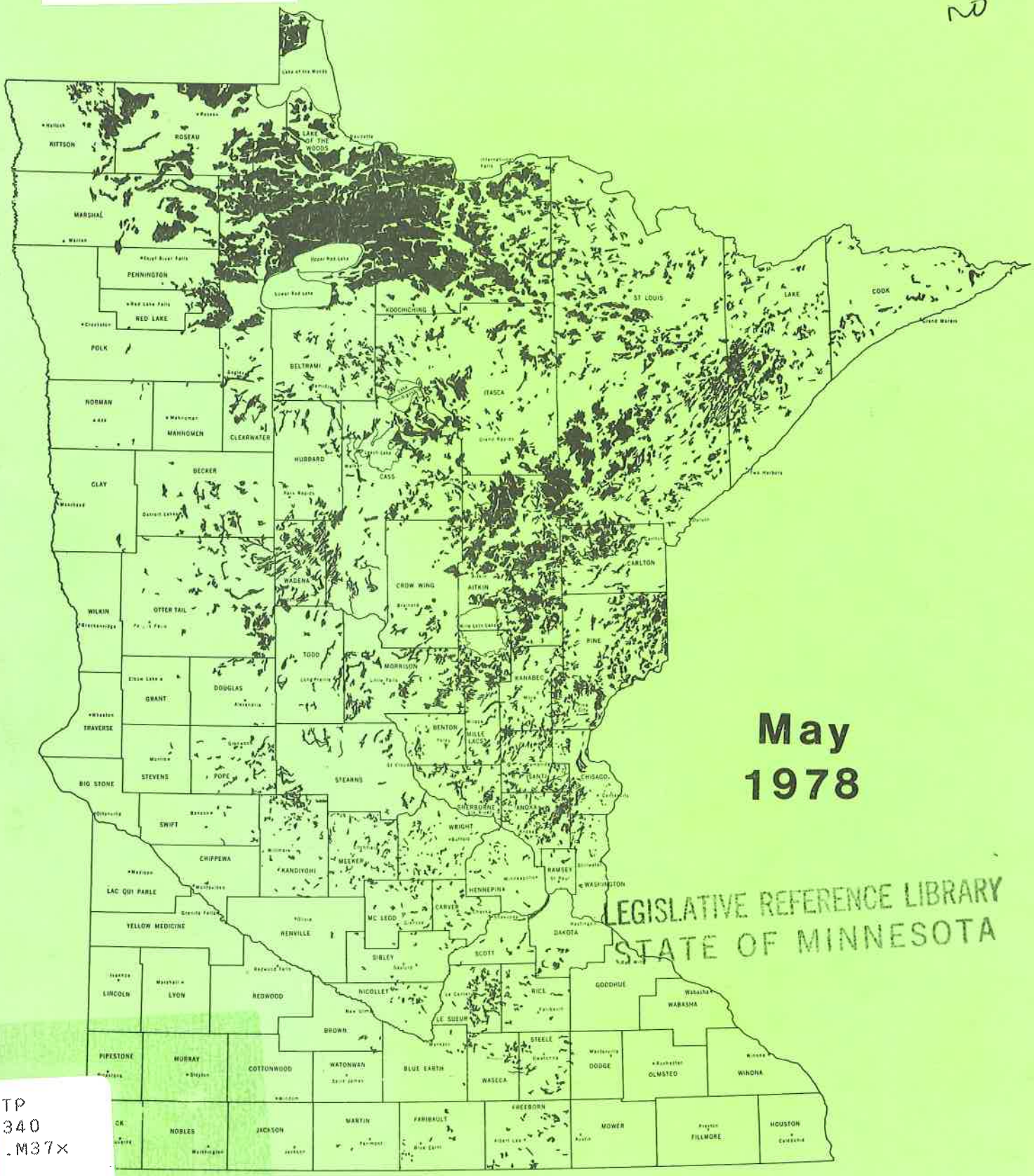
TERRESTRIAL WILDLIFE
MINNESOTA PEATLANDS



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TERRESTRIAL WILDLIFE OF MINNESOTA PEATLANDS

A Literature Search

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SUMMARY AND RESEARCH RECOMMENDATION

The information presented clearly shows that a variety of birds and mammals are found in peatland habitats for different portions of the year and at different population levels. Some are quite obligate, but for most the dependence is seasonal. In each case the elimination of habitat by extraction could well reduce or even eliminate these populations.

In evaluating these data as to impact, two judgements must be made:

The first is clearcut and overriding--if habitats are eliminated in an area the wildlife populations will disappear.

However, a long range judgement involves the certainty that plants and, with them, animals will reinvade the areas. The rates at which this occurs will vary with the physical characteristics of the site that is left by the extraction operations. This will undoubtedly be slow. For some species it may well be that a more desirable habitat than existed previously will develop.

The size, shape, and depths of the areas left after extraction will govern both the rates of reestablishment and the interspersion of food and cover in the resulting landscape.

This leads to our recommendation as to further research. We believe that "pilot" projects to test the results varying operational techniques are most important. These studies should be initiated as soon as possible on presently existing extraction sites. They could lead to recommendations to those responsible for the projected operations to insure, if possible, that a landscape favorable to wildlife will develop after the operation ceases in any one area.

PREFACE

This report is based on a literature search for ecological information on Minnesota birds and mammals that are known to be wholly or partially dependent on the habitats found on peat soils in northern Minnesota.

The search relied heavily on WILDLIFE REVIEW (U.S. Fish and Wildlife Service) and on the literature cited sections of articles in scientific journals or bulletins. Data from Minnesota were used wherever possible, but often important information from other areas in the general region were relied upon.

The Distribution and Abundance of each species in northern Minnesota is described as well as possible. Since wildlife populations are dependent on habitat conditions--in particular food and cover--stress was placed on information concerning Habitat and Food Habits. Further, the interspersion of food and cover must be analysed so data on Seasonal Movements is presented. Often other significant information was found and presented as General Comments. Finally, an opinion as to Possible Impacts of peat extraction is presented. This opinion is based on a qualitative evaluation of the data and on our field experiences.

Fairly comprehensive data on avian communities were found so that it is possible to present this aspect. Similar information on mammal communities is lacking. In addition, short sections on European literature citations, animals of special concern, and a listing of plants by common and scientific names are presented.

We wish to thank Mr. Carrol Henderson of Minnesota Department of Natural Resources and Mr. Stephen Fritts, U.S. Fish and Wildlife Service, who provided us with recent information on the fisher and the timber wolf.

BIRDS OF THE MINNESOTA PEATLANDS

This review of information on birds and peat habitats is in two parts. The first is a general listing of the avian species that have been recorded in various peatland types. While such information is not available on all the peatland communities found in Minnesota, this section should provide a framework within which a basic understanding of some of the more common avian-peatland associations can be achieved.

The second, and longer section gives individual accounts of some of the bird species typical of and often dependent on peatlands as their primary habitat. For some of these species there has been enough research done so that their basic habitat and food requirements are fairly well understood. For others, especially the passerines (songbirds), there has been little work done at the species level. In general, the amount of information available is reflected in the length of the discussion on the respective species.

The 5 game birds which utilize peatlands in a major fashion are the ring-necked duck, common snipe, spruce grouse, sharp-tailed grouse and sandhill crane. An in depth discussion of these species is provided in the "individual account" section.

AVIAN-PEATLAND COMMUNITIES

There have been very few studies conducted in Minnesota concerning the avian community structure of peatlands and most of these have been in Itasca State Park, where bog ponds in association with a variety of other vegetation types have been studied. Roberts (1932), who provided the basic groundwork of information on Minnesota ornithology with his Birds of Minnesota, made many of his observations in Itasca State Park. His work will be cited often in the accounts of the individual birds.

Hickey (1956) followed the changes in bird populations as related to the successional stages of a bog pond in the park. In a sedge community some of the more common nesters were the ring-necked duck, common loon, redwinged blackbird, swamp sparrow, and long-billed marsh wren. In the bog birch community, the mallard, redwinged blackbird, yellowthroat, song sparrow, yellow warbler, and alder flycatcher were found nesting. In the tamarack zone, the next successional stage, the swamp sparrow, yellowthroat, alder flycatcher, and Nasville warbler were present. The mature black spruce forest was the preferred habitat of the boreal chickadee, olive-sided flycatcher, Wilson's warbler, Cape May warbler, palm warbler, and Connecticut warbler.

The more extensive French Creek Bog in Itasca State Park was studied by LeFebvre (1959) using the same vegetation zonation as did Hickey (1956). Her data on breeding birds is summarized in Table 1. Unlike Hickey (1956),

LeFebvre did not find swamp sparrows in the open sedge, but rather in the bog birch and tamarack areas. Song sparrows did not use the bog itself but confined themselves to the transition zone between bog and upland. Nests of four species were found in sedge (open bog), six in bog birch (muskeg), eight in tamarack (Swamp conifer: Tamarack) and three in the "Bog meets upland" (Wood fen) habitats. This indicates an increased diversity of species with advancing stages of succession. However, the open bog had the greatest nesting density of one species.

Table 1. Breeding birds recorded in the northern half of French Creek Bog (from LeFebvre 1959).

Species	Type of Habitat: Sedge	Bog Birch	Tamarack	Bog meets upland	Total number of pairs	Number of nests found
American Bittern	f	n		x	1	1
Virginia Rail	n				1	1
Sora	n				1	1
Eastern Kingbird	f	f	f,n		2	2
Eastern Phoebe			x	f,n(?)		
Traill's Flycatcher		n	f,n(?)		5	1
Cedar Waxwing			f,n	f	6	3
Red-eyed Vireo			f,n	f,n(?)	3	1
Nashville Warbler			n		1	1
Parula Warbler			n		8	
Yellow Warbler		n	n	x	9	
Yellowthroat	x	n	n		20	2
Redwinged Blackbird	n,f	n	x	x	30	15
LeConte's Sparrow	n	x			8(?)	1
Swamp Sparrow		n	n		23	2
Song Sparrow			x	n	2	

f feeding

n nesting

x presence observed

There were about 20 species of birds that were observed on the bog but which nested elsewhere. Most of these were observed flying overhead, but many may have used the bog for specific activities, such as feeding. This may be common where low lying peatlands are well interspersed with a variety of upland vegetation types, since birds normally associated with uplands may fly out into peatlands. In these settings, peatlands may provide a valuable addition, such as a food source, and may raise the variety and density of birds found in the total area (Erskine 1977).

Since the majority of the peatland areas in northeastern and north central Minnesota are extensive, the species diversity is probably much lower than that of areas studied in Itasca State Park. Thus, Green and Janssen (1975) listed seventeen species they considered typical of the "muskeg-black spruce bogs" formed on the glacial lakes of northern St. Louis, Koochiching, Lake, and Cook counties, namely:

spruce grouse
yellow-bellied flycatcher
gray jay
boreal chickadee
hermit thrush
golden-crowned kinglet
ruby-crowned kinglet
solitary vireo
Tennessee warbler
Nashville warbler
Cape May warbler
myrtle warbler
bay-breasted warbler
palm warbler
Connecticut warbler
dark-eyed junco
Lincoln's sparrow

Unfortunately, they do not discuss the specific habitat types in which these birds are typically found.

Much of the work concerning density of and habitat selection by boreal birds has been done in Canada. Erskine (1977) has synthesized most of this information, and the following discussion is taken largely from his work . (A summary is provided in Table 2).

Open, fairly wet bogs dominated by sedges and various willows may have the following birds, depending on the availability of open water: ring-necked duck, black duck, common snipe, solitary sandpiper, and greater and lesser yellowlegs (see Table 2, column 1). This is the peatland habitat where the short-eared owl is most typically found. The most common birds found in these areas are passerines, such as: alder flycatcher, common yellowthroat, redwinged blackbird, common grackle, Lincoln's sparrow, swamp sparrow, and song sparrow. Since most of these can also be found in a variety of other habitats, they are probably not dependent on peatlands for continued existence, though certain populations may be centered around bogs. Erskine (1977) believes this open bog type is more common along the southern edge of the boreal forest, and is probably one of the more fertile types of peatlands. This is reflected in the high overall mean density of breeding pairs (324 pairs per mi^2). Though the range of values is quite wide (95 to 440) it seems that this is one of the most productive peatland types for birds.

Slightly drier sites characterized by ericaceous shrubs and sedges are the typical haunts of the savannah sparrow, a species found in almost any

Table 2. Density = pairs/100 acres; + = present in low numbers (<.5/00 acres). The number in parentheses in the headings is the number of study plots sampled. (from Erskine 1977)

Peatland Bird Census

Species	Habitat Provinces # Study plots	Open Bog N.B.-Man. (4)	Muskeg Nfld.-Ont. (8)	Tamarack Ont.-Man. (8)	Young Spruce Forest N.S.-Ont. (4)	Medium-Mature Spruce Forest Ont. (2)
Mallard/black duck		1	1	+		
Common snipe		+	1			
Lesser yellowlegs		+				
Spruce grouse				2	+	3
Northern 3-toed woodpecker						1
Eastern kingbird		4	+	+		
Alder flycatcher		2	2			
Yellow-bellied flycatcher					6	12
Least flycatcher				2		
Tree swallow		6	+			
Canada jay			+	1	1	1
Boreal chickadee				2	2	2
Red-breasted nuthatch				+	1	2
Brown creeper				+	+	4
Winter wren				1	4	5

Table 2 - cont.

Species	Habitat - Provinces - # Study plots -	Open Bog N.B.-Man (4)	Muskeg Nfld.-Ont. (8)	Tamarack Ont.-Man. (8)	Young Spruce Forest N.S.-Ont. (4)	Medium-Mature Spruce Forest Ont. (2)
Hermit thrush			1	+	6	3
Swainson's thrush			1	+	5	4
Golden-crowned kinglet				1	7	5
Ruby-crowned kinglet				+	6	8
Red-eyed vireo				8		
Solitary vireo					2	
Tennessee warbler				9		
Nashville warbler				25	11	20
Magnolia warbler			+	2	15	16
Cape May warbler						
Black & white warbler				4		
Blackpoll warbler			5		+	
Bay-breasted warbler				+	1	
Palm warbler			2	+	3	
Connecticut warbler				2		
Myrtle warbler			+	6	10	8
Yellowthroat		56	21	8	12	1
Redwinged blackbird		8				

Table 2 - cont.

Species	Habitat Provinces # Study plots -	-Open Bog -N.B.-Man. (4)	Muskeg Nfld.-Ont. (8)	Tamarack Ont.-Man. (8)	Young Spruce Forest N.S.-Ont. (4)	Medium-Mature Spruce Forest Ont. (2)
Purple finch		+	+	1	1	2
Dark-eyed junco			2	2	6	3
Savannah sparrow		+	5			
White-throated sparrow			2	14	22	35
Lincoln's sparrow			8	+	1	
Swamp sparrow		81	8	1	+	
Overall Mean Density		211	89	129	150	159
(Range)		(62-287)	(10-188)	(97-190)	(84-189)	(94-225)

open grass or sedge habitat across the northern U.S. and Canada. Again, while this species is commonly found on these drier peatlands, it is not dependent on them as a primary habitat.

Fens are described as areas with very little tree cover, a large percentage of grasses and grass-like plants (graminoids), and a water table that is almost at the surface. Nutrients are in adequate supply on these areas, which are probably even more fertile than open bogs. Birds associated with fens include: marsh hawk, sandhill crane, yellow rail, common snipe, solitary sandpiper, greater and lesser yellowlegs, least sandpiper, Banaparte's gull, short-billed marsh wren, LeConte's sparrow, and sharp-tailed sparrow. The last three birds are found in this type only at the southern fringe of the boreal zone. As can be seen, there is some overlap between species found on fens and open bogs.

Muskegs usually have dense willow and ericaceous shrub cover and a vigorous sphagnum growth, but only scattered trees, most of which are tamarack and black spruce. Birds characteristic of these mostly open regions include: hermit thrush, myrtle warbler, dark-eyed junco, chipping sparrow, and white-throated sparrow (see Table 2, column 2). Some of these birds, such as the hermit thrush, junco, and white-throated sparrow, will also be associated with wooded edges or openings in forests. The muskeg vegetation type has the lowest overall mean density of breeding birds ($137/mi^2$) of all peatland types for which data is available. It seems that, in terms of the avian community, this is not a very productive area.

The tamarack forests are relatively wet forests dominated by tamarack alone, or in combination with black spruce. Some of the birds associated with this type include: cedar waxwing, red-eyed vireo, Tennessee warbler, Nashville warbler, myrtle warbler, common yellowthroat, dark-eyed junco, chipping sparrow, and white-throated sparrow (see Table 2, column 3). Most of these birds are characteristic of other northern coniferous forests. Nashville warblers are more commonly associated with edges, while the yellowthroat and Tennessee warblers are more common in the shrub undergrowth. The total bird densities (averaging 12.9 pairs per mi^2) are slightly less than those of black spruce forests or open bogs, but greater than those of muskeg.

The swamp conifer-black spruce forest is a climax forest community dominated by black spruce. The most typical bird species of this vegetation type are: spruce grouse, northern three-toed woodpecker, yellow-bellied flycatcher, Canada jay, boreal chickadee, Swainson's thrush, ruby-crowned kinglet, golden-crowned kinglet, Nashville warbler, myrtle warbler, dark-eyed junco, chipping sparrow, and white-throated sparrow (see Table 2, columns 4 and 5 for young and old spruce forests). The hermit thrush may be added to the list where more open stands, such as disturbed or young forests exist. Other species occur in this vegetation type but under more restricted conditions. For instance, the Cape May warbler and bay-breasted warbler can be abundant in spruce forests, but usually only in the presence of the spruce budworm (Morris et al 1958, Kendeigh 1947). Other species, such as the Tennessee warbler and solitary vireo,

are associated with a broad-leaved element in the understory. The boreal chickadee, the two kinglets, the Cape May, magnolia, bay-breasted, and myrtle warblers are most often associated with a closed canopy spruce forest (Stewart and Aldrich 1952, Morse 1976). The yellow-bellied flycatcher and Swainson's thrush are dependent on a coniferous brushy understory, while the hermit thrush, Nashville warbler, junco, and white-throated sparrow are often found in a wooded edge or opening in the forest which has a well developed herbaceous layer.

In black spruce scrub bogs the palm warbler and Lincoln's sparrow are most commonly found. Juncos, yellowthroats, palm warblers, and myrtle warblers are more common in young versus older spruce forests, while in the medium to mature forest the Nashville warbler, the ruby-crowned kinglet, and the spruce grouse are more likely to be found.

The spruce community is not considered a particularly rich habitat in either variety of species or total productivity of animal biomass (Erskine 1977). While the two types of spruce forests (young and old) lay between the extremes represented by other peatland types, none of these peatlands are particularly high in vegetational, and presumably in animal productivity. However, where spruce budworm infestations occur, bird densities can increase significantly (Kendeigh 1947, Morris et al 1958, Erskine 1977).

For comparative purposes, Table 3 lists the overall mean densities of the 5 peatland types in Table 2, plus some other boreal coniferous and deciduous forest mean densities. As can be seen, peatlands are generally a less productive habitat than are forests on mineral soils.

Table 3. Mean densities of breeding pairs on peatlands vs. other boreal forests. (from Erskine 1977)

Habitat	Open Bog	Musket	Tamarack	Young Spruce	Med-Mature Spruce	Hemlock	White-Red-Pitch Pines	Jack Pine	Aspen/Birch S. Ont.	Mixed Aspen
Provinces	N.B.-Man	Nfld.-Ont.	Ont.-Man	N.S.-Ont.	Ont.	N.S.-Ont.	Ont.	N.B.-Man.	(Algon.Pk.)	N.B.-Ont.
# Plots	(4)	(8)	(8)	(4)	(2)	(6)	(4)	(8)	(5)	(6)
Density/100	211	89	129	150	159	253	253	52	193	230
(Range)	(62-287)	(10-188)	(97-190)	(84-189)	(94-225)	(206-355)	(176-288)	(34-76)	(136-272)	--

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INDIVIDUAL ACCOUNTS OF AVIAN SPECIES

Information on some species of birds that utilize peatlands is presented below. The account of some species is quite short, reflecting the relative paucity of data. In general, there is little information available on the passerine birds, but sufficient information exists for many of the larger birds, especially the 5 game birds.

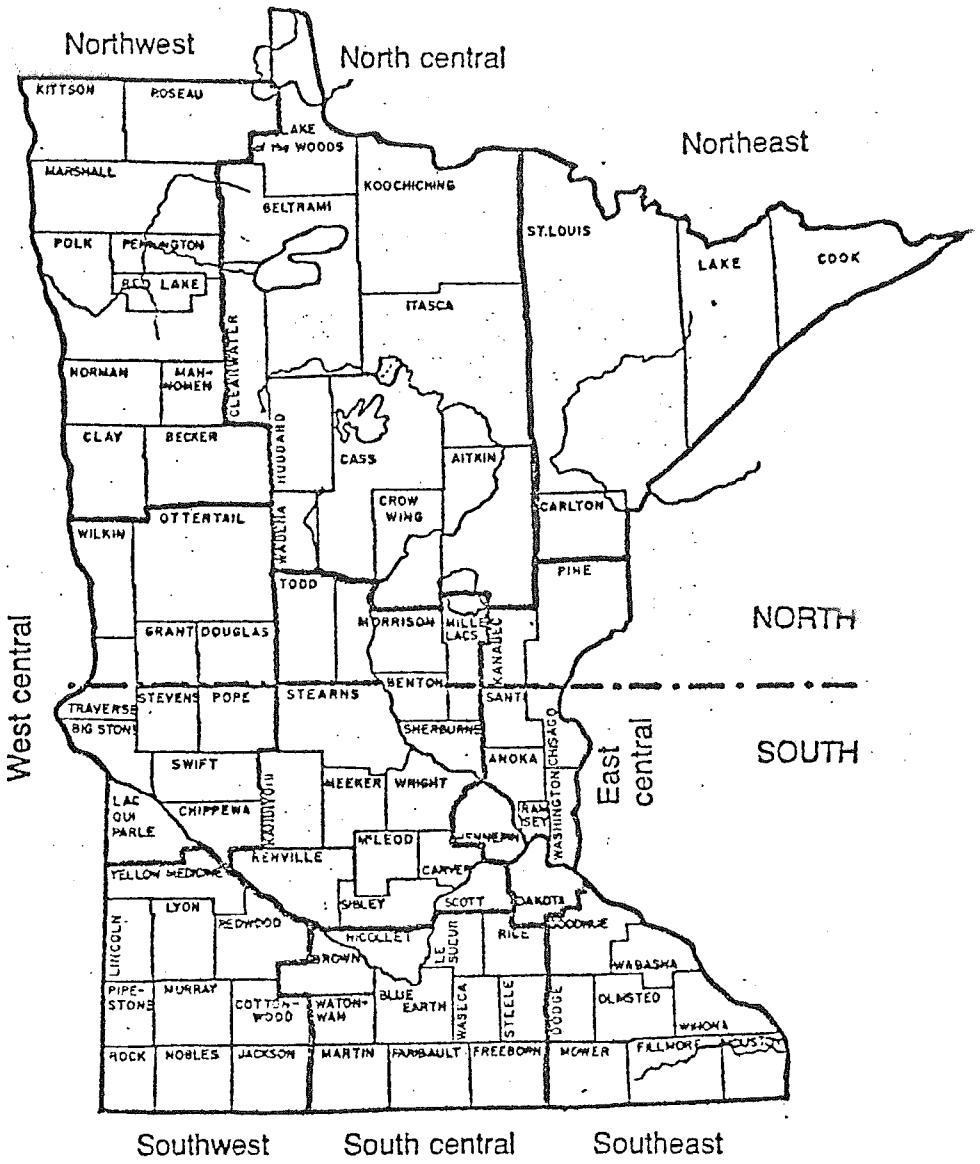
Data on the distribution and abundance of birds was taken from Green and Janssen's Birds of Minnesota (1975). They have divided the state into 9 geographic regions: northwest, north central, northeast, east central, central, west central, southwest, south central, and southeast (Fig.1). The northwest and north central regions include the big bog country around Red Lake while the northeast includes the bog areas of St. Louis and Carlton counties.

The following definitions are used in assigning each species to a particular status within the state:

1) Regular: Occurs somewhere in the state every year.
2) Casual: Not known to occur every year but expected at intervals of a few years: 9 or more acceptable records for each species.
3) Accidental: Not expected to occur again or expected to occur again only very infrequently: 8 or fewer acceptable records for each species.

The following abundance terms are used in discussing migration:

1) Abundant: Daily counts of as many as 50 birds; season count of 250 or more birds.
2) Common: Daily counts of 6 to 50 birds; season counts of as many as 250 birds by an active observer.
3) Uncommon: Daily counts of 1 to 5 birds; season counts 5 to 25 birds by an active observer.
4) Rare: Season counts of no more than 5 birds by an active observer.
5) Casual: Up to 3 birds seen in a decade by an active observer.



I. Counties and geographic regions in Minnesota.

RING-NECKED DUCK

Minnesota Distribution/Abundance - The ring-necked duck (Aythya collaris) is a regular migrant and summer resident in Minnesota (Green and Janssen 1975). The Great Lakes Region in general is reported to have the largest number of nesting ringnecks in the United States at 25,000, with Minnesota harboring about 10,000 (Bellrose 1976). Ringnecks are the third most numerous breeding duck in the state, ranking behind the mallard and blue-winged teal in abundance (Moyle 1964a). The nesting population is primarily in the northeast and north central regions and adjacent counties of the northwest, west central, central, and east central regions (Green and Janssen 1975).

This species migrates in the spring through Minnesota from mid-March to late May, with a peak in mid-April. In the fall it is seen migrating in Minnesota from late September through early December with a peak in mid-October. The migration routes followed in fall bring many ringnecks into Minnesota from Canada (Bellrose 1976). On October 24, 1968, 88,000 ringnecks were estimated to be on Nett Lake, Koochiching County, 25,000 on Rice Lake National Refuge in Aitkin County, 10,000 on Squaw Lake, Itasca County, and 17,000 elsewhere in the state. On October 3 of the same year, there were 32,500 on Rice Lake National Refuge and probably large numbers on Lower Red Lake in Beltrami County (Benson 1969).

Habitat - Ringnecks commonly nest in the forested part of the state and are usually found on boggy, marshy areas or small lakes (Moyle 1964a). Unlike many of the other diving ducks, which frequent open expanses of water, ringnecks prefer sedge-meadow marshes and bog habitat types. Because of

this preference, ringneck nests and broods are found in habitats that are only sparingly utilized by other waterfowl (Mendall 1958).

There are several reports on habitat usage by breeding ring-neck ducks in Minnesota. Goodwin (1958) studied ringnecks in Itasca State Park. He devised a pond classification system based on vegetative formations, which separated ponds into 3 main types: permanent, semi-permanent, and shallow boggy and marshy areas. He further broke down permanent and semi-permanent ponds into 4 types each. A summary of these types is given in Appendix A.

Semi-permanent ponds held 81.5% of the ring-necked duck pairs, permanent ponds had 14.8%, and shallow boggy areas with small openings of water had 3.7% (the small amount of usage was apparently due to a lack of food supply). Forty-eight percent of available semi-permanent ponds were used, while 29% of all permanent ponds were utilized.

A decided preference was apparently shown for the B4 type ponds (see summary in Appendix A), for all such available ponds were utilized. Types A2 and A3 were used 50%, and B3 ponds were used 42.9%. The B1 and B2 ponds were moderately used with 28.6% and 33.3% respectively.

Goodwin believed there to be 3 important elements contributing to ringneck pond preference and selection: 1) open water with a good food supply, 2) nesting sites on large sedge tussocks or small floating cattail islands, and 3) good brood cover, usually in the shallow water near shore. Only A3 and B4 types provided all three on a single pond. The presence or absence of a Class C pond in proximity to any other types (except A3 and B4) was an important factor determining the amount of usage of other pond types. Class C ponds provided good nesting sites and brood cover but generally had no feeding area. Where these were near to or connected to

another type by a beaver channel then the combination of the 3 factors could be provided, and nesting and rearing of young occurred.

Johnson (1963) found that in Big Rice Pond, a typical semi-bog in Beltrami County, ringnecks were the most common nester. No detailed description of the area was given.

Stoudt (1940) censused breeding pairs in Chippewa National Forest and found ringnecks to prefer lakes which were completely surrounded by a floating bog shoreline of sedges, with aquatic plants such as coontail, bladderwort, duckweed and some wild rice present on the lakes.

The ringneck was reported as the third most common breeder in a study area in Mahnomen County (Jessen et al 1964). In contrast to the above habitat descriptions, this area does not contain bog-like wetlands at all, but rather has potholes of 5 main types. The type most often used was deep fresh marshland with at least 50% of the area covered by emergent vegetation such as bulrush, cattail, whitetop grass and sedges, and with aquatics such as muskgrass, water milfoil, and sago pondweed also present. Another study in Mahnomen County (Goodwin 1957) revealed that ringnecks nest in shallow bulrush marsh areas, which are separated from the loafing, feeding, and brood raising ponds by distances up to a quarter of a mile.

In general, the habitat utilized by ringnecks in the northeast U.S. is characterized by similar species of aquatic, emergent, and terrestrial vegetation. In Maine, water lilies and water shield are two plants typically found in areas sought out by ringnecks for nesting (Mendall 1958). Submerged vegetation found on the open water typically includes water bulrush, whose tubers are a favored food, and bladderwort. Emergent plants such as pickerel weed, spikerushes, buckbean, and three-way sedge are fairly common. In the shallows of the water are many sedges, arrowhead,

St. John's wort, and bellflower. Beyond this belt of sedges grows a zone of shrubby vegetation including species such as sweetgale, leatherleaf, and perhaps some alder.

In the Seney marsh in Schoolcraft County, upper Michigan, waterfowl usage of beaver ponds was studied by Beard (1953). Ringnecks were found to be the second most common duck on two of four study areas. One of these study areas was a 6 acre river marsh surrounded by leatherleaf, alder, bog birch, spirea, willow, sedges, manna grasses, and bluejoint grass. The dominant forms of vegetation in the marsh itself were two sedges, Carex lacustris, which grows in tussocks, and Carex stricta, which forms the beds of the "sedge meadow" type. The most common vegetation zone was a sedge-brush marsh well broken up by water into a multitude of small units, so that there was a high degree of interspersion of cover and water. The only submerged aquatic plant to occur in any appreciable amount was bladderwort. Water depth measurements showed that the deepest water was 34 inches and the shallowest was 9 inches.

The other study area on the Seney marsh heavily used by ringnecks was a beaver pond surrounded by bracken fern, blueberry, and leatherleaf. The shoreline zone was characterized by abundant sedges, leatherleaf, and manna grass. Cattail, rough sedge, and bluejoint grasses occur in a few spots. There were small leatherleaf islands in the open water areas. Of the aquatic plants, only bladderwort existed in considerable amounts. There was a medium degree of interspersion of water and cover. Water depth measurements showed the minimum depth to be 7 inches and the maximum 37 inches.

Townsend (1966) found ring-necked ducks to be the second most common duck nesting on a lake in the Saskatchewan river delta. This lake had a

floating shoreline, largely of sedges and some short willows. Along part of the shore, phragmites formed a tall border between the open water and the sedge community. There were many islands on the lake, mostly of the floating sedge type, with varying amounts of willows interspersed. Several islands had a mixture of cattail, and sedge as a co-dominant, and many had a small patch of phragmites bordering part of the island.

Nests are generally located on floating islands or where the pattern of the marsh is broken by a cove or back channel (Mendall 1958). Most studies show a similarity in their description of nesting sites. The ideal conditions in northeastern U.S. are in the border dividing the sedge and leatherleaf-sweetgale zones (Mendall 1958). Almost half (47.9%) of the nests found by Mendall were on islets of floating marsh plants, 38.4% were in clumps of marsh vegetation, 9.1% on solid islands, and the rest (4.6%) on miscellaneous types. Nests were located among sedges, sweetgale, leatherleaf, spireae, cattail, and bog rosemary.

Stoudt (1971) found that in the Chippewa National Forest ringnecks nested on bodies of water with a floating bog shoreline. Floating islands were also used. Typical nest sites among cattails, sedges, and reeds were located along creeks or channels in bogs. Goodwin (1958) reported most nests in Itasca State Park to be completely surrounded by water. Five of nine nests were entirely within large tussocks of wide leaf sedge. Two nests were built in clumps of cattail on islands, and two were built in narrow leaf sedge growths of shallow water. All nests were constructed of the same materials that concealed them.

Wellein (1942) found 75% of ringneck nests to be located in the sedge cattail floating bog type in the Chippewa National Forest. Nests were

made of the surrounding vegetation, and sedges and cattails were the most common ground cover.

In the Saskatchewan river delta, ringnecks selected nest sites in a sedge or sedge-cattail habitat (Townsend 1966). Nesting success was highest in flooded or floating sedge, similar to the situation found in Maine (Mendall 1958). The floating mats used by the ducks were riddled with small channels and openings that provided a good interspersion of nesting cover and water that made escape from terrestrial predators easy. Nests averaged 1-2 feet from the nearest water and about 83 feet from a large body of water (usually the lake itself).

Food Habits - The feeding habits and preferences of ring-necked ducks have been studied by only a few observers. Mendall (1958) has done the most thorough work on the subject, and is the main source of information in this discussion.

While the bulk of the food is obtained by diving (as would be expected from a diving duck), this is by no means the only means of feeding. Ringnecks have been observed reaching up to feed on wild rice, wallowing on mudflats to root out animal matter, and even tipping up in a manner analagous to the surface-feeding ducks. When diving, water depths less than five feet are preferred (Mendall 1958). Beard (1953) found optimum depth for feeding ringnecks to be 2 to 3 feet.

Mendall (1958) analyzed 133 stomachs of ringnecks, tabulating information separately for spring, summer, and fall. For the summer collection, downy young (birds less than 3 weeks old) were analyzed separately from adults and young that were over half grown.

In the spring, 88.5% (volumetric percentage) of the food was vegetable matter, and 11.5% animal. Sedges (Cyperaceae) made up nearly 40% of the

food, with Torrey's three-square bulrush and water bulrush making up 19.4% and 14.6% respectively. These two plants occur commonly in Maine, and the tubers especially are favored by many species of ducks. During spring, beds of three square bulrush are under 2 to 5 feet of water, and are particularily sought after by ringnecks. As water levels drop, this bulrush is not as accessible to ringnecks. Water bulrush, ranked second in importance of spring foods, is taken throughout the three seasons that ringnecks remain in Maine. Floating-leaved pondweed and other Potamogetons made up 17.9% of the spring diet. The seeds (and to a slight extent, the vegetative parts) of the ponweeds are primarily utilized at this time. Seeds of burreeds make up 13.3% of spring foods, seeds of water shield (5.9%), and winter buds of wild celery (3.7%) were also fed upon.

Snails (Gastropods) made up approximately 4.5% of the spring diet while miscellaneous insects made up 6.3%.

Analysis of summer foods of adults shows a preponderance of plant food in the diet (86.2%). Compared to spring, pondweeds have replaced sedges as most important, as these groups respectively comprise 32.4% and 16.3%. Floating-leaved pondweed is by far the most important pondweed (22.9%) with bushy pondweed (6.7%), and others also being taken. Seeds of the pondweeds were the parts primarily taken, although the vegetative parts and rootstalks were occasionally eaten. Instead of taking tubers of bulrush, as occurred in the spring, ringnecks concentrated on the seeds of this plant group to obtain 16.3% of their summer intake. Spikerush was most important in summer (6.1%) with Torrey's three square bulrush (4.4%), and water bulrush also being widely taken. Wild rice was consumed in large quantities (9.0%) especially in the later part of the summer. The seeds of water lily, spores

of horsetail, wild celery, and burreeds were taken at 5.4%, 4.2%, 4.2%, and 3.7% respectively.

Clams (Pelecypoda) (4.4%), snails (6.2%), and larvae of caddis flies (Trichoptera) (2.0%) were the primary animal foods that made up a total of 13.8% of the summer diet.

In contrast to the adults in summer, downy young consume vegetable and animal matter in approximately equal amounts. Seeds of three square, water, and other bulrushes, pondweeds, and burreeds made up 35.1% of the diet. Caddis flies, particularily the larval form, were commonly taken (23.0%). Beetles (Coleoptera), water beetles (Haliplidae), dragon and damsel flies (Odonata) and water striders and boatmen (Hemiptera) made up 5.5%, 5.0%, 4.9%, and 5.5%, respectively, for a total of 20.0%.

Fall is the season best sampled for ringneck food habits because of the ease of obtaining specimens. Sedges, pondweeds, and burreeds are again the most important groups, with all vegetative matter making up 88.9% of the diet. In the sedge family, the tubers of water bulrush were highly preferred (28.8% of the diet), with Torrey's three square sedge (3.4%) and three-way sedge (4.6%) also being used, so that total sedge use was 39.9% of the diet. Floating-leaved pondweed was again the most preferred pondweed (11.5%) with seeds of it and others of the Zosteraceae making up 21.6% of the fall food intake. Burreeds contributed 8.6% to the diet, and wild rice made up 5.5%. Animal food, primarily snails (7.1%) and insects (1.9%) totaled 11.1% of the diet.

Beard (1953) found slightly different feeding habits of ringnecks in the Seney marsh of upper Michigan (a setting perhaps more similar to Minnesota habitat). She believed ducklings of all species are almost

entirely dependent on animal food for the first 2 to 3 weeks of life. Her sample of 11 stomachs from ring-neck ducklings from 3 to 8 weeks old showed 77.7% of all foods to be animal. Dragon and damsel flies (probably larvae) made up 32% of all foods, caddis flies 28%, and snails 14%. The only plant species taken in significant amounts (18%) was pondweed.

Seasonal Movements - In spring, ringnecks probably arrive on the breeding marshes of Minnesota around the middle of April, after all the ice has left the ponds. Goodwin (1958) found them on the ponds and lakes at Itasca State Park by April 18. When the pairs that remain for nesting in specific areas arrive on those sites is not known, but Goodwin believed there to be alot of movement occurring up to April 26, when numbers stabilized on all ponds, indicating final pond selection for most pairs.

Summer observations by Goodwin suggest that broods may move distances up to a quarter of a mile to new ponds. This capacity for movement allowed usage of ponds that had quality nesting sites, but had little food or brood cover. Beard (1964) reported that the number of broods utilizing an observed sedge marsh varied daily, suggesting movements between bodies of water to be quite common. These movements to another site with sufficient cover and food make greater utilization of the various ponds possible, and therefore, allow greater densities of birds to exist since all available resources are being used to a greater extent due to the interspersion of water types.

Little is known of the summer habitat preferences. The females with broods remain in the brood area, but the males usually leave early in July. These males and perhaps unsuccessful females apparently congregate on bodies of water with lush vegetation around the edges to moult. Mendall (1958) was

familiar with one such marsh that was regularily used by large numbers of moulting birds in July and August. How far these birds will travel from breeding habitats is unknown, but Mendall speculates it may be hundreds of miles.

Fall concentrations of one to five thousand birds occur on many lakes in the northern part of Minnesota. There is a definite eastern movement of ringnecks from their breeding grounds on the prairie provinces of Canada into Ontario and the eastern United States. One of the three largest migration corridors funnels ringnecks southeastward across Minnesota to the Mississippi River and south into Iowa (Bellrose 1976). Very large concentrations occur in the Lake States region, especially Minnesota where numbers up to 140,000 have been recorded for one day (Benson 1969). Some of the lakes mentioned by Benson (1969), such as Nett Lake, Rice Lake National Wildlife Refuge, and Squaw Lake, are no doubt important stopover areas.

General Statements - There are a number of potential limiting factors that must be considered when looking at the biology of ringnecks.

While ringnecks are the third most common breeder in the state, they are considered to be the eighth most important species in the hunting bag (Moyle 1964a). This apparent lack of hunting pressure is due to the influx of the more abundant and more preferred (by hunters) waterfowl species in the fall. However, hunting does have a significant pressure on this species. Immature ringnecks banded in Minnesota suffered a first-year hunting mortality of 77% (Bellrose 1976). Moyle (1964a) believed this species to be quite vulnerable to hunting, citing as an example that at Big Rice Lake in Cass County, ringnecks made up 69% of the bag on the second day of hunting season after other species like the mallard had become

considerably warier. It is probable that the ringneck is the number one duck taken by hunters in northern Minnesota.

The interspersion of marsh and water is an important factor determining rinkneck usage of areas. Both Beard (1953) and Mendall (1958) found that increasing the edge effect through better interspersion of marsh and water will help increase productivity of a given area. This intersperison creates more nesting sites and more brood cover, the lack of which can lower total utilization of an area and successful brood rearing.

Changing water levels can have unfavorable effects on nesting due to flooding of nests by rising water, excessive predation due to low water, and loss of nest sites due to either excessively high or low water levels. Fefer (1977) found that ringnecks became more abundant on a bog wetland area as the floating sedge mat became more available due to changes in water levels. Nests on drier lands are more accessible to terrestrial predators, and therefore, suffer a higher loss (Townsend 1966).

In relation to water levels, the existence of a floating mat edge can be very important to nesting success. Most nests of ringnecks are situated within several inches of water level, but few are flooded due to the fact that the floating sedge mats will rise and fall with changing water conditions (Goodwin 1958).

More important than a floating mat bordering the pond are the islands of sedge that are isolated from any other land mass. These are the most preferred nesting sites for ringnecks. Almost half (47.9%) of the ringneck nests located by Mendall (1958) were on floating islets. These island nests had the highest egg hatching success (83%) compared to open marsh (62%) and solid islands (53%). In Minnesota it has been suggested that the absence of floating islands could be a limiting factor (Johnson 1963).

Also, it has been suggested that management practices for this species include the creation of these floating islands in otherwise suitable habitat (Mathisen 1967).

Beard (1964) has suggested that another potentially limiting factor is the absence of loafing sites. The use of loafing sites by surface feeding ducks is well known (Hochbaum 1944), but it is not as well known that ringnecks make extensive use of these dry sites (Mendall 1958). Beard has demonstrated that such loafing sites are very important in the daily activities of a duck brood. Flattened muskrat houses and low mud bars or mounds appear to be the type of site most highly preferred by duck broods. That the absence of such sites could be a limiting factor was demonstrated by the fact that in the Seney marsh in Upper Michigan, where this study was conducted, there was a great demand for these sites and competition existed for use of them. In marshes which appear otherwise suitable for brood rearing, the placement of artificial loafing spots may be a pratical and worthwhile management procedure.

Possible Impacts - The importance of peatlands to ringnecks is sometimes difficult to ascertain due partially to the fact that many authors fail to differentiate between marshes and bogs. However, it seems that according to habitat descriptions in general, and Minnesota descriptions in particular (Goodwin 1958, Moyle 1964a, Mathisen 1965), bog wetlands associated with open water are of critical importance for successful reproduction by ringnecks. Removal of peat, or drainage associated with operations, which reduces such very wet sites could be detrimental to ringnecks. However, if removal techniques left irregularily shaped water areas with associated open bog islands and edges and aquatic plants became established, new available habitat could result.

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Appendix A

Classification Scheme Devised by Goodwin

A1. Permanent ponds with sparse or no emergent vegetation along the shore. Few or no submergents present. The shore may be lined with sparse growths of sedge. Emergent cover 5 percent or less.

A2. Permanent ponds with a border of bulrush (Scirpus spp.) and submergents in the shallow water. Sedges present as floating mats in shallow bays. Sedges and cattails may line the shore but do not grow into the shallow water to any extent. Sedges and cattail form 5 to 15 percent cover on the pond.

A3. Permanent ponds with a large area of shallow water with an abundance of emergent and submergent vegetation. Shore line and shallow water often dominated by sedge in small clumps and occasional tussocks. Emergent brood type cover 20 to 35 percent, mostly in shallow bays and arms.

A4. Permanent ponds in the process of being filled in by a floating sedge mat. The percent of cover by emergents varies with the age of the mat.

B1. Semi-permanent ponds with abundant submergents but few brood cover emergents. Shore line often lined with a narrow band of sedge or cattail giving only 5 to 10 percent cover on the pond. The shallow water along the shore may have dense growths of arrowhead forming part of the emergent cover.

B2. Semi-permanent ponds like B1 but with floating or stationary sedge and cattail mats and or islands. The emergent brood type cover on the pond is increased to between 10 and 20 percent.

B3. Semi-permanent ponds with abundant submergents and floating leaf emergents. The shore and shallow water are dominated by sedges and or cattail giving 10 to 20 percent cover. The brood cover type emergents in shallow water form a band of vegetation 5 to 15 feet wide. The sedges are in shallow broken clumps with water between the clumps.

B4. Semi-permanent ponds like B3 but with sedges or cattail mats and or islands present. Sedges may be in tussocks in boggy bays. The emergent brood type cover ranges from 30 to 50 percent.

C. Shallow boggy or marshy areas with small areas of open water. Emergent brood type cover being 60 to 85 percent. The sedges and cattails are in clumps and tussocks. Centers of the areas may be of heaths. Open water often the result of beavers making channels. Water level may be maintained by a beaver dam.

GREATER SANDHILL CRANE

Minnesota Distribution/Abundance - The greater sandhill crane (Grus canadensis tabida) is a regular migrant and summer resident of Minnesota. It is common in the spring and fall in the northwestern region and adjacent Wilkin County, but rare elsewhere (Green and Janssen 1975). The fall migration period extends from early September to mid-November, with a peak in October, when concentrations of 1,000-5,000 birds commonly occur. The spring migration occurs from late March to early May, with a peak in mid-April.

The greater sandhill crane is a summer resident primarily in the northwestern region and in a few localities in the east central part of the state. No complete survey of the crane population of Minnesota has been made, partly due to the fact that most bog areas utilized by cranes are large and inaccessible. Information given below is the result of a recent questionnaire survey of game management personnel by Johnson (1976). Cranes are known to occur in the summer in 12 counties. Most of Minnesota's summer crane population reside in Roseau and Kittson counties, where survey results indicate the presence of approximately 45 pairs. It is estimated that 30 of these pairs reside in Roseau River Wildlife Management Area, making this the largest known concentration of breeding cranes in the state. The rest of the reported population for these 2 counties is found within a radius of approximately 20 mi around the Roseau WMA. Cranes were also reported as nesting in or near the Agassiz National Wildlife Refuge of Marshall County. Several pairs reportedly nest in Pennington County, west of the Red Lake Indian Reservation. The only other area known to be

used in the northwestern part of the state is the Kiwosay Marsh in Clearwater County. The accumulated known population for northwestern Minnesota then, is 50 to 60 pairs.

Nearly all of the habitat known to be utilized in the east central part of the state is in game management areas and wildlife refuges. Nesting locations include the Grayling Marsh WMA, Rice Lake (Aitkin County), Mille Lacs WMA (Mille Lacs County), Sherburne National Wildlife Area (Sherburne County), and Carlos Avery WMA and adjacent marshes (Anoka and Chisago counties). Non-refuge areas where cranes are also found are Thunder Meadow and St. Croix River marshes (Pine County), and in the vicinity of Rice and Skunk Lakes (Morrison County). The total known population of the east central region is 20-25 pairs. Based on the information collected by the mail survey, then, 70 to 85 pairs of sandhills presently summer and/or nest in 12 Minnesota counties.

Habitat - There are no descriptions of habitats utilized by sandhill cranes in Minnesota. However, such information is available from nearby states and Canadian provinces where the habitats are similar.

Hamerstrom (1938) concluded from his work on 7 sites in Wisconsin that there are several elements important to the composition of suitable crane habitat. The presence of shallow water areas, over forty acres in size, seemed very important. Deep open water appeared to be definitely less attractive. There is a need for isolation and lack of human interference. Ranges were composed of two parts: a relatively small nucleus within which the habitat must be particularily suitable and a larger bordering zone in which unfavorable circumstances are more tolerable. Both the nucleus and bordering zone include a variety of cover

types, which may or may not be advantageous. Uplands occurred in all study areas, and their possible role may be related to rearing of young and to feeding. The one common denominator in all of the Wisconsin crane habitat was peat. However, it was not clear from Hamerstrom's observations whether the peat basins were preferred or used because they were the only areas which provided the size and isolation needed by cranes.

Hamerstrom (1938) described typical crane habitat in the central plains of Wisconsin. "Soils are of two major types, sand and peat, both acid and lacking in essential plant foods....The plain is actually a mixture of low marsh basins, and slightly higher sand islands....The whole pattern is cut through by many drainage ditches....The larger peat areas were more resistant to drainage, and to this fact, apparently, most of the remaining crane habitat can be traced. There are a few tamarack spruce swamps and leatherleaf-labrador tea bogs,...Open water is confined to drainage ditches, a few breaks in the floating bog, and the impounded waters of the cranberrymen's reservoirs....One exception to this general condition was found: the Cutler Range. It is an area of small marshes and sand islands and is more typical of the region as a whole than are the relatively few large peat areas."

Walkinshaw (1949) agrees with Hamerstrom that requirements for nesting habitats of the greater sandhills include isolated, large open areas with shallow water, but also important, he notes, is the presence of dense vegetation, such as sedges, grasses, phragmites, rushes, or leatherleaf.

There are two types of crane habitat found in the Upper Peninsula of Michigan (Walkinshaw 1949). One is located in the Seney, Schoolcraft County marsh area, which was lumbered and drained at the turn of the century. It is now covered with sedges and a few scattered groups of

cane. A few muskeg-type marshes are also found in this area. Scattered through these marshes are a few willows, alder, and some aspen in the drier areas.

The other crane habitat type in upper Michigan, found to the east of the Seney area, are leatherleaf-sphagnum bogs, bordered by large tracts of black spruce and white cedar which help to isolate the areas. Walkinshaw says, "The predominant growth was sphagnum moss, with large patches of leatherleaf. There were patches of Labrador tea, bog rosemary, pitcher plant, and blueberry; on the drier areas, trailing arbutus, wintergreen, club mosses, and scattered grasses; in the marshes, a thin sprinkling of fine sedges and cotton grass." Walkinshaw states that the Minnesota crane areas resemble those of northern Michigan, but he does not clearly state which of the two (or whether both) are like the Minnesota habitat.

Taylor (1976) recently reviewed crane use of the Hiawatha National Forest in the Upper Peninsula of Michigan. He agrees with both Walkinshaw and Hamerstrom that isolation is a necessary condition for nesting habitat. Most nests in this area were located in sphagnum bogs, where typical plants surrounding the nests included sphagnum moss, leatherleaf, cotton grass, stunted black spruce, and jack pine. All nests were closely associated with surface water and most were surrounded by water or located on an unstable bog mat. The size of the bog utilized was considered less important than its isolation from human disturbance. Nesting bogs ranged in size from 0.5 to 2,000 acres (in contrast to Wisconsin sites where 40 acres was considered necessary by Hamerstrom).

Upland areas within several miles of the next site were important feeding areas. Open areas with sparse ground cover were preferred. The vegetation of these preferred areas varied from a sedge-grass-reindeer moss

association to low stages of tree regeneration. Stands with pole size or slightly larger trees with a sparse shrub layer were used before leaf out occurred. Preferred roosting habitat was a mud flat, sand bar, or bog mat surrounded by water, with surface water being the primary requirement. During dry periods when bog water levels are low, beaver ponds and shallow marshes are used as roosting sites.

At Fawcett, Alberta, Walkinshaw (1949) states that the marshes used by the cranes during nesting season, "were often continuous chains of open muskeg, some wet, some dry, cut by many lakes varying in size and many dry knolls covered sparingly with jack pine and poplar. On the muskeg areas, moss was the predominant vegetation, with some sedges, grasses and numerous two to three-foot dwarf birches. Interwoven through the mossy areas were ridges, standing a foot or two higher, and two to four or five feet wider, maintained by the roots of scattered tamaracks and the heavier growth of dwarf birch. These rows of tamaracks crisscrossed back and forth for long distances; in some areas they existed in tiny zigzagging parallel lines between which were basins of damp moss where one sank in several inches of water; the cranes nested in these basins."

The nest site is usually in an open or semi-open area, but there are always some rushes, sedges, grasses, or some type of vegetation tall and dense enough to hide a crane sitting on the nest (Walkinshaw 1949). Twelve of thirteen nests found in the Upper Peninsula of Michigan (Walkinshaw 1965) were built in bogs where sphagnum moss predominated. These nests were built on small mossy islands well above the surrounding water and were composed of wads of moss and small sticks from nearby bushes and trees (usually the most available materials were used). Although these nests were situated in a generally open area, they were always placed adjacent to

a small tree or bush. Similar settings were described for nests in Wisconsin (Roberts 1932), Alberta (Walkinshaw 1949) and Hiawatha National Forest in upper Michigan (Taylor 1976).

It should be noted that there are many greater sandhill crane habitats that are not peatlands. The Malheur Wildlife Refuge in Oregon (Littlefield and Ryder 1968), southern Michigan areas (Walkinshaw 1973), and Rocky Mountain habitats (Drewien and Bizeau 1974) are a few such examples.

Food Habits - In all seasons, the greater sandhill crane leaves the roosting area near sunrise, flies to a feeding area where it searches for food until mid-morning when it returns to the roosting area to rest and preen (Walkinshaw 1949). They will usually return to feed in mid-afternoon and remain until sunset. During the breeding season, cranes will do much of their feeding in the nesting marshes. In areas where waters are fairly acidic (such as northern Michigan, central Alberta, and probably many Minnesota sites) the cranes leave the nest area for the uplands to feed.

The summer diet of sandhill cranes has not been well documented, but general reports reveal that the bird is omnivorous, though predominately vegetarian (Walkinshaw 1949). Hamerstrom states that, "Observation on feeding birds indicate that grains - particularily buckwheat, although corn and oats are also taken - are a large part of the diet in spring, early summer, and autumn". In northern Michigan, blueberries (apparently a favorite item) and grasshoppers are commonly taken. Bill holes found in the ground suggest cranes had bored for insects in sandy areas there (Walkinshaw 1949). Specific information concerning food habits during the summer months is apparently not available.

Approximately 70 fecal droppings were collected in late October in Clay County, Minnesota (Tanner 1971). About 94.4% (by volume) of the air dried material consisted of corn, 4.4% sweet clover, and 1.3% flax. Oat hulls and grasshopper fragments were also found. A late September fecal analysis by Hamerstrom (1938) suggested that buckwheat was the predominant food, but elderberry, blueberry, huckleberry, grasshoppers, and some bettles were also taken.

Seasonal Movements - During the fall, migrant sandhill cranes pass through northwestern and western Minnesota in fairly large numbers, congregating at several points. Important staging areas include the Roseau River Game Refuge, eastern Kittson County, near Rothsay, Wilkins County, areas of Clay County, and near Borup, Norman County, where the largest concentration usually occurs (Green and Janssen 1975, Johnson 1976). The major attraction of these areas appears to be the presence of agricultural lands where grains are readily accessible (Hamerstrom 1938, Walkinshaw 1949, Hoffman 1976).

During the spring, sandhill cranes are found more generally scattered throughout areas of the state, and concentrations are not as large as in the fall.

The racial composition of this migrant population is not well known. However, of a sample collected in Kittson County in September of 1970 (Johnson and Stewart 1973), 65% were found to be the greater subspecies. Apparently most of the fall migrants in Minnesota are from other areas, probably southwestern Ontario and central Manitoba (Johnson 1976).

The east central Minnesota population probably does not have any staging grounds in the state. It is suspected that these birds may move into Crex Meadows Wildlife Area in Burnett County, Wisconsin.

General Statements - The extent of usage of peatlands by cranes in Minnesota is largely unknown. The inaccessibility of many areas makes accurate censusing difficult. Therefore, the mail questionnaire survey conducted by Johnson (1976) probably underestimated actual population levels in Minnesota. How much error is involved is difficult to predict.

Prior to 1870, sandhill cranes were probably common in all but the northeastern part of Minnesota. The encroachment of civilization, hunting pressures, settlement of prairies, drainage of marshes, and the drought of the 1930's, all contributed to the demise of the state's population. The species was considered rare in 1942 (Roberts 1942), and Walkinshaw (1949) estimated 10-25 pairs to be nesting in the state in 1944.

More recently crane population levels seem to be increasing in Minnesota. Since 1950, governmental land acquisition and restoration of marshes has improved conditions for cranes. Reports of cranes in areas not previously occupied and an increase in sightings suggest numbers may be increasing as the species re-establishes itself in Minnesota. However, continued drainage of marshes for agricultural purposes in the northwestern part of the state still threatens loss of the habitat used by the majority of sandhills in the state (Johnson 1976).

All authors agree that one of the most important conditions for the maintenance of a crane population is isolation. Either large tracts of land or well protected areas must be maintained for successful nesting. Management practices presently being conducted include protection of marshes utilized and clearing of uplands (partially by timber sales) near bogs for the necessary open feeding grounds used by cranes (Taylor 1976). Judging from the food habits data, the maintenance of open upland areas by grazing or by agricultural practices could be important.

Possible Impacts - The removal of peat over large areas of bog or open bog types would undoubtedly reduce sandhill crane habitat. On the other hand, removal of peat from the fen or swamp types might well result in large open areas and be beneficial in the long run. In both cases invasion by plants to recreate bog or open bog types would be necessary.

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COMMON OR WILSON'S SNIPE

Minnesota Abundance/Distribution - The common snipe (Capella gallinago delicata) is a regular migrant and summer resident in the state of Minnesota (Green and Janssen 1975). During the breeding season it is most numerous in the north central region and the adjacent counties in the northeastern region. It is a common spring and fall migrant throughout the state. The spring migration period extends from mid-March to mid-May, with a peak in mid- and late April. There may be congregations as early as mid-July due to the drying out of feeding sites used earlier. Fall migration begins in early September and continues through mid-November, with most of the birds leaving between late September and late October. The bird is an uncommon winter resident in the southeastern quarter of the state.

Nearly all of the following disussion is based on information gathered by Tuck (1972), primarily at Codroy and Colinet, Newfoundland; Churchill, Manitoba; and Winisk, Ontario.

Habitat - The breeding habitat of the common snipe is restricted to organic soils, primarily peatland areas within the boreal forest biome (Tuck 1972). However, within this general habitat, snipe are mainly found in shallow or fringe areas where there is some influence of the mineral substrate such as sedge bogs, fens and alder swamps.

Sedge bogs are nutrient rich pockets of land occurring in shallow peatlands. These bogs are minerotrophic and, therefore, can support a plant community that is more demanding than that found on blanket bogs. The principle mosses in a typical sedge bog are Sphagnum fallex and S. augustifolia. Sedges such as Carex exilis, C. Micheauxiana, and C. livida

are usually common. Herbaceous vegetation typically found includes goldthread, bog goldenrod, false Solomon's seal, buckbean, bog aster, and Canadian burnet. When shrubby vegetation is present on sedge bogs, it is usually bog myrtle.

Though sedge bogs usually make up less than 5% of a peatland complex, breeding densities on these areas can be quite high. Populations vary from 2.2 pairs per 100 acres in northern Ontario (the low density in this northern, tundra-associated bog was due to a lack of food resources and nesting sites) to 5.3 pairs per 100 acres in Newfoundland.

Fens make up considerable portions of many peatland complexes. This peatland type develops on wet, shallow areas where there is a significant influence near the surface from the mineral substratum. Widely spaced trees such as tamarack, black spruce, and occasionally balsam fir and white spruce are found on fens. Tall, densely situated shrubs are often present, the most common being speckled alder, willows, serviceberry, and bog birch. Bog myrtle is an extensively occurring low shrub that is especially important to snipe for nesting covers.

The ground cover of fens is a moss-sedge low shrub community. Sphagnum mosses are common in the wetter (mesotrophic) sections, while brown mosses are more often found in the moderate to rich (eutrophic) fens. Horsetail is present in the more nutrient rich portions of fens. Sedges such as Carex rostrata, C. lasiocarpa, C. tenuiflora, which are characteristic of fens, are, in general, tossock-forming plants and are, therefore, important to snipe in providing shelter. Fen sedges, in association with bog myrtle and reed bent-grasses, provide the preferred loafing and nesting cover. Herbs such as Canadian burnet, bog aster, false solomon's seal, golden

ragwort and tall meadow-rue are abundant in fens and important in providing shelter and cover for the raising of chicks.

Fens are the most important breeding habitats in Canada, partly because of their large extent. Breeding densities vary with the wetness and richness of the fen. In the mesotrophic fens of Newfoundland, breeding densities averaged 2.7 pairs per 100 acres while in the eutrophic fens of Churchill, Manitoba, they averaged only 1.4 pairs per 100 acres.

Swamps are forested wetlands with shallow peat and slightly acidic waters. They exist in areas where the summer water table is above soil level. Alder and willow swamps are important nesting habitats for snipe. However, these areas will not be used as nesting sites if spring flooding frequently occurs. They will still be used, however, as shelter for raising young and for molting adults. The ground vegetation is often similar to that of fens, but plants which require shade and wetness, such as marsh marigold and meadow rue will also be found here. Very high breeding densities can be found in swamps. In 2 alder swamps of Newfoundland, the average breeding densities were 7.0 and 5.9 pairs per 100 acres. Near Churchill, Manitoba, a willow swamp held 5.4 pairs per 100 acres, while in Winisk, Ontario, another willow swamp averaged 3.8 pairs per 100 acres.

In addition to these three preferred habitat types, snipe will also utilize areas of decomposed wet plant litter along ponds, rivers, brooks, and other marshy areas. The requirements appear to be the presence of bare mucky organic soils with scanty vegetation. Breeding snipe will be vritually absent in marshes dominated by tall plants, such as cane and cattails.

Raised or blanket bogs are common in some peatland areas. These bogs cover undulating semi-uplands where the surface peat is undecomposed

sphagnum and the vegetation cover is usually Labrador tea or other ericaceous shrubs. Snipe do not normally utilize these relatively dry, nutrient poor sites. Since Tuck did not report on the use of coniferous bogs by snipe, it can be assumed these are avoided.

There is almost no data on snipe breeding habitat in Minnesota, but the following indicate similar requirements to those discussed above. Roberts (1937) records the presence of nests in a boggy meadow in Isanti County, in a tamarack swamp in Anoka County and in a meadow near Twin Lakes, Kittson County.

In 1949 a nest was found in a grass-covered hummock in a meadow in Edina, Hennepin County (Warner 1950).

A nest found in Anoka County was hidden in the center of a large sedge tussock growing in an overgrazed pocket of peat (Marshall 1950). Another nest found in 1974 near Esko was in a grassy hummock under open alder and red osier dogwood on poorly drained peat. Also, Marshall (personal comm.) has observed breeding displays of snipe over peatlands in and adjacent to the Cloquet Forest Research Center annually since 1946. These areas are mixtures of open growing alder and willow with reed canary grass and/or sedges and scattered cattail clumps lying along Big and Little Otter Creeks where early drainage had failed.

Food Habits - During the spring and early summer snipe feed primarily on the water saturated peatlands. As the summer progresses and these areas dry up, feeding sites are often located in swampy areas that were formerly too wet to use as nesting sites. Food studies, primarily stomach content analysis, show that the diet of snipe is composed primarily of insects, crustaceans, earthworms, mollusks, plant fiber, and seeds (Tuck 1972).

Invertebrate animal matter, the primary food resource, usually occurs in the stomach in quantities up to 50%. The animal material in snipe stomachs is principally composed of insects, earthworms, crustaceans, and mollusks. Insects, particularly larvae, are usually an important component in the diet, often comprising more than 80% of the total animal material ingested. Crane flies of the Diptera are particularily important to snipe on the breeding grounds. The larvae of crane flies are abundant on organic wet soils, such as sphagnum and other mosses, and are readily available to snipe. Other important dipterans in the snipe's diet are soldier and horse flies. Aquatic beetles are also taken frequently by snipe. Earthworms will be eaten when they are available, but they are primarily inhabitants of mineral soils and will not be found on the acidic peatlands where snipe normally breed. However, in such places as alder swamps or in the wintering range, earthworms may be more common in the diet. Crustaceans such as cladocerans, copepods, ostracods, isopods, and amphipods, may comprise a substantial portion of the diet. Gastropods, especially small aquatic snails, are another important food taken by snipe.

Although most studies show that plant material usually makes up more than half of the total volumetric stomach contents, this is actually of no nutritive value and is probably taken up only coincidently as the bird's long bill is being used to probe for invertebrates in organic soils. The digestive system does not process the plant fiber, and most of it is usually regurgitated. Seeds are known to comprise 3.8 to 27.3% of the contents of a stomach, but like plant fiber, they are not digestible and should, therefore, not be considered a food item.

A study conducted in 8 localities around Minnesota in fall (Erikson 1941) shows results similar to the above. Animal matter (mostly snails,

larvae of midges, crane flies, horse flies, and dragonflies) made up 61.43% of the total volume while vegetative matter (fruits and some green parts of sedges and bulrush) made up 38.4%.

Seasonal Movements - By late summer, areas where broods have been raised usually dry out and snipe are forced to move onto small pockets of wet organic soils around beaver dams, edges of bog ponds, and along slow rivers and creeks. An obvious change in habitat preference occurs as early as July when feeding shifts to exposed areas of wet organic soils, short grasses, and sedge bogs. By August the birds appear in areas where they were previously absent, such as in mucky sedge marshes where clumps of sedge, and willow or alder swamps provide cover yet enough bare ground exists as feeding areas.

While snipe rarely breed in marshes, these wetlands are very important in fall and winter when the vegetation is battered and dead, thereby exposing the mucky substrates which the snipe can then probe into. Many birds will overwinter in the subtropical areas of the U.S., Mexico, and South America on inland marshes, rice fields, and borders of marshy lakes, though most prefer the extensive coastal marshes of these regions. A few birds will remain further north. It is known that some snipe remain in the southeast quarter of Minnesota.

General Statements - During the 20th century when other shorebird populations were being decimated by market-hunting, the common snipe did not appear to be seriously affected. Later, though, abnormal droughts, exceptionally cold winters, destruction of winter habitat and perhaps overhunting by the sportsman brought on a closed season for this game bird from 1941 to 1953 in the U.S. However, it is now considered fairly common and in no danger. Its safety lies in the following facts: it is a widely distributed bird,

breeding in the more remote, inaccessible peatlands of the U.S. and Canada; it seldom flies in flocks; and its erratic flight creates a handicap for the hunter that is hard to overcome (Erikson 1953).

The common snipe has been considered a well protected bird because it utilizes, for the most part, the nutrient-poor fringe of marginal organic soils which are usually remote and impractical for agricultural, pastural, or other uses. Its wide distribution and habitat preference make management of this species seem unnecessary. However, one instance of bog reclamation at Colinet, Newfoundland, proved beneficial to snipe (Tuck 1972). A former blanket bog dominated by ericaceous shrubs was drained, fertilized, and converted into pasture. Drainage ditches, one meter deep, intersected the pastures at 150 m intervals. The principal pasture grasses established were reed canary, timothy, brown top, and Kentucky blue. Drainage compacted the peat soils, but frequent rains, especially in the fall, kept the area almost continuously suitable for probing by snipe, while close cropping by cattle kept the soil available to snipe. There were abundant foods, particularly insect larvae (crane fly larvae heavily infest the area), partially due to the cattle manure in which insects will lay their eggs. In dry years there are fewer snipe, but normally 3,000 to 4,000 frequent a study area of 200 acres each fall.

It is interesting that Marshall (1952) reported heavy use by snipe of an overgrazed pothole site in Ramsey County. Also that Neely (1959) reports on management of rice paddies in Louisiana by a combination of draining, partial reflooding, and grazing after the harvest.

Possible Impacts - It seems reasonable to conjecture that the removal of peat deposits so that mineral soils are close to the surface without

effective drainage might add to snipe breeding and summer habitat. This could be true if mixtures of open bog, fen, or swamp thicket vegetation developed as a result of reinvasion by plants. Should land use for grazing develop, the situation might be further enhanced.

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CANADIAN SPRUCE GROUSE

Minnesota Distribution/Abundance - The Canadian spruce grouse (Canachites canadensis canace) is a regular permanent resident in the northeastern and north central regions of Minnesota and in adjacent Roseau County (Green and Janssen 1975). It is found primarily in counties along the Canadian border. Despite an abundance of peatlands in southern St. Louis County, there are no recent records of birds in this vicinity.

Habitat - Haas (1974) and Anderson (1973) studied habitat utilization of female and male spruce grouse during the spring and summer in the Big Falls area of Koochiching County, using radio-telemetry techniques. This area is predominantly peatland sparsely interspersed with some uplands. Eleven habitat types were identified here: 1) black spruce forest, 2) young black spruce forest, 3) stunted black spruce forest, 4) black spruce-feathermoss forest, 5) poor swamp forest, 6) black spruce-alder forest, 7) rich swamp forest, 8) upland hardwood forest, 9) shrub community, 10) black spruce clear-cuts, and 11) shrub community clear-cuts (see Tables 1 and 2 for a summary).

The black spruce forest was considered by both investigators to be the most important habitat type for the spruce grouse. Anderson described the forest type as:

> dominated by black spruce (Picea mariana) stands with a few tamarack (Larix laricina) interspersed. The type has a cover of 52% and a basal area of 154 square feet per acre. The shrub layer, averaging 13% cover, is dominated by black spruce with speckled alder (Alnus rugosa) and swamp-birch (Betula pumila) subdominant. Labrador-tea (Ledum groenlandicum), wild lily of the valley (Maianthemum canadense), leather-leaf (Chamaedaphne calyculata),small cranberry (Vaccinium oxycoccus), mountain-

Table 1. Stand characteristics.

Forest Type	Tree		Shrub		Herb	Surface (mosses)
	Density/Acre	Cover (%)	Density/Acre	Cover (%)	Cover (%)	Cover (%)
pland Hardwood	925	59	3267	32	59	0
Black Spruce Feathermoss	2015	76	77	1	20	97
Black Spruce	2192	52	977	13	55	72
oung Black Spruce	599	14	2774	27	67	83
tunted Black Spruce	1468	30	2397	29	74	79
Rich Swamp	1067	40	3085	35	58	47
lack Spruce/Alder	925	50	2741	31	59	92
Poor Swamp	501	30	35223	40	25	20
hrub Community	0	0	33246	60	42	83
hrub Community Clear-cut	0	0	2613	20	81	0
Black Spruce Clear-cut	98	5	1470	17	64	81

Table 2. Tree height and height to canopy.

Forest Type	Tree Height (ft)	Height to Canopy (ft)
Black Spruce Feathermoss	55	40
Black Spruce	55	14
Young Black Spruce	13	2
Stunted Black Spruce	12	2
Rich Swamp	38	6
Poor Swamp	40	9
Black Spruce Alder	40	5
Black Spruce Clear-cut	8	.5

cranberry (Vaccinium vitis-idaea), and swamp-laurel (Kalmia polifolia) are common in the herbaceous layer. The surface layer is dominated by sphagnum with lesser amounts of feather-moss (Calliergonella schreberi) and Dicranum rugosum.

A quantitative description of the black spruce forest is given in Table 3.

Haas, working with hens, determined habitat use and selection in three periods: pre-nesting, nesting, and post-nesting. The most heavily used habitat types were examined to see if selection within a defined habitat was occurring.

During the pre-nesting period (April-May) female spruce grouse used the black spruce forest in proportion to its availability while other types received 10% or less use per type. The shrub community, the black spruce clear-cut, and the shrub community clear-cut were not used by hens in this period. Further analysis of use within the black spruce forest revealed that hens selected for stunted and more open areas.

During the nesting period there was a strong selection for the young black spruce forest as a nesting site. Of 10 located nests, 7 were found in the young black spruce forest, and 3 in the black spruce forest. Within the young black spruce forest there was selection for high shrub density and canopy values. These, coupled with the dense herbaceous layer, provided good horizontal and vertical cover for the nesting birds. The part of the black spruce forest utilized was more open than in general, and thus similar to the young black spruce forest. A comparison of nest sites within both habitat types reveals that while there were differences in the shrub density and cover, both types had a similar herbaceous canopy coverage characterized by plants belonging to the Ericaceae family.

Hens with broods consistently utilized the black spruce forest

Table 3. Black spruce forest - Tree, shrub, herbaceous, and surface layers based on 332 quadrats.

Species	Import. Value	Pcent. Freq.	Pcent. Cover	Density/ Acre	B.A./ Acre
TREE LAYER					
Picea mariana	295.8	100.0	51.5	2185.6	153.2
Larix laricina	4.2	3.6	T	6.5	0.5
Total	300.0	100.0	51.9	2192.1	153.7
SHRUB LAYER					
Picea mariana	265.2	74.7	11.8	846.1	
Larix laricina	3.0	1.5	T	7.6	
Salix spp.	2.5	T	T	7.6	
Alnus rugosa	15.7	2.7	T	57.7	
Betula pumila	13.5	3.3	T	57.7	
Total	300.0	81.0	13.3	976.7	
HERBACEOUS LAYER					
Picea mariana	6.1	26.8	T		
Salix spp.	0.2	T	T		
Ledum groenlandicum	64.2	97.8	25.8		
Kalmia polifolia	13.6	54.2	2.3		
Andromeda glaucophylla	1.3	6.3	T		
Chamaedaphne calyculata	26.8	76.5	7.3		
Vaccinium angustifolium	6.5	25.9	1.1		
Vaccinium myrtilloides	0.1	T	T		
Vaccinium Vitis-Idaea	17.1	64.4	3.2		
Vaccinium Oxycoccos	17.6	69.6	2.9		
Maianthemum canadense	28.4	77.4	8.1		
Cypripedium acaule	0.1	T	T		
Rubus acaulis	0.2	T	T		
Eriophorum spissum	2.9	12.3	T		
Carex trisperma	2.2	9.3	T		
Carex leptalea	9.0	36.4	1.5		
Carex limosa	0.6	3.0	T		
Carex disperma	0.5	2.1	T		
Carex interior	0.4	1.8	T		
Gramineae	1.9	7.5	T		
Lycopodium annotinum	0.3	1.2	T		
Total	200.0	100.0	54.7		

Table 3. (continued)

Species	Import. Value	Pcent. Freq.	Pcent. Cover	Density/ Acre	B.A./ Acre
SURFACE LAYER					
Sphagnum of. S. palustre	46.5	80.7	19.7		
Sphagnum of. S. magellanicum	78.5	90.4	48.3		
Sphagnum of. S. fuscum	7.7	12.0	3.7		
Sphagnum spp.	0.1	T	T		
Calliergoenella schreberi	35.2	56.9	16.3		
Aulacomnium palustre	0.1	T	T		
Hypnum crista-castrensis	0.2	T	T		
Dicranum rugosum	9.7	23.2	2.0		
Polytrichum spp.	0.2	T	T		
Litter	21.8	35.8	9.9		
Total	200.0		100.0		

T - Less than 1%.

throughout the brood-rearing period. During the first two weeks after hatching, hens with chicks selected for open stunted portions of the black spruce forest with a high herbaceous layer canopy. During this period the ericaceous plants were less important at sites utilized, while false lily-of-the-valley was in much higher proportions at hen locations than in the vegetation as a whole. It is not known if the grouse were selecting for areas of the black spruce forest with high coverage of this species of lily for food (young grouse were seen eating the plentiful false lily-of-the-valley berries) or some other factor, such as a high insect population (another source of food), which might have been associated with the plant.

Following this first 2 week period, hens with broods intensively used areas of the black spruce forest with low tree density, tree cover, and shrub density, but a higher density of the herbaceous layer. The sedges, blueberry, and cranberry plants were more important at the sites used by the older broods. The rich swamp forest was used to some extent.

Hens without broods intensively used the black spruce forest, while the young black spruce and rich swamp forest were used to some degree. All three types were used in approximate proportion to their availability while the other habitat types received less than 10% use per type. These hens selected for portions of the black spruce forest that were denser and had more tree and shrub cover.

Anderson found only 5 of the habitat types to be significantly used by male spruce grouse; 1) black spruce forest, 2) stunted black spruce forest, 3) black spruce-feathermoss forest, 4) poor bog forest, and 5) black spruce-alder forest. However, he found spring male activity to be concentrated in specific parts of the black spruce forest and divided the

spring habitat usage by grouse cocks into snow-cover and snow-free periods. During the pre-display period of early spring (late March-April) when the ground was still covered with snow, adult males intensively utilized the black spruce forest. Within this type, the cocks were usually found in taller, more dense portions with low shrub densities and shrub cover. As snow melted, and patches of bare ground exposed newly available food resources, increased usage of such open areas was noted.

During the snow-free period (May-June), territorial cocks used 2 types of cover. In the morning, evening, and night, they were in taller portions of the black spruce forest which Anderson refers to as "display type habitat." The actual display sites were probably selected for either good visibility under the canopy or for their available perches. Selection is apparently for sites where cocks can see under the canopy, yet have enough lower branches for display perches.

In the middle of the day adult cocks were found in a more open black spruce forest with a dense shrub layer, referred to as "afternoon habitat." This afternoon habitat is similar to the black spruce forest itself, suggesting that no selection within the type was occurring. During the late display and post-display periods, adult cocks utilized the more open portions of the afternoon habitat to a greater extent. This area was often in the transition zone between black spruce and stunted black spruce forests. Occasionally cocks made long excursions out of their home range into the poor bog forest.

Juvenile males used a slightly more open habitat in the pre-display, snow-covered period in which spruce was somewhat lower in density and basal area while the shrub layer was greater in frequency, density, and cover. During the snow-free period, juvenile males mainly used the same

afternoon type habitat as the adults. This suggests that juvenile males are not particularily selective in their use of the black spruce forest. Occasionally, juveniles were found in poor bog, stunted black spruce, black spruce-feathermoss, and black spruce-alder forest.

Spruce grouse utilization of habitat types in Minnesota was also observed by field biologists of the Bureau of Game in 1950-51 in Lake, Cook, St. Louis, Koochiching, and Lake of the Woods Counties (Stenlund and Magnus 1951). Forty-four percent of one set of observations occurred in pure conifer forests. Seventy-nine percent of another set of observations were made in forests that were 75% conifer, with jack pine the most common tree, followed by black spruce, balsam fir (Abies balsamea) and tamarack. Of 79 observations, 57 (72%) were made in upland rather than in lowland or swamp types. The general pattern of habitat utilization held year round. Use of black spruce increased in the summer, almost equaling use of jack pine. Cedar, red and white pine, and white spruce were considered relatively unimportant.

Ammann (1963) listed 4 descriptions of habitat types where spruce grouse were most consistently found in the upper peninsula of Michigan as: 1) medium age to old jack pines, either as scattered single trees or in groves, with at least 50% shading, 2) scattered old white spruce, interspersed with mixed young conifers, poplars, and small openings, 3) medium-aged conifer-poplar-birch with scattered small openings, and 4) small bogs with scattered black spruce and tamarack, interspersed with upland ridges and knolls with medium-age to old jack, red and white pine.

Robinson (1969) compared available to selected summer habitat of spruce grouse on the Yellow Dog Plains of northern Michigan. He found that the birds selected diverse stands, especially those of mixed spruce (mostly

black spruce) and jack pine. Pure stands of mature jack pine were avoided (in contrast to Ammann 1963). Of the low vegetation, blueberries, trailing arbutus, and black spruce were more common in the selected habitat than in general, while bracken fern, grasses, and lichens occurred at lower frequencies than average. The combination of younger, mixed-age stands of unpruned (lower limbs have not died and fallen away) conifers and a ground cover of blueberry plants apparently provides the spruce grouse with the essential requirements of the summer habitat in this particular region of Michigan.

Food Habits - No data on foods eaten by spruce grouse in Minnesota are available. However, five studies (Central Alberta - Pendergast and Boag, 1970; Alaska - Ellison, 1966; northwestern Montana - Jonkel and Green, 1963; north central Washington - Zwickel, Boag and Brigham, 1974; central Ontario - Crichton, 1963) have been reviewed in detail and will be used to characterize the seasonal changes (Table 4). Most of these studies are based on data from hunter killed birds.

The major food during the winter is the needles of conifers - white or black spruce being reported in Alaska, jack pine in Ontario, and lodgepole pine (and some spruce) in Alberta.

During the spring months the birds still consume needles - in Alberta, lodgepole pine and spruce, in Alaska, spruce - but shifted to cranberry leaves and berries or blueberries; with one report showing oxytrope leaves.

The summer months show a major use of leaves and berries of ericaceous plants and some other foods, i.e., Alaska - cranberries, blueberries, crowberries, and horsetails; Alberta - cranberry with some spruce and lodgepole pine.

Table 4. Foods taken by spruce grouse as determined by crop analysis in 5 years.

Area	Summer		Fall		Winter		Spring	
Central Alberta	Cranberry l & b*	25.2%	Spruce	3.0%	Lodgepole Pine	98.5%	Lodgepole Pine	53.3%
	Spruce	21.9%	Lodgepole Pine	29.2%	Spruce	1.3%	Old Cranberry l & b	25.1%
	Lodgepole Pine	4.1%	Blueberry l & b	33.8%				
			Cranberry l & b	23.1%			Spruce	19.5%
Alaska	Cranberry l & b	38.0%	Cranberry l & b	40.1%	Spruce	99.9%	Spruce	35.2%
	Blueberry l & b	33.1%	Spruce	10.0%			Cranberry l & b	25.5%
	Crowberry l & b	18.0%	Blueberry l & b	27.0%			Blueberry l & b	18.9%
	Horsetail	3.7%					Oxytrope	11.1%
Northwest Montana			Western Larch	39.4%				
			Grasshoppers	11.4%				
			Pine	7.3%				
			Huckleberry	6.4%				
Ontario			Jack Pine	50.6%	Jack Pine	99.9%		
			Tamarack	36.3%				
			Blueberry leaves	8.4%				
			Black Spruce	0.6%				
Washington			Lodgepole Pine	47.0%				
			Western Larch	16.0%				
			Vaccinium spp.	8.0%				

*l & b = leaves and berries. For all conifers the needles were eaten.

The data from all five studies show that during the fall the birds continue to consume blueberries, cranberries and/or huckleberries in considerable quantities. However they begin to shift to conifer needles - spruce, lodgepole pine, larch or jack pine depending on the area. This shift towards a coniferous diet occurs before snowfall makes the low-growing ericaceous plants inaccessible, and is completed by the time these foods are covered. Pendergast and Boag (1971) have suggested that the degree of adaptation through conditioning of the gastro-intestinal tract, both anatomically and physiologically, which apparently takes some time, can be critical to the grouse's ability to utilize a diet of conifer needles. Sudden, early prolonged periods of heavy snow cover may cause considerable stress, and heavy autumn mortality, particularly in the young of the year, could be a possible result.

How availability relates to utilization is not well documented, except in Alberta (Pendergast and Boag 1970). Here lodgepole pine was heavily preferred in winter, with an index of utilization (% volume consumed divided by frequency available) of 1.25, while the index for spruce in winter was only 0.2. In Ontario, Crichton (1963) found black spruce to be only lightly used, despite the fact that he considered it highly available. Apparently some pine species are favored over spruce if both are available.

Ellison (1976) found that in Alaska, where the winter diet consists exclusively of needles of spruce trees, white spruce was more heavily favored than black spruce, and within the white spruce species, certain trees were heavily browsed while other nearby individuals were left untouched. These "feeding spruce" trees were selectively fed upon by grouse for periods up to 4-5 years. Trees less than 14 years old were not utilized at all.

The discrimination against black spruce and for individual white spruce

may be based upon an interaction between needle morphology, nitrogen content, and digestibility. Longer and less dense needle formations were more preferred, apparently because these physical attributes allowed easier removal by the grouse. Nitrogen has been considered a possible limiting factor for spruce grouse in some areas (Gurchinoff and Robinson 1972). High crude fat levels may be indicative of high concentration of essential oils that might inhibit digestion. High crude fiber content is also negatively associated with digestibility. Nitrogen, on the other hand, is often positively correlated with digestibility. Black spruce has relatively shorter, more densely situated needles, a generally lower nitrogen content, a higher crude fat and crude fiber content than white spruce. These four factors then, may interact to cause a preference for white spruce. Selection for individual white spruce trees may be due to the same factors. However, while the birds did select for white spruce trees with longer, less densely spaced needles and for trees with a low crude fiber level, there was no direct evidence they selected for a high nitrogen content.

Trees growing in lowland bogs tend to have a lower availability of nitrogen and short, dense needles. Discrimination against black spruce may be explained by the fact that it is often associated with boglands.

Gurchinoff and Robinson (1972) found interestingly similar results to those of Ellison's for jack pine in northern Michigan. Jack pine is the most important species in the winter diet of the spruce grouse on the Yellow Dog Plains, and observations revealed that individual trees were selectively utilized. Trees browsed upon had a significantly higher nitrogen content, lower crude fat, and higher ash content. Increased age was apparently coincident with higher protein and mineral values. Though fats are a valuable food source, high fat content in jack pine may also be associated with large

amounts of inhibitory essential oils. Selectivity of high ash (or total mineral) content may be important for prevention of disease and for successful reproduction.

Seasonal Movements - The spruce grouse is a year round resident wherever it is found. Therefore, any movements made by individuals will be local in extent. All figures concerning home range sizes given below must be considered minimum size, since in only a few instances were enough data collected so that estimates leveled off with increasing numbers of observations.

During the spring male spruce grouse enter into a period of territoriality involving a spectacular display behavior, which ends coincident with the start of incubation by hens (Ellison 1971). During this time of year, males occupy a small area and defend it from all other males. In Minnesota, size of defended territory ranged from 0.5 to 7.8 acres in size, and averaged 3.9 acres (Anderson 1973). In Alaska, Ellison (1971) found 5 adult males to defend territories ranging in size from 4.6 to 8.9 acres, with an average of 6.4 acres.

Greater movements of adult cocks were more common during the pre- and post-display periods than in the display period (Anderson 1973). Home ranges of 9 adult males in Minnesota ranged from 4.5 to 26.5 acres and averaged 11.0 acres. Usually the center of activity in a home range is part of the territory defended in the spring. Occasional long distance movements out of the home range were recorded. All pre-display period movements were either to bare patches of ground, probably used as feeding sites, or to gravel roads to obtain grit. Most post-display movements were to roads, or to poor bog forests (possibly to feed on tamarack trees, which were less abundant on the spring home ranges).

Ellison (1973) reported that male spruce grouse will move into "molting ranges" in late June and early July, where dense cover, either black spruce or alder, exists. Of 5 radio-collared cocks monitored, none moved more than 295 yds from the center of its spring territory.

Haas (1974) studied seasonal movements of hen spruce grouse in Minnesota. During the pre-nesting period the mean home range size was 45.6 acres, with a range in values of 6.5 to 87.6 acres. In the nesting period there were too few observations of birds off the nests to calculate a home range but it was undoubtedly small. In the post-nesting period, hens without broods had an average home range of 25.0 acres, with values from 10.3 to 42.7 obtained. Hens with broods restricted their movements in the first few weeks after hatching to a small area of a specific habitat type. The mean during the first two week period was 19.7 acres, whereas, for the remainder of the brood rearing period, the home range averaged 49.0 acres, with a range of 8.4 to 130.4 acres.

Ellison (1973) found movements of 3 radio harnessed hens in the pre-incubation period covered 14.8 to 51.9 acres, with an average of 33.4 acres. This is comparable to Haas' figure but both are from small sample sizes. During the summer, hens with broods averaged 104.0 acres with a range of 15.1 to 383.0 acres, a much higher average than what Haas reported.

Fall observations suggest that adults remain on or near their spring and summer ranges (Ellison 1973). Juveniles have a tendency to disperse into new areas at this time.

Winter movements by grouse are not well studied, but it appears that both cocks and hens will occupy the same general area as they did in late fall and winter (Ellison 1973). Flocking is known to occur in the fall and winter. These groups, which are usually made up of 2-4 birds, are

transitory, generally consisting of adult hens and juveniles of both sexes, adult males apparently exhibiting a more solitary behavior.

The need to obtain grit is one of the biggest factors stimulating long range movements. In Minnesota it is known that both male and female spruce grouse utilize roads after the snow melts in the spring, but information concerning how far birds travel is not reported. Birds are attracted to gravel roads and lakeshores in the fall prior to snowfall in Alaska (Ellison 1973). It is known that some juveniles show up 6 mi from their brood ranges, while adults are known to travel to roads 2 mi from their summer ranges.

General Statements - The Canadian spruce grouse was a common bird in Minnesota as far south as Mille Lacs, Wadena, and Carlton counties through most of the 1800's (Roberts 1932). However, in the later part of the century and in the first half of this century its abundance diminished greatly and Roberts describes the spruce grouse as being rare throughout its Minnesota range. He suggests the tameness of the bird made killing of it an easy and common occurrence, thus lowering the size and range of the population.

Widespread logging operations and major fires are also credited with reducing the population size by eliminating the mature conifer forests needed by the species (Stenlund and Magnus 1951). With the regrowth of these forests and complete protection from hunting the population increased significantly, but it is still found predominantly only in the uninhabited region just south of the Canadian border from Lake of the Woods to Lake Superior. Hunting seasons on this species were reopened in 1969, indicating a major return of spruce grouse populations.

Both logging and fire apparently have an early negative effect and

later positive effect on spruce grouse. In Alaska wildfire resulted in a 60% decrease in the subsequent spring breeding density (Ellison 1975). At least 35% of the adults using the burn were birds that had previously occupied the area and were apparently reluctant to abandon the established home range, despite the drastic alterations due to the fire. Most of the cocks on the burn were associated with islands of unburned trees.

The black spruce and black spruce-feathermoss forests were the main vegetation types affected by logging practices in Minnesota (Haas 1974). No female spruce grouse were observed utilizing a shrub community clear-cut, which had been bulldozed and planted to black spruce. Recent black spruce clear-cuts (1 to 30 years) were not used, except by a few hens during part of the brood-rearing period, and here, usage of these areas occurred only at the edges where blueberry, false lily of the valley, and members of the genus Rubus were plentiful.

Tracts of young black spruce forest resulting from previous fire and/or logging are important hen spruce grouse habitat. This habitat type was important for nesting and to hens without broods during the post-nesting period.

Spot-cutting (harvesting of black spruce for Christmas trees) done in the black spruce forest where tree height was 20 to 30 feet, opens up the tree canopy. Twenty-nine percent of the pre-nesting period hens, 67% of the early-brood rearing hens, 33% of the brood-rearing hens, 38% of the hens without broods, and 27% of hen nest sites on Haas' study site were located on sites where spot-cutting had occured.

Several studies (Ellison 1973, 1974, Haas 1974, and Anderson 1973) report graveled roads to be an important source of grit for spruce grouse. Anderson (1973) found that, for cocks, road use increased in the spring as

the snow began to melt, reached a peak in the later part of April, dropped off during the display period, and then sharply increased at a time coincident with the end of the display period. This increase drops off again in the latter part of June and early July, when molting causes birds to localize their movements.

Gravel roads were heavily used by hens during the pre-nesting period (Haas 1974), especially during the week following disappearance of snow from the area. Roads were neither used during the nesting period, nor during the first two weeks of brood rearing. Hens without broods and with broods older than 2 weeks selected for gravel roads, but usage was not great.

Since Anderson and Haas conducted only spring and summer studies, road usage for fall is not known in Minnesota. In Alaska, however, Ellison (1973) found usage of roads to be greatest in the fall. Since hunting of spruce grouse is allowed in Alaska, this has an important effect on harvest rates. Hunters rarely go into the forest to search for grouse so nearly all birds are taken along roads (Ellison 1974). Hunters removed about 13% of all banded birds in the study area, but this did not result in any discernible downward trend in the population. It should be noted however, that this area was a large tract of undisturbed habitat that extended for 4 mi on either side of the road. In other instances a similar harvest rate may be excessive.

Territoriality among males did not seem to be a limiting factor on mortality rates of males (territorial males suffered the same mortality rates as nonterritorial males), or in mortality rates of hens. Females are not dependent on the resources of a particular territory at any one time, nor are they normally excluded from any territory. Population regulating mechanisms are not well understood. Perhaps some subtle behavioral

mechanism may be operating in late winter or during the breeding season that would determine the number of both sexes remaining in a given area to breed (Ellison 1973).

Possible Impacts - It appears abundantly clear from these studies that the spruce grouse is very much dependent on coniferous forests - older and denser ones for spring display sites and for food and cover during the winter while more open or younger stands are used for nesting, brood rearing, and feeding during the summer and fall. Here, the growth of ericaceous berry producing plants associated with early to mid stages of succession seem to be major foods. Although spruce needles may be an important winter food, other conifers which grow on uplands may be preferred if available. The data on movements clearly show that these birds habitually remain in areas of less than 100 acres. Large open areas created by extensive logging and/or fires are certainly avoided for periods up to 30 years. This clearly suggests that removal of major acreages of swamp conifer-spruce forests will reduce if not eliminate spruce grouse populations for a very considerable period of time.

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SHARPTAIL GROUSE

Minnesota Distribution/Abundance - The prairie sharptail grouse (Paediocetes phasianellus campestris) is found in habitats scattered throughout northern Minnesota north of a line from Pine County to Hubbard County. It occurs where there is a combination of forested/brushy/grassy uplands and bog areas with open habitat. During the time of early agriculture and logging it was widespread and abundant, but its numbers have dropped sharply in most of the region over the past 30 years. Largest populations are in the agricultural-forest zone of northwestern Minnesota.

Habitat - An early discussion of sharptail habitat requirements in northern Wisconsin (Grange 1948) can probably be applied to northern Minnesota. He states that: "there must be a bog area (sphagnum, leather leaf, Labrador tea, bog birch, cranberry) for cover in the winter; a grassy area (grasses or sedges) for spring dancing grounds; a shrub area (hazel, chokecherry, rose,willow);and a weedy area (smartweeds, hawkweed, pussy toes, aster, golden rod) for spring and summer foods. A wild fruit area (wintergreen, dew berry, strawberry, blueberry) also for spring and fall foods. A forest area (birch, aspen, pin cherry, black cherry, service berry, chokecherry) for winter and fall foods."

During the spring, summer and fall periods sharptails are found mostly on uplands. However peat habitats--especially muskeg or open bog are of importance during the winter for roosting cover. In fact Doll (1953) states "The usual winter sharptail roost is in a deep hollow in quite

dense marsh or swamp vegetation such as Labrador tea, sphagnum (moss) or carex (sedges)" and "It is common for winter roosts to occur in open stands of tamarack and spruce in Wisconsin. During snowless periods, except during the growing season, sharptails appear to return to marshes--their night roosts are commonly situated in dense and generally coarse vegetation (often Carex)".

We found no direct reference to use of open bog or muskeg for the spring dancing grounds in the Lake States. However, Hanson (1953) reports that the northern subspecies uses muskeg for display areas in the James Bay area of Ontario. The birds in the large bogs of Minnesota may also use this type for display.

Food Habits - A report on winter food habits of sharptail grouse in Hubbard County, based on analyses of droppings in night roosts, lists bearberry (51%), rosehips (29%), wild buckwheat (10%), and wolfberry (6%) with other upland plants making up 4% (Swanson 1940). In central Wisconsin winter foods were listed as buds of white birch, aspen, balsam, poplar, willow, bog birch, leather leaf, and seeds or berries of smartweed, wintergreen, and cranberry (Schmidt 1936). Also, Grange (1948) reports that buds and catkins of white birch and hazel, the buds of aspen, and rose hips are taken.

Foods taken during other seasons are reported by Grange (1948) as follows: Spring - "The diet still includes buds, catkins, and tree flowers until the growth of green fresh leaves, such as clovers, blackberry, grasses, pussy toes as well as fruits of blackberry and wintergreen;"

Summer - "leaves of hardhack, golden rod, horsetail, fleshy fruits, as well as grasshoppers, ants, and spiders"; Fall - "The fall food of sharptail shows greater dependence on seeds and grains" with use of buckwheat, grasshoppers, fleshy fruits, and leaves of aspen, clover, and sheep sorrel occurring.

However, Amman (1957) reports from Michigan that "cultivated grains utilized at feeding stations, food patches and grain fields are wheat, buckwheat, field peas, corn, barley, soybeans, millet, and rye" and Grange (1948) made a similar observation. In many management areas food patches with one or more of these grains are maintained by wildlife departments.

All of these studies were carried out in areas of sandy soils with bogs intermixed. A more complete Nebraska study (Sisson 1976) shows that in spring 99% of the foods were the flowers or leaves of herbs. In summer similar plant foods made up 57% of the diet with 42% being grasshoppers. In the fall they turned to seeds (79%) but continued to utilize grasshoppers. Probably these broad groupings would apply in Minnesota.

Seasonal Movements - Sharptail apparently have a daily cruising range of up to a mile (Hammerstrom 1951) although this probably is less during the summer. There are more extensive movements between summer and fall/winter habitats. Thus Hammerstrom (1951) reports that "of 162 birds with complete data about 38 percent were taken in one place only; 81 percent

within two miles; only 12 percent more than three miles from the banding place, and 10 percent more than five miles. The largest move was 21 miles".

General Statement - The sharptail grouse in the northern lake states is known to make use of open bog or muskeg for winter cover. However, undoubtedly populations are dependent on adjacent uplands for most of the year. Since these birds are quite mobile, an interspersion of extensive bogs with uplands may well be adequate to maintain populations.

Probable Impact - Removal of open bog types in areas where the ratio of upland brushy/grassy habitats is low might well drastically reduce populations.

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GREAT GREY OWL

Minnesota Distribution/Abundance - The great grey owl (Strix nebulosa) is a rare winter visitant in the northern half of the state, most regularly occurring within 100 miles of the Canadian border (Green and Janssen 1975). During invasion years, which occur at irregular intervals, the birds are considered uncommon in localized areas. However, this owl is a casual summer resident in Roseau County, where four reported nestings have occurred (1935, 1970, 1974, 1976). They have been seen during the breeding season in St. Louis County (3 in 1974), Lake County (2 in 1974), Koochiching County (1974), Aitkin (2 young seen with 2 adults in 1975, suspected nesting 1976), Cook, Itasca, Clearwater, and Lake of the Woods counties.

Habitat - All records of breeding birds in the Minnesota area have come from peatlands. The first nest, found in Roseau County in 1935 was in a tamarack tree within a "tamarack swamp" (Turner 1935). Reports by Nero (1970) and Nero et al (1974) also state the nests used by great grey owls were found in tamarack trees located in a black spruce-tamarack bog. One of these was located near a freshly logged area which the birds apparently used as a hunting ground. Parmelee (1968) recorded use of a nest in a small island of tall aspens, surrounded by muskeg in Manitoba. In Sweden, nesting locals have been found in a variety of habitats; forests close to clearings, swampy mixed forest, and dense vegetation were all used, but they were usually in or close to bog areas (Hoglund and Lansgren 1968).

All investigators, including those in Sweden, have reported that great grey owls do not build their own nests (Hoglund and Lansgren 1968,

Parmelee 1968, Nero 1970). Rather, they will use any large bulky bird's nest such as that of a hawk owl (Parmelee 1968), a hawk (Nero 1970), or even an artificial nest (Nero, et al 1974).

There is use of a greater variety of winter habitats than in summer, due mainly to the fact that during invasion years habitat use changes greatly. Many of the observations have been made in areas the owls have temporarily invaded. In southeastern Ontario Brunton and Pittaway (1971) reported that the areas most frequently occupied were open fields with scattered elms, patches of shrubbery, weedy areas, overgrown fence rows and abandoned farmlands. The bordering areas consisted of fairly extensive mixed forests and secondary roads where the owls were only rarely seen. The birds seemed to establish home ranges of no greater than 112 acres of typical habitat. Nero (1969) notes that in Manitoba great grey owls are usually seen hunting in open fields but are seldom far from a heavy spruce forest.

Food Habits - It appears that great grey owls are specialists in hunting small rodents and shrews. In Fennoscandia (Mikkola and Sulkova 1970), 79-90% of the prey items in pellets collected from the nesting season were of the vole family Microtidae, while 3.6-5.1% were of the Soricidae, or shrew family. Hoglund and Lansgren (1968) arrived at similar conclusions after collecting and analyzing pellets during the breeding season in Sweden. Voles made up 94.6% of the animals found in pellets collected around nests, shrews 4.9%, and other prey only 0.5%.

In winter Hoglund and Lansgren (1968) stated that all stomach contents collected were made up of the vole and shrew families. Twenty-seven stomachs analyzed in Fennoscandia (Mikkola and Sulkova 1970) during the

non-breeding season contained 42.7% shrews, and 56.3% voles. In Manitoba Nero (1969) found the meadow vole to make up 61% of the total prey individuals in winter; 7% were heather voles and 30% masked shrews. Brunton and Pittaway (1971) concluded from field observations and pellet analysis that the owls in the Ottawa Ontario-Hull, Quebec District to be feeding almost exclusively on meadow voles, with an occasional short-tailed shrew.

Seasonal Movements - The great grey, along with several other owls, is well known for its irregular movements south in winter. The cause of these mass movements has usually been attributed to lack of available food resources. Hoglund and Lansgren (1968) state, "After good reproduction and in connection with decreasing frequency of small rodents in the breeding localities the great grey owl will not rarely occur outside its normal range. According to our opinion this occurrence is largely to be understood as a more or less pronounced starvation migration." They go on to say, "Like a number of other owls also the great grey owl is probably living a sort of nomadic life within its normal range and will settle periodically in localities which for the time can offer sufficient food for maintenance of life and for breeding."

Nero (1969) states that, in Manitoba, the owl is generally unknown outside its breeding range in the northern coniferous forest, except in late fall and winter when it occasionally wanders south. The same sporadic winter occurrence was reported by Brunton and Pittaway (1971) and Green (1966, 1969). During these influxes the birds apparently establish semi-permanent hunting territories.

In Minnesota, recent invasions have occurred in the winters of 1965-1966 and 1968-1969 (Green 1966, 1969). The birds did not arrive in Minnesota until later in the winter, and then they were most common in the muskeg region of the northwestern part of the state. The remoteness of this area makes accurate censusing and observations difficult. In the 1965-1966 invasion, birds were first seen in Cook county, around early December, while observations in Lake, St. Louis, Carlton, Aitkin, and Becker counties were reported later. The 1968-1969 movement appeared to be larger in terms of numbers and geographical distribution. It was suggested (Green 1969) that these birds probably came from an area east of Winnipeg where there was a concentration build-up in late October through early November. During the invasion there were many reports from Duluth, the Twin Cities (notable because it is so far south of the coniferous forests), as well as from Koochiching county, and the Agassiz Wildlife Refuge in Roseau county. Apparently many of these birds die before they can make the return migration. However, if the small mammal population is high, the owls may occasionally nest in suitable habitat south of the normal breeding range (Nero 1970). This may be an explanation why, in the Roseau area, several nestings have been reported.

General Statements - The peat bog areas of northern Minnesota are used to a limited extent for breeding, and at intervals there may be invasions from Canada during the winter either when owl populations are high or prey populations are low. Nero (1970) suggests that drainage of cedar swamps, cutting of spruce stands, increased motor traffic, and increased shooting pressure are all human factors which may be restricting its

occurrence as a regular breeder in the northern region of the state. The dependence on the presence of nests built by other large birds could also be a potentially limiting factor.

Nero (1970) also notes that freshly logged areas, where prey may be especially vulnerable, can be attractive hunting areas. Judging from the food habits data the owls usually forage in open areas with dense stands of grasses or sedges.

One comment made by all observers concerns the tameness of the birds. The nest found near Roseau, for example, was 100 yards from a highway, and the birds were apparently not disturbed either by the traffic or the presence of observers very close to the nest. This same tameness makes the bird susceptible to "varmit shooting." On the other hand, it makes the great grey owl especially interesting to the many bird-watchers in the state. It is a highly attractive addition to their field experiences.

Possible Impacts - Removal of mature timber stands would have a negative influence since these provide nest sites and also perching cover during the entire year. If grass or sedges invaded the removal sites, possibly higher mouse populations would result, and this bird could be benefited in the long run.

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HAWK OWL

The hawk owl (Surnia ulula) is a rare but regular visitant in the wooded portions of the northern regions. Like the great gray owl, it is a bird that invades Minnesota in winter, occasionally lingering on to nest. The most recent invasion occurred in 1962-63, when they were commonly seen in the northern part of the state. Reports of breeding birds in Minnesota come from Norman, Roseau, and St. Louis counties (Green 1963).

Like the short-eared owl, this species is a diurnal hunter of the open bog and muskeg preying primarily upon meadow voles and other small rodents. However, unlike the short-eared, the hawk owl is a tree nester, and is therefore usually associated with a stand of spruce or tamarack (Smith 1970). It will hunt from dead trees or any suitable perch, looking out onto an open area. Minnesota peatlands are primarily important to the hawk owl only as a refuge during invasion years.

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SHORT-EARED OWL

The short-eared owl (Asio flammeus) is a regular summer resident throughout most of the state, but is most numerous in the northwestern and west central regions (Green and Janssen 1975, Roberts 1932). This bird is capable of using a wide range of open wetlands, and when found on peatlands, it is typically on open bogs (Erskine 1977), or muskeg (Manning 1952). The distribution and abundance of this ground-nester is largely dependent on the presence and abundance of the meadow vole, its primary prey species (Clark 1975). Even with low density vole populations, the short-eared owl can exist in low populations by utilizing large areas. While open peatlands are used by short-eared owls, they are by no means crucial habitat to this species, which is commonly found in many open wetland environments.

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YELLOW-BELLIED FLYCATCHER

The yellow-bellied flycatcher (Empidonax flaviventris) is a regular summer resident throughout the northeastern and north central regions of Minnesota, but has been reported as far west as Moose River, Marshall County, and as far south as Bruno, Pine County. However, the only verified breeding records are from northern Lake County.

This flycatcher is usually found in the presence of alder swales, willows, or some type of brushy understory (Kendeigh 1947, Stewart and Aldrich 1952, Roberts 1932). Roberts (1932) found it common in Beltrami County along the willow covered banks of a river, and in dense spruce, tamarack, and cedar swamps. The nest is usually placed on the ground, often in a mossy hummock. Bent (1942) reported that in Quebec nests were often situated in the sphagnum at the border of forested bogs. In Ontario two distinct types of habitat were used (Brunton and Crins 1975). The most commonly used was large black spruce-tamarack bogs or swamps with dense brushy vegetation, but there was also a population using a dense pine-hemlock-cedar-fir forest. Both types of habitat had a floor richly carpeted with a variety of mosses and lichens. Since yellow-bellied flycatchers are ground-nesters, perhaps the character of the forest floor is most important.

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GRAY JAY

The gray jay (Perisoreus canadensis) is a regular permanent resident throughout the northeastern and north central regions of Minnesota. Family groups (indicating breeding) have been reported as far west as Itasca State Park and as far south as Mille Lacs Lake, Aitkin County.

Coniferous forests, especially black spruce of small to medium size are the preferred cover types (Rutter 1969, Bent 1946). Hardwood stands are used as foraging sites, but in one study in Ontario there was no evidence of any territories being established in areas with less than 50% conifers (Rutter 1969). Roberts (1932) found that, in Minnesota, the gray jay is closely associated with dense spruce, cedar, or tamarack swamps during the nesting season (late March, early April). Nests are typically located from 8 to 14 feet above the ground on the south or southwest side of a black spruce, often facing some kind of opening (Rutter 1969). After the nestlings have fledged, the family groups can be seen foraging in a variety of habitats.

The gray jay is an omnivorous bird that will take advantage of any available food resource. During the summer it is probably largely insectivorous (Bent 1946), but jays have also been seen feeding on blueberries, and mountain ash berries (Ouellet 1970). The gray jay will scavenge meat off of any type of carcass, and there is evidence that it is a more proficient predator than is generally assumed (Ouellet 1970).

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BOREAL CHICKADEE

The boreal chickadee (Parus hudsonicus) is a permanent resident throughout the northeastern and north central part of the state, with reports of breeding as far south as Aitkin County. While the boreal chickadee is commonly found in association with its congener the black-capped chickadee its preferred nesting site is in the lowland moist conifer swamp, while theblack-capped tends to nest on the upland ridges (Dixon 1961). Where the two co-exist it has been suggested that the boreal chickadee feeds in the tops of trees while the black-capped remains lower down (Bent 1946). Foods of both species are primarily the adult and larval insects found in conifer trees. The nest itself is usually located in a hole in an old or rotting tree, the type of tree being not so important as the ease with which a hole can be created (McLaren 1975). Two nests in Minnesota, described by Roberts (1932) were both in spruce swamps.

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HERMIT THRUSH

The hermit thrush (Catharus guttatus) is a regular summer resident throughout the northeastern and north central regions, and adjacent Roseau, Mille Lacs, and Pine counties. This bird is usually found in the more open spruce forests, often in disturbed or young successional forests, where it replaces the Swainson's thrush (Erskine 1977). It is primarily an insectivorous bird, (though considerable amounts of fruit are taken) that is more commonly found feeding on the ground than is the Swainson's thrush (Morse 1972). The hermit thrush appears to prefer nesting in sphagnum bogs with dense cover over the nest. Roberts (1932) found the hermit thrush common in the spruce swamps of Itasca State Park where he located a nest, at the edge of a sphagnum bog, that was sunk into the moss and concealed by blueberry bushes, Labrador tea, and bunchberry. Nests may occasionally be situated several feet up in a conifer.

This bird is a widespread adaptable species occurring throughout the northern woodlands in a variety of settings. Because of this adaptability, the species is not dependent on peatlands for maintenance of the population.

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SWAINSON'S THRUSH

The Swainson's thrush (Catharus ustulatus) is a resident throughout the northeastern and north central regions and the adjacent northwestern counties. This thrush is most likely to be found in the lowland dense growths of spruce stands, where there are some openings, but also a brushy coniferous understory (Bent 1949, Stewart and Aldrich 1952). The Swainson's thrush is often associated with damp places bordering streams. However, like the hermit thrush, it is a wide ranging species not dependent on bogs for successful nesting, though peatlands are a common nesting site. It usually nests several feet off the ground in a conifer of some sort (Bent 1949). The Swainson's thrush is primarily insectivorous, though vegetative matter is also taken.

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GOLDEN-CROWNED KINGLET

The golden-crowned kinglet (Regulus satrapa) is a summer resident primarily in the northern regions, but also in the eastern part of the central regions. Breeding records extend as far west as the Agassiz and Tamarac National Wildlife Refuges. In general, this species is found in the dense, closed canopy conifer forest (Stewart and Aldrich 1952, Bent 1949, Lepthien and Bock 1976). Even where a variety of conifers are available, spruce seem to be the tree they are most commonly associated with. Roberts (1932) found the golden-crowned kinglet confined to the spruce and cedar bogs of northern Minnesota during the breeding season. The nest is usually a pensile structure of green moss hidden high up near the top of a spruce tree. The kinglets obtain their insectivorous diet by searching the trunks, branches,and twigs of coniferous trees and by taking flying insects on the wing.

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RUBY-CROWNED KINGLET

The ruby-crowned kinglet (Regulus calendula) is a regular summer resident of northeastern and north central Minnesota, with records as far west as Itasca State Park. There was no positive evidence of nesting occurring in Minnesota until the 1940's, but it is now considered a rather common summer resident and nester in the boreal forests of the state.

Like the golden-crowned kinglet, the ruby-crowned kinglet is a bird of the closed canopy conifer forest (Stewart and Aldrich 1952). This kinglet typically uses black spruce bogs during the breeding season, building a nest similar to that of the golden-crowned kinglet. The habitat and food requirements for the two North American kinglets are very similar. However, if their overall distribution is examined, it will be seen that the ruby-crowned kinglet nests further north into Canada in the summer, extending its range past the edge of the boreal forest to the edge of the tundra, and winters further south than does the golden-crowned kinglet. In these settings, it is forced to use areas that are not heavily forested. This may indicate a tolerance, or perhaps preference for open or edge habitats on the part of the ruby-crowned kinglet (Lepthien and Bock 1976).

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SOLITARY VIREO

The solitary vireo (Vireo solitarius) is a regular summer resident throughout most of the boreal forest zone of Minnesota, especially in the northeastern and north central regions with the western boundary appearing somewhere around Itasca State Park. Green and Janssen (1975) considered it to be a bird typical of the muskeg-black spruce bogs of northern Minnesota. Roberts (1932) found this vireo common in or near spruce or tamarack swamps around Itasca State Park. It seems that it prefers to inhabit edges or openings of swamp conifer-black spruce forests where there is a broad-leafed element in the understory for cover (Erskine 1972, Erskine 1977). While the solitary vireo is capable of nesting in a wide variety of settings, the majority of birds confine themselves to conifer forests (Bent 1950). In Minnesota, Roberts (1932) found four nests, all of which were in conifers, and two of which were in tamaracks. Like other members of this family the solitary vireo is almost entirely insectivorous.

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TENNESSEE WARBLER

The Tennessee warbler (Vermivora peregrina) is a regular summer resident throughout the northeastern and north central regions, but is considered scarce except along the Canadian border of Cook, northern Lake, and northern St. Louis counties. It has also been known to nest as far south as Itasca State Park (Green and Janssen 1975).

This bird is primarily associated with swamp thickets and openings or early successional stages of bog forests. It is commonly found in alder thickets which are interspersed with taller trees, or at least have the presence of some scattered trees (Erskine 1972, Erskine 1973, Bent 1953, Kendeigh 1947). The Tennessee warbler apparently needs a broad leafed element for singing and perching cover (Kendeigh 1947). Considering these requirements, it is not surprising that it is found on upland mixed stands as well as low peatlands (Grant 1962).

The nests are most commonly located at the edge of an opening or swamp thicket, or slightly recessed back into the forest. Roberts (1932) found that most nests located in Minnesota were in open spruce and tamarack swamps which have a deep layer of sphagnum moss and a thick growth of Labrador tea. Nests are usually situated in the side of a hummock, often beside a bush, and are always well concealed by over-hanging grasses, and sedges (Bowdish and Phillips 1916, Roberts 1932).

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NASHVILLE WARBLER

The Nashville warbler (Vermivora ruficapilla) is a summer resident mainly of the northeastern and north central regions of Minnesota. It is also a resident to the south and west where there are tamarack-spruce swamps. While in other parts of the country this warbler is known to use a variety of habitats, in Minnesota it is found almost solely in spruce-tamarack forests (Roberts 1932, Bent 1953). It apparently has a preference for drier sites at the base of tamarack trees, and is often found near wooded edges and openings that have a well developed herbaceous layer (Stewart and Aldrich 1952, Fairfield 1959, Erskine 1972). Roberts (1932) reports that of 10 nests found in Minnesota, all were located on the ground of a spruce-tamarack swamp, usually well concealed in the side of a hummock of moss. However, the Nashville warbler is apparently also capable of nesting on upland sites (Bent 1953).

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MAGNOLIA WARBLER

The magnolia warbler (Dendroica magnolia) is a summer resident of northeastern and north central Minnesota, but is most common in the eastern part of its range. It is a bird of the closed canopy spruce forests, usually nesting about 5 feet off the ground in small spruces or other conifers at the edge of a forest stand (Stewart and Aldrich 1952, Bent 1953). While the magnolia warbler can be found on peatlands in spruce forests, in general it seems to be associated with slightly drier habitats (Grant 1962). However, it occurs commonly enough so that it should be mentioned as a bird capable of utilizing peatland habitats.

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MYRTLE WARBLER

The myrtle, or yellow-rumped warbler (Dendroica coronata) is a regular summer resident of the northeastern and north central regions of Minnesota, being most common in the northern part of these regions. This species is an inhabitant of the closed canopy, mature spruce forests (Stewart and Aldrich 1952, Erskine 1972). It is considered by Green and Janssen (1975) to be one of the species characteristic of the black spruce bogs of northern Minnesota. Like most wood warblers, it is primarily insectivorous. It's nests are most commonly found in conifers 4 to 10 feet off the ground (Roberts 1932). However, the male can often be found singing much higher up in the canopy (Kendeigh 1947).

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CAPE MAY WARBLER

The Cape May warbler (Dendroica tigrina) is a summer resident primarily in the northern part of the northeastern region of Minnesota, but observations of the bird have been made as far south as southern St. Louis County and Itasca State Park. This warbler prefers to nest in open park-like spruce stands or at the edge of dense forests (Bent 1953). Grant (1962) found it restricted to pure spruce-balsam stands around Lake Saganaga, Ontario. It is primarily a tree top bird, with the male singing from the tops of spruce trees and the females later building their nest there (Kendeigh 1947, Bent 1953). Roberts (1932) could find no reports of breeding in Minnesota, but it is now known to breed in the state irregularily. Green and Janssen (1975) believed it to be a bird of the muskeg-black spruce habitat, and Cottrille (1962) found the Cape May warbler nesting in Lake County in a "typical black spruce, sphagnum leatherleaf bog" that was fairly open with comparatively low trees. This species is most likely to be present in areas that have high infestations of the spruce budworm (Kendeigh 1947). For instance, the area where Cottrille (1962) found a pocket of breeding Cape May warblers was the site of a local spruce budworm outbreak.

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BAY-BREASTED WARBLER

The bay-breasted warbler (Dendroica castanea) is a summer resident primarily in Cook, Lake, and northern St. Louis counties. While it has been reported as far south and west as Itasca State Park in Clearwater County and in a tamarack swamp in Sherburne County, it is generally quite scarce west of the northeastern tip of the state where it is most often found in closed canopy black spruce bogs (Green and Janssen 1975, Stewart and Aldrich 1952). While males often sing in the tree tops (Kendeigh 1947), Phillip and Bowdish (1917) found the nests of this wood warbler to be situated in small spruces 4 to 10 feet off the ground. This species, like the Cape May warbler, is irregular in distribution and abundance, being most common where spruce budworm infestations occur (Kendeigh 1947, Erskine 1977.

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PALM WARBLER

The palm warbler (Dendroica palmarum) is a summer inhabitant of the northeastern and north central regions and in adjacent Marshall and Roseau counties. This species is considered scarce throughout most of its range except where large areas of its preferred habitat exist.

The palm warbler is usually found in thick black spruce scrub stands on bogs (Burns et al 1974, Stewart and Aldrich 1952). However, often they are also closely associated with some mature trees, existing in stands or at least scattered throughout the area. Green and Janssen (1975) state that the preferred habitat in Minnesota is extensive areas of open parklike tamarack-black spruce swamps. Welsh (1975) found all territories on his study site to include an open area and forest edges. Apparently the trees on the periphery of the forest edge help to provide natural boundaries between territories. Tamaracks were the preferred tree for high song posts. Two nests reported by Roberts (1932) were situated on the forest floor of spruce tamarack bogs, sunk to the rim in sphagnum moss hummocks, and surrounded by shrubby plants.

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COMMON YELLOWTHROAT

The common yellowthroat (Geothlypis trichas) is a regularly occurring warbler throughout the state. It can be found in almost any open habitat near water, in swamps, sedge marshes, or in willow alder thickets. On peatlands it is confined to the more open shrubby areas, open bogs, muskegs, or alder swales (Burns et al 1974, Erskine 1972). However, in these areas it can be found in very high densities. The nesting site is usually on the drier portion of a brushy swamp. While the common yellowthroat is not restricted to peatlands, it is notable because of its capability of utilizing these areas in high densities where proper requirements are met.

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CONNECTICUT WARBLER

The Connecticut warbler (Oporonis agilis) is a regular summer resident of northeastern and north central Minnesota. It is scarce throughout most of the state, but plentiful in the northwestern corner and from Koochiching County to the northwest in the tamarack-black spruce bogs and upland jack pine and aspen forests.

This species of warbler is very much dependent upon spruce tamarack bogs as its primary habitat, and is never found far from them. It is a relatively rare and elusive bird throughout its range, and in Minnesota only several nests have been reported. Most nests tend to be at the edge or opening of a black spruce swamp. Huff (1920) collected the first Minnesota nest in a small opening of a large black spruce-tamarack swamp in Aitkin County. The nest was sunk into a luxuriant growth of sphagnum moss, with Labrador tea, swamp laurel, and other low bog shrubs growing in a dense tangle around the nest. Another nest was found in the same general vicinity by Kilgore and Breckenridge (1929) in the same year. Cottrille found a nest in Lake County in 1962, and two nests have been found in St. Louis County (Parmelee and Oehlenschlager 1972). A nest was reported in Hubbard County near Itasca State Park by Parmelee and Oehlenschlager (1972) in a grassy opening near a boreal spruce forest. In general, the majority of nesting activity by the Connecticut warbler occurs further north in Minnesota and Canada, where more extensive spruce bogs exist.

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SAVANNAH SPARROW

The Savannah Sparrow (Passerculus sandwichensis) is a resident throughout the state of Minnesota, wherever there are low-lying grassy fields. While the savannah sparrow is restricted in its breeding site to grassy or grasslike vegetation, these conditions are met by a wide variety of ecological situations (Baird 1968). These sparrows have been found on a number of open bogs, that are largely treeless areas with shrubs less than one foot tall, but with sedges and peatmoss present (Burns et al 1974, Erskine 1968, Erskine 1970a, Erskine 1970b). However, none of these reports are from Minnesota, and it is not known if savannah sparrows make much usage of the open peatlands.

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LINCOLN'S SPARROW

Lincoln's sparrow (Melospiza lincolnii) is a summer resident primarily in the northeastern region. Its main range is in Cook and Lake counties, and the northern two-thirds of St. Louis County, but even there it is considered scarce. The Lincoln's sparrow's range outside of this area is poorly known, with only single reports coming from Itasca, Crow Wing, Cass, and Beltrami counties.

Lincoln's sparrow will often be found in association with the palm warbler, and somethimes the yellowthroat in shrubby open bogs, scrub black spruce, or muskeg (Burns et al 1974, Erskine 1968, Erskine 1970a, Erskine 1970b). The main habitat requirements are the presence of shrub growth less than eight feet high for concealment and from which the male can sing, openings with grasses, shrubs or any low vegetation less than two feet high in which the birds can forage, some kind of grasses, brushy or sphagnum ground cover into which the nest can be sunk, and perhaps some scattered taller trees to be used as singing and perching sites (Speirs and Speirs 1968). Such requirements are met in the scrub growth after a forest has been cut, the new growth following forest fires, and the brush strips along water (Speirs and Speirs 1968, Ryel and Janson 1971). In the Thunder Bay District of Ontario, just north of Minnesota, the Lincoln's Sparrow has been found on dry and rocky hillsides with low shrub growth of dogwood, alder, willow and birch, with grassy openings, and also in recently cutover areas full of brush piles, fallen logs, and new growth interspersed with grass openings and rain pools (Speirs and Speirs 1968). However, this bird is most often

associated with peatland habitat, where the proper elements needed to insure successful nesting can most consistently be found.

The type of peatland and the plant species present is probably not as important as the structure of the vegetation. Scrub spruce and ericaceous plants seem to be used about equally (Shelton 1971, Burns et al 1974, Erskine 1968). However, areas dominated by black spruce scrub will be selected over low tamarack because the Lincoln's sparrow generally establishes its territory while the tamaracks are still bare and offer no cover (Erskine 1970a). The nest is usually sunk into a shallow depression on sphagnum mounds and concealed by surrounding grasses and brush (Hofslund 1969, Speirs and Speirs 1968)

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MOOSE

Minnesota Distribution/Abundance - The present range of the moose (Alces alces andersoni in Minnesota is broken down into a major range and a peripheral range, Fig. 1. (Idstrom 1965). The peripheral range has very few moose and is more or less an area that moose only occasionally wander into. Within the major range, there exists two rather distinct populations. One segment inhabits the coniferous forest region of northeastern Minnesota, and the other exists in the willow, aspen, and bog birch lowland north of Upper Red Lake (Idstrom 1965). The latter includes some of the major peatland areas of Minnesota and is the main focus of this report.

The Minnesota Department of Natural Resources has conducted aerial surveys of the moose population since 1946 (Idstrom 1965). Karns (1974b) has reported on the survey from 1962 to 1974. Northwestern estimates varied from 1,450 $\pm$ 350 in 1962-63 to 2,760 $\pm$ 210 in 1973-74 showing a small but steady increase. Northeastern estimates varied from 2,760 $\pm$ 640 to 2,210 $\pm$ 210 during the same period and did not show an increase.

Figure 2 displays the density of moose in northwestern Minnesota for the 1972-1973 census (Karns 1974a). This map provides a good indication of where the 1972-73 concentrations occured in the Red Lake region.

Habitat - The Red Lake or northwestern moose range is part of the nearly flat basin of glacial Lake Agassiz where three main vegetation types are available to moose: peatlands, conifer hardwood transition, and semi-agricultural transition (Idstrom 1965).

Idstrom (1965) has described the main body of the peatland, and moose usage of it, thusly:

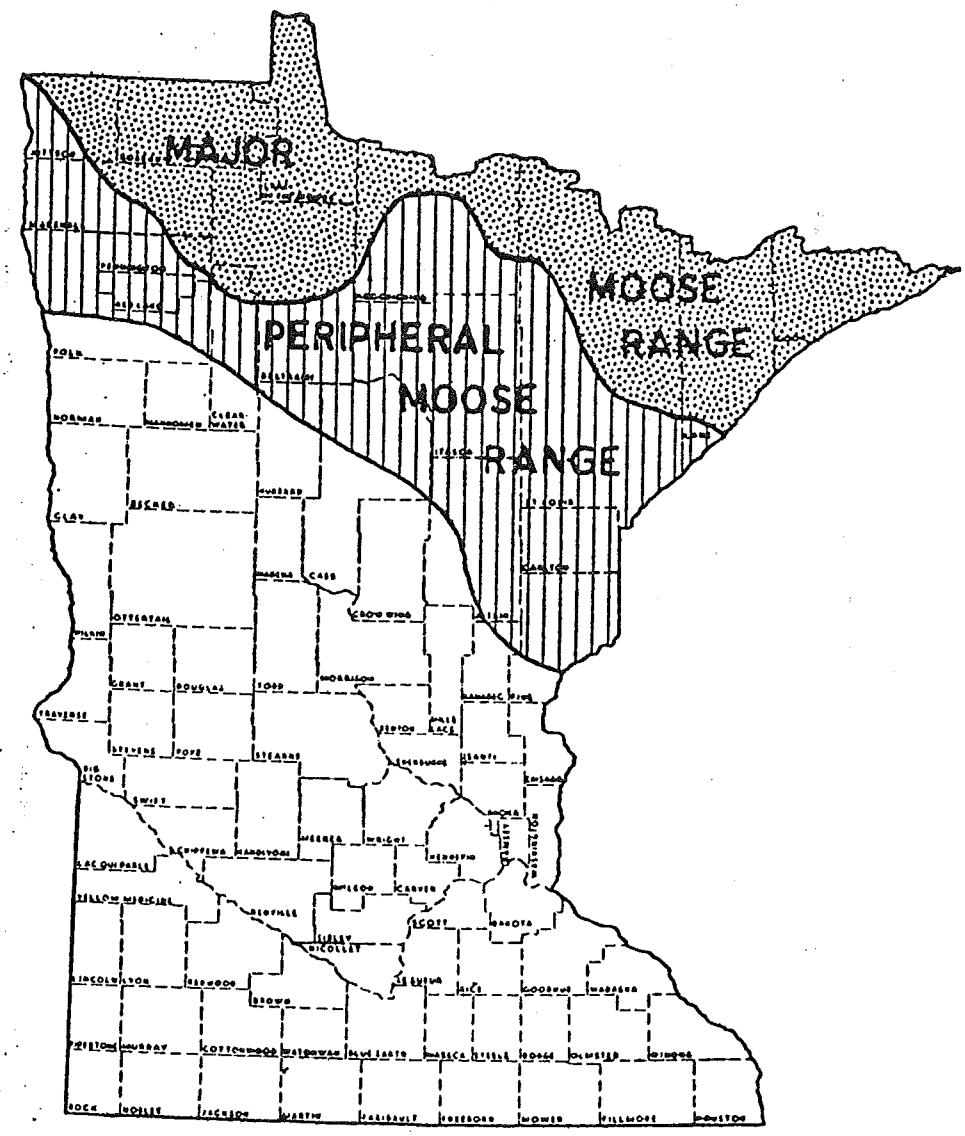

FIGURE 1. PRESENT MOOSE RANGE IN MINNESOTA (FROM IDSTROM 1965)

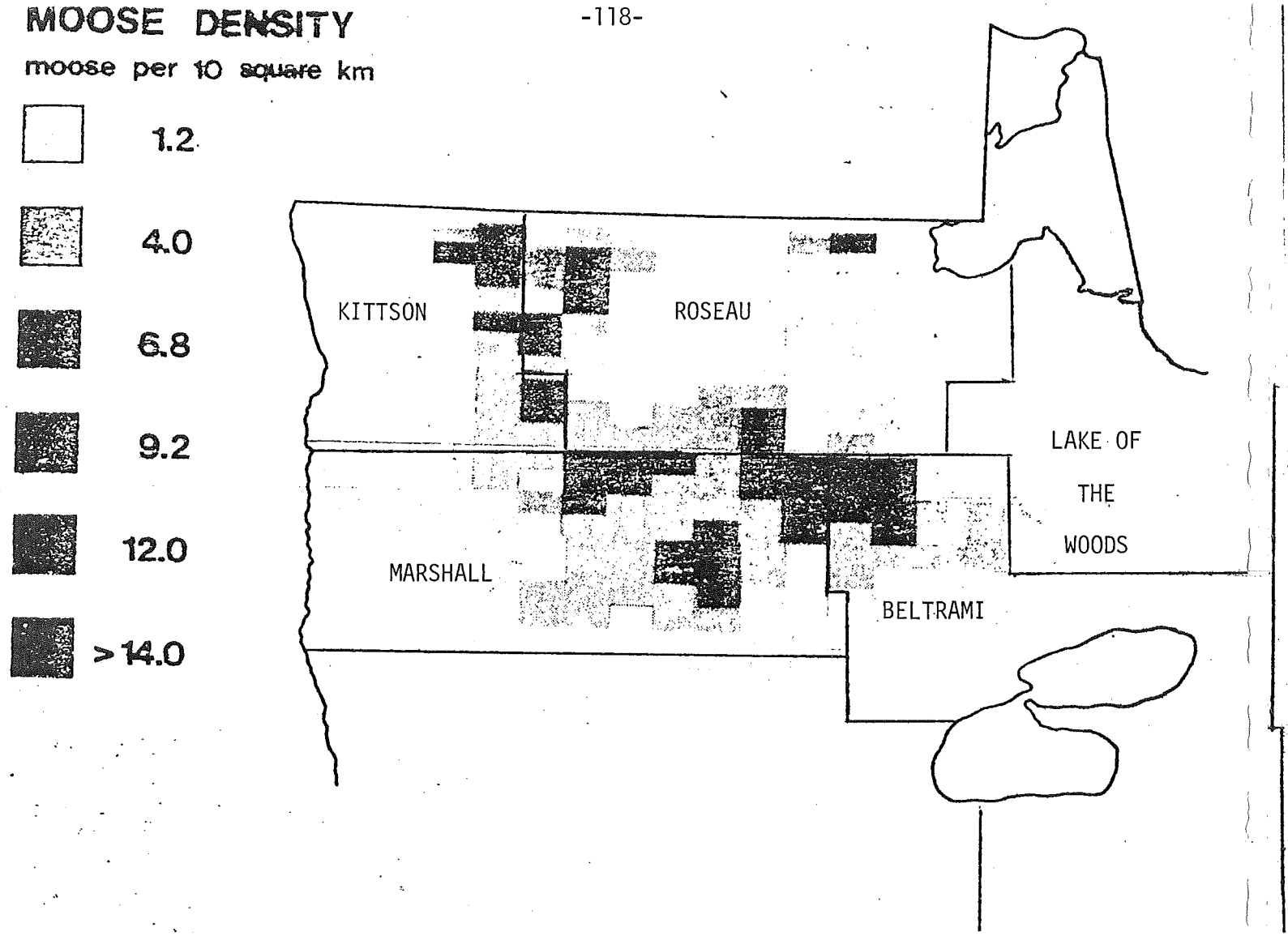

FIGURE 2. MOOSE DENSITY IN NORTHWESTERN MINNESOTA (FROM KARNS 1974a)

> The major peatlands make up a 300 square-mile unit of nearly unbroken peat. Scattered islands of black spruce and tamarack of various sizes occur in a mixture of muskeg and marsh characterized by sedges interspersed with bog birch, willows, and alder. Toward the north and west the peat spreads out as fingers extending between knolls and ridges on which grow aspen and balsam poplar. Extensive areas of willows, alder, and bog birch are found in the moist lowlands. Moose are quite common in this transition zone.

Apparently moose do not use most of the extensive peatland areas. While the black spruce and tamarack stands may provide sufficient cover, food may be a limiting factor. Moose are able to exist where peatlands are mixed with some upland areas.

The conifer-hardwood transition zone has a varied array of vegetation. On the organic soils black spruce, tamarack, and cedar are typically found. Near the swamp margins there exists stands of birch, black ash, balsam poplar and balsam fir, while on the upland mineral soils there is a mixture of conifers and hardwoods, with aspen, balsam poplar, black and white spruce, and jack pine being found in some localities. Moose are considered common in this transition vegetation zone (Idstrom 1965).

Further west and north is the semi-agricultural transition zone. Here aspen is the typical tree of the uplands, and willows and alder were common in the lowlands. Elm, ash, and birch are also common, and oak persists on the old beachlines. Conifers have for the most part been logged from this area, but leatherleaf-sphagnum bogs with black spruce islands exists in some of the lowlands.

It is in the semi-agricultural zone that a considerable amount of research has been done by Berg and others (Berg 1971, Phillips and Berg 1971, Berg and Phillips 1972, Phillips, Berg, and Siniff 1973, Berg and Phillips 1974). Berg studied movements and habitat utilization by radio-collaring moose in the Agassiz National Wildlife Refuge. This is an area where peatlands have largely been drained in early farming attempts, and

consequently much of the peat has blown away. Most of the farmlands have been abandoned, and much of the land has reverted to large expanses of willow, aspen, or marsh, the combination of which provides an excellent environment for moose.

Berg (1971) divided the vegetation into two main categories, based on the following structural classification: 1) low-open type, which included sandbar willow, mixed willow less than 10 feet tall, open willow, marsh, open water, fields, grass-sedge; and 2) tall-mature type, which included willow over 10 feet tall, aspen, aspen-willow, mature hardwood, and black willow. There were some tamarack and black spruce islands and pure stands of cane.

The tall-mature category was characterized by dense, mature trees and shrubs of generally poor food quality and was the most heavily used during the later winter and early spring. Aspen-willow stands were the most commonly utilized type. Results of the study suggest that use of heavy cover was directly related to snow depths. As the winter progressed, and snow depth increased to a maximum of 23 inches, there was an increased usage of tall-mature types. Interestingly, black spruce and tamarack stands were not used at all during the late winter period. However, they made up only 3% of the total study area.

In mid-April there was a dramatic shift in habitat use as moose moved from the tall-mature types to the more open habitats. Particularily sharp increases in the use of open willow and mixed willow occurred, while use of the aspen-willow type decreased by a factor of four. Throughout the summer months, the low-open category continued to be most important, averaging 60% of the total radio locations. The four vegetation types that were used most extensively were mixed willow greater than 10 feet, mixed willow less than 10 feet, open willow, and aspen-willow.

The use of aquatic vegetation has been shown to be a very important part of the diet in summer in many areas, including northeastern Minnesota (Van Ballenberghe and Peek 1971), Onatrio (DeVos 1958), and Isle Royale (Botkin et al 1973). However, in Agassiz National Wildlife Refuge, Berg (1971) found that little use was made of the extensive aquatic habitat available. Aquatic plant usage may have been underestimated though, since moose were often seen in the extensive system of drainage ditches while feeding on milfoil, and cattail shoots and roots.

During the fall and early winter period (September 1 to December 31) the habitat utilization pattern changed only slightly from that of the summer. Mixed willow less than and greater than 10 feet, open willow, and aspen-willow were used the most, representing 71% of all radio locations. However, nearly equal use was made of these low-open and tall-mature habitats.

An analysis of habitat usage versus availability reveals that marshes, fields, black willow, and cane stands were selected against all year long, while mixed willow less than ten feet, open willow, aspen and aspen-willow types were selected for year around. Sandbar willow and mixed willow greater than 10 feet were selected against in late winter and early spring but were selected for during the rest of the year. Though not discussed, it seems that black spruce and tamarack stands were selected against since no usage of them occurred.

Food Habits - Lee (1949) conducted a browse survey in the Red Lake Game Refuge of Minnesota. The survey apparently included both moose and deer browsing. Willow was found to constitute 58.3% of the winter diet. Balsam, poplar, red-osier dogwood, raspberry, mountain ash, aspen, and tamarack, listed in order of the percent of browse eaten, together made up 39.2% of

the diet. White cedar was probably taken primarily by deer, since it is not a preferred food of moose (Peek 1971). Balsam fir composed 8.6% of the food eaten, but only 0.9% of available browse, showing that it was highly preferred. Bog birch, balsam poplar, and red osier dogwood, comprised 5.7, 5.2, and 4.1% of the diet, respectively, and were also taken in excess of availability, suggesting that they are important foods. Black spruce, tamarack, black ash, hazel, white birch, highbush cranberry, and alder together comprised only 4.1% of the diet. Black spruce and alder were considered abundant, yet they were taken in only small amounts.

It is interesting to note that of the plants occurring on peatlands, willow and bog birch are important winter foods, but black spruce, black ash, highbush cranberry, tamarack, and alder are not. Large stands of black spruce and tamarack apparently offer little food to moose, but the more open, muskeg-like areas where willow and bog birch are present may be able to support a sizeable moose population if proper cover requirements are also met.

Berg and Phillips (1974) studied food habits of moose for both summer and winter on the Agassiz National Wildlife Refuge. Seasonal preferences were noted for key browse species. While all 5 willows present on the refuge were browsed to some extent in winter, sandbar and heart-leaved willow were the most heavily utilized. Balsam poplar was also an important component in the winter diet. In summer two broad-leaved willows, long-beaked and pussy willow were most heavily used. According to rumen analysis, the fall diet consisted of 80% willow in October and 63% in December. There was no information available for the spring.

As with Lee's work, this data points out the importance of willows in the year around diet of moose. Berg and Phillips (1974) further show that it is important for moose to have a variety of willows present, broad-leaved

willows being used in summer, and narrow-leaved willows in winter. This report does not say if conifers are part of the winter diet, but from the description of the vegetation types used during winter, it is unlikely that conifers are present in amounts large enough to make a significant contribution to the diet. Black spruce, perhaps the most common conifer, is not a preferred food. From studies in northeastern Minnesota (Peek et al 1976) is was found that black spruce, as well as leatherleaf and Labrador tea had very low aggregate percentage use values (a measure of what percentage of the diet is made up by that species) and the smallest possible importance value (a measure of the importance of the species in the diet). In contrast, willows had the highest values for both aggregate percentage use and importance.

Seasonal Movements - It is known that moose have summer and winter ranges, but how distinct the two are is largely dependent on the area inhabited. In Agassiz National Wildlife Refuge, Berg (1971) found that winter home ranges averaged 1.0 and 0.8 mi^2 for cows and bulls, respectively.

The home ranges during the summer, fall, and early winter were much larger than those which were used in late winter. Summer home ranges of cows and bulls were 5.2 and 5.6 mi^2, respectively. Considerable movement occurred within the home range, but the most intensive use occurred within a "core area" of the home range.

Despite the level terrain, definite seasonal shifts of home ranges occurred in the study area. A movement away from the winter areas was noted as the snow depth decreased in early spring, although some winter ranges were adjacent to or within the summer range. The distance traveled from winter to summer ranges for winter residents of the refuge varied from 1 to 6, but averaged 3 miles. However, six radio-collared moose (17% of

the radioed population) that were not considered winter residents traveled considerably further (Berg and Phillips 1972). These moose traversed distances of 9 to 21 miles out of the study area to aspen stands in the adjacent argicultural zones. All animals returned to the refuge for the summer along the same travel route used while leaving.

Data collected by Berg and Phillips (1972) suggest that moose usually spaced themselves out on the study area in late winter and led a solitary existence. Intraspecific fighting was observed twice, and other areas where fighting had apparently occurred were also found, suggesting that moose space themselves out by agnostic behavior in winter. The reasons for the long distance migrations noted in Agassiz are unknown, but possibly the movement to more suitable habitat is somehow related to intraspecific competition for habitat. The availability of the proper winter habitat may, therefore, be a limiting factor in this population.

General Statements - The northwestern moose herd appears to be a healthy population. Neither Lee (1949) nor Berg and Phillips (1974) found evidence of overbrowsing, even on the most palatable willow species. The net productivity, or the percent of calves in the identified population based upon classification of animals during the 12 year period 1962-1974, was 30.6% in the northwest, as compared to 16.4% in the northeast (Karns 1974b). However, the calves per cow-with-calf ratio was the same in both areas (1:15), at least for the 1973-74 census.

Movement by moose into the Agassiz Wildlife Refuge may be a relatively recent phenomenon. This area and indeed, large portions of northwestern Minnesota were cleared and drained in the early 1900's for farmlands, but by the mid-1930's much of the land had been abandoned. This land, which has

a thin layer of peat, has since reverted to willow, aspen, and marsh, providing excellent habitat for moose and represents a major addition to the total Minnesota moose habitat. However, much of the earlier abandoned land is now being redrained and bulldozed for agricultural purposes (Berg and Phillips 1974). Unfortunately, most of the areas that have good agricultural potential are also the best moose habitat, and much prime moose habitat is rapidly disappearing.

Possible Impacts - The large, continuous areas of bog, open bog, muskeg and of swamp conifer forests are apparently little used by moose, so there would be little effect on them if mining occurred in these habitats. However, where peatlands are interspersed with uplands, or where the mineral influence is great enough to provide adequate food supply in the form of willow, aspen, and bog birch, and there is adequate cover in the form of tall willow and aspen stands, removal of peat would have a negative impact. Reclamation of peatlands, especially if done so as to promote willow growth, could provide moose habitat in the future.

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WHITE TAILED DEER

Minnesota Distribution/Abundance - The white-tailed deer (Odocoileus virginianus) is found throughout all of Minnesota, occurring in different densities depending on the habitat. The three main zones into which Minnesota can be divided are the northern forest zone, central transition zone, and the southeast transition and agricultural zone (Erickson et al 1961). Of these, the northern forest which includes the peatlands has by far the largest percentage of deer in the state.

Deer pellet surveys have been carried out for some areas of northern Minnesota for years up to 1975 (Mooty 1975). The Rainy River subunits I (which includes most of Lake of the Woods County, the northern half of Beltrami County, and the eastern third of Roseay County), and II (which includes the western half of Koochiching County) include much of the big bog acreage north and northeast of Upper Red Lake. Subunit IV of the Itasca deer management unit includes much of the peatland area in southern St. Louis and Carlton counties. Pellet counts reveal the following number of deer for these areas for 1975: Rainy River subunit I - 11.10 $\pm$ 3.01 deer per mi^2; Rainy River subunit II - 12.80 $\pm$ 4.95 deer per mi^2; Itasca subunit IV - 14.20 $\pm$ 6.12 deer per mi^2. These estimates show no major differences from other areas sampled in the northern part of the state.

Habitat - The spring, summer and fall ecology of deer in northern Itasca County was studied using radio telementry techniques by Pierce

(1975), Kohn (1970), and Waddell (1973), respectively. This area is mostly upland interspersed with some peatlands, and is fairly representative of the north central area of Minnesota.

There have been few studies of spring habitat utilization by whitetails. Data on radio locations collected by Pierce (1975) revealed that deer were very individualistic in their habitat preferences at this time, but that the majority of relocations were from uplands. Lowland forests seemed to be used in about equal proportion to their availability. McCaffery and Creed (1969) reported that forest openings were heavily used during May and June in Wisconsin.

During the summer in northern Itasca County, deer seemed to retain their preference for upland habitats (Kohn 1970). The upland deciduous and upland mixed areas were used in approximate proportions to their availability, and fields and lowland areas were avoided. It is important to note that all lowland habitats--lowland deciduous, lowland conifer, lowland mixed, and lowland shrub types--were all selected against. The availability of preferred forage species was considered the most important factor determining deer use of habitat types.

Dahlberg and Guettinger (1956) state that the ideal summer habitat for white tails should contain a wide variety of cover types interspersed with openings and supplies of fresh water. McCaffery and Creed (1969) found that aspen and jack pine stands provided good summer range for white tails. Kohn (1970) found radio-located deer to show a preference for young aspen and birch forests.

Most of these data suggests that white tailed deer prefer a diverse summer range, and show a tendency to stay on the uplands. With these preferences it is unlikely that deer will be found on the peatlands, especially large, uninterrupted tracts.

Knowledge of the fall habitat relationships of white tails in the Lake States is very limited. Waddell (1973) has done the most work on this subject in northern Itasca County. Fall habitat selection appeared to have no easily discernible pattern. For the entire fall period deer seemed to be in habitat types in about equal proportion to their availability, suggesting that no selection was occurring. If relations were analyzed in two week intervals, however, selection for specific types occurred after leaf fall. From October 1-15, upland mixed forest dominated by herbs were favored, while young forests were avoided. From October 16-31, deciduous and coniferous uplands were preferred while upland mixed young forests were avoided. This selection probably represents an attempt on the part of the deer to obtain herbaceous and other still green foods for as long as possible.

Winter is a critical period for deer in Minnesota and the Lake States Region in general (Erickson et al 1961, Peek 1971, Dahlberg and Guettinger 1956, Verme 1965, Ozoga 1968). The cold, snow, and reduced availability of food resources makes winter a stressful period. Yarding is a strategy employed by deer to combat the cold and deep snows and allow easier movements. The degree to which yarding occurs is strongly influenced by the severity of the winter (Rongstad and Tester 1969, Ozoga 1968).

The key to overwintering survival for white tails in northern Minnesota appears to be the presence of mature swamp conifer cedar forests interspersed with an easily available food supply, usually found on the uplands. The presence of proper cover types is of crucial importance. Heavy swamp conifer cover provided by mature cedar maintains warmer average temperatures than the uplands during very cold weather, provides a comparatively narrow thermal spread that is desired by deer, limits the amount of wind action and provides a more shallow, packed snow accumulation, all of which are favorable conditions for deer (Verme 1965, Ozoga 1968). Ozoga (1968) sampled several other environments, including upland openings, hardwoods, mixed hardwood conifers, sapling swamp conifers, and pole-size swamp conifer, and found that during the coldest winter months, these offered deer less favorable microclimates and travel conditions.

Large stands of spruce forests are generally not used by deer. Of 56 deer yards evaluated from 1949-1956, 47 (84%) in Beltrami, Lake of the Woods, and Koochiching counties were either pure cedar stands or cedar associated with some combination of balsam fir, spruce or tamarack (from Table 1 of Appendix, Erickson et al 1961). The presence of mature cedar is obviously an important component of most north central Minnesota deer yards. In Beltrami Island State Forest, Beltrami County, black spruce and spruce-cedar stands are commonly used as winter cover (Fritts pers. comm.). However, only areas which have a high degree of interspersion with uplands are used. In general, swamp conifer, black spruce and swamp conifer

cedar stands do not provide a sufficient food supply for overwintering deer, so for an area to be used, there must be an adjacent upland that can be used to obtain food. Verme (1965) suggested that an assortment of closely associated even-aged blocks of lowland and upland types would bring the greatest utilization of an area.

On the semi-agricultural peatlands in northwestern Minnesota, the situation is somewhat different. In the Mud Lake National Wildlife Refuge in Marshall County, no mature swamp conifer forests exist except for small spruce-tamarack bogs which are apparently avoided. The habitats most heavily used as winter cover were willow thickets, larger stands of conifer-hardwoods, and marshes consisting of cattails, cane, and bulrushes. (Hunt and Mangus 1954).

Food Habits - In the spring deer move to areas where snow disappears early in the season and new growth comes up quickly. In northern Itasca County, Pierce (1975) found that deer selected new succulent growth wherever possible. In early April, snow was still deep enough to cover up low growing plants, so red-osier dogwood, hazel, juneberry, and black ash were important foods. As the snow melted, grasses, sedges, bush honeysuckle, and marsh marigold became a significant part of the diet. In May nearly all of the diet consisted of newly sprouted herbaceous plants. With the advent of leaf-out of woody vegetation in June, the leaves of hazel, honeysuckle, red maple, and willow were commonly taken. Use of bracken ferns and wild sasparilla also increased.

During the summer, in the same area, leaves of woody plants accounted for 68%, forbs 32%, and grasses only 1% of total use (Kohn 1970). Hazel, aspen, willow, and paper birch in decreasing order of importance, received the most use of the shrub species. Large-leaved aster, purple pea, jewelweed, and bracken fern were some forbs that were important in the summer diet.

During the fall months (August, September, and October) in northern Itasca County, leaves and current years' twigs of shrubs average 49% and 45% of the diet in August and September, respectively, but declined to 22% in October (Waddell 1975). Forb usuage was relatively constant at 50%, 54%, and 49% for the three months. Grasses and sedges were hardly taken in August and September (1.0% and 0.5% of diet) but usuage increased dramatically in October (20%).

The information given above is all from a specific study area, but the general trends are probably applicable throughout most of the north central part of the state.

There is a much broader base of information available for the winter food habits of white tails in Minnesota. A classification of some winter foods based on deer preferences is presented in Table 1. This table is not an exact rating, for both preferences and availability seem to vary throughout the state, but it is a useful guide. As can be seen, some of the common peatland species - tamarack, bog birch, black spruce, and alder - are considered poor foods. In fact Erickson et al (1961) stated that alder and black spruce are perhaps the poorest of all deer foods in Minnesota.

Table 1. Classification of Some Minnesota Plants Eaten by Deer, Based on Deer Preference

(From Erickson et al 1961)

Good	Medium	Poor
White Cedar	Choke Cherry	Red Pine
Red-osier Dogwood	Basswood	Tamarack
Mountain Maple	Jack Pine	Alder
Staghorn Sumac	White Birch	Bog Birch
Oaks (browse and acorns)	Some Willows	Black Spruce
Alternate-leaved Dogwood	Hazel	
Red Maple	Aspen	
Juneberry	Honeysuckle	
Hard Maple	White Pine	
Black Ash	Balsam Fir	
Mountain Ash		

Cedar is considered to be one of the highest quality winter foods available, and is the only native browse species that when fed alone, can allow a deer to maintain its weight in winter for periods up to 60 days (Erickson et al 1961). Unfortunately, most of the cedar has already been browsed out of reach in many yards, and any new growth is eaten as fast as it comes up. Black ash is another lowland tree whose sprouts are an important addition to the winter diet. With these considerations it can be seen that swamp conifer cedar forests do not have enough food, in terms of quantity or quality, to insure survival of deer in winter. While they provide an excellent source of cover from the severe winter weather, there must be an interspersion with upland areas that do provide a reliable and high quality food supply.

A rather unique situation exists in northwestern Minnesota. As already stated, the habitat utilized in this semi-agricultural zone is primarily willow stands. Willow, which is usually considered to be of medium to low value as a browse species for deer, was found to be sustaining the highest degree of utilization, but red-osier dogwood and balsam poplar were present in only limited quantity, so the bulk of the winter browsing was absorbed by the various species of willow. (Hunt and Mangus 1954).

Seasonal Movements - The spring migration has been recently studied with radio telemetry techniques by three workers in Minnesota (Hoskinson 1975, Pierce 1975, and Nelson 1977). Hoskinson and Nelson worked in northeastern

Minnesota (Lake County) and Pierce in north central Minnesota (Itasca County), but many of their findings are similar.

Deer generally started migration out of the winter yards in late March and April when temperatures increased and the snowpack melted. Nelson (1977) found that the average mean daily maximum temperature during the last half of March was highly correlated with the onset for spring migration. When deep snow restricts movements prior to migration, temperature is the key factor determining time of mirgation primarily through its effect upon snow melt. Even in years when snowmelt was not a restrictive element, temperature itself seemed to trigger migration. This correlates well with the idea that yards function primarily as protection against cold and wind (Verme 1965, Ozoga 1968).

In northeastern Minnesota, radioed deer averaged a straight-line migration distance of 11.9 $\pm$ 2.6 miles (Nelson 1977). In north central Minnesota, Pierce (1975) reported 4.2 miles as the average distance traveled, and in the northwestern part of the state, Hunt and Mangus (1954) found that, of the animals that traveled out of the Mud Lake Refuge, the average distance traveled was 22 miles. However, many more deer remained within the refuge boundaries, so the average movement was much less.

Fall migration also appears to be initiated by a change in temperature. It seems that, with a sharp drop in temperature, deer move quite quickly to their winter ranges. Most movements did not occur until late November (Nelson 1977).

Using a trapping and tag recovery technique, Carlsen and Farmes found that on the semi-agricultural lands in and around Mud Lake National Wildlife Refuge, tag recoveries were an average 9.7 miles away from the original capture site. Bucks averaged 14.0 miles, and does 6.8 miles away. In comparison, in the coniferous forest (most animals were tagged in Superior National Forest, but work was also done in Itasca State Park, Cloquet Valley State Forest and Beltrami Island State Forest) tag recoveries averaged 5.1 miles away from the original capture site. Carlsen and Farmes (1957) concluded that deer from northwestern Minnesota traveled further than those of the north central and northeastern parts, but did not suggest any reasons for the differences.

General Statements - In considering the ecology of deer in northern Minnesota, it is important to recognize the importance of the deer-wolf relationship. The location of deer yards and summer ranges with respect to wolf-pack territories is of particular interest (Hoskinson and Mech 1976). In northeastern Minnesota, three of the four winter yards that were studied were situated along the borders of wolf-pack territories, and the fourth was within 2 miles of an edge. Of 16 deer for which summer ranges were known, 14 of them were situated along wolf territory edges, 2 lived within 1.5 miles of an edge, and one summered where no information on wolves was available. It seems likely that deer near the center of wolf-pack territories would bear the heaviest predation pressure since wolf activity is greater there.

Possible Impact - Large tracts of open peatland interspersed by swamp conifer-spruce forests are apparently not utilized by deer. However, mature stands of swamp conifer cedar forests are of prime importance in insuring the overwintering survival of white-tailed deer. If these areas were to be logged, mined or completely removed, it would have a severe impact on the deer population in northern Minnesota. However, there does exist a management scheme, devised by Verme (1965), that includes logging as a means of retaining both food supplies and older, even-aged stands of cedar.

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EASTERN TIMBER WOLF

Minnesota Distribution/Abundance - The eastern timber wolf (Canis lupus lycaon) is a resident of the northeastern and north central regions and adjacent counties in the northwestern region. An estimated population of 1,000 to 1,200 animals resides in the state (Mech 1977a). The greatest density of wolves is probably to be found in the Superior National Forest, where a population was believed to have saturated the area at one wolf per 10 mi^2 in the winter of 1971-1972 (Mech 1973). However, the population had declined by about 40% by 1975, at least in the interior area of the forest (Mech and Karns 1977).

Habitat - In general, wolf utilization of an area is related more directly to the availability of prey species than to particular vegetation types. In Minnesota, wolves are most likely to be found in areas inhabitated by deer, moose, and beaver. For instance, in Beltrami Island State Forest, Beltrami County, radio locations of wolves were more often made on the uplands where deer are more common than on the peatlands (Fritts pers. comm.). However, radio locations have been made, and signs of wolves have been seen on the open muskeg in this vicinity. Only a few locations were made in the "big bog", but this area was not intensively studied.

Wolf utilization of peatlands was most evident along the extensive system drainage ditches found on many of the peatlands in the north central part of the state (Fritts pers. comm.). Usuage of these ditches could have been for two possible reasons. Firstly, beaver are known to inhabit

these ditches, and in summer wolves could be walking the banks in search of beaver that have strayed too far from water. Secondly, the ditches could act as travel lanes, especially in winter, when the frozen water, and banks could provide an easy means of traveling between areas where prey are more abundant. However, these are only speculations, and the exact relationship of wolves to peatlands is not really known.

Food Habits - All food habits data from northeastern Minnesota and adjacent Ontario reveal that deer, moose, and beaver are the three main prey species taken by wolves (Van Ballenberghe et al 1975, Pimlott et al 1969, Stenlund 1955). In all three studies (a total of 5 study sites--3 in Ontario and 2 in Minnesota) deer were the most important component in the diet, ranging from 27.3% occurrence in Pakesley, Onatario (beaver was a very important food item here) to 80.5% in Algonquin Park, and averaging 57.5%. Deer were the preferred food even in two areas where the ratio of biomass favored moose over deer (Van Ballenberghe et al 1975, Peterson 1955). Deer, being smaller animals than moose, are an easier prey species for wolves to attack and kill, and are therefore subject to a more intense predation pressure. Mech (1977b) observed an increase in predation on moose in one pack after a precipitous decline of the deer population. Furthermore, the decline of the wolf population in the Superior National Forest was directly attributable to the decline of the deer population. (Mech 1977c).

The relative importance of beaver in the diet is probably more directly related to its abundance than is the case for either deer or moose.

Other foods known to be taken include snowshoe hare, rodents, such as red squirrels, chipmunks, voles, woodchucks, and muskrat, and plant materials, principally the fruits and seeds of rasberry, blueberry and juneberry (Van Ballenberge et al 1975).

Seasonal Movements - Wolves are social animals that group together into packs which maintain distinct boundaries across which other packs normally do not trespass. Most pack territories range in size between 40 to 180 mi^2 (Mech 1974, Van Ballenberghe et al 1975, Stenlund 1955, Pimlott 1969). Generally pack movements are greater in winter than in summer (Mech 1977b). During the summer, pack activity centers around the rearing of the pups, with adults leaving "rendevous sites" to hunt and returning with food for the young. In winter, pups usually join the pack, allowing freer movements throughout the territory.

General Statements - Between adjoining territories of wolf packs in northern Minnesota, there lies a strip about 1.5 miles wide, termed a "buffer zone" in which the pack on either side of the zone probably spends less time than in most of the territory (Peters and Mech 1975). The importance of the zone as a reservoir for prey populations, particularly the white-tailed deer, has already been mentioned (see white-tailed deer report). It seems likely that such buffer zones also exist in northwestern Minnesota in the Beltrami Island State Forest (Fritts pers. comm.). Preliminary examinations suggest that small stretches of open muskeg, 1 to 2 miles wide, may act as naturally occurring buffer zones between adjacent

packs. Such a situation could exist only where there is a highly degree of interspersion of peatlands and uplands. Under these conditions, peatlands could help to minimize social stress in a wolf population by minimizing inter-pack contact.

The federal and state status of wolf, along with management considerations, will be discussed in the "Animals of Special Concern" section.

Possible Impacts - Removal of particular vegetation types will probably not affect wolves directly. However, the wolf population of Minnesota appears to be strongly dependent on deer populations. Therefore, any actions that could be potentially harmfull to deer populations, particularly the removal of mature swamp conifer cedar forests, may adversely affect the wolf population as well.

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CANADA LYNX

Minnesota Distribution and Abundance - The lynx (Lynx canadensis) has been reported as far south as Anoka and west to Marshall and Pennington counties (Gunderson and Beer 1953). However, probably any lynx that are "permanent residents" are to be found only in the counties adjacent to the Canadian border.

In Minnesota lynx numbers have shown dramatic changes over the years. Henderson (1978) reports that DNR estimates of lynx kills, based on hunter and trapper reports, have averaged 177 annually over a 47 year period. However, each year during 1940, 1952, 1962, and 1973, kills of more than 300 have been estimated.

Similarly in North Dakota, Adams (1963) reports that in the winter of 1962-63 there were about 150 lynx kills reported. Most of these were adults taken in the Turtle Mountains and Pembina Hills along the Canadian border although a few were taken far to the south in agricultural areas. Adams states, "the fact that lynx were as commonly seen and killed is evidence that they were wanders in a strange area."

Only one estimate of lynx population density was found. In Central Alberta Brand, et al (1976) reports that in 1971-72 there were 3.9 animals per mi^2 while in 1974-75 there were 1.2 per mi^2. During the first winter the snowshoe hare density was 1,400 per mi^2. This had dropped nearly 1/3 to 452 per mi^2 in 1974-75.

Habitat - Little direct evidence on habitat preferences was found in the literature. However, the food habits and population data show that lynx depend on the snowshoe hare. Thus it can be inferred that the habitats

which sustain hare populations, especially at low densities, are vital to lynx populations. As reported in the discussion of the snowshoe hare, these are swamp conifer, swamp thickets and fen.

Food Habits - Five Canadian studies of lynx food habits based on scats or stomach contents show a very high degree of dependence on the snowshoe hare. The percentages varied as follows: 91% year-round in Central Alberta (Brand et al 1976); 83% year-round during low hare populations in the McKenzie District, NWT (Moore 1976); 79% year-round in the same general area (Van Zylle de Jong 1976); 79% of the winter diet in central Alberta (Nellis and Keith 19); and 73% year-round in Newfoundland (Saunders 1963). Other foods taken in relatively low percentages were carrion, birds (small), ruffed grouse, red squirrel, and voles. Further Brand et al (1976) reported that 73% of 361 kill attempts recorded by tracking in snow were for snowshoe hare.

Seasonal Movements - Information on what might be termed "normal" movements of lynx is based almost entirely on tracking studies during winters. In Central Alberta home ranges of 7.3-19.0 mi^2 with daily travel distances of 1.9-5.5 miles are reported by Brand et al (1976). Saunders (1963) reports home ranges of 6, 7, and 8 mi^2 from Newfoundland.

In contrast there are a few reports of long distance movements. Mech (1977) reports on a move of 300 miles by a young adult female. She was tagged and released near Isabella, St. Louis County and taken by a trapper three years later some 300 miles (air line) to the northwest in Ontario. Also, Nellis and Wetmore (1969) report that a lynx, which had been live-trapped several times in central Alberta was taken by a trapper 102 miles away and 163 days later.

General Statements - The history of lynx numbers in Minnesota is very much like that of the great grey owl. Each emigrates south from Canada at intervals and may be found throughout the northern part of the state especially where there are swamps and conifers. It is doubtful that there is an extensive breeding population in the intervening years. Probably most survive but a short time, although one tagged lynx was trapped 300 miles north of Isabella after a three year interval.

Lynx pelts have a high value. There is also a recreational value as those who have seen this animal, which like the great grey owl are apparently not wary during these exceptional years, have a truly thrilling experience not soon forgotten.

Possible Impacts - Removal of the preferred habitats of the snowshoe hare will undoubtedly adversely affect the chances of a lynx surviving following its emigration into Minnesota. There may be areas where a small resident lynx population would be eliminated for the same reason.

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FISHER

Minnesota Distribution/Abundance - The fisher (Martes pennanti) now occurs across the northern tier of counties to the prairie border in the northwest corner of the state. The "Minnesota Fisher Harvest Survey" as provided by the Department of Natural Resources shows a total recorded take of 2,150 animals between December 1, 1977 and January 31, 1978. This was the first legal trapping season since 1931. Reported taken by counties where there are extensive peat bogs was as follows: St. Louis County (808), Itasca County (351), Koochiching County (333), and Beltrami County (120).

Habitat - DeVos (1952) states "Fisher seem to prefer heavy timber" and "the species is not too strict in its habitat requirements, it occurs in mixed stands as well as coniferous stands, in flat as well as rocky country". Review of his data obtained by tracking in the snow, indicates that, in winter, there is a decided preference for cedar swamps or fringes along creeks or lakes. Black spruce-cedar swamps, jack pine, black and white spruce stands were used in proportions about equal to their availability. Although most miles of tracks followed were in mixed conifer-hardwoods in uplands, this had by far the greatest acreage of habitat in the area. Contrary to general opinion fisher rarely climbed trees. In the summer lake beaches were frequented regularly as shown by tracks in the sand.

Food Habits - Data on the foods eaten by fisher are indeed scarce. For the Adirondack region of New York Hamilton and Cook (1955) report that

white tail deer (carrion) red squirrel, and red backed mice occurred most frequently in stomachs of trapped animals, followed closely by snowshoe hare, shrews, porcupines, blue jay and ruffed grouse. Other prey in very small percentages were deer mouse, mink, muskrat, fish and insects. One animal had gorged on beech nuts and an other on the berries of swamp holly.

Fron central Ontario, Devos (1952) indicates a similar broad array of foods based on 101 samples. The occurrences were: Snowshoe hare - 25%, porcupine - 25%, white tail deer (carrion) - 8%, fish - 7%, red backed mice - 5%, shrews and birds - 4%, raccoon, otter, beaver, caribou, red squirrel, flying squirrel and mountain ash berries - 1% each. More limited data based on scats and notes while tracking added moose (carrion) to the list.

It is apparent then that fisher have very broad food preferences with snowshoe hare, porcupines, red squirrels, red backed mice, fish and carrion being most important during the winter months.

Seasonal Movements - Evidence obtained by DeVos (1952) from trappers and by tracking indicated fishers move in a more or less circuitous route with a diameter of some 10 miles. One report from the mountains of northern British Columbia cites an area 4X8 miles as covered by one fisher during the winter (Quick 1953). Probably terrain and the pattern of forested habitats as well as food availability govern the size and shape of the areas that an individual covers.

General Statement - The fisher has greatly increased its numbers in Minnesota over the past 50 years. Balser and Longley (1966) reported that very few confiscated pelts were obtained by game wardens in the 1930's. However, this number increased to 123 in 1962, and, as shown earlier, the legal catch in the 1977-78 winter was over 2,000 animals. Similar increases have been reported from Maine (Coulter 1960), New Hampshire (Hamilton 1957) and New York (Hamilton and Cook 1955). This is probably due to protection from trapping, but also to increased areas of suitable forests following the reduction in both logging and wild fires over the years.

This animal has very broad requirements as to both food and cover--a variety of forest stands which support mid-sized prey animals apparently suffice. Probably bog and muskeg lack both while swamp conifer-spruce habitats are inadequate as to food. The fen, swamp thicket, swamp hardwood and swamp conifer-cedar spruce may well be adequate on both counts. However, fisher also use a variety of upland forests.

Possible Impact - Unless large areas of forested peatlands are harvested for peat the impact on the fisher will probably be negligible.

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BEAVER

Minnesota Distribution/Abundance--The beaver (Castor canadensis) has been reported from nearly every county in Minnesota (Gunderson and Beer 1953). Wherever there is open water and an adequate food supply this rodent is likely to be found.

Population surveys, which have been conducted since the 1950's, are usually made by flying over established routes following water courses or around lakes and counting the active colonies. This method does not give a precise figure for the number of beaver in the area but does provide a means of assessing year to year trends. Of five routes which possibly include peatlands (South St. Louis, Hay Creek - Kelliher, Black Duck, Red Lake - Pine Island, Northrome), surveyed between 1971-1975, the average density was .58 live colonies per mile of census route (Karns 1975). This estimate was not appreciably different from the average (.57) for all census routes for the years 1957-1975.

Habitat--The beaver is likely to be found wherever open water, such as streams, rivers, lakes, or ponds exist in combination with proper foods. Beaver are quite capable of modifying their environment through the building of dams to create a favorable aquatic habitat. Through their dam building capabilities, beaver enlarge small ponds or waterways into extensive tracts of open water, providing more deep water and easier access to a food supply.

Beaver can exist in acidic waters of peatlands. Originally beaver were probably quite scarce or non-existent in the peatland complex in northern Minnesota due to the absence of open water. However, around 1915, an extensive drainage ditch system was dug to drain peatlands for

agricultural purposes. These ditches proved to be inhabitable by beaver, some of which were apparently transplanted into the ditches (Vesall et al 1947). The mineral soil that had been dredged out of the ditches and deposited on the banks provided a good substrate for the establishment of aspen, willow, and balsam poplar, favored beaver foods. By 1947, the beaver population in these ditches was estimated at one active colony per 1.3 miles of ditch, or 3.2 beaver per mile.

Long standing beaver ponds tend to create conditions that promote the development of open bogs. The well known "beaver meadow" is an example of this. Beard (1953) conducted a vegetation analysis on 4 beaver ponds in the Seney National Wildlife Refuge in Upper Michigan. Tamarack, black spruce, alder, willow, leatherleaf, bog birch, and sedges, all of which are characteristic plants of peatlands, were found in some combination on all 4 sites.

Food Habits--In nearly all research on beaver habits, aspen is considered the favored winter food (Aldous 1938, Longley and Moyle 1963, Hall 1960, Hodgdon and Hunt 1966). Willow, birch, and alder can be important components of the diet where they are available (Hall 1960). Vesall and McCain examined 27 food piles in 8 northern Minnesota counties and found aspen in 85% of the piles, willow in 78%, and alder in 36% (from Longley and Moyle 1963). Hodgdon and Hunt (1966) found that at 5 beaver colonies in Maine, aspen made up 44.6% of the woody plant utilization, alder 28.9%, birch (grey and white) 10.0%, and willow 6.8%. During the summer months, aquatic vegetation is heavily used in some areas (Shelton 1966, Northcott 1971).

Aspen will be utilized by a colony until the available resource is completely depleted. The greater the supply of aspen, the more intensely it will be utilized (Hall 1960). Where aspen is not available, beaver are still capable of existing on secondary foods, such as willow (Hall 1960) or alder (Northcott 1971).

Usually twigs up to ½ inch are eaten in their entirety, but only the bark and cambium layer of larger branches and trunks are consumed (Longley and Moyle 1963). Aldous (1938), studying beaver in the Superior National Forest, found that of 456 aspen trees cut by beaver, 27% were completely used, 44% were partially used, and 29% were completely wasted. Of 19,420 pounds of available food, only 6,987 pounds (36%) was used. For white birch, of 32 trees, 16% were completely used, 62% were partially used, and 22% were completely wasted. The greatest waste was in the larger diameter classes, where only the tops were utilized.

Hiner (1938) found that beaver in Itasca State Park seldom traveled more than 270 feet to obtain aspen. Beaver appeared to select for sites where aspen grew on a slope towards their colony site, which made the hauling process easier.

Seasonal Movements--A colony site is apparently chosen by a mature female, usually in late summer or early fall. Once a site has been picked, the female may remain there for the rest of her life. Most colonies are actually family units, with the maternal female being the important element holding the colony together. With her death, the colony is apt to be abandoned. However, if the adult male dies, he is usually quickly replaced (Longley and Moyle 1963).

During the fall the kits aid the adults with the underwater storage of food in large piles anchored to the bottom of the pond, and in repairing the dams and lodge in preparation for winter. Throughout the winter, when surface travel is obviously not possible due to the presence of ice, the family group usually remains together in one large lodge, swimming under the ice to the food pile.

Since the number of animals in a colony is limited by food supply and mutual tolerance of individuals, some dispersal must occur. In spring, it is usually the yearlings that leave the site in which they were reared and disperse into new areas. Beer (1955) studied movements of beaver tagged in St. Croix State Park. No adults were trapped outside the park boundaries. Trapping was not allowed within the park, but the lack of adult animals outside the park suggest there were few movements made by this age class. However, 10 yearlings retrapped at least 4 months after the original trappings were taken an average 19 miles from the original site.

General Statements--Because beaver are so capable of making major alterations on their environment, they have been cited as producing many situations, considered both good and bad. (Longley and Moyle 1963, Beard 1953, Highby 1940, Vesall et al 1947). Damage to roads, agricultural lands, and lakeshore property is fairly common (Smith and Knudson 1955). The trout-beaver relationship differs with the condition of the specific locale. In some areas the deepening of pools provides water through the dry season. As long as cold springs supply a stream, beaver are generally

beneficial. However, in other areas, flooding and cutting operations destroy shade and permit the warming of the water, or dams may slow streams up enouth to cause a rise in temperature. Further, the decomposition of organic debris above an old dam produces carbon dioxide and substances potentially toxic to trout (Highby 1940).

In Koochiching County, there has been concern that beaver dams and resultant high water could affect timber production (Vesall et al 1947). The drainage ditches dug in the early part of this century had the effect of improving timber growth an average distance of 252 to 444 feet back from the ditches. Also, man made dams were installed in some areas in an attempt to restore water levels for the reduction of fire hazards (Manweiler 1938).

While these man made dams have not been maintained, they did give the impetus for beaver to spread throughout the drainage network. The number of active beaver dams per mile found in a 1947 study (Vesall et al) varied from 0 to 10 with an average 2.5. The average difference in water levels above and below actively maintained dams was 1.7 feet, but where beaver dams had been superimposed on man-made structures as much as 6 feet of water was held back.

Along 56 miles of ditches surveyed, damage to timber, Christmas trees, and reproduction was noted on 1,635 acres, averaging 29 damaged acres per mile of ditch. Flooded areas extended an average 588 feet back from the ditch and ranged in size from .3 to 277 acres. Black spruce made up 75% of the affected trees, tamarack 13%, white cedar 10%, and mixed balsam fir and aspen 2%. Beaver were believed to be having a significant effect on

timber growth on potentially good sites. To counteract these losses, trapping has been practiced as a means of controlling the population. This study was conducted after a series of wet years. Under drier conditions, dams may help supply needed water to some areas.

Wilde et al (1950) studied some of the changes in composition of ground water, soil fertility, and forest growth produced by the presence and removal of beaver dams in Wisconsin. Following the removal of a dam, an area is usually invaded by sedges. This cover increases the fire hazard and obstructs the natural regeneration of trees. On sandy soils sedges are replaced by aspen and birches in a few years, but on peat or organic soils, sedge meadows may resist the invasion of forest species (willows and alder, and later swamp conifers) for several decades.

Where waters are stagnant, or there is sluggish drainage, such as in a beaver pond, the backwater becomes strongly acidic. With almost no exceptions, the ground water of previously flooded land is deficient in oxygen and possesses a low oxidation-reduction potential. These types of conditions are favorable for the development of anaerobic microorganisms whose by-products can be toxic to other animals. In general the soil of drained areas is impoverished in available nutrients and enriched with growth inhibiting substances, such as hydrogen sulfide and ferrous iron.

When an area is initially dammed, the impounded water produces a rise in the ground water table in adjacent soils. This in turn depresses the growth of forest stands on the nearby lowlands either by drowning, or

by decreased aeration of soil. However, on uplands, the raised water table can actually benefit the growth of trees. When a dam is removed, the result often causes more drainage than the initial flooding. The rapid change can affect growth due to the possibility of drought, in both uplands and lowlands. Wilde et al (1950) concluded that, considering the effects, it may be wiser to allow beaver to remain in areas already flooded, but to take preventive measures where necessary to keep beaver out of specified new areas. Furthermore, the drainage of beaver ponds removes the climatically beneficial water reservoir, increases the fire hazard, and destroys the habitat of much wildlife. The negative effects of drainage seem to be particularly pronounced when the soil is peat or organic.

While there are negative impacts associated with the presence of beaver, there are also a number of positive factors. In addition to those mentioned above, the beaver's importance to the trapper and fur industry cannot be overlooked. Beaver ponds act as a water source and firebreak to aid in the control of forest fires. Beaver ponds and meadows provide habitat and food for deer, moose, and furbearers (Highby 1940). Beard (1953) has shown the importance of beaver dams to waterfowl nesting and rearing success in Upper Michigan.

Possible Impacts--Beavers use the extensive peatlands wherever drainage ditches provide high ground for a food supply - aspen, willow, balsam poplar - to grow. These animals were not found in this region originally. Peat removal would probably have the effect of removing local populations.

However, reclamation of these areas could be directed so as to provide beaver with a suitable habitat.

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SNOWSHOE HARE

Minnesota Distribution/Abundance - The snowshoe hare (Lepus americanus) is found throughout northern Minnesota, its southern limits being Anoka, Sherburne, Todd, Ottertail and Clay counties. (Gunderson and Beer 1953). In any one area, the numbers of snowshoe hare fluctuate widely over an approximate 10 year "cycle". Near Lake Alexander in 1932 the estimated population was 478 per mi^2 (Green and Evans 1940). During the next four years it dropped to 32 and then more than doubled to 73 the last year of that study. Also, at the Cloquet Forestry Center in Carlton County there were hare populations of 125-150 per mi^2 in 1950-51 and again in 1961-62, while they were down to 10-20 per mi^2 in 1946 and 1955 (Marshall 1977). Live-trapping studies in central Alberta show populations of 161, 51, 8, 58, 45, and 54 per mi^2 between 1962 and 1967. (Meslow and Keith, 1968). In 1971 they had risen to 390 per mi^2. (Brand et al 1976).

Habitat - At the Cloquet Forestry Center during high populations the snowshoe hare is found in all forested or bushy habitats--they do avoid open areas. During the years of low hare densities, such as 1946 and 1955, they are found only in the swamp conifers (cedar-spruce and spruce), swamp thicket and fen habitats (Marshall pers. comm.). Similarly, during "low" years in Alberta "The remaining hares were associated with bog edge thickets of small black spruce and alder and with patches of hazel" (Keith 1966).

Food Habits - As summarized by Hanson and Flinders (1969)--"In winter,

snowshoes feed mainly on woody plants. Succulent forbs and grasses are highly preferred and constitute the major part of the diet when they are available", i.e. spring, summer, early fall.

Thus, near Cushing, Minnesota jack pine, white pine, red pine and black spruce were reported as preferred winter foods in that order. (Aldous 1936). In April and May hares shifted to aspen, willow and birch (leaves), but also took strawberry and pussytoe leaves. During the summer the main kinds of plants eaten were clover, pussytoes, willow (leaves) and grasses. Similarly near Grand Rapids winter diets were white pine, black spruce, and red pine. (Kittredge 1927). In Quebec, 12 species of hardwoods were utilized during the winter, but white cedar, white fir, hazel and striped maple were the plants heavily fed on. (DeVos 1964).

The most recent and perhaps best reports on snowshoe hare foods is from near Fairbanks in the interior of Alaska (Wolff 1978). He reports that "Hare foods changed from hardwood (willow, birch) browse and spruce bark and needles in the winter to leaves and other herbaceous materials in the summer" and that their diets shifted from one season to the other as the snow depth changes.

This dependence on woody twigs and barks is believed to be the underlying cause of the population crashes as, at peak population, the hares soon deplete all of the food they can reach above the snow line. Thus Wolff (1978) states "When the hare population reached a peak density of 166 per mi^2 nearly 100 percent of all available browse in all habitat types was consumed". As a result of lack of food, the number of litters

drops off quickly, and the number of predators, which have responded to the recent high hare population continue to increase for a period of time, thus further depressing the dropping hare population.

Seasonal Movements - The snowshoe hare is a very sedentary animal. For instance, hunters using trailing dogs let their dogs run and wait by a "trail" for the rabbit to double back. More specifically, studies in Montana, Ontario, and Alaska have shown the "home range" varies from 5-40 acres (Meslow and Keith 1968). In their central Alberta study area, 97% of the adults were repeatedly recaptured within 330 yards of the first trapping and tagging. According to this study the hares emigrated from the spruce-alder coverts as populations increased and only moved short distances even in the aspen habitat.

General Statements - While snowshoe hares may be found in all types of forested or bushy areas when they are abundant, during the years of scarcity they are restricted mostly to swamp conifers, swamp thickets, and fen habitats. Here their winter food requirements are met by woody vegetation such as black spruce, balsam fir and white cedar as well as alder, birch, aspen and similar plants which grow in or adjacent to bogs. A lack of woody plants is the underlying factor influencing population crashes as at "peak" years the hares eliminate the available twigs and bark and then suffer spectacular declines.

The snowshoe hare is the major food of the Canada lynx and of importance to many other predators. Thus it is a "key" animal in the food chain of northern coniferous forests and its absence will adversely affect many predators.

Possible Impacts - Since the snowshoe population "reservoir" is dependent on swamp conifers, swamp thickets and fens and, in fact, they avoid open areas at all times, the removal of these plant communities will eliminate populations. In addition it must be remembered that their movements are very restricted so that large scale peat operations with a slow return of woody plants will have a lasting effect.

As this animal is an important prey species of many northern predators, especially the lynx, the disruption of the food chain will affect this group of animals directly.

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SMALL MAMMALS

There are some 13 species of "small" mammals that may be found in peatlands in northern Minnesota. These animals are all relatively short lived and their movements are quite restricted. These two facets of their life history mean that they are very much dependent on a particular habitat but that they can recover quickly if the habitat is re-established. Many of them are important food for predatory birds and mammals. Information available on this group in peat habitats is relatively general so they will first be listed by habitat groups in which they are most commonly found, followed by a brief individual write up.

The open bog, bog and muskeg types are least known from the standpoint of small mammals--probably because of relative scarcity in these habitats. If the cover has a high percentage of sedges one could expect to find the cinereus shrew, the southern bog lemming, perhaps the northern bog lemming, the meadow mouse, and the meadow jumping mouse.

In the swamp forest types the cinereus, short tailed and arctic shrews, the two squirrels--red and northern flying squirrel, and the red-backed vole will most commonly be found.

The fen types can be expected to have not only the most species, including the ones listed above, but also the star-nosed mole, the least chipmunk, and the white-footed mouse. This is undoubtedly related to the comparative richness of the substrate which is influenced by mineral rich waters or soil, and to the fact that these types are often adjacent to upland types.

The true relationship of the star-nosed mole (Condylura cristata) to peatlands is not well known. Gunderson and Beer (1953) state that it is not common except in the extreme northern and northeastern counties of Minnesota where it inhabits swamps, bogs, and wet meadows. Other studies also suggest that this species is restricted to moist swampy habitats or even wet uplands where burrowing is relatively easy (Cahn 1937, Jackson 1961). The food of the star-nosed mole consists chiefly of aquatic worms, insects, and other invertebrates, while less than one quarter of its diet consists of terrestrial invertebrates.

The cinereus shrew (Sorex cinereus) is one of the most common small mammals to be found in northern lowlands. It generally occurs in all types of habitats--coniferous or deciduous woods, marshes or grassy bogs, spruce cedar swamps, alder thickets along brooks, spruce, tamarack and leatherleaf bogs (Jackson 1961). Some authors reported it most common in swamp conifer-tamarack sites, especially those infested with the larch sawfly (Brown and Lanning 1954, Buckner 1957, Buckner 1966). Getz (1961a) suggested that moisture was the most important component of the habitat for this species, and that vegetation types were important only in so far as they affected that particular factor. This shrew is apparently capable of existing in areas with standing water (Getz 1961a), but Buckner (1966) found rainfall was a serious mortality factor for nestlings. The home range of the cinereus shrew averaged 1.37 $\pm$ 0.9 acres in a tamarack swamp (Buckner 1966). One instance of an individual being recaptured one-half mile from the original capture site, following a rise in the water table, suggests these animals are capable of traveling considerable distances. Hamilton (1930, from Jackson 1961) found the

summer diet to consist of 65% insects, 7% vertebrates (probably mostly young mice), 7% centipedes, and 4% worms. Getz (1961a) believed the cinereus shrew capable of using food items of smaller size than those of a short-tailed shrew, allowing a wider tolerance of habitats. Buckner (1966) found population sizes of the cinereus shrew to be inversely related to numbers of arctic shrews.

The short-tailed shrew (Blarina brevicauda) can be found in most habitats but is most common in heavy forest and low, damp, swampy areas (Burt 1948). Brown and Lanning (1954) found this species fairly common in tamarack swamps, as did Buckner (1966), who determined its home range to average .97 $\pm$ 0.9 acres. The short-tailed shrew prefers areas where the soil moisture is great enough to keep the air in the burrows or in the humus layer satuarated, but areas inundated with water are avoided. Earthworms and the larger soil insects which are most abundant in moist humus are the major foods. Thus the type of cover is not important except as it relates to these other biotic and abiotic factors (Getz 1961a).

The arctic shrew (Sorex arcticus) is known to occur chiefly in wet spruce and tamarack swamps, but it is also known to exist in open muskeg, leather-leaf-sphagnum bogs, and grass meadows (Quimby 1943, Jackson 1961), Heaney and Birney 1975). It was found to have a home range of 1.46 $\pm$ .14 acres in a swamp conifer tamarack site (Buckner 1966). Relatively little is known concerning the habits and biology of this species.

The southern bog lemming (Synaptomys cooperi) has been found only in the northern half of Minnesota (Heaney and Birney 1975). It is primarily an inhabitant of the open sphagnum bog, although in times of abundance

some specimens are taken in woodlands and grassy areas. The chief requirement of the bog lemming appears to be the presence of sedges and grasses, which are the main source of food (Connor 1959). Wherever a good stand of sedges, especially Carex, is found, these animals can be expected to occur. The presence of ericacious shrubs or other woody vegetation is not a hindrance to them (such sites are avoided by the meadow vole). Moisture appears to be an important factor limiting its distribution (Getz 1961b). In autumn and winter, in an area with a high degree of interspersion of uplands and peatlands, Connors (1959) found that most lemmings had moved into the uplands, but with the beginning of spring growth they quickly return to the bogs. Most were found not more than 160 feet from the bog edge. He found the average minimum range to be about .2 acres, while Gunderson (1950) reported .28 acres.

Only three specimens of the northern bog lemming (Synaptomys borealis) have been taken in Minnesota, one each from Lake of the Woods, Koochiching, and Roseau counties (Heaney and Birney 1975). Its habitat requirements are apparently similar to those of its southern congener.

The meadow vole (Microtus pennsylvanicus) may be found in close proximity to the southern bog lemming, often utilizing the same runways (Connors 1959, Getz 1961b). It also is found primarily in moist, open grassy settings (Richens 1974, Gunderson 1950, Getz 1961b), and avoids areas with woody vegetation. On the other hand, it is more tolerant of varying water conditions, and is often abundant where standing water exists, a site the bog lemming will not be found in.

The red-backed vole (Clethrionomys gapperi) is found throughout the forested part of the state (Gunderson and Beer 1953). It apparently prefers moist wooded habitat (Kaline 1976, Brown and Lanning 1954), but seems to reach its greatest abundance in swamp conifer forests (Ozoga and Verme 1968, Gunderson 1950, Manville 1949). Here the runways and nests are often found along logs, stumps, and roots where the herbaceous cover is fairly sparse. Manville (1949) found the size of the home range to vary from .12 to .23 acres, but considered this to be the minimum size. Over large tracts of suitable habitat, the red-backed vole may only average one or slightly more per acre, though locally it can commonly be found in densities of 4 or 5 per acre (Jackson 1961). This vole will consume a wide variety of nuts, seeds, berries, green vegetation, fungi, and bark, the diet largely determined by availability.

The white-footed mouse (Peromyscus maniculatus) can be found throughout the state of Minnesota, the woodland species (P.m. Gracilis) being found only in the northern half of the state (Gunderson and Beer 1953). This species can tolerate a wide variety of conditions, but is commonly found in lowland mature forest, such as swamp conifer cedar (Ozoga and Verme 1968). The foods of the white-footed mouse include various seeds, small nuts, many small fruits, and a considerable number of insects, especially the larvae (Jackson 1961).

The meadow jumping mouse (Zapus hudsonius) has been found throughout most of Minnesota (Gunderson and Beer 1953). It most commonly inhabits moist grassy areas, shrubby fields, sedge meadows, or willow and alder swales (Cahn 1937, Quimby 1949, Jackson 1961). It is seldom found in

great abundance. The home range size is about 3 acres for males, and 2 for females (Gunderson and Beer 1953). The diet of this species consists of seeds, grasses, grains, and weeds (Jackson 1961).

Although the red squirrel (Tamiasciurus hudsonicus) is found throughout Minnesota, it appears to be most predominate in habitats that contain mature conifers (Kalin 1976). Although Layne (1954) found it common in various deciduous forests, most investigators suggest that it prefers coniferous forests (Cahn 1936, Sargeant and Marshall 1959, Gunderson and Beer 1953). The seeds of conifers are the most important items in the diet, but fruits, and berries, seeds, blossoms, and young leaves of hardwoods, and mushrooms are also commonly taken where available (Jackson 1961). Kemp (1970) found red squirrels to be non-territorial in deciduous habitats but strongly territorial in mature coniferous habitats. Strong territorial behavior exists where defense of the food supply is necessary to year-round survival. The absence or weakness of territorial behavior in deciduous woods may be due to the insecurity associated with no assurance of a year-round food supply (Kemp 1970), or the inability to successfully defend a territory or food cache from squirrels of other species with similar food habits (Smith 1968). Kemp (1970) found the size of the territory to average 1.5 acres in coniferous forests but evidence suggests that an inverse relationship exists between the quality and quantity of the food supply and the size of the territory (Smith 1968).

The northern flying squirrel (Glaucomys sabrinus) is found primarily in the coniferous belt of the northern half of the state (Gunderson and Beer 1953). It is usually found in heavily wooded areas of mature coniferous or mixed coniferous and deciduous trees, often preferring moist forests with many large fallen and decaying logs (Jackson 1961). Relatively little is known about the biology of this species. The nest, which is used as a resting site and home during the winter, is usually in a tree cavity. The northern flying squirrel has a quite varied diet, consuming quantities of hazel nuts, spruce, balsam fir, and cedar seeds, the fruits of cherry, juneberry, the berries of mountain ash and various viburnum species, mushrooms, and flesh wherever it is able to procure it (Jackson 1961).

The least chipmunk (Eutamias minimus) is restricted to the coniferous zone of Minnesota, where it is found mainly on the uplands (Gunderson and Beer 1953, Kaline 1976). It is most commonly associated with brushy edges of disturbed early succession forest (Forbes 1966, Sargeant and Marshall 1959). However, it has been reported in swamp conifer-black spruce and cedar swamps (Manville 1949, Burt 1957).

General Statement - The numbers of these small mammals may be expected to fluctuate violently in yearly and even monthly intervals (Manville 1949, Getz 1961, Wilson 1966, Buckner 1966). The reasons for these dramatic changes in population densities is not well understood, but may point out

the sensitivity these animals have in reacting to subtle environment factors. It should be expected that during intervals in which the population is particularly high, animals will spread into areas that are not considered prime habitats.

Possible Impacts - Removal of any of these types will undoubtedly eliminate the species in that area. With recovery reinvasion can be expected in a short time.

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ANIMALS OF SPECIAL CONCERN

Below is a partial listing of birds and mammals in need of special consideration in Minnesota, as determined by the Minnesota Department of Natural Resources (Moyle 1974). Only animals which are known to make significant use of peatlands, or whose true relationship to peatlands in Minnesota is not really known, are reported below. The 7 species listed are assigned to one of 3 categories, depending on the rarity of the species, its past history in Minnesota, whether or not it is present in Minnesota during the reproduction period, how certain the information on it is, and what can be done from a practical point of view to aid it. The short discussion of each species, except where noted, is taken from Moyle (1974).

In the following list, these explanatory symbols appear in parentheses after the species' name to describe the legal status and rarity:

T--Species classified under federal regulations as threatened.
P--Afforded some degree of protection under Minnesota laws, the amount and kind of protection varying with the species.
U--Specifically listed as "unprotected" under Minnesota laws.
N--Status not specified under Minnesota laws--not legally designated either "protected" or "unprotected".
R--Probably have always been rare or uncommon in Minnesota. Some of these are peripheral species.
*--Probably increasing at present.

It should be noted that all migratory birds, including hawks and owls, are now protected under the Migratory Bird Act of 1916, though this is not shown in the table.

1. Threatened Species--Species which could become endangered in Minnesota in the foreseeable future but not necessarily throughout their entire natural range.

    1. Pine Marten (P) - - - - - - - - - - Martes americana
    2. Greater Sandhill Crane (P)- - - - Grus canadensis tabida

2. Species of Changing or Uncertain Status--Species that are uncommon or local in Minnesota but which are not presently endangered or threatened but which could become threatened. Conversely, they could increase under favorable circumstances.

    1. Fisher (P, *) - - - - - - - - - - - Martes pennanti
    2. Canada Lynx (U) - - - - - - - - - - Lynx canadensis
    3. Marsh Hawk (P,*)- - - - - - - - - - Circus cyaneus hudsonius
    4. Eastern Timber Wolf (T, P)- - - - Canis lupus lycaon

3. Species That Are Extirpated Or Rare In Minnesota And Have Little Future--Species that once lived in Minnesota but which were early extirpated, or nearly so. Because of habitat loss or alteration associated with increase in human population and changes in land and water use there appears to be little possibility of re-establishing them as viable, sizable wild populations.

    5. Woodland Caribou (P) - - - - - - Rangifer tarandus sylvestris

The pine marten is a moderate-sized weasel that was once common in the coniferous forests of Minnesota. Because it is so easily trapped, it became rare by the end of the 19th century in Minnesota, and was probably extirpated somewhat later. It is now legally protected in the state, and animals have been seen along the Canadian border. Note: Recent reports to the Department of Natural Resources indicate clearly that it is increasing in both range and number.

As mentioned in the individual account, sandhill cranes are easily upset by human encroachment, and for this reason, deserve special consideration and encouragement in Minnesota. The present population is much smaller than the original, being restricted now to large tracts of suitable habitat, primarily on game management refuges. Wherever this species is found in the state, special concern should be given to it.

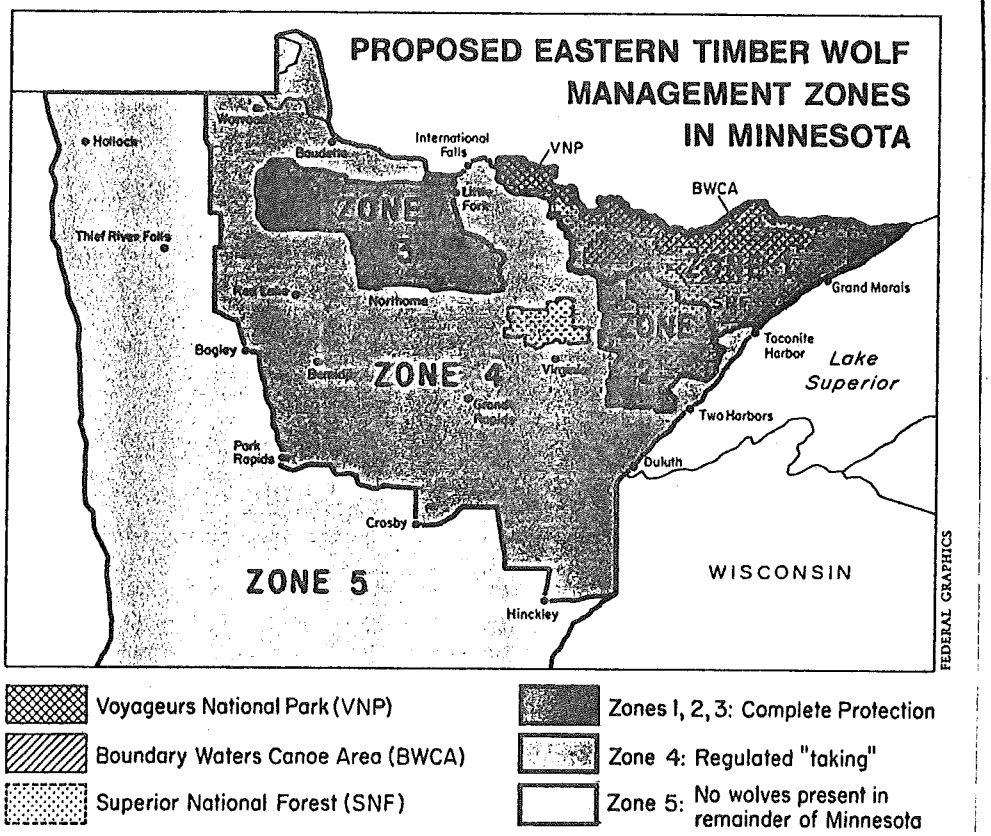
The fisher has become fairly common in some parts of Minnesota after being rare for many years. Note: A trapping season was opened in 1977-78, in which 2,170 animals were legally taken. However, the status of this species should be monitored for any future changes.

The Canada lynx is an animal of uncertain status in Minnesota. It is possible that many of the animals reported in Minnesota are emigrants from Canada, but there is not enough information on this species in Minnesota to make specific management recommendations feasible.

The marsh hawk was formerly a common summer resident throughout the state, breeding mainly in open country. It usually nests in open or brushy meadows or drier portions of swamps. The degree of utilization of open peatlands by the marsh hawk has not been reported upon in Minnesota. It is presently less abundant than originally, apparently due to the loss of habitat and possible effect of pesticides.

The Minnesota Department of Natural Resources has classified the eastern timber wolf to be of changing or uncertain status (Moyle 1974). The grey wolf was formerly classified as "endangered" by the federal government. However, as of April 10, 1978, the wolf was reclassified as "threatened" and critical habitats have been determined in the state of Minnesota by the U.S. Fish and Wildlife Service (Federal Register, Vol. 43, N. 47--Thursday, March 9, 1978). This reclassification allows the taking of wolves by state or federal employees if such wolves commit significant depredations on lawfully present domestic animals. Further, the state of Minnesota is broken down into 5 zones, with 3 designated as "critical habitat" (see map. p.). In accordance with the Endangered Species Act, federal agencies are required to insure that actions authorized, funded, or carried out by them do not adversely affect the critical habitat of endangered or threatened species.

Though no longer a resident, the woodland caribou was once a fairly common animal in the mature boreal forests and peatlands of northern Minnesota. It's original range extended as far south as Aitken County. The last animals known to exist in the state inhabited the extensive muskeg



From Mech, L. D. 1977. A recovery plan for the eastern timber wolf. National Parks and Conservation Magazine 51: 17-21.

area north of Red Lake. These were last seen in the 1940's. Note: A transplant attempt in 1939 failed to re-establish a population. The decline of this species may have been closely connected to an increase in white-tailed deer, which carry a brain worm (Paralaphostrongylus tenuis) which, while fatal to caribou, is apparently unharmful to deer. Recently, there has been an appeal made, strongly supported by the Safari Club International, to attempt another re-introduction of caribou to Minnesota.

EUROPEAN LITERATURE

During reviews of literature a few citations in scientific journals pertaining to animal ecology in peat habitats were found. Usually these dealt with species not occurring in Minnesota, or even North America. Many were not available or had not been translated. For possible future use those references which apparently pertained to bird populations of bogs (Hakala 1971, Hayrinen 1965, Hilden, 1965, Hilden 1967, Seiskari 1954, Sammalisto 1955, 1957, Mustakallio 1966, Koponen 1967, and Pi Hl Asalo 1968), regional trends in peatland avifauna (Hayrinen 1970, Hayrinen 1973, Jarvinen and Sammalisto 1976), human impact on bird populations of peatlands (Asbirk 1975), and small mammals (Millanby 1966, Kalela et al 1971, and Flowerdew et al 1977) are listed below.

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PLANT NAMES

COMMON NAME	SCIENTIFIC NAME
Balsam Fir	*Abies balsamea*
Green alder	*Alnus crispa*
Striped maple	*Acer pennsylvanicum*
Mountain maple	*Acer spicatum*
Speckled alder	*Alnus rugosa*
Juneberry	*Amelanchier spp.*
Bog-rosemary	*Andromeda glaucophylla*
Low or Swamp Birch	*Betula pumila* var. *glandulifara*
Leather-leaf	*Chamaedaphne calyculata*
Red-osier Dogwood	*Cornus stolonifera*
Black Ash	*Fraxinus nigra*
Bog-Laurel	*Kalmia polifolia*
Tamarack	*Larix laricina*
Western larch	*Larix occidentalis*
Black or Bog-Spruce	*Picea mariana*
White Spruce	*Picea glauca*
Jack Pine	*Pinus banksiana*
Lodgepole Pine	*Pinus contorta*
Red Pine	*Pinus resinosa*
White Pine	*Pinus strobus*
White Cedar	*Thuja occidentalis*
Balsam poplar	*Populus balsamifera*
Aspen	*Populus tremuloides*

COMMON NAME	SCIENTIFIC NAME
Labrador Tea	*Ledum groenlandicum*
Sweet Gale	*Myrica gale*
Raspberry	*Rubus idaeus*
Willow	*Salix spp.*
Long-beaked Willow	*Salix bebbiana*
Heart-leaved Willow	*Salix cordata*
Pussy Willow	*Salix discolor*
Sandbar Willow	*Salix interior*
Elderberry	*Sambucus spp.*
Low Sweet or Late Sweet Blueberries	*Vaccinium angustifolium*
Sour-Top-Blueberries or Velvet-Leaf-Blueberries	*Vaccinium myrtilloides*
Small Cranberry	*Vaccinium oxycoccus*
Mountain Cranberry	*Vaccinium vitis-idaea*
Huckleberry	*Vaccinium spp.*
Bog Aster	*Aster nemoralis*
Marsh Marigold	*Caltha palustris*
Bellflower	*Campanula spp.*
Goldthread	*Coptis groenlandica*
Trailing arbutus	*Epigaca repens*
Strawberry	*Fragaria spp.*
Bedstraw	*Galium labradoricum*
Small fringed gentian	*Gentiana procera*
St. John's Wort	*Hypericum virginicum*

COMMON NAME	SCIENTIFIC NAME
Wild Lily-of-the Valley	Maianthemum canadense
Smartweed	Polygonum spp.
Wild buckwheat	Polygonum convolulus
Wintergreen	Pyrola spp.
Rose	Rosa spp.
Canadian burnet	Sanguisorba canadensis
Pitcher Plant	Sarracenia purpurea
Golden ragwort	Senecio aureus
False Solomon's-Seal	Smilacina trifolia
Bog Golden Rod	Solidago uliginosa
Tall meadow-rue	Thalictrum polygamum
Water Shield	Braesnia schreberi
Coontail	Ceratophyllum spp.
Horsetails	Equisetum spp.
Buckbean	Menyanthes trifoliata
Water milfoil	Myrrophyllum spp.
Water Lily	Nuphar spp.
Bushy pondweed	Najas flexilis
Water lily	Nymphaea ordorate
Pickerel weed	Pontedaria cordata
Floating leaved pondweed	Potamogeton natans
Sago pondweed	Potomageton pectinatus
Pondweed	Potomageton pusillus
Arrowhead	Sagitlaria latifolia
Water Bulrush	Scripus spp.

COMMON NAME	SCIENTIFIC NAME
Bur reed	*Sparganium spp.*
Duckweed	*Spirodela spp.*
Cat Tail	*Typha latifolia*
Bladderwort	*Utricularia spp.*
Wild celery	*Vallisneria americana*
Brown top	*Agrostis tenuis*
Blue-Joint Grass	*Calamagrostis canadensis*
Northern Reedgrass	*Calamagrostis inexpansa*
Sedge	*Carex spp.*
Sedge	*Carex exilis*
Rough Sedge	*Carex lacustris*
Narrow Leaf Sedge	*Carex lasiocarpa*
Sedge	*Carex livida*
Sedge	*Carex micheauxiana*
Sedge	*Carex rostrata*
Sedge	*Carex stricta*
Sedge	*Carex tenuiflora*
Muskgrass	*Chara spp.*
Three-way-sedge	*Dulichium arundinaceum*
Spikerush	*Eleocharis spp.*
Cotton-grass	*Eriophorum* spp.
Manna grass	*Glyceria canadensis*
Manna grass	*Glyceria borealis*
Grasses	*Gramineae*
Reed-Canary grass	*Phlaris grundinacea*
Timothy	*Phleum pretense*

COMMON NAME	SCIENTIFIC NAME
Cane	*Phragmites spp.*
Kentucky blue grass	*Poa pretenis*
Whitetop grass	*Scolochola festucacea*
Torres's three-square bulrush	*Scirpus torreyi*
Wild rice	*Zizania aquatica*
Bracken fern	*Pteris aquilina*
Feathermoss	*Calliergonella schreveri*
Brown Moss	*Campyllum spp.*
Reindeer Moss	*Cladonia spp.*
Feathermoss	*Dicranum rugosum*
Sphagnum or peat moss	*Sphagnum* spp.
Sphagnum or peat moss	*Sphagnum angustifolia*
Sphagnum or peat moss	*Sphagnum fallex*
Club Moss	*Lycopodium* spp.

(After Table E-1 Flora of Minnesota Peatlands: A preliminary list. Plant names from other literature have been added).