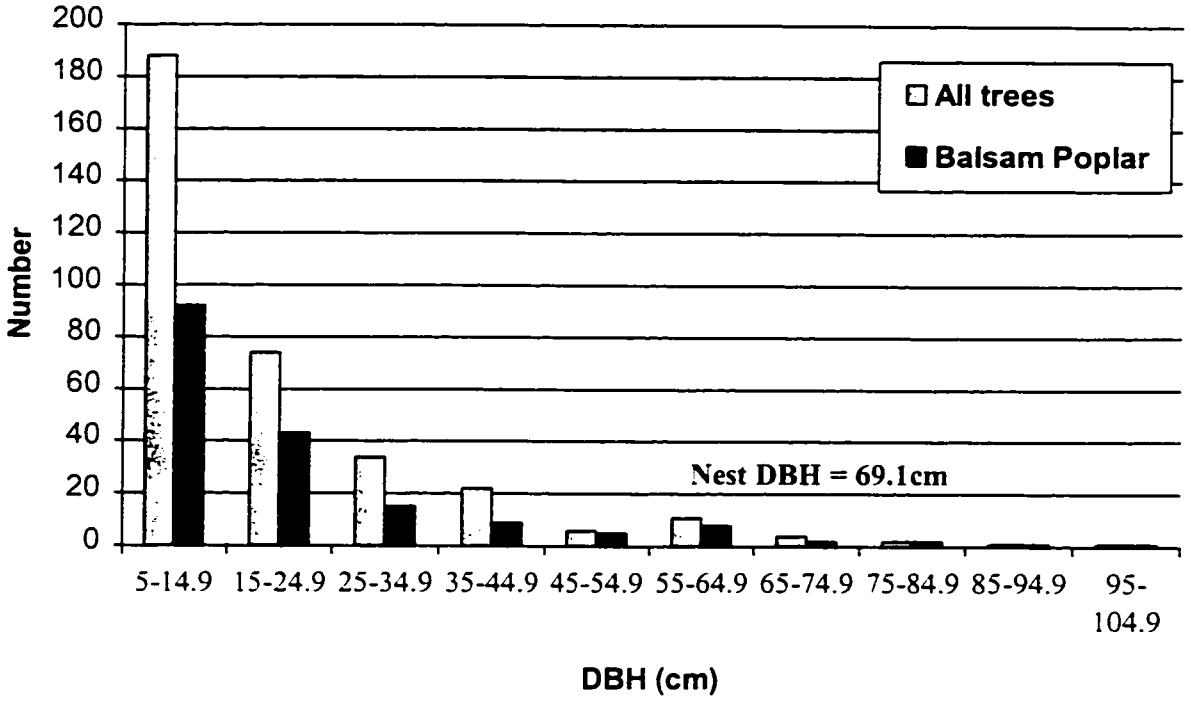


Figure 3-10e: Diameter of Solomon nest tree compared to diameters available in the stand.

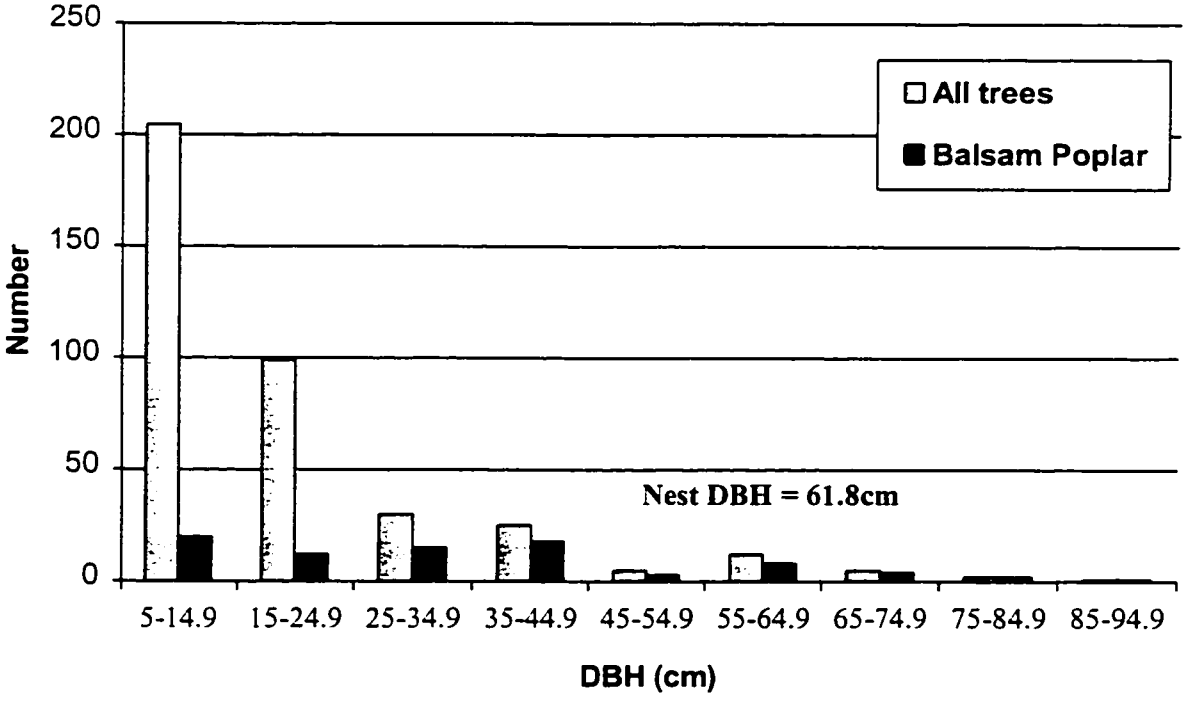


Figure 3-10f: Diameter of Blackcat nest tree compared to diameters available in the stand.

Table 3-7: Example of test for skewness and kurtosis on the Blackcat nest plot average diameters.

	Mean	S.D.	Kurtosis	S.E. Kurtosis	Skewness	S.E. Skewness
Nest	16.784	14.94	3.525	0.506	2.041	0.255
Stand	14.597	9.968	5.582	0.270	2.235	0.135
Log Nest	1.055	0.076	0.506	0.975	0.255	0.422
Log Stand	1.112	0.108	0.248	0.556	0.124	0.334

Table 3-8: Average of nest plot and surrounding stand and significance values.

Nest	Nest Plot Average Tree Diameter	Stand Average Tree Diameter	P
Blackcat	16.8	14.6	0.572
Lynx	24.5	20.6	0.042*
Solomon	17.0	14.4	0.032**
Miette1	20.3	14.5	0.016***
Miette2	20.9	14.6	0.030**
Miette3	25.1	19.8	0.001***

* significant, ** very significant, ***highly significant

Barred Owls seem to be choosing specific trees for nesting in the FMF. There is still a possibility that the owls may use stubs of trees, but this has not been documented in the Foothills Model Forest. None of the Pileated Woodpecker cavities that were located during the nest searches had Barred Owls in them, however, Boreal and Northern Saw-whet Owls used them readily.

Mean diameter of the canopy and subcanopy trees ≥ 12.5 cm in nest stands ranged from 21.8 to 35.3 cm (Figure 3-11). Nest stands had dense canopies, ranging from 66.6 to 80.2 percent (Table 3-9). Canopy closure was significantly different between the nest plot and the four cardinal direction plots (ANOVA, p=0.04), but not significantly different between the canopy closures of the six nest plots (ANOVA, p=0.08). According to the densiometer readings the stand densities were C (51-70%) and D (71-100%), whereas Alberta Vegetation Inventory from air photos determined densities to be B density with A, B, and C understories (Table 3-9). Therefore the densiometer gives a higher canopy closure. The highest canopy closure of a nest stand was 80.2%.

Nest sites had medium shrub cover (range 28 to 59 %). Common shrubs included green alder (*Alnus crispa*), prickly rose (*Rosa acicularis*), lowbush cranberry (*Vibernum edule*) and red osier dogwood (*Cornus stolonifera*). The herb cover was quite sparse (range 14 to 35%).

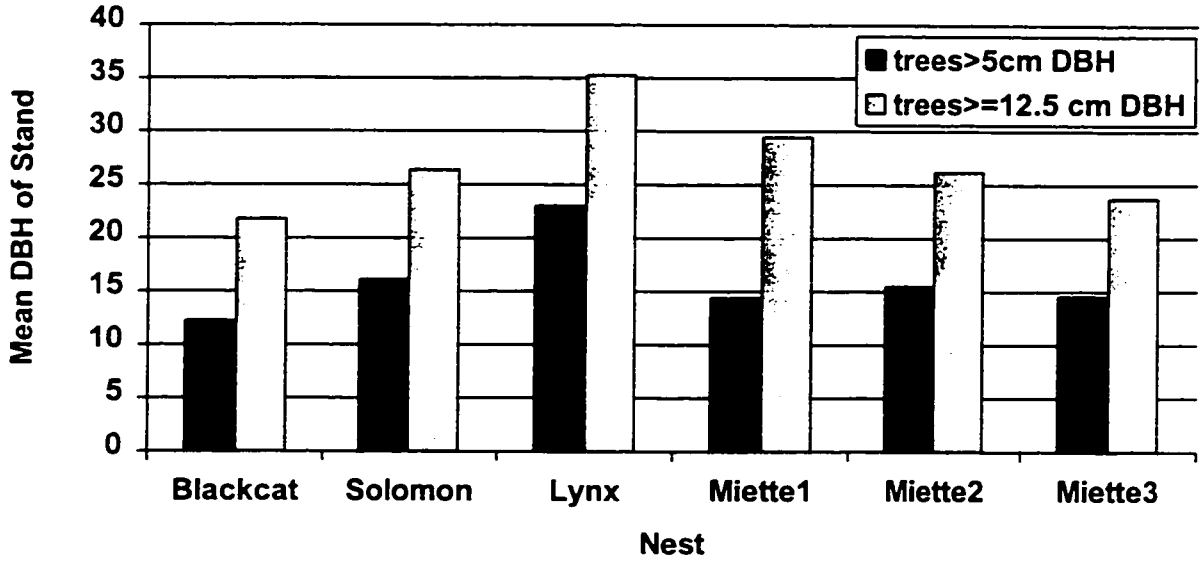


Figure 3-11: Comparison of the mean diameter of trees >5 cm dbh and the mean diameter of canopy trees >12.5 cm dbh in Barred Owl nest stands.

Table 3-9: Stand description density and tree height measured with a spherical densiometer and clinometer versus aerial photos interpretation AVI typed by Weldwood (overstory/ understory).

Nest	%Cover of Species	Density	Tree Height (m)	Weldwood Air Photo *(AVI)
Blackcat	80Sw10Pb10Aw	80.2	25.2	B26 / C11
Solomon	70Sw20Pb10Aw	66.6	25.8	B26 / B10
Lynx	70Sw20Aw10Pb	70.5	27.4	B28 / A8
Miette 1	50Sw30Pb20Aw	78.0	29.1	n/a
Miette 2	60Sw20Pb20Aw	67.5	27.3	n/a
Miette 3	50Sw30Aw20Pb	79.4	24.8	n/a

*Density: A=6-30%, B=31-50%, C=51-70%, D=71-100%. Height in meters.

Roost Sites

Twenty-five roost sites were located, 17 sites were from the radiotagged owl and 8 were from the other owls. Three species of trees were used for roosting: trembling aspen (n=11), balsam poplar (n=8), and white spruce (n=6). The average diameter of these trees was 35.7 cm and ranged from 17.0 to 69.7 cm (Figure 3-12). The roost trees were found in a variety of stand types: mixedwood, pure trembling aspen, pure balsam poplar, and pure white spruce. The stands had very little or no lodgepole pine in them.

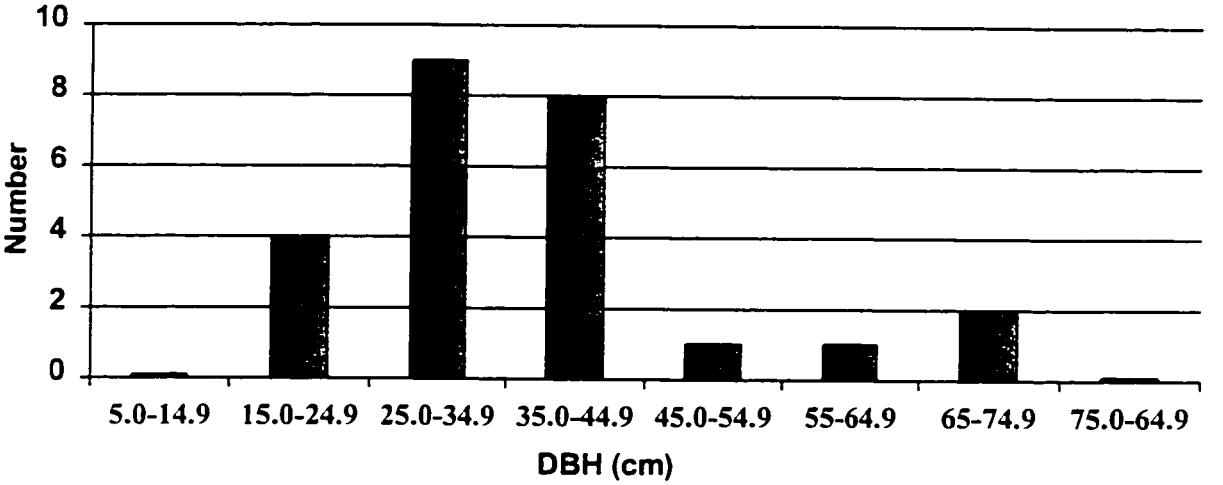


Figure 3-12: Distribution of diameters of the roost trees chosen by Barred Owls in the FMF (mean=35.7 cm).

The average diameters of the stands ranged from 12.6 to 31.7 cm (trees > 5 cm), or 19.2 to 41.8 cm (trees > 12.5 cm). The skewness and kurtosis were high for the distribution of tree diameters therefore the data was log transformed before comparing the roost site to the surrounding stand. There was no significant difference between the roost site and surrounding stands' diameters in the first seven sites, therefore only one plot was surveyed for the remaining roost sites (Figure 3-13). Stand characteristics were similar to the nest stands, C and D density stands with tall canopies (average=24.4 m) (Figures 3-14 and 3-15). All stands contained many trees greater than 35 cm DBH (average 45 trees/ha), a characteristic of older forests.

Barred Owls roosted 40.0 cm from the trunk on average (range 5 to 300 cm). The roost heights ranged from 3.5 to 19.5 m (average=11.6 m, S.D.=4.5 m). The aspect of the roost perch sites ranged from 20° to 270° (average=157.8°). No roost perch sites were chosen between north and northwest aspects (Figure 3-16).

Table 3-10: Example of test for skewness and kurtosis on the first Solomon Creek female roost plot average diameters.

	Mean	S.D.	Kurtosis	S.E. Kurtosis	Skewness	S.E. Skewness
Roost	22.910	11.422	2.457	0.312	2.215	0.264
Stand	23.821	10.721	2.166	0.287	2.004	0.129
Log Roost	1.187	0.211	-0.229	0.312	0.124	0.264
Log Stand	1.384	0.134	0.147	0.287	0.022	0.129

Table 3-11: Average of roost plot and surrounding stand diameters and significance values.

Roost	Roost Plot Average Tree Diameter	Roost Stand Average Tree Diameter	*P
Solomon 1	21.325	22.714	0.096
Solomon 2	23.821	22.910	0.164
Solomon 3	24.432	24.019	0.574
Solomon 4	20.143	20.566	0.598
Solomon 5	17.138	17.276	0.271
Solomon 6	18.522	17.914	0.078
Blackcat 1	12.615	12.982	0.327

*none of the P values are significant

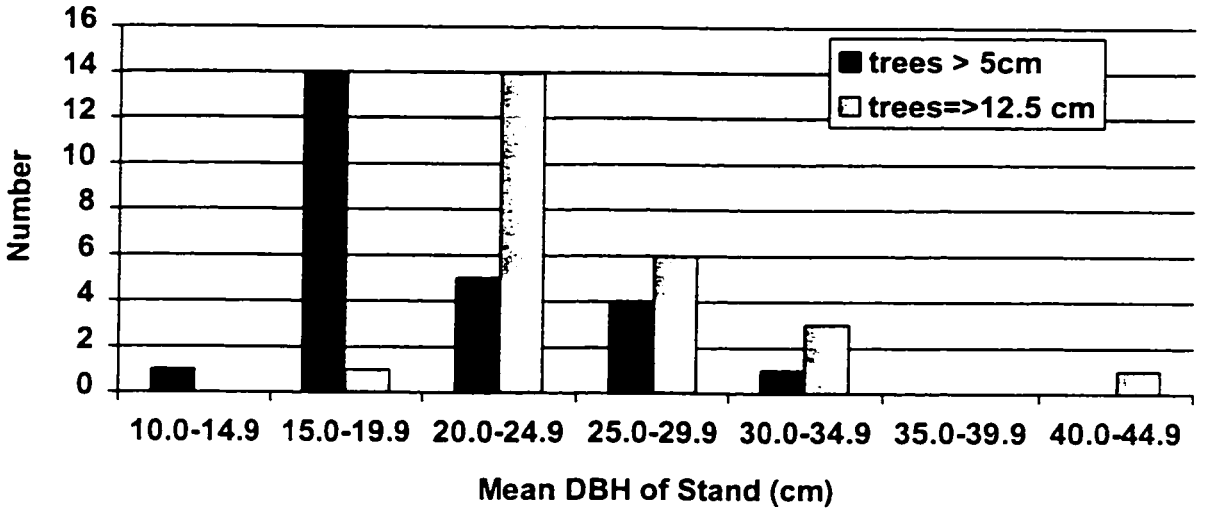


Figure 3-13: Mean diameter of trees in the roost stands, when all trees > 5 cm dbh are measured, and when all trees > 12.5 cm dbh are measured.

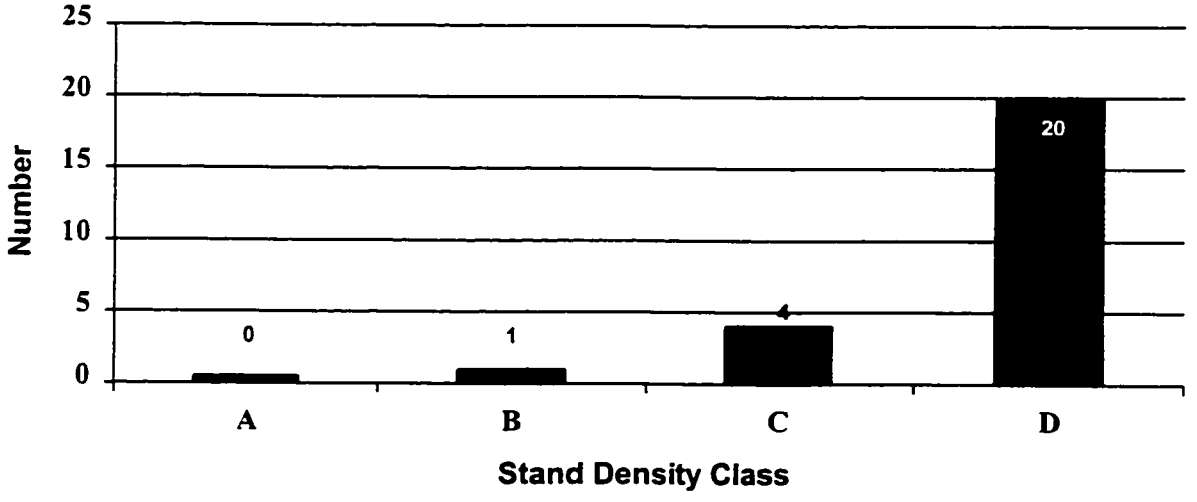


Figure 3-14: Stand density associated with roost sites. Density codes: A is 5-30%, B is 31-50% C is 51-70%, and D is 71-100% canopy closure.

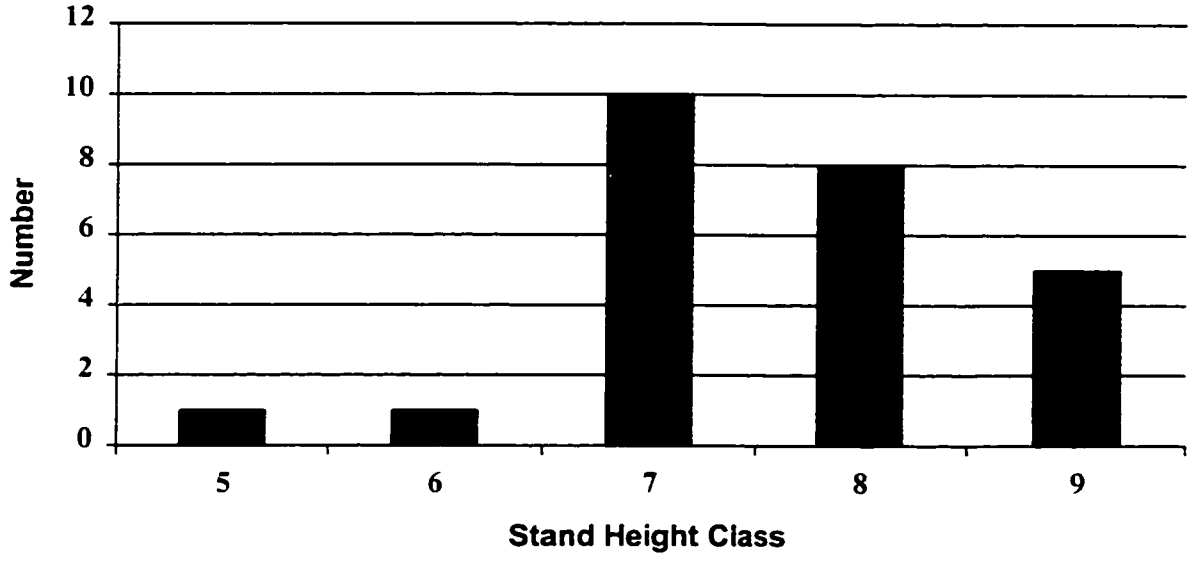


Figure 3-15: Stand tree heights associated with roost sites of Barred Owls. Height codes: 5 is 15.1 to 18.0 m, 6 is 18.1 to 21 m, 7 is 21.1 to 24 m, and 8 is 24.1 to 27 m.

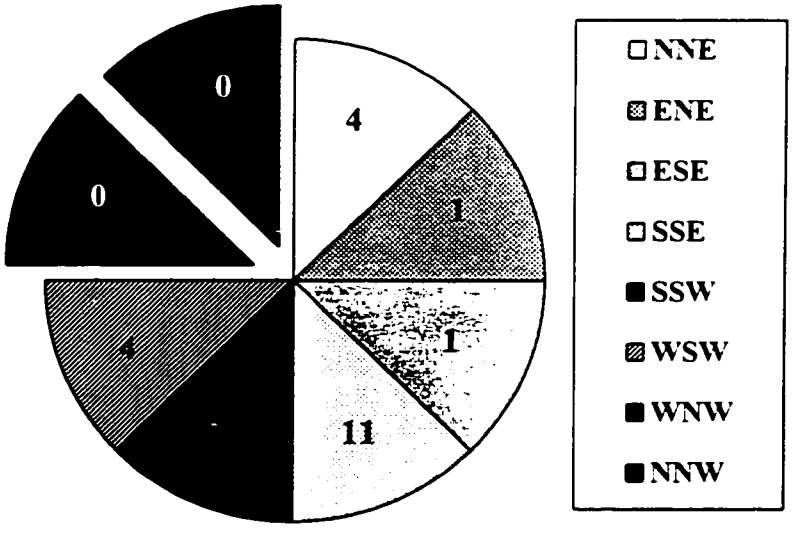


Figure 3-16: Roost site perch aspect of Barred Owls in the Foothills Model Forest (n=25).

Forage Sites

Eleven forage sites were located during this project. Eight were from the radiotagged female Barred Owl at Solomon Creek (four in 1995 (Takats 1996) and four in 1996). Three foraging attempts, one each, by the male Solomon Creek Barred Owl, the Blackcat male, and the Wild Hay female were observed. Eight live trees (seven trembling aspen, one balsam poplar), one white spruce stub, one trembling aspen snag, and one man-made post were used as forage perches. Mean diameter and height of the hunting structures were 27.5 cm and 18.3 m respectively. Mean perch height was 5.2 m, and mean distance of the perch site from trunk was 10.0 cm. The owls did not choose specific exposures to forage from.

The canopy cover of the forage stands was lower than for the roost and nest stands, averaging 61.5 percent canopy closure (range 22.9-89.7 percent). The average tree diameters of the forage stands were not significantly different from the center forage plots (Tables 3-10 and 3-11), in the three of the sites. The foraging plot had a slightly lower average tree diameter than the surrounding stand. Foraging areas were not located in the same stand as nest trees, but were found near the roost sites on four occasions. Average total shrub cover was significantly lower under the forage trees than the surrounding stand (T-test, P=0.02). The average total herb cover was also significantly lower (T-test, P=0.04).

Table 3-12: Example of test for skewness and kurtosis on the first Solomon female Barred Owl foraging observation average tree diameters.

	Mean	S.D.	Kurtosis	S.E. Kurtosis	Skewness	S.E. Skewness
Forage Plot	21.114	12.049	2.479	0.717	1.513	0.365
Forage Stand	22.594	12.486	2.539	0.428	1.428	0.216
Log Forage	1.265	0.226	-0.380	0.717	0.274	0.365
Log Stand	1.280	0.265	-0.428	0.428	-0.248	0.216

Table 3-13: Average tree diameters of forage plot and surrounding stand and significance values of three sites (* none of the P values are significant).

Forage Site	Forage Plot Average Tree Diameter	Forage Stand Average Tree Diameter	*P
Solomon 1	21.114	22.594	0.086
Solomon 2	19.625	20.452	0.097
Wild Hay 1	19.212	20.734	0.126

3.4 Discussion

Distribution and Abundance

The Barred Owls in the Foothills Model Forest had a clumped distribution (Figure 3-3). The habitat and topography in the FMF is not uniform. Looking at the distribution of general subregions, we can see that the Barred Owls are using lower elevations associated with watersheds. The older mixedwood stands of white spruce and balsam poplar are patchy in their distribution across the landscape, whereas continuous stands of lodgepole pine and trembling aspen are more prevalent. Because the Barred Owl was found in old growth uneven-aged mixedwood forests, their distributions reflect the distribution of these habitats. The total area within an 80 km radius around Hinton was not surveyed, therefore Barred Owls could be found in some of the unsurveyed areas.

Barred Owl densities are different throughout their range across North America. The density of 0.025 pairs/km^2 determined for the FMF falls close to the range of 0.03 to 1.0 pairs/km reported from across its breeding range (Craighead and Craighead 1969, Bosakowski *et al.* 1987, Stewart and Robbins 1958). The densities of Barred and Great Horned Owls were similar. The Boreal Owl appears to have the highest abundance in the FMF (Table 3-1 and 3-2), with a density of 0.17 owls/km^2. This is high compared to a study in Manitoba where densities were estimated to be 0.061, 0.034 and 0.069 owls/km in 1991, 1992, and 1993 (Duncan and Duncan 1993). The number of Barred Owls found during this project demonstrates that they are not as rare as once believed in the province (Boxall and Stepney 1982).

Great Horned Owls were not found on Barred Owl territories. There was a Great Grey Owl that was depredated by a Great Horned Owl near a Barred Owl territory. Baumgartner (1939) reported that no other species of large owls intrude into *Bubo*'s territorial range. Fuller (1979) found that no mated Barred Owls ranged near the nest of a Great Horned Owl, and LeDuc (1970) noted that the territory of a pair of Barred Owls was taken over by a Great Horned Owl which displaced the Barred Owls. Great Horned Owls will prey on other owls in their territories (Laidig and Dobkin 1995, Court pers. comm.), and as fragmentation of the forest increases, it creates habitat for open forest species like the Great Horned Owl. The lack of suitable habitat, plus the increased presence of Great Horned Owls were major factors in determining the absence of Barred Owls in Michigan (Craighead and Craighead 1969).

Telemetry

Live trapping of Barred Owls was not successful. Fuller and Christenson (1976) discuss a variety of techniques for capturing raptors. A variety of techniques need to be employed to be able to capture individuals. Barred Owls are difficult to capture because they are wary of humans. They are also subject to predation by other owls and hawks and will seldom fly into open areas. Mist netting was successful in capturing one owl. This technique will work for some individuals, but other methods need to be used to trap more cautious individuals. Drop-lid trapping is not recommended for capturing Barred Owls, however, this method is useful for capturing other species of raptors.

The radiotagged Barred Owl increased its home range slightly from summer 1995 to winter 1995/96. Increases in home range allow for an increased area for foraging, when prey populations are less available. The home range also shifted into white spruce dominated habitat to take advantage of better thermal cover, which is required to shelter the owls from microclimate extremes (Demarchi and Bunnell 1993). The Blackcat male increased its home range, from 1995 to 1996, when the Northern Goshawk did not nest in the same location again. The Barred Owl and Northern Goshawk are known to be competitors (Eifrig 1907).

Habitat Use

By using stick nest searches and casual observations, 61 nests were located, however none were used by Barred Owls. There is one record of a Barred Owl using a stick nest in Alberta (G. Court, pers. comm.), and two in Saskatchewan (Mazur, pers. comm.). In the United States, there are also other records of Barred Owls using stick nests (Apfelbaum and Seelbach 1983). Our lack of success in finding stick nests during the aerial surveys indicates that stick nests in this area were not very visible from above.

A range of habitats were surveyed during the broadcast transects, including lodgepole pine, white spruce, black spruce, aspen, balsam poplar, Douglas fir, Engelmann spruce, and mixedwood stands of these species. Clearcuts and younger forests were also surveyed. A variety of topographic areas were surveyed including river valleys, lakes, streams, lower foothills, upper foothills, and montane ecoregions. The Barred Owls were found in mature and old growth mixedwood stands of white spruce, balsam poplar and trembling aspen (Appendix 3-3).

The stands were uneven aged stands where flooding was a major disturbance. The stands had greater than 50 % canopy closure, and had tree heights above 18 m. The use of a spherical densiometer masked the small gaps, and therefore produced a higher measure of canopy closure than that taken off air photos (Bunnell and Vales 1990). The habitats used by the Barred Owl were located in lower elevations, along watersheds, where large balsam poplar trees were present, little fragmentation had occurred, and white spruce was present to provide cover. This habitat use is similar to habitat chosen by Barred Owls in Saskatchewan, where Barred Owls demonstrated a preference for mature and old growth mixedwood (James *et al.* 1995, K. Mazur pers. comm.).

Nests were in natural cavities of large diameter balsam poplar trees. A critical component of Barred Owl habitat is the availability of trees of sufficient size to provide nesting cavities (Allen 1987). Trembling aspen trees with cavities created by woodpeckers were not used by the Barred Owls, although Boreal and Northern Saw-whet Owls used them readily. Dunstan and Sample (1972) note that nest sites are ≥ 7.6 m above the ground. The six nest sites in this study were ≥ 10.4 m above the ground. The canopy closure was higher on the ground then when interpreted from air photos.

Elsewhere, Barred Owls nest in tree cavities close association with water (Carter 1925, Applegate 1975, Soucy 1976) as found in this study. Old, large balsam poplar trees are found near water in areas that are usually bypassed by fire and are more nutrient rich. Succession in this ecosystem is driven by flooding and accumulation of sediment (Annas 1977, Peterson 1981).

Barred Owls used trembling aspen, white spruce, and balsam poplar for roosting. Forage sites had less shrub and herb cover, which would increase visibility to the forest floor. Roosting and foraging stands were mixedwood forests of white spruce, trembling aspen, and balsam poplar.

1.5 Conclusion and Recommendations

1. Barred Owls rely on old growth mixedwood riparian forests with balsam poplar trees for nesting. They are good indicators of the availability of old growth forests. In these riverine balsam poplar forests, old-growth attributes begin to appear after a stand age of about 80 years (Timoney and Robinson 1996). White spruce and balsam poplar can reach 200 years of age in these riparian areas (Timoney *et al.* 1997). Forest harvesting practices need to mimic this natural cycle of the forest, ensuring forests are left to mature to old growth forest.

2. The effect fragmentation and disturbance on Barred Owls needs to be studied. Barred Owls may be affected by forest fragmentation because suitable nest, roost and forage habitats are opened up. Riparian areas are difficult to regenerate after clearcutting practices. Patch cuts are recommended to ensure that the forest is not fragmented to the stage where Barred Owls will no longer nest, and this will increase the speed at which the forest regenerates. Forestry practices must ensure that continuous stands of old mixedwood forest remain on the landscape.

3. Radiotelemetry is an excellent way to get detailed information about the habitat use (nesting, roosting and foraging) by Barred Owls. Other trapping techniques should be used to capture Barred Owls.

4. The difference in stand characterization between the photo interpreted AVI and the in field data collection, demonstrates the need to do ground truthing. As well, way data is collected should be compatible with forest harvest inventories, to ensure the data can be directly used in forest management.

5. The number of Barred Owls and other owls found during this project demonstrates the fact that the ecology of owls is still a relatively unknown. Broadcast surveys are a good way to get general owl habitat use, distribution, and relative abundance information of owls.

6. More information needs to be compiled on the owls in the Foothills Model Forest. These are long-lived species require long-term monitoring to understand the natural population fluctuations, so that anthropogenic caused declines can be seen. Baseline data needs to be collected to ensure that declines can be detected. Little is known about the reproductive success, productivity, percent of the populations breeding, and density.

3.6 Literature Cited

Alberta Environmental Protection. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division, Edmonton, Alberta. 44 pp.

Alberta Forestry Lands and Wildlife. 1991. Alberta Vegetation Inventory standards manual. Version 2.1. Land Information Services Division, Resource Information Branch, Edmonton, Alberta. 36 pp.

Allen, A.W. 1987. Habitat suitability index models: Barred Owl. U.S. Fish and Wildlife Service Biological Report 82. 17 pp.

Allin, A.E. 1944. Nesting of the barred owl (*Strix varia*) in Ontario. The Canadian Field-Naturalist 58: 8-9.

American Ornithologists' Union. 1983. Check-list of North American birds, 6th edition. American Ornothologists' Union, Washington, DC. 877 pp.

Amlaner, C.J. 1980. The design of antennas for use in radio tlelmetry. In: A Handbook of Biotelemetry and Radiotracking by C.J. Amlaner and D.W. Macdonald (eds.). Pergamon Press, Oxford.

Annas, R.M. 1977. Boreal ecosystems of the Fort Nelson area of northeastern British Columbia. PhD. Thesis, University of British Columbia, Vancouver. 409 pp.

Apfelbaum, S.I. and P. Seelbach. 1983. Nest tree, habitat selection, and productivity of seven North American raptor species based on the Cornell University nest record card program. Raptor Research 17(4): 97-113.

Baumgartner, F.M. 1939. Territory in the great horned owl. Auk 56: 274-282.

Bent, A.C. 1961. Life histories of North American birds of prey. Dover Publications, Inc. New York, New York. Pp. 182-197.

Berger, D.D. and H.C. Mueller. 1959. The bal-chatri: a trap for the birds of prey. Bird-Banding 30: 18-26.

Bessie, W. 1995. Habitat structure sampling manual for wildlife habitat suitability index projects. Interim Report to the Foothills Model Forest, Hinton, Alberta. 34 pp.

Bibby, C.J. and N.D. Burgess. 1992. Bird censusing techniques. Academic Press Ltd., London. 257 pp.

Bloom, P.H. 1987. Capturing and handling raptors. In Raptor Managment Techniques Manual by B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird. National Wildlife Federation, Washington, D.C. Pp. 99-123.

Bosakowski, T. 1987. Census of Barred Owls and spotted owls. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 307-308.

Bosakowski, T., R. Speiser, and J. Benzinger. 1987. Distribution, density, and habitat relationships of the Barred Owl in Northern New Jersey. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 135-143.

Boxall, P.C. 1986. Additional observations of the barred owl in Alberta. Blue Jay 44: 41-43.

Boxall, P.C. and P.H.R. Stepney. 1982. The distribution and status of the Barred Owl in Alberta. The Canadian Field-Naturalist 96(1): 46-50.

Bub, H. 1991. Bird trapping and bird banding: a handbook for trapping methods all over the world. Cornell University Press, Ithaca, New York. 325 pp.

Bull, E.L. 1987. Capture techniques for owls. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 291-294.

Bunnell, F.L. and D.J. Vales. 1990. Comparison of methods for estimating forest overstory cover: differences among techniques. Canadian Journal of Forest Research 20: 101-107.

Butler, J. 1994. Dialog with a frog on a log: poems of nature and deep ecology. Duval House Publishing, Edmonton, Alberta. 120 pp.

Campbell, R.W. 1973. Coastal records of the barred owl for British Columbia. Murrelet 54: 25.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall (eds.). 1990. The birds of British Columbia. University of British Columbia Press, Vancouver, B.C.

Carey, A.B., S.P. Horton, and B.L. Biswell. 1992. Northern spotted owl: influence of prey base and landscape character. Ecological Monographs 62(2): 223-250.

Cartwright, B.W. 1931. Notes and observations on some Manitoban birds. The Canadian Field-Naturalist 45(8): 181-187.

Craighead, J.J. and F.C. Craighead, Jr. 1969. Hawks, owls and wildlife. Dover Publications, New York. 443 pp.

Demarchi, M.W. and F.L. Bunnell. 1993. Estimating forest canopy effects on summer thermal cover for Cervidae (deer family). Canadian Journal of Forest Research 23: 2419-2426.

Devereux, J.G. and J.A. Mosher. 1982. Nesting habits of the barred owl in western Maryland. Maryland Birdlife 38(4): 124-126.

Devereux, J.G. and J.A. Mosher. 1984. Breeding ecology of barred owls in the central Appalachians. Raptor Research 18: 49-58.

Dunbar, D.L., B.P. Booth, E.D. Forsman, A.E. Hetherington, and D.J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia. Canadian Field-Naturalist 105: 464-468.

Duncan, J.R. 1994. Barred owl habitat use literature review. Manitoba Raptor Foundation, Balmoral, Manitoba. 23 pp.

Duncan, P.A. and J.R. Duncan. 1993. Nocturnal audio/playback owl survey of south eastern Manitoba and adjacent Minnesota. Progress report.

Duncan, P.A. and D.M. Kirk. 1994. Status report on the northern goshawk, *Accipiter gentilis*, in Canada. Environment Canada, Canadian Wildlife Service, Hull, Quebec. 47 pp.

Dunstan, T.C. 1972. A harness for radio-tagging raptorial birds. Inland Bird Banding News 44: 4-8.

Dunstan, T.C. 1973. A tail feather package for radio-tagging raptorial birds. Inland Bird News 45: 3-6.

Dunstan, T.C. and S.D. Sample. 1972. Biology of barred owls in Minnesota. Loon 44: 111-115.

Eckert, A.W. 1974. The owls of North America (north of Mexico). Doubleday and Company, Inc., Garden City, New York.

Eifrig, G. 1907. American goshawk versus man and barred owl. Auk 24: 437-438.

Elody, B.J. 1983. Techniques for capturing, marking, monitoring and habitat amalysis for the Barred Owl in the Upper Peninsula of Michigan. MSc. Thesis, Michigan Technological University. 104 pp.

Elody, B.J. and N.F. Sloan. 1985. Movements and habitat use of Barred Owls in the Huron Mountains of Marquette County, Michigan, as determined by radio-telemetry. Jack-Pine Warbler 63(1): 3-8.

Ethier, T. 1995. Survey methods for raptors in British Columbia. Draft report for the Wildlife Branch, Ministry of Environment, Lands, and Parks, Victoria, BC. 50 pp.

Fuller, M.R. 1979. Spatiotemporal ecology of four sympatric raptor species. PhD. Thesis, University of Minnesota, Minneapolis, Minnesota. 220 pp.

Fuller, M.R. and G.S. Christenson. 1976. An evaluation of techniques for capturing raptors in east-central Minnesota. Raptor Research 10: 9-19.

Fuller, M.R. and J.A. Mosher. 1987. Raptor survey techniques. In Raptor Research Management Techniques Manual by B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird. National Wildlife Federation, Washington, D.C. Pp. 37-65.

Fuller, M.R., T.H. Nicholls, and J.R. Tester. 1974. Raptor conservation and management implications of bio-telemetry studies from Cedar Creek Natural History Area. In: Management of Raptors, Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, Colorado by F.N. Hamerstrom, Jr., B.E. Harrell, and R.R. Olendorff (eds.). Pp. 33-44.

Fuller, M.R. and J.R. Tester. 1973. An automated radio tracking system for biotelemetry. Raptor Research 7: 105-106.

Grant, J. 1966. The barred owl in British Columbia. Murrelet 47: 39-45.

Guetterman, J.H., J.A. Burns, J.A. Reid, R.B. Horn, and C.C. Foster. 1991. Radio telemetry methods for studying spotted owls in the Pacific Northwest. General Techinical Report PNW-GTR-272, Portland Oregon. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station. 43 pp.

Hamer, T.E. 1988. Home range size of the northern barred owl and northern spotted owl in western Washington. MSc. Thesis, Western Washington University. 85 pp.

Houston, S. 1959. First records of the barred owl in Saskatchewan. The Blue Jay 17(3): 94.

Houston, S. 1961. First Saskatchewan nest of Barred Owl. The Blue Jay 19(3): 114-115.

Hunter, M.L., Jr. 1990. Wildlife, forests, and forestry principles of managing forests for biological diversity. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 370pp.

Jacobs, E.A. 1996. A mechanical owl as a trapping lure for raptors. Raptor Research 30(1): 31-32.

James, P.C., K.M. Mazur, and S.D. Frith. 1995. The Barred Owl as an indicator of old forest and its role in long-term forestry planning. Annual Report. Saskatchewan Environment and Resource Management. 27 pp.

Johnsgard, P.A. 1988. North American owls: biology and natural history. Smithsonian Institution. 295 pp.

Johnson, D.H. 1980. The comparison of usage and availability measurements for evaluating resources preference. Ecology 61: 65-71.

Jones, E.T. 1966. Barred Owl nest record for Alberta. The Blue Jay 24: 140.

Jones, E.T. 1987. Early observations of barred owls in Alberta. Blue Jay 45: 31-32.

Kenward, R.E. 1978. Radio transmitters tail-mounted on hawks. Ornis Scand. 9: 220-223.

Kenward, R.E. 1985. Raptor radio-tracking and telemetry. In Conservation Studies on Raptors by I. Newton and R.D. Chancellor (eds.). ICBP Technical Publication No. 5. 482 pp.

Kenward, R.E. 1987. Wildlife radio tagging, equipment, field techniques and data analysis. Academic Press, London.

Kenward, R.E., M. Karlbom, and V. Marcstrom. 1983. The price of success in goshawk trapping. Raptor Research 17(3): 84-91.

Kirk, D.A., D. Hussell, and E. Dunn. 1994. Raptor population status and trends in Canada. Bird Trends 4: 2-9.

Laidig, K.J. and D.S. Dobkin. 1995. Spatial overlap and habitat associations of barred owls and great horned owls in southern New Jersey. Raptor Research 29(3): 151-157.

Leder, J.E. and M.L. Walters. 1980. Nesting observations for the barred owl in western Washington. Murrelet 61(3): 111-112.

LeDuc, P. 1970. The nesting ecology of some hawks and owls in southeastern Minnesota. Loon 42: 48-62.

McGarigal, K. and J.D. Fraser. 1984. The effect of forest stand age on owl distribution in southwestern Virginia. Journal of Wildlife Management 48(4): 1393-1398.

McGarigal, K. and J.D. Fraser. 1985. Barred Owl responses to recorded vocalizations. Condor 87(4): 552-553.

McGowan, J.D. 1975. Distribution, density, and productivity of goshawks in interior Alaska. Alaska Department of Fish and Game, Juneau, Alaska. 31 pp. and Appendices.

Meng, H. 1971. The Swedish goshawk trap. Journal of Wildlife Management 55: 832-835.

Mills, L.S., R.J. Fredrickson, and B.B. Moorhead. 1993. Characteristics of old-growth forests associated with northern spotted owls in Olympic National Park. Journal of Wildlife Management 57(2): 315-320.

Morrison, M.L., B.G. Marcot, and R.W. Mannan. 1992. Wildlife-habitat relationships concepts and applications. The University of Wisconsin Press, Madison, Wisconsin. 343 pp.

Nicholls, T.H. and M.R. Fuller. 1987. Territorial aspects of Barred Owl home range and behavior in Minnesota. In The Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 121-128.

Nicholls, T.H. and D.W. Warner. 1968. A harness for attaching radio transmitters to large owls. Bird Banding 39: 209-214.

Nicholls, T.H. and D.W. Warner. 1972. Barred Owl habitat use as determined by radio-telemetry. Journal of Wildlife Management 36(2): 213-224.

Oeming, A.F. 1955. A preliminary study of the great gray owl (*Scotiaptex nebulosa nebulosa*) in Alberta with observations of other species of owls. MSc. Thesis, University of Alberta, Edmonton, Alberta.

Paris, O.H. 1947. "Squeaking" to attract barred owl. Chat 11:73.

Peterson, E.B. 1981. Alluvial ecosystems, MacKenzie River Basin Study, Report Supple. 2. MacKenzie River Basin Committee, Ottawa. 129 pp.

Preble, E.A. 1941. Barred Owl on Athabasca River. Auk 58: 407-408.

Price, H.F. 1940. Nests and eggs of the great horned and barred owls. The Oologist: 38-39.

Proudfoot, G., J.L. Mays, S.L. Beasom, R. Bingham. 1997. Effectiveness of broadcast surveys in determining habitat use of ferruginous pygmy-owls in southern Texas. Paper presented at the Biology and Conservation of Owls of the Northern Hemisphere, Winnipeg, Manitoba.

Redpath, S.M. and I. Wyllie. 1994. Traps for capturing territorial owls. Raptor Research 28(2): 115-117.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A variable circular plot method for estimating bird numbers. Condor 82: 309-313.

Reynolds, R.T., E.C. Meslow, and H.M. Wight. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. Journal of Wildlife Management 46: 124-138.

Schaffer, W. 1996. Northern goshawk habitat characterization in the Foothills Model Forest. Final report, Foothills Model Forest, Hinton, Alberta.

Springer, J.T. 1979. Some sources of bias and sampling error in radio-transmitters on snail kites in Florida. Journal of Wildlife Management 43(4): 926-935.

Stewart, R.E. and C.S. Robbins. 1958. Birds of Maryland and the District of Columbia. USDI, Fish and Wildlife Service, North America Fauna No. 63.

Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources, Edmonton, Alberta. Technical Report T/4.

Takats, D.L. 1995. Rare bird sightings in the boreal forest of northern Alberta. Alberta Naturalist 25(4): 79-81.

Takats, D.L. 1996. Foraging observations of a Barred Owl in the Foothills Model Forest. Alberta Naturalist 26(2): 29-30.

Timoney, K. 1993. Timber berth 408 ecosystem monitoring plan. Wood Buffalo National Park. Unpublished.

Timoney, K.P. and A.L. Robinson. 1996. Old-growth white spruce and balsam poplar forest of the Peace River Lowlands, Wood Buffalo National Park, Canada: development, structure, and diversity.

Timoney, K.P., G. Peterson, and R. Wein. 1997. Vegetation development of boreal riparian plant communities after flooding, fire, and logging, Peace River, Canada. Forest Ecology and Management 93: 101-120.

Van Ael, S. 1995. Barred owl habitat project progress report. Lakehead University, Thunder Bay, Ontario. 22 pp.

Appendix 3-1: Roost/Forage/Nest tree information recorded on all vegetation surveys.

Observer	Who observed the owl at its nest/roost/forage tree
Date	The date the owl was observed
Time	The time the owl was observed
Temperature	The temperature when the owl was observed
Cloud Cover	The cloud cover (%) when the owl was observed
Wind	The wind (Beaufort scale) when the owl was observed
Precipitation	Any precipitation (snow/rain) when the owl was observed
Moon	Moon phase (if at night) when the owl was observed
Veg. survey by	Person(s) name
Date	Date veg. survey done
Location	Location name and sex of owl
Plot	1, 2, 3, etc. (if more than one roost/nest/forage site is found/individual)
Tree species	see Appendix B
Tree Type	"
DBH	"
Basal Area	calculated as $A=\pi r^2$ (diameter/2)
Lean	"
Condition	"
Damage	"
Cavities	number
Tree height	in meters using clinometer
Crown Base	in meters using clinometer
Crown Width	average of longest canopy branch and one perpendicular to it (m)
Perch/Roost/Nest Height	in meters using clinometer
Direction/Exposure	in degrees
Distance from trunk	in centimeters
Crown Density	0-0, 1-low, 2-medium, 3-high, 4-very high
Nest type	1-stick, 2-cavity, 3-other
Nest materials	description
Nest size	depth, width, surface area
Flight corridor	Presence of a 2 meter opening that is 5 meters in length
Distance to clearing	Natural and/or artificial (in meters)
Sketch	Drawing of tree from side view, location in stand

Appendix 3-2: Tree/Log characteristics recorded on vegetation surveys (0.04 ha area).

Tree species	Aw	Trembling Aspen (*Populus tremuloides*)
	Pb	Balsam Poplar (*Populus balsamifera*)
	Sw	White Spruce (*Picea glauca*)
	Sb	Black Spruce (*Picea mariana*)
	Pl	Lodgepole Pine (*Pinus contorta*)
	Fb	Balsam Fir (*Abies balsamea*)
	Fd	Douglas fir (*Pseudotsuga menziesii*)
	Lt	Tamarack, larch (*Larix laricina*)
Type	t	tree
	n	snag (above 1.4 m)
	m	stump (<= 1.4 m)
	c	cut stump
	s	stub
Distance from center	in meters	
DBH	diameter at breast height (cm), all trees to 5 cm are measured	
% Lean	lean of tree, 100 % flat on ground, 0% straight	
Tree Condition	0	healthy
	1	leaf/needle loss
	2	dieback
Sang/Stub/Stump Condition	1	Fresh/recently dead - leaves may still be attached
	2	Hard, dead a short time - fine branches present
	3	Hard, dead a few years - fine branches absent, bark crumbling
	4	Hard, dead many years - branches few to none, stem softening
	5	Soft - no branches, stem decomposing, bark mostly absent
	6	Decomposed - no branches, stem punky/rotten, bark absent
Damage	0	none
	1	insects
	2	falling/breakage
	3	animal
	4	other
	5	fungus
	6	cracking
	7	fire
	8	competition
Animal Cavities	number, exposure, height	
Seedlings	number of live and dead trees less than 1.4 m in height	
Saplings	number of live and dead trees > 1.4 m in height but < 5 cm DBH	
Log length	total length (m) all logs with base DBH > 5 cm in 0.04 ha plot	
Tip Diameter	diameter at the tip (cm)	
Base Diameter	diameter at the base (cm)	
Condition	1 fresh/green	
	2 Hard, branches absent	
	3 Soft, bark breaks with effort	
	4 Rotten/punky, bark breaks easily	
	5 Log becoming part of ground	

Appendix 3-3: Stand characteristics associated with Barred Owl locations - broadcast surveys.

No.	Date	Owl Location	Sex	Paired	*Density	**Height	%Tree Species
1	04/07/95	Solomon Creek	F	Y	C	8	80Pb10Aw10Sw
2	04/07/95	Solomon Creek	M	Y	B	8	60Pb20Aw20Sw
3	05/04/95	Solomon Creek	F	Y	B	7	70Pb20Aw10Sw
4	05/04/95	Solomon Creek	M	Y	C	7	70Aw20Sw10Pb
5	05/10/95	Solomon Creek	M	Y	D	7	80Sw20Aw
6	05/16/95	Solomon Creek	F	Y	C	7	70Sw30Aw
7	03/04/96	Solomon Creek	M	Y	C	7	60Sw20Pb20Aw
8	03/04/96	Solomon Creek	F	Y	C	7	60Sw20Pb20Aw
9	05/04/95	Blackcat Ranch	F	Y	D	7	80Sw20Pb
10	05/10/95	Blackcat Ranch	F	Y	D	7	80Sw20Pb
11	05/16/95	Blackcat Ranch	F	Y	C	7	80Sw20Pb
12	03/04/96	Blackcat Ranch	M	Y	C	7	70Sw30Aw
13	03/04/96	Blackcat Ranch	F	Y	C	7	80Sw20Pb
14	03/26/95	WildHay Ridge	F	Y	C	7	70Sw30Aw
15	04/07/95	WildHay Ridge	F	Y	C	7	60Aw40Sw
16	04/07/95	WildHay Ridge	M	Y	C	8	100Sw
17	04/02/96	WildHay Ridge	F	Y	C	7	60Aw30Sw10Pl
18	04/02/96	WildHay Ridge	M	Y	C	7	60Aw30Sw10Pl
19	03/17/95	Gregg Lake	M	N	C	7	60Aw30Sw10Sb
20	03/26/95	Gregg Lake	M	N	C	7	100Sw
21	04/07/95	Gregg Lake	M	N	C	7	100Sw
22	04/02/96	Gregg Lake	M	N	C	7	80Sw20Aw
23	03/17/95	Cold Creek	M	N	C	7	60Aw40Sw
24	04/07/95	Cold Creek	M	N	B	7	60Aw40Sw
25	04/07/95	Cold Creek	F	N	C	7	70Aw30Sw
26	05/04/96	Cold Creek	U	N	C	7	70Aw30Sw
27	05/13/95	Lynx Creek Pt. 5	U	U	C	7	70Sw30Aw
28	04/20/96	Lynx Creek Pt. 5	U	U	C	6	70Sw2Pl10Aw
29	05/24/95	Lynx Creek	F	Y	C	8	60Sw40Pb
30	03/05/96	Lynx Creek Pt. 8	U	U	C	7	70Sw20Pl10Aw
31	04/11/95	Medicine Lodge	U	U	C	7	60Sw20Pl20Aw
32	04/10/95	Prest Creek	U	N	C	7	80Sw20Aw
33	05/03/95	Prest Creek	M	N	C	7	80Sw20Aw
34	05/09/95	Gregg River	F	N	C	8	90Sw10Pb
35	04/25/96	Gregg River	F	N	C	8	90Sw10Pb
36	03/18/95	TriCreeks	M	U	C	8	90Sw10Aw
37	05/13/96	Cache Percotte	M	U	C	7	60Sw30Aw10Pl
38	04/28/95	Pedley	U	U	C	7	90Sw10Aw
39	03/20/96	Pedley	U	U	C	6	100Sw
40	05/16/95	WildHay North A	M	N	B	7	40Aw40Sw10Pb
41	04/14/96	WildHay North A	M	N	C	7	40Aw40Sw10Pb
42	04/26/96	WildHay North A	M	N	B	7	60Sw30Aw10Pb
43	05/16/95	WildHay North B	U	U	C	7	50Sw40Aw10Pl
44	04/22/96	Patricia Lake	M	N	C	6	90Pb10Pl
45	04/22/96	Miette	F	Y	C	8	60Sw30Aw10Pb

* Density - B=31-50, C=51-70 D=71-100%; Height - 6=18.1-21 m, 7=21.1-24 m, 8=24.1-27 m;
** Species - Aw=trembling aspen, Pb=balsam poplar, Sw=white Spruce, Sb=black spruce, Pl=lodgepole pine.

Appendix 3-4: List of all territorial Barred Owl locations, sex of the owl, whether it is paired, and breeding evidence.

No.	Location	Sex	Paired	Breeding Evidence
1	Solomon Creek	F	Y	Nest (1996)
2	Solomon Creek	M	Y	Nest (1996)
3	Blackcat Ranch	F	Y	Nest (1996)
4	Blackcat Ranch	M	Y	Nest (1996)
5	WildHay Ridge	F	Y	No
6	WildHay Ridge	M	Y	No
7	Gregg Lake	F	Y	No
8	Gregg Lake	M	Y	No
9	Jarvis Creek	M	N	No
10	Jarvis Lake	U	U	No
11	Miette	F	Y	Nest (1994,95,96)
12	Miette	M	Y	Nest (1994,95,96)
13	Lynx Creek	F	Y	Nest (1995)
14	Lynx Creek	M	Y	Nest (1995)
15	Cold Creek	M	N	No
16	Cold Creek	F	N	No
17	Pedley 1	M	U	Unknown
18	Pedley 2	U	U	Unknown
19	Karen Owl	F	N	No
20	TriCreeks	M	U	Unknown
21	Gregg River	F	U	Unknown
22	Prest Creek	M	N	No
23	Marke Owl	U	U	Unknown
24	Emerson Lake	F	U	Unknown
25	Brian Owl	U	U	Unknown
26	Sheila Owl	U	U	Unknown
27	Lynx/Emerson	M	U	Unknown
28	Lynx Point 5	U	U	Unknown
29	Medicine Lodge	U	U	Unknown
30	Cache Percotte	M	N	No
31	WildHay North A	M	N	No
32	WildHay North B	U	U	Unknown
33	Camp Owl	M	N	Unknown
34	Patricia Lake	M	N	Unknown
35	Cottonwood	U	N	Unknown
36	Mina Lake	M	N	No
37	Kinky Lake	U	U	Unknown
38	Willow Creek	U	U	Unknown
39	Kirby Owl	U	U	Unknown
40	Jody Owl	U	U	Unknown
41	Polecat	U	U	Unknown
42	Carl Owl	U	U	Unknown

*M-male, F-female

**Y-yes, N-no, U-unknown

Appendix 3-5 – Alberta Vegetation Inventory

(Alberta Forestry Lands and Wildlife 1991)

Crown Closure – the percentage of ground area covered by a vertical projection of tree crowns

Crown Closure (%)	Database Code
< 5	Sc
6 – 30	A
31 – 50	B
51 – 70	C
71 – 100	D

Stand Height – is determined through field measurements and recorded to the nearest meter

Stand Height (m)	Database Code
0 – 3	0
3.1 – 6	1
6.1 – 9	2
9.1 – 12	3
12.1 – 15	4
15.1 – 18	5
18.1 – 21	6
21.1 – 24	7
24.1 – 27	8
27.1 – 30	9
30.1 – 33	10

Chapter 4

Barred Owl Prey Use in the Foothills Model Forest

4.0 Introduction

The previous chapter focussed on Barred Owl habitat selection for nesting, roosting, and foraging. However, it must be noted that Barred Owls would probably not select these habitats if prey were not present or available nearby. Therefore, an important ecological variable to look at is what prey the Barred Owl uses (O'Neil *et al.* 1988), if prey are present in the habitats found in the Barred Owl's home range, and finally if prey are available to the Barred Owls. Availability can be defined as the state of being readily obtainable, accessible, or ready for use (Flexner 1988). The prey should be present in the habitat that the Barred Owl uses for foraging.

The foraging habitat of the Barred Owl is described as mature forests with large trees that provide clear unobstructed flight paths for hunting (Duncan 1994). Prey are more exposed to predators where there is little understory vegetation in which to hide (Elody 1983, Devereux and Mosher 1984). In the foothills of Alberta, the Barred Owl selects older mixedwood forests of trembling aspen (*Populus tremuloides*) and white spruce (*Picea glauca*) for foraging (Takats 1996).

The usual method for determining the diet of owls is to examine the contents of pellets. Owls swallow their prey whole and regurgitate pellets, which are masses of indigestible prey remains that raptors cough up (Craighead and Craighead 1969). Owls have relatively less efficient digestive process than hawks. As a result, their pellets contain a higher proportion of bones then those of hawks (Johngard 1988).

Nest and forage observations, and prey remains are also important in determining what different prey raptors are consuming. Pellets alone can provide a bias towards small mammals, as birds, amphibians, and insects will digest more fully, making it difficult to identify them in the pellet (Sensenig 1945). Errington (1930) disputes this claims, by showing that 49 sets of bird mandibles were recovered from pellets of a Barred Owl that consumed 55 English Sparrows (*Passer domesticus*).

It should be recognized that using prey remains and nest and forage observations alone would provide bias as well. More birds show up in prey remains because they are usually plucked of feathers, and eaten in pieces. Nest and forage observations will favor larger prey items, because the observer may not be able to see or identify a small item being brought into the nest or being captured. Therefore, collecting information from all three should reduce bias.

Literature Review

There are a variety of opinions as to the feeding ecology of the Barred Owl. According to Errington (1932) considered the Barred Owl a generalist species, which takes a wide variety of prey. He also noted that their food choice was further determined by what was within their power to kill. The diet of the Barred Owl is comprised of small mammals, birds, reptiles, amphibians, fish, and insects showing they are clearly an opportunistic feeder (Karalus and Eckert 1974, Bent 1938, Johnsgard 1988).

Barred Owls appear to be specializing on small mammals in many cases (Table 4-1). Wilson (1938) found that *Microtus* comprised about 83 % of the Barred Owls' diet in Michigan. Errington and McDonald (1937) found that Barred Owls turned to small mammals in winter. Marks *et al.* (1984) discovered that *Microtus* dominated the diet of Montana Barred Owls. Devereux and Mosher (1984) recorded mammals, birds, and arthropods (crayfish, insects) in the diet of Barred Owls in the Central Appalachians, but found that mammals dominated the diet.

The Barred Owl supplements its diet with birds, fish, amphibians, and insects (Table 4-1). Marks *et al.* (1984) found some unusually large items including a Sharp-shinned Hawk (*Accipiter striatus*), and a Ring-necked Pheasant (*Phasianus colchicus*). Jackson and White (1995) located a road-killed Barred Owl with a freshly killed Loggerhead Shrike (*Lanius ludovicianus*) in its talons. The Shrike had a grasshopper in its bill. They also observed an owl hunting for grasshoppers on a roadside. Devine *et al.* (1985) also found Barred Owls hunting insects (noctuid moths) in Florida. Smith *et al.* (1983) observed Barred Owls fishing and Sweeny (1959) watched one plunge feet first into one meter of water, then flapped its wings to make its way to shore.

Although there is an abundance of literature on Barred Owl diet in the United States, there is very little literature on diet in Alberta, or Canada (Table 4-1). The only diet information existing for Alberta are of single sightings (Jones 1956, Takats 1996).

Objectives

The purpose of this study was to determine the diet and feeding ecology of the Barred Owl in the Foothills Model Forest, Alberta. The objectives were to determine 1) the prey of the Barred Owl, 2) the species and relative abundance of possible prey in a range of habitats, and 3) what prey was available to the Barred Owl.

Table 4-1: Literature review of the diet of Barred Owls throughout North America.

Author (date)	Location	Mammals*	Birds*	Reptiles/ Amphibians*	Fish*	Invertebrates*	Other*
Blakemore (1940)	Minnesota	44.4	11.0	2.4			42.2
Bosakowski and Smith (1992)		55.0	16.1	3.3	2.5	23.1	0.0
Devereux and Mosher (1984)	Maryland	65.9	14.6			19.5	
Errington (1932)	Wisconsin	47-76	7-40				11-38
Fisher (1893)		56.1	15.8	4.4	1.8	21.9	
Marks *et al.* (1984)	Montana	96.3					3.7
Snyder and Wiley (1976)	General range	76.0	5.8			15.8	2.5
Wilson (1938)	Michigan	97.1					2.9

Author (date)	Location	Species List**
Bosakowski *et al.* (1987)	New Jersey	5 Short-tailed Shrew, 1 Starnose Mole, 18 Meadow Vole, 2 White-footed Mouse, 1 Southern Flying Squirrel, 2 Blue Jay, 2 Crayfish
Cahn and Kemp (1930)	Illinois	Small mammals, birds, reptiles, amphibians, fish and invertebrates
Dexter (1978)	Ohio	Meadow Voles, Short-tailed Shrews, White-footed Mice
Elody and Sloan (1985)	Michigan	Shrews, Red-backed Voles, Chipmunks, Red Squirrels
Errington and McDonald (1937)	Iowa	Small mammals, crayfish, small fish, frogs, garter snakes, insects, birds
Imhof (1976)	Alabama	Large insects, small birds, crayfish, frogs, snakes, and a variety of small mammals
James *et al.* (1995)	Saskatchewan	Cricetid rodents, Red Squirrel, shrews, Ruffed Grouse, some passerines
Jones (1956)	Alberta	Stomach analysis: 3 Red-backed Voles, 1 Masked Shrew
Leder and Walters (1980)	Washington	Northern Flicker, Snowshoe Hare, shrews, Deer Mice, voles, Ruffed Grouse
LeDuc (1970)	Minnesota	11 Meadow Voles, 1 Common Grackle, 1 Blue Jay, 1 Ruffed Grouse, 1 snake
Lowery (1974)	Louisiana	Rats, mice, and on rare occasion poultry
Mazur *et al.* (1997)	Saskatchewan	Cricetid rodents, Red and Northern Flying Squirrels, Pocket Gophers, frogs, beetles
Oberholser (1938)	Louisiana	Large insects, small birds, crayfish, frogs, snakes, and a variety of small mammals
Price (1942)	Indiana	Mice, shrews, small birds
Takats (1996)	Alberta	1 Red Squirrel, 1 vole, other Microtines

* Percent of prey items in diet. ** Scientific names in Appendix B.

4.2 Methods

Study Area

The Foothills Model Forest (FMF) is located in west-central Alberta and encompasses the Weldwood of Canada Forest Management Area, William A. Switzer Provincial Park, the Cache Percotte Forest, and Jasper National Park (2.3 million hectares). The study efforts were restricted to an area within a radius of 80 km from the town of Hinton, where pairs of Barred Owls had been located by broadcast surveys. Lodgepole pine (*Pinus contorta*) dominates the landscape in the foothills, while white spruce (*Picea glauca*), black spruce (*Picea mariana*), and trembling aspen (*Populus tremuloides*) are common at lower elevations, and balsam poplar (*Populus balsamifera*) and balsam fir (*Abies balsamea*) are uncommon. In the mountains Douglas fir (*Pseudotsuga menziesii*) is common and lodgepole pine are dominant (Strong and Leggat 1981).

Prey Use

Pellets and prey remains can be found under favorite roost trees (Blakemore 1940) or near nests (K. Mazur, pers. comm.). Searches were made for pellets and prey remains under and around roost and nest sites (within a 300 m radius). The pellets were picked apart and all skulls, jawbones, feathers, insect parts, and fur were identified. Unidentifiable parts were given to Wayne Roberts (Zoology museum, University of Alberta) and John Acorn (host of "The Nature Nut", Great North Productions, Edmonton) for identification. Other methods included observing owls forage and watching prey transfers at nests. Barred Owl feathers were collected and provided for stable isotope analysis (Duxbury, in prep.). This last method will not be discussed in this thesis.

Prey Surveys

A list of all potential prey species (birds/mammals/amphibians) was compiled over the first field season, in and near Barred Owl territories. To determine the relative abundance of these prey species, grouse drumming and bird point counts were conducted in 1996 in a range of habitats. Transects were randomly laid through 24 habitats (Appendix 4-2) ensuring that most habitat types found in Barred Owl territories were covered. Transects were chosen on or near Barred Owl territories and were measured using a 50 m chain. The transects varied in length, but were usually two kilometers.

Track counts were conducted in snow from February through April 1996. We recorded all tracks that crossed the transect, including species of animal that made the track and the amount of use. The counts were completed 12 to 96 hours after a snowfall so that tracks would be

identifiable. The amount of use was divided by the number of 12-hour time periods between the time of snowfall and when the survey was conducted, in order to standardize the data. The habitat surrounding each track was also recorded. The relative abundance of the most abundant species was calculated by adding all the track occurrences recorded in each habitat type together, and dividing by the total length of transects in each habitat type.

Point count stations were established every 250 m along these transects. Ruffed Grouse (*Bonasa umbellus*) drumming surveys were conducted from late April through mid-May 1996, during 5-minute listening counts. Songbird surveys were conducted from late May through early July (Reynolds *et al.* 1980). For five minutes at each station, the observer recorded all songbirds seen or heard within 50 m, and outside 50 m but within 125 m. Species seen flying over and en route between stations were recorded separately. Each transect was surveyed twice for songbirds. We did not survey during inclement weather (precipitation, wind) and transects were started at sunrise and finished by 11:00. Red Squirrels were recorded during bird surveys.

The relative abundance of the 12 most abundant species was calculated in each habitat type. As well, I determined the relative abundance in each habitat type for those species of birds the Barred Owl used as prey during this study.

4.3 RESULTS

Prey Use

During the winter and spring (1995/96) four foraging observations were made on the radiotagged female Barred Owl at Solomon Creek (Takats 1996, Appendix 4-3). Four more foraging bouts were documented in August and September 1996. Eight prey items were determined (Table 4-2): one shrew species (*Sorex sp.*), one deer mouse (*Peromyscus maniculatus*), one southern red-backed vole (*Clethrionomys gapperi*), two unidentified microtines, one red squirrel (*Tamiasciurus hudsonicus*), one young Ruffed Grouse, and a wood frog (*Rana sylvatica*).

Three other owls were observed foraging in the Fall of 1996: 1) a male Barred Owl (Blackcat Ranch) was observed trying to catch an unknown species of bat, 2) a female Barred Owl (Wild Hay) caught a southern red-backed vole, and 3) a male Barred Owl (Solomon Creek) caught a wood frog along a small creek bed. Most of the foraging attempts were on small mammals (72.7%).

Five prey transfers were observed during the project (Table 4-2). One microtine was brought in to the Miette nest and at the Solomon Creek nest one deer mouse, one Ruffed Grouse, and two unknown microtines were brought in. All the observations were made in April, May and June, 1996. The diet items were 75.0 percent mammals, 12.5 percent birds, and 12.5 percent amphibians. Microtines made up 31.3 percent of all prey items found by these two methods.

Table 4-2: Prey identified by direct observation of foraging or prey transfers.

Species	Forage	Prey Transfer	Total	% of Diet Items
Mammals				
Unidentified Shrew	1		1	
Deer Mouse	1	1	2	
Red-backed Vole	2		2	
Unidentified Microtine	2	3	5	
Red Squirrel	1		1	
Unidentified Bat	1		1	
Total Mammals	**8**	**4**	**12**	**75.0**
Birds				
Ruffed Grouse	1	1	2	**12.5**
Amphibian				
Wood Frog	2		2	**12.5**
Total	**11**	**5**	**16**	**100.0**

All other prey items were determined through pellet and prey remains analysis. In the first summer, no prey remains or pellets were found. The Barred Owls did not use specific trees for roosting and no nests were located, so it was difficult to find any signs of prey use. Most of the pellets (91.0%) and all but one of the prey remains were found 30-200 m away from active nests, in 1996. The remaining pellets were found in the winter above the snow under roost trees.

Seventy-eight pellets and eleven prey remains were collected and analyzed and were found to contain 155 prey items of a variety of mammals, birds, amphibians, and insects (Table 4-3). Wood Frogs were identified using jawbones found in pellets. Most of the wood frogs were adults based on the size of the jaws. Birds were identified by feathers and small mammals were determined using skulls, jaws, teeth and leg bones. The elytra of the beetles were used to identify them to species. The Barred Owls' diet consisted of 71 small mammals (45.8%), 39 birds (25.2%), 38 amphibians (24.5%), and 7 invertebrates (4.5%). Almost all the prey remains were birds (90.9%) while most of diet items in the pellets were small mammals (48.6%).

Table 4-3: Prey species identified in pellets and prey remains of Barred Owls in the FMF, Alberta.

Prey Items	Pellets	Prey Remains	% of Diet Items
Mammals			
Water Shrew (*Sorex palustris*)	1		
Unidentified Shrew (*Sorex sp.*)	5		
Deer Mouse (*Peromyscus maniculatus*)	8		
Jumping Mouse (*Zapus sp.*)	1		
Southern Red-backed Vole (*Clethrionomys gapperi*)	14		
Meadow Vole (*Microtus pennsylvanicus*)	7		
Long-tailed Vole (*Microtus longicaudus*)	11		
Unidentified Cricetid	6		
Bushy-tailed Woodrat (*Neotoma cinerea*)	2		
Red Squirrel (*Tamiasciurus hudsonicus*)	5	1	
Northern Flying Squirrel (*Glaucomys sabrinus*)	7		
Snowshoe Hare (*Lepus americanus*)	1		
Unidentified Weasel (*Mustela sp.*)	1		
Unidentified Bat (Vespertilionidae)	1		
Total	**70**	1	**45.8**
Birds			
Ruffed Grouse (*Bonasa umbellus*)	4	1	
Northern Flicker (*Colaptes auratus*)	2		
Gray Jay (*Perisoreus canadensis*)	1	1	
Varied Thrush (*Ixoreus naevius*)	3	7	
Swainson's Thrush (*Catharus ustulatus*)	1		
American Robin (*Turdus migratorius*)	3		
Common Yellowthroat (*Geothlytis trichis*)	1		
White-throated Sparrow (*Zonotrichia albicollis*)	2		
Dark-eyed Junco (*Junco hyemalis*)		1	
Unidentified Birds	12		
Total	**29**	**10**	**25.2**
Amphibians			
Wood Frog (*Rana sylvatica*)	38		
Total	**38**	**0**	**24.5**
Invertebrates			
Predaceous Diving Beetle (*Dytiscus alaskanus*)	6		
Snail (Planorbidae)	1		
Total	**7**	**0**	**4.5**
Total number of all prey items	**144**	**11**	**100.0**

Almost half of the diet was made up of small mammals, and microtines were 30.3% (n=47) of the diet. The three vole species were made up 20.6 percent of the diet items. Some interesting and abundant diet items include the wood frog (n=38) and the three species of Thrush (n=14), in particular the Varied Thrush (n=10). Each pellet contained 1.8 prey items on average.

When the prey items (pellets, prey remains, foraging observations) are divided by individual Barred Owl, some birds appear to have unique feeding habits (Table 4-4). The Solomon Creek female Barred Owl was the only one found to be eating beetles. Amphibians were only found in the pellets of the Solomon Creek male and female and the Miette female Barred Owls. The Wild Hay female Barred Owl was taking more birds (70.6 %) than mammals (29.4 %). Both the Blackcat Ranch male and the Miette female had a high proportion of small mammals in their diets.

Table 4-4: *Prey items (%) of individual Barred Owls (sample size in brackets)

Location	Mammals	Birds	Amphibians	Invertebrates	Total
Solomon Creek Female	41.3 (45)	20.2 (22)	32.1 (35)	6.4 (7)	100 (109)
Solomon Creek Male	50.0 (4)	12.5 (1)	37.5 (3)		100 (8)
Miette Female	77.8 (21)	14.8 (4)	7.4 (2)		100 (29)
Blackcat Male	80.0 (4)	20.0 (1)			100 (5)
Wild Hay Female	29.4 (5)	70.6 (12)			100 (17)

*Does not include prey transfers.

Snow Track Surveys

A total of seventeen species were recorded during snow track surveys (Table 4-5). Only ten of these species could serve as potential prey for the Barred Owl, and therefore are the only ones analyzed for abundance in different habitats. The species analyzed are: Ruffed Grouse, shrew sp., deer mouse, jumping mouse, vole sp., red squirrel, snowshoe hare, least weasel (*Mustela nivalis)*, long-tailed weasel (*Mustela frenata)*, and ermine (*Mustela erminea)*. The red squirrel, Ruffed Grouse, and snowshoe hare were the most abundant species recorded on the snow track counts. Species that were not used by Barred Owls as prey, but were recorded on the snow transects include: fisher (*Martes pennanti*), marten (*Martes americana*), coyote (*Canis latrans*), wolf (*Canis lupus*), moose (*Alces alces*) and deer (*Odocoileus sp.*).

Ruffed Grouse were most abundant in old growth balsam poplar/white spruce mixedwood,

Table 4-5: Snow track survey results showing relative abundance of each species detected in each habitat (# of tracks/day since last snowfall/distance covered x 1000).

	[1]HABITAT TYPE												
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Birds													
Ruffed Grouse	2.1	0	0	0.1	0.6	0	0.2	1.2	0	0	0	0	0.3
Mammals													
Shrew	0	0	0	0	0	0	0	0	0	0	0	0	0
Deer Mouse	0.1	0	2.8	0	0	1.3	0.1	0	0	0	0	0	0
Jumping Mouse	0	2.8	2.8	0	0	0	0	0	0	0	0	0	0
Vole	0.1	0	2.8	0	0	1.3	0.4	1.0	0	0	0	0	0
Red Squirrel	4.5	1.0	0	0.1	4.0	5.3	4.3	9.0	0.3	2.5	0	3.1	5.0
Snowshoe Hare	0.2	11.4	11.4	0.4	5.0	0	12.2	4.9	0	0	37.5	0	0.7
Least Weasel	0.1	0	0	0.1	0	0	0	0	0	0.4	0	0	0
Long-tailed Weasel	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Ermine	0	0	0	0.4	0.8	0	0.4	0	0	0.4	0	0	0

[1]Habitats: Aw-trembling aspen, Pb-balsam poplar, Sw-white spruce, Pl-lodgepole pine, Fb-balsam fir, Sb-black spruce.
1=AwSw, >25 m; 2=PbSw, >25 m; 3=Pb, >25 m; 4=Aw, 20-25 m; 5=SwPl, >25 m; 6=SwFb, 20-25 m; 7=Sw, 15-20 m; 8=Sw, >25 m; 9=Sw/Aw, regen. Clearcut, 3-6 m; 10=AwSw, 15-20 m; 11=PbAw, >25 m; 12=Pl, >25 m; 13=Pl, 15-20 m.

Table 4-5: Con't.

	[1]HABITAT TYPE										
Species	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Birds											
Ruffed Grouse	0	1.9	0	0	2.1	0	2.0	1.7	0	0	0
Mammals											
Shrew	0	0	0	0	0	0.2	0	0	0	0	0
Deer Mouse	0.5	0.2	0	0	0	0	0	0	0	0	0
Jumping Mouse	0	0.2	0	0	0	0	0	0	0	0	0
Vole	0	0.1	0	0	0	0	0	0	0	0	0
Red Squirrel	4.3	5.8	4.2	6.7	1.1	0.8	0	3.1	1.2	1.2	4.0
Snowshoe Hare	0	5.7	0.2	26.7	0	3.3	0	1.7	0	0	6.0
Least Weasel	0	0	0	0	0	0	0	0	0	0	0
Long-tailed Weasel	0	0	0	0	0	0	0	0	0	0	0
Ermine	0	0.2	0.5	0	0	0	0	0	0	0	0

[1]Habitats: Aw-trembling aspen, Pb-balsam poplar, Sw-white spruce, Pl-lodgepole pine, Fb-balsam fir, Sb-black spruce.
14=PlAw, >25 m; 15=Sb, 10-15 m; 16=SbPl, 1-20 m; 17=PlFb, 20-25 m; 18=SbAw, 15-20 m; 19=SwSb, 15-20 m; 20=AwPl, regenerating clearcut, 0.5-3 m; 21=Sw, sparse 10 m; 22=Pl, 6-8 m regenerating clearcut; 23=Sw, dense 10 m; 24=cutlines

mature black spruce, and younger forests containing white spruce. They were also found to be fairly abundant in regenerating clearcuts (trembling aspen/lodgepole pine) and in mature white spruce forests. The red squirrel was closely associated with conifer stands and was never found in pure deciduous forests (habitat types 3 and 11). The snowshoe hare had the highest abundance in balsam poplar/trembling aspen mixedwood, mature and old growth white spruce, mature lodgepole pine/balsam fir mixedwood, and mature black spruce stands. The hares were not found to be using clearcuts.

Grouse Drumming Counts

Ruffed Grouse surveys were conducted on eight of the fifteen transects due to time constraints. Grouse began drumming in early April and continued through to late May. Fifteen grouse were recorded on 55 stations. Grouse were heard drumming primarily in pure deciduous or deciduous dominated mixedwood stands that were above 20 m in height (Table 4-6). No grouse were heard in older pure coniferous stands.

Table 4-6: Locations and habitats associated with drumming Ruffed Grouse.

Habitat	Stand Height (m)	# of points	# of Ruffed Grouse
Trembling Aspen/White Spruce	>25	12	4
Balsam Poplar/White Spruce	>25	2	1
Balsam Poplar	>25	2	2
Trembling Aspen	>25	12	3
White Spruce/Lodgepole Pine	>25	1	0
White Spruce/Balsam Fir	20	1	0
White Spruce	15-20	2	0
White Spruce	>25	5	0
Trembling Aspen/White Spruce	15-20	7	1
Balsam Poplar/Trembling Aspen	>25	2	2
Lodgepole Pine	>25	1	0
Trembling Aspen/Lodgepole Pine	1-3	4	0
White Spruce (sparse)	10	3	1
Lodgepole Pine	7	1	0
White Spruce (dense)	10	1	1

Bird/Squirrel Point Counts

Sixty-three species of birds and Red Squirrels were recorded on the point counts (Appendix 4-4). The species of birds that had more than 15 records were: Black-capped Chickadees, Gray

Jays, Swainson's Thrushes, Varied Thrushes, Least Flycatchers, Myrtle Warblers, Orange-crowned Warblers, Ovenbirds, Ruby-crowned Kinglets, Golden-crowned Kinglets, White-throated Sparrows, Chipping Sparrows, and Red Squirrels. Species that were recorded during point counts and were used as prey by the Barred Owl included: Ruffed Grouse, Northern Flickers, Gray Jay, Varied Thrushes, Swainson's Thrush, American Robin, Common Yellowthroat, White-throated Sparrow, Dark-eyed Junco. The relative abundance of each of these species in the different habitat types was calculated (Table 4-7).

The Black-capped Chickadee, American Robin, Swainson's Thrush, Ruby- and Golden-crowned Kinglet, Myrtle Warbler, White-throated Sparrow, Dark-eyed Junco, and Chipping Sparrow were found in a range of habitats. Varied Thrushes were restricted to forested areas dominated by conifer trees. The highest relative abundance of Least Flycatchers, Orange-crowned Warblers, and Ovenbirds were recorded in older mixedwood and deciduous stands. Stands with trees greater than 25 m had the highest abundance of Northern Flickers.

Few Ruffed Grouse were recorded on the point counts to make habitat associations from these data. Three forest types were found to be associated with the Gray Jay's presence: trembling aspen/white spruce mixedwood, white spruce/balsam fir mixedwood, and black spruce/trembling aspen mixedwood. The Common Yellowthroat was only recorded on two occasions in balsam poplar and in balsam poplar/white spruce mixedwood.

The red squirrel was absent from pure deciduous forests. The clearcut white spruce/trembling aspen and pure lodgepole pine stands also did not have any red squirrels recorded in them. The highest abundance of this species was recorded in stands dominated by white spruce.

Other Species

There were other prey species of Barred Owls that were recorded while in the field, but not during formal surveys. Many wood frogs were seen making their way through the damp forest after precipitation events. None were seen in pure lodgepole pine or clearcuts, instead they seemed to be associated with older shade forests of mixedwood white spruce/trembling aspen. Northern flying squirrels were heard and seen on many nights during broadcast surveys. They were recorded in mixedwood trembling aspen/white spruce that was greater than 20 m in height.

Table 4-7: Point count results showing relative abundance of each species detected in each habitat (number observed/plot/visit).

	[1]HABITAT TYPE											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Birds												
Ruffed Grouse	0.09	-	-	-	-	-	-	-	-	-	-	-
Northern Flicker	0.36	0.50	-	0.25	-	-	-	-	-	-	-	-
Least Flycatcher	0.63	1.00	-	0.75	-	-	0.14	0.17	-	-	-	1.00
Gray Jay	1.00	-	-	-	-	0.17	-	-	-	-	-	-
Black-capped Chickadee	0.45	-	-	0.25	-	-	-	-	-	0.33	-	-
American Robin	0.64	-	-	0.33	-	-	-	0.50	-	-	-	-
Swainson's Thrush	1.00	1.00	1.00	0.42	-	1.00	1.00	0.33	-	-	-	-
Varied Thrush	-	-	-	-	-	0.17	-	-	-	-	-	-
Golden-crowned Kinglet	0.63	-	0.50	0.08	0.67	1.00	0.29	1.17	-	0.33	-	0.33
Ruby-crowned Kinglet	1.00	1.00	-	0.42	0.67		0.86	1.00	-	1.33	1.50	-
Myrtle Warbler	0.81	1.00	1.50	0.75	1.67	2.00	0.71	0.83	-	1.00	1.00	0.33
Orange-crowned Warbler	0.27	1.50	1.50	0.42	0.17	-	-	-	-	0.33	-	0.33
Common Yellowthroat	0.11	0.11	-	-	-	-	-	-	-	-	-	-
Ovenbird	0.63	0.11	1.00	1.08	-	-	0.14	-	-	0.33	1.00	-
White-throated Sparrow	0.64	-	-	0.58	-	-	0.86	0.83	-	-	2.00	-
Chipping Sparrow	0.36	-	-	0.33	0.33	-	0.43	0.83	-	0.33	1.00	-
Dark-eyed Junco	1.00	-	-	0.33	0.33	-	0.43	0.17	1.00	-	-	-
Mammal												
Red Squirrel	1.09	1.00	-	0.33	0.33	1.00	0.29	1.33	-	0.67	-	-

[1]Habitat types: see bottom of Table 4-6.

Table 4-7 (Con't.): Point count results (number observed/plot/visit).

	[1]HABITAT TYPE										
Species	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Birds											
Ruffed Grouse	-	-	0.11	-	-	-	-	-	-	-	-
Northern Flicker	-	-	-	0.11	-	-	-	-	-	-	1.00
Least Flycatcher	-	-	-	-	-	-	1.00	-	0.33	1.00	1.00
Gray Jay	-	-	-	-	-	0.25	-	-	-	-	-
Black-capped Chickadee	0.20	-	0.11	0.33	-	0.25	-	-	-	-	-
American Robin	-	0.33	0.44	0.11	1.00	0.25	-	0.25	-	-	-
Swainson's Thrush	1.00	1.00	0.67	0.67	-	1.00	3.00	-	0.33	-	-
Varied Thrush	0.40	0.33	-	0.44	-	-	-	-	-	-	-
Golden-crowned Kinglet	-	-	0.22	0.22	1.00	0.25	1.00	-	-	-	-
Ruby-crowned Kinglet	1.00	1.67	1.56	0.22	1.00	1.25	2.00	0.50	1.67	2.00	1.00
Myrtle Warbler	1.00	2.00	0.56	0.78	2.00	2.00	2.00	-	0.67	1.00	-
Orange-crowned Warbler	-	0.33	0.22	0.33	-	0.25	-	0.75	-	-	-
Common Yellowthroat	-	-	-	-	-	-	-	-	-	-	-
Ovenbird	-	-	-	-	-	0.25	-	-	-	-	-
White-throated Sparrow	0.80	0.33	-	0.11	-	0.25	1.00	0.25	1.00	1.00	1.00
Chipping Sparrow	0.60	0.33	0.67	0.22	1.00	0.25	-	0.75	0.67	-	2.00
Dark-eyed Junco	0.40	1.00	0.11	0.22	1.00	0.25	1.00	1.00	0.33	-	-
Mammal											
Red Squirrel	0.80	1.33	0.89	0.89	1.00	1.00	-	0.25	0.67	-	2.00

[1]Habitat types: see bottom of Table 4-6.

4.4 Discussion

Prey Use

The Barred Owls in the FMF are taking a wide variety of prey, and therefore appear to be a generalist feeder over their foothills range. A major portion of their diet consisted of small mammals, birds, and amphibians. However, if the wood frog and Varied Thrush are eliminated from the totals, the Barred Owl is a specialist on microtines and sciurids (56.9% of diet items) and 68.1 % of the diet is mammals. According to the literature Barred Owls are prey generalists (Bent 1938), exploiting a wide range of resources (Krebs 1994). When each individual Barred Owl's diet is examined, we find some opportunistic feeding behavior on certain prey items, at certain times of the year, in certain locations.

The diet of the Barred Owls was found to be 75.0 % mammals when foraging and prey transfers were observed, whereas only 45.8 % of the diet items were mammals when pellets and prey remains were analyzed. All of the foraging attempts and the prey transfers were observed between late summer and early spring. The pellets and prey remains were collected throughout the year. The Barred Owls may be feeding on more birds during June, July and August when they are more available. The addition of Varied Thrushes and wood frogs to the diet also decreased the percentage of small mammals in the pellets and prey remains.

The Barred Owls appeared to be opportunistically feeding on two occasions, taking food that was most available at that time. In early May, a winter snowstorm produced 78 cm of snow in two days. The Varied Thrushes had already arrived in numbers from the south. This species is known to return early April to mid-May (Holroyd and Van Tighem 1983), but is not adapted to this colder weather. Many birds were seen in flocks along the open roads and cutlines, perched on the ground in places where snow had melted. The Barred Owls targeted this food source for one week.

When the Varied Thrush became less available to the Barred Owl and it returned to its usual habitat, wood frogs became more common in the pellets. Many predators will seek another prey species, when the one they have been specializing on becomes rare or unavailable. Prey switching occurs when one prey item becomes less available and another becomes more available (Begon *et al.* 1990). The Barred Owls appeared to be opportunistically feeding on wood frogs in May and early June when the adults were dispersing from breeding ponds Russell and Bauer

1991). Great Gray Owls have been observed foraging for frogs that were making night migrations across roads (Nero 1986).

The combination of pellets and prey remains produced different results than the combination of prey transfers and foraging attempts. The foraging attempts and prey transfers showed a higher preference for small mammals. Only one amphibian and no insects were recorded using this method. The pellets alone would not have represented the diet accurately, since a high percentage of bird prey was found in the prey remains. Wood frogs were identified by the jawbones, but it was suggested I look for the pelvis bones. No frog pelvis bones were found in any of the pellets.

Prey Availability

The Barred Owl was observed foraging in older mixedwood forests containing balsam poplar, trembling aspen, and white spruce. Therefore the prey that the Barred Owl uses should be abundant in this habitat type. As well, the method of capture that was observed was primarily flying down from a perch to catch animals on the forest floor. Most of the prey the owls selected had a higher relative abundance in the older mixedwood forests, and utilized the forest floor for foraging.

Snow track surveys were successful for determining relative abundance of Ruffed Grouse, snowshoe hares, and red squirrels. It was not successful for the microtine surveys. Because of the small size of microtines, they are at a disadvantage for temperature regulation and therefore spend much of the winter as subnivean animals (Chapman and Feldhamer 1982). Track counts are limited to species of animals that spend time above the snow pack.

The Ruffed Grouse is dependent upon forest as habitat (Johnsgard 1973) and prefers aspen dominated mixedwood forests with prominent logs for drumming. Wiggers *et al.* (1992) also noted that, in Missouri, 7-15 year-old hardwood regeneration had the highest abundance of Ruffed Grouse and that a high canopy cover (70-89%) was important. According to the drumming surveys in the FMF, Ruffed Grouse were found predominently in older mixedwood and deciduous forests with a high canopy closure. The snow track counts placed Ruffed Grouse in more conifer dominated forests, which would have a higher canopy closure in the winter because they maintain their needles.

The highest abundance of snowshoe hares was recorded in pure deciduous forest. There was also a high abundance in pure coniferous forest. Snowshoe hares occur in a variety of different habitats (Wrigley 1969, Keith 1974, Wolff 1980, Litvaitis *et al.* 1985), however the amount of understory cover is the most important factor in the winter months, to provide thermal protection (Meslow and Keith 1968, Conroy *et al.* 1979, Litvaitis *et al.* 1985). There is little cover in a deciduous stand in the winter due to loss of leaves, and little shrub cover due to snow pack. A conifer forest would provide better thermal cover than a deciduous stand when air temperatures are colder.

The red squirrel was found to be associated with conifers. This species was never found in pure deciduous stands during the snow track surveys and was only recorded once during the point counts. The majority of its diet consists of seeds extracted from conifer cones, therefore spruce and/or pine are an essential part of their habitat (Pattie and Hoffman 1992). Although the red squirrel is primarily arboreal, the Barred Owl was able to catch one in a tree (Takats 1996).

The Northern Flicker was abundant in old deciduous and mixedwood forests with a high number of snags. Woodpeckers are dependent on older trees and snags for nesting, roosting, and foraging (Conner *et al.* 1975). Mannan *et al.* (1980) found the highest abundance of flickers in 200 year old stands in western Oregon, and Semenchuk (1992) reports this species uses a variety of habitats in Alberta. Northern Flickers spend much of their time foraging on the ground for ants, beetles and other invertebrates.

The Gray Jay chose predominantly coniferous stands and was only found in older forest. Conversely, Farr (1995) found that the Gray Jay had a higher abundance in younger forest. The Varied Thrush was also found in coniferous stands, which is similar to the findings of Farr (1995) and Semenchuk (1992). Quinlan *et al.* (1990) notes that there is little provincial research on the habitat associations of the Varied Thrush. This thrush is frequently seen foraging on the ground. The American Robin is also a ground feeder, and is in highest density in white spruce and trembling aspen forests. The points counts showed that the robins was more of a generalist and was found in lodgepole pine/balsam fir, black spruce, and white spruce/trembling aspen mixedwood.

The microtines were a very important part of the Barred Owls diet. No conclusions could be reached based on the snow track surveys. According to Holroyd and Van Tighem (1983) red-

backed voles are widespread and common in the mountain parks. They are most common in mature forests of Engelmann spruce, lodgepole pine, white spruce, and subalpine fir. Mature white spruce forests were common in the Barred Owl territories. The long-tailed vole is also widespread in Jasper and was the most abundant in the Miette Barred Owl's diet. The common factor in vegetation types chosen by this species is the dominance of grasses and abundant shrub cover and deadfall (Holroyd and Van Tighem 1983), which was found at the Miette site. Grasses and sedges are also important for the meadow vole and deer mouse.

4.5 Conclusion

This study found that the Barred Owl:

- will select a wide range of prey.
- is a generalist predator over its entire range, but some individuals may be specialists.
- will opportunistically feed on certain species of prey when they are in high abundance and are available.
- will switch prey species when one becomes unavailable and another becomes available.
- forages in mixedwood forest of trembling aspen, balsam poplar, and white spruce.

This study also found that:

- snow transect surveys do not work for microtines.
- using pellets, prey remains, foraging observations, and prey transfers are good methods for determining the diet of Barred Owls.
- more studies are required, throughout the year, on seasonal diet to better understand the feeding habits of the species.

4.6 Literature Cited

American Ornithologists' Union. 1997. Forty-first supplement to the American Ornithologists' Union check-list of North American birds. The Auk 114(3): 542-552.

Begon, M., J.L. Harper, and C.R. Townsend. 1990. Ecology: individuals, populations, and communities, 2nd edition. Blackwell Scientific Publications, Cambridge, MA. Pp. 298-334.

Bent, A.C. 1938. Life histories of North American birds of prey. Dover Publications, Inc. New York, New York. Pp. 182-197.

Bibby, C.J. and N.D. Burgess. 1992. Bird censusing techniques. Academic Press Ltd., London. 257 pp.

Blakemore, L.A. 1940. Barred owl food habits in Glenwood Park, Minnesota. The Flicker 12: 21-23.

Bosakowski, T. and D.G. Smith. 1992. Comparative diets of sympatric nesting raptors in the eastern deciduous forest biome. Canadian Journal of Zoology 70: 984-992.

Bosakowski, T., R. Speiser, and J. Benzinger. 1987. Distribution, density, and habitat relationships of the Barred owl in northern New Jersey. In The Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 135-143.

Cahn, A.R. and J.T. Kemp. 1930. On the food of certain owls in east-central Illinois. Auk 47: 323-328.

Chapman, J.A. and G.A. Feldhamer (eds.). 1982. Wild mammals of North America. John Hopkins University Press, Baltimore, Maryland. 1147 pp.

Connor, R.N., R.G. Hooper, H.S. Crawford, and H.S. Mosby. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. Journal of Wildlife Management 39: 144-150.

Conroy, M.J., L.W. Gysel, and G.R. Dudderar. 1979. Habitat components of clear-cut areas for snowshoe hares in Michigan. Journal of Wildlife Management 43(3): 680-690.

Craighead, J.J. and F.C. Craighead, Jr. 1969. Hawks, owls and wildlife. Dover Publications, Inc. New York, NY. 443 pp.

Devereux, J.G. and J.A. Mosher. 1984. Breeding ecology of barred owls in the central Appalachians. Raptor Research 18: 49-58.

Dexter, R.W. 1978. Mammals utilized as food by owls in reference to the local fauna of northeastern Ohio. Kirtlandia 24: 1-6.

Devine, A., D.G. Smith, and M. Szantyr. 1985. Barred owl hunting insects. Raptor Research 19: 145.

Duncan, J.R. 1994. Barred owl habitat use literature review. Manitoba Raptor Foundation, Balmoral, MB. 23 pp.

Duxbury, J.M. In prep. The application of stable isotope ecology to the study of raptor diets. MSc. Thesis University of Alberta, Edmonton, Alberta.

Elody, B.I. 1983. Techniques for capturing, marking, monitoring, and habitat analysis for the barred owl in the upper peninsula of Michigan. MSc. Thesis Michigan Tech. University. 104 pp.

Elody, B.I. and N.F. Sloan. 1985. Movements and habitat use of barred owls in the Huron Mountains of Marquette County, Michigan, as determined by radiotelemetry. Jack-Pine Warbler 63(1): 3-8.

Errington, P.L. 1932. Food habits of Southern Wisconsin raptors, Part 1 Owls. The Condor 34: 176-184.

Errington, P.L. and M. McDonald. 1937. Conclusions as to the food habits of the Barred Owl in Iowa. Iowa Bird Life 7: 47-49.

Farr, D.R. 1995. Forest birds and ecosystem conservation in the Rocky Mountain foothills of Alberta. PhD Thesis, University of Alberta, Edmonton, Alberta. 81 pp.

Fisher, 1893. The hawks and owls of the United States in their relation to agriculture. USDA Division Ornithology and Mammalogy Bull. 3: 1-210.

Flexner, S.B. (ed.). 1988. The random house college dictionary revised edition. Random House, Inc. New York. 1568 pp.

Holroyd, G.L. and K.J. Van Tighem. 1983. The ecological (biophysical) land classification of Banff and Jasper National Parks, vol. 3, the wildlife inventory. Canadian Wildlife Service, Edmonton, Alberta. 691 pp.

Imhof, T.A. 1976. Alabama birds. 2nd ed. University of Alabama Press.

Jackson, J.A. and R. White. 1995. Diurnal roadside hunting by barred owls. Journal of Louisiana Ornithology 3(1): 13-15.

James, P.C., K.M. Mazur, and S.D. Frith. 1995. The barred owl as an indicator of old forest and its role in long-term forestry planning. Annual Report to the Prince Albert Model Forest, Saskatchewan. 27 pp.

Johnsgard, P.A. 1973. Grouse and quail of North America. University of Nebraska Press, Lincoln, Nebraska. 553 pp.

Johnsgard, P.A. 1988. North American owls: biology and natural history. Smithsonian Institution, Washington. 295 pp.

Jones, E.T. 1956. New and unusual bird records for Alberta. Canadian Field-Naturalist 70: 143-144.

Karalus, K.E. and A.W. Eckert. 1974. The owls of North America. Doubleday and Company, Inc., Garden City, NY. 280 pp.

Keith, L.B. 1974. Hinterland who's who: snowshoe hare. Canadian Wildlife Service Catalogue No. CW 69-4/44.

Krebs, C.J. 1994. Ecology, 4th edition. HarperCollins College Publishers, New York, NY. 801 pp.

Krebs, J.R. and N.B. Davies. 1993. An introduction to behavioural ecology, 3rd edition. Blackwell Scientific Publications, Inc. Cambridge, MA. 420 pp.

Leder, J.E. and M.L. Walters. 1980. Nesting observations for the barred owl in western Washington. Murrelet 61(1): 110-112.

LeDuc. P. 1970. The nesting ecology of some hawks and owls in southeastern Minnesota. Loon 42: 48-62.

Litvaitis, J.A., J.A. Sherburne, and J.A. Bissonette. 1985. Influence of understory characteristics on snowshoe hare habitat use and density. Journal of Wildlife Management 49(4): 866-873.

Lowrey, G.H. 1974. Louisiana birds. 3rd edition. Louisiana State University Press, Baton Rouge.

Mannan, R.W., E.C. Meslow, and H.W. Wight. 1980. Use of snags by birds in Douglas-fir forests, western Oregon. Journal of Wildlife Management 44(4): 787-797.

Marks, J.S., P.L. Hendricks, and V.S. Marks. 1984. Winter food habits of barred owls in western Montana. Murrelet 65: 27-28.

Mazur, K.M., P.C. James, and S.D. Frith. 1997. The ecology of the Barred Owl and its role in sustainable forestry. Draft final report prepared for the Prince Albert Model Forest.

Meslow E.C. and L.B. Keith. 1968. Demographic parameters of a snowshoe hare population. Journal of Wildlife Management 32(4): 812-834.

Morse, D.H. 1968. A quantitative study of foraging of male and female spruce-woods warblers. Ecology 49(4): 779-784.

Morse, D.H. 1976. Variables affecting the density and territory size of breeding spruce-woods warblers. Ecology 57: 290-301.

Nero, R.W. Great gray owls apparently feeding on frogs on roads at night. Blue Jay 44(3): 189-190.

Oberholser, H.C. 1938. The bird life of Louisiana. Louisiana Dept. of Conservation, Bull. 28.

O'Neil, L.J., T.H. Roberts, J.S. Wakely, and J.W. Teaford. 1988. A procedure to modify habitat suitability index models. Wildlife Society Bulletin 16: 33-36.

Pattie, D.L. and R.S. Hoffman. 1992. Mammals of the North American parks and prairies, 2nd edition. Northern Alberta Institute of Technology, Edmonton, Alberta. 579 pp.

Price, H.F. 1942. Contents of owl pellets. American Midland Naturalist 28: 524-525.

Quinlan, R.W., W.A. Hunt, K. Wilson, and J. Kerr. 1990. Habitat requirements of selected wildlife species in the Weldwood Forest Management Agreement Area. A final report submitted to the Weldwood Forest Management Agreement Area Integrated Resource Management Steering Committee.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A variable circular plot method for estimating bird numbers. Condor 82: 309-313.

Russell, A. and Bauer. 1991. The amphibians and reptiles of Alberta. University of Calgary Press, Calgary, Alberta.

Salt, W.R. and J.R. Salt. 1976. The birds of Alberta with their ranges in Saskatchewan and Manitoba. Hurtig Publishers, Edmonton, Alberta.

Semenchuck, G.P. (ed.). 1992. The atlas of breeding birds of Alberta. Federation of Alberta Naturalists, Edmonton, Alberta. 391 pp.

Sensenig, C.E. 1945. The formation of pellets by the barred owl. Wilson Bulletin 57(2): 132.

Smith, D.G., A. Devine, and D. Devine. 1983. Observations of fishing by a barred owl. Journal of Field Ornithology 54: 88.

Snyder, N.F. and J.W. Wiley. 1976. Sexual dimorphism in hawks and owls of North America. Ornith. Monographs 20: 1-96.

Sweeny, S. 1959. Barred owl fishing. Chat 23: 66.

Takats, D.L. 1996. Foraging observations of a Barred Owl in the Foothills Model Forest. Alberta Naturalist 26(2): 29-30.

Wiggers, E.P., M.K. Laubhan, and D.A. Hamilton. 1992. Forest structure associated with ruffed grouse abundance. Forest Ecology and Management 49: 211-218.

Wilson, K.A. 1938. Owl studies at Ann Arbor, Michigan. Auk 55:187-197.

Wolff, J.O. 1980. The role of habitat patchiness in the population dynamics of snowshoe hare. Ecological Monographs 50: 11-30.

Wrigley, R.E. 1969. Ecological notes of the mammals of southern Quebec. The Canadian Field-Naturalist 8: 201-211.

Appendix 4-1: Common and scientific names of Barred Owl prey items found in literature.

Common Name	Scientific Name
Small Mammals	
Short-tailed Shrew	*Blarina brevicauda*
Masked Shrew	*Sorex cinereus*
Starnose Mole	*Condylura cristata*
Chipmunk	*Tamias striatus*
Northern Pocket Gopher	*Thamomys talpoides*
Red Squirrel	*Tamiasciurus hudsonicus*
Northern Flying Squirrel	*Glaucomys sabrinus*
Southern Flying Squirrel	*Glaucomys volans*
Deer Mouse	*Peromyscus maniculatus*
White-footed Mouse	*Peromyscus leucopus*
Red-backed Vole	*Clethrionomys gapperi*
Meadow Vole	*Microtus pennsylvanicus*
Rat	*Rattus sp.*
Snowshoe Hare	*Lepus americanus*
Birds	
Ruffed Grouse	*Bonasa umbellus*
Northern Flicker	*Colaptes auratus*
Blue Jay	*Cyanocitta cristata*
Invertebrates	
Crayfish	*Cambarus sp.*

Appendix 4-2: List of the 24 habitat types covered by the prey transects.

Number	Habitat	Canopy Height (m)
1	Trembling Aspen/White Spruce mixedwood	>25
2	Balsam Poplar/White Spruce mixedwood	>25
3	Balsam Poplar	>25
4	Trembling Aspen	20-25
5	White Spruce/Lodgepole Pine	>25
6	White Spruce/Balsam Fir	20-25
7	White Spruce	15-20
8	White Spruce	>25
9	White Spruce/Trembling Aspen clearcut regeneration	3-6
10	Trembling Aspen/White Spruce mixedwood	15-20
11	Balsam Poplar/Trembling Aspen	>25
12	Lodgepole Pine	>25
13	Lodgepole Pine	15-20
14	Lodgepole Pine/Trembling Aspen mixedwood	>25
15	Black Spruce	10-15
16	Black Spruce/Lodgepole Pine mixedwood	15-20
17	Lodgepole Pine/Balsam Fir	20-25
18	Black Spruce/Trembling Aspen mixedwood	15-20
19	White Spruce/Black Spruce mixedwood	15-20
20	Trembling Aspen/Lodgepole Pine clearcut regeneration	0.5-3
21	White Spruce	10 (sparse)
22	Lodgepole Pine	6-8
23	White Spruce	10 (dense)
24	cutline/opening	-

Tree Species

Common Name	Scientific Name	Species Code
Balsam Fir	*Abies balsamea*	Fb
Balsam Poplar	*Populus balsamifera*	Pb
Black Spruce	*Picea mariana*	Sb
Lodgepole Pine	*Pinus contorta*	Pl
Trembling Aspen	*Populus tremuloides*	Aw
White Spruce	*Picea glauca*	Sw

Appendix 4-3: Article on four foraging observation on a female Barred Owl.

Foraging Observations of a Barred Owl in the Foothills Model Forest

D. Lisa Takats

Throughout its range, the Barred Owl *(Strix varia)* is known to feed on a wide variety of prey including small mammals (especially rodents), birds, frogs, lizards, small snakes, salamanders, fish and insects (Johnsgard 1988). In most cases, prey have been determined through analysis of pellets and prey remains. The Barred Owl is thought to be a semi-nocturnal to nocturnal hunter. On four separate occasions, I observed a radio-tagged, female Barred Owl foraging near Brule, Alberta.

On two occasions, the owl flew to the ground from low perches in trembling aspen *(Populus tremuloides)* trees. The habitat was a mixedwood stand of aspen and spruce *(Picea glauca)*. The perch trees were on the side of a small hill, which minimized the distance the owl had to travel to the ground. The owl appeared to be foraging for small mammals, but was unsuccessful. These observations were made at 8:05 p.m. on August 2, 1995 and at 11:30 a.m. on October 1, 1995.

The third foraging observation was more interesting. The owl was found at 9:30 a.m. on December 30, 1995 roosting 5 m up in an aspen snag. The habitat was white spruce-dominated mixedwood. A red squirrel *(Tamiasciurus hudsonicus)* ran across an opening and drew the attention of the owl. She sat watching the squirrel for 10 minutes, but flew away a short time later when it went underground. I followed in hot pursuit. I could hear a squirrel barking loudly about 50 m away and walked in that direction. Just as I spotted the squirrel 5 m up in a spruce tree, the owl flew into the scene and right at the squirrel. The squirrel bolted up the tree out of reach of the owl. The owl flew up to another aspen tree, perched 7 m up and watched the squirrel.

The squirrel sat 5 m up in a spruce tree barking and rattling for over a half hour, then quieted down. Then the owl suddenly flew at the squirrel a second time, but missed her target, as the squirrel ran up the tree. The owl's wings were tangled in the dense branches, and it was a while before it was able to get its talons secured onto a branch. The owl flew to another perch and sat watching the squirrel intently. The squirrel was barking loudly, running from tree to tree, but did not leave the area.

The squirrel calmed down again about 20 minutes later. The owl immediately flew at the squirrel, once again missing, and once again getting tangled in the branches. Without stopping, the owl flew at the squirrel again and again missed. This time she really got caught up in the branches, and almost fell out of the tree.

Being too low for good flight, the owl proceeded to scale up the spruce tree's trunk until she reached a 6 m perch. She scratched her bill with a talon, looking down at me with an exasperated expression. "You can do it," I willed her. She scratched one more time, stretched one wing and preened it for a short time. Then she sat quietly, staring intently at the squirrel running up and down from tree to tree but never going to the ground. I believe the squirrel thought it was safer in the trees than on the ground. The squirrel finally stopped running and sat still in a spruce tree about five meters up. Another squirrel in an adjacent territory started barking. The barking must have distracted the first squirrel, because the owl flew at it and killed it with her talons. There was no struggle; the owl sat there for a short time, then flew off with her prize.

The fourth foraging observation was not nearly as exciting. On March 17, 1996, at 6:30 a.m., the owl was perched in a 30 cm diameter aspen tree, about 4 m off the ground. The habitat was mixedwood with balsam poplar *(Populus balsamifera)*, white spruce and aspen. I looked over to see what the owl was looking at and observed a vole scurrying along the ground. In a split second, the owl grasped the prey and flew up to a perch. The vole disappeared in one swallow.

In my Masters thesis, I am studying the ecology of the Barred Owl in the Foothills Model Forest, Alberta. The Barred Owl has the potential to serve as an indicator of older age class forests. My objectives are to determine what key habitat features are important to the Barred Owl for nesting, roosting and foraging. I am also trying to determine what prey species are selected by the Barred Owl, through the analysis of pellets and prey remains. In the first field season, I did not find any pellets or prey remains. Observing foraging attempts is an alternate way of determining prey used by the Barred Owl, and it is much more interesting than picking through bones and feathers.

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Literature Cited:

Johnsgard, P.A. 1988. *North American owls: biology and natural history.* Smithsonian Institution Press, Washington, D.C.

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Appendix 4-4: List of bird species recorded during point counts in 1996.

Number	Species	Scientific Name
1	Bufflehead	*Bucephala albeola*
2	Creeper, Brown	*Certhia americana*
3	Crow, American	*Corvus brachyrhynchos*
4	Chickadee, Black-capped*	*Poecile atricapillus*
5	Chickadee, Boreal	*Poecile hudsonicus*
6	Chickadee, Mountain	*Poecile gambeli*
7	Cowbird, Brown-head	*Quiscalus quiscula*
8	Finch, Purple	*Carpodacus purpureus*
9	Flicker, Northern	*Colaptes auratus*
10	Flycatcher, Alder	*Empidonax alnorum*
11	Flycatcher, Least	*Empidonax minimus*
12	Grosbeak, Rose-breasted	*Pheucticus ludovicianus*
13	Grouse, Ruffed	*Bonassa umbellus*
14	Grouse, Spruce**	*Falcipennis canadensis*
15	Hawk, Cooper's	*Accipiter cooperii*
16	Hawk, Red-tailed	*Buteo jamaicensis*
17	Jay, Gray	*Perisoreus canadensis*
18	Junco, dark-eyed	*Junco hyemalis*
19	Killdeer	*Charadrius vociferus*
20	Kinglet spp.	*Regulus sp.*
21	Kinglet, Golden-crowned	*Regulus satrapa*
22	Kinglet, Ruby-crowned	*Regulus calendula*
23	Loon, Common	*Gavia immer*
24	Mallard	*Anas platyrhynchos*
25	Nuthatch, Red-breasted	*Sitta canadensis*
26	Ovenbird	*Seiurus aurocapillus*
27	Owl, Barred	*Strix varia*
28	Raven, Common	*Corvus corax*
29	Redstart, American	*Setophaga ruticilla*
30	Robin, American	*Turdus migratorius*
31	Sapsucker, Yellow-bellied	*Sphyrapicus varius*
32	Siskin, Pine	*Carduelis pinus*
33	Snipe, Common	*Gallinago gallinago*
34	Solitaire, Townsend's	*Myadestes townsendii*
35	Sparrow, Chipping	*Spizella passerina*
36	Sparrow, Clay-colored	*Spizella pallida*
37	Sparrow, Lincoln's	*Melospiza lincolnii*
38	Sparrow, White-crowned	*Zonotrichia leucophrys*
39	Sparrow, White-throated	*Zonotrichia albicollis*
40	Squirrel, Red	*Tamiasciurus hudsonicus*
41	Swallow, Barn	*Hirundo rustica*
42	Tanager, Western	*Piranga ludoviciana*
43	Thrush, Hermit	*Catharus guttatus*

Appendix 4-4 (Con't.)

44	Thrush, Swainson's	*Catharus ustulatus*
45	Thrush, Varied	*Ixoreus naevius*
46	Vireo, Red-eyed	*Vireo olivaceus*
47	Vireo, Blue-headed***	*Vireo plumbeus*
48	Vireo, Warbling	*Vireo gilvus*
49	Warbler, Bay-breasted	*Dendroica castanea*
50	Warbler, Black-throated green	*Dendroica virens*
51	Warbler, Myrtle	*Dendroica coronata*
52	Warbler, Orange-crowned	*Vermivora celata*
53	Warbler, Tennessee	*Vermivora peregrina*
54	Warbler, Yellow	*Dendroica petechia*
55	Waterthrush, Northern	*Seiurus noveboracensis*
56	Waxwing, Bohemian	*Bombycilla garrulus*
57	Western Wood-peewee	*Contopus sordidulus*
58	White-winged Crossbill	*Loxia leucoptera*
59	Woodpecker spp.	Picidae
60	Woodpecker, Hairy	*Picoides villosus*
61	Woodpecker, Pileated	*Dryocopus pileatus*
62	Woodpecker, Three-toed	*Picoides tridactylus*
63	Wren, Winter	*Troglodytes troglodytes*

1997 AOU changes (American Ornithologists Union 1997)

* the genus for chickadee changed from *Parus* to *Poecile*

** the genus of the Spruce Grouse was formerly *Dendragapus*

*** the Plumbeus Vireo is formerly known as the Solitary Vireo, *Vireo solitarius*

Chapter 5

Habitat Suitability Index Model for the Barred Owl in the Foothills Model Forest

"...when the sun peeked finally peeked through, it was
evident that the nesting was a failure. In the clearing morning
the owls' territorial calls had a distinctly melancholy tone. The
The proud duets of the mates stopped – only one owl hooted now."

J.E. Maslow, from "The Owl Papers"

5 Introduction

Habitat suitability index models (HSI) are useful tools that can help in forest management. The main objectives of HSI models are to understand the key environmental factors that affect the abundance of a species, and to use this information to predict the future of the species when changes in the environmental conditions occur (Lancia *et al.* 1982, Morrison *et al.* 1992). HSI modeling is one way of estimating the ability of forested lands to support specific species (Beck and Beck 1995). The planning and evaluation process called Habitat Evaluation Procedures (HEP), focuses on the quantification of the habitat requirements of certain wildlife species based on two primary variables: the HSI and the total area of available habitat (Schamberger *et al.* 1982, USDI 1981).

Three categories of life requisites, that could limit a species in a given habitat or range of habitats, are specified in HSI models: food, cover, and reproduction (Van Horne and Weins 1991). The HSI model for the Barred Owl (*Strix varia*) in the United States identifies the most critical component of Barred Owl habitat as the availability of trees for nesting (Allen 1987). The variables in this model are: number of trees ≥51 cm dbh/0.4 ha, mean diameter of overstory trees, and percent canopy cover of overstory trees.

The draft HSI model for the Barred Owl in the Foothills Model Forest uses breeding habitat as the focus (Olsen *et al.* 1996). The variables measured in this draft model include: mean diameter (DBH) of stand (S1 and S7), number of deciduous trees greater than 35 cm DBH (S2), tree canopy closure (S3), the percent spruce and/or fir in the canopy (S4), percent deciduous forest (S5), distance from human disturbance (S6), and distance from opening (S8) (Figure 5-1, Table 5-1). The formula is: HSI = MAX [S1xS2, 0.3xS7xS5] x S3 x S4 x S6 x S8. The main nest tree components (S1 and S2) can be partially compensated (0.3) when the mean DBH of the trees is over 20 cm DBH (S5 and S7). This higher average diameter allows for the possibility that the Barred Owls may choose a cavity or a stick nest in a smaller tree.

This HSI model produces index values that are proportional to the forest stands ability to provide suitable reproductive habitat for the Barred Owl. An HSI value of 1.0 is assumed to represent the highest quality reproductive habitat. A forest stand with an HSI value of 0.0 is assumed to represent unsuitable reproductive habitat for the Barred Owl. The model produces a 0-1.0 index with the assumption that there is a direct linear relationship between the HSI value and carrying capacity (USDI 1981).

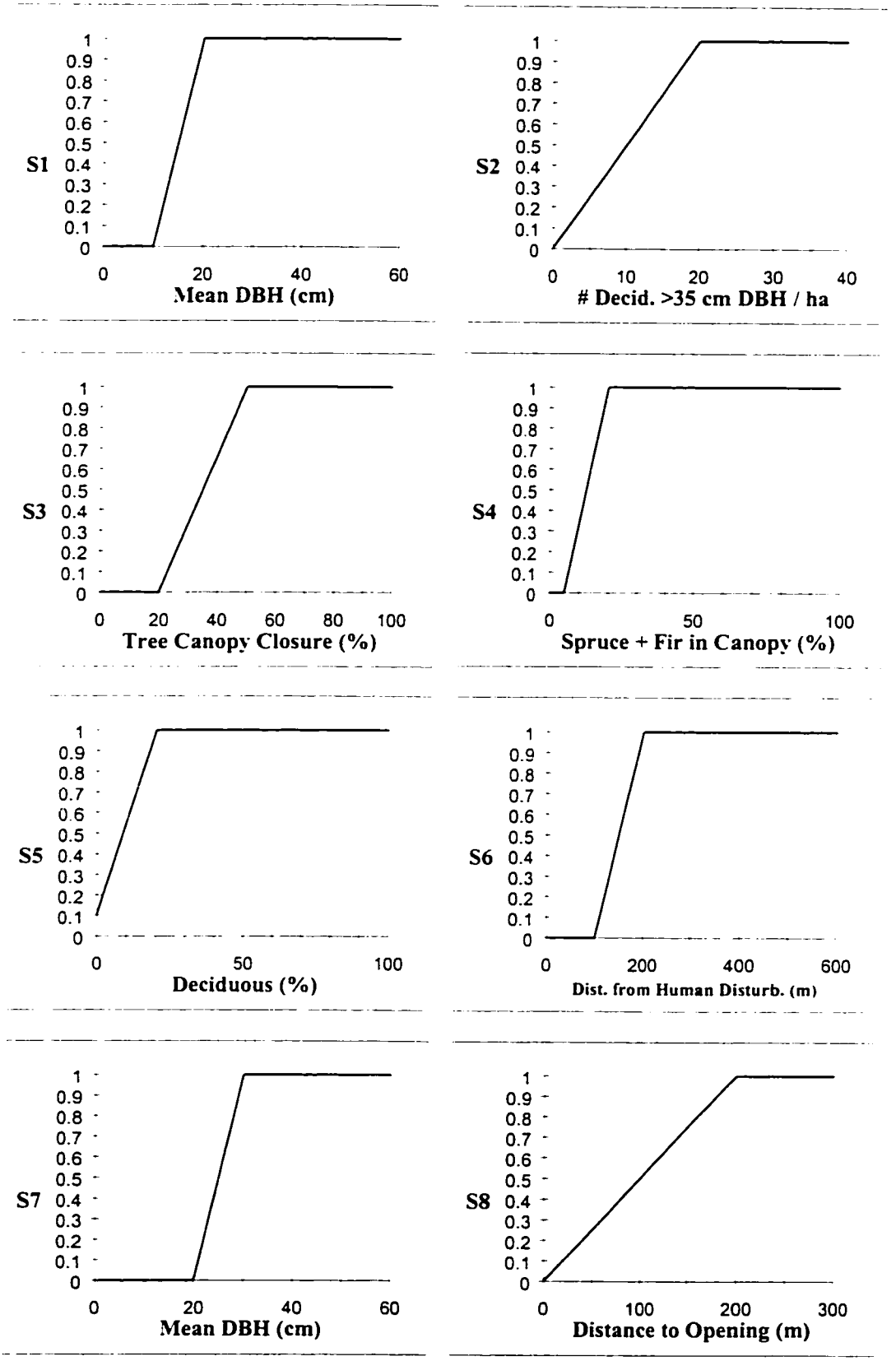

Figure 5-1: Relationships between habitat and spatial variables for suitability indices S1 to S8 of the draft Barred Owl HSI model (Olsen *et al.* 1996).

Table 5-1: Relationship of habitat variables to life requisites for Barred Owl year-round range. Life requisites are either nesting or cover since food is not assumed to be limiting (Olsen *et al.* 1996).

HSI Variable	Description Requisite	Life	Definition
S1	Mean DBH of Stand (cm)	Cover	Mean diameter of all dominant and codominant canopy trees at 1.4 m height (≥12.5 cm DBH).
S2	Deciduous Trees > 35 cm DBH/ha	Nesting	Number of balsam poplar trees with a minimum diameter of 35 cm at 1.4 m height.
S3	% Canopy Closure	Cover	Projected horizontal coverage of canopy trees in relation to the total stand area.
S4	% Spruce and/or Fir	Cover	Sum of the percent composition of all spruce and fir trees as determined from proportion of total tree volumes.
S5	% Deciduous	Nesting	Sum of the percent composition of aspen, balsam poplar, and paper birch trees as determined from proportion of total tree volumes
S6	Distance From Human Disturbance (m)	Nesting, Cover	Human disturbance is defined as roads and trails with motor vehicle access, train tracks, industrial sites, active well sites, and settlement areas.
S7	Mean DBH (cm)	Nesting/ Cover	Mean diameter of all dominant and codominant trees at 1.4 m height.
S8	Distance From Opening (m)	Cover	Openings are defined as all areas (≥1 ha) with 'A' class crown closure (< 6 %). This also includes regenerating clearcuts which do not yet have canopy tree development

The objectives of this chapter are:

1. To use information gathered on the habitat use of the Barred Owl in the Foothills Model Forest to test the draft habitat model.
2. To modify the variables and formula of the draft HSI model to fit the current data.
3. To make recommendations on future work needed to improve the model further.

5.1 Methods

Study Area

The data for this model were collected in the Foothills Model Forest (FMF) in west-central Alberta. Lodgepole pine (*Pinus contorta*) dominates the landscape in the foothills, while white spruce (*Picea glauca*), black spruce (*Picea mariana*), trembling aspen (*Populus tremuloides*), and Douglas fir (*Pseudotsuga menziesii*) are common at lower elevations, and balsam poplar (*Populus balsamifera*) and balsam fir (*Abies balsamea*) are uncommon. In the mountains lodgepole pine is dominant. Stands were surveyed for Barred Owls in the Boreal Foothills, Boreal Uplands, and Subalpine ecoregions (Strong and Leggat 1981).

Locating Barred Owls

Pairs of Barred Owls were located using two methods: 1) broadcast surveys along transects on roads and in other areas of the FMF, and 2) casual observations by researchers and birdwatchers in the study area. Nest and roost sites were located by using radiotelemetry, casual observations, and bird watchers. Home range size was determined by plotting radiotelemetry locations, owl call sites, and casual observations on aerial photo maps. Density was calculated by dividing the number of owls recorded on 10 transect surveys by the total area those 10 transects covered (10 transects x 16 km length x 2 km width = 320 km^2). Carrying capacity (breeding pairs per ha where HSI=1.0) was based on home range size of nesting owls, and was determined by radio telemetry (refer to chapter 3 for detailed methodology).

Variables

The habitat variables measured at nesting and roosting sites, based on the draft habitat model, were: mean diameter of canopy trees (trees with dbh ≥12.5 cm), number of trees ≥35 cm dbh/ha, tree canopy closure, percent spruce and/or fir in the canopy, percent deciduous trees in the canopy, nest distance from human disturbance, and nest distance from an opening. Number of balsam poplar trees ≥ 60 cm dbh/ha was added on, because this was the minimum DBH of tree used for nesting by the Barred Owl in the FMF.

Testing and Modification

Lancia *et al.* (1982) suggest developing the model with one set of data, and evaluating it with new data collected at another time or in another place. Three of the nests were randomly chosen and used in the draft model equation to determine if the model accurately reflected the

owls' choice of stands. The average measure of each variable for the three nests was used to modify the graphs to better fit the data. Three other nests were used to verify the equation.

5.2 Results

Minimum Habitat Area

Minimum habitat area is defined as the minimum amount of contiguous habitat required before an area can be occupied by a species (Allen 1987). Based on home range data collected from two nesting pairs in the FMF, the minimum habitat area occupied by a pair was 300 ha.

Carrying Capacity

The density of Barred Owls was determined to be 0.05 owls/km^2 (see Chapter 3), which translates to 0.0025 pairs/ha. This density covers the entire study area (calculated by number of owls that responded on broadcast surveys in a measured area, see Chapter 2 of this thesis) and therefore includes suitable and unsuitable habitats.

Test

The three test nests had similar measures for the variables included in the draft HSI model (Table 5-2). The mean stand DBH of the three nests ranged from 21.8 to 29.5 cm. The number of deciduous trees ≥ 35 cm DBH/ha and the tree canopy closures (measured by a densiometer) were quite high. The spruce/fir in the canopy was over 50 percent in all nest sites, and the deciduous component was always over 20 percent. The distance from human disturbance was less than 100 meters in one case. The distance to an opening ≥ 1 ha was 15, 20, and 40 meters.

Table 5-2: Measured variables (S1 to S7) for the three randomly chosen nests.

Nest	Mean DBH (cm)	# deciduous ≥ 35 cm DBH/ha	Tree Canopy Closure (%)	% Spruce/Fir in Canopy
1 (Blackcat)	21.8	40	80.2	80
2 (Miette 1)	29.5	30	78.0	50
3 (Miette 3)	23.7	25	79.4	50

Nest	% Deciduous in Canopy	Distance from Human Disturbance (m)	Distance to an Opening (m)
1	20	70	15
2	50	100	20
3	50	250	40

Two of the three random nests that were chosen did not fit the formula and graphs, and showed that the habitat had a low suitability value for Barred Owl breeding in all cases (Table 5-3).

Table 5-3: SI and calculated HSI values for three nests for the draft habitat model.

Nest	S1	S2	S3	S4	S5	S6	S7	S8	HSI
1	1.0	1.0	0.98	1.0	1.0	0.0	0.18	0.075	0.0
2	1.0	1.0	1.0	1.0	1.0	0.0	0.95	0.1	0.0
3	1.0	1.0	1.0	1.0	1.0	1.0	0.37	0.2	0.2

Modification

The SI values for S1 to S5 accurately reflected the suitability of the site, however distance to human disturbance, distance to an opening, and the mean DBH (S8) values, had very low SI values. The changes that were made in the draft model include the following (Table 5-4):

1. S1 remains unchanged. The average DBH's of the nest stands ranged from 21.8 to 35.3 cm (Figure 5-2).
2. S2 becomes Balsam Poplar trees ≥ 60 cm (Figure 5-3). All six nests were in natural cavities of Balsam Poplar trees, therefore trembling aspen was changed to balsam poplar and the DBH was increased to 60 (the minimum DBH of nest tree was 61.8 cm).
3. S3 has an SI value of 0 until a canopy closure of above 30 is reached (B density). At 80 percent the SI value drops until it reaches 0 at 90 percent (Figure 5-4). Barred Owls were not found in stands with higher than 87% canopy closure.
4. The SI value for S4 does not become 1 until 25 % spruce/fir is found in the canopy, and begins dropping in value after 80 % is reached. SI is 0 at 100 % spruce/fir in canopy. Barred Owls were not found nesting or roosting in stands containing more than 80 percent white spruce. This eliminates the need for the original S5 variable of percent deciduous trees in canopy (Figure 5-5).
5. S5 changes to number of deciduous trees ≥ 35 cm DBH. These trees may be used for nesting as well, but will be multiplied by 0.5 because large balsam poplar trees are ideal nest sites (Figure 5-6).
6. Distance from human disturbance has been reduced from 100 m to 50 m based on nests found near roads. This pair of owls has been in the same area for year, and probably adapted over time to the increasing disturbance. For owls that have never been disturbed before, the effects of human disturbance may be drastic (Figure 5-7).

7. The size of opening in the draft model is 1 ha (the smallest polygon visible on a GIS map). This component is to ensure habitat is not suitable for the Great Horned Owl. Great Horned Owls require larger opening in the forest, and therefore this component has been changed to distance to openings (<6% canopy closure) greater than 5 ha (Figure 5-8).

Table 5-4: Modified relationship of habitat variables to life requisites for Barred Owl year-round range. Life requisites are either nesting or cover, as food is not considered limiting.

HSI Variable	Description Requisite	Life	Definition
S1	Mean DBH of Stand (cm)	Cover	Mean diameter of all dominant and codominant canopy trees 1.4 m height (≥12.5 cm DBH).
S2	Balsam Poplar Trees ≥ 60 cm dbh/ha	Nesting	Number of Balsam Poplar trees with a minimum diameter of 60 cm at 1.4 m height.
S3	% Canopy Closure	Cover	Projected horizontal coverage of canopy trees in relation to the total stand area.
S4	% White Spruce and/or Fir	Cover	Sum of the percent composition of all spruce and fir trees as determined from proportion of total tree numbers in canopy.
S5	Deciduous Trees ≥ 35 cm dbh/ha	Nesting	Number of deciduous trees with a minimum diameter of 35 cm at 1.4 m height.
S6	Distance From Human Disturbance (m)	Nesting, Cover	Human disturbance is defined as roads and trails with motor vehicle access, train tracks, industrial sites, active well sites, cutblocks, and settlement areas.
S7	Distance From Opening (m)	Cover	Openings are defined as all vegetated areas (≥5 ha) with 'A'class crown closure (< 6 %). This also includes regenerating clearcuts which do not yet have canopy tree development.

The new formula is:

$$\mathbf{HSI = MAX[S1xS2, 0.5xS5xS1]x\ S3\ x\ S4\ x\ S6\ x\ S7}$$

Table 5-5: New measured variables (S1 to S7) for the three randomly chosen nests.

Nest	S1 Mean DBH (cm)	S5 # deciduous ≥ 35 cm DBH/ha	S3 Tree Canopy Closure (%)	S4 % Spruce/Fir in Canopy
4 (Solomon)	26.4	20	66.6	70
5 (Lynx)	35.3	70	70.5	70
6 (Miette 2)	26.2	25	67.5	60

Nest	% Deciduous in Canopy	S6 Distance from Human Disturbance (m)	S7 Distance to an Opening (m)	S2 # balsam poplar ≥ 60 cm DBH/ha
4	30	250	170	10
5	30	300	200	40
6	40	250	200	15

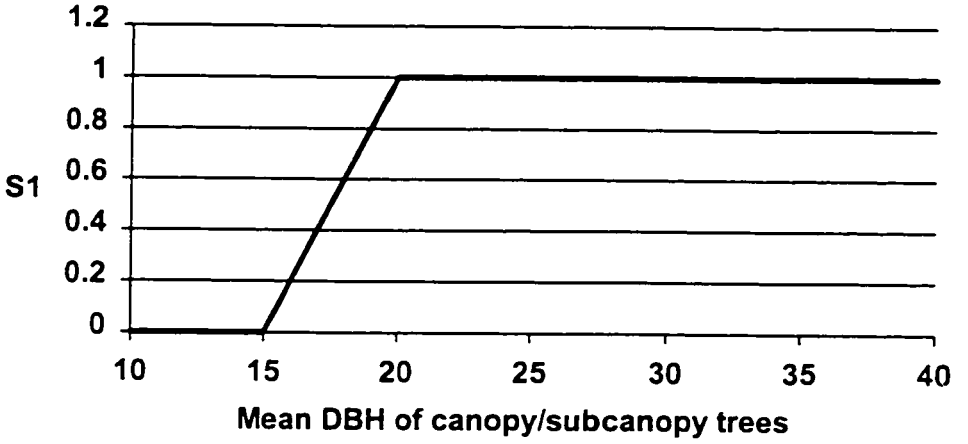

Figure 5-2: S1 variable of mean DBH of canopy/subcanopy trees in stand (trees≥12.5 cm DBH).

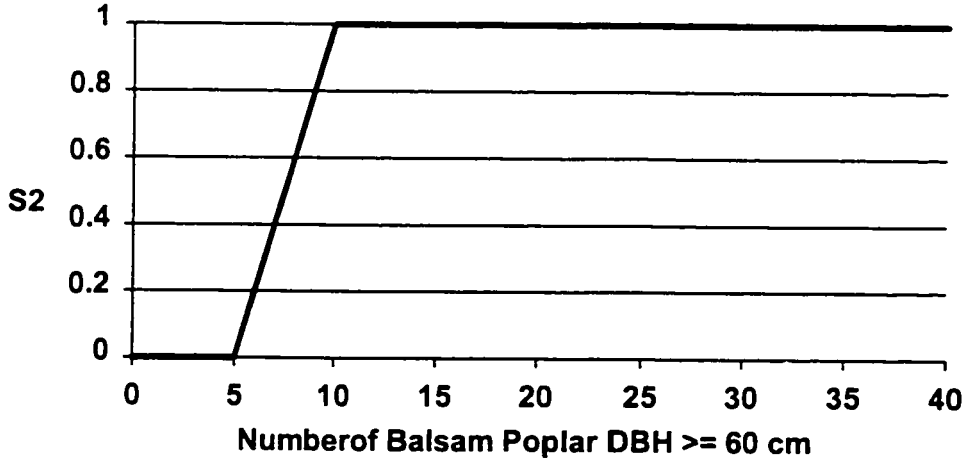

Figure 5-3: S2 variable - number of balsam poplar trees with DBH ≥60 cm.

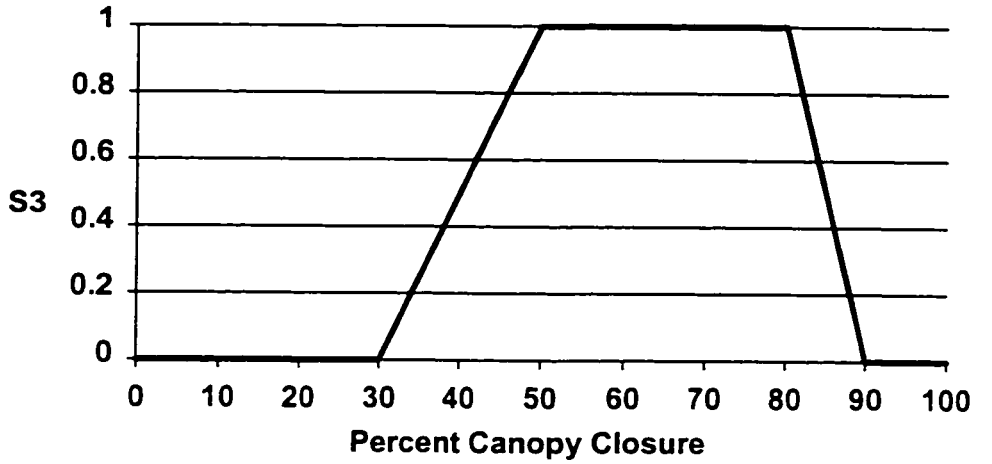

Figure 5-4: S3 variable - percent canopy closure of the stand.

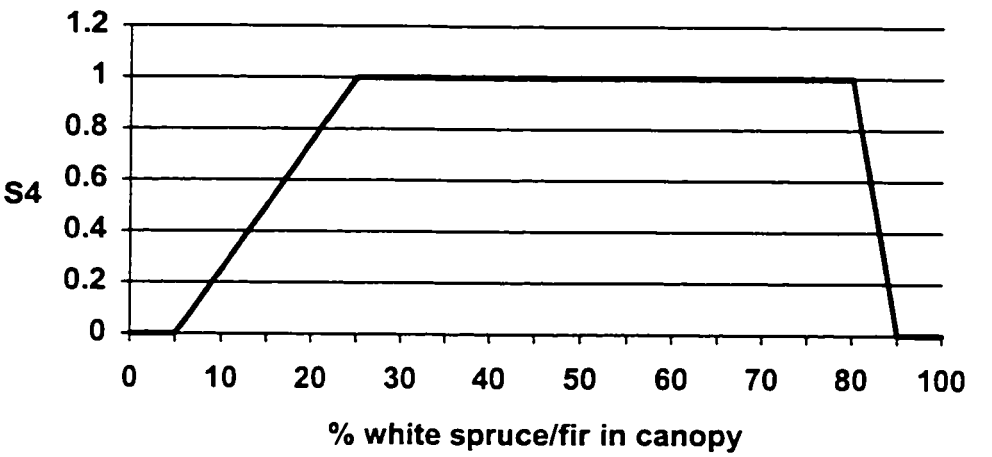

Figure 5-5: S4 variable - percent white spruce and/or fir in the canopy.

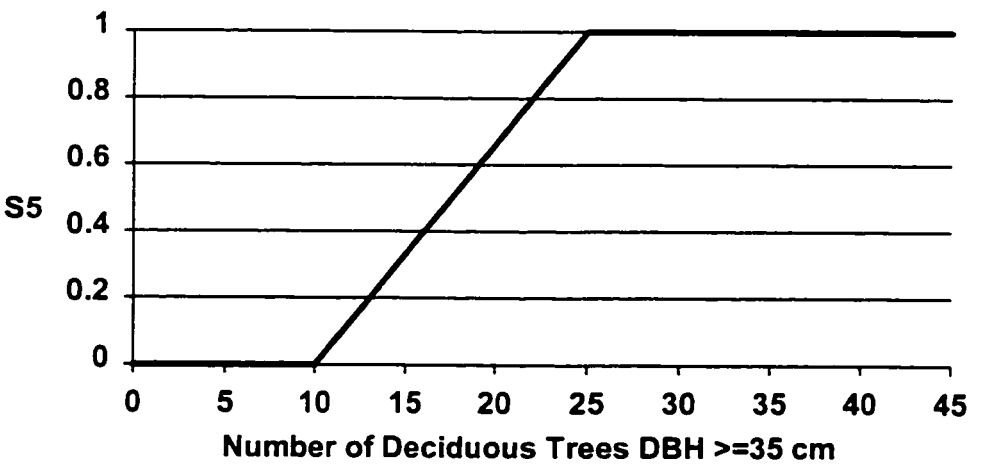

Figure 5-6: S5 variable - number of deciduous trees with diameter $\geq$ 35 cm.

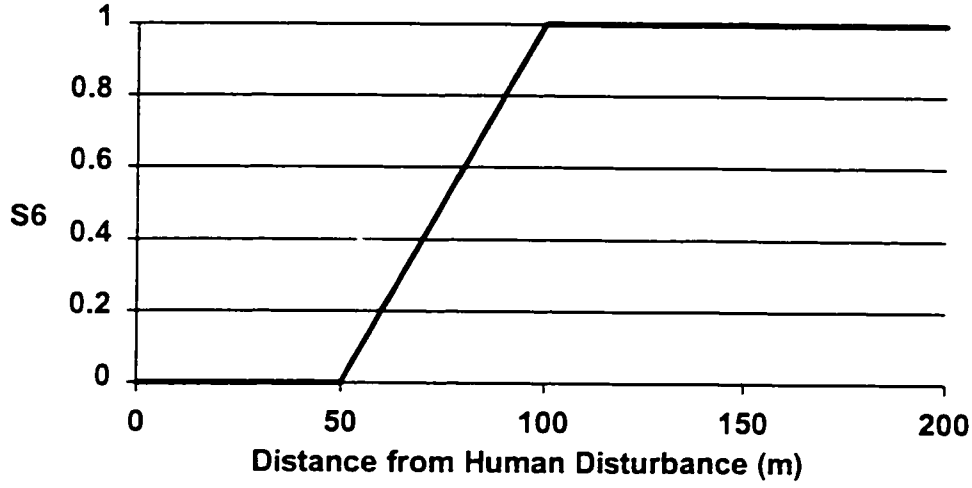

Figure 5-7: S6 variable - distance from human disturbance (m).

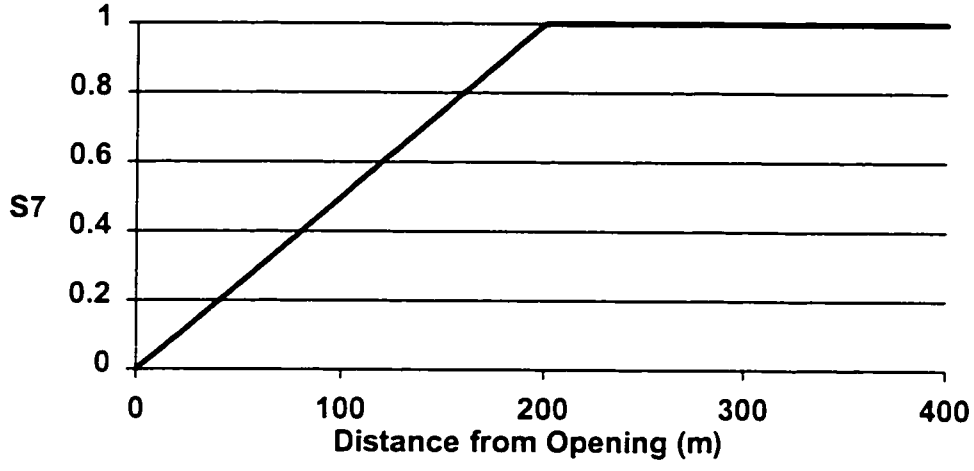

Figure 5-8: S7 variable - distance from opening (m).

The new SI and HSI values more accurately predict the suitability of the stand for reproduction (Table 5-6). Nest five failed to produce any young because forest harvesting exposed the nest tree to an opening. The variable S7 is the results of an opening that was enlarged by a clearcut. The SI values before the harvesting occurred would have been 1.0 for S6 and 0.75 for S7. The calculated HIS would have been 0.75. Nest one does not reflect the suitability of the stand. One young fledged from this nest site. Variables S6 and S7 are low (0.5) because of a small road that is near the nest and the canopy closure is quite high (80.2%).

Table 5-6: HSI values for the modified habitat model on three new nests and three previously tested nests.

Nest	S1	S2	S3	S4	S5	S6	S7	HSI
4	1.0	1.0	1.0	1.0	1.0	1.0	0.85	0.85
5	1.0	1.0	1.0	1.0	1.0	0.5	0.05	0.0025
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1	1.0	1.0	0.98	1.0	1.0	0.5	0.5	0.245
2	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

5.3 Discussion

5.3.1 Habitat Variables and HSI Components

The calculation of this HSI for the Barred Owl considers only the life requisite of reproductive habitat (nesting and roosting). The main nest tree components (S1 x S2) can be partially compensated for low values when there are deciduous trees over 35 cm DBH. The value of this compensation is reduced by weighting it at 0.5, and once a suitable density of deciduous trees over 35 cm DBH are present the trees smaller than that are not used. The remaining variables are all regarded to be equal in value, non-compensatory for each other and completely interactive such that if any one component yields a 0 value, the HSI also has a 0 value. For example, even if seemingly perfect habitat exists adjacent to a road or clearing, it will compute to HSI = 0.

The relationship of habitat variables to nest tree and nesting cover HSI components which are required to allow year-round distribution of the Barred Owl are given in Table 5-2. Each variable used to predict the HSI components are then defined.

Model Description

This model is based on the assumption that reproductive habitat, which includes nesting and roosting, is the most limiting characteristic of year-round Barred Owl distribution. Based on data collected on foraging habitat, forested habitats that contain cover for nesting and roosting are suitable for foraging. Stands of mature trees with large diameters for nesting sites and suitable canopy closure are essential reproductive habitat components for the Barred Owl. The Barred Owls use mature stands with little or no understory vegetation to facilitate hunting.

The presence of large diameter trees increases the potential for suitable nesting sites and is therefore more representative of high quality reproductive habitat than the density of understory plants. Availability and distribution of water is not assumed to be a limiting component of Barred Owl habitat in Alberta and has not been addressed in this model. The association with streams is assumed to be associated with Barred Owls choosing older forested stands with balsam poplar trees, which are usually found along riparian areas.

Nest Tree

This model evaluates potential nesting habitat for Barred Owls based on the characteristics of trees, which must be present in order to build a nest or utilize an existing cavity. Barred Owl nests in the FMF were found exclusively in balsam poplar (*Populus balsamifera*) trees with high DBH (average DBH= 74.0 cm, range= 61.8-85.0 cm DBH). The main habitat variable used to characterize this attribute is the number of balsam poplar trees > 60 cm which is used to determine SI component S2. The forest development results in tall canopy trees with large diameters, numerous dead or dying trees with cavities and the tops of stubs suitable for nesting. There is still the potential that the Barred Owl will use deciduous tree stubs or cavities in large aspen trees, therefore nest trees greater than 35 cm in diameter is component S5. Because the nesting habitat with smaller deciduous trees is not as good as that with the large Balsam Poplar (> 60 cm DBH) trees, component S5 is multiplied by 0.5. Stick nests may also be used, but cavities are assumed to be the ideal nest type, and considered limiting.

Nesting Cover

Owls prefer to nest in mature or old growth forest stands (Devereux and Mosher 1984, Bosakowski *et al.* 1987, Dunbar *et al.* 1991). The area around Barred Owl nests are associated with certain cover characteristics which determine suitability of the habitat for year round use. These variables are mean tree DBH, tree canopy closure, and spruce/fir composition in the canopy. The tree DBH component (S1) ensures that the stand has developed to a mature state, and that trees are large enough to provide sufficient cover. The tree canopy closure component (S3) ensures that the stand has enough shelter in the canopy, and percent white spruce and/or fir component (S4) ensures that there are sufficient numbers of conifer branches in the vertical plane for shelter (thermal cover) and concealment.

Barred Owls are adversely affected by human disturbance, including roads and trails with motorized access (including railroads), camps, industrial activity (oil and gas, forestry), and human settlements (Nichols and Warner 1972, Fuller *et al.* 1974, Laidig and Dobkin 1995). The

distance to human disturbance areas is SI component S6. Barred Owls also typically avoid clearings or other open areas as well as the mature forest edge within the first few hundred meters, so this distance is used to predict SI component S7 (Bosakowski *et al.* 1987). The distance to opening is a penalty for the creation of Great Horned Owl habitat. Great Horned Owls (*Bubo virginianus*) move into fragmented forests and will prey on the Barred Owl (Laidig and Dobkin 1995).

5.3.2 MODEL ASSUMPTIONS

1. The availability of reproductive habitat is the most limiting factor in year-round Barred Owl distribution. If the nesting and roosting habitat is available in a forested area adequate foraging habitat will be available. Water is not assumed to be limiting.
2. Reproductive habitat quality increases as forest stands develop structurally to have larger trees, more dying or dead trees, and more trees with broken tops or cavities for nest locations.
3. Mean DBH is indicative of stand age and maturity and is therefore representative of potential nesting habitat quality.
4. Balsam poplar (*Populus balsamifera*) are most likely to contain suitable nesting sites for the Barred Owl because they are prone to break up and disease as they mature. The density of large Balsam Poplar trees ≥ 60 cm DBH in a particular stand is representative of reproductive habitat quality. Barred Owls may nest in stick nests built by other raptors, in stubs, or in Aspen cavities therefore deciduous trees ≥ 35 cm. Most stick nests located in the FMF are found in deciduous trees, therefore conifers are not considered important for nest tree choice.
5. Barred Owl reproductive habitat quality is dependent on the roosting requirements of that species. The percent spruce and fir in the overstory and the canopy closure of the stand are the most significant factors that determine roosting habitat. Barred Owls prefer C and D density stands where the overstory canopy cover is ≥50% but not greater than 80%.
6. Snags are not used for nesting in this model, but could potentially be used.

5.4 Conclusion

The recommendations for changes are based on six nests and general habitat information of 42 territorial owls. As more information is learned about Barred Owls, these may have to be modified again. Future work should include:

-determining fledging success of Barred Owls.

-determining turnover rates.

-studying the affects of habitat fragmentation and human disturbance on Barred Owls.

This model has been written for the Foothills Model Forest, and may have to be modified for other geographical locations. Habitat models can be used as the first step to improved habitat management and increased understanding of habitat relationships (Schamberger *et al.* 1982), but continued surveys need to be conducted to ensure that populations of Barred Owls and other species are being maintained.

5.5 Literature Cited

Allen, A.W. 1987. Habitat suitability index models: Barred Owl. U.S. Fish and Wildlife Service Biological Report 82. 17 pp.

Beck, J.A. Jr. and B.H. Beck. 1995. Integration of timber and wildlife habitat supply. Forestry Canada and Alberta Forest Service. 110 pp.

Bessie, W.C. 1995. The development of habitat structure yield curves for use in wildlife habitat supply analyses in the Foothills Model Forest, Unpublished Draft Report.

Bosakowski, T., R. Speiser, and J. Benzinger. 1987. Distribution, density, and habitat relationships of the Barred Owl in Northern New Jersey. In Biology and Conservation of Northern Forest Owls by R.W. Nero, R.J. Clark, R.J. Knapton, and R.H. Hamre (eds.). USDA Forest Service Technical Report RM-142. Pp. 135-143.

Devereux, J.G. and J.A. Mosher. 1984. Breeding ecology of barred owls in the central Appalachians. Raptor Research 18: 49-58.

Dunbar, D.L., B.P. Booth, E.D. Forsman, A.E. Hetherington, and D.J. Wilson. 1991. Status of the spotted owl, Strix occidentalis, and barred owl, Strix varia, in southwestern British Columbia. Canadian Field-Naturalist 105: 464-468.

Fuller, M.R., T.H. Nichols, and J.R. Tester. 1974. Raptor conservation and management implications of bio-telemetry studies from Cedar Creek Natural History Area. In Management of Raptors, Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, Colorado, by F.N. Hamerstrom, Jr., B.E. Harrell, and R.R. Olendorff (eds.). Pp. 33-44.

Laidig K.J. and D.S. Dobkin. 1995. Spatial overlap and habitat associations of barred owls and great horned owls in southern New Jersey. Raptor Research 29(3): 151-157.

Lancia, R.A., S.D. Miller, D.A. Adams, and D.W. Hazel. 1982. Validating habitat quality assessment: an example. In: Trans. North American Wildlife and Natural Resources Conference 47: 96-110.

Maslow, J.E. 1983. The owl papers. Vintage Books, Random House, New York, NY. 183 pp.

Morrison, M.L., B.G. Marcot, and R.W. Mannan. 1992. Wildlife-habitat relationships, concepts and applications. The University of Wisconsin Press, Madison, WI. 343 pp.

Nichols T.H. and D.W. Warner. 1972. Barred Owl habitat use as determined by radio-telemetry. Journal of Wildlife Management 36(2): 213-224.

Olsen, B. L. Takats, B. Beck, and J. Beck. 1996. Barred Owl (*Strix varia*) breeding habitat: draft habitat suitability index model. In Habitat Suitability Index Models for 35 Wildlife Species in the Boreal Foothills of West-Central Alberta. Interim Report, Foothills Model Forest, Hinton. 11 pp.

Schamberger, M., A.H. Farmer, and J.W. Terrell. 1982. Habitat suitability index models: introduction. USDI Fish and Wildlife Service. FWS/OBS-82/10. 2 pp.

Strong, W.L. and K.R. Leggat. 1981. Ecoregions of Alberta. Alberta Energy and Natural Resources. Edmonton, Alberta. Technical Report T/4.

USDI. 1981. Standards for the development of habitat suitability index models. Division of Ecological Services, U.S. Fish and Wildlife Service. Department of the Interior, Washington, D.C. 104 pp.

Van Horne, B. and J.A. Weins. 1991. Forest bird habitat suitability models and the development of general habitat models. United States Department of the Interior, Fish and Wildlife Service, Washington, D.C. 31 pp.

Chapter 6

Conclusion

"I hope to assist, even if only in a minor role, in laying a foundation on which abler hands and better heads may later build. In this way I may perhaps be instrumental, at least to some extent, in the work of saving from entire destruction some of those interesting and useful dwellers in our waste places in whom lie unexpected possibilities that await but a little kindness and understanding . . ." - Grey Owl

6.1 Overview

Human activities have dramatically disturbed the natural environment. With increases in population growth, there has been an increase in the exploitation of natural resources for human use (Morrison *et al.* 1992). This increased exploitation of resources results in a conflict with wildlife habitat, in many cases. This is true with the forest industry, an industry that has become a cornerstone of Alberta's economy. The Spotted Owl (*Strix occidentalis*), an old growth dependent raptor, is the most dramatic example of conflict between wildlife and the forest industry in North America.

As older forests are usually targetted first for harvest, the amount of old growth forest remaining becomes lower and increasingly fragmented. Older forests are said to be decadent, overmature, and unhealthy (insects and disease) by the forest industry. The words on a sign at a demonstration forest near Whitecourt, Alberta describes old growth forest as this:

> "Look around. You are surrounded by an 'old growth forest' – a white spruce forest which has escaped destruction by fire and is now in a state of decline due to old age and other natural forces. The white spruce trees are approximately 150 years old, long past the normal lifespan of healthy maturity. Look carefully and you can see evidence of the decline: trees blown over by the wind, interior fungus rot, extremely visible insect damage to bark, mosses growing on the branches, and balsam fir saplings beginning to take over the stand. Stands such as this, if left alone, usually succumb to natural decay or fire, and result in the loss of timber for lumber or pulp. A managed forest is harvested before the trees reach this state and subsequently reforested with seedlings, perpetuating the cycle of establishment, growth and harvest."

As well, clearcut harvesting practices select for even-aged, single species forests. Barred Owls in the Foothills Model Forest use old, uneven-aged, mixedwood forests.

Barred Owl populations are affected by the loss of habitat. Loss of nesting, roosting and foraging habitat occurs when a forest is clearcut, and the Great Horned Owls move in with increased fragmentation. There is direct conflict between these two owl species, with the Barred Owl losing out to the larger Great Horned Owl (Bent 1961, Johnson 1993, Laidig and Dobkin 1995, Court personal comm.). The lack of suitable habitat, plus the increased presence of Great Horned Owls were major factors in determining the absence of Barred Owls in Michigan (Craighead and Craighead 1969).

Sustaining wildlife populations involves maintaining populations of the animals that use the forest, and also maintaining the habitats in which they live (Kimmins 1991). The forest becomes economically mature and is ready to be cut and replanted for the next crop long before it becomes biologically mature (Hunter 1990). Many species rely on older stands for various ecological reasons.

The Spotted Owl has become a surrogate for old growth forests (in the United States), a symbol of conflicting values – short-term economics versus other human values (Maser 1990). The Barred Owl is dependent on older forests in the Foothills Model Forest, Alberta, and can be used as an indicator. With fewer old stands remaining in most parts of the world, there are fewer old growth dependent species remaining. Forest management should ensure that large tracts of in tact older forests are maintained on the landscape to ensure that species relying on this specific habitat type do not decline.

6.2 Research Recommendations

Management of forests must include wildlife concerns. The Barred Owl can serve as an indicator of older mixedwood forests and needs to be managed, if it is not to mirror the Spotted Owl. There is a lot of potential for future work on owls in the Foothills Model Forest.

1. Barred Owls are long-lived species that rely on old mixedwood forests for nesting, roosting, and foraging, and require healthy prey populations in order to survive. Long-term owl monitoring programs need to be set up to ensure baseline data is collected on distribution, abundance, and important areas, to ensure populations are maintained. Longer lived species can have natural population fluctuations that cannot be determined based on two years. By understanding the dynamics of the owl populations in the FMF, they can be better managed, sustainably, for the long-term.

2. Broadcast surveys are a good way to get information on the presence of owls and general habitat use information. Use of playback increases response rate for some owls species. The surveys can be run by trained volunteers and/or researchers with little time spent. Using a standardized method is important to ensure results are comparable over time and between locations.

3. Understanding the prey populations is also important. The dynamics of the prey populations should be studied to better understand prey use by Barred Owls.

4. Radiotelemetry is a good way to get detailed information about the Barred Owl nesting, roosting and foraging. Although this study was unsuccessful in trapping, there is other methods that may be used for trapping Barred Owls successfully. The use of hand nets with a lure animal and the use of live decoy with mist nets have been used successfully in other studies (Court, Cromie, Olsen pers. comm.).

5. Raptors are excellent indicators of ecosystem health (Oliphant 1994). Raptor surveys need to be continued to better understand the distribution and abundance of raptors in the Foothills Model Forest. Daytime road surveys and banding of all species of raptors will ensure a database is started.

6. More ecological information needs to be collected on owls. To know how a species is affected by fragmentation it is important to measure breeding success and turnover (Redpath 1995). Little is known about the reproductive success, productivity, percent of the population breeding, and density. I recommend setting up a 10 km^2 area for study. It is important to collect detailed information on the number owls, species, number nesting, number of young, and number of young fledging in a known area. Similar studies have been conducted in Finland (P. Saurola, pers. comm.).

7. To maintain biodiversity and ecological function, clearcuts are not advisable in a boreal riparian ecosystem (Perry *et al.* 1989, Timoney and Peterson 1996). Barred Owls used large diameter balsam poplar trees for nesting. Balsam poplar is associated with wetter sites and forest companies have a difficult time regenerating these stands. Although, leaving these areas standing will provide some good Barred Owl habitat, forestry operations must ensure that enough old mixedwood uneven-aged forest remains to ensure healthy populations of Barred Owls are maintained.

8. Barred Owls are directly affected by forest fragmentation (Laidig and Dobkin 1995). Nest sites are lost and suitable roost and forage habitats are lost. As well, Great Horned Owl populations can move into fragmented areas and will prey upon Barred Owls and Great Gray Owls. Nesting areas need to be protected with at least a 100 m buffer, and disturbance should be minimized during the nesting season (February through July).

9. Studies need to look at the effects of anthropogenic changes (fragmentation) and Great Horned Owls on Barred Owl productivity and survival.

6.3 Literature Cited

Bent, A.C. 1961. Life histories of North American birds of prey. Dover Publications, Inc. New York, New York. Pp. 182-197.

Craighead, J.J. and F.C. Craighead, Jr. 1969. Hawks, owls and wildlife. Dover Publications, New York. 443 pp.

Kimmins, J.P. 1991. Sustainable forestry: can we use and sustain our forests. Forest Industry Lecture No. 27, University of Alberta, Edmonton, Alberta. 18 pp.

Laidig, K.J. and D.S. Dobkin. 1995. Spatial overlap and habitat associations of barred owls and great horned owls in southern New Jersey. Raptor Research 29(3): 151-157.

Maser, C. 1990. The redesigned forest. Stoddart Publishing Co. Limited, Toronto, Ontario. 224 pp.

Morrison, M.L., B.G. Marcot, and R.W. Mannan. 1992. Wildlife-habitat relationships concepts and applications. The University of Wisconsin Press, Madison, Wisconsin. 343 pp.

Oliphant, L. 1994. A report on results of national and regional ornithological surveys in Canada. Bird Trends 4:1.

Owl, Grey. 1936. Tales of an empty cabin. Published in 1992 by Stoddart Co. Limited, Canada.

Perry, D.A., M.P. Amaranthus, J.G. Borchers, S.L. Borchers, and R.E. Brainerd. Bootstrapping ecosystems. BioScience 39(4): 230-237.

Redpath, S.M. 1995. Habitat fragmentation and the individual: tawny owls *Strix aluco* in woodland patches. Journal of Animal Ecology 64: 652-661.

Timoney, K.P. and G. Peterson. 1996. Failure of natural regeneration after clearcut logging in Wood Buffalo National Park, Canada. Forest Ecology and Management 87: 89-105.

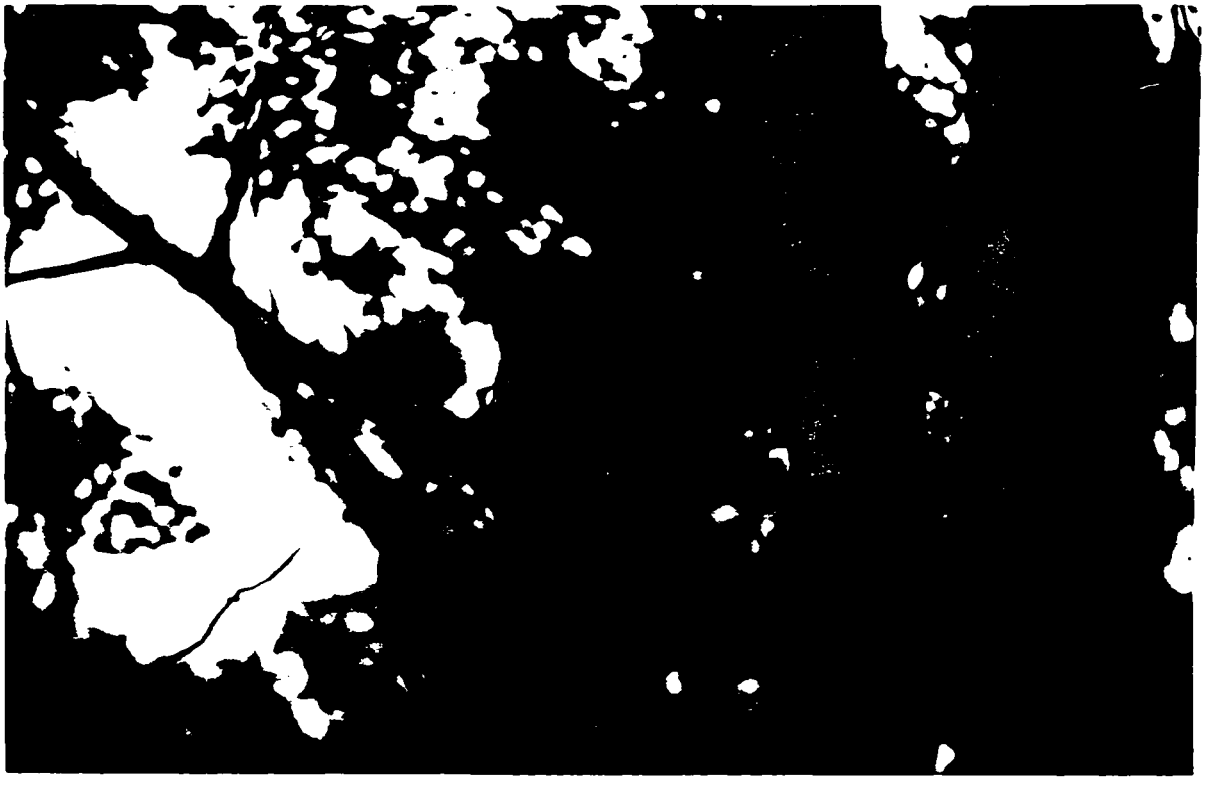

IMAGE EVALUATION
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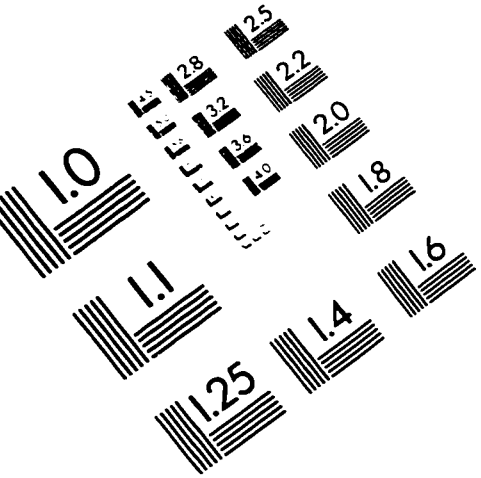

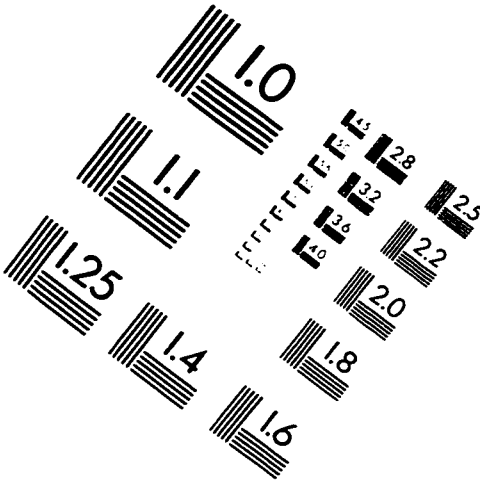

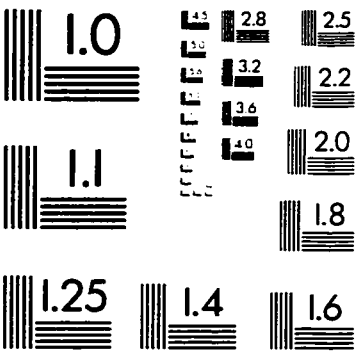

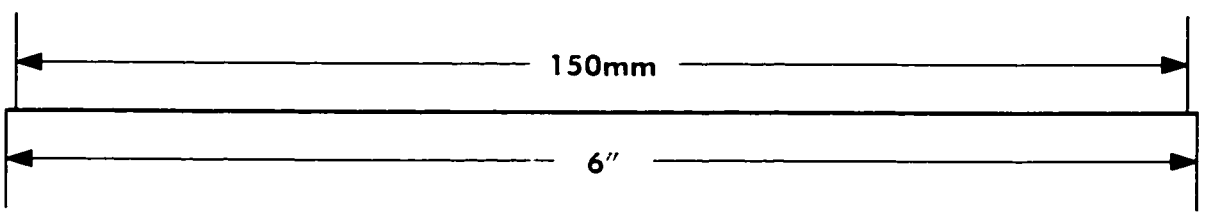

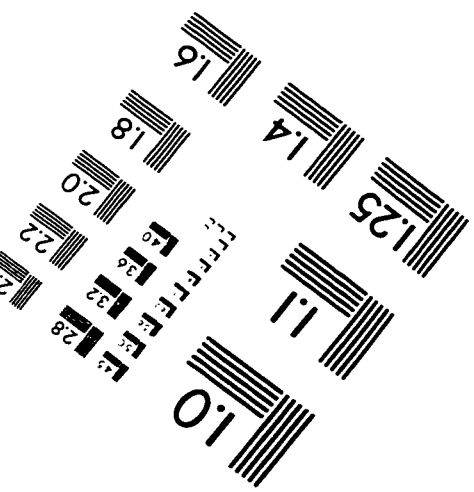

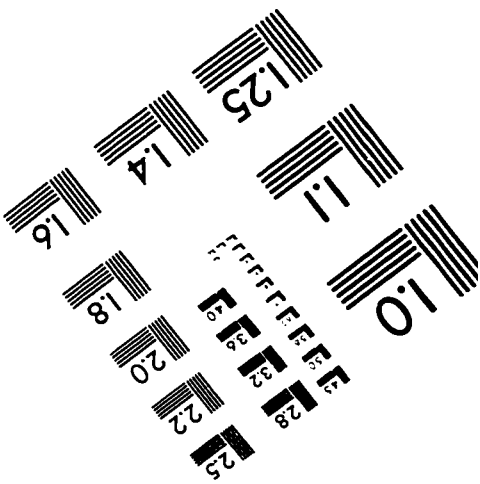

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