Great Gray Owl Habitat Use in Southeastern Manitoba and the Effects of Forest Resource Management

by

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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

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ABSTRACT

Habitat at 119 winter great gray owl (Strix nebulosa) locations and 14 nest sites was examined throughout southeastern Manitoba. Forest inventory data were used to examine tree species composition, site class, cutting class and crown closure characteristics of each specific location. In winter, owls were choosing softwood forests out of proportion to availability but not choosing a specific softwood type. Owls also did not choose a specific type of site class, cutting class, or crown closure. Owls did appear to concentrate in certain areas. Nest site data revealed tamarack, black spruce and aspen as important species with tamarack and aspen often serving as nest sites. Differences were found in habitat characteristics of artificial versus natural nest sites.

Trends in the amount of habitat since the early 1950's were investigated. At one time there was a decline in the amount of softwood habitat in the study area but this trend has since been reversed. Tamarack has shown dramatic increases since the 1950's, in part due to recovery from severe larch sawfly infestations. Black spruce and aspen have remained fairly constant in abundance over time.

Literature was reviewed to determine the impacts of logging activities on great gray owls. Unlogged mature or overmature forests are a common factor at many nest sites. Selectively logged and clearcut stands may not be detrimental to great gray owls under certain conditions.

Recommendations for future research and habitat management for great gray owls are made.

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Chapter I

INTRODUCTION

1.1 BACKGROUND

The great gray owl (Strix nebulosa), largest of North American owls, is generally considered to be scarce over most of its North American and European ranges. In Canada, it has been designated as "rare" by the Committee on the Status of Endangered Wildlife (Nero 1979); in California it is on the endangered species list because of the loss of old-growth habitat (Nero 1980:151). Fyfe (1976) classified it as rare across Canada, being slightly more abundant in the Prairie Provinces, British Columbia and the Yukon.

The great gray owl has a circumboreal distribution, occupying northern coniferous forest habitat and its successional stages in North America and Europe (Clark et al. 1987). There is evidence of a preference for mature poplar (Populus spp.) stands near muskeg in Alberta, for mature forests in California (Nero 1980:151), and for successional white spruce (Picea glauca) forest in interior Alaska (Osborne 1987). Hardwood stands within tamarack (Larix laricina) swamp systems were identified as important for great gray owls in Minnesota (Spreyer 1987). Black spruce-tamarack (Picea mariana - Larix laricina) bogs appear to be the preferred summer habitat of great gray owls in Manitoba (Servos 1986), where they often use nests built by other stick-nesting birds (Nero 1980:102).

Despite its "rare" status, the great gray owl is reported as fairly common in southeastern Manitoba (Nero 1979), an area that is also very productive in terms of forestry products. Black and white spruce, balsam fir (Abies balsamea), and jack pine (Pinus banksiana) are the primary species harvested, while small quantities of black poplar (Populus balsamifera), white birch (Betula papyrifera) and tamarack are also cut. To understand what effects these forestry activities may have on great gray owl populations, it is important to assess the species year-round habitat requirements in southeastern Manitoba.

1.2 PROBLEM STATEMENT

The availability of suitable habitat is critical for the survival of any species. The southeastern region of Manitoba is important for both great gray owls and forest resource management. The mandate of the Department of Natural Resources, Wildlife Branch includes a program aimed at protecting, restoring and assessing rare and endangered wildlife species. On the other hand, the mandate of the Forestry Branch is to provide a sustained growth of material for harvest. Thus, the problem lies in providing a viable forestry resource while at the same time ensuring maintenance of adequate wildlife habitat.

1.3 OBJECTIVES

The primary objective of this study was to examine the year-round habitat requirements of great gray owls and assess the possible effects of forestry activities on that habitat in southeastern Manitoba.

Specific objectives are:

1. To define the characteristics of the habitat used by great gray owls in terms of species composition, forestry cutting class, site class, and crown closure.

2. To determine the past and present amount and distribution of great gray owl habitat in southeastern Manitoba.

3. To review the literature to identify possible effects of forest resource management activities on great gray owl habitat.

4. To make recommendations for the management of great gray owl habitat in southeastern Manitoba.

1.4 SCOPE

This study was based on forest inventory data provided by the Manitoba Department of Natural Resources Forestry Branch, and on radio-marked owl locations provided by Wildlife Branch personnel. The study focused on habitat in southeastern Manitoba (Appendix A).

Chapter II

LITERATURE REVIEW

2.1 INTRODUCTION

This literature review covers aspects of forest resource management in Manitoba, as well as great gray owl biology relating to habitat use.

2.2 FOREST RESOURCE MANAGEMENT

2.2.1 Forest Composition

Manitoba ranks fifth to other Canadian provinces in forest area and merchantable volume of timber (MDNR 1986a). For forest classification purposes, Manitoba has been subdivided into the Tundra Transition Zone and the Forest Zone. The Tundra Zone covers 35% of the provincial land base and offers few possibilities for commercial forest use. The Forest Zone comprises 65% of the province and contains all of the productive forest land (MDNR 1986a). All land within the Forest Zone has been classified as to its productivity - Productive Forested Land, Nonproductive Forested Land, Nonforested Land, and Water (MDNR 1986b). Definitions of these terms are found in Appendix B.

The Forest Zone has been subdivided into 65 Forest Management Units (FMUs), which aggregate into 10 Forest Sections (Figure 1). Forest Management Unit 20 in southeastern Manitoba is comprised of 56% Productive Forested Land, 22% Nonproductive Forested Land, 19% Nonforested Land and 3% Water area. Of the Productive Forested

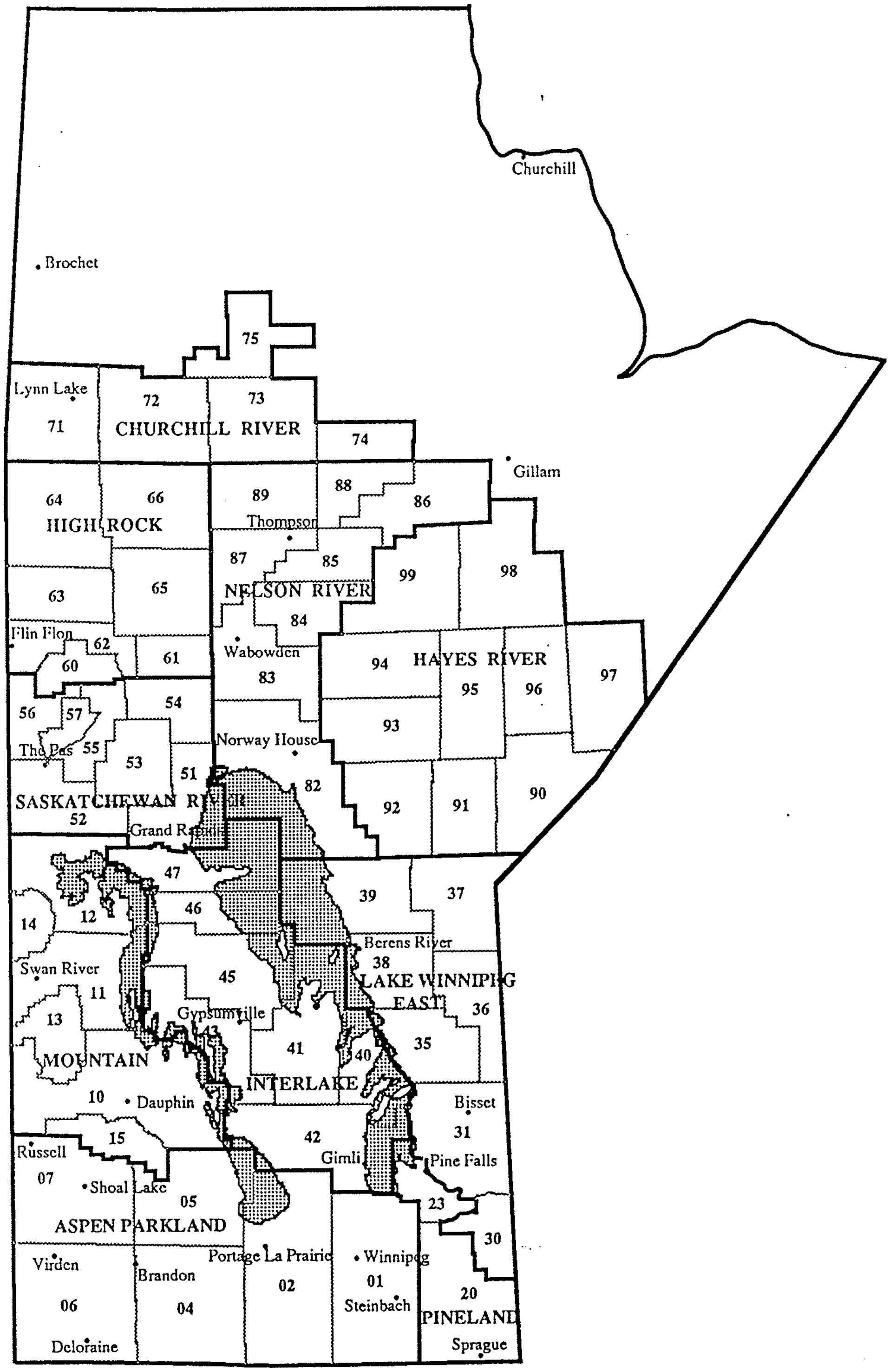

Figure 1: Forest sections and forest management units of Manitoba (MDNR 1986a)

Land, 60% is classified as Softwood stands, 27% Hardwoods, and 13% Mixedwood stands.

2.2.2 <u>20-Year Forest Management Plan</u>

In December 1981, the Forestry Branch and Forestal International completed a 20-Year Forest Management Plan for Manitoba which laid out management of the province's forest resources from 1981 to the year 2000. The purpose of the plan was "to serve as a broad guide and framework and as a planning tool " (Forestal 1981) for forestry in Manitoba. It was a blueprint for forest utilization, monitoring, fire management, forest renewal, and tending programs (MDNR 1986a) to achieve a balance between the growth of the forest and the depletion of the resource. The main recommendations of the management plan are (Forestal 1981):

1. To develop forestry policy which is consistent and stable over a long period while at the same time being dynamic and flexible to progressive changes in technology.

2. To improve fire detection and suppression activities.

3. To develop new industries or expand existing ones in order to utilize wood surpluses or unused annual allowable cuts as well as development of facilities to recover large volumes of forest and mill residues to maximize efficiency.

4. To develop primary access roads into inaccessible areas to facilitate utilization of the resource.

5. To implement intensive forest management (i.e. stand establishment and stand improvement programs) within the Forest Sections where the return will be greatest, including Pineland and Lake Winnipeg East.

The end result of these recommendations is an estimated doubling of the coniferous growth from 23.6 million to 47.1 million cubic metres of wood over the 20-year period, creating many positive economic benefits for Manitoba. The plan makes no reference to wildlife habitat considerations except to say that "the objective is the full utilization of the forest resource on a sustained yield basis...concurrent with the multiple-use of the forest for such other uses as recreation, preservation of wildlife habitat and watershed protection" (Forestal 1981).

2.2.3 Inventory System

As a result of the Canada/Manitoba Forest Renewal Agreement signed in March 1984, a Geographic Information System (GIS), also known as FORIST, was acquired. This system allows for the modification and evaluation of the status of the forest resource (MDNR 1986a). Once an area is inventoried and computerized, subsequent changes to the forest land base, such as areas of timber harvest, silvicultural activities, and fire depletion, can be incorporated into the system on a continual basis. This allows for an up-to-date, accurate forest database. Such a system not only facilitates forest management but is also extremely valuable in management of wildlife. The relationship between wildlife distribution and habitat parameters can be examined. As more is learned about wildlife requirements, computer modeling in combination with a GIS can be used to determine the impacts of habitat change on wildlife before they occur.

2.2.4 Annual Allowable Cut

Annual allowable-cut (AAC) volumes are calculated for each forest management unit on a sustained-yield basis (MDNR 1986a). Each year, the volume of wood in the forest increases by one year's growth. It is the annual increase in the volume of wood that is the allowable cut for that year. Regulation of the forestry resource occurs essentially through the AAC system. In southeastern Manitoba, trembling aspen (Populus tremuloides) constitutes 35% of the AAC for the area, jack pine 22%, black spruce 19% and tamarack 2% (MDNR 1986b). However, actual harvest rates may be considerably different. From 1981 to 1985, pine was overcut by approximately 6.5% each year while spruce was undercut by almost 15% per year. Tamarack has been consistently undercut by 20% or more (MDNR 1986b).

2.3 GREAT GRAY OWLS

2.3.1 Description

The great gray owl was first described by John R. Forster in 1772 (Nero 1980:58). Two subspecies are recognized, one in Europe (S. nebulosa laponica), and the other in North America (S. nebulosa nebulosa). The feathers of the owl are gray, white and brown tones. The upper body is marked irregularly with dark and white, while the lower body is boldly streaked over fine barring and the legs are fully feathered (Mikkola 1983:178). The large, circular facial disk is emphasized by six or more concentric brown rings on a gray background (Nero 1980:73; Mikkola 1983:178).

A distinctive part of the facial plumage are two large outward-facing crescents of white feathers (Mikkola 1983:178) and prominent white patches in the middle of the fore-neck (Nero 1980:80; Mikkola 1983:178). These white "chin" stripes reflect so much light that they are useful in identification of the species in low light conditions (Nero 1980:80).

2.3.2 Distribution

The North American breeding range of the great gray owl extends from northern Alaska and Canada, to central California, northern Idaho, western Wyoming and Montana, and northwest Minnesota, to central Ontario (Nero 1980:59) (Figure 2). Because of their nomadic habits, the great gray owl's winter range expands in some years. The North American breeding range is concentrated in Canada, extending from most of British Columbia, to north and central Alberta, northern Saskatchewan, most of Manitoba, and Ontario west of James Bay (Nero 1980:59).

Great gray owls in Manitoba appear to be concentrated in the southeastern region. Nero et al. (1984) found that 75 % of winter sightings of great gray owls, collected over a 15 year period, occurred within a rectangular area 106 km x 184 km in the extreme southeastern corner of the province. Summer sightings of birds during that same period were also concentrated in the southeast, with a few scattered observations extending northwest to The Pas and Wabowden.

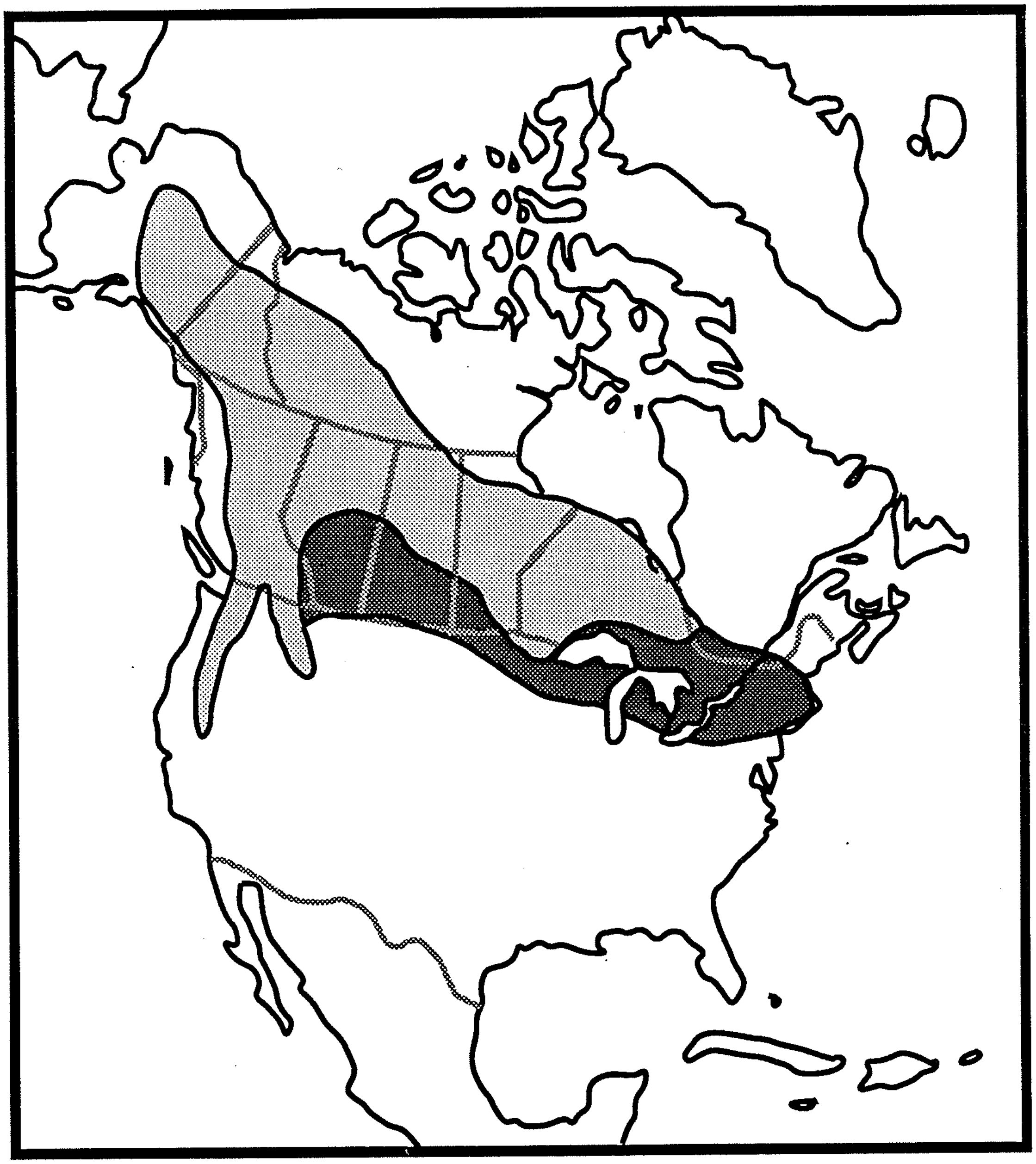

Figure 2: Distribution of great gray owls in North America (dark shading represents occasional winter range) (Nero 1980)

2.3.3 Status

Nero et al. (1984) estimated that the mixedwood and northern coniferous forest regions of the province supported up to 1,500 great gray owls. Estimates of the North American great gray owl population are from 5,000 to 50,000 birds (Nero 1979). Because they depend on small mammals for food, great gray owl numbers are thought to fluctuate according to local prey conditions. It is difficult to estimate the abundance of great gray owls because of population fluctuations, the owl's extensive range, and lack of density data (Nero 1980:62). Nero et al. (1984) note that there seem to be more great gray owls in southern Manitoba than in earlier times, but insufficient data on the owl's past range and population size makes trends difficult to assess.

2.3.4 Summer Habitat Use

For the purpose of this review, "summer" habitat use refers to habitat use during the breeding season. Although timing of breeding is variable, the period from April through October is generally regarded as the breeding season for the species (Collins 1980).

2.3.4.1 Nest Selection

Between January and April, pair formation and courtship among great gray owls take place (Nero 1980:102). Visits to nests may begin as early as mid-February with egg laying as early as mid-March in mild winters (Collins 1980).

Great gray owls do not build their own nests but use vacant nests built by other stick-nesting birds. Nests of the American crow (Corvus brachyrhynchos), common raven (Corvus corax), red-tailed hawk (Buteo jamaicensis), broad-winged hawk (Buteo platypterus), and northern goshawk (Accipter gentilis) are used most frequently (Bent 1938; Nero 1980:102). Artificial nest structures are also used (Mikkola 1983:201; Nero et al. 1984). Usually nests are located in trees, however great gray owls have been known to nest on the ground or on tops of large stumps (Mikkola 1983:186). They do not add any new material but the female may scratch at the bottom of the nest (Nero 1980:102; Mikkola 1983:199). The male usually finds suitable nests but the female probably makes the final choice (Mikkola 1983:202). The presence of two or three nest structures in close proximity may provide additional nesting stimulus (Nero 1980:110).

As great gray owls rely on vacant nests of other birds, nests may vary considerably in height, size, durability, and in the habitat in which they occur. Selection of a nest may also be based on the abundance of prey (Nero 1980:103; Collins 1980:30) or nest-site fidelity (Collins 1980:31). In Manitoba, black spruce-tamarack or pure tamarack bogs appear to be preferred nesting habitat in many areas (Servos 1986). Nest sites dominated by hardwood species and excessive soil moisture were favored by great gray owls in northcentral Minnesota (Spreyer 1987). Mature poplar woods, mixed with either black spruce or jack pine and adjacent to muskeg appear to be the preferred nesting habitat by great gray owls in Alberta (Nero 1980:59). In Finland, damp coniferous forests were the preferred nesting habitat (Mikkola 1983).

2.3.4.2 Nesting Period

The nesting period consists of the activities surrounding egg laying, incubation, and chick rearing. Egg-laying may occur from mid-March (Nero 1980:103) to early May (J. Duncan pers. comm.; Collins 1980:41) in Manitoba, depending on factors such as climatic conditions (Franklin 1987), food supply, or the condition of the female with respect to her egg-laying ability (Collins 1980:39). See Collins (1980), Nero (1980) and Mikkola (1983) for details of nest biology.

During the nesting period, the female tends the nest and young while the male hunts, providing himself and the female with food. The great gray owl feeds almost exclusively on small mammals, particularly voles (Cricetidae) and shrews (Soricidae) (Nero 1969; Mikkola 1983). Their peak hours of activity are during periods of low light in the early morning and late afternoon to dusk; they generally do not hunt after dark (Nero 1980:93; Mikkola 1983), except when food is scarce, in which case the male may hunt at all hours (Nero 1980:117). Great gray owls typically hunt in an open bog, marsh, clear-cut area or a field (Mikkola 1983). Males will generally hunt within a few hundred metres of the nest, although they venture farther afield if prey is scarce (Nero 1980:103). Once the young can maintain their own body temperature, the female may occasionally leave the nest for a few minutes at a time (Nero 1980:112).

2.3.4.3 Fledgling Period

After leaving the nest at 3 to 4 weeks of age the young proceed to climb trees. They cannot fly but use their talons and bill to climb. The young stay together near the nest tree for 6 to 8 weeks after leaving the nest, still being fed by the male (Mikkola 1983).

Servos (1986) found that newly fledged great gray owls preferred pure tamarack bogs and nearly pure (90%-10%) tamarack-black spruce bogs. The tamarack bogs were generally free of a dense shrub layer and ground cover was mostly low-growing mosses and grasses. The horizontal growth of the tamarack branches also provide suitable perches.

Forested land not restocked following fire or some other major disturbance, and with some scattered residual trees, as well as treed muskeg, were selected by adult great gray owls during this period (Servos 1986). These areas supported an abundance of the preferred prey species, allowed unimpeded hunting access for the owls, and the scattered trees provided suitable perches (Servos 1986). These areas were not utilized much by the young, probably because they provided little or no shade or concealment (Servos 1986).

2.3.5 Winter Habitat Use

"Winter" habitat use refers to habitat used during the non-breeding season, the period November through March (Collins 1980).

Most owl sightings are made during winter. About 82% and 60% of great gray owl sightings in Manitoba and Saskatchewan, respectively, were reported from November through March (Harris 1984; Nero et al. 1984) despite the fact that breeding populations occur in both areas. Harris (1984) stated that this is not due to more time being spent searching during fall and winter; 75% of the time was spent searching from June to August. Both Nero and Harris believed that their results were due to seasonal changes in habitat use and behavior of great gray owls.

Great gray owls may sometimes hunt all day long (Brunton and Pittaway 1971; Nero 1979; Nero et al. 1984) although they are normally diurnal in their hunting behavior (Godfrey 1967; Brunton and Pittaway 1971; Mikkola 1983:189). Although there is evidence that some prey are taken on the snow surface (Brunton and Pittaway 1971; McNicholl and Scott 1973), great gray owls usually detect their prey moving under the snow by acoustical cues and plunge after them (Law 1960; Godfrey 1967; Nero 1969; Brunton and Pittaway 1971; Collins 1980; Mikkola 1983:191; Nero 1980:87). The depth of plunge-holes varies depending on the depth and softness of snow, and the level at which the prey species are active. Nero (1980:90) found that by making a plunge and thrusting down with their feet, owls could reach prey as deep as 18 inches (46 cm). In one area, Nero (1980:91) observed owls breaking through a one-inch crust. Collins (1980:82) found the mean depth of plunge-holes in hard snow was 20.4 cm and in soft snow was 22.3 cm. Snow hardness had no apparent effect on the depth of the plunge-hole but in hard snow, only the bird's feet penetrated the hard crust.

Bull and Henjum (1989) found that, outside the nesting season, great gray owls spent their day roosting in stands that provided them shelter from the weather and cover from avian predators. Of birds located during radio-tracking, 64% were found roosting, usually on a branch adjacent to the trunk, which makes them difficult to see. Owls are frequently reported in winter perched in trees, on fence posts, or on telephone poles along roads (Harris 1984; Franklin 1987).

Movements of great gray owls during winter seem to be quite variable. Birds may wander far outside their breeding range but may also be seen within their breeding range in winter (Nero et al. 1984). If there is a scarcity of food within a particular area, local populations may move elsewhere (Loch 1985; Duncan 1987). Loch (1985) found that in less than a month's time, birds could travel up to 275 km in order to find prey. He suggested that nomadic movements as displayed by great gray owls probably serve to test the local environment for variation in food supply and that if resources are not adequate to sustain a breeding effort, the owl is likely to move on.

There are two prey-related hypotheses with respect to owl movements in winter: prey availability and prey abundance. Snow depth affects prey availability by increasing the barrier between the owl and the small mammals at the snow-soil interface. At some depth, prey are out of reach and the owls move to areas with shallower snow and thus more accessible prey (Collins 1980; Franklin 1987; Bull et al.

1988a). Franklin (1987) found that in Idaho and Wyoming the mean elevation of winter sightings was significantly lower than the elevation of summer sightings and snow depths were shallower at lower elevations. He concluded that owls may have been moving to lower elevations because of deeper snow and inaccessible prey at higher elevations. Similarly, Winter (1986) found that great gray owls in California moved to lower elevations in winter. Bull et al. (1988a) suggested that the short distances that owls in Oregon moved during winter were a function of topography - owls only had to travel a short distance to change elevation, snow depth and probable availability of prey. In Ontario, Manitoba, and Minnesota, owls must travel greater distances to change elevation and/or snow depth (Duncan 1987).

The second hypothesis is that winter movements are caused by low prey abundance because of the cyclical nature of small mammal populations (Bent 1938:218, Mikkola 1983:187,211, Loch 1985, Nero 1988). In Scandinavia, Mikkola (1981) thought that in years when vole densities were normal, most great gray owls wintered in their nesting areas; during mass die-offs of voles, owls are thought to wander in all directions. Likewise, Loch (1985:2) thought that owls might have been moving in relation to a "more or less synchronized, widespread, and predictable (occurring at 3 to 4 year intervals) microtine crash".

2.3.6 Great Gray Owl Management Projects

Minnesota has recognized the importance of managing habitat for great gray owls. In 1981, Loch (1981) outlined habitat management guidelines for great gray owls in Minnesota. He suggested that great gray owls are dependent on the availability of large tracts of potential habitat with connecting corridors between these tracts. To this end, Loch recommended a mosaic of tamarack, hardwood (black ash) and open communities be maintained as important for owls. Seed tree or shelterwood cuts with 75 stumps, snags, or nonmerchantable trees per hectare left in place to provide hunting perches, were deemed desirable. Rectangular cuts, 200 m or less in width were suggested.

In 1987, the State developed a management plan designed to maintain great gray owl populations in the "Roseau Bog" area in northwestern Minnesota (Haws 1987). The plan integrated great gray owl habitat requirements with timber harvesting under a multiple-use philosophy. Specific habitat management techniques, such as size, location, and limitations of harvesting near nests, were outlined with the expected result being protection of nests and perpetuation of tamarack and black spruce habitat types. In general, the recommendations are for clear cuts of 2 hectares or less with 25 snag trees per hectare being reserved in tamarack cuts. All existing and potential great gray owl nests are to remain undisturbed, including an area of at least a 100 m radius from the nest. New cuts are not placed adjacent to cuts less than 5 years old. Implementation of this plan is proceeding, for the most part, as proposed although snag density recommendations are higher than necessary (Haws, pers. comm.). As implementation of the plan has just begun, the response of great gray owls to the habitat alterations has not yet been evaluated.

The Manitoba Department of Natural Resources formulated a series of wildlife guidelines for forest management in the province (MDNR

1988). Although primarily dealing with game species, it is acknowledged that, in certain areas, blocks of mature cover may have to be retained to accommodate great gray owls.

The MDNR is also developing a management plan for a great gray owl ecologically significant area in southeastern Manitoba (MDNR 1989a). The intention is to provide management prescriptions to protect great gray owl habitat and maintain the natural ecosystems. The area will be divided into core and buffer zones. Within the core, owl habitat will be rigorously protected and carefully managed and timber harvesting will occur only when agreed to by the management group. In the buffer area, a broader range of management and harvesting activities will be acceptable. Specific management prescriptions regarding size, location, and timing of timber harvesting are outlined in the plan (MDNR 1989a).

As both the Manitoba and Minnesota management plans are very recent, there has been little or no opportunity to evaluate their effectiveness. Since 1986 both areas have been under detailed study for concurrent small mammal and great gray owl population fluctuations (Duncan 1987). Therefore, in time these areas will provide excellent opportunities for examining the effects of timber harvesting on raptorial species.

Chapter III
METHODS

3.1 STUDY AREA

Because this study relied to a large extent on forestry inventory data the study area in southeastern Manitoba was defined as Forest Management Unit 20. This area extends from the Manitoba-United States border to approximately 45 km south of Pine Falls, and from the Manitoba-Ontario border to about 20 km east of Steinbach (see Figure 1).

The western edge of the study area lies in the Manitoba Lowlands section of the Boreal Forest Region, while the remaining area also has strong boreal affinities, lying in the Rainy River section of the Great Lakes-St. Lawrence Forest Region (Rowe 1972). The area is characterized by low relief with flat to undulating topography. Lacustrine and modified glacial deposits are found in areas once covered by Glacial Lake Agassiz. The Sandilands Provincial Forest, an area not covered by the lake, is higher land with till and outwash sands. Low relief and poor drainage have favored the development of extensive swamps with black spruce, tamarack, eastern cedar (Thuja occidentalis), willow (Salix spp.) and alder (Alnus spp.) scrub. Trembling aspen and jack pine are common on the drier sites throughout the area (Rowe 1972).

3.2 DEFINITION OF HABITAT

In order to manage habitat effectively for great gray owls, the habitat the species uses over its annual cycle must be characterized. In this study, great gray owl habitat was defined with respect to tree species composition, site class, cutting class, and crown closure. These terms have been defined by the MDNR Forestry Branch (MDNR 1986b) as follows:

Species Composition - species composition of the stand is based on the comparison of the tree count (basal area) for each species to the total tree count (basal area) of the stand, expressed as a percentage. The abundance of each species present is rounded off to the nearest 10%. These are then organized into cover type and subtype groups. Four broad categories of cover type are recognized based on the percentage of softwoods within a stand - Softwood (S), Softwood-Hardwood (M), Hardwood-Softwood (N), and Hardwood (H). Subtypes indicate the species composition in groups within the cover type designation. Appendices C and D list the cover types and subtypes that make up the species composition variable. Species composition pertains only to Productive Forested Land. Nonproductive and Nonforested classifications are defined in Appendix B.

Site Class - Site class is an indication of the potential for growth of the stand. Site class takes into consideration moisture, soil, and light conditions. Site class ranges on a scale from 1 to 3, where 1 is a site with the best potential for growth of the major species, while 3 has the least potential for productive growth. Site-class designations differ between species. For example, black spruce and jack pine grow optimally under very different conditions. The site class 1 designation represents optimal growing conditions for the major species and is different for different species. Site class is also specific within a region. Soil and moisture conditions on a site class 1 black spruce stand in southeastern Manitoba are not necessarily the same as conditions on a site class 1 black spruce stand in northern Manitoba.

Cutting class - Cutting class is based on the size, vigor, state of development and maturity of a stand for harvesting purposes. Cutting class ranges on a scale from 0 to 5, with class 5 being overmature stands which should be given priority in cutting. Appendix E outlines the categories of the cutting class variable.

Crown closure - Crown closure is based on the density of the crown for each stand and is estimated from photographs by an experienced photo interpreter. Crown closure ranges on a scale from 0 to 4, with 4 representing crown closure densities of 71% and greater. Appendix F outlines the range of the crown closure variable.

3.2.1 Winter Habitat Use

The locations of 31 radio-marked owls, obtained by Manitoba Department of Natural Resources Wildlife Branch personnel, were used to examine habitat use during the winter. For details regarding radio-telemetry see Loch (1985) or Duncan (1987).

Radio fixes were obtained on 68 different days from 2 January 1986 to 31 March 1988 (excluding the months April to August). When a radio-marked owl was located, two or more compass bearings were taken from different locations. The owl's location was estimated to be in the centre of the intersected bearings (Mech 1983). Owl locations were plotted on a 1:50,000 topographic map from which UTM (Universal Transverse Mercator) coordinates were determined. Owl locations were recorded to the nearest 50 m.

A radio-fix represents a location in which an owl has chosen to remain long enough for its coordinates to be identified. The length of time the owl remained at this location, or its activity, is unknown. Owls may have been roosting, hunting or just passing through.

Once UTM coordinates were obtained, habitat maps were produced by the Forestry Branch F.O.R.I.S.T. Geographic Information System (GIS). For each owl location, a map was produced displaying the habitat within a 1,000 m radius around the location. Computerized inventory data produced information on each of the stands in the habitat map.

Originally, 154 owl locations were obtained. Habitat maps were produced for only 119 of these radio-fixes. Of the remaining 35 locations, 28 fell outside the study area, either wholly or partially, and 7 were not produced for undetermined reasons.

From the habitat maps, two types of data were extracted for analysis: point data and area data. Point data were used to describe characteristics of the habitat at the owl's actual location, including species composition, site class, cutting class and crown closure. Area data were used to examine the habitat within 1 km of the owl. Only species composition was examined. These two approaches were used because although the owl chose a specific location, owls were presumably using an area rather than a specific point.

To determine whether owls selected a specific habitat type, it was necessary to compare habitat use to availability (Neu et al 1974; Byers et al 1984). Observed use of habitat was compared to expected use based on availability of various habitat types. Comparisons were made using a chi-squared goodness-of-fit test. The null hypothesis for this test was:

Ho: Great gray owls use each habitat type in proportion to its availability over the entire study area.

Rejection of the null hypothesis indicates a statistically significant difference between utilization and availability, but does not indicate which habitat types were being used. Bonferroni confidence intervals were then calculated to determine which habitat types were being selected or avoided (Neu et al 1974; Byers et al 1984). Chi-squared tests and Bonferroni confidence intervals were conducted on each habitat variable (species composition (subtype), site class, cutting class, and crown closure characteristics) to determine preference or avoidance of classes within the variable.

In order to employ chi-squared tests to area plots, it was necessary to have frequency data rather than measurement data. Thus, the winter area plots were examined and the predominant habitat type (i.e. the habitat subtype that covered the greatest percentage of the area) for each of the 119 areas was determined. These predominant habitat types were then used in chi-squared analysis to compare the use of habitat as represented by the area plots to the availability of habitat within the study area as a whole.

3.2.2 Summer Habitat Use

An examination of breeding season habitat involved use of great gray owl nest sites, rather than owl locations. Fourteen nest sites known to have been used by great gray owls were used. Six of the nests were artificial nest structures, seven were natural raptor stick-nests and one was a natural nest that deteriorated and was rebuilt (artificial). For the purpose of analysis, this nest was included with the natural nests because the location of the nest was chosen naturally (i.e. by other raptors) rather than by humans. Great gray owls used this nest both before and after it was reconstructed.

Each nest was plotted on a 1:50,000 topographic map from which UTM coordinates were determined. Habitat maps were then produced by the Forestry Branch GIS and the exact location of each nest was plotted. This reduced error in identifying nest locations due to the less detailed topographic maps. The actual tree species in which nests were found was also recorded.

Species composition, site class, cutting class, crown closure and stand areas were recorded for each of the nests. Stand areas were calculated manually, using township maps with a scale of 4" = 1 mile and a dot planimeter. The tree species in which nests were found and distance to nearest meadow, field, cutover or muskeg was also recorded. Artificial nests were compared to natural nest sites.

3.2.3 Limitations of the Data

3.2.3.1 Owl Locations

In this study habitat use is based on radio-marked owls. It was assumed that habitat use by radio-marked owls is representative of that used by all great gray owls in the region.

One of the requirements of chi-squared analysis is independence of observations. In determining owl locations, searches were made on the basis of each owl's last-known location. Thus observations are not necessarily independent. For statistical precision, an equal amount of time should have been spent in each township systematically searching for radio-marked owls.

The accuracy of the radio-telemetry equipment was on average 8 degrees.

3.2.3.2 Habitat Maps

Stand areas for winter owl locations were calculated automatically by the computer. Nevertheless, an average error of 0.52% in stand areas resulted. Error may have occurred from small inaccuracies in the production of the original cover maps, digitizing to computer format or as rounding errors in calculations. Summer plots averaged 1.81% error in area. This larger degree of error was due primarily to the variability inherent in manually calculating stand areas with a dot planimeter. Planimeters only approximate areas and their accuracy is dependent on stand size and planimeter scale.

3.2.3.3 Nest Sites

Six of the fourteen nest sites used to examine breeding season habitat were artificial nests, constructed and placed in specific locations. The artificial nests introduce bias into the analysis of habitat because the factors that wildlife personnel use to decide on a location for a nest may be very different from the factors that raptors use to choose a site. Nevertheless, all fourteen nest sites were used at least once by nesting great gray owls. Thus, there must have been some common factor between the natural and artificial nests which prompted the owls to use them. Comparisons between the two nest types are made in the Results.

3.2.3.4 Forest Management and Owls

This study attempts to characterize owl habitat in terms of forest management classifications. The classification system was designed for accurate, convenient inventory of the forest. Owls likely view the forest differently from foresters and as a result it is possible that the habitat preferences of great gray owls are governed by factors or combinations of factors which are not measured by this system. The lack of standardization of variables, such as site class, further complicate the interpretation of results.

3.3 AMOUNT AND DISTRIBUTION OF HABITAT

Once the type of habitat used by great gray owls was defined, the amount and distribution of that habitat in southeastern Manitoba were determined. Comparisons were made in changes in the amount of habitat over time.

Forest inventory data, available from the Forestry Branch GIS, were used to examine the present amount and distribution of great gray owl habitat. Habitat types were specified by subtype codes which the GIS used to produce maps of habitat distribution within the study area. Thus, important areas for great gray owls could be identified.

In order to investigate trends in the amount of habitat over time, Forest Inventory Reports from 1956, 1974 and 1989 were examined (MDNR 1956, 1974, 1989b). The area of Softwood, Hardwood, and Potentially Productive habitat were extracted for all land classifications in the study area. As tamarack, aspen and black spruce seem to be most important to owls, the area of these species were also investigated over time.

Because changes occurred in the boundaries of the Forest Management Units (FMU) between 1956 and 1989, the area used for comparisons from 1956 to 1974 differed from that used from 1974 to 1989. The map in Appendix A shows these two areas. The area which in 1956 was called the Southeastern Forest Section is equivalent to the 1974 FMU 20 and 21, combined. The 1989 FMU 20 is equivalent to the 1974 FMU 20,21, and 22, combined. Data from 1956 to 1989 are not directly comparable but can be tied together by the 1974 statistics.

Chapter IV

RESULTS

4.1 HABITAT WITHIN THE STUDY AREA

The study area has a total area of 897,223.6 ha: Productive Forested Land is 56% (506,566.6 ha), Nonproductive Forested Land is 22% (195,572.9 ha), Nonforested Land is 19% (167,557.7 ha) and Water is 3% (27,526.4 ha). Of the Productive Forested Land, 60% (306,456.5 ha) is classified as Softwoods, 27% (134,819.3 ha) as Hardwoods and 13% (65,290.8 ha) as Mixedwoods.

There are 95 different habitat subtypes within the study area. Appendix G outlines the amount of each type of habitat. Trembling aspen (subtype 90) is the most predominant habitat type, covering 14.4% of the area. Fifty percent of the study area is covered by only 5 habitat types - trembling aspen (subtype 90), tamarack treed muskeg(subtype 702), black spruce 71-100% (subtype 13), muskeg(subtype 831), and jack pine 71-100%(subtype 04).

It is only the habitat subtypes of the productive forested land that carry site class, cutting class, and crown closure designations. Appendix H outlines the area of habitat within each of these classifications. The habitat within the study area is divided between site class 1 (most productive) and site class 2 (moderately productive), with only a very small portion designated as site class 3 (least productive). In terms of cutting class, class 3 stands (immature stands with merchantable volume growing at or near their maximum rate) cover just over half of the area. With respect to crown closure, almost 60% of the area is designated class 4, (stands with 71% and greater crown density).

4.2 WINTER HABITAT USE

Figure 3 shows a habitat map, produced by the GIS, for one winter owl location. Figure 4 shows the distribution of great gray owl locations in the study area from early September to late March.

4.2.1 Point Data

Of 95 habitat subtypes available throughout the study area, great gray owls were found in only 26 (Figure 5): 54% (64) of locations were in Softwoods, 15% (18) in Hardwoods, 13% (16) in Nonproductive Forested Land, 10% (12) in Mixedwoods and 8% (9) in Nonforested Land. Habitat subtype 13 (black spruce 71-100%) was used most frequently, followed by subtypes 90 (trembling aspen), 04 (jack pine 71-100%), 16 (black spruce 40-70%) and 702 (tamarack treed muskeg).

When compared to availability of habitat, there was a significant difference in the use of some habitat types, suggesting that great grays selected or avoided certain major cover types (x^2=25.47, df=5, $P<0.005$). Bonferroni confidence intervals were calculated to determine which cover types were being used disproportionately (Table 1). Softwood cover types were used more than expected based on their availability and Nonproductive Forested Land and Nonforested Land were used less than expected. Mixedwood and Hardwood cover types were used in proportion to their availability in the study area. Further analysis of the Softwood subtypes showed that owls did not use a

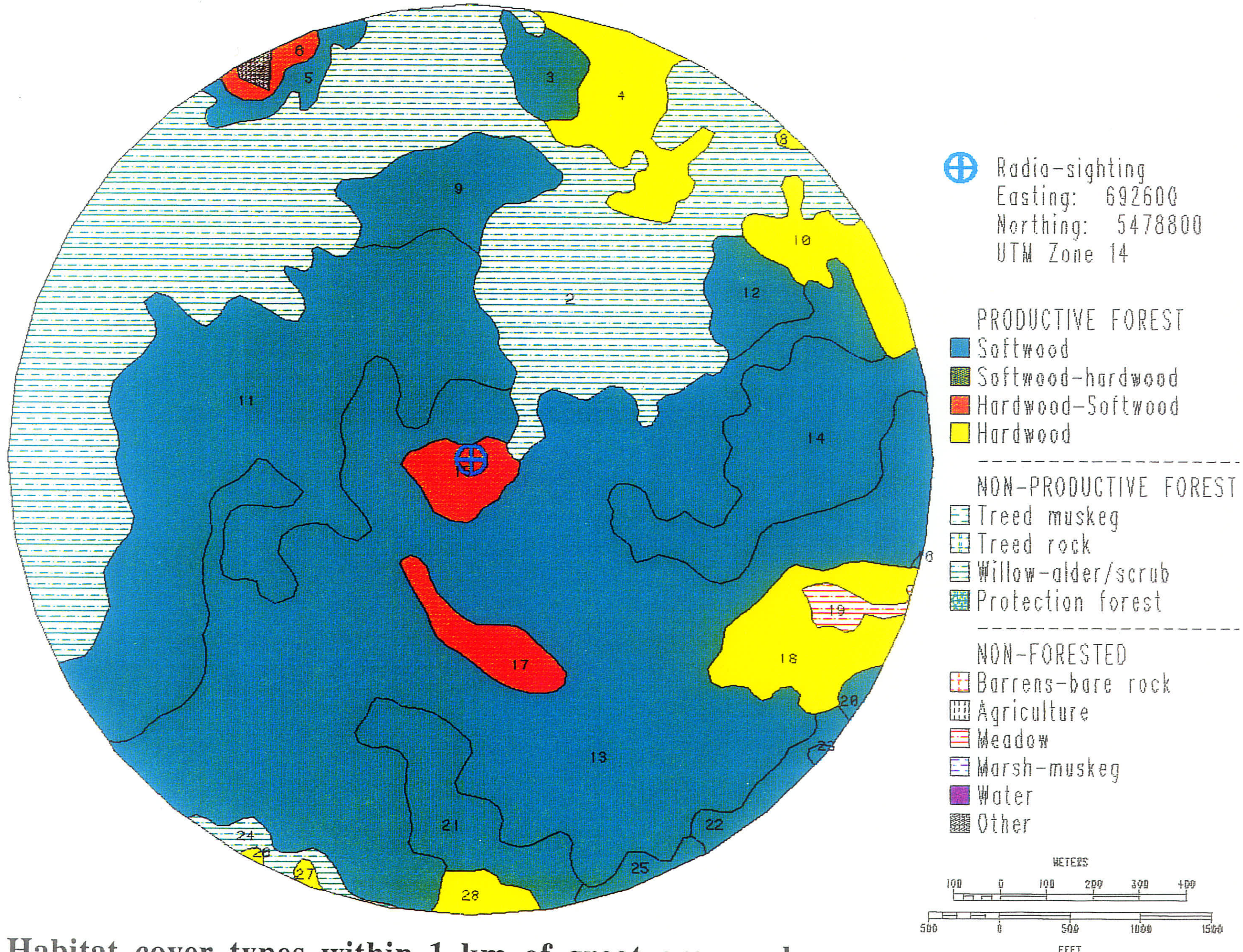

Figure 3: Habitat cover types within 1 km of great gray owl location

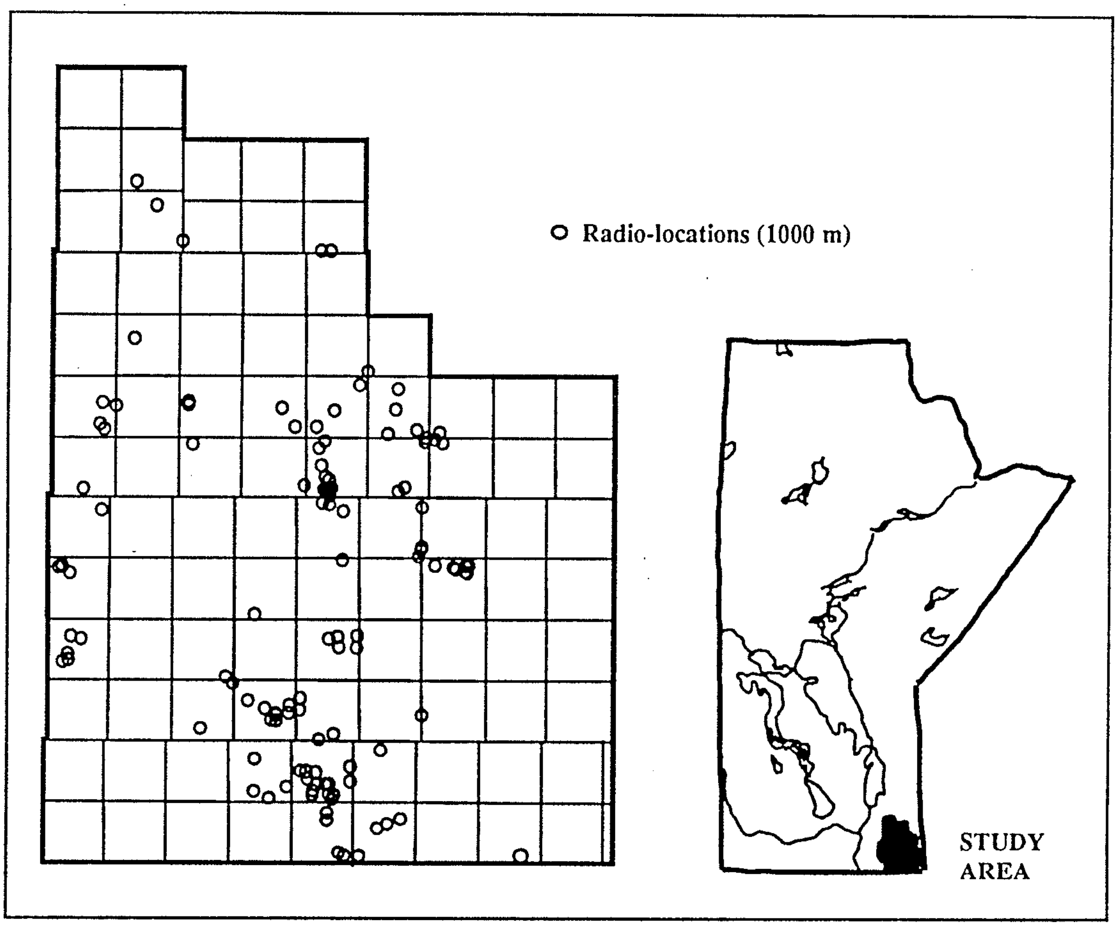

Figure 4: **Distribution of radio-marked great gray owl locations in winter throughout the study area**

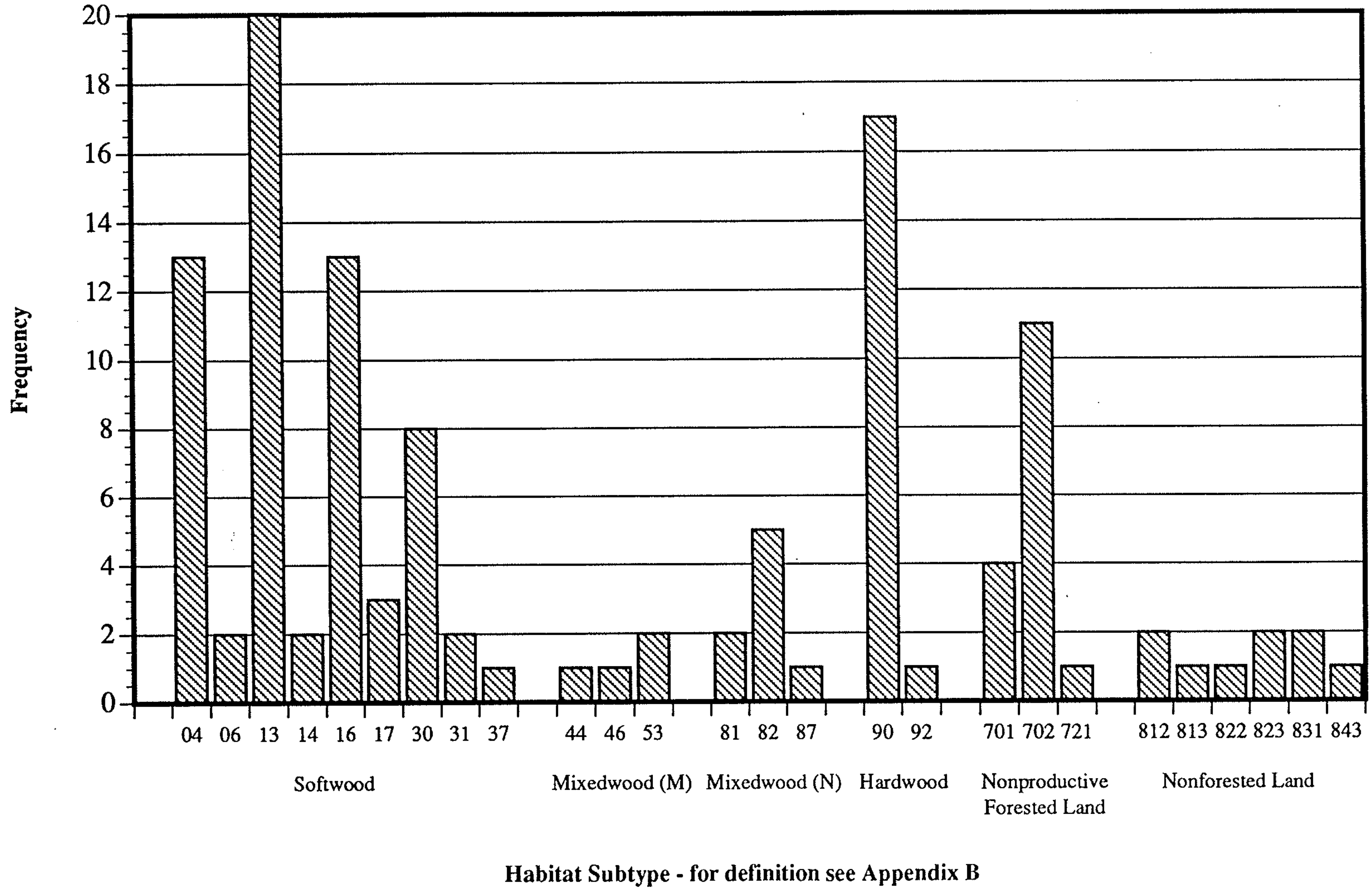

Figure 5: Habitat subtypes in which radio-marked great gray owls were located

Table 1: Preference or avoidance of cover types by radio-marked great gray owls in southeastern Manitoba.

Cover Type	Bonferroni Confidence Interval	Expected Use	Conclusions
Softwood	$0.4176<p<0.6584$	0.3524*	Used More
Mixedwood (M))	$0<p<0.0778$	0.0248	No Difference
Mixedwood (N)	$0.0066<p<0.1274$	0.0502	No Difference
Hardwood	$0.0645<p<0.2375$	0.1550	No Difference
Nonproductive Forested Land	$0.0517<p<0.2163$	0.2249*	Used Less
Nonforested Land	$0.0120<p<0.1400$	0.1927*	Used Less

* significant at the 0.05 level.

specific Softwood habitat type out of proportion to its availability (x^2=11.506, df=7, 0.50>P>0.10). Likewise, analysis of the Nonproductive and Nonforested habitats revealed only nonsignificant differences between specific types (x^2=3.67, df=4, P>0.10).

Similarly, there was no significant difference when compared to availability in the use of habitat by site class (x^2=1.68, df=1, 0.50>P>0.10), cutting class (x^2=4.70, df=5, 0.50>P>0.10), and crown closure (x^2=5.60, df=3, 0.50>P>0.10) characteristics, respectively (Figures 6, 7, and 8).

While there are not statistically significant results, there do appear to be some trends in habitat use. With respect to site class, owls tend to use class 2 and 3 more than expected compared to habitat availability, and class 1 less than expected (Figure 6). An examination of cutting class revealed that owls were using most of the habitat classes in proportion to their occurrence (Figure 7). In fact, for cutting class 3, habitat use and availability corresponded almost exactly. Cutting class 4 was the only class for which habitat use by owls was relatively greater than expected. With respect to crown closure, great grays tended to use class 3 more than expected and all other classes less than expected based on availability (Figure 8). However, these are only trends and are not statistically significant results. A larger sample size may or may not have shown significant differences.

A chi-squared test of independence determined that owl distributions relative to habitat subtype did not change significantly throughout the winter (x^2=3.41, df=6, 0.90>P>0.50). Likewise, use of habitat by site

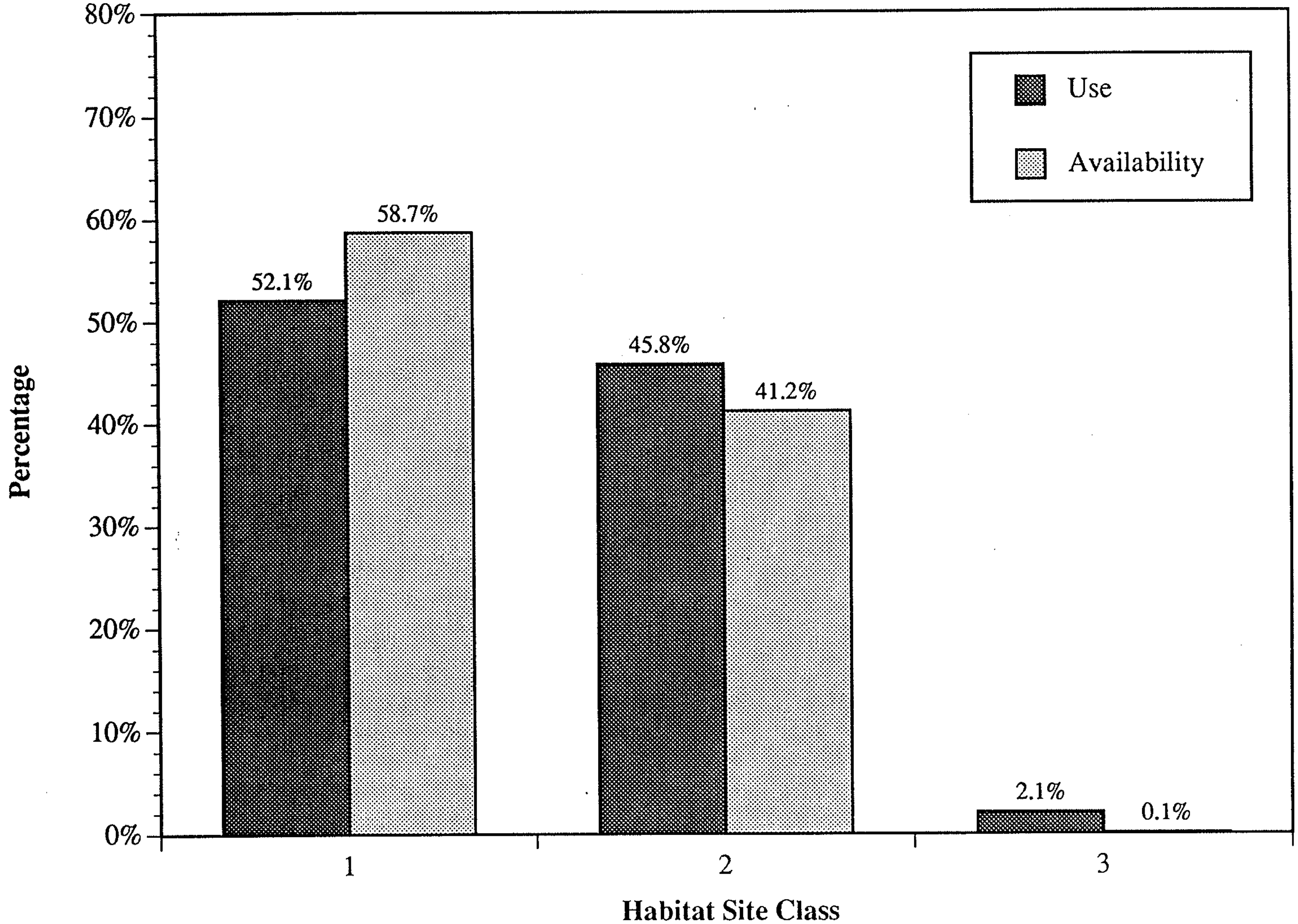

Figure 6: Use of habitat site class by radio-marked great gray owls

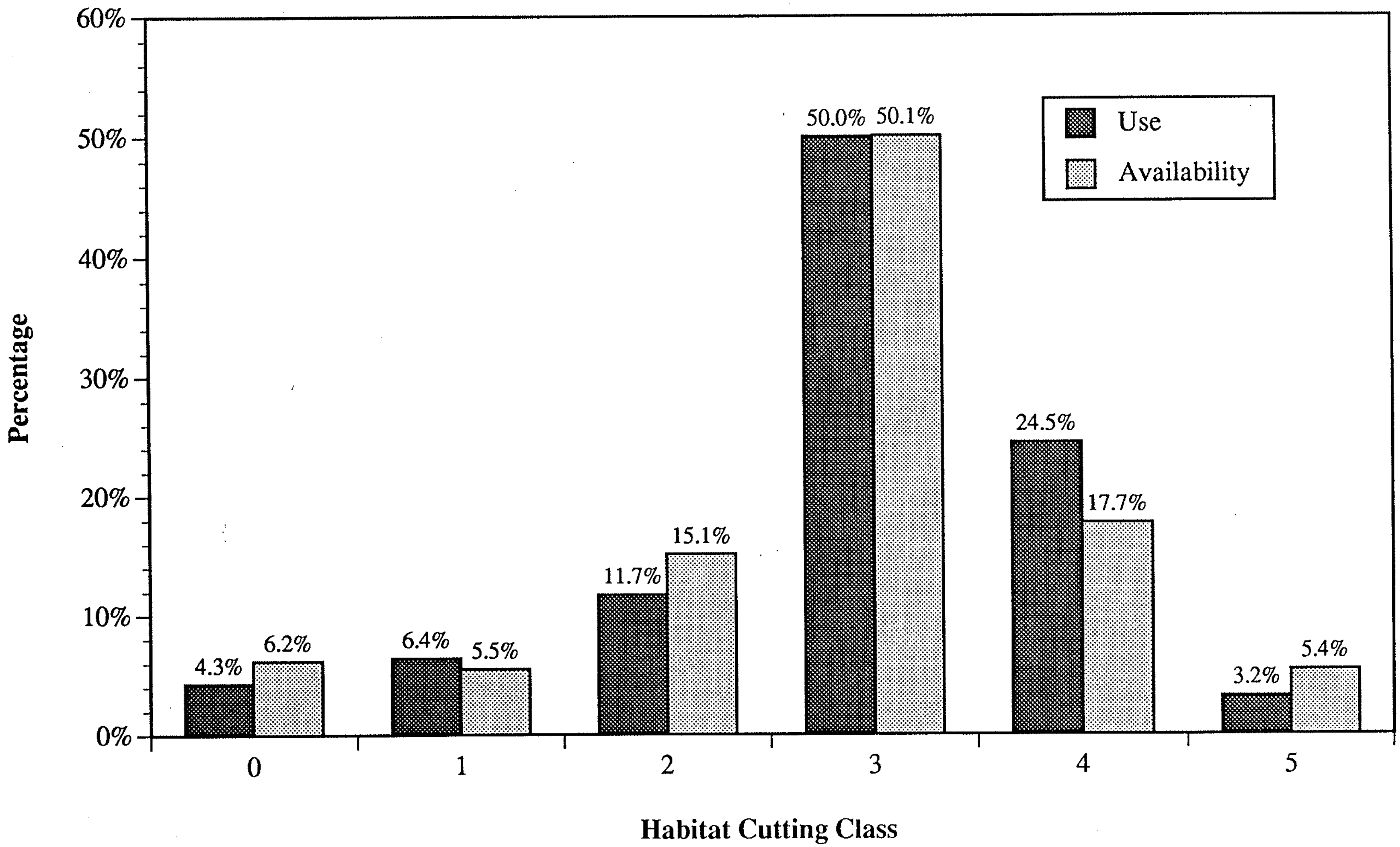

Figure 7: Use of habitat cutting class by radio-marked great gray owls

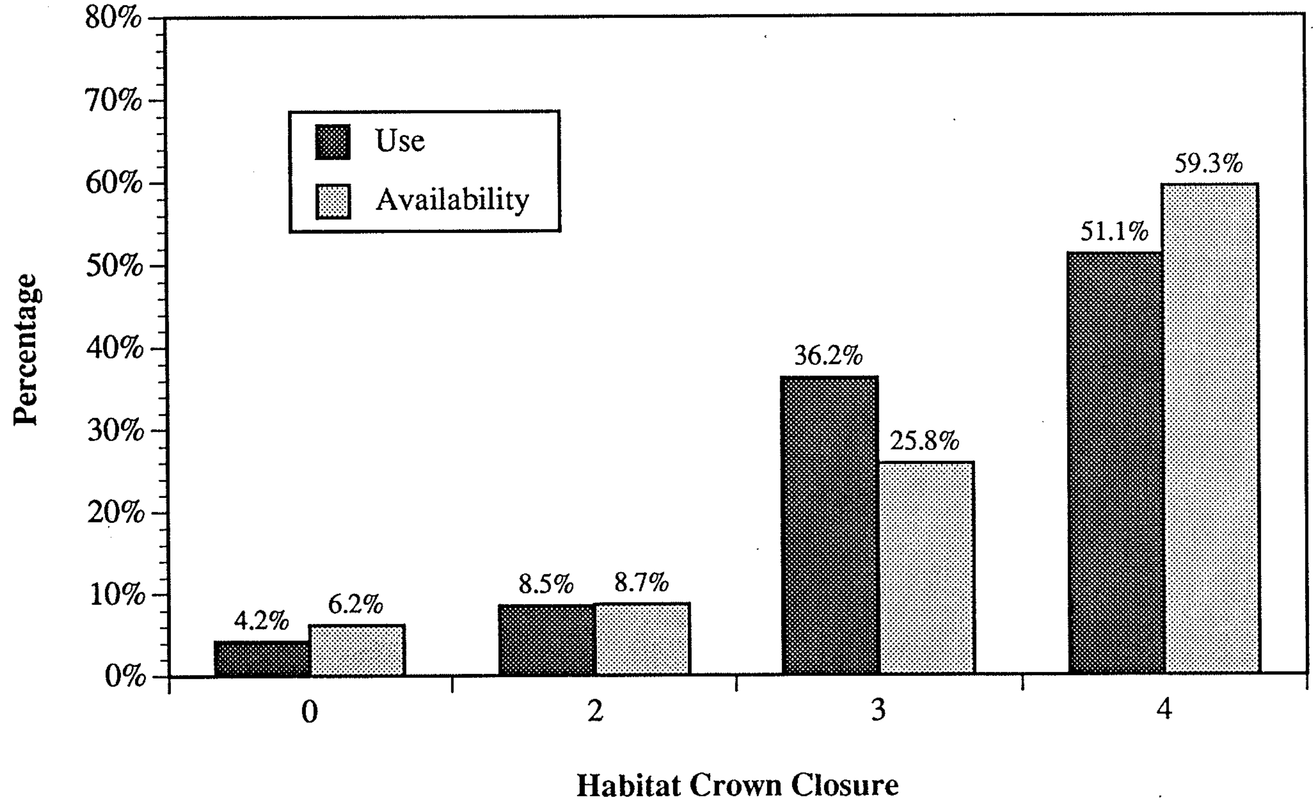

Figure 8: Use of habitat crown closure classes by radio-marked great gray owls

class, cutting class, and crown closure did not differ (x^2=9.80, df=6, 0.50>P>0.10; x^2=0.64, df=2, 0.90>P>0.50; x^2=0.04, df=2, P>0.50). Thus, owls apparently did not alter their habitat preferences with time.

4.2.2 Area Data

Appendix I outlines the average amount of each habitat subtype within the area plots. The area was predominantly Softwoods (48% (151.2 ha)), 9% (28.4 ha) was Mixedwoods, 12% (36.6 ha) was Hardwoods, 17% (52.8 ha) was Nonproductive Forest, 10% (32.2 ha) was Nonforested Land, and 4% (10.7 ha) was cutovers.

The most abundant productive habitat within the area plots was black spruce 71-100% stands (subtype 13) covering on average 14% (44.1 ha) of the study area. This was followed by trembling aspen (subtype 90) at 12% (36.0 ha), black spruce 40-70% (subtype 16) at 10% (30.4 ha), and jack pine 71-100% (subtype 04) at 8% (25.8 ha).

In terms of Nonproductive and Nonforested land, Treed Muskeg (subtype 701,702) covered 12% (36.1 ha) of the area, followed by Willow/Alder habitat (subtype 721, 723, 724) covering an average of 5% (16.0 ha), Marsh Muskeg (subtype 831, 832, 835) at 4% (12.1 ha) and Fields/Meadows (subtype 811, 812, 813, 815, 816, 822, 823) at 4% (11.6 ha) of the area.

Chi-squared analysis revealed a significant difference in the occurrence of habitat within the area plots. Great gray owls were choosing areas with certain major habitat cover types (x^2=37.50, d.f.=4, P<0.01). Figure 9 shows the breakdown of habitat use and availability

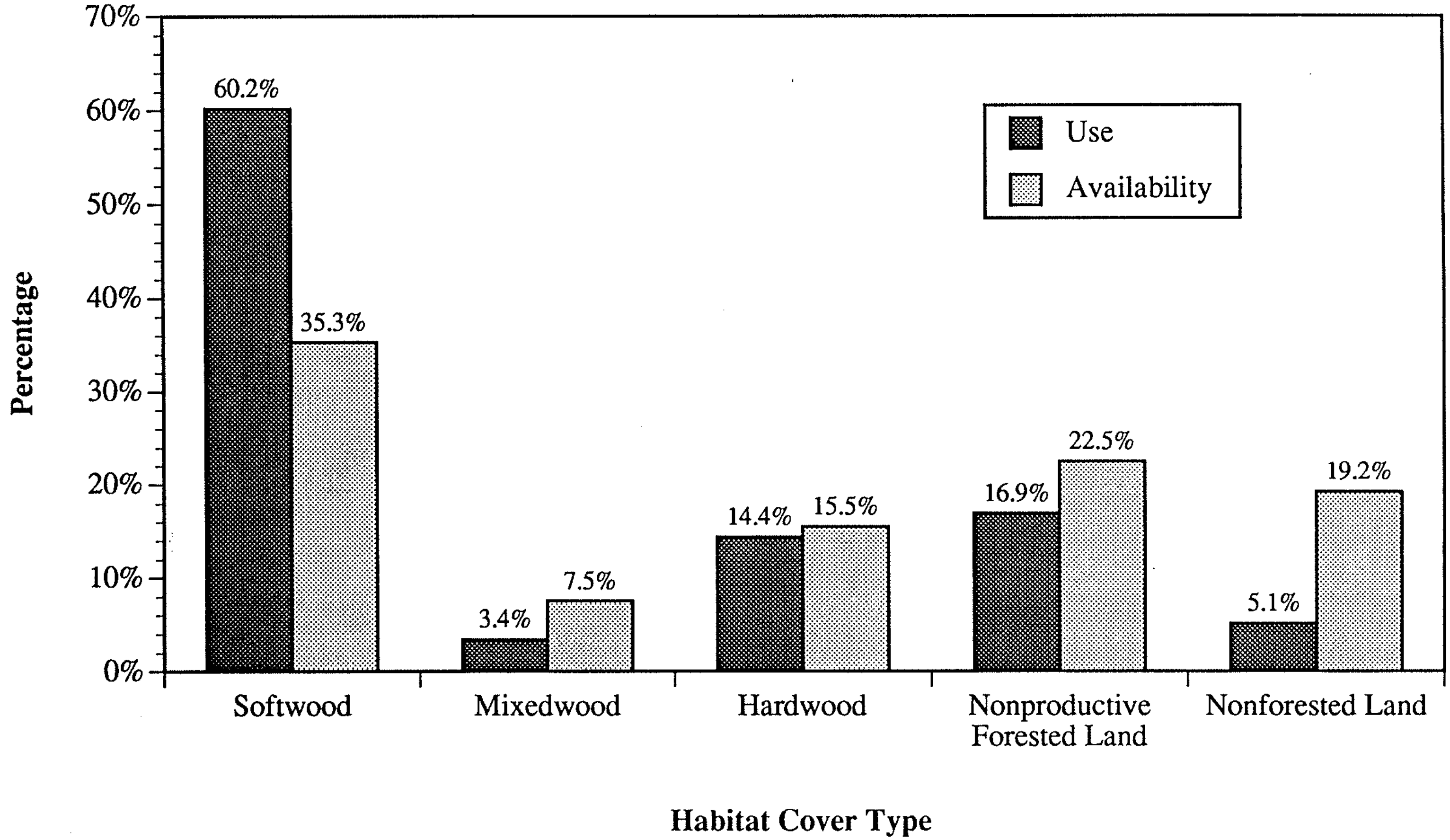

Figure 9: Use of habitat cover type by radio-marked great gray owls in winter area plots compared to habitat availability

within the study area. Bonferroni confidence intervals were calculated to determine which cover types occurred out of proportion to their availability (Table 2). As with the point data, Softwood cover types occurred more frequently and Nonforested Land occurred less frequently as a predominant habitat within the area plots than expected. The remaining cover types did not occur out of proportion to availability. Further analysis of the Softwood subtypes revealed only nonsignificant differences (x^2=13.76, d.f.=7, 0.10>P>0.05), suggesting owls did not choose areas with a specific Softwood type but simply used areas with a greater amount of any Softwoods.

Although statistically great gray owl habitat seems to be defined in general terms as Softwoods, the distribution map of owl winter locations (see Figure 4) shows certain areas of owl concentrations, approximately described as T02 R13, T03 R12, T05 R15, T07 R13, T07/08 R14/15. These areas were further investigated by examining the predominant habitat subtype within each of the area plots which make up the specific concentrations. Black spruce, trembling aspen, tamarack and muskeg were found to be predominant in these areas. In T02 R13, aspen (subtype 90), tamarack (subtype 30), and treed muskeg (701,702) were predominant. In T03 R12, jack pine (subtype 04), black spruce (subtype 13,16), and aspen (subtype 90) were predominant. Treed and open muskeg (701, 702, 831) and black spruce (subtype 13, 16) predominated in T05 R15. All of the plots in T07/08 R14/15 were dominated by black spruce (subtype 13), and in T07 R13, black spruce (subtype 13) and tamarack (subtype 30) were abundant.

Table 2: Occurrence of predominant habitat types within 1 km of great gray owls compared to average occurrence throughout the study area.

Cover Type	Bonferroni Confidence Interval	Expected Use	Conclusions
Softwood	0.4860<p<0.7180	0.3524*	More Frequent
Mixedwood (M+N)	0<p<0.0770	0.0750	No Difference
Hardwood	0.0608<p<0.2272	0.1550	No Difference
Nonproductive Forested Land	0.0802<p<0.2578	0.2249	No Difference
Nonforested Land	0<p<0.1032	0.1927*	Less Frequent

* significant at the 0.05 level.

4.3 SUMMER HABITAT USE

Habitat maps were produced for all of the great gray owl nest sites. Figure 10 shows the distribution of the nests throughout the study area. Two of the 14 nests fell outside the study area, one in T13 R12 and the other in T15 R12. These nests were included in the analysis to increase the sample size and thus allow for a better understanding of great gray owl nest sites. However, sample sizes were not large enough to conduct statistical analyses.

4.3.1 Point Data

Table 3 outlines information on the nest type, nest tree, stand composition, and predominant habitat 1 km around each great gray owl nest. All of the six artificial nests were erected in tamarack trees. Of the natural nests, 4 were in trembling aspen and one each in tamarack, balsam fir, cedar, and elm. With respect to species composition, nests were found in 8 stand types (subtypes 13, 30, 31, 32, 82, 87, 90, 702). All artificial nests were in types 30,31,32 - stands of at least 60% tamarack. Four of the natural nests were found in trembling aspen cover types (82,90), two nests were in black spruce habitat (type 13), one nest was in white birch (type 87), and one nest in treed muskeg (702). Thus, it appears that important nest trees/stands are composed largely of trembling aspen or tamarack.

In terms of site class, cutting class, crown closure, nest sites are distributed fairly evenly among the classes. Distribution among the classes roughly followed the availability of habitat. For example, with

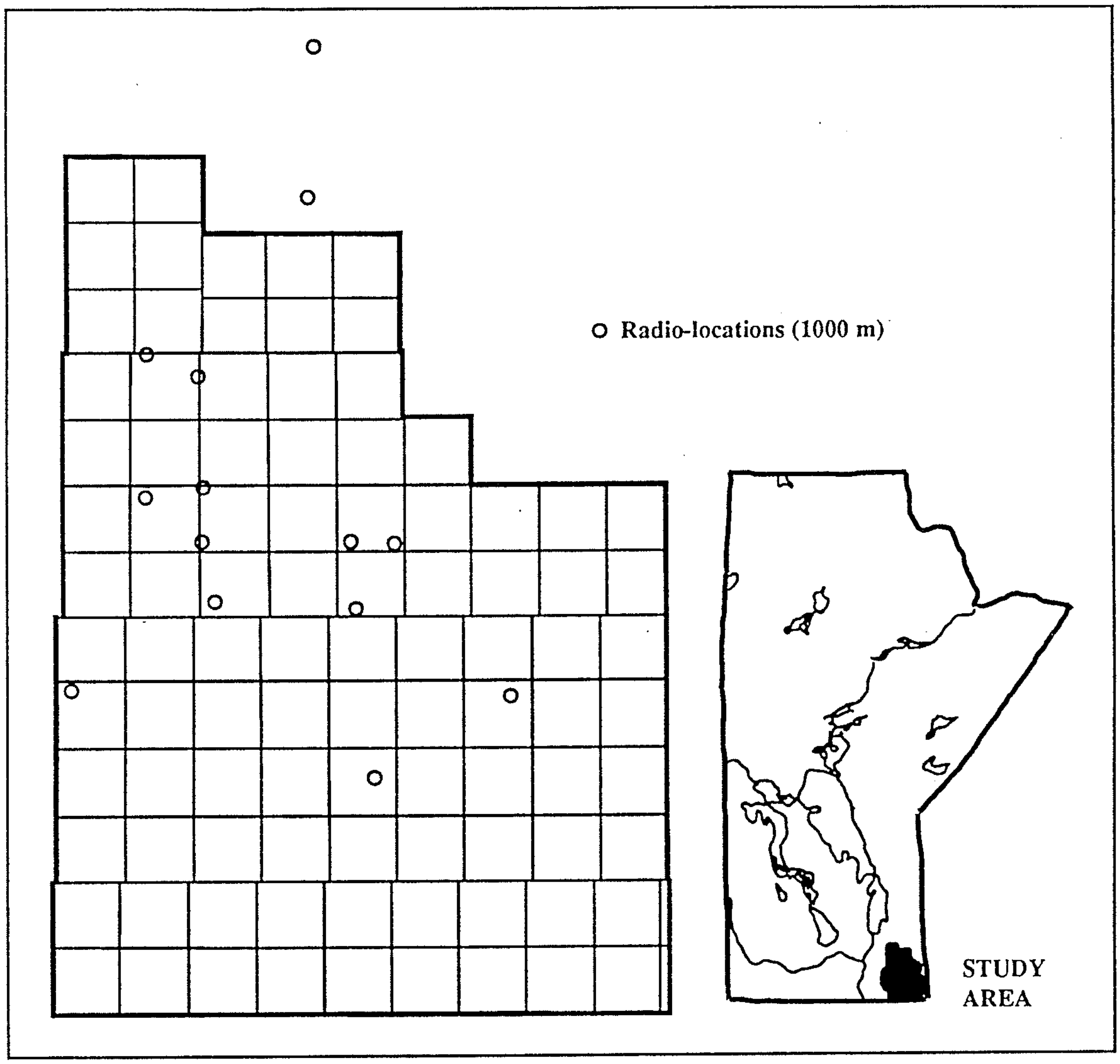

Figure 10: **Distribution of great gray owl nests throughout the study area**

Table 3. Habitat characteristics of great gray owl nest sites in southeastern Manitoba

Nest	Type	Stand Data					Area Data	
		Nest Tree	Subtype	Site Class	Cutting Class	Crown Closure	Predominant Habitat	Nearest Opening
1	Artificial	Tamarack	30 (TL8EC2)	2	4	4	721 (Willow)	1000 m
2	Artificial	Tamarack	30 (TL10)	1	3	4	30 (TL 71-100%)	264 m
3	Artificial	Tamarack	32 (TL6EC3BS1)	2	3	4	90 (TA)	553 m
4	Artificial	Tamarack	30 (TL8BS2)	2	3	4	30 (TL 71-100%)	27 m
5	Artificial	Tamarack	31 (TL6BS4)	2	3	4	31 (TL 40-70% Spruce)	850 m
6	Natural	Aspen	82 (TA6BF4)	1	4	3	90 (TA)	272 m
7	Natural	Tamarack	13 (BS8TL2)	1	0	0 *	13 (BS 71-100%)	—
8	Natural	Balsam Fir	702 (TL Treed Muskeg)	--	--	--	721 (Willow)	0 m
9	Natural	Aspen	90 (TA10)	1	4	2	90 (TA)	37 m
10	Natural	Aspen	82 (TA3BA2WB1TL3BS1)	1	2	4	831 (Muskeg)	108 m
11	Artificial	Tamarack	31 (TL6BS4)	1	4	4	16/31 (BS 40-70% TL)	52 m
12	Natural / Artificial	Cedar	13 (BS8TL2)	2	3	3	702 (TL Treed Muskeg)	18 m
13	Natural	Elm	90 (TA8BA1EC1)	1	5	3	721 (Willow)	38 m
14	Natural	Aspen	87 (WB6EC2BF1BS1)	1	2	4	702 (TL Treed Muskeg)	112 m

* Nest was used before stand was cut.

respect to crown closure, most nests were found in class 4 habitat. However class 4 is the most abundant habitat type (see Figure 8).

4.3.2 Area Data

The species composition of habitat 1 km around great gray owl nests is outlined in Table 4. The predominant habitat types near nests were: black spruce, tamarack, trembling aspen, muskeg, willow, and agricultural fields. There were some differences between the natural and artificial nest locations. Muskeg was predominant at three, and agricultural fields were predominant at two of the natural nests, but at none of the artificial nests. Tamarack habitat types predominated at three of the artificial nests but at none of the natural nests. These differences in habitat reflect the choices of humans in erecting the artificial nests. Both natural and artificial nests had some willow, trembling aspen, and black spruce habitat.

There was also a difference between artificial and natural nests with respect to openings (both natural and man-made) 1 km around nests. Openings were defined as any habitat designated as cutting class 0, treed muskeg (701,702), treed rock (711-713), agricultural fields (811-816), meadow (822,823), or muskeg (831). The amount of open habitat averaged 23.7% for the 14 nests combined (range 0 to 61.4%). However, for the artificial nests, openings averaged only 8.2% (range 0 to 31.7%), while for the natural nests, openings averaged 35.4% (range 7.4% to 61.4%). Distance to the nearest open habitat was also measured. Average distance was 256 m (range = 0 to 1,000 m).

Table 4: Habitat composition (%) at fourteen great gray owl nests

Habitat Component	Nest 1	Nest 2	Nest 3	Nest 4	Nest 5	Nest 6	Nest 7	Nest 8	Nest 9	Nest 10	Nest 11	Nest 12	Nest 13	Nest 14	$\bar{X}$
Jack Pine (04,06,44)	—	9.2	—	11.6	2.1	—	17.3	4.6	—	—	0.1	—	—	—	3.2
Black Spruce (13-17,53,56)	35.2	14.7	—	18.8	32.7	28.0	28.5	14.7	—	0.8	55.0	27.8	14.5	36.1	21.9
Tamarack (30,31,32)	18.5	35.1	23.7	35.5	56.3	—	—	—	—	17.8	32.2	2.4	3.8	—	16.1
Cedar (36,37)	4.9	—	—	—	—	—	—	—	—	—	—	0.1	—	—	0.4
White Spruce (51)	—	—	—	—	—	2.8	—	—	—	—	—	—	—	—	0.2
Trembling Aspen (81,82,90,91)	8.3	—	31.7	10.6	1.3	48.5	19.8	14.0	16.8	20.0	4.8	17.6	13.3	1.7	14.9
White Birch (87)	—	—	—	—	—	—	—	—	—	—	—	—	—	12.0	0.9
Cutting Class 0	—	15.2	0.4	7.7	—	—	13.0	5.5	11.0	—	1.8	—	0.9	1.3	4.0
Treed Muskeg (701,702)	—	—	—	—	2.6	7.4	13.3	8.8	—	14.7	1.9	27.5	4.8	29.4	7.9
Treed Rock (711,713)	—	—	—	—	—	—	—	—	8.2	—	—	—	1.2	—	0.7
Willow (721)	33.1	7.8	28.7	12.5	4.5	0.7	0.9	24.2	7.0	—	1.7	4.2	13.4	—	9.9
Agricultural Fields (811-816)	—	—	—	—	—	—	2.2	—	26.2	—	—	12.5	22.4	—	4.5
Meadow (822,823)	—	16.5	—	—	—	—	1.1	—	—	—	—	0.5	0.9	0.3	1.4
March (835)	—	—	—	—	—	—	—	12.4	—	—	—	—	—	—	0.9
Muskeg (831)	—	—	1.5	0.7	0.5	—	—	4.0	—	46.7	—	—	—	19.0	5.2
Water (900,901)	—	—	11.2	—	—	—	—	9.6	11.5	—	—	0.6	2.5	—	2.5
Other (732,840-849)	—	1.5	2.8	2.6	—	12.6	3.9	2.2	19.3	—	2.5	6.8	22.3	0.2	5.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Natural nests averaged 84 m from nearest opening while artificial nests averaged 350 m.

4.4 AMOUNT AND DISTRIBUTION OF HABITAT

Softwoods generally were important for great gray owls during winter. Approximately 34% (306,456.5 ha) of the study area is currently productive softwood forests. Table 5 shows the trends in the amounts of Softwood, Hardwood and Potentially Productive forest in the study area from 1956 to 1989. The amount of Softwood forest decreased by 10% between 1956 and 1974, and then increased by 7% to 1989. Hardwoods increased approximately 5% from 1956 to 1974 and have since remained fairly constant. Potentially Productive land has decreased steadily since 1956, as more land becomes productive.

Tamarack, aspen and black spruce were common around nesting sites as well as in areas where owls concentrated in winter. Figure 11 shows the distribution of tamarack and Figure 12 shows the distribution of black spruce throughout the study area. Statistics from the Forest Inventory Reports (1956, 1974, 1989b) show that there has been a 77% increase in the area of tamarack habitat (22,360.4 ha to 39,577.8 ha) between 1956 and 1974, and a further 87% increase (42,297.0 ha to 79,045.7 ha) to 1989. Trembling aspen increased 7% (121,127.9 ha to 129,282.5 ha) from 1956 to 1974, but remained constant thereafter (167,014.7 ha to 167,368.9 ha). Black spruce decreased by 12% (106,205.3 ha to 93,543.9 ha) to 1974, and then increased 25% (113,859.5 ha to 142,346.9 ha) to 1989.

Table 5: Trends in habitat (% cover type) between 1956 and 1989 in southeastern Manitoba (based on area)

Cover Type	1956	1974	1974	1989
Softwood	37.16%	27.86%	26.33%	33.68%
Hardwood	13.72%	18.45%	19.47%	19.28%
Potentially Productive	10.09%	6.46%	6.17%	3.49%
Other	39.03%	47.23%	48.03%	43.55%

Softwood - includes cover types S and M, any stands with greater than 50% softwoods

Hardwood - includes cover types N and H, any stands with less than 50% softwoods

Potentially Productive - areas designated as cutting class 0 , land which is capable of producing forest, either softwood or hardwood

Other - all the Nonproductive, Nonforested and Water areas.

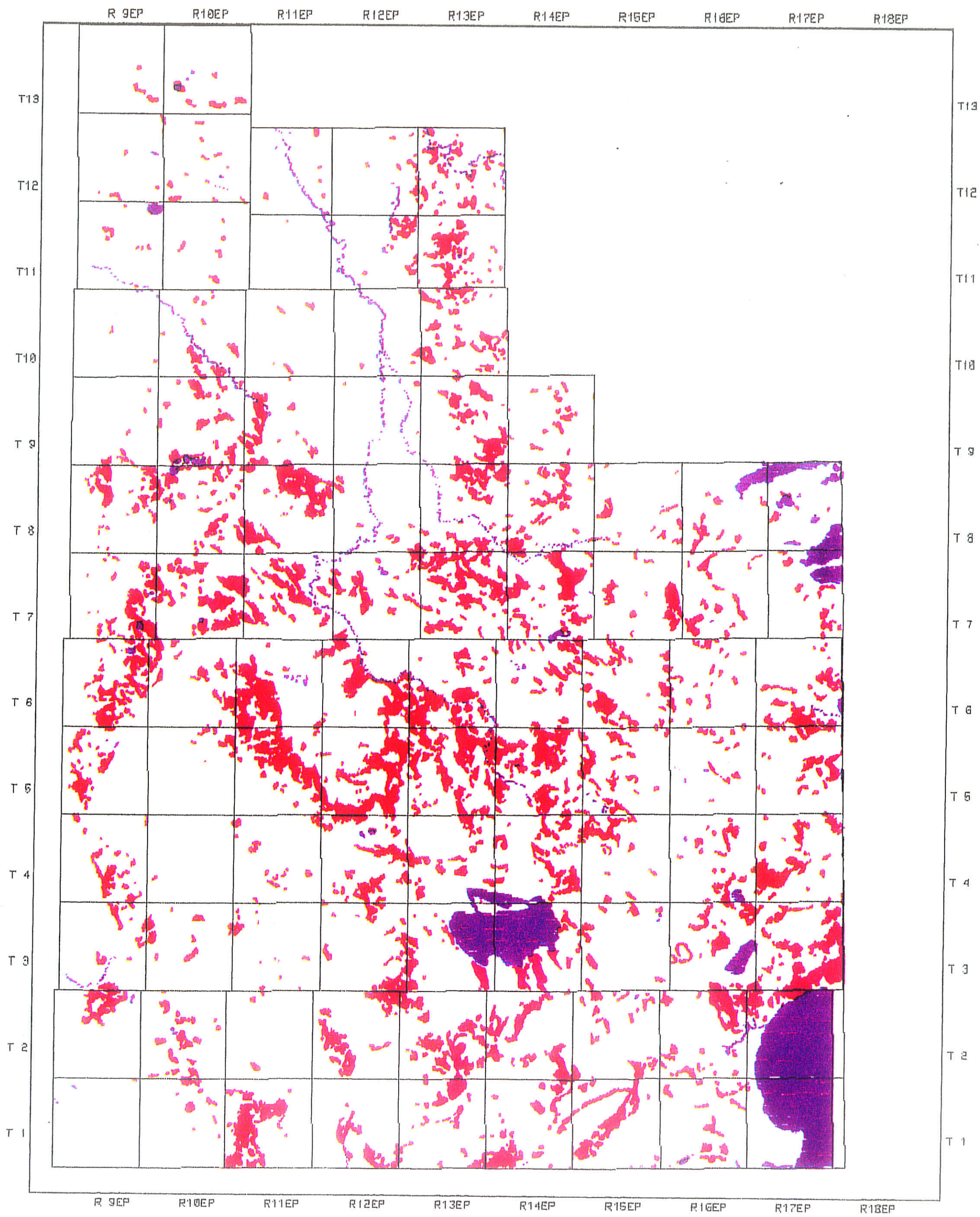

Figure 11: Distribution of tamarack throughout the study area (subtypes 30 - 32)

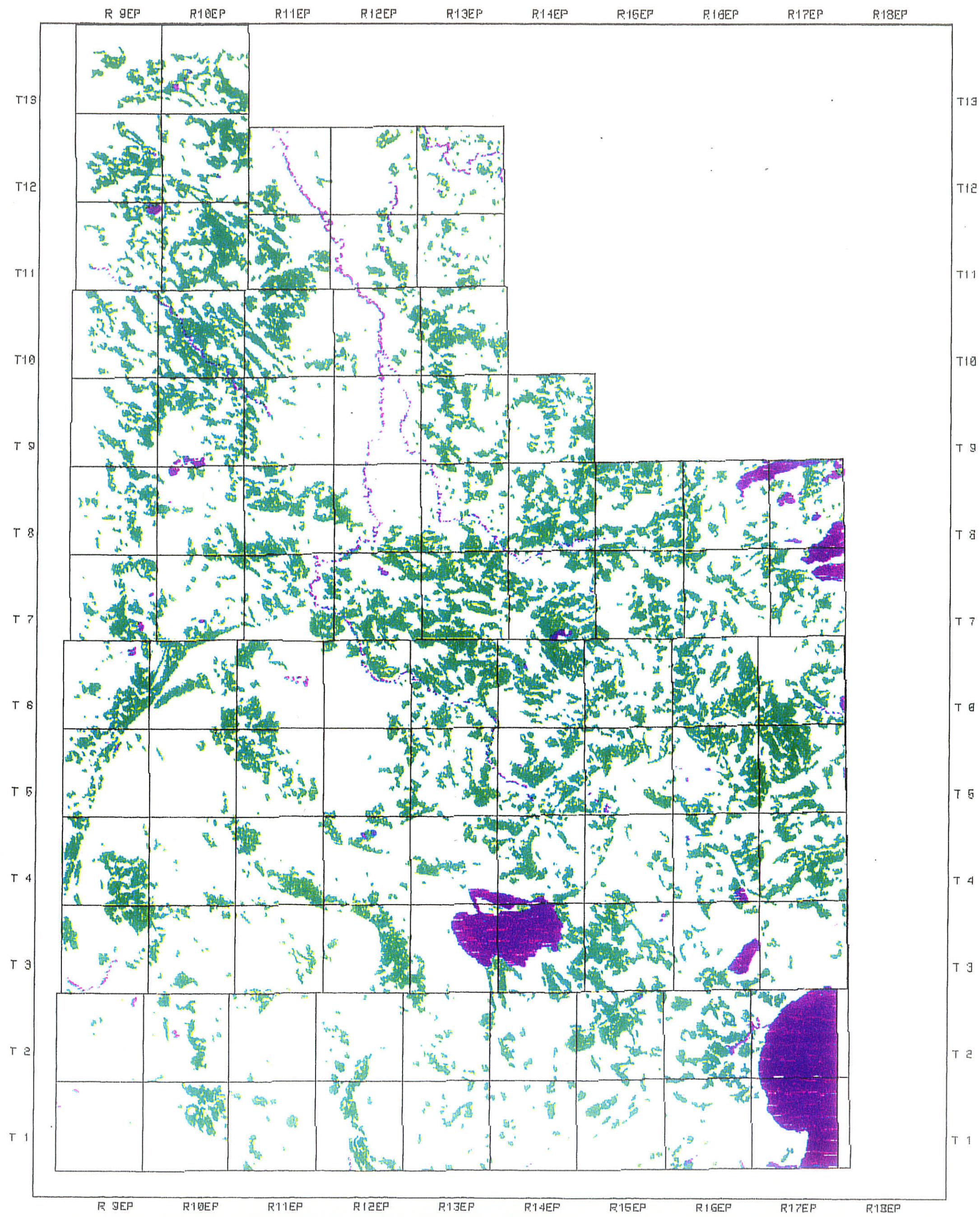

Figure 12: Distribution of black spruce throughout the study area (subtypes 13 - 17)

The fact that tamarack increased in extent by 164% between 1956 and 1989 while the total area of Softwoods decreased slightly over the same period is likely the result of two factors: changes in inventory methods and recovery from larch sawfly infestations. Past forest inventories were less precise about the amount and distribution of commercially less important species (G. Peterson pers. comm.). Better technology and more emphasis on the value of all forest components has promoted more accurate inventories in recent times (G. Peterson pers. comm.). However, the most significant factor in the increase in tamarack may be explained by a serious larch sawfly (Pristiphora erichsonii (Hartig)) infestation which nearly eradicated tamarack from northwestern Ontario and Manitoba in the late 1940's and early 1950's. Since the end of this epidemic in the mid 1950's, tamarack has shown dramatic increases (R. Lamont pers. comm.).

Chapter V
DISCUSSION

5.1 WINTER HABITAT USE

In Manitoba, Nero (1969) describes great gray owl habitat as open fields and sparsely wooded tracts of jack pine, tamarack, and aspen, seldom far from dense spruce forests. Bogs, wet meadows, abandoned and active farm lands provide openings adjacent to and within the forest for hunting areas (Nero 1969). In Saskatchewan, Law (1960) observed owls near "dense bluffs of spruce, poplar, pine and tamarack with many open meadows". Harris (1984) noted that during the nonbreeding season, great gray owls are found in a variety of forest communities from aspen to pine forest and that there is a slight preference towards forests with a mixed deciduous-coniferous (aspen-spruce) component. Godfrey (1967) observed an approximate 10:1 ratio in favor of open habitats for great gray owls in Ontario in winter - sparse wood edges bordering open fields or weedy fields with posts, scattered trees or low bushes. The attraction to these areas was presumably the presence of the meadow mouse, Microtus pennsylvanicus (Godfrey 1967). Similarly, Brunton and Pittaway (1969, 1971) found that the areas most frequently occupied by great gray owls were open fields with scattered large elms (Ulmus americana), patches of shrubbery, weedy areas and overgrown fence rows; typical of poor quality, abandoned farmlands. These fields generally border extensive mixed or coniferous forests (Brunton and Pittaway 1969, 1971). Great gray owls were seldom seen in forested areas, and they did not occupy heavily grazed or cultivated land, probably because of the unsuitability of this habitat for owl prey (Brunton and Pittaway 1971).

These descriptions of winter owl habitat may tend to overemphasize the openness of the landscape. Owls are much more conspicuous in open areas than in forests, and thus are more likely to be observed. Godfreys (1967) observations of a 10:1 ratio in favor of open habitats were of owls outside their normal range and under adverse conditions. None of the above studies used radio-marked owls for evaluation of habitat use. In the present study, however, owls were radio-marked and identification of habitat did not depend on owl visibility. Under these circumstances, results suggested that areas in which owls were found were predominantly Softwood forests, although there was a significant amount of open habitat (44% classified Nonproductive, Nonforested, or cutting class 0).

In terms of winter habitat use, great gray owls were choosing Softwoods more than expected and Nonproductive and Nonforested land less than expected. Owls were not choosing a particular Softwood type but were simply choosing Softwoods of any type. Likewise, owls were not avoiding a specific Nonproductive/Nonforested type but were avoiding all types equally. While it seems valid to assume owls were selecting Softwoods, it does not seem valid to assume owls actually avoided Nonproductive and Nonforested land. Owls were found to use Muskeg, Meadows, and Agricultural Fields, while Willow/Alder, Treed and Barren Rock were not used. Use of these habitat types is likely related to their suitability as hunting areas. Owls appeared to be using these areas less than expected because there is a large amount of

Nonproductive/Nonforested habitat: 41% (363,130.6 ha.) of the study area. While this habitat is likely important for hunting, or at least as a source of prey for nearby forested areas, it does not appear to be a limiting factor in great gray owl habitat requirements.

5.2 OTHER HABITAT FACTORS

The results of this study were not specific with respect to defining species composition of habitat used by great gray owls in winter. This suggests that there may be factors other than or in addition to species composition that are more important in determining habitat use. Snow depth increases the barrier between the owl and the prey species at the snow-soil interface. Several authors have suggested that when snow depth increases such that prey become unavailable, owls presumably must move to other areas or habitats where snow is shallower and prey is more accessible (Nero 1969, Collins 1980, Duncan 1987, Franklin 1987, Bull et al. 1988a). Bull et al. (1988a) found that over 80% of adult great gray owls were located where snow depths were less than 40 cm, some moving to areas with a mean snow depth of 24 cm. No birds wintered where snow depth was 70-100 cm except one female which was located for two winters in an area with more than 150 cm of snow. Collins (1980:82) found the mean depth of plunge-holes to be 20-22 cm, depending on conditions, while Nero (1980:90) discovered holes as deep as 46 cm. Thus, in Bull's study, owls moved to areas with snow thickness such that prey were within reach. The fact that one bird wintered in an area where prey beneath the snow were probably not accessible led Bull and Henjum (1989) to suggest that this bird preyed on squirrels, hares, and birds, species that are not normally part of the great gray owl's diet.

Franklin (1987) found that the mean elevation of winter sightings to be significantly lower than the mean elevation of active nests or young. Snow depths were shallower at lower elevation, indicating that owls may have moved to lower elevations because of deeper snow at higher elevations. (see Winter 1980). Laymon (1985) also documented elevational migrations during the winter by spotted owls (S. occidentalis) in the same mountain range.

Winter habitat use by owls may be dictated by small mammal abundance which fluctuates cyclically (Mikkola 1983, Loch 1985, Nero 1988). Voles, lemmings, mice (Cricetidae) and shrews are the primary prey species for great gray owls (Godfrey 1967, Collins 1980, Mikkola 1983). Populations of these small mammal species tend to fluctuate on an approximate three to four year cycle (Krebs et al. 1973). When prey species are abundant, owls may overwinter on the breeding grounds, but when prey decline, owls likely move to other areas (Mikkola 1981). The choice of new area would be dependent on prey abundance and accessibility, rather than habitat type per se.

Neither snow depth nor prey abundance were measured in this study. However, Franklin (1987:61), in Idaho and Wyoming, concluded that owls moved in response to snow depth and prey availability rather than prey abundance. He found that great gray owls preyed predominantly on pocket gophers (Thomomys spp.), populations that are not known to fluctuate cyclically (Teiper et al. 1983).

5.3 WINTER TERRITORIES

Some authors have suggested that owls establish feeding territories in winter. Godfrey (1967) noted that individual great gray owls established winter territories and could usually be located there day after day. Similarly, Brunton and Pittaway (1971) suggested that owls establish definite home ranges and seldom stray beyond their boundaries. Great gray owls have also been observed using the same wintering areas in certain years. Of eight adults followed two or more winters, Bull et al. (1988a) found that six returned to the same area or even the same stand in more than one winter. Nero et al. (1984) observed a tendency for owls to appear in winter in favored areas in successive years. In one instance, three different birds were banded on consecutive weekends in almost the same group of trees. "Different birds used the habitat in the same way as previous occupants, suggesting that they are attracted not only by small mammals, but also by landscape features, particular configurations of woods and fields" (Nero et al. 1984:134).

The results of this study suggest that there may be some preferred areas for great gray owls in winter in southeastern Manitoba (T02 R13, T03 R12, T05 R15, T07 R13, T07/08 R14/15). Because the identities of the birds were not recorded for the purpose of this study, it was not determined whether these concentrations were territories of individuals or areas favored by more than one owl. If, as Bull et al. (1988a) and Nero et al. (1984) suggest, owls may use the same wintering areas year after year, these concentrations may indicate favored wintering areas for owls in southeastern Manitoba. Mapping owl locations in future winters would help to determine if these areas are favored in winter and thus enhance management of winter habitat for great gray owls.

There are trends in species composition of habitat found in the areas of owl concentrations. Black spruce, aspen, tamarack, and muskeg are the predominant habitat types found in each of these areas. In addition to these species, many of the stands in the areas of owl concentration were fairly homogeneous. Tamarack (subtype 30), jack pine (subtype 04), and black spruce (subtype 13) stands composed of 71 to 100% of the respective species are predominant habitat types where winter owl concentrations are found.

5.4 SUMMER HABITAT USE

Habitat at fourteen great gray owl nests was examined. The six artificial nests were all situated in tamaracks. Of the eight natural nests, four were in aspen and one each in tamarack, balsam fir, eastern cedar, and American elm. The artificial nests were specifically placed in tamaracks. Clearly, natural nests appear in a wider variety of tree species. Great gray owl nests in other areas have been found in a number of tree species, including balsam poplar (Oeming 1955, Kondla 1973), birch (Eckert 1979), American elm (Houston 1984), black spruce (Oeming 1955), trembling aspen (Oeming 1955, Parmalee 1968, James 1977, Nero 1980:126, Houston 1984), and tamarack (Oeming 1955, Follen 1979, Nero 1980:124).

Because great grays do not build their own nests, the tree species in which the nest is located reflects the choice of the nest builder. Nests may vary considerably in height, shape, durability and habitat. Bull et al. (1987) found that owls sometimes preferred more durable wooden platforms when natural nest sites were available nearby, presumably because of greater stability. Given a choice, owls also preferred higher nests, but used lower ones if nothing else was available. Large diameter trees seem to be important for nesting great gray owls. Bull et al. (1988b) found the majority of stick nests in large diameter (>50 cm dbh), live western larch (Larix occidentalis) and the majority of stump nests were in large diameter ponderosa pine (Pinus ponderosa) (at least 7 m tall). Large diameter (and thus older) trees are better able to support nests and allow them to be higher up.

In this study the predominant habitats 1 km around great gray owl nests tended to consist of stands of black spruce, tamarack, trembling aspen, muskeg, willow and agricultural fields. Other authors have made similar suggestions. In Alberta, Oeming (1955:45) found nests located most frequently in large white and black poplar stands near sizeable muskeg tracts. Tamarack-black spruce wetlands were associated with 25 of 27 suspected breeding locales in Saskatchewan (Harris 1984). Tamarack and black spruce dominated at seven of nine nests examined by Collins (1980:19), which lead him to conclude that these species are of greater significance and aspen forests are of lesser significance to gray owl breeding in southeastern Manitoba. Loch (1985:1) stated that "mature stands of tamarack and tamarack-black spruce, especially when adjacent to or interspersed with semi-open grassy communities, afford excellent breeding habitat". Commenting on the use of artificial nests, Nero (1980:145) found that although some upland aspen sites have attracted owls, the majority of nests used have been in spruce-tamarack or tamarack bogs, often over water.

Servos (1986) concluded that great gray owls preferred summer habitat is pure tamarack bogs, but also used old burns, treed muskeg, and areas of 90% tamarack - 10% black spruce. Owls did not use areas of 90% black spruce - 10% tamarack, marsh-muskeg, or willow-alder habitat.

The predominance of tamarack, trembling aspen and muskeg near great gray owl nests seems to be common to both this study as well as studies by Collins(1980), Loch (1985) and Servos (1986) within the region. Servos (1986) suggested that within her 19.4 km^2 study area, areas of tamarack were preferred because they provide sufficient concealment for young, supported their preferred prey species, and were generally free of a dense shrub layer that allowed them to locate and capture prey easily. Muskeg, especially with scattered trees for perches, provided suitable hunting areas (Oeming 1955, Nero 1980, Servos 1986) because they supported the preferred prey species as well as allowing unhindered access to the ground for prey.

Although black spruce was the predominant habitat type at many of the owl nests on the study area, Servos (1986) found owls avoiding areas with greater than 60% black spruce, possibly because of low numbers of meadow voles found in this habitat type. Similarly, willow habitat covered at least 24% of the area at three nests, although Servos (1986) suggested these areas were avoided due to the dense shrub layer, which possibly hindered access to prey. Agricultural fields covered at least 22% of the area at two nests despite the fact that Oeming (1955:45) found nests well removed from agricultural activities. Servos (1986:50) suggested that those habitats that are not used or seldom used by great gray owls (and which in the present study were found to be abundant near some nests) should not be dismissed as unimportant because they may act as a source of prey during certain years.

Although habitat type is one factor governing nest site selection, there may be a number of other factors influencing choice of a nest. Mikkola (1973) observed that the suitability of the nesting site seems to be more important than the biotype. Nest-site fidelity (Collins 1980, Nero 1980:63, Franklin 1987, Bull and Henjum 1989), availability of prey (Collins 1980:30, Mikkola 1983, Janes 1985, Duncan 1987, Bull et al. 1988b), adequate nest structures (Collins 1980, Nero 1980:110, Nero et al. 1984, Bull et al. 1988b), unimpeded hunting areas and cover and concealment for young (Servos 1986) may all influence the final selection of a site.

5.5 HABITAT STATUS

Results of the habitat analysis suggest that great gray owls are general in their choice of habitat in winter, choosing softwood areas out of proportion to availability. Currently, over 300,000 ha, or one third, of the study area is classified as softwoods. Between 1956 and 1974, the amount of softwoods decreased by 10%. If this trend had continued, great gray owl habitat in southeastern Manitoba would have been at serious risk. However, between 1974 and 1989, softwood habitat increased by 7%, resulting in an approximate return to the amount of habitat present 33 years ago.

An equally important factor as the presence of sufficient winter habitat is the maintenance of adequate breeding habitat. Results of this study and others suggest that tamarack, black spruce and aspen are the predominant species near nests, with tamarack and aspen trees often supporting nest sites. Aspen covers 19% (167,000 ha) and tamarack 9% (79,000 ha) of the study area. Furthermore, these species are not declining in abundance and, in fact, tamarack has significantly increased since 1956. However, quality as well as quantity must be considered. Although there seems to be significant amounts of tamarack and aspen, age/size proximity of hunting areas (muskeg, meadows, burns, clearcuts, etc), existing stick nests, or deformed trees which may act as nest sites in future also contribute to the quality of the habitat. Old-growth stands are more likely to contain stick-nests or trees suitable for them. Only 11% (9,028.5 ha) of the tamarack within the study area is designated as mature or overmature (cutting class 4 or 5), the rest being new growth or immature stands (cutting class 0-3). Forty-three percent (61,052.9 ha) of aspen is classified as cutting class 4 or 5, with the remainder being young or immature. It is these areas with mature timber that will be harvested first.

The proposed annual allowable cut for the tamarack in the years 1985/86 and 1986/87 under the 20-year forest management plan was 7,074 m^3/year (MDNR 1989b). This value translates into 147 ha/year, assuming an average productivity for tamarack 48.2 m^3/ha. Given an area of 9,000 ha of mature or overmature tamarack, the annual allowable cut represents only 1.6% of the area. Similarly, the AAC for trembling aspen is equivalent to 3,004 ha/year, assuming an average productivity of 32.76 m^3/ha. Given an area of 61,000 ha of mature aspen, the AAC represents 5% of the total. In each of the years 1985/86 and 1986/87, both tamarack and aspen were undercut by as much as 18% and 12%, respectively.

5.6 FOREST MANAGEMENT IMPACTS

There is little literature on the effects of forest management activities on great gray owls or their habitat. In winter, Bull et al. (1988a) twice observed owls adjacent to active logging activities. As logging operations moved to new stands, the birds followed. They speculated that tree falling and soil disturbance displaced many small mammals, which enhanced their accessibility to the birds.

All forests in which great gray owls were located by Bryan and Forsman (1987) were mature stands characterized by relatively large overstory trees. Winter (1986) noted that "it seems more than an ecological coincidence that a substantial portion of the population of great gray owls in California are thriving in Yosemite, an area in which nearly completely virgin stands of timber surround their hunting and nesting grounds". A long-term study of the spotted owl, a relative of the great gray, found that most pairs (97.6%) of owls were found in unlogged old-growth forests or in mixed forests of old-growth and mature timber (Forsman et al. 1984). Individuals tended to occupy the same areas year after year and the principal cause of site abandonment was timber harvest. Most nests were located in old-growth forests with canopy closure in excess of 70% (Forsman et al. 1984).

Bull et al. (1988b) found that of 46 great gray owl nests, 41% occurred in overmature and 33% in remnant stands. Remnant stands were stands with a few large trees (1-3 trees/ha ≥ 50 cm dbh) with the remainder being subclimax (< 30 cm dbh). Sixty-three percent of the nests in Bull's study were in stands with greater than 60% canopy closure. Large diameter (>50 cm dbh) live western larch were where the majority of stick nests were located. Seventy-two percent of nests occurred in unlogged stands, 19% in selectively cut stands, and 9% adjacent to clearcuts. Owls favored unlogged stands because 60 to 80% of the stands in each study area had been logged within the previous 15 years. Owls either preferred unlogged stands or there was a disproportionate number of potential nest sites in these stands. Logging activities often remove large-diameter living and dead trees that could support nests.

Selectively logged areas may be acceptable for owls in some circumstances. Forty-four of 63 owl nest sites examined by Bryan and Forsman (1987) had been selectively logged or cut for firewood within the previous 20 years. Bull et al. (1988b) found selectively logged stands were favored by foraging males. Partially logged stands that created forests with 11-59% canopy closure, were preferred over clearings and dense over-mature forest for hunting. Vegetative cover and downed woody material within the stands seemed to be common factors at the majority of prey capture locations, suggesting that the downed wood provided cover for small mammals. In southeastern

Manitoba, almost all mature aspen forests have had softwoods and large hardwoods high-graded out (G. Peterson, pers. comm.). Thus, given the importance of aspen as nest trees, great gray owls are nesting in selectively logged forests in many instances.

Openings within the forest are important for owls as foraging areas. In this study, openings ranged from 0 to 61.4% within 1 km to nests. Natural nests had significantly more openings (x=35.4%, range 7.4% to 61.4%) than did artificial nests (x=8.2%, range 0 to 31.7%). Thus, artificial nests were being established in areas with a much greater percentage of forest than the natural sites chosen by other raptors. Winter (1986) reported that great gray owls foraged primarily in or along meadow edges. Franklin (1987) found them foraging in clearcuts. Bull et al. (1988b) found that the total area in openings around nests, natural and clearcut combined, ranged from 18 to 26%. Franklin (1987) found the total meadow/clearcut ranged from 17 to 46% around nests.

Selection of a nest site may depend on its proximity to suitable hunting areas (Collins 1980). This study found that the average distance from a great gray owl nest to openings (either clearcuts, muskeg, fields or meadows) was 256 m. Nero (1980) found that owls may find sufficient food within 800 m of the nest while Bull et al. (1988b) observed owls moving as much as 3.2 km from the nest. Bryan and Forsman (1987) found that the average distance between meadow and nest was 275 m. Similarly, Winter (1986) reported all nests were within 260 m of a meadow. In Finland, Mikkola (1983) observed that 44 nests averaged 142 m from clearcuts, the farthest of which was 500

m. The mean distance from nests to clearcuts in Franklin's (1987) study was 143 m. Owls do not appear to be averse to nesting near clearcuts or open areas. However, Bull et al. (1988b) demonstrated that given a choice, owls preferred to nest 100 to 200 m away from a clearcut rather than adjacent to one.

Investigating changes in small mammal species composition and abundance, Martell and Radvanyi (1977) found the most noticeable change after clearcutting was in the composition rather than density of small mammals. Clearcutting of upland black spruce resulted in sites that were less desirable than uncut sites for red-backed voles (Clethrionomys gapperi), rock voles (Microtus chrotorrhinus), and bog lemmings (Synaptomys cooperi), while the opposite was true for deer mice (Peromyscus maniculatus), meadow voles (M pennsylvanicus), heather voles (Phenacomys intermedius) and least chipmunks (Eutamias minimus). Decreases in the number of red-backed voles after clearcutting have been noted by others in Douglas-fir forests (Gashwiler 1959, 1970, Tevis 1956) and in jack pine forests (Sims and Buckner 1973). Red-backed voles may remain rare or absent on clearcuts for 4-10 years after harvest (Gashwiler 1970, Krefting and Ahlgren 1974), but become common sooner if thick ground cover becomes established (Ahlgren 1966, Lovejoy 1975, in Martell and Radvanyi 1977). Deer mice exploit the relatively barren habitat of clearcuts and increase from remaining stocks. Meadow voles were trapped only on clearcuts at least 1 year old. Martell and Radvanyi (1977) suggest that voles return once sufficient moist, graminoid vegetation is established and in densities proportional to the amount present. Selective cuts seemed to benefit small mammals most, resulting in greater overall abundance than in mature forest or on clearcuts (Martell and Radvanyi 1977).

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

Winter great gray owl habitat in southeastern Manitoba can be defined as softwood forests. Great gray owls do not choose a specific softwood habitat type, site class, cutting class, or crown closure type but use habitat in proportion to its availability. Owl sightings were concentrated in certain areas dominated by black spruce, aspen, tamarack, and muskeg. Snow thickness and prey abundance may be more important in habitat choice in winter than habitat characteristics.

During summer, tamarack, aspen and black spruce seem to be preferred breeding areas, with tamarack and aspen often serving as nest trees. Natural nests had a greater amount of open habitat and were closer to open habitat than artificial nests. In summer, prey abundance and adequate nest sites may also influence habitat selection.

Examinations of habitat trends show that at one time there was a decline in the amount of softwood habitat in southeastern Manitoba. This trend has been reversed with a return to amounts of habitat present in the 1950's. Tamarack has increased dramatically since 1956, due to modified and improved inventory methods and, most importantly, recovery from severe larch sawfly infestations. Aspen and black spruce abundance has remained fairly constant. However, habitat quality must be considered as well as quantity.

It appears from the literature that unlogged mature or overmature forests are a common factor around many great gray owl nest sites .

Selectively logged stands in which the openness of the understory allows relatively unimpeded flight, and ground cover supports a greater abundance of small mammals than mature forest or clearcuts, may act as suitable hunting areas for owls. Clearcuts may also not be detrimental to gray owls provided the nest site is left uncut and downed woody material and herbaceous ground cover are re-established as soon as possible to provide habitat for small mammals.

6.1 RESEARCH

This section suggests future research which would provide information useful in managing great gray owl habitat. A cooperative effort should be initiated between the Forestry and Wildlife Branches of the Manitoba Department of Natural Resources in order to achieve research objectives that would contribute to better management of the ecosystem, both forest and wildlife.

1. More radio-fixes of winter great gray owl locations should be mapped throughout southeastern Manitoba (FMU 20) to determine areas or townships that may be important or favored wintering areas for great gray owls. Once identified, prey abundance, snow thickness and habitat studies could be undertaken to determine why these areas attract owls.

2. Mapping of additional great gray owl nests should be undertaken in order to evaluate the distribution and density of great gray owl nesting areas. Favored areas could be surveyed to determine the number of actual nests and/or potential (deformed trees) nest sites per hectare. A study could be undertaken to determine the

habitat characteristics of nest sites that have never been used as compared to nests that have been used. Nesting success would be a factor in such a study.

3. Studies should be conducted on species of raptors on which great gray owls depend for nest sites. Trends in population levels and preferred habitat of red-tailed hawks, broad-winged hawks, northern goshawks, northern ravens, and other stick-nest builders should be assessed in order to forecast the future for great gray owls in southeastern Manitoba.

4. Studies on the effect of clearcutting, selective cutting, burning, and regeneration activities, should be initiated to determine effects on great gray owls and the small mammal species on which they prey. Such studies could help to determine the size and shape of clearcuts that are beneficial or detrimental to great gray owls.

5. The effect of peat extraction and burning on great gray owl habitat in southeastern Manitoba should be examined to determine possible impacts on breeding habitat.

6.2 MANAGEMENT

Although trends seem to indicate that great gray owl habitat is not declining in abundance, habitat quality as well as quantity must be maintained. The following recommendations are made to preserve or enhance the quality of great gray owl habitat in southeastern Manitoba while maintaining habitat for other species as well. Accomplishing these recommendations will require the cooperation of foresters, loggers, and other land-users. Promoting the importance of the ecosystem, and the relationship between great gray owls, their habitat, and other species will play an important role in managing owls and habitat in the future.

Nero (1979) suggested that winter concentration areas need not receive the same kind of protection as nesting areas. Unless future studies reveal more specific winter habitat preferences than were demonstrated in this study, there would seem to be sufficient softwood forest habitat to accommodate adequate numbers of great gray owls without specific winter habitat management.

Management recommendations are made for nesting habitat. Priority in habitat management for great gray owls should focus on mature or overmature tamarack and aspen stands, as these are the areas most likely to contain great gray owl nest sites.

1. Any nests known to have been used repeatedly (e.g. three times in 10 years) should be mapped and protected from habitat alterations (agriculture, peat extraction, forestry activities) within 300 m of the nest site until such time as the nest degenerates or is no longer used. If feasible, nests could be repaired if they degenerate; however, feasibility would depend on available time and finances. In all habitats, active nests should be protected from disturbance of any kind until after the young have left the nest.

2. In selectively cut stands, large diameter (35 cm d.b.h.) or deformed trees, or trees with raptor stick-nests, should be left uncut in order to serve as nest sites in the future. This may be particularly important in tamarack or aspen stands with a fairly thick crown closure (class 4) which protects and shades the nest.

3. Selective cutting may be suitable in areas adjacent to nest stands, serving as foraging areas for owls. Selective cuts open up the understory to permit easy flight maneuverability, allow greater amounts of ground vegetation, and thus small mammals, than in mature forests.

4. Clearcuts may be acceptable within great gray owl breeding habitat provided that they do not approach closer than 300 m to the nest site. Clearcuts should not encircle a nest so as to isolate it, but only approach the nest from any one direction. Dead and downed woody material should be left as cover for small mammals. Ground disturbance should be minimized such that vegetative cover is established as quickly as possible.

5. Snags must be left in clearcuts to serve as hunting perches. Snags may be live or dead trees and must have horizontal branches for perching. Any trees which pose a safety hazard should be removed. 25 snags/hectare may be used as a guideline until such time as further study reveals otherwise.

6. Aspen and tamarack within the study area should be mapped with respect to cutting class and all potential breeding areas identified.

Areas should be surveyed for nest structures and breeding great gray owls. The minimal amount of suitable habitat required to maintain populations should be estimated.

7. Develop an educational package to inform foresters, loggers, and other land users (both recreational and resource-based) on great gray owl habitat requirements and the importance of the ecosystem. Such a package could also be used to solicit specific information on owl locations or nest sites.

8. These recommendations should be considered for inclusion in the Manitoba "Wildlife guidelines for forest management".

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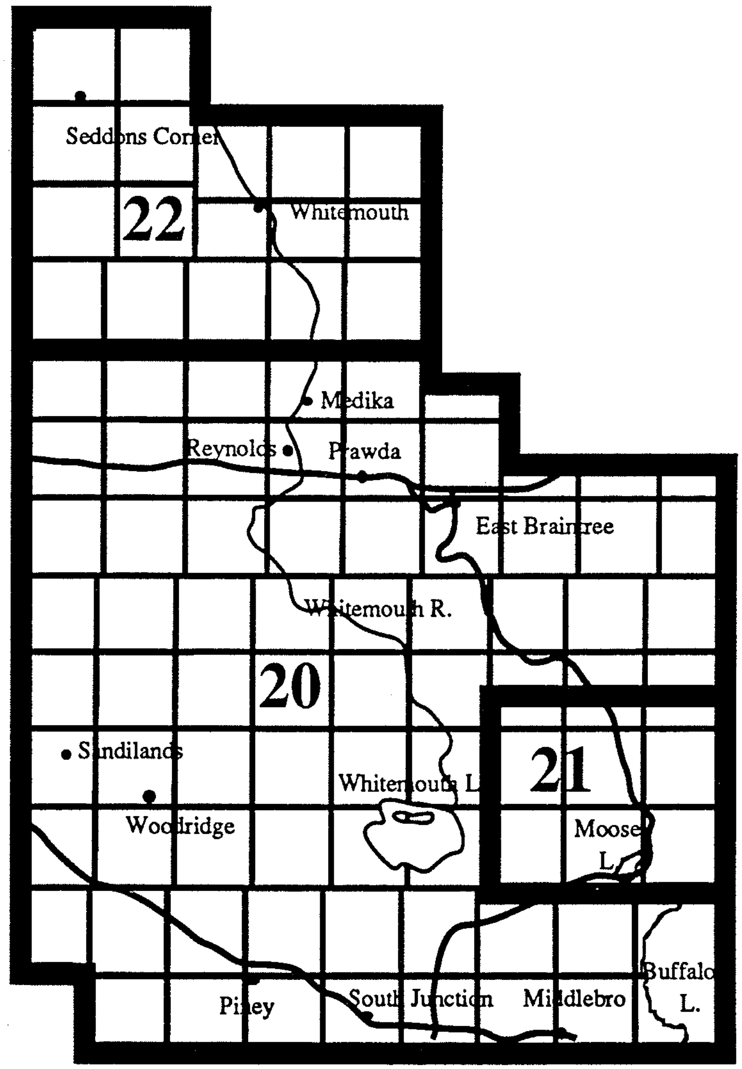
Appendix A

FOREST MANAGEMENT UNITS 1956, 1974 AND 1989



The Forest Management Unit layout above depicts the 1974 pattern of FMU's. A separate inventory was conducted for each area. The 1956 inventory data covered an area equivalent to FMU 20 and 21, combined. The 1989 inventory data represents the areas 20, 21 and 22 combined.

Appendix B

MANITOBA FOREST LAND PRODUCTIVITY CLASSIFICATION

Productive Forested Land - includes all forest land capable of producing merchantable wood regardless of its existing stage of productivity.

Nonproductive Forested Land - includes all forest land not capable of producing merchantable timber due to very low productivity.

Nonforested Land - includes areas withdrawn from timber production for a long period of time, such as cultivated fields, hay meadows, pastures, settlements, right-of-ways, gravel pits, beaches, wide ditches, summer resorts, bare rock, mines, marsh and muskeg.

Water - includes lakes and rivers, measured at the high water mark.

Appendix C

MANITOBA FOREST INVENTORY COVER TYPE CLASSIFICATION

<u>Softwood</u> (S)

- all stands where at least 76% of the total basal area consists of coniferous tree species
- includes subtypes 01 - 37

<u>Softwood-Hardwood</u> (M)

- all stands where the basal area of all the coniferous species is between 51% and 75% of the total basal area
- includes subtypes 41 - 77

<u>Hardwood-Softwood</u> (N)

- all stands where the basal area of all coniferous species is between 26% and 50% of the total basal area
- includes subtypes 80 - 88

<u>Hardwood</u> (H)

- all stands where the basal area of all coniferous species is less than 25% of the total basal area
- includes subtypes 90 - 9E

Appendix D

MANITOBA FOREST INVENTORY SUBTYPE CLASSIFICATION

Productive Forested Land

Softwood (S)

Code	Subtype	
01	Red Pine	71 - 100%
02	Red Pine	40 - 70% - jP
04	Jack Pine	71 - 100%
05	Jack Pine	40 - 70 % - rP, sP
06	Jack Pine	40 - 70% - Spr
08	Scots Pine	71 - 100%
09	Scots Pine	40 - 70% - jP
10	White Spruce	71 - 100%
11	White Spruce	40 - 70% - bF, jP, bS
13	Black Spruce	71 - 100%
14	Black Spruce	40 - 70% - jP
15	Black Spruce	40 - 70% - bF, wS
16	Black Spruce	40 - 70% - tL
17	Black Spruce	40 - 70% - eC
20	Balsam Fir	71 100%
21	Balsam Fir	40 - 70% - Spr
22	Balsam Fir	40 - 70% - eC
30	Tamarack	71 - 100%
31	Tamarack	40 - 70% - Spr
32	Tamarack	40 - 70% - eC
36	Eastern Cedar	71 - 100%
37	Eastern Cedar	40 - 70%

Softwood-Hardwood (M)

Code	Subtype	
41	Red Pine	51%+
42	Red Pine	50% or less - jP
43	White Pine	51%+

44	Jack Pine	51%+
45	Jack Pine	50% or less - rP
46	Jack Pine	50% or less - Spr
48	Scots Pine	51%+
49	Scots Pine	50% or less - jP
50	White Spruce	51%+
51	White Spruce	50% or less - bF, jP, bS
53	Black Spruce	51%+
54	Black Spruce	50% or less - jP
55	Black Spruce	50% or less - bF
56	Black Spruce	50% or less - tL
57	Black Spruce	50% or less - eC
58	Black spruce	50% or less - wS
60	Balsam Fir	51%+
61	Balsam Fir	50% or less - Spr
62	Balsam Fir	50% or less - eC
70	Tamarack	51%+
71	Tamarack	50% or less - Spr
72	Tamarack	50% or less - eC
76	Eastern Cedar	51%+
77	Eastern Cedar	50% or less

Hardwood-Softwood (N)

Code	Subtype	
80	Trembling Aspen	- rP
81	Trembling Aspen	- jP
82	Trembling Aspen	- Spr, bF, tL
85	Birch	- rP
86	Birch	- jP
87	Birch	- Spr, bF, tL
88	Balsam Poplar	- Spr, bF, tL

Hardwood (H)

Code	Subtype
90 *	Trembling Aspen
91 **	Trembling Aspen
92	Birch
93	Basswood
94	Ash
95	American Elm
96	Oak
97	Manitoba Maple

98 **	Balsam Poplar
9A	Largetooth Aspen
9B	Eastern Cottonwood
9C	Hackberry
9D	Hop Hornbeam
9E	Willow

Nonproductive Forested Land

Code	Subtype	
701	bS Treed Muskeg	- 51%+
702	tL Treed Muskeg	- 51%+
703	eC Treed Muskeg	- 51%+
704	Taiga	
711	jP Treed Rock	- 51%+
712	bS Treed Rock	- 51%+
713	Hardwood Treed Rock	- 51%+
721	Willow	- 51%+
722	Alder	- 51%+
723	Dwarf Birch	- 51%+
724	Shrub	- 76%+
725	Shrub/Prairie	- 51% shrub
731	Recreational Sites	
732	Small Islands (< 2 ha)	
733	Precipitous Slopes/Fragile Site	
734	Shelter Belts	

Nonforested Land

Code	Subtype
801	Barrens - Tundra
802	Igneous Bare Rock
803	Sedimentary Bare Rock
804	Open Sand Dunes
811	Hayland - cultivated
812	Cropland - cultivated
813	Pastureland
815	Land Clearing in Progress
816	Abandoned Cultivated Land
821	Dry Upland Ridge Prairie
822	Moist Prairie
823	Wet Meadow
824	Sand Prairie

831	Muskeg
832	String Bogs
835	Marsh
838	Mud/Salt Flats
839	Sand Beaches
841	Townships/Residential Sites
842	Airstrips
843	Roads/Railroads
844	Transmission Lines/Pipelines
845	Gravel Pits/Mine Sites
846	Fence Lines/Fire Guards
847	Drainage Ditches
848	Beaver Floods
849	Dugouts/Water Holes
851	Oil Fields

Water

Code	Subtype
900	Water
901	Rivers

* Code 90 - where Trembling Aspen and Balsam Poplar together equal 51% and Aspen predominate.

** Trembling Aspen is 50% or less with 20% or greater White Birch.

Abbreviations

jP = Jack Pine
rP = Red Pine
sP = Scots Pine
wS = White Spruce
bS = Black Spruce
bF = Balsam Fir
tL = Tamarack
eC = Eastern Cedar
Spr = Spruce

Appendix E

MANITOBA FOREST INVENTORY CUTTING CLASS CLASSIFICATION

Class 0 - forest land not restocked following fire, cutting, windfall or other major disturbances (hence, potentially productive land). Some reproduction or scattered residual trees may be present.

Class 1 - stands which have an average height of less than 3 metres. They may have been restocked either naturally or artificially and have scattered residual trees.

Class 2 - advanced young growth of post size, with some merchantable volume. The average height of the stand must be over 3 metres.

Class 3 - immature stands with merchantable volume growing at or near their maximum rate, and should definitely not be cut. The average height of the stand should be over 10 metres and the average diameter should be over 9.0 cm at DBH.

Class 4 - mature stands which may be cut as they have reached rotation age.

Class 5 - overmature stands, which should be given priority in cutting.

Appendix F

MANITOBA FOREST INVENTORY CROWN CLOSURE CLASSIFICATION

Class 0 - 0% to 20% crown density

Class 2 - 21% to 50% crown density

Class 3 - 51% to 70% crown density

Class 4 - 71% and greater crown density

Appendix G

AMOUNT OF EACH HABITAT SUBTYPE WITHIN THE STUDY AREA

Productive Forested Land

Subtype	Area (ha)	Subtype	Area (ha)
01	1,682.0	53	5,725.8
02	388.6	54	655.6
04	64,482.1	55	1,400.5
05	1,100.6	56	1,145.6
06	4,078.9	57	275.4
08	36.4	58	180.5
09	139.8	60	625.3
10	71.2	61	1,763.9
11	579.7	62	137.1
13	93,114.8	70	540.0
14	1,804.5	71	429.1
15	2,869.2	72	125.8
16	42,685.4	76	39.8
17	7,274.2	77	164.4
20	61.2	81	12,079.0
21	966.4	82	30,545.8
22	281.6	85	38.3
30	42,199.0	86	136.3
31	33,998.5	87	426.1
32	3,854.4	88	449.5
36	509.0	90	129,333.4
37	4,279.0	91	893.0
42	36.8	92	823.9
43	14.2	94	1,841.0
44	6,222.8	95	74.6
45	24.8	96	170.1
46	956.1	97	156.6
50	89.3	98	1,526.7
51	1,063.3		
		TOTAL	506,566.6 ha

Nonproductive Forested Land

Subtype	Area (ha)	Subtype	Area (ha)
701	40,800.0	722	83.2
702	95,624.3	723	7,711.8
703	49.4	724	143.7
711	1,490.6	725	30.5
712	1,126.8	731	59.9
713	131.6	732	20.3
721	48,179.4	734	121.4
		TOTAL	195,572.9 ha

Nonforested Land

Subtype	Area (ha)	Subtype	Area (ha)
802	317.5	835	1,682.8
811	11,227.7	839	33.1
812	30,307.0	841	3,863.5
813	8,865.9	842	11.2
815	5,119.2	843	10,378.5
816	1,507.2	844	2,120.7
821	33.7	845	3,971.2
822	5,051.0	846	89.8
823	4,635.3	847	1,145.5
831	69,781.3	848	5,677.8
832	1,684.1	849	53.7
		TOTAL	167,557.7 ha

Water Area

Subtype	Area (ha)
900	26847.9
901	678.5
TOTAL	27,526.4 ha

TOTAL AREA = 897,223.6 ha

Appendix H

HABITAT BY SITE CLASS, CUTTING CLASS, AND CROWN CLOSURE

Site Class

Class	Area (ha)	Percentage
1	297,382.1	58.7%
2	208,587.8	41.2%
3	596.7	0.1%
	506,566.6 ha	

Cutting Class

Class	Area (ha)	Percentage
0	31,340.3	6.2%
1	27,910.1	5.5%
2	76,539.6	15.1%
3	253,632.8	50.1%
4	89,740.0	17.7%
5	27,403.8	5.4%
	506,566.6 ha	

Crown Closure

Class	Area (ha)	Percentage
0	31,340.3	6.2%
2	44,348.6	8.7%
3	130,535.3	25.8%
4	300,342.4	59.3%
	506,566.6 ha	

Appendix I

AVERAGE AMOUNT OF EACH SUBTYPE WITHIN THE WINTER PLOTS

Subtype	Area (m^2)	Subtype	Area (m^2)
01	4,140.3	87	19,955.4
02	852.9	88	252.9
04	258,014.0	90	360,022.4
05	3,264.9	91	368.7
06	18,609.5	92	1,636.4
08	250.5	94	2,561.4
11	233.0	98	1,170.3
13	440,657.8	701	103,008.7
14	13,492.5	702	258,088.0
15	12,264.4	711	7,053.3
16	304,025.9	712	691.7
17	40,835.4	721	146,400.7
21	4,643.6	723	12,891.2
22	8,686.9	724	313.6
30	228,574.8	702	1,532.3
31	138,738.4	811	17,176.3
32	20,353.6	812	36,751.9
36	1,990.9	813	12,606.6
37	12,813.3	815	6,636.4
44	22,241.8	816	3,471.3
46	6,759.8	822	11,873.9
51	23.6	823	27,761.6
53	31,293.3	831	120,371.9
54	2,598.2	832	160.1
55	8,814.9	835	234.2
56	483.7	841	12,344.1
57	202.6	843	33,551.0
58	5,940.6	844	11,406.6
60	5,312.6	845	8,598.1
62	413.6	846	8.1
70	1,711.2	847	2,277.5
71	1,154.4	848	15,610.9
81	52,624.5	849	29.2
82	123,339.5	900	4,196.9
86	418.6	901	1,794.4
		cutover	106,547.7
		TOTAL	3,125,121.2 m^2