

[1978]

Prevalent model species within each community

IA. Black Spruce bog

Picea mariana
Gaultheria hispidula

II. Mixed spruce-jackpine

Pinus banksiana
Vaccinium angustifolium
Lycopodium annotinum
Coptis groenlandica

III. Jack pine

Fragaria spp.
Amelanchier spp.
Salix bebbiana
Apocynum androsaemifolium
Alnus crispa
Anaphalis margaritacea
Comptonia peregrina
Dryopteris spinulosa

IV. Red pine

Comus canadensis
Pinus resinosa
Maianthemum canadense
Rosa aciculasis
Diervilla lonicera
Rubus pubescens
Vaccinium myrtilloides
Anemone quinquefolia
Oryzopsis asperifolia
Rubus idaeus
Viola spp.
Epilobium angustifolium
Vicia americana
Aster ciliolatus
Prunus virginiana

IB. Tamarack bog

Carex spp.
Larix laricina
Chamaedaphne calyculata
Sphagnum spp.
Betula pumila
Andromeda glaucophylla
Ledum groenlandicum
Vaccinium oxycoccus
Smilacina trifolia
Salix pedicellaris
Sarracenia purpurea
Kalmia polifolia
Equisetum fluiratile
Salix sp.
Coptis trifolia
Pleurozium schreberi
Rubus acaulis

VA. Ash bog

Fraxinus nigra
Alnus rugosa
Aster puniceus
Viola spp.
Thuja occidentalis
Mentha arvensis
Thalictrum dioicum
Acer saccharinum
Onoclea sensibilis
Caltha palustris
Iris versicolor

VI.. Aspen - birch

Aster macrophyllus
Populus tremuloides
Corylus cornuta
Aralia nudicaulis
Betula papyrifera
Pteridium aquilinum
Streptopus roseus
Lycopodium obscurum
Galium triflorum
Gramineae
Acer spicatum
Lonicera canadensis
Acer rubrum

VII. Mixed coniferous - deciduous

Clintonia borealis
Abes balsamea
Linnaea borealis
Sorbus american
"moss"
"Rubus"

VIIIA. Alder carr

Hypericum spp.
Calamagrostis canadensis
Spiraea alba
Lycopus u niflorus
Potentilla palustris
Scirpus spp.
Dryopteris cristata
Cornus stolinifera
Campanula aparinoides
Rumex crispus
Salix discolor

The 2000 square mile Regional Copper Nickel Study Area lies east of a line between Mountain Iron and the west arm of Vermilion Lake in Lake and St. Louis counties, Minnesota. (Figure 1) The area includes a 560 square mile area centering on the zone of mineralization bearing the highest copper-nickel potential. This 560 square mile area corresponds to the MINESITE project, a DNR computerized resource inventory. Studies of terrestrial habitats conducted by the Regional Copper Nickel Study were focused on the 560 square mile area. Unless otherwise stated, the words "study area" in the following habitat descriptions refer to this 560 square mile area.

Very little of the study area can be called "virgin" timber. The area was surveyed and opened for settlement in the 1880's. At that time the predominant forest types were white and red pine, aspen-birch, and jack pine.

(Figure 1) Lowlands were occupied by conifer bogs. Areas with large white pines (especially in the south) were the first to be logged while the jack pine region in the northeast was left until the most recent logging era.

Extensive logging continues in this part of the study area at the present time.

Soils of the study area range from thin sandy-loam soils in the northeast to thick loams in the Toimi drumlin field of the south. (Figure 3)

A series of end moraines cross the area from west to northeast. The most prominent of these, the Hoyt Lakes moraine, is characterized by a distinct well-drained sandy-loam soil type. The depth of the soil above bedrock is generally greater along end moraines than in the intervening area. Out-wash soils are generally thick but their gravelly texture produces well-drained situations favoring jack pines. Peat soils are developed extensively in the east central portion of the study area.

Over half the study area is in the national forest ownership. (Figure 4)

Three Ranger districts of the Superior National Forest administer these lands: the Kawishiwi District, the Isabella District and the Aurora District. Management has been most intensive in the northeastern and southwestern portions of the area. Plantations in the extreme southwestern portion postdate the 1936 Palo-Markham-Aurora fire. Aspen stands arising after this fire will reach rotation age within the next twenty years. In the northeastern part of the area the last of the virgin jack pine stands are

currently being harvested. Both jack and red pines are being used in reforestation. The central portion of the study area was logged in the late 1930's through the 1950's and reforestation was often incomplete. Much of the area has regenerated in open aspen-birch communities with dense brush cover. Plantations are less common than in the northeast and southwest.

Five major development zones have been identified. (Figure 5) The first and third includes watersheds of north-flowing rivers (Bear Island, Kawishiwi, South Kawishiwi, Denley; Isabella, Nip Creek, Stony River) that drain into^{and through} the BWCA. The present taconite industry is concentrated in the second zone, including watersheds of the Dunka, Argo, Embarrass, Colvin and Partridge rivers. The last two zones include relatively undisturbed watersheds that drain southward including those of the St. Louis, Whiteface, North and Sand rivers.

Nine major forest communities were identified within the area. (Table I) These include: I Wetland conifers, II Mixed spruce-jack pine, III Jack pine, IV Red pine, V Ash, VI Aspen-birch, VII Mixed deciduous-coniferous,

VIII. Shrub carr, and IX. White spruce. Several of these types may be further subdivided into easily recognized subgroups. Wetland conifers are comprised of black spruce, tamarack and cedar bogs. Red pine, jack pine, and white spruce generally occur as plantations.

Ash stands and shrub carrs are restricted mainly to wetlands receiving nutrients from nearby uplands. The remaining seven subtypes form a floristic continuum that does not appear to demonstrate clear successional trends. These types include; VI D pure aspen, VI B nearby pure aspen-birch, VI C aspen-birch with fir, VII A aspen-birch-fir-spruce, VII B aspen jack pine spruce, and II spruce-jack pine. Broad community types correspond with MINESITE vegetation cover types which can be used to estimate the proportion of the study area in each vegetation type. (Figure 6)

Methods

Findings summarized in the following habitat characterization are drawn from both primary and secondary data sources.

A set of two-hundred and seventy-seven semiquantitative field surveys

(Braun-Blanquet relevés) provides the basis for classification of the vegetation into community types. Quantitative data are available for sixty-two of these two-hundred and seventy-seven stands. Summaries dealing with the floristic composition of vegetation types are drawn from releve' data, while estimates of plant species density, coverage, and/or basal area are drawn from the quantitative data set. Plant communities were identified by a computerized method of cluster analysis that joins together stands with similar floristic composition, while also taking into account the relative coverages of the respective species.

Discussions of small mammals within each habitat type and comparing these values between habitat types. Only those mammals capable of being caught in a "Museum Special" (rat-sized) trap were included in the small mammal census. Examples of such mammals are mice, shrews, and smaller members of the squirrel family.

Habitat preferences for medium sized (weasel, porcupine) and large mammals (moose, deer) were ascertained from an extensive literature review. This review was supplemented in the case of fur-bearing mammals by examination of Department of Natural Resources fur purchase records. Such records enabled us to identify the portions of the study area being used most extensively by particular species. Deer hunter surveys and aerial censuses for deer and moose provided similar information. A literature review pertaining to game birds and waterfowl was supplemented by a spring singing ground census for woodcock,

a spring drumming census for ruffed grouse, and an aerial census for migratory waterfowl. These techniques do not provide a direct population estimate because they only account for resident displaying male game birds. In the case of migratory waterfowl, census flights were scheduled during the migration season (when population levels are highest) in order to compare use in various parts of the study area. The census does not reflect resident breeding populations.

On the other hand, studies of song birds were most intensely addressed toward the breeding population. Singing bird censuses were conducted in _____ stands of _____ habitat types during the breeding season. Each stand was visited a total of _____ times and locations of singing birds were mapped. Data from these observations were subjected to cluster analyses that 1) grouped stands by their similarity of bird species and 2) grouped species by the coincidence of occurrences. Stable clusters of species were identified as bird communities independent of vegetation type. The bird communities were then related to vegetation types. Winter bird census were conducted both by visual observation and by sounds.

Definitions

The following specialized terms are used in this report.

barrel scarification--

basal area--square meters of tree (or shrub) stem cross section

per hectare. Trees were measured ____in above the ground and
shrubs _____.

bog--

carr--a wetland dominated by shrubs from knee to shoulder height

clear cutting--

climax--

continuum--

community, habitat, cover type, vegetation type--these words are used as synonyms to relieve the reader of boredom.

density--number of individuals per unit area. In this report densities are expressed as numbers of plants, animals, or birds per hectare.

dominant--the most important species in a community type (habitat) based on density, basal area, frequency, percent cover, or a combination of these values.

fauna--all animal species present in a given unit. Animal species include both birds (avian fauna) and mammals. The unit may be a geographic area such as the RCNSA, a habitat type, or a specific stand, according to the context.

flora--all plant species present within a defined unit. The unit may be a geographic area, such as the RCNSA, a habitat type, or a specific stand depending on the context.

frequency--the number of sample plots within stands in which a species occurred expressed as a percent of total plots sampled.

guild

hectare--a 100 x 100 inch square (2.5 acres).

herb--

high shrub--

Index of distinctness--a measure of the degree to which a community type is distinct from related community types based on the number of model prevalent species expressed as a percentage of the total # of prevalent species within a community type.

Index of homogeneity--a measure of similarity among stands within a habitat type expressed by the ratio of the sum of presence values of prevalent species to the sum of presence values of all species. The range of the index is from 0.00 for no similarity to 1.00 for totally alike floras.

Low shrub--

MINESITE

Modal species-- those species attaining their highest percent presence within a given habitat. Habitats with three or fewer samples were omitted from the consideration in determining modal species.

Prevalent species--the topmost species counted off to a number equal to the average number of species per habitat when all species are arranged in descending order on the basis of their percent presence.

presence--the number of stands in which a species occurred.

rare plant habitat index--

RCNSA--

relative density--

release

rock raking

rotation--the age at which tree species are harvested for commercial use

SAF cover type-- a classification scheme developed by the Society of American Foresters that describes forest types based upon commercial tree species.

seed tree--

shelterwood--

stand--a single location in which data were collected. One stand may contain five quantitative sample plots. Slants usually have homogenous overstories.

structure--

Succession--the process by which one community type outlives its ability to replace its mature trees with more of the same species and is replaced by another type whose dominant species are able to regenerate under the soil, light or nutrient conditions created by the original community.

tree--

Wetlands

Treeless wetlands vary from fen (open grass and sedge meadows usually adjoining lakes and streams) through heath bogs dominated by low shrubs to carrs dominated by tall shrubs.

Heath bogs (MINESITE vegetation type 11) occur throughout the study area in association with spruce and tamarack bogs. In the northern part of the study area they are best developed in draws between rocky ridges and at the margins of lakes. The type is most extensively developed in the watershed of the North River on bog soils overlying glacial outwash. (Slue 19) Heath bogs are uncommon in the St. Louis River watershed. Because they generally have poorly developed tree and high shrub layers, these bogs are generally classified by foresters as "nonproductive swamp."

The continuous low shrub layer is dominated by members of the heath family (Ericaceae) such as leatherleaf (Chamae daphne calyculata), bog laurel (Kalmia pulifolia) and bog rosemary (andromeda glaucophylla). The herb layer is generally sparse, with low species diversity dominated by sedges (Cyperaceae) and bog cranberries (Vaccinium oxycoccus). Carnivorous plants such as pitcher plants (Sarracenia purpurea) and sundew (Drosera rotundifolia) develop their best populations here, relying on insects as a source of nitrogen. The habitat is preferred by several orchid species (protected by Minnesota Statue 17.23) including Arethusa bulbosa, rose Pogonia (Pogonia ophioglossoides), Grass pink (Calopogon pulchellies) and Lister's twayblade (Listera cordata). Sphagnum mosses often form a continuous

groundcover. Leading families are Ericaceae, Cyperaceae.

Our data do not allow us to calculate synecological coordinates for this community type because bogs were characterized by their scattered trees, but heath bogs are high in both moisture and sunlight. Because their nutrient supply is derived more from rainfall than runoff from neighboring uplands they are often acidic and poor in nutrients. Accumulation of undecomposed organic matter, especially Sphagnum and sedges, (Carex spp.) in water-logged acid conditions results in the buildup of peat soils (soil type associations 19B, PA, SPA) achieving depths up to five feet. Where such wetlands are extensively developed, they exhibit patterns in the vegetation reflecting the flow of nutrients and nuances of underlying topography. The patterns in the large wetland lying T59N, R10W are associated with the position of the underlying Laurentian divide.

Where heath bogs grade into open sedge meadows (fens) near water, they become important for waterfowl which rely on the sedges for food. The extensive development of such fens in the watershed of the North River probably accounts for its being the most important waterfowl habitat in the study area. Use of heath bogs by large mammals appears to be occasional as they pass through on their way to water. Winter use is limited by deep accumulations of snow. Although the habitat per se was not sampled in the small mammal census, there is a drop in the number of characteristic species between closed and open tamarack bogs, suggesting that only those species most highly correlated

with wetlands and dense cover of low shrubs, such as the arctic shrew (Sorex arcticus) would persist in heath bogs.

Alder carrs (MINESITE vegetation type 4) differ from heath bogs in both their structure and species composition. Trees and low shrubs are generally infrequent while shrubs between one and three meters in height achieve their highest basal area in this habitat. Within the study area alder carrs are best developed in the Toimi drumlin field on bog soils between the drumlins. In contrast with ericaceous bogs which are better developed on outwash soils or between thin-soiled ridges of the Kawishiwi and Isabella watersheds, alder carrs are well supplied with nutrients from the deep-soiled loamy drumlins. The good supply of minerals is enhanced by the nitrogen-fixing abilities of the alder. Average synecological coordinates for the community are: moisture, 3.81; nutrients 2.30; heat, 2.04; and light, 3.30. Cluster analysis of wetlands based on synecological coordinates suggests that within the study area, alder carrs are most similar to cedar bogs.

While alder (Alnus rugosa) is the dominant shrub species, willows (Salix spp.), red osier dogwood (Cornus stalinifera) and "green alder" (ellex verticellata) are frequent. Composites and mints (Lamiaceae) are well represented in the herbaceous flora. The ground layer is patchy, with sedges, ferns such as the sensitive fern (Anoclea sensibilis), forbs such as violets (Viola spp.) water horehound (Lycopus uniflorus) and marsh marigold (Caltha palustris) interspersed with exposed mud and

water. The diversity of plant (lichens, mosses) species is high () but rare plants are infrequent (rare plant habitat index = .30).

Alder carrs are prime habitat for woodcock throughout their resident season. They are used for cover, food (open patches of mud), display grounds and nesting. The importance of this habitat for woodcock suggests the Toimi drumlin field as a target area for future management of this relatively unexploited game species. Moose use alder carr for spring and fall cover and food (willow and red osier dogwood). Along with the slow-flowing streams for aquatic summer foods, recent cuts, and mature upland deciduous stands for early winter use. The presence of alder carrs helps make the St. Louis river watershed the most important for moose. This habitat also provides summer cover for the hens and broods of ruffed grouse. Insects harbored among the ferns provide the sole diet of the brood for their first three weeks.

Small mammal use of alder carrs appears to be restricted to the shrews (Sorex arcticus and Sorex cinereus) which prefer moist habitats in general.

Tamarack bogs (MINESITE vegetation type 20, SAF type 38) intergrade with both black spruce bogs and open ericaceous wetlands. In general the canopy is more open than spruce bogs and attains less height. High shrubs are virtually absent. Low shrubs are generally sunloving members of the heath family (Ericaceae) such as: leatherleaf (Chamaedaphne calyculata), bog rosemary (Andromeda glaucophylla) bog laurel (Kalmia

polifolia), and labrador tea (Ledum groenlandicum). In pure tamarack stands, the herbaceous flora is limited in species, characterized by bog cranberries (Vaccinium oxycocos), false Solomon's seal (Smilacina trifolia) and carnivoraous plants (Sarracenia purpurea and Drosera rotundifolia). Considering the low overall species diversity of pure tamarack bogs, the rare plant habitat index is remarkably high (2.28), second only to cedar bogs. Rare species are generally members of the orchid family. Orchids characteristic of fens and open heath bogs (rose Pogonia, Pogonia ophioglossoides; grass pink, Calopogon pulchellus; Arethusa bulbosa; and Lister's twayblade, Listera cordata) flourish along with those of wider habitat tolerance (Habenaria hyperborea). The largest continuous tamarack bog sampled as part of the Regional Copper-Nickel Study (G45) harbored a fair population of blooming arctic raspberry (Rubus acaulis). Although this plant is not considered rare for the state, most Minnesota collections have been made in wetlands west of the Study Area and blooming colonies are difficult to locate. Sphagnum mosses often form a continuous groundcover, but tamarack seedlings require sunlight and are outcompeted where spruce form a closed canopy. Although tamarack bogs are often viewed as a successional stage between ericaceous bogs and spruce bogs their slow growth rate and susceptibility to flooding and wind damage often slows succession to the point where they appear to be stable communities.

the distribution of tamarack bogs in the Study Area is similar to that of open heath and black spruce bogs. They are best developed on peat soils (slu 19, soil associations 19B, PA and SPA) in draws between ridges in the Kawishiwi watershed, around lakes, or overlying outwash plains in the watershed of the North River.

Although their open structure and deciduous canopy make tamarack bogs unsuitable cover for large mammals, summer browsing by snowshoe hare may cause heavy seedling loss. Only three small mammals are characteristic of open tamarack bogs: the arctic shrew (Sorex arcticus), masked shrew (Sorex cinereus), and meadow vole (Microtus pennsylvanicus). The meadow vole, generally a denizen of grasslands (density 40/ha), achieves densities of 10-11/ha in tamarack, three times higher than in all other habitats other than grassland, open tamarack, and cedar. In the absence of large tracts of agricultural land the voles apparently turn to wetlands with abundant sedges for their seed supply. Small mammal populations of closed tamarack bogs resemble those of spruce bogs with six characteristic species: masked shrew (Sorex cinereus), arctic shrew (Sorex arcticus), short-tailed shrew (Blarina brevicauda), pigmy shrew (Microsorex hoyi), red-backed vole (Lethrionomys gapperi) and meadow vole (Microtus pennsylvanicus).

Unlike black spruce, tamarack seldom attains sufficient size to provide nesting trees for bald eagles and ospreys. Songbirds of tamarack bogs are part of the wetland-conifer bird community, dominated by ground nesters which pick and glean their food supply off shrubs and trees. This bird community is dealt with more fully in the discussion of black spruce bogs.

Black spruce bogs (MINESITE vegetation type 19, SAF type 12, "black spruce") are well developed throughout the study area except in the Toimi Drumlin field where they are replaced by alder carrs. North and east of the Giant's Range they occupy narrow draws between the uplands and margins of small lakes. Portions of the extensive wetland in T59N, R10W have developed a spruce canopy of merchantable size. Spruce bogs are also an important element in the bed of Glacial Lake Dunka, southeast of Babbitt. In the central portion of the study area, spruce bogs are well developed along the major streams, especially between the upper forks of the Dunka River. The more extensive nature of these bogs than those in the Kawishiwi watershed has resulted in their commercial use. Unlogged spruce bogs along Twenty Proof Creek are denser and of lower diameter than their logged counterparts. Customary practice usually involves logging in strips rather than clearcutting and regeneration is usually good. Where spruce bog grades into heath bog and nutrient supplies are poor, trees are widely spaced and dwarfed. Such open grown

forms are commercially valuable as Christmas trees.

The community is usually characterized by open or closed spruce canopies, often festooned with the lichen Usnea (old man's beard) that is used as winter food by white-tailed deer.

Generally there are few high shrubs and a variable low shrub layer. Where low shrubs are well developed Labrador tea (Ledum groenlandicum), bog birch (Betula pumila), and leather-leaf (Chamaedaphne calyculata) are common. Herbaceous layers vary according to the available nutrient supply and moisture (light competition). Where the bog intergrades with the transitional black spruce-jack pine type feather mosses, ground pines (Lycopodium spp.) twinflower (Linnaea borealis) and other damp forest herbs are common. More acid, wet situations favor the development of Sphagnum mosses, bog cranberries (Vaccinium oxycoccus) and sedges (Carex spp.). Of habitats investigated in this study, spruce bogs show the highest fidelity of sub-canopy structural layers to canopy type.

The rare plant habitat index is lower for black spruce bogs than for either tamarack or cedar bogs. Most rare plants located in this habitat are members of the orchid family (Orchidaceae), protected by Minnesota statute 17.23. Geocaulon lividum, a boreal member of the Sandalwood family (Santalaceae) its southern range limits, was found in one spruce bog (T05).

The site was drier and more open than the preferred Minnesota habitat of salmonberry (Rubus chamaemorus) another species of similar distribution with stations recorded near Basswood or Snowbank lakes.

The single most important user of black spruce bogs is probably the spruce grouse, which uses the habitat year round for food (spruce needles), cover, display grounds, and brood cover.

Black spruce bogs provide winter cover for deer, moose, and snowshoe hares and year round food, cover, and nesting habitat for spruce grouse, whose diet consists mainly of conifer needles. Where trees are mature enough, such bogs provide nesting sites for ospreys and bald eagles. The value of spruce bogs to these two species is enhanced if the sites are near water because fish are the major part of their diet. Both fisher and marten prefer mature coniferous habitats. Since martens avoid logged and burned areas and fishers prefer to be in the vicinity of water, the habitat should be suitable for both species. Mature spruce provide nesting habitat for bald eagles and ospreys, both of which rely on fish as their major food source.

Spruce bogs are not the single most important habitat for any of the small mammal species. Sorex arcticus, which attains high frequencies in all conifer bogs, prefers those with dense low shrub layers. This preference suggests that it should be more

common in more open spruce bogs with ericaceous understories than in the closed mature ones with well developed moss layers and poor development of high shrubs, low shrubs and herbs. The abundance of both Sorex cinereus and Microsorex hoyi is positively correlated with higher cover of mosses, suggesting that they should be more important in more mature shaded spruce bogs with open shrub layers. Three additional small mammal species are characteristic of black spruce bogs: Blarina brevicauda, Clethrionomys gapperi and Microtus pennsylvanicus.

Conifer Wetlands

The bird communities of the mature conifer lowlands, including tamarack, black spruce and cedar stands, were consistently recognized (i.e. by various methods of cluster analysis) as faunistically different from bird communities in other habitats. The only exception was a very open tamarack bog. This plot was consistently separated from the other mature lowlands and was considered more faunistically similar to young upland plots or the wetland alder.

Perhaps the most distinguishing feature of the mature conifer lowlands is that approximately 70% of the individuals present are ground nesters. The values ranged from 43.5% in the open tamarack bog to 90.0% in an open spruce bog. The average percentage of ground nesters present in other habitats ranged from 12% in the grassland to 54% in the alder. Together the thick sphagnum ground cover in the conifer lowlands and the

dense cover of low ericaceous shrubs combine to provide excellent nesting material and cover for many species. A significant correlation was found between the absolute abundance of ground nesters and the diversity of ground cover. Ground nesters that are characteristic of the conifer lowlands include the nashville warbler, conneticut warbler, lincoln's sparrow, yellow-bellied flycatcher, winter wren, tennesse warbler and dark-eyed junco. The tennesse warbler has been recognized^{by} the State of Minnesota as a species "meriting special concern." All but one of these speices, the nashville warbler, have been recognized as potentially critical, unique or indigenous species dependent upon habitats found in northeastern Minnesota. The only ground nester that was unique to the conifer lowlands was the tennesse warbler.

Tree nesters contributed only 9-19% of the total avian density. The most characteristic tree nesters are two species which were also unique to the habitat; ruby-crowned kinglet and cape may warbler. The cape may warbler has also been recognized the state as a species "meriting special concern" and as a unique species dependent upon habitats found in northeastern Minnesota.

Shrub nesters were third in importance, contributing between 0-1-% of the avian density. Characteristic shrub nesters, again speices that were also unique to the conifer lowland, include the gray jay and swainson's thrush. The density of shrub nesters was significantly correlated to the density of high shrubs.

Although approximately 70% of the individuals in the conifer lowland are ground nesters only 6% are ground foragers while approximately 71% are pickers and gleaners, foraging in the shrubs and trees. Therefore, although nearly three-quarters of the individuals present are dependent on the unique substratum of the conifer lowland for nesting cover, most of these individuals are also dependent on the canopy and subcanopy for food requirements.

Nine basic avian communities have been recognized in this study; they include:

- 1) recent clearcuts
- 2) young plantations
- 3) aspen regeneration
- 4) mature conifer upland
- 5) mature deciduous upland
- 6) conifer lowland
- 7) alder
- 8) disturbed shrub
- 9) grassland

When these habitats are ranked by their average summer density (number of breeding pairs per km²), the conifer lowlands, averaging 714 pairs/km, ranked eighth out of nine. The lowest densities were found on the recent clearcuts (an average of 544 pairs/km). The conifer lowlands also ranked low (eighth of nine) with regard to diversity, 5.79, the lowest being the deciduous upland with a diversity of 5.39. Perhaps a better measure of the richness of this habitat is the number of species, which averaged 12.8, of 13. Compared to the average number of species found in the other habitats, the onifer lowland ranked four out of nine.

Regarding the winter bird study, characteristic winter birds of the conifer lowland included the gray jay, northern three-toed woodpecker and boreal chickadee, the boreal chickadee being the only species that was unique to the conifer lowland. The average number of observations per habitat per five hours was approximately 5.7 (i.e. an observer would record only one bird for every hour spent in a conifer lowland!). When the winter plots are classified into five major habitat types: 1) lowland conifer; 2) aspen-birch; 3) conifer plantation; 4) mixed upland; and 5) clearcut, the lowland conifer ranked third in the average number of observations.

Six lowland conifer stands were sampled in the winter of 1977; three of these plots were stands with a dense, closed canopy, while three had a very open canopy. The dense canopy stands averaged twice as many (7.8) observations per five hours as the open canopy stands (3.6). Maintenance of body heat could be a principal factor operating; exposure to winds and subsequent loss of body heat would presumably be much higher in the open canopy stands. In addition, because of the lower tree density, available food resources (primarily insect larvae and seeds) would be lower in the open canopy bogs.

Regarding summer birds, a similar distinction can also be made between open and closed canopy lowlands. Breeding bird density in the open conifer plots, 444 pairs per km was nearly half that found in the closed canopy plot, 849 pairs per km.

Bird species diversity was also lower in the open canopy bogs (5.24 compared to 6.07). As discussed above, approximately 70% of the individuals in conifer bogs are ground nesters. The available ground cover in open bogs would not seem to be a limiting factor. However, since most of these ground nesters depend upon the canopy for food, the decrease in available canopy (hence, food resources) may help to explain the lower bird density and diversity.

**The dominant species of the mature conifer wetlands further distinguish the bird communities of this habitat. Dominant species are defined as the species that contribute the highest relative densities. With the exception of the open tamarack bog, the nashville warbler was the dominant species in all mature wetlands, contributing between 26% and 48% of the total avian density. In the open tamarack bog the common yellowthroat was dominant. Species that were second in dominance included the connecticut warbler, white-throated sparrow, chestnut-sided warbler and common yellowthroat.

Alder

Like the bird communities of the mature conifer wetlands, cluster analysis consistently distinguished the bird communities the alder habitat as faunistically unique. Species that are characteristic of the habitat include alder flycatcher, catbird, veery, golden-winged warbler, common yellowthroat and swamp sparrow. Although none of these species were unique to the community, all species demonstrated higher density and important

values in the alder. Not included in this list is the chestnut-sided warbler, the dominant species on both alder plots sampled in 1977, contributing 15% and 27% of the total community density. Despite its importance in the alder community, the chestnut-sided warbler is more characteristic of the young successional stages of upland communities, and its presence and importance in the alder does not aid in distinguishing the habitat as unique. Species unique to the alder community were rare and observed on only one of the two plots. They include yellow warbler, sora rail and short-billed marsh wren.

Although faunistically distinct from other bird communities, the two alder plots sampled in 1977 differed significantly from one another. The alder plot near Skibo had a total density of 2400 pairs per km, the highest density in the bird community study, and a total of 26 species, the largest number of species in the study. The alder plot further south on county road #16 had a total density of 880 pairs per km and only 12 species. This discrepancy is partially explained by structural differences in the vegetation. Structurally, the Skibo alder plot is more diverse than the county road #16 alder. Dead standing and live paper birch, black ash and white cedar trees are scattered throughout the Skibo alder, providing an additional dimension for avian habitat utilization. These trees, for example, provide a nesting platform for tree nesters like the rose-breasted grosbeak and cedar waxwing, and a foraging perch for pursuers that sally forth from dead snags or trees to catch insects on the

wing, like the great-crested flycatcher and american redstart. The relative abundance of the avian functional groups also reflect these structural differences. Fourteen percent of the total avian density in the Skibo alder was composed of tree nesters and nearly 6% was composed of cavity nesters; neither nesting guild was present in the county #16 alder. In addition, the total acreage of the Skibo alder is smaller than the county #16 alder. The ecotone between the alder and the nearby upland deciduous community provides another habitat dimension to the bird community; some of the species censused in the Skibo alder may be associated with the vegetational ecotone rather than with the alder community proper. By contrast, the alder plot on county road #16 was much larger in size and, with fewer trees, the vegetational structure less diverse. Comparison of these two plots illustrates that as the structure of the vegetation becomes increasingly diverse, new habitat dimensions are available for utilization by different bird species, thereby increasing the complexity and diversity of the avian community.

White cedar stands (MINESITE vegetation type, SAF type 37) within the RCNSA appear to be restricted to isolated wetlands well supplied with nutrient runoff from surrounding uplands. Such stands are present in both the northern and southern part of the study area. This may well be the most unique vegetation type in the area both because of its limited extent (0.2% of the 560 sq. mile area) and its floristic composition. Although its shade tolerance would suggest that it might be the final stage in wetland succession this situation is seldom attained

because most wetlands in the study area lack the internal drainage and nutrient supply needed by cedar. Wetland cedar stands develop better on shallow sedge or wood peat (soil associations 19B, PA) rather than the deep acid peat soils (soil associations SPA and SPB) favored by heath and tamarack bogs. Cedar bogs in the RCNSA are of more diverse species composition (119 species), wetter, and more open than those in the north central portion of the state where the understory is so shady and the litter so deep that little else grows. Stands included in this study were all near or in disturbed areas. Their open canopies and high species diversity may be largely accounted for by the non-homogeneous and disturbed nature of the stands. Floristically the RCNSA cedar bogs have affinities with both spruce bogs and alder carrs. While feather mosses (e.g. Pleurozium schreberi, Hypnum cristacastrensis, Hylocomnium splendens) and damp forest floor species are present, so are nutrient-loving wetland species such as march-marigold (Caltha palustris) and water horehorend (Lycopus uniflorus). Cedar bogs are impressive in their diversity of ferns (nine species) and fern allies (six species) and abundance of orchids (four species in three stands). The latter group of protected species raises the community rare plant habitat index to 6.18. Of all habitats investigated cedar bogs presented the best habitat for rare lichens (partly because of the rarity of the habitat). Rare lichen species collected in cedar bogs include: Cetraria aurescens, Cetrelia chicitae, Chaenotheca

ferruginea, Chaenotheca laevigata, Chaenotheca trichialis,
Pannaria pityrea, Physia setosa, and Parmelia revoluta (first
record for the state).

White cedar has been emphasized as the preferred winter browse
for deer in Michigan and Wisconsin. Its importance as a browse
species in the RCNSA is limited by the extent of the habitat and
the poor condition of the stands. These bogs probably provide year-
round cover for marten and fisher and winter cover and browse
for snowshoe hares. A variety of small mammals were characteristic
of the three cedar bogs sampled. Species that were also character-
istic of other wetland coniferous communities include the masked
shrew (Sorex cinereus) short-tailed shrew (Blarina brevicauda),
meadow vole (Microtus pennsylvanicus) and red-backed vole
(Clethrionomys gapperi). The presence of Peromyscus maniculatus
is a bit surprising since it generally prefers drier, young
upland habitats. It may have retreated to the moist cedar bogs
during the extremely dry 1976 season. The least chipmunk
(Eutamias minimus) follows the same distribution pattern as
Peromyscus maniculatus and is positively correlated with high
percentages of deadfall, a common situation in cedar bogs.
Birds of cedar swamps fall into the wetland coniferous bird
community, discussed in detail in the section on spruce bogs.

Black Ash communities (MINESITE type 5, SAF tupe 39) account for
a very small proportion of the study area (0.1%) and are distri-
buted in all parts of the area in small draws or along rivers.

Stands located in the floodplain of the Kawishiwi River differ from stands in draws in the central and southern parts of the study area. Flood plain stands have poorly developed herb and shrub layers because of their annual exposure to flooding.

Silver maple (Acer saccharinum) is a frequent associate in the canopy layer of such stands. Vines are common.

Ash stands in draws have well developed shrub layers dominated by alder (Alnus rugosa) and willow (Salix spp.). The herb layer is characterized by nutrient-loving wetland species such as mint (Mentha arvensis) water horehound (Lycopus uniflorus), marsh marigold (Caltha palustris) and meadow rue (Thalictrum spp.).

Cedar is a common associate in the canopy layer of ash stands in draws and is assumed to succeed ash in undisturbed conditions.

This community type was not sampled for small mammals but the literature suggests that the following species are characteristic of ash communities: woodland deer mouse (Peromyscus maniculatus) red backed vole (Clethrionomys gapperi) meadow jumping mouse (Zapus hudsonicus), woodland jumping mouse (Napaeozapus insignis) and American water shrew (Sorex palustris). The water shrew generally prefers streambanks and was not collected in any of the habitats sampled for mammals in this study. Brushy ash stands are used by woodcock for fall cover and young ash stands are used by deer for winter browse.

Black spruce--jack pine

The black spruce--jack pine community is not recognized per se

in the MINESITE vegetation inventory, but field data from areas mapped as unit 2, "spruce-fir" show that within the Kawishiwi watershed, MINESITE type 2 corresponds with the black spruce-jack pine community. The community can be referred either to SAF cover type 6, a successional community with black spruce invading jack pine stands or to cover type 7 with black spruce and balsam fir codominant. Stands of this type are the closest approximation of boreal forest in the Study Area.

This community is both topographically and floristically transitional between wetland black spruce bogs and upland jack pine stands. It occurs most frequently on slopes between rocky ridges and bogs on thin, sandy-loam soils of Rainy lobe origin (slu 4). Both these soils and the black spruce-jack pine community are best developed in the Kawishiwi watershed in the northeastern part of the study area.

Black spruce and jack pine dominate the canopy, with balsam fir and birch as common associates. The high shrub layer is less dense than in upland deciduous stands but more common than in pine stands. Hazel (Corylus comuta) and juneberry (Amelanchier spp.) are the most common members of this layer, while Labrador tea (Ledum groenlandicum) and rose (Rosa acicularis) are the most frequent low shrubs. The common upland herbs large leaved aster (Aster macrophyllus), bunchberry (Cornus canadensis), false lily of the valley (Maianthemum canadense), wild sarsaparilla (Aralia

nudicaulis) and twinflower (Linnaea borealis) enhance the mossy groundcover. The ladyslipper Cypripedium acaule, a member of the protected orchid family, is significantly correlated with this habitat type.

Black spruce-jack pine stands provide excellent cover for fisher and marten. Fisher populations appear to be concentrated in the portion of the study area where this community type is most common. Spruce grouse and ruffed grouse both use this habitat year round but while it is excellent habitat for spruce grouse, it is only marginal for ruffed grouse. No data are available for small mammals within the black spruce-jack pine community.

Jack pine

The jack pine habitat type, corresponding with MINESITE type 10, SAF type 1, is present throughout the study area. All but two stands in the southern portion are on deep loam soils of Rainy lobe origin (s.l.u. 6) at the west edge of the Toimi drumlin field. They take their origin as plantations postdating the 1936 Palo-Markham-Aurora fire. Land survey records show that original pineries in this area were dominated by white and red pine and/or these species were mixed with deciduous types. Stands in the northern part of the study area occur on shallow sandy-loam soils of Rainy origin (s.l.u. 4) or on Land survey records show that jack pine was most common in the northern two-thirds of the Study Area and almost absent from

Natural jack pine stands in northeastern Minnesota are even-aged, dating from years with a record of extensive forest fires. Stands north of Birch Lake and south of highway 1 take their origin in fires of approximately 1910, as do stands on the outwash plain of glacial lake Dunka, southeast of Babbitt.

In this part of its geographic range, jack pine cones are most often serotinous, covered with a waxy organic substance that keeps the cone sealed unless it is opened by the heat of fire. This adaptation to fire assures that the seeds will fall on mineral soil where germination is more effective than on the thick duff of unburned forest soils. The effect of forest fire in preparing a mineral seedbed is simulated in silvicultural practice by such techniques as barrel scarification.

The open nature of young stands after either fire or site preparation encourages flowering of species such as fireweed (Epilabium angustifolium) and large-leaved aster (Aster macrophyllus) that only bloom under high light conditions. Many of the herbaceous species of the forest floor persist after site preparation (e.g. false lily-of-the-valley, Maianthemum canadense and bunch berry, Cornus canadensis). Invasion by disturbance species (weeds) such as pearly everlasting (Anaphalis margaritacea), yarrow (Achillea millefolium), orange hawkweed (Hieracium aurantiacum), and thistles (Cirsium spp.) depends on several factors. Degree of soil disturbance, distance from seed sources, competition by forest herbs, and rate of regeneration of shade producing trees (such as aspen) all

influence the establishment of weedy species.

In their earliest stages (1-2 years) young plantations are very open, with large patches of bare ground suitable for woodcock probing. Young jack pine plantations in the RCNSA suffer from heavy competition by aspen and hazel unless they are released by hand removal of the aspen or by herbiciding. Young plantations with high densities of sapling aspen and shrubs provide excellent browse for moose and deer. Where site preparation included "rock-raking" producing windrows of deadfall, raspberries achieve maximum densities along the windrows. Fruiting of blueberries (Vaccinium angustifolium and Vaccinium mytilloides) is more prolific in the sun of young plantations. Although they are omnivores, bears are drawn to this habitat by the berry crops in summer and use windrows as winter dens. Red squirrels do considerable damage to young pine plantations by eating the buds of the leaders. Snowshoe hares do similar damage to any branches they can reach. Small mammal populations in young pine plantations are more similar to those in other young stands than to those in mature plantations. Both the least chipmunk, Eutamias minimus, and the woodland deer mouse (Peromyscus maniculatus) achieve their highest frequencies in young habitats where they are 2-6 times more common than in the corresponding mature habitats. Eutamias minimus is positively correlated with increasing amounts of deadfall, a common feature of clearcuts and very young plantations. The red-backed vole is

also characteristic of young jack pine plantations occurring in all sites sampled with average densities of approximately 5 individuals per hectare.

Although our data do not indicate generally higher populations of small mammals in plantations from a forest management viewpoint small mammals are a serious problem. Red squirrels (Tamiasciurus hudsonicus) remove the leaders of young trees. Both snowshoe hares and deer in high populations can do serious damage to pine plantations.

Mature jackpine plantations are characterized by poorly developed shrub layers with Juneberry (Amelanchier spp.) and honeysuckle (Lonicera canadensis) having the highest presence values. A continuous herb layer is dominated by species such as

insert modal

The high rare plant habitat index of jack pine stands is derived mainly from the presence of the orchids Corallorhiza and Goodyera. Because of their droughty situation, southwest-facing slopes of jack pine stands are the most likely locations for outlier populations of species, such as hoary puccoon (Lithospermum cenescens), that are more commonly found in prairies and dry open woods.

Jack pine is generally considered pioneer species because it is shade intolerant, grows rapidly and is short-lived. In the absence of fire, jack pine in northeastern Minnesota should be replaced either by red pine and then white pine or by black spruce and balsam fir. Fire suppression during the last half century may have encouraged these successional trends, but harvest of most mature jack pine stands in the RCNSA at 50-70 years prevents further successional change. Cluster analysis of 277 more closely related to the black spruce-jack pine community than to the red pine community. The relationship is explained by the fact that about a fifth of the sampled jack pine stands are of natural origin and are closely allied to the black spruce-jack pine stands both geographically and floristically. All the red pine stands in the RCNS sample are plantations.

With the exception of red squirrels, mature jack pine stands are important to an entirely different set of animals than those found in young plantations. Red squirrels use a different resource in mature stands, cutting the cones in midsummer to stored for winter food. Porcupine scar studies in Lake and St. Louis counties show that this animal prefers jack pine as a winter food. Since studies in Michigan suggest that porcupines selectively eat those species nearest their dens, their apparent preference for jack pine may be related to the proximity of safe rocky denning sites. In an area where there are high populations of

their chief predator, the fisher, safe denning sites become even more important. Fisher populations are currently so high in northeastern Minnesota that a trapping season was opened in 1977 and trap records show a concentration of fishers in the northeastern part of the RCNSA. Although fishers prefer to be nearer water they will also use mature jack pine communities for cover. Although they prefer deciduous stands hawks and owls find suitable nesting sites in mature jack pine stands.

Two of the three small mammals characteristic of mature jack pine stands are also characteristic of young plantations.

Clethrionomys gapperi occurs with less frequency but in higher densities in mature stands while Peromyscus maniculatus occurs with both lower frequencies and densities in the mature stands. Sorex cinereus is the third small mammal species characteristic of the mature jack pine stands sampled as part of the Regional Copper-Nickel Study.

Red Pine

Red pine communities (MINESITE type 18, SAF type) in the RCNSA are almost exclusively plantations and are scattered throughout the area. On Superior National Forest lands acreages of red and jack pine plantations are fairly comparable in Lake County but in St. Louis County acreages of red pine are approximately a third those of jack pine. Land survey records show that before clearance, red pine was mixed with white pine and ran in a band from the southeastern part of the study area northeastward to the east of Birch Lake crossing several soil types but avoiding thin sand-

loam soils of Rainy origin in the northeastern part of the study area (slu 4) where jack pine was better developed. Red pine plantations in the RCNSA today generally range in age from 3 to 40 years and are on a variety of soil types including well drained sandy loams over gravelly loamy sand (slu 1) thin sandy-loams of Rainy origin (slu 4), well drained, deep loams of the Toimi drumlin field (slu 6) and sandy loams over sandy gravel (slu 13). Silvicultural guidelines for the Superior National Forest recommend that red pine be planted on sand, sandy loams, and light sandy loams with 10-20% silt and clay.

Mature red pine resembles jack pine in its resistance to fire but differs in that it has non-serotinous cones. Good seed years occur every four to seven years with poor crops in the intervening years.

Like jack pine it prefers sunny conditions and mineral soil for establishment, so that in the absence of management stands probably regenerated from the coincidence of fire years with years of good seed crops. Because of its sporadic seed production, site preparation and planting of seedlings is preferred over natural seeding from seed trees (e.g. shelterwood or seed tree silvicultural systems).

Red pine is generally viewed as an intermediate member in the succession from jack pine to white pine and ultimately to spruce-fir. Although white pine is longer lived, more shade tolerant, and capable of forming multi-aged stands, it has been virtually

eliminated from the successional sequence in the RCNSA by white pine blister rust ().

Succession from red pine to spruce-fir is unlikely to occur within the RCNSA because red pine stands are harvested at ages of 120 years or less and their sites prepared by barrel scarification or controlled burning to expose mineral soil for the succeeding generation.

Exposure of mineral soil not only enhances germination of young pines but prepares a habitat favoring woodcock. Adult male woodcock use 1-2 year-old plantations in the spring for display grounds. Although the female raises her brood in medium to mature deciduous stands, they return to young plantations for feeding grounds after the young can fly. Woodcock probe for soil arthropods in open areas. Densities of woodcock are highest in areas where logging roads are available as avenues of escape because they require a long open launching area for flight. Populations of sparrow hawks are also favored by openings such as young plantations.

Red pine plantations in the RCMSA experience competition from aspen and hazel. The silvicultural guidelines for the Superior National Forest call for release of the red pine as soon as possible. Herbicides such as 2-4D are used for this purpose. Usefulness of both jack pine and red pine plantations to moose and deer is inversely proportional to the success of release. If all young pine plantations were successfully rid of aspen competition, these animals would turn to regenerating aspen for browse.

Because of the similarity of pre-planting treatment and of structure (size and spacing of trees), young red pine and jack pine plantations provide similar resources for animals. Small mammals characteristic of young red pine plantations include the least chipmunk (Eutamias minimus), woodland deer mouse (Peromyscus maniculatus), red backed vole (Clethrionomys gapperis) and the meadow jumping mouse (Zapus hudsonius). Both Eutamias and Peromyscus attain their highest densities in young habitats. All but Zapus were also characteristic of young jack pine plantations.

Mature red pine plantations are similar in structure to mature jack pine plantations with sparse shrub layers and continuous herb layers. Cluster analysis based on species composition recognizes red pine as a distinct type while lumping jack pine stands with mixed black spruce-jack pine stands. Although red pine is recognized as a more discrete community, its variability appears to be greater than jackpine's (Index of homogeneity _____ for red pine and _____ for jack pine). Within the red pine community there are great between-stand differences in species composition. Over half the red pine stands contain birch while less than a fourth of the jack pine stands do. Modal species for red pine stands are: Red pine (Pinus resinosa).

Red squirrels (Tamiasciurus hudsonicus) damage red pine in the same way they do jack pine, by removing the cones. Once seeds are on the ground, woodland deer mice (Peromyscus maniculatus),

red backed voles (Clethrionomys gapperi) and chipmunks (Eutamias minimus and Tamias striatus) devour them, Peromyscus, Clethrionomys, and Eutamias were all found to be characteristic of mature red pine stands. These three species and Zapus hudsonius were also characteristic of immature stands. A fifth species, the masked shrew (Sorex cinereus) which favors wetlands was also characteristic of red pine stands in the damper 1977 season but still exhibited over twice as high densities in wetland habitats. Mature red pine stands provide the same resources for large mammals and raptors as do jack pine stands. Owls and hawks use mature trees as nesting sites and fisher use the habitat for cover and food. Use by porcupine is not documented for northeastern Minnesota. Deer use mid-aged stands for winter cover when other habitats are not available.

Successional Upland Conifers

The upland conifer communities of the Regional Copper-Nickel Study Area consist primarily of managed jack pine, red pine and white spruce plantations; natural stands are scarce. During the vegetational succession from a clearcut stand to a mature conifer stand three different bird communities can be recognized; they include recent clearcut, young plantation and mature plantation.

Mature Conifers

The composition of the breeding bird community of the mature conifer plantations was consistently recognized by cluster analysis as faunistically unique. Characteristic species include

hermit thrush, eastern wood pewee, yellow-rumped warbler, brown creeper, blackburian warbler and red-breasted nuthatch. Other important species may include solitary vireo, dark-eyed junco, chipping sparrow and golden-crowned kinglet. All eight mature conifer stands that were sampled in 1977 had only two species in common; ovenbird and nashville warbler. Although this was not the preferred habitat for either species, the ovenbird was the dominant species in five of the eight stands while the nashville warbler was second in dominance on four of the eight stands. None of the songbird species reported in the mature conifer stands were unique to this habitat.

The bird communities found in mature jack pine stands were not faunistically distinct from the bird communities found in mature red pine stands. For example, two stands whose community compositions were recognized as being the most similar of the mature conifer uplands included one mature jack pine stand and one mature red pine stand. The only apparent distinction between the two vegetation communities is that the mature jack pine is the preferred habitat for the brown creeper. The average density on the red pine and jack pine stands was 660 breeding pairs per km², and the average number of species was eleven. In contrast, the mature white spruce stand maintained a breeding bird density of 1197 pairs per km², and although it supported ten different species, its composition was dissimilar from the other mature conifer stands. The two dominant species, for example,

were the yellow-rumped warbler and nashville warbler; other characteristic species, besides the ovenbird, were absent. This was also the only stand where the golden-crowned kinglet was recorded on more than one visit. Perhaps a major reason for the dissimilarity of this plot to others is its small size; only 1.3 ha in size, the mature white spruce stand was the smallest of the conifer stands sampled, and may not be large enough to support many of the characteristic mature conifer species.

Like the mature white spruce stand, the community composition of a northern jack pine stand was also unlike that of the other stands. The vegetation of the stand included a 27-year-old jack pine plantation interspersed with small patches of alder and mature black spruce bogs. This vegetational diversity was reflected by the diversity in the composition of the bird community. With a total of 17 species, the stand included species that were characteristic of shrub communities, such as mourning warbler and chestnut-sided warbler. Two species that were recorded only once, yellow-bellied flycatcher and ruby-crowned kinglet, are characteristic of mature spruce bogs.

The relative contribution of the four major nesting guilds (ground nesters, shrub nesters, tree nester and cavity nesters) is also similar among many of the mature conifer stands. Ground nesters contribute between 35% and 70% of the total density, averaging 53%; tree nesters contribute between 21% and 62% of the density, averaging 40%. One northern red pine community was

exceptional in its lack of tree nesters; this may be the result of the young age of the stand, 29 years old, and the high density of deciduous shrubs. The high shrub density permitted a relatively high proportion of shrub nesters, nearly 20%, while the other conifer plots averaged only 7%. Cavity nesters were absent on all but two of the conifer stands, one being the northern red pine stand lacking tree nesters.

During the winter, the average number of bird observations per 5 hour period in the mature conifer upland was 2.6, the lowest from all six habitats that were sampled. Species observed on these plots included great horned owl, hairy woodpecker, raven, black-capped chickadee, downy woodpecker and black-backed 3-toed woodpecker; none of the species however, were unique to the winter habitat. The absence of seed eating finches from the winter bird list is worth noting. Winter finches, such as common redpolls, pine grosbeaks, and crossbills are notorious for their large yearly fluctuations. Throughout the state, during the winter of 1976-1977, these finch species were very rare; a flock of the most common finch, the common redpoll, was observed on only one occasion in the intensive study zone after nearly 10 weeks of winter observation. During a winter when these species are more abundant, the mature conifer uplands may be more important to the winter birds.

Young Plantations

The second major bird community that can be recognized in the succession from recent clearcut to mature plantation is the young plantation community. Like bird communities found on other young stands, the bird community characteristic of young plantations is not as well-defined faunistically as the bird community found on mature stands of vegetation. The greater variance in the avian composition of the stands reflects their greater variance in vegetational composition; the variance in vegetational history of the stand reflects their cutting history. A dense growth of shrubs atop the remnants of windrows and slash piles, for example, can provide nesting cover for shrub nesting species like the song sparrow. In addition, trees which are generally not harvested, such as paper birch, soon die and provide nesting cavities and foraging perches for many flycatchers and cavity nesters, such as the olive-sided flycatcher, eastern kingbird and tree swallow. Because the structure of the vegetation may vary considerably, density of the communities may also vary widely; densities on the five upland plantations in this study ranged from about 700 breeding pairs per km² to 1640 breeding pairs per km². Characteristic species which were present on all 5 young plantations include white-throated sparrow, blue jay, chestnut-sided warbler and song sparrow. The white-throated sparrow is the only species that reaches its highest density in this habitat. Other characteristic species include: mourning warbler, nashville warbler, black-and-white warbler, golden-winged warbler, veery, common

yellowthroat, rose-breasted grosbeak, evening grosbeak, shipping sparrow, cedar waxwing, robin, alder flycatcher and common flicker. Although absent from one of the plots, the common flicker reached both its highest density and importance value in the young plantation habitat. The structural and compositional variability of the vegetation in this habitat is also evidenced by the variability in dominant species; no two plots were alike in this respect. The species first in importance may have been the white-throated sparrow, chestnut-sided warbler or song sparrow; the species second in importance may have been magnolia warbler, nashville warbler or common yellowthroat.

Ground nesters, shrub nesters and tree nesters were present in all young plantations sampled. Ground nesters contributed between 24% and 63% of the total community density; shrub nesters contributed between 21% and 43% of the community density. As expected, tree nesters were the least important of the three nesting guilds, contributing between 8% and 22% of the density. Cavity nesters, primarily common flicker, yellow-bellied sapsucker, great-crested flycatcher and tree swallow, contributed between 0% and 8% of the density.

Young plantations were not sampled during the winter bird survey 1977.

Recent Clearcuts

The third major bird community that can be recognized in the succession from clearcut forest to mature forest is the recent clearcut community. Although the stands may vary from 0 to 10 years in age, they are very similar in their structural simplicity. Lacking a tree layer and a dense deciduous shrub layer, the stands contain only a herbaceous layer, a young conifer seedling layer and perhaps some scattered paper birch trees. On some plots the tree harvest has been too recent to allow development of dense aspen sucker growth, on other plots the deciduous growth has been controlled with hand-release or the use of herbicide. The only exception to this generalization was a jack pine clearcut; the contractor was only permitted to harvest the mature jack pine trees, the numerous mature red pine trees were to remain standing. The resulting vegetational structure of the stand is reflected by its relative abundance of tree nesters, which contributed approximately 32% of the community density and included some characteristic tree canopy species such as eastern wood pewee, rose-breasted grosbeak and chipping sparrow.

The four conifer clearcuts that were sampled in 1977 shared three species in common: mourning warbler, white-throated sparrow, and chestnut-sided warbler. None of the three species however, attained their highest density or importance in this habitat. Other common species include common yellowthroat, blue jay and song sparrow; none of the species were unique to the

habitat. Some of the larger passerines and non-passerines, although relatively rare, are characteristic of the open habitat provided by some of the recent clearcuts, such as: eastern kingbird, common snipe, brewer's blackbird, olive-sided flycatcher, evening grosbeak, raven, brown thrasher and sparrow hawk. Many of these species may also be seen in the young plantations. Although not observed on any of the conifer clearcuts in 1977, the killdeer, observed in the habitat in 1976, is also a rare but characteristic species. The only unique species to this habitat, the common nighthawk, was observed on only one occasion when a pair of birds were seen aerially pursuing one another.

The dominant species on three of the four stands was the chestnut-sided warbler; on the fourth stand the white-throated sparrow was dominant. Species second in importance included brewer's blackbird, mourning warbler, song sparrow and white-throated sparrow.

Ground nesters contributed between 34% and 51% of the community density; shrub nesters contributed between 10% and 4% of the community density. The high importance of shrub nesters reflects the heterogeneity of some of the clearcuts. One stand, for example, contained a wet ravine with a dense growth of alder. Shrub nesters may also be associated with high slash pilings or windrows, or with the dense shrubby growth atop the slash. As mentioned previously, tree nesters are relatively unim-

portant. Cavity nesters were present on 2 of the plots and contributed 5% or less of the density.

One conifer clearcut was sampled during the winter of 1977. The plot however, was somewhat atypical in that several mature aspen trees were still standing, in addition to one large white pine and a few dead aspen birch. As a result, the most abundant species on the plots were hairy woodpecker and downy woodpecker, species clearly associated with the standing aspen and capped chickadee, of which there was a single observation. Therefore, without the presence of some scattered trees, recent clearcuts have a rather depauperate winter bird fauna.

White spruce

The white spruce community type in the RCNSA is an artifact of forest management. Although the MINESITE map (type 2) describes a spruce-fir type consisting of over 50% white spruce and balsam fir the situation in the field does not support the presence of such a community type. Stands mapped by MINESITE as spruce-fir are generally dominated by black spruce, often with jack spruce as a coordinate species. Acreage of natural upland black spruce on National Forest lands in Lake and St. Louis counties is between 3 and 4 times that in white spruce plantations.

Since 1936 white spruce plantations have been established in the southern portion of the study area, southeast of Aurora and in the very eastern part of the area near highways 1 and 2. Three such plantations were sampled as part of the Regional

Copper-Nickel Study. The mature stand (age years) was characterized by an extremely dense canopy with _____ trees per _____ and an average basal area of _____ per hectare. The site was poorly drained and the forest floor was characterized by such species as

In keeping with the silvicultural recommendation of mineral soil for the establishment of white spruce, both of the younger plantations (aged) were apparently rock raked before being planted. Although one of these sites was on loamy soils of the Toimi drumlin field (slu 6) and the other on lake clays of possible Des Moines lobe origin (St. Louis sublobe) (slu), neither was well drained. White spruce has the capacity to grow on a variety of soils although it does not do as well on coarse textural soils. The vegetation pattern in young white spruce plantations sampled by the RCNS is very patchy. The presence of windrows in both sites favored growth of raspberries and deciduous trees along their margins but between windrows patches of bare ground were common. The protected orchid Malaxis unifolia was located in the younger of these two stands. Modal species were not calculated for this habitat type because of the small size of the sample and the variability between the three plots.

The poorly drained nature of the three study sites is reflected in the presence of both the masked shrew (Sorex cinereus) and the arctic shrew (Sorex arcticus) as

characteristic species. The red-backed vole (Clethrionomys gapperi) was also characteristic of this habitat type. Mature white spruce plantations would appear to offer suitable habitat for spruce grouse and fisher.

In regions where it is a major component of the natural forests, such as northern Canada, white spruce is recognized as a climax species. Its shade tolerance is similar to that of black spruce but it is longer lived. Wood products are the same as those from black spruce. Instead of recommending a monoculture, management guidelines for white spruce plantations in the Superior National Forest recommend leaving at least 30% aspen-birch with the young spruce to aid growth and prevent forest damage. Harvest should occur at 100 years.

Deciduous stands dominated by aspen and paper birch occur today throughout the RCNSA and produce the most variable of the community types identified in this study. Differences in the species composition and condition of aspen-birch stands appear to reflect the soil types and treatment patterns preferred by these species.

Both aspen and birch are cold-tolerant, short-lived, light-loving species that are considered to be pioneers in the successional series. In northeastern Minnesota they are replaced in undisturbed stands by more shade-tolerant coniferous species (red and white pine, black spruce, and balsam fir). Where fire is a part of the ecosystem, both species regenerate to form even-aged

stands. Aspen suckers form the roots while birch forms stump sprouts. In either case, complete removal of the succeeding generation results in more complete stocking. The same site preparations used for jack pine (clearcutting and slash-burning) encourage development of aspen suckers. It appears that both aspen and birch are more susceptible to disease where stands are poorly stocked (sparse).

Aspen is known to attain better growth on loamy soils than on sandy, thin, rocky, or organic soils. Within the study area, land survey records show that in the 1880's aspen-birch communities were most extensively developed on the loam soils of the Toimi drumlin field (slu 6) with other stands along the Vermilion and Isabella moraines (T60N, R11W, slu 1) in soils greater than 4 feet to bedrock and on the thin sandy loams north and northeast of Birch Lake (slu 4).

Today the best development of aspen-birch stands is in the Toimi drumlin field and along the Vermilion and Isabella moraines near the Stony River. A combination of soil types and past treatment probably accounts for their homogeneity, vitality, and good stocking (density). In addition to the favorable soils of the Toimi drumlin field, the area was logged early to remove its large white pines. Such logging was usually followed by burning of the slash. Land surveyors recognized the moraine country near the Stony River (T60N, R11W) to have the best

marketable timber resource in the northern part of the study area. It was generally logged in the early part of the century and practices were probably similar to those in the southwest. In 1936 all of T57N, R14W, and the west half of T57N R13W were burned in the Palo-Markham-Aurora fire leaving an area completely exposed to sunlight.

In contrast with the Toimi drumlin field and Vermilion-Isabella moraines, the central portion of the study area was selectively cut mainly in the middle of this century. Serial examination of aerial photos at roughly ten-year intervals reveals that in many parts of T59 and 60N, R12 and 13W scattered mature aspen and/or birch were left, shrub layers were not removed and reforestation was delayed by several years after cutting. In this situation aspen suckering was probably inhibited by the remaining mature trees. Today these townships support a heterogeneous mosaic of poorly stocked aspen and birch, upland shrubs (mainly hazel), and interspersed coniferous plantations.

The MINSITE vegetation map shows 48.9% of the study area in the aspen-birch cover type. Seventy of the 277 stands included in the RCNS vegetation survey are classified as aspen-birch stands by cluster analysis.

Three subtypes of the aspen-birch community are recognized: pure aspen (12 stands), nearly pure aspen-birch (20 stands) and aspen-birch with fir (21 stands). The aspen-birch community, as a whole, exhibits high frequencies of coniferous elements, emphasizing the similarity between this community and the mixed

deciduous-coniferous community may in fact represent a later successional stage of the same community type. Prevalent modal species in the aspen-birch community include aspen birch and red maple in the canopy, hazel (Corylus cornuta) and mountain maple (Acer spicatum) in the tall shrub layer, honeysuckle (Lonicera canadensis) in the low shrub layer, and the following herbs: large-leaved aster (Aster macrophyllus), wild sarsaparilla (Arabis nudicaulis), bracken-fern (Pteridium aquilinum), twisted-stalk (Streptopus roseus) ground pine (Lycopodium obscurum) and sweet bedstraw (Galium triflorum). Densimeter readings, used to evaluate canopy coverage, are significantly higher for stands whose shrub layer is dominated by mountain maple than for those dominated by hazel, suggesting that mountain maple does better under shadier canopies. Mountain maple attained comparable numbers of stems per unit area in nearly pure aspen birch stands and in aspen-birch stands with fir but hazel attained higher densities and average diameters in nearly pure aspen birch stands. Both the densities and basal areas of shrub size aspen suckers were greater in nearly pure aspen-birch stands than in those with fir. Apparently aspen-birch stands within the RCNSA are more variable than those within the BWCA. Ordination of aspen-birch stands from the RCNSA produces a cloud of points much more highly dispersed than the cloud for BWCA stands (using the same species

and discriminant functions for both groups).

The youngest stages of aspen-birch regeneration (1-3 years-old) have wildlife resources similar to those of the youngest pine plantations. Aspen clearcuts are used by woodcock throughout their resident season. After about the third season, aspen suckers become too dense to support large woodcock populations. Sapling size aspen are of extremely high food value for deer, moose, and beaver. These stands retain their value for deer and moose because, as succession proceeds, hazel, willow, and mountain maple become the principal winter browse species and the animals use the stands for fall and spring cover. Beaver generally reach their highest densities in areas that are dominated by sapling and pole-sized aspen. Medium to mature aspen stands are the preferred habitat of ruffed grouse which eat aspen buds, drum on aspen logs, and use aspen for nesting. Mature stands are used by hawks and owls for nesting. Where fir is an important component of mature stands, fishers may use this habitat if mature coniferous stands are not available.

Small mammals characteristic of very young aspen stands are the same as those characteristic of young pine plantations: the woodland deer mouse (Peromyscus maniculatus) the least chipmunk (Eutamias minimus) and red-backed vole (Clethrionomys gapperi), as well as the masked shrew (Sorex cinereus) which generally prefers damper situations. Mature stands are characterized by

six species: red backed vole (Clethrionomys gapperi), masked shrew (Sorex cinereus), woodland deer mouse (Peromyscus maniculatus), short-tailed shrew (Blarina brevicauda), woodland jumping mouse (Napaeozapus insignis) and eastern chipmunk (Tamias striatus). The woodland jumping mouse and eastern chipmunk both attain their highest average relative densities in mature aspen-birch. In each case these densities are three or more times higher than densities in all other vegetation types. The chipmunk shows a significant correlation not only with the aspen-birch canopy type but with the Aster macrophyllus herb group. The short tailed shrew is found in densities similar to those in closed tamarack bogs and two to three times higher than in all other habitats. Where aspen-birch communities have fir understories the woodland jumping mouse and eastern chipmunk occur in low densities comparable to other habitats in which they are found.

The mixed deciduous-coniferous community (MINESITE 14, no SAF type) is similar to the aspen birch-fir community but differs in its lower frequency of birch and higher frequency of black spruce, white pine and jack pine. The community is best developed in the northeastern part of the study area on thin sandy loams (slu 4) with a preponderance of exposed bedrock. Mixed deciduous-coniferous stands are found less frequently in the north on loamy sands over sandy gravel parent materials (slu 13) and in the south on thin sandy loams (slu 3) and on thicker loams of the Toimi drumlin field (slu 6). There appears to be a relationship between shallow soil depth and the development of a mixed

community rather than the more pure aspen-birch-fir type.

Because of its mixed species composition, current management guidelines suggest conversion of deciduous-coniferous stands to marketable timber types. During the last ten years large areas of this community type in the northeastern part of the study area have been clearcut. Such areas are customarily reduced to mineral soil by barrel scarification and replanted to red or jack pine. The extensive clearcut area north of August Lake is an example of such an area.

The habitat is generally dominated by a mixture of aspen and black spruce with fir and birch. Jack pine is common. Fir reaches its highest percent presence in this community. Within the RCNSA, it appears that the mixed deciduous-coniferous community is the nearest approximation to the often-postulated "spruce-fir climax." Modal species in addition to fir, include mountain ash (Sorbus americana), Clinton's lily (Clintonia borealis) and twin flower (Linnaea borealis). Shrub layers are less continuous than in the aspen-birch communities.

Because of their higher proportion of conifers, mixed deciduous-coniferous stands provides better habitat for denizens of coniferous forests than do aspen-birch stands. Fishers, spruce grouse and bald eagle are favored by mature conifers. Although ruffed grouse may use mixed stands year round, they are especially important in providing winter cover.

Characteristic small mammals are similar to those of mature aspen-birch-fir communities with three out of four species in common: the masked shrew (Sorex cinereus), the short-tailed shrew (Blarina brevicauda), and the red-backed vole (Clethrionomys gapperi). A third shrew, the pigmy shrew (Microsorex hoyi), is also characteristic of mixed deciduous-coniferous communities. Average relative densities of the pigmy shrew in this community are equivalent to those in closed tamarack bogs and over three times higher than in all other communities.

Successional Deciduous Bird Communities

The upland deciduous communities of the Regional Copper-Nickel Study area consist primarily of aspen-birch forests. On the rocky, thin soils north of the Laurentian Divide. Balsam fir also becomes an important member of this community. Within these upland deciduous forests, four distinct bird communities are recognized; they include: recent clearcut, aspen regeneration, disturbed shrub and mature upland.

Mature Deciduous Upland

The most distinct and well-defined bird community in the upland deciduous forests is the mature upland community. Characteristic species that were common to all eleven stands sampled in 1977 include red-eyed vireo, ovenbird, and veery. Other common species include mourning warbler, black-and-white warbler, nashville warbler rose-breasted grosbeak, least flycatcher,

chestnut-sided warbler and yellow-bellied sapsucker. Although a total of 30 different bird species were observed in the mature deciduous uplands, none of the species were unique to the community. The absence of a unique fauna was also noted for the mature upland conifer community. This is not unexpected in light of the natural history of these two forests. The first, the aspen-birch forest, is regarded as a pioneer community, an early successional stage leading to the climax boreal forest of spruce-fir. Presently, however, this successional forest is being perpetuated in areas like the Regional Copper-Nickel Study Area where logging operations are active. Yet, because of the historically transitional nature of this forest, it could be evolutionarily disastrous for a bird species to restrict its activities to a forest. That would disappear with time. Natural disturbances however, such as lightning-induced fires and spruce budworm, occur frequently enough to guarantee the continued presence of some pioneer deciduous forests. Therefore, it would be advantageous for a bird to be adapted to several successional communities that contain deciduous trees or saplings rather than to a single stage such as the "mature" aspen-birch forest. Two-thirds of the species registered in the "mature" pioneer forests were also able to exploit the habitat found in younger pioneer communities, such as the aspen regeneration and disturbed shrub communities. The other ten species were registered only in the "mature" pioneer forest; however, eight of the species, demonstrating a preference for mature forests, were also registered

in mature upland or lowland conifer forests. Of the two remaining species, the first, american redstart, was an important member of the alder bird community; the second, ruffed grouse, was observed once in the aspen regeneration community and once in the disturbed shrub community.

The mature upland conifer forest also lacked a unique bird fauna. As discussed earlier, the mature conifer uplands are not natural forests, they are instead, managed plantations. Because plantations are relatively recent in evolutionary time, birds have not had an opportunity to specifically adapt to them. Generally, the birds that inhabit these forests are also found in the mature conifer lowlands or are characteristic of the mature boreal forest of spruce-fir.

One of the major differences among the "mature" deciduous stands was the importance of conifer, thus, primarily balsam fir, in the canopy and subcanopy. The presence of conifers in a deciduous stand provides an additional dimension to the vegetation for utilization by the birds. Birds that depend on coniferous trees for nesting, food, or shelter can now accomodate themselves in the deciduous forest. Species that appear to exploit the aspen-birch forest only as the basal area of conifers increases include white-throated sparrow, black-capped chickadee, magnolia warbler, yellow-rumped warbler and winter wren. Within the range fo communities sampled where conifers never contributed more than 18% of the total basal area, only one species, chestnut-sided warbler, demonstrated an obvious trend to decrease in

density as the basal area of conifers increased. In addition, stands that were recognized by vegetation analysis to be primarily aspen-birch-fir forests, averaged one more species per plot than stands recognized primarily as aspen-birch forests. Overall, the "mature" deciduous forests supported an average of 9.7 species per plot, fewer species than in any other habitat. The density of breeding birds in the aspen-birch-fir stands, 939 pairs/km², was also somewhat higher than the density of breeding birds in the "pure" aspen-birch stands. The density on all deciduous plots combined was approximately 900 pairs/km².

As in all other communities previously described, ground nesters were an important component of the community composition. Contributing between 33% and 70% of the total community density, and averaging 46%, the most conspicuous ground nester was the ovenbird. Like the mature conifer uplands, where this bird was the dominant species on 5 of the 8 plots, the ovenbird was either first or second in dominance on 9 of the 11 mature deciduous stands sampled. Unlike the other mature communities, shrub nesters are also an important component of the fauna. Contributing between 11% and 43% of the total density, and averaging 26%, the most conspicuous shrub nester was the red-eyed vireo. The red-eyed vireo was the dominant species on one plot and second in dominance on 3 plots. Tree nesters, contributing about 23% of the total density, ranged from 0% to 44%. The

absence of the nesters from one stand may reflect the small size of the sample plot, 1.8 ha, or may reflect a sampling error. The most conspicuous tree nesters were the least flycatcher and rose-breasted grosbeak. The least flycatcher was the dominant species on three plots and was second in dominance on three plots. The last major nesting guild, cavity nesters, was present on 7 of the 11 plots and contributed between 0% and 15% of the community density. The predominant cavity nester was the yellow-bellied sapsucker.

During the winter of 1977, three aspen-birch plots were sampled and three mixed uplands, containing aspen-birch and various conifers, such as white pine, jack pine and balsam fir were sampled. A total of six species were observed on the aspen-birch plots. Three species were either observed in all three plots or observed flying over all three plots; they include hairy woodpecker, common raven and black-capped chickadee. In addition, the downy woodpecker was observed on two plots, the gray jay on one plot and the ruffed grouse on one plot. Together the aspen-birch plots had an average of seven observations per five hours, ranking third among the six habitat types sampled in the winter. On the mixed uplands a total of 10 species were observed. Species common to all three plots include common raven, black-capped chickadee, and gray jay. The hairy woodpecker, downy woodpecker and pine grosbeak were observed on two plots

while the pileated woodpecker, black-backed-three-toed woodpecker, northern three-toed woodpecker and blue jay were each observed on only one of the mixed upland stands. Together, the mixed uplands had on average of nearly 12 observations per five hours, ranking first among the six winter habitats sampled.

Disturbed Shrub

The vegetation in the middle of the intensive study zone is characteristically different from that further to the north and south. During the past thirty to forty years, this area has been heavily disturbed by the activities of logging operations. The vegetation is now characterized by an open canopy with scattered clumps of live or dead standing aspen, birch or pine, and by a very well-developed high shrub layer. Young red pine and jack pine plantations are also found scattered throughout the area. The bird communities that were associated with this very heterogenous vegetation structure were recognized as distinct from other upland bird communities.

The bird faunas of the two stands that were sampled in this area were more similar than that found on stands in any other community type. Sharing 14 species in common, six of these species attained their highest density and importance value in this habitat; they include, blue jay, black-and-white warbler, canada warbler, rose-breasted grosbeak, magnolia warbler, and yellow-bellied sapsucker. On both stands the chestnut-sided warbler was the dominant species, contributing 19% and 24% of the total density, while the black-and-white warbler was second in dominance

contributing 10% of the density on each plot.

The vegetational diversity in this region of the study zone is reflected in the density and diversity of the bird community. Its average density of 1160 breeding pairs per km² was nearly equal to the highest upland density of 1180 pairs per km² found in the young plantation bird community. With an average of 18 species per plot, the disturbed shrub community was second only to the alder community (19 species) in the diversity of its breeding fauna.

The diversity of these communities is further reflected by the fact that all of the four major nesting guilds are represented. Ground nesters are again the most important group contributing approximately 43% of the density; shrub nesters are second in importance contributing approximately 32% of the density.

Tree nesters contributed 17% of the density and cavity nesters, 9%. Cavity nester, which included yellow-bellied sapsucker, downy woodpecker, common flicker and sparrow hawk, contributed more to the density of the disturbed shrub community than to any other bird community recognized in the study area.

The disturbed shrub community was not sampled during the winter.

Aspen Regeneration

Two to three years after a stand has been harvested, a very dense growth of young aspen appears. Unless the stand is

seeded or planted for pine regeneration and the aspen growth is controlled by mechanical means or with the use of herbicides, the aspen will continue to grow and form a dense stand 3-5m high. Three such stands, ranging in age from 4-6 years, were sampled in the summer of 1977 and the composition of their bird communities was recognized as distinct from that found in other habitats.

The characteristic species of the young aspen community include the mourning warbler, red-eyed vireo and chestnut-sided warbler. Both the mourning warbler and chestnut-sided warbler reached their highest density and importance values in this habitat. Other common species include white-throated sparrow, black-and-white warbler, nashville warbler, common yellowthroat, veery, cedar waxwing, blue jay, rose-breasted grosbeak, song sparrow and alder flycatcher. The chestnut-sided warbler was the dominant species in all stands sampled, contributing between 25% and 38% of the total density; the mourning warbler was second in dominance, contributing between 12% and 24% of the density.

Shrub nesters were the most important nesting group, averaging about 48% of the community's density, ground nesters averaged about 39% of the density. Tree nesters and cavity nesters were relatively unimportant, contributing an average of 8% and 4% of the density, respectively. The high density of young aspens was probably the major reason for the high density of breeding birds, 1050 pairs per km², observed in this habitat. The young aspen

can support approximately 150 more breeding pairs per km² than the mature aspen, which averages 900 pairs per km². The diversity of the fauna is also slightly higher on the younger plots which supported an average of 12 species per plot compared with 10 species per plot on the mature deciduous uplands.

The aspen regeneration community was not sampled during the winter.

Recent Clearcut

The youngest deciduous upland community is the recent clearcut. Stands that are discussed in this section were mature deciduous plots before being harvested. Structurally, however, conifer stands that have been harvested in the past 1-2 years are generally indistinguishable from deciduous stands that have been harvested in the past 1-2 years. With the exception of scattered dead standing birch or aspen, both lack a tree canopy and a well-developed shrub layer. As a result of their vegetational similarity, the bird communities are also similar in both types of stands.

Like the conifer clearcuts, the mourning warbler, white-throated sparrow, and chestnut-sided warbler were the characteristic species found on both plots sampled. Other species included the killdeer, black-and-white warbler, evening grosbeak, chipping sparrow, cedar waxwing, ruby-throated hummingbird, american goldfinch, purple finch, red-eyed vireo, song sparrow and black-billed cuckoo. Only the killdeer was unique to this

community and, as discussed under the conifer recent clearcuts, should also be considered a characteristic species of the recent clearcut community. The mourning warbler and chestnut-sided warbler were the dominant species on one of the two deciduous clearcuts contributing 21% and 20%, respectively, of the density. On the second stand, the red-eyed vireo was the dominant species, contributing 22% of the density, while the mourning warbler was second, contributing 19% of the density. Of all six clearcuts sampled, this was the only stand where the red-eyed vireo was important. This species importance resulted from the fact that two small pockets of young red maple had been left standing; the red-eyed vireo was clearly associated with these trees.

Ground nesters contributed approximately 36% of the community density and shrub nesters approximately 31%. Tree nesters were also fairly important, contributing approximately 25% of the total density. The influence of the influence of the young maples on the red-eyed vireo, which is typically a high shrub nester was discussed above. On the same plot, these trees were also important for the chipping sparrow, robin and purple finch, all tree nesters. On the other deciduous clearcut young trees infringing on one corner of the plot were also important to tree nesters such as the cedar waxwing and evening grosbeak. In addition, both these plots had at least one edge of the plot bordered by a "mature" deciduous upland. Many of the tree nesters recorded in these plots may

may have been feeding in the clearcut or near the edge, but nesting in the trees of the "mature" deciduous stands.

When all six coniferous and deciduous clearcuts are grouped together, the average density for the community is approximately 540 breeding pairs per km², the lowest breeding density of all communities sampled. This low density reflects the structural simplicity of the habitat; the low density of shrubs provides little cover for nesting species either on the ground or in the shrubs. What trees are left standing are always utilized by the few individuals their low density can support.

Deciduous clearcuts were not sampled during the winter of 1977. However, the utilization of the habitat should be similar to that of the conifer clearcuts. As discussed earlier, woodpeckers were the most important winter inhabitant, attracted to the area by the dead standing aspen and birch. One of the most important vegetational features that influences the composition of both winter and summer bird faunas of recent clearcuts are the trees that are not harvested during the standard logging operations.

Man-made openings are scattered throughout the study area as a result of logging activities, agriculture, and industrial development. Areas such as old landings where the soil has been packed, or gravel pits, where soil is excessively drained, may remain open for decades. Where adequate moisture is available and the soil has not been packed, invasion by aspen (Populus tremuloides) is rapid (a few years). Most anthropogenic openings are of the latter type and therefore are ephemeral in

nature. Old openings are characterized by the presence of a large number of species of the daisy family (Compositae) and grasses (Poaceae). The importance of the composite family influences the phenological pattern of the community to make it the latest flowering of the habitat types.

Ephemeral openings, like abandoned logging roads and landings, have floristic affinities with roadside ditches and abandoned agricultural lands. While they are an ever-changing community in the sense that they are reinvaded by forest species they provide an important habitat for wildlife. In their early years, they are heavily used by wood cock and _____.

Densities of wolves are enhanced by the presence of abandoned logging roads and the edge they provide is important too.