Volume 5-Chapter 6

# FOREST LANDS AND THE FOREST PRODUCTS INDUSTRY

Minnesota Environmental Quality Board
Regional Copper-Nickel Study
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# REGIONAL COPPER-NICKEL STUDY REPORT OUTLINE

Standard Abbreviations.

| | | | |
|---|---|---|---|
| ha | - hectare | ppm | - parts per million |
| st | - short ton of 2,000 lb | ppb | - parts per billion |
| lt | - long ton of 2,240 lb | um | - micron or $10^{-6}$ meters |
| mt | - metric ton of 2,205 lb | % | - percent by weight unless otherwise noted |
| mtpy | - metric ton(s) per year | | |

| ELEMENT | SYMBOL | ELEMENT | SYMBOL | ELEMENT | SYMBOL |
|---|---|---|---|---|---|
| Actinium | Ac | Holmium | Ho | Rhenium | Re |
| Aluminum | Al | Hydrogen | H | Rhodium | Rh |
| Americium | Am | Indium | In | Rubidium | Rb |
| Antimony | Sb | Iodine | I | Ruthenium | Ru |
| Argon | Ar | Iridium | Ir | Samarium | Sm |
| Arsenic | As | Iron | Fe | Scandium | Sc |
| Astatine | At | Krypton | Kr | Selenium | Se |
| Barium | Ba | Lanthanum | La | Silicon | Si |
| Berkelium | Bk | Lawrencium | Lw | Silver | Ag |
| Beryllium | Be | Lead | Pb | Sodium | Na |
| Bismuth | Bi | Lithium | Li | Strontium | Sr |
| Boron | B | Lutetium | Lu | Sulfur | S |
| Bromine | Br | Magnesium | Mg | Tantalum | Ta |
| Cadmium | Cd | Manganese | Mn | Technetium | Tc |
| Calcium | Ca | Mendelevium | Md | Tellurium | Te |
| Californium | Cf | Mercury | Hg | Terbium | Tb |
| Carbon | C | Molybdenum | Mo | Thallium | Tl |
| Cerium | Ce | Neodymium | Nd | Thorium | Th |
| Cesium | Cs | Neon | Ne | Thulium | Tm |
| Chlorine | Cl | Neptunium | Np | Tin | Sn |
| Chromium | Cr | Nickel | Ni | Titanium | Ti |
| Cobalt | Co | Niobium | Nb | Tungsten | W |
| Copper | Cu | Nitrogen | N | Uranium | U |
| Curium | Cm | Nobelium | No | Vanadium | V |
| Dysprosium | Dy | Osmium | Os | Xenon | Xe |
| Einsteinium | Es | Oxygen | O | Ytterbium | Yb |
| Erbium | Er | Palladium | Pd | Yttrium | Y |
| Europium | Eu | Phosphorus | P | Zinc | Zn |
| Fermium | Fm | Platinum | Pt | Zirconium | Ar |
| Fluorine | F | Plutonium | Pu | | |
| Francium | Fr | Polonium | Po | | |
| Gadolinium | Gd | Potassium | K | | |
| Gallium | Ga | Praseodymium | Pr | | |
| Germanium | Ge | Promethium | Pm | | |
| Gold | Au | Protactinium | Pa | | |
| Hafnium | Hf | Radium | Ra | | |
| Helium | He | Radon | Rn | | |

## A NOTE ABOUT UNITS

This report, which in total covers some 36 chapters in 5 volumes, is both international and interdisciplinary in scope. As a result, the problem of an appropriate and consistent choice of units of measure for use throughout the entire report proved insurmountable. Instead, most sections use the system of units judged most common in the science or profession under discussion. However, interdisciplinary tie-ins complicated this simple objective, and resulted in the use of a mix of units in many sections. A few specific comments will hopefully aid the reader in coping with the resulting melange (which is a reflection of the international multiplicity of measurement systems):

1) Where reasonable, an effort has been made to use the metric system (meters, kilograms, kilowatt-hours, etc.) of units which is widely used in the physical and biological sciences, and is slowly becoming accepted in the United States.

2) In several areas, notably engineering discussions, the use of many English units (feet, pounds, BTU's, etc.) is retained in the belief that this will better serve most readers.

3) Notable among the units used to promote the metric system is the metric ton, which consists of 2,205 pounds and is abbreviated as mt. The metric ton (1,000 kilograms) is roughly 10% larger (10.25%) than the common or short ton (st) of 2,000 pounds. The metric ton is quite comparable to the long ton (2,240 pounds) commonly used in the iron ore industry. (Strictly speaking, pounds and kilograms are totally different animals, but since this report is not concerned with mining in outer space away from the earth's surface, the distinction is purely academic and of no practical importance here).

4) The hectare is a unit of area in the metric system which will be encountered throughout this report. It represents the area of a square, 100 meters on a side (10,000 $m^2$), and is roughly equivalent to $2\frac{1}{2}$ acres (actually 2.4710 acres). Thus, one square mile, which consists of 640 acres, contains some 259 hectares.

5) Where electrical energy is converted to thermal units, a conversion factor of 10,500 BTU/kWH is used. This means that the energy lost to waste heat in a central power plant is included, assuming a generating efficiency of 32.5%.

The attached table includes conversion factors for some common units used in this report. Hopefully, with these aids and a bit of patience, the reader will succeed in mastering the transitions between measurement systems that a full reading of this report requires. Be comforted by the fact that measurements of time are the same in all systems, and that all economic units are expressed in terms of United States dollars, eliminating the need to convert from British Pounds, Rands, Yen, Kawachas, Rubles, and so forth!

Conversions for Common Metric Units Used in the Copper-Nickel Reports

| | | |
|---|---|---|
| 1 meter (m) | = | 3.28 feet = 1.094 yards |
| 1 centimeter (cm) | = | 0.3937 inches |
| 1 kilometer (km) | = | 0.621 miles |
| 1 hectare (ha) | = | 10,000 sq. meters = 2.471 acres |
| 1 square meter ($m^2$) | = | 10.764 sq. feet = 1.196 sq. yards |
| 1 square kilometer ($km^2$) | = | 100 hectares = 0.386 sq. miles |
| 1 gram (g) | = | 0.037 oz. (avoir.) = 0.0322 Troy oz. |
| 1 kilogram (kg) | = | 2.205 pounds |
| 1 metric ton (mt) | = | 1,000 kilograms = 0.984 long tons = 1.1025 short tons |
| 1 cubic meter ($m^3$) | = | 1.308 $yd^3$ = 35.315 $ft^3$ |
| 1 liter (l) | = | 0.264 U.S. gallons |
| 1 liter/minute (l/min) | = | 0.264 U.S. gallons/minute = 0.00117 acre-feet/day |
| 1 kilometer/hour (km/hr) | = | 0.621 miles/hour |
| 1 kilowatt-hour (kWH) | = | 10,500 BTU (for production of electricity at 32.5% conversion efficiency) |
| degrees Celsius (°C) | = | (5/9)(degrees Fahrenheit -32) |

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Volume 5-Chapter 6 FOREST LANDS AND THE FOREST PRODUCTS INDUSTRY

## 6.1 INTRODUCTION AND SUMMARY OF FINDINGS

Forested areas are the most prevalent land cover type in northeastern Minnesota covering almost 77% of the Study Area and about 82% of Region 3 (as compared to roughly 34% for the state as a whole). Study Area forest lands, which are roughly 50% publically owned, are currently managed for several uses many of which may occur simultaneously in a given area. Land uses found in forested areas include forestry, recreation of various types, wildlife management, watershed protection, and wilderness protection.

This chapter will focus on forest lands as a source of timber for the forest products industry, which includes logging operations, wood products manufacturing, and paper products manufacturing (ecosystems of forested portions of the Study Area and the impacts to them are presented in Volume 4-Chapter 2). First, the current status of the Study Area forest lands as a timber resource will be characterized in terms of species distribution, potential productivity, and suitability for commercial forestry. This characterization will also include an overview of the forest products industry in northeastern Minnesota, a discussion of forest management policies at the state and federal government levels, and rough estimates of future timber supplies and demands for wood products.

The section analyzing the possible impacts to forest lands and the subsequent affects on the forest products industry categorizes potential impacts according to three major classifications: the direct impacts resulting from actual appropriation of forest lands for mining purposes; the indirect impacts resulting from sulfur dioxide ($SO_2$) emissions from a smelter in the area; and the impacts resulting from secondary growth spurred by new mining development, in this case, new residential settlement. The analysis of potential impacts suggests that there will only be slight impacts to the forest products industry in northeastern Minnesota, but the recent removal of BWCA lands from commercial forestry and the much discussed possibility of a "softwood deficit" in the region has focused the attention of loggers, particularly, on the debate over future management of regional forest lands. In this context, any additional impacts to productive forest lands will certainly be subject to close scrutiny by loggers seeking to protect shrinking procurement areas.

### 6.1.1 Characterization Summary

1) Three forestry related industries (logging, wood products manufacturing, and paper products manufacturing) together ranked third in Region 3 in total gross output in 1970. Paper products manufacturing is the largest consumer of the area's timber resources--more than 80% of the 73,686,000 cu ft of timber harvested in the USFS Lake States Forest Survey Unit I (Cook, Lake, St. Louis, Carlton, and Koochiching counties) in 1975 was used as pulpwood compared to only 35% of the timber harvested nationwide.

2) Of the roughly 73,686,000 cu ft of timber harvested in Unit I in 1975; almost 45% (32,900,000 cu ft) was aspen, a low-grade hardwood used primarily for pulpwood; slightly more than 19% (14,070,000 cu ft) was white, red, and jack pine (roughly 80% of the total pine harvest is accounted for by jack pine); and almost 17% (12,408,000 cu ft) was spruce. The total harvest was split nearly 50-50 between softwoods and hardwoods.

3) The distribution of forest cover types in the 1,049,360 acres (424,842 ha) of forest covered land in the Study Area (which is nearly 77% of the total Study

Area acreage) includes: 600,640 acres (243,174 ha) or 57% of all forest lands covered by aspen-birch stands; 310,880 acres (125,862 ha) or almost 30% of all forest lands covered by spruce and spruce-fir cover types; and 104,360 acres (42,251 ha) or almost 10% covered with pine. Altogether, about 40% of all Study Area forest land is covered in softwoods and 60% in hardwoods.

4) Analysis of the potential productivity of Study Area forest lands (as determined by soil characteristics) shows that approximately 70% of forested lands have "poor" potential productivity (less than 50 cu ft/acre/yr) and only 17% have "good" potential productivity (more than 80 cu ft/acre/yr). The most potentially productive Study Area forest lands and the land considered most suitable for commercial forestry (see section 6.2.3 of this chapter) are located in the south-central and southeastern portions of the Study Area.

5) Federal and state management policies currently in effect for public forests in the Study Area generally provide for the management of extensive acreages at low productivity levels. Management policies at both levels of government are more than ten years old and revisions underway are expected to emphasize intensive management of high productivity lands.

6) Data showing forest land coverage by age class for each cover type suggest that present acreages of mature and overmature timber are greater than the acres of timber that can be expected to reach maturity at any time during the next 60 years. <u>If present management policies are continued</u>, demand will pass supply in Minnesota in the early 1990s because of expected increases in the demand for wood products coupled with decreases in both the overall acreages of commercial forest land and in the acres of timber reaching rotation age.

### 6.1.2 Impacts Summary

1) The severity of impacts resulting from the direct consumption of forest land by new mining development is entirely dependent on the size and number of developments and the siting of the mine facilities.

2) A development scenario in which three copper-nickel mines are hypothesized (total production, 300,000 mt metal/year) would consume an estimated 23,213 acres (9,398 ha). If this new mine acreage displaced only Study Area forest land, it would decrease the current extent of forest land by 2.2%.

3) The largest estimated dollar value for timber production lost as a result of copper-nickel mining (based on: (1) a three mine model (2) 1974 stumpage prices and (3) the loss of 90 years worth of pine sawtimber production on 23,213 acres of land with good productivity) is $12.7 million compared to estimated gross revenues of the three mine models of $19,500 million over 25 years. Virtually total mitigation of these production losses could be achieved by: (1) siting mine developments on land less valuable to the forest products industry, (2) making additional lands available for commercial forestry, (3) siting mine developments such that the harvest of mature timber from the site would offset some of the lost production or such that the harvest of very young timber would waste the smallest number of producing years, and/or (4) reclaiming and reforesting land occupied for mining once mining ceases.

4) Available evidence suggests that air quality changes resulting from copper-nickel development will not cause visible damage to commercial forest species except in the case of accidental fumigations caused by the breakdown of emission control systems. Repeated accidental fumigations could cause visible injury to forest stands from 8 to 10 km from the smelter. The deposition of heavy metals

and resultant increased loading of soils probably represents the most severe terrestrial impact of air pollution that can be expected from a smelter in northeastern Minnesota. Heavy metal loadings decreases the rate of litter decomposition and may produce deep litter layers which are poor seedbeds for species such as red and jack pine that require mineral soil for establishment. In addition, reduction in litter decomposition rates reduces nutrient recycling in forest ecosystems (Volume 4-Chapter 2, section 2.9.1.1). Avoiding the use of a spray drier for concentrate drying in the smelter and/or using state-of-the-art particulate control systems could reduce the areal extent of slowed decomposition to within a distance of 2 km of the smelter.

5) Impacts resulting from the consumption of forest lands for new residential settlement are expected to be inconsequential (maximum direct impact projected is 5,053 new acres--2,046 ha--of land consumed by settlement or 0.5% of all Study Area forest lands). New residential settlement, however, may also impact the forestry industry by limiting access to commercial forest hinterlands and by disrupting certain forest management practices, particularly protective management techniques such as airborn chemical spraying and fire control.

6.1.3 <u>Methodology and Data Sources Used in This Chapter</u>

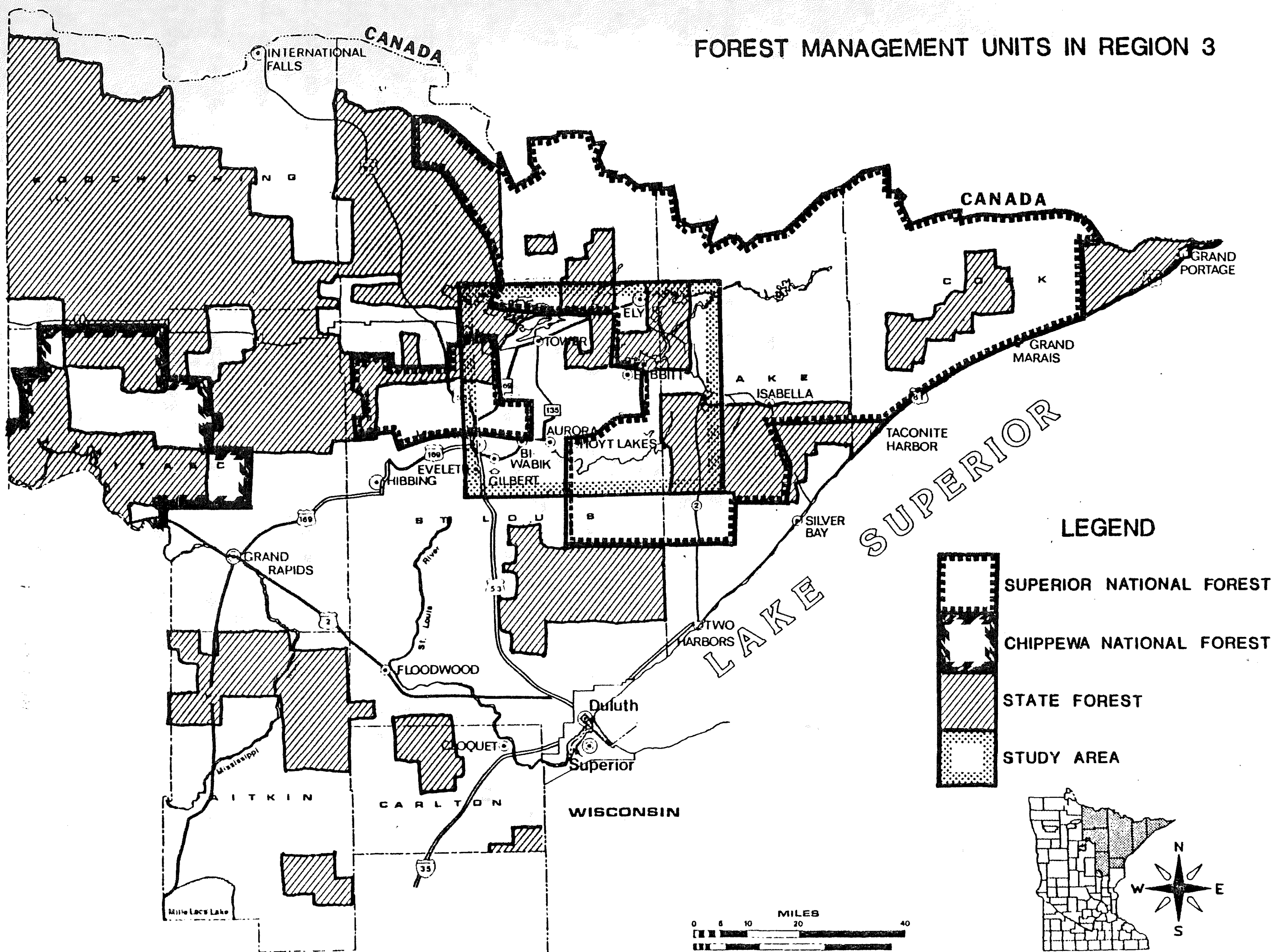
Several sources in addition to the primary research conducted by the Regional Copper-Nickel Study were used to compile the inventories presented in the characterization section of this chapter. These sources included the Minnesota Land Management Information System (MLMIS), the North Central Forest Experiment Station (NCFES), the Superior National Forest (SNF), and the Minnesota Department of Natural Resources (MDNR). Because the information available from the various sources generally discussed figures only for land under their jurisdiction, not all tables and figures include data for comparable geographical areas. Figure 1 illustrates the four most common areas for which data was available: the seven counties of Region 3 (Cook, Lake, St. Louis, Koochiching, Itasca, Aitkin, and Carlton); the five counties of the United States Forest Service (USFS) Lake States Forest Survey Unit I (Cook, Lake, St. Louis, Koochiching, and Carlton); the USFS Superior National Forest (SNF); and the Regional Copper-Nickel Study Area (Study Area).

Commercial forest resources discussed in this chapter are classified according to the Society of American Foresters (SAF) cover types used in the MLMIS, MDNR, and SNF inventories. Forests are usually classified for commercial purposes by the species for which they are managed. This type of classification, however, with its built-in bias towards commercially valuable species such as red and jack pines, presents a simplified picture of forest cover and underestimates the extent of stands with mixed species in comparison to systems of classification based solely on species composition (for a comparison of SAF cover types with the ecosystem classification system developed by the Regional Copper-Nickel Study, see Table 6, Volume 4-Chapter 2).

For commercial purposes, hardwood types found in northeastern Minnesota include aspen-birch, maple-birch-basswood (northern hardwoods), and elm-ash-cottonwood (bottomland hardwoods). Softwood types include spruce-fir and pine (including white, red, and jack pine). The Regional Copper-Nickel Study/MLMIS inventory includes upland and lowland black spruce and white spruce in the spruce-fir type. Data obtained from the SNF and NCFES were more detailed but several categories were combined for compatibility with the MLMIS classifications.

FIGURE 1

FOREST MANAGEMENT UNITS IN REGION 3




MEQB REGIONAL COPPER-NICKEL STUDY

## 6.2 CHARACTERIZATION OF EXISTING FOREST LANDS AND THE FOREST PRODUCTS INDUSTRY

### 6.2.1 Timber Resources

6.2.1.1 Forest Distribution--Table 1 presents the proportions of lands in each of eight cover types within the Study Area, SNF (outside the BWCA), Region 3, and the state. As the table indicates, conifers, in general, cover a greater proportion of lands in the Study Area than on a statewide basis. This trend is particularly true in the case of spruce-fir, which accounts for 30% of all forested lands in the Study Area as compared to 17% of the forested lands in the state. Lands classified in the spruce-fir cover type include lowland black spruce, upland black spruce-pine, upland deciduous stands with high basal area of black or white spruce and fir, and plantations of both black and white spruce. Such lands are concentrated mainly in the southeastern and northern portions of the Study Area (Figure 2).

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Figures 2 and 3, Table 1

Figure 2 illustrates the distribution of forested lands in the Study Area, emphasizing coniferous communities in detail. Figure 3 lumps all coniferous communities, but emphasizes the individual deciduous community types.

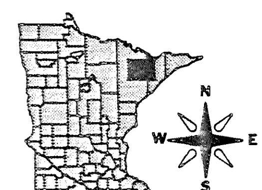
Although white, red, and jack pine cover a relatively small proportion of forested lands in the Study Area (10%) this proportion is slightly higher than the proportion of all state forest lands in pine (7%). Within the Study Area, pinelands are concentrated mainly in the north and northeast (Figure 2) adjacent to the BWCA.

The dominant forest type in the Study Area is aspen birch, which is widespread (Figure 3) and accounts for 57% of Study Area forest lands as compared to 51% of


LEGEND

- LOWLAND SPRUCE
- UPLAND SPRUCE-FIR
- WHITE, RED, JACK PINE
- OTHER FOREST
- NON-FORESTED

SOURCE: MLMIS




KEY MAP

1:422,400

# MEQB REGIONAL COPPER-NICKEL STUDY

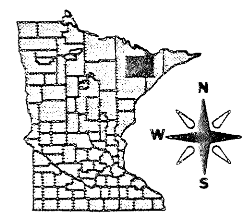
FIGURE 2

FOREST COVER: CONIFEROUS


LEGEND

ASPEN / BIRCH
MAPLE / BIRCH / BASSWOOD
ELM / ASH / COTTONWOOD
OTHER FOREST
NON-FORESTED

SOURCE: MLMIS




KEY MAP

1:422,400

MILES
0 1 2 3 4 5 10

0 1 2 3 4 5 10 15
KILOMETERS

# MEQB REGIONAL COPPER-NICKEL STUDY

FIGURE 3

FOREST COVER: DECIDUOUS

Table 1. Forest cover types in the Study Area, Region 3, SNF (outside the BWCA), and the state.

| COVER TYPE | STUDY AREA % Total Area | STUDY AREA % Forested Area | REGION 3 % Total Area | REGION 3 % Forested Area | SNF % Total Area | SNF % Forested Area | STATE % Total Area | STATE % Forested Area |
|---|---|---|---|---|---|---|---|---|
| Aspen-Birch | 44 | 57 | 49 | 56 | 46 | 47 | 20 | 51 |
| Spruce-Fir | 23 | 30 | 22 | 25 | 31 | 31 | 7 | 17 |
| White, Red, Jack Pine | 8 | 10 | 7 | 7 | 17 | 17 | 3 | 7 |
| Maple, Birch, Basswood (northern hardwoods) | * | * | 2 | 3 | 3 | 3 | 2 | 5 |
| Elm, Ash, Cottonwood (lowland hardwoods) | * | * | 2 | 2 | 1 | 1 | 2 | 6 |
| Oak | 0 | 0 | * | * | 0 | 0 | 3 | 7 |
| Other (clearcut, unproductive) | 2 | 3 | 6 | 7 | 1 | 1 | 2 | 5 |
| Non-Forest | 23 | | 12 | | * | | 62 | |

SOURCES: MLMIS, 1977; USFS, 1977.

*Less than 1%.

all state forest lands. On the other hand, most other deciduous forest types in the Study Area, as well as unforested agricultural lands, are under-represented by comparison with statewide land cover figures (Table 1) (see volume 5-Chapter 3, "Land Use-Land Cover Overview"). Within the Study Area, agricultural lands are concentrated in the southwest and the Embarrass Valley, where soils are potentially most productive. The early withdrawal of these more productive lands from the original public domain into private ownership influenced the geographic distribution of publicly-owned forest lands in the area (Figure 1).

Figures for the SNF presented in Table 1 can be compared with those in Table 2, which shows timber volume by species for the SNF (outside the BWCA) and the five counties of Unit 1. Figures in Table 2 represent the volume of growing stock on commercial forest lands, both public and private, in the designated regions. Aspen-birch represents approximately one-half of the volume of all species with spruce-fir accounting for between 26 and 33% of the volume. The close relationship between timber volume and areal coverage by forest type can be seen by comparing Tables 1 and 2. This relationship provides the basis for understanding potential future timber volumes since data by age-class are available only for areal coverage and cover type in the SNF, whereas volume projections are not.

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Table 2

6.2.1.2 Forest Productivity--The potential productivity of the land is dependent on soil characteristics and varies within each species according to soil properties. For example, coarse soils have a greater potential for producing jack pine than northern hardwoods. Potential productivity ratings are made by assuming a forest of normal stocking (regardless of species) with rotation age determined by the culmination of mean annual increment (Sando 1976). Lands in

Table 2. Volume of timber on commercial forest lands[a] in the SNF (outside the BWCA) and Unit I[b] by cover type.

| COVER TYPE | % OF TOTAL VOLUME SNF | % OF TOTAL VOLUME Unit I |
|---|---|---|
| Aspen-Birch | 51 | 50 |
| Spruce-Fir | 26 | 33 |
| White, Red, Jack Pine | 17 | 10 |
| Maple, Birch, Basswood | 2 | 2 |
| Elm, Ash Cottonwood | 4 | 5 |

SOURCE: USFS, 1977.

[a]Land capable of producing at least 20 cu ft/acre/yr.
[b]Cook, Lake, St. Louis, Carlton, and Koochiching counties.

Region 3 have been classified according to three potential productivity ranks: poor land capable of supporting less than 50 cu ft/acre/yr of timber growth; medium, supporting 50-80 cu ft/acre/yr; and good, supporting greater than 80 cu ft/acre/yr (Sando 1976). These rankings represent potential productivities, not current volumes.

Potential productivity figures (Table 3) for the Study Area and Region 3 represent an estimate of the amount of new growth (in cu ft/acre/yr) that the land will support. Data were obtained from MLMIS and were not available for the SNF or Unit 1 as separate management units.

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Table 3

Examination of Table 3 reveals that about 70% of forested land in the the Study Area has "poor" potential productivity, whereas only 17% of the forested land has "good" timber-producing potential. As can be seen from Figure 4, the most potentially productive forest lands lie in the southeastern portion of the Study Area. As a result of methods of disposal from the original public domain, private owners hold a large proportion of lands in the 50-80 cu ft/acre/yr class. The best lands were taken up first for agriculture. Comparison of Figures 2 and 4 reveals that the most desirable pine species are concentrated on thin and coarse soils in the north, while the most potentially productive lands lie on deeper, finer soils in the southern part of the Study Area. The large diameter of pine stumps remaining in the southeastern part of the Study Area after harvest in the first half of this century provides evidence of the high production potential for pine in this area presently dominated by aspen.

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Figure 4

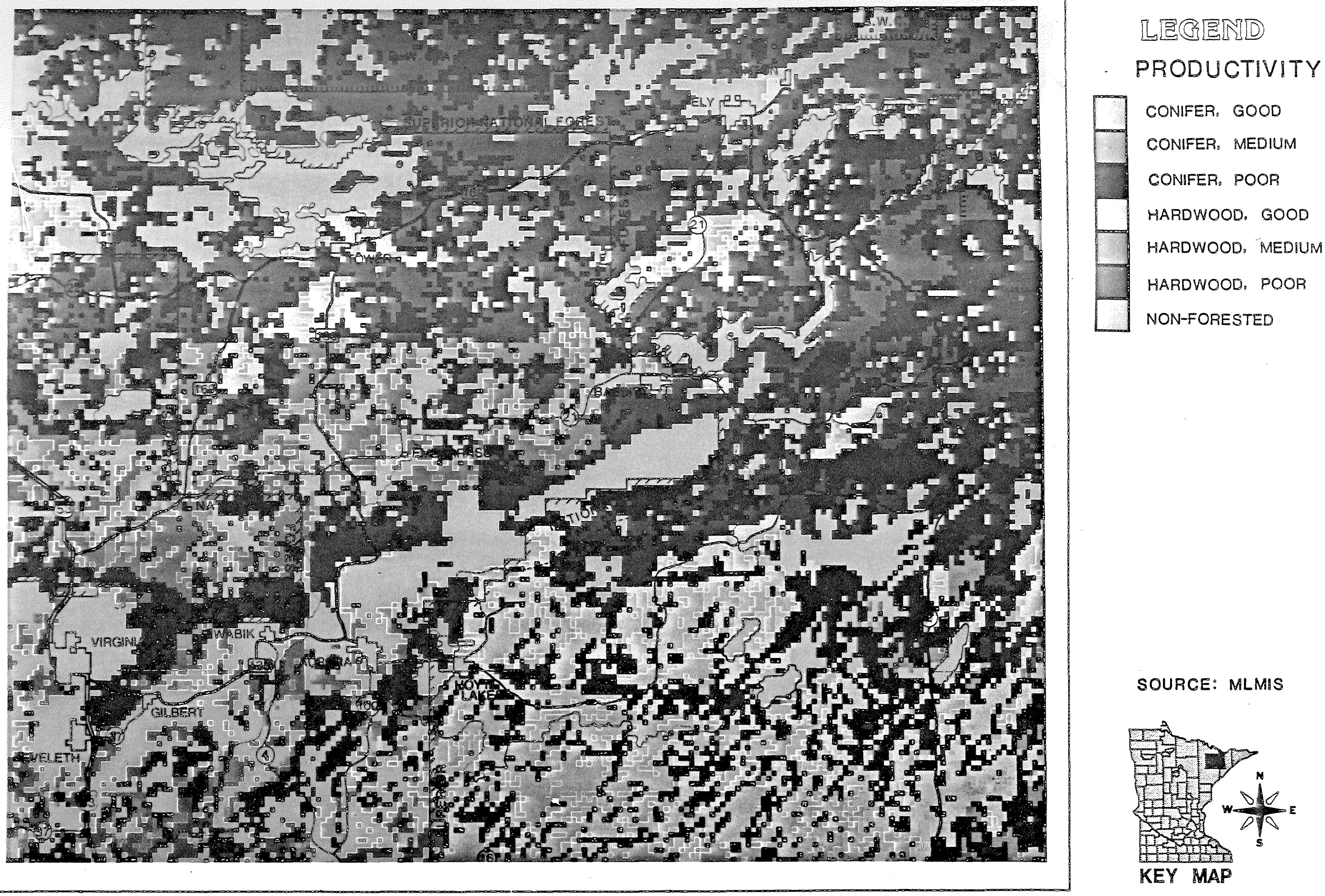


FIGURE 4

# MEQB REGIONAL COPPER-NICKEL STUDY

FOREST LAND POTENTIAL PRODUCTIVITY

Table 3. Potential productivity of forest lands in the Study Area and Region 3.

| POTENTIAL PRODUCTIVITY | COVER TYPE | STUDY AREA % Total Area | STUDY AREA % Forested Area | REGION 3 % Total Area | REGION 3 % Forested Area |
|---|---|---|---|---|---|
| GOOD (greater than 80 cu ft/acre/yr) | Conifer | 5 | 6 | 5 | 6 |
| | Hardwood | 8 | 11 | 22 | 27 |
| | TOTAL | 13 | 17 | 27 | 33 |
| MEDIUM (50-80 cu ft/acre/yr) | Conifer | 3 | 4 | 3 | 4 |
| | Hardwood | 6 | 8 | 9 | 10 |
| | TOTAL | 9 | 12 | 12 | 14 |
| POOR (less than 50 cu ft/acre/yr) | Conifer | 23 | 31 | 20 | 25 |
| | Hardwood | 29 | 39 | 22 | 27 |
| | TOTAL | 52 | 70 | 42 | 52 |

SOURCE: MLMIS 1977.

6.2.1.3 Suitability of Land for Commercial Forestry--The suitability of land for commercial forestry is dependent on several variables including the existing cover types, the potential productivity of the land, the capacity demand of the land (discussed below), and accessibility (Sando 1976). Since conversion from an existing cover type is a slow and expensive process, large-scale cover type conversion is impractical although conversion of individual sites may occur where site characteristics favor reforestation by an alternative, more economically valuable species. Regardless of cover type, the greater the potential productivity of the land, the greater the annual increment of growth and the more suitable the land for commercial forestry.

Capacity demand is a calculated measure of the economic feasibility of transporting timber a given distance. Sando (1976) calculated a value for capacity demand for each township in Minnesota using the following expression:

$$\text{Capacity demand} = \frac{\text{Mill capacity (cords)}}{\text{Distance from mill location (miles)}}$$

Less valuable species, such as aspen and birch, do not allow significant transportation costs to be incurred before costs exceed prices, whereas more valuable conifer species can be transported greater distances before costs exceed prices.

Because of the importance of transportation costs, accessibility to roads becomes an important determinant of commercial forest suitability. Areas with a better-developed network of existing roads are thus considered more suitable than areas with relatively undeveloped roads.

The combination of these four variables yields an index of suitability defined by both production and removal constraints. Highest ranking is given to productive

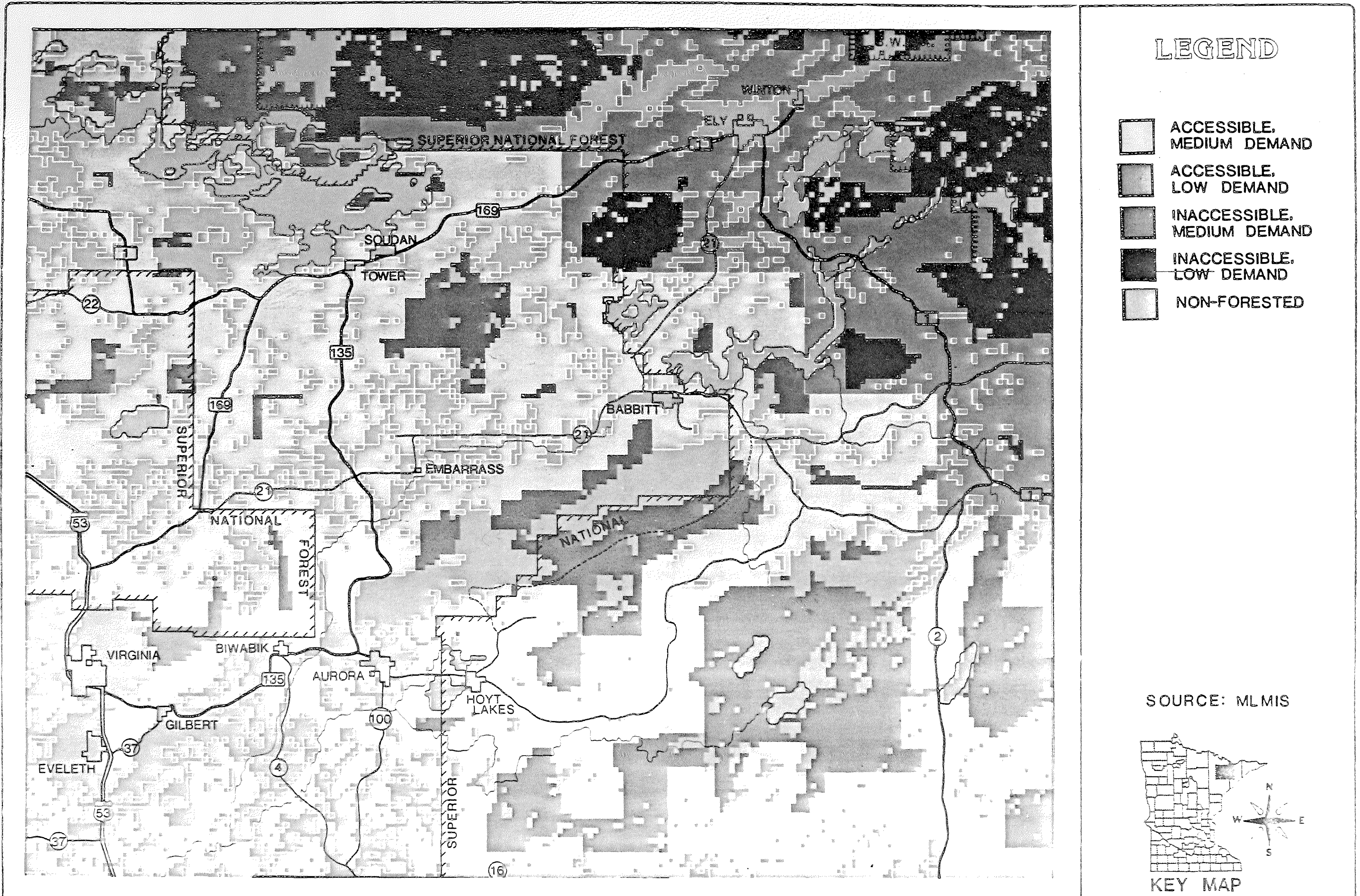


FIGURE 5 MEQB REGIONAL COPPER-NICKEL STUDY

FORESTLAND ACCESSABILITY AND CAPACITY DEMAND lands with marketable species on good access roads near markets. Figure 5 illustrates the distribution of lands by accessibility and capacity demand and can be used in conjunction with Figure 4 to gain an understanding of the distribution of lands by suitability class. Figure 6 shows the percentages of the total forest area in each suitability class. The concentration of suitable lands in the southern part of the Study Area suggests that this is the region in which forest management could be intensified most profitably.

6.2.2 Timber Resource Use

6.2.2.1 Forest Products Industry--The forest products industry is a combination of logging, manufacturing of wood products, and manufacturing of paper products. In 1970, the three forestry-related industries combined accounted for a total gross output of $246 million, or 8.4% of the total economic output of Region 3, plus Douglas County, Wisconsin, compared with 19% for the iron ore industry (SIMLAB Output 1978). During that year, forestry-related industries ranked third of 53 economic sectors in total gross output and fifth in total employment in Region 3. Within this region, including Douglas County, Wisconsin, the paper products industry has a much greater influence than the other two sectors of the forestry industry. Pulp procurement areas for several major paper and wood products mills in Region 3 extend beyond 50 miles in any direction from the mills (Figure 7).

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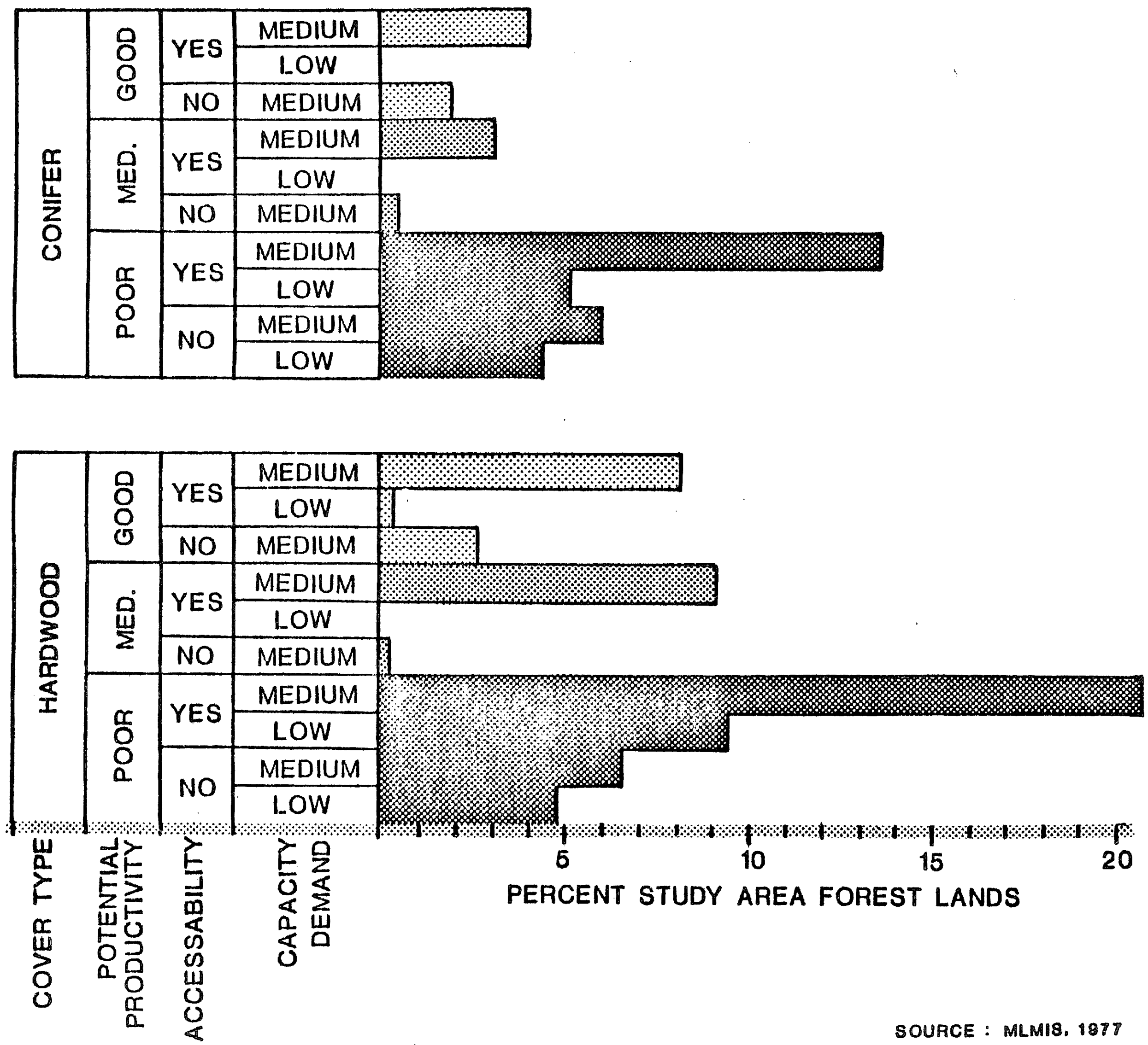
Figure 6

Within Unit 1, St. Louis and Lake counties accounted for 55% of the 1975 total timber production. Preliminary data from the North Central Forest Experiment Station (NCFES) show that 73,686,000 cu ft of forest products were produced by

FIGURE 6

## COMMERCIAL FOREST SUITABILITY OF STUDY AREA FOREST LANDS




SOURCE : MLMIS, 1977

the forestry industry in Unit 1 in 1975. Of this amount, 82% (60,115,000 cu ft) was in the form of pulpwood and 11% (8,168,000 cu ft) was in the form of saw timber (the remaining 7% was in the form of veneer, poles, posts, and other wood products). By comparison, nationwide figures on timber utilization show that only 35% goes into fiber (pulpwood) products and 63% goes into lumber and other structural products (John and Preston 1976).

Within the Study Area in 1976, there were no pulp mills and only 8 sawmills. Two additional sawmills close to the east boundary of the Study Area serve the east and southeast portions of the area (Figure 7). Table 4 roughly estimates the annual maximum value of production and the board feet of each species sawn at these mills. As can be seen from the table, pines are the preferred species for local manufacturers of sawn lumber. If all ten of these small mills operated to capacity, they would have the capability of generating approximately $1,425,000 worth of milled lumber annually. Further discussion of the local economic impact of forest production is found in Volume 5-Chapter 16.

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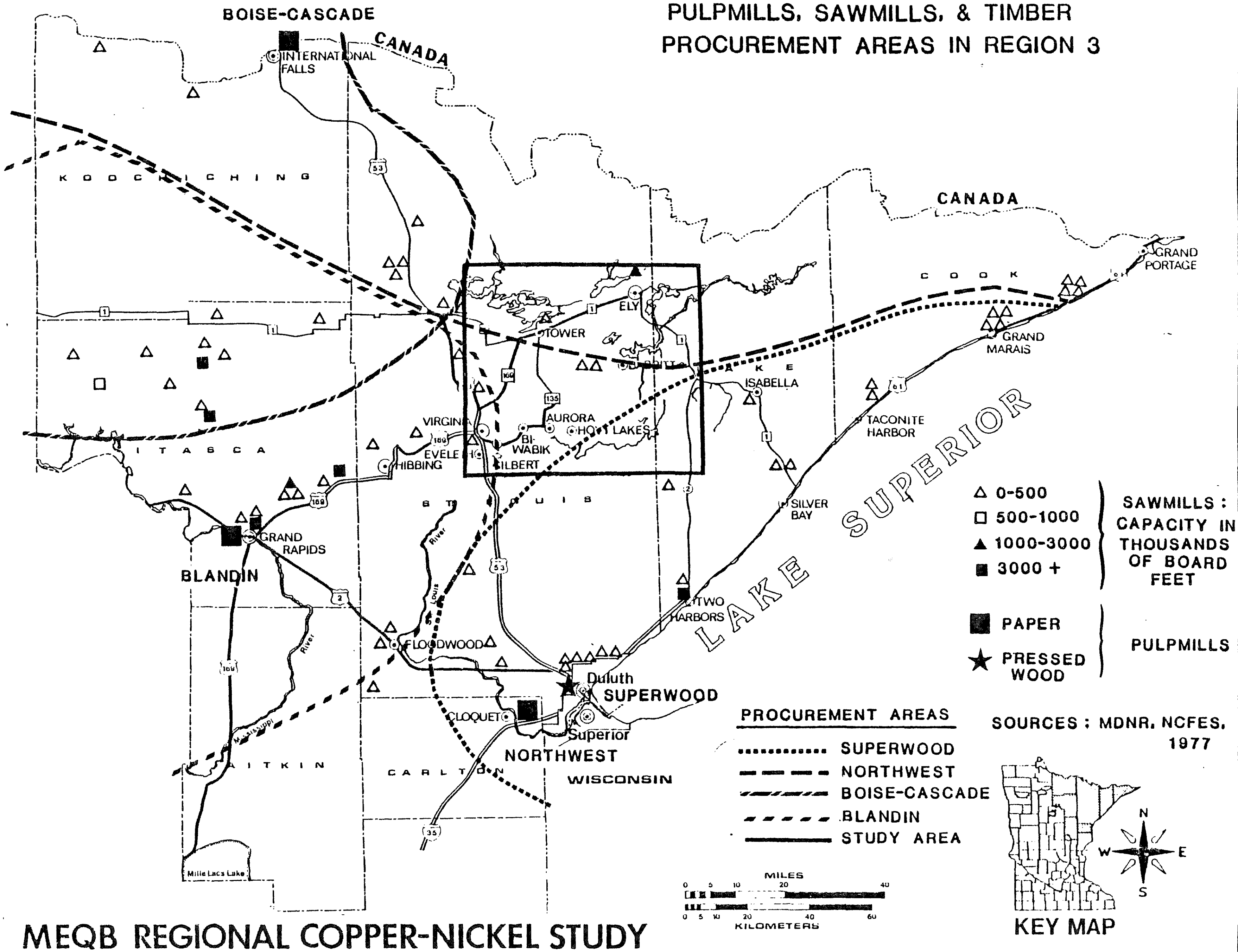
Figure 7, Table 4

6.2.2.2 Economic Species--Preliminary figures obtained from the NCFES show that of all timber production in Unit 1 for 1975 (73,686,000 cu ft), approximately 50% was in softwood species and 50% was in hardwoods.

Despite the fact that aspen has only recently become acceptable as pulpwood, it accounts for about 45% of production in Unit 1. Nearly half the aspen harvested in the five-county unit comes from St. Louis County. Spruces and pines together comprise slightly over one-third (36%) the annual harvest in Unit 1. The harvest of lowland conifers comes mainly from Koochiching County, whereas upland conifers

FIGURE 7

PULPMILLS, SAWMILLS, & TIMBER PROCUREMENT AREAS IN REGION 3




MEQB REGIONAL COPPER-NICKEL STUDY

TABLE 4

# ESTIMATED PRODUCTION OF 10 SAWMILLS IN AND IMMEDIATELY ADJACENT TO THE STUDY AREA

| MILL LOCATION | MILL CAPACITY IN BOARD FEET (X1000) | ESTIMATED BOARD FEET PRODUCED (X 1000) A | | | | | | | | | | ESTIMATED DOLLAR VALUE OF ANNUAL PRODUCTION B (X1000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PINE | | | | | | | | | | |
| | | WHITE | RED | JACK | BALSAM FIR | CEDAR | ASPEN | BIRCH | WHITE SPRUCE | NOT RE-PORTED D | OTHER | |
| ELY | 0-500 | | | | | | | | | 500 | | $101 |
| ELY | 0-500 | 210 | 220 | 50 | | | | | | | 15 | 101 |
| ELY | 1000-2900 | 1102 | 1276 | 435 | | | | | | | 58 | 579 |
| EMBARRASS | 0-500 | | 100 | 200 | 100 | | 100 | | | | | 83 |
| EMBARRASS | 0-500 | 50 | 450 | | | | | | | | | 102 |
| TOWER | 0-500 | | | | | | | | | 500 | | 83 |
| VIRGINIA | 0-500 | | 100 | 100 | | | 300 | | | | | 79 |
| BRITT | 0-500 | 200 | 250 | 50 | | | | | | | | 103 |
| BRIMSON (OUTSIDE STUDY AREA) | 0-500 | 380 | | 45 | 25 | 25 | 20 | | | | | 107 |
| ISABELLA (OUTSIDE STUDY AREA) | 0-500 | | | | 45 | 20 | | 230 | 140 | | 30 | 87 |
| TOTAL BOARD FEET (X1000) | | 1942 | 2046 | 880 | 170 | 45 | 420 | 230 | 140 | 1000 | 103 | |
| MEDIAN PRICE C PER 1000 BOARD FEET | | $225 | 202 | 150 | 187 | 275 | 145 | 170 | 210 | D | E | |
| ESTIMATED DOLLAR VALUE OF ANNUAL PRODUCTION (X1000) | | $437 | 484 | 132 | 32 | 12 | 61 | 39 | 29 | 184 D | 15 E | 1425 |

SOURES: MDNR. NCFES 1977: WISCONSIN FOREST PRODUCTS PRICE REVIEW

A. REPORTED PERCENT CONSUMPTION OF SPECIES X MAXIMUM MILL CAPACITY

B. MEDIAN PRICE PER 1000 BOARD FEET (BY SPECIES) X THOUSAND BOARD FEET PRODUCED AT MILL

C. PRICES ARE FOR MILL RUN (UNGRADED). LOCALLY SUPPLIED. FOUR-QUARTER ROUGH LUMBER OF RANDOM WIDTHS AND LENGTHS. SOLD GREEN.

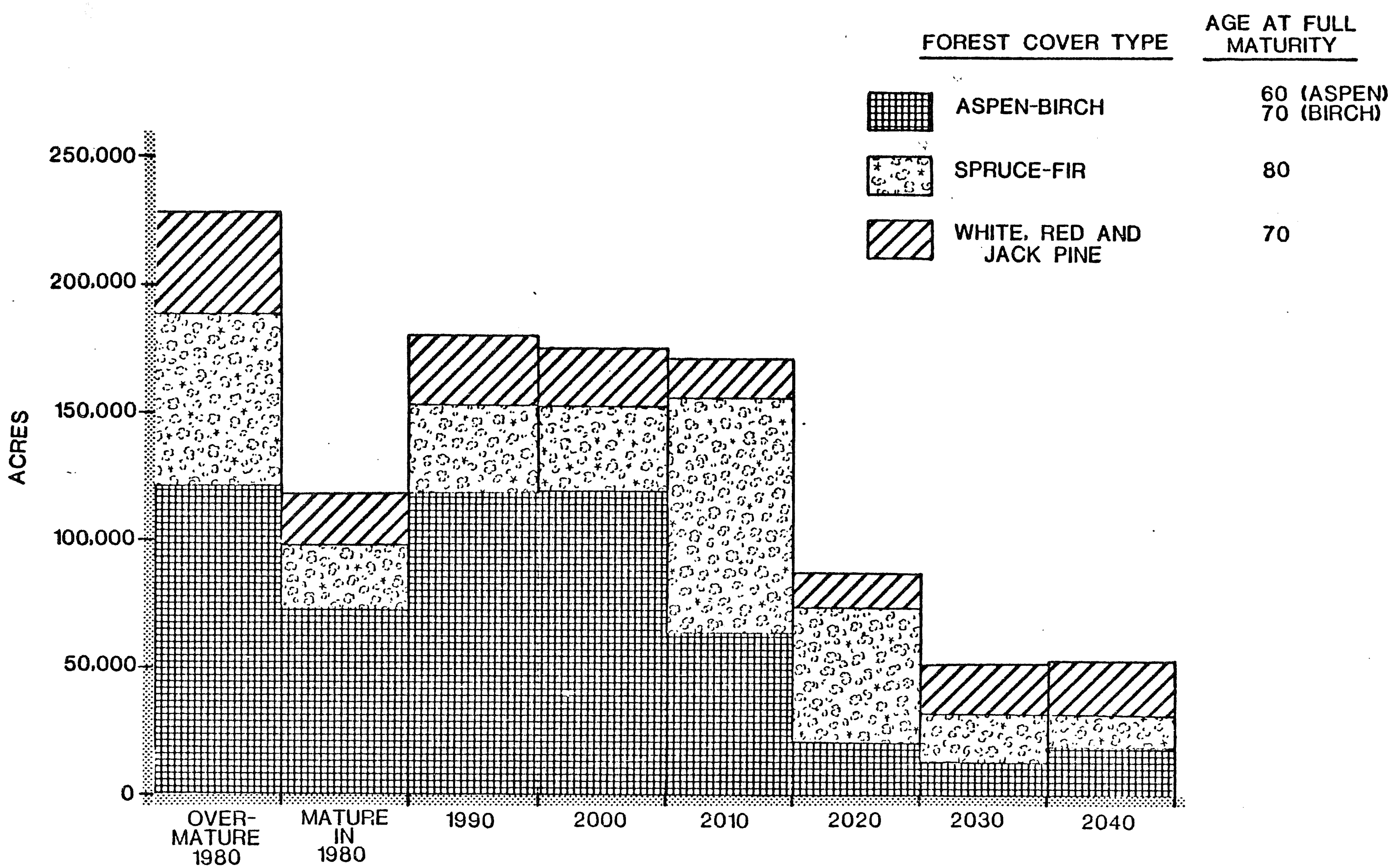
D. PRODUCTION FOR MILLS NOT REPORTING SPECIES CONSUMPTION WAS ALLOCATED AMONG SPECIES ACCORDING TO THE PERCENT DISTRIBUTION AT THE MILL GEOGRAPHICALLY CLOSEST

E. ESTIMATED DOLLAR VALUE OF ANNUAL PRODUCTION FOR SPECIES REPORTED AS "OTHER" IS BASED ON THE MEDIAN PRICE PER 1000 BOARD FEET OF ASPEN are derived mainly from Lake and St. Louis counties. Spruce represents 17% and jack pine 15% of the total harvest in Unit 1. Other commercial species include: balsam fir (9%), birch (4%), tamarack (3%), white pine (2%), red pine (2%), and cedar (2%). Harvests of the three major species appear to be roughly proportional to current areal extent of mature and overmature stands of these types (Figure 8).

6.2.2.3 Projected Supply and Demand--No data are available from which to project timber supply in the Study Area alone, but data showing coverage in the SNF outside of the BWCA by age class for each cover type suggest that present acreages of mature and overmature timber are greater than the acres of timber that can be expected to reach maturity at any time during the next 60 years (Figure 8). Approximately one-fifth of the area of the SNF outside the BWCA now supports stands of mature and overmature timber--more than half of which is aspen-birch. In large part, these aspen-birch forests are the result of natural regeneration after the early logging era. Their disproportionate acreage reflects the emphasis of the pulpwood industry on harvest of softwood species until the recent past. As can be seen from Figure 8, forests that will reach maturity after the year 2020 are much more balanced in species composition but represent greatly reduced acreages. The greater proportion of softwoods reaching maturity after the year 2000 is the result of site conversion to pine during the era of the mid-1900s and the concomitant de-emphasis on regeneration of deciduous stands. Approximately 175,329 acres (70,983 ha) of forest land in the SNF outside the BWCA will reach rotation age in the year 2000 (Figure 8). This area represents roughly 1% of the projected total statewide acreage of commercial forest land for that year, or about 8% of all national forest lands in the state (Figure 9).

FIGURE 8

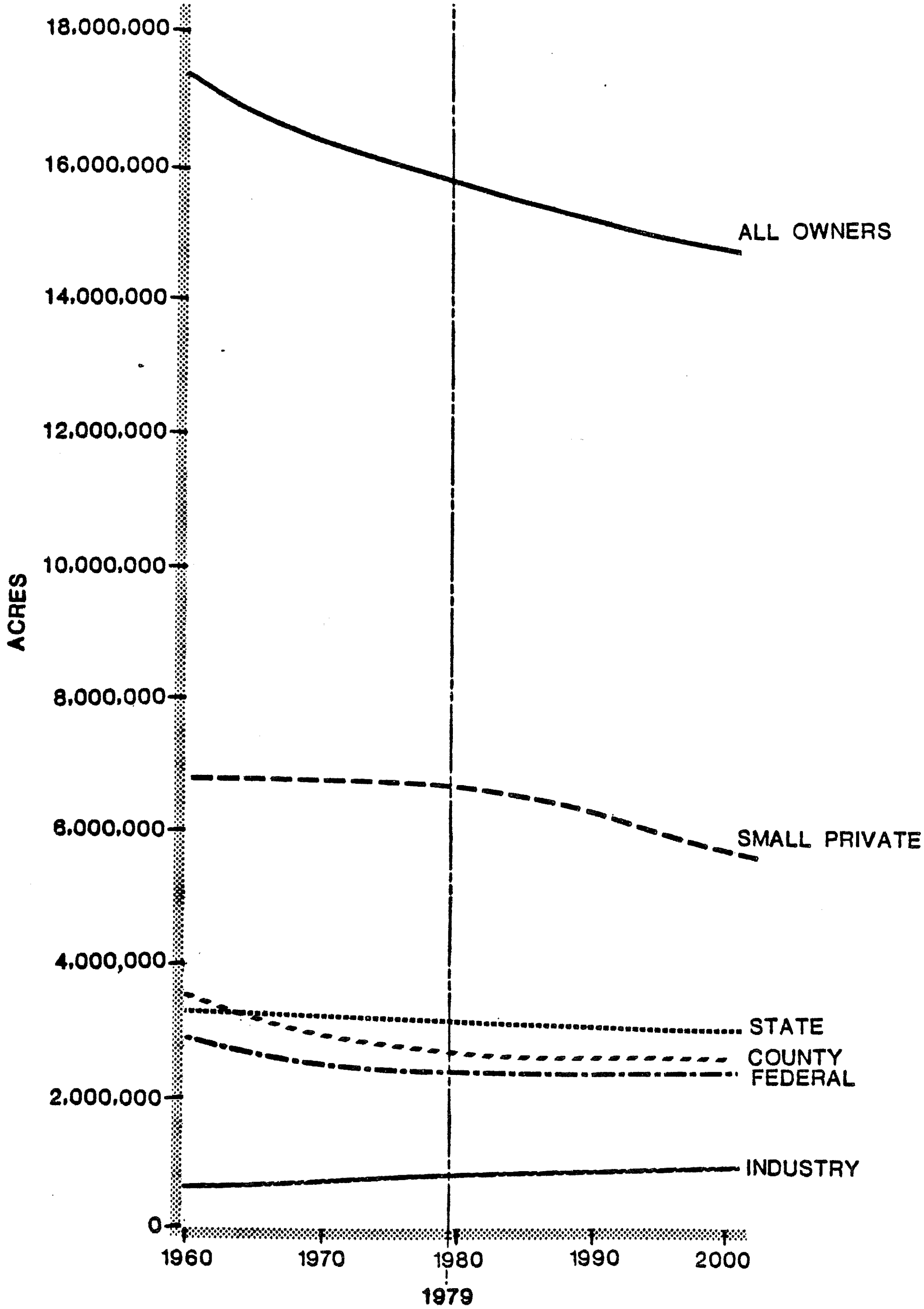
# ACRES OF THE MOST FREQUENTLY HARVESTED FOREST COVER TYPES REACHING FULL MATURITY DURING THE NEXT 60 YEARS ON REGULATED COMMERCIAL FOREST LAND IN THE S.N.F. (OUTSIDE B.W.C.A.)




SOURCE: SUPERIOR NATIONAL FOREST, 1977

FIGURE 9

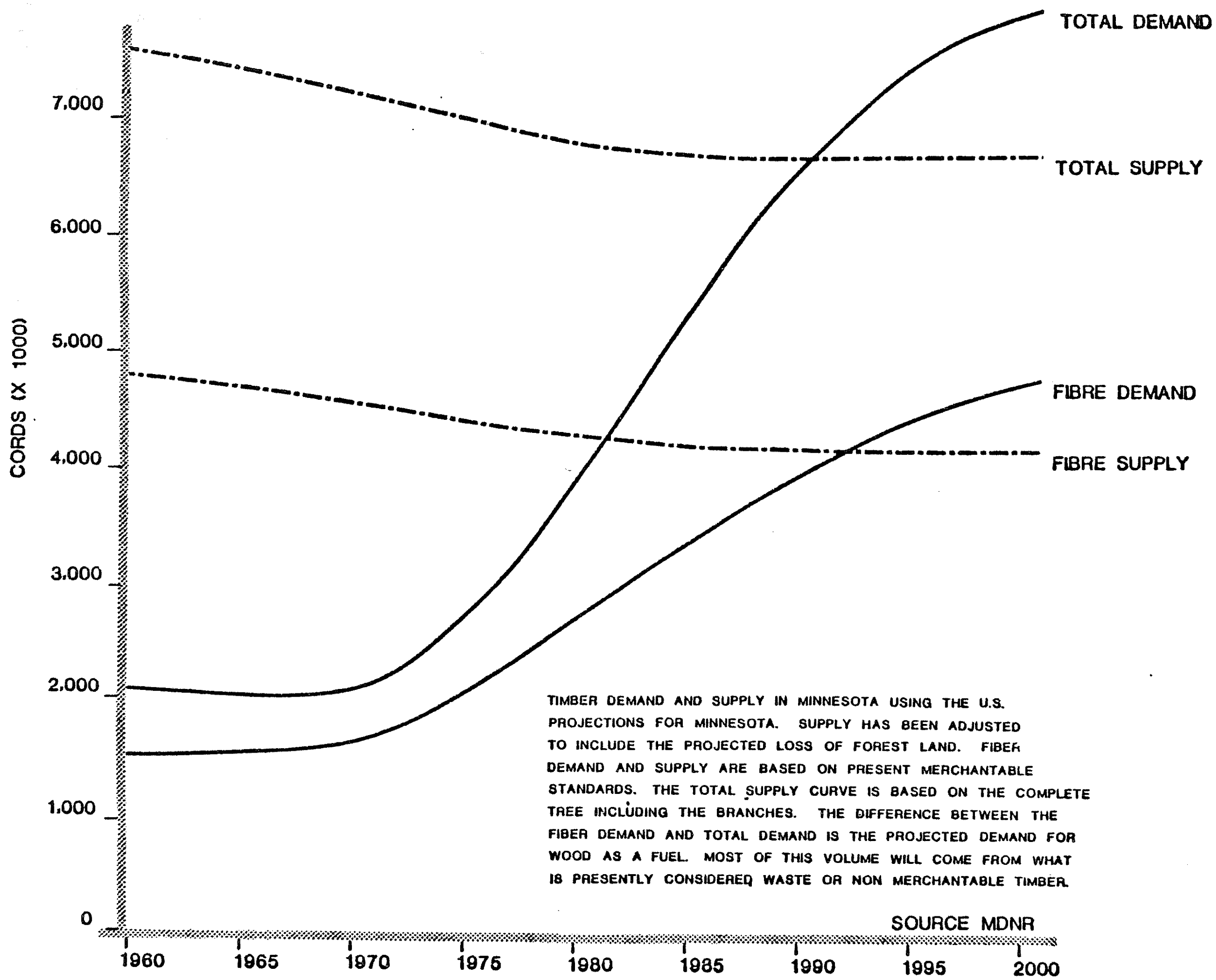
# PROJECTED LOSS OF COMMERCIAL FOREST LAND IN MINNESOTA BY CLASS OF LANDOWNERS




SOURCE : MDNR

FIGURE 10

## PROJECTED TIMBER DEMAND AND SUPPLY IN MINNESOTA



Figures 8 and 9

The projected loss of commercial forest land in Minnesota caused by lower acreages of young forests and removal of lands for recreation and development is approximately 1,125,000 acres (455,466 ha) (MDNR 1977) between now and the year 2000 (Figure 9). Although industry-owned forests will increase slightly in size, they will not compensate for the lowered acreage of mature forests on county, state, and federal lands during that era. Projected timber supply in Minnesota (MDNR), has been adjusted in Figure 10 to include the projected loss of forest land. Both supply and demand figures are based on present merchantable standards. Total drain includes woods, such as fuelwood, that generally would not be considered merchantable. It can be seen from Figure 10 that demand will surpass supply early in the 1990s if present (1977) management policies are continued. On the other hand, large portions of presently overmature aspen stands could be expected to reach minimum harvest size by 2020 if they were regenerated now, which could partially ameliorate the projected decreases in harvestable timber in that and following years.

Figure 10

Trends in Minnesota generally appear to follow nationwide projections for growth on commercial forest lands. There will undoubtedly be a decrease in future growth caused by loss of commercial forest lands. Some or all of the lost growth could be compensated for by intensification of management (Sando 1976).

6.2.2.4 Current Management Policies--Roughly half of the Study Area forest lands are publicly-owned forest lands within the boundaries of national, state, and county forests (see Figure 1). Each level of government (county, state, federal) allows timber harvest on forest land it controls according to estabished guidelines.

State forests, managed by the MDNR, account for roughly 9% of Study Area forest lands. In the past, large areas of such lands have been managed at low levels of productivity, with little attention to concentration of commercial forestry on lands of highest potential productivity. Current management practices in forestry districts in the Study Area are more than 10 years old (Hansen 1977), and new plans now in preparation may not be implemented for 2 or 3 years. It is expected that new management plans may place more emphasis on intensive management, making use of a recent inventory of forest land suitability in Region 3 (Sando 1976).

This inventory emphasizes the need for stable, long-term commitment of contiguous lands to commercial forestry. Forestry management could be more efficient if incompatible land uses are kept to a minimum in areas designated for intensive forest management. The elimination of incompatible uses would not affect the current multiple-use concept of management because most recreational uses are not considered to be incompatible with efficient forest management. On the basis of the forest suitability analysis discussed previously, it appears that future demands for timber can best be met by intensively managing productive sites rather than extensively managing poor sites. Intensification procedures include: reforestation, timber stand improvement through protection from insect pests and fire, fertilization, genetic improvement, and stand conversion to high-value conifers. Thus, more wood can be obtained from a smaller area. Intensive management of the most suitable areas implies that such forests be located as close as possible to mill locations.

The redirection of management practices toward intensive management has been focused by the need to replace the timber resources from 253,900 acres (102,794 ha) of the portal zone and 30,988 (12,546 ha) acres of the Superior National Forest recently added to the BWCA. The replacement issue centers around the production of softwood because most natural stands of pine in northeastern Minnesota outside the BWCA have been previously harvested and the oldest plantations available to major buyers will not reach harvest age for another decade. It is, therefore, often argued that withdrawal of pinelands in the portal zone from commercial logging will result in a short-term "softwood deficit" until plantations reach harvestable age. Both the state and federal governments look to intensified management as a method of offsetting the loss of harvestable timber within the BWCA in the long run. The MDNR estimates the cost of management intensification on 36,000 acres (14,575 ha) to be approximately $6,696,000 over the next 10 years. Utilizing the concept of the allowable cut effect (ACE), current allowable cuts of softwoods on state lands would be increased in response to investment in intensified management.

Superior National Forest lands outside the BWCA account for roughly 36% of forest lands in the Study Area and BWCA lands account for another 5%. Present USFS management guidelines are in the process of revision. Current policies make use of "site specific" management techniques with management goals being determined stand-by-stand at the time of compartment inventory. Because the maximum allowable cut on federal forest lands is restricted by legislation, annual harvests cannot be exceeded. For this reason, as well as because of the limited supply of softwood on federal lands, the USFS foresees increased harvest (and use) of hardwoods as the method of compensating for the softwood deficit incurred by loss of commercial lands from the Portal Zone. Federal and state cost estimates for a 10-year management intensification program made in 1977 are roughly the same. The USFS cost estimate is $7.2 million versus $6.6 million estimated by the state. However, the USFS adds $21.4 million for upgrading transportation in the forests and $5.0 million for research and development.

Communication from Dr. John McGuire, Chief, U.S. Forest Service to Congressman Vento in April, 1978, suggest that the U.S. Forest Service believes that the immediate deficit in total timber production incurred by withdrawal of the Portal zone from commercial logging can be compensated for by harvests outside the BWCA even without intensification of management. This contention is not supported by the forest products industry in the region.

### 6.3 IMPACTS OF COPPER-NICKEL MINE DEVELOPMENT ON FOREST LANDS AND THE FOREST PRODUCTS INDUSTRY

Most indications are that there will only be a slight impact on the regional forest products industry and the forest lands of the Study Area as a result of the development of copper-nickel mining operations in northeastern Minnesota. Impacts to the local Study Area forestry industry are also expected to be minimal since most impacts due to the removal of land from commercial forestry will probably be mitigated by relocating harvest activities to a site within the same general area where forest resources are comparable to those in affected areas and where transportation costs are acceptable. The most significant impacts to the forestry industry are expected to be the result of mine development or residential settlement in areas of prime commercial forest suitability which could limit the efficacy of intensified forest management practices in the future.

Impacts to forest lands and the forest products industry have been assessed primarily by determining the areal extent of three major classifications of impactors (direct, indirect, and secondary) and then estimating the maximum amounts of forest land which could be removed from production. Direct impacts refer to those impacts which would result from the actual consumption of land not previously used for mining by pits, processing plants, tailing basins, stockpiles, waste dumps, and other mining land uses. Indirect impacts refer to those impacts such as air quality changes, water quality changes, and noise pollution which, although directly linked to the mine developments, would affect areas outside of the immediate mine site. In the case of forestry, only air quality changes have been considered relevant. Secondary impacts refer to those impacts which result from the economic growth and population increases which will accompany copper-nickel mine development. The major secondary impactor in terms of the forestry industry is the expected increase in the consumption of land for residential settlement.

### 6.3.1 Direct Impacts

Figure 11 illustrates the zones which have been created for the purpose of assessing direct land consumption impacts in the area where future copper-nickel mining is most likely to occur. Identified copper-nickel mineral deposits are located in a corridor roughly one and one-half miles wide (the Resource Zone) paralleling the basal contact of the Duluth Complex which runs from a point south of Hoyt Lakes north-northeast to a point along the South Kawishiwi River. This is the zone in which actual extractive operations may take place and where land consumption for pits and processing facilities is most likely to occur. The remainder of the Development Area extends a mile and one-half on either side of the Resource Zone and represents the estimated area in which it would be economically feasible to transport waste rock and lean ore for dumping and stockpiling. While it may be feasible to transport and dispose of tailings up to ten

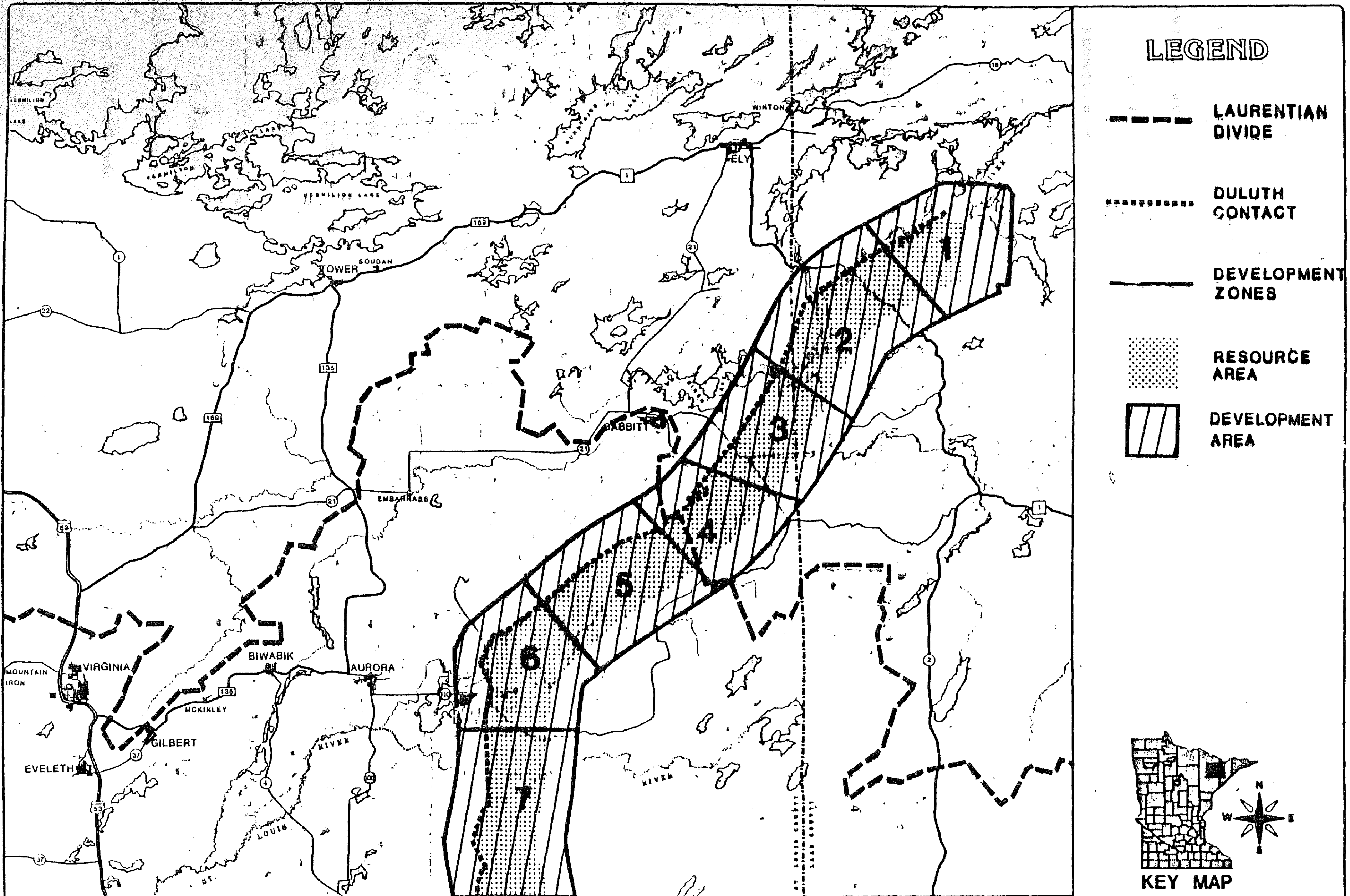



FIGURE 11

# MEQB REGIONAL COPPER-NICKEL STUDY

MN CU-NI DEVELOPMENT AND RESOURCE ZONES

miles from the processing plant, it is assumed that these facilities will be located as close to the processing plants as possible with the resultant assumption that most direct land consumption impacts will occur in the Development area and Resource Zone. The overall area encompassed by the Development Area is further divided into seven zones from north to south referred to as Development Zones.

Figure 11

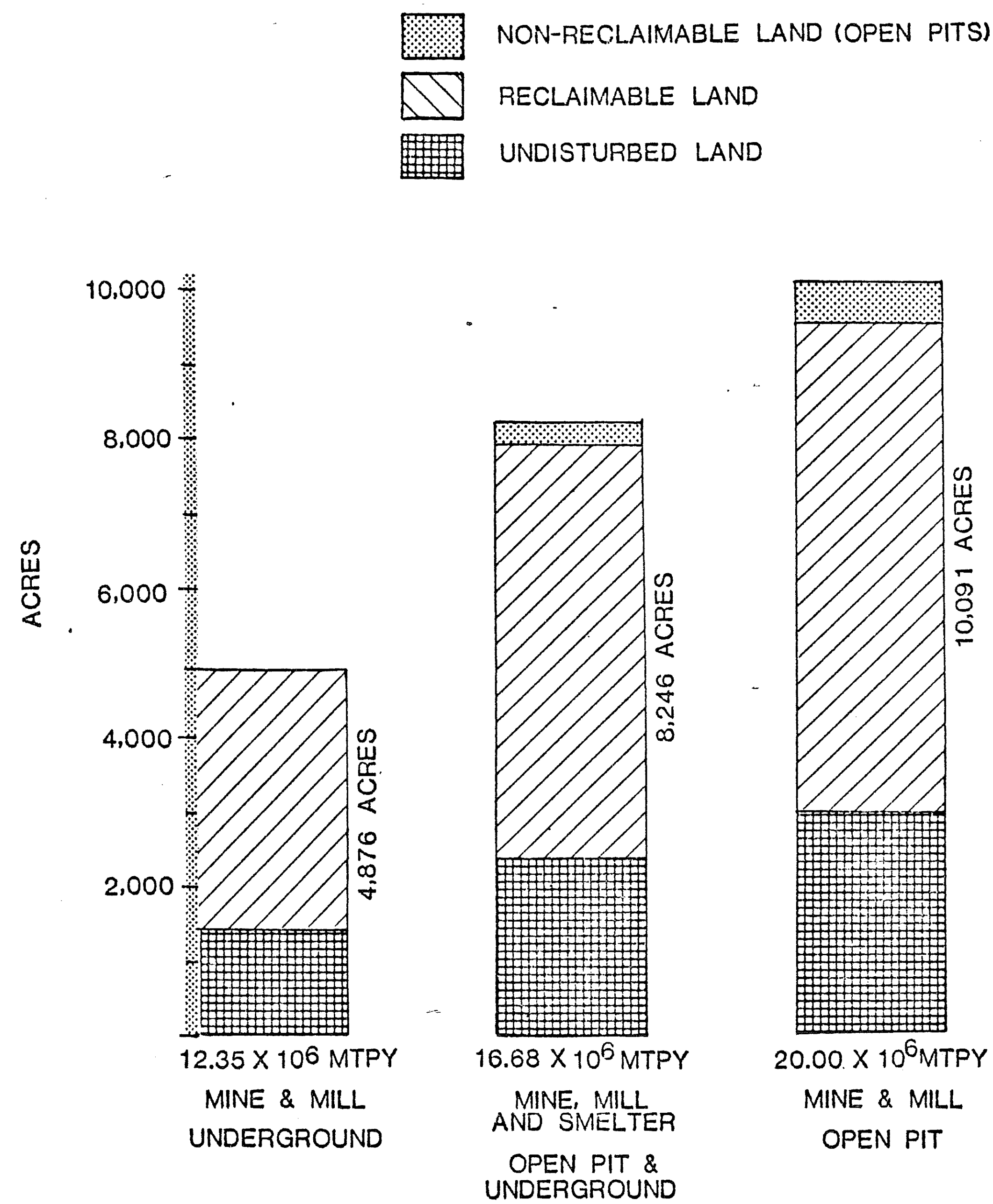
Actual impacts as a result of direct land consumption will, of course, be contingent on the number, size, and location of future mining operations. For illustration purposes, land consumed by three hypothetical mines--a $12.35 \times 10^6$ mtpy underground mine, a $20.00 \times 10^6$ mtpy open pit mine, and a $16.68 \times 10^6$ mtpy combination open pit and underground mine with a 100,000 mtpy smelter/refinery (such a smelter could be located anywhere in the region or even in another state)--is presented in Figure 12 and has been used to estimate direct impacts in the Study Area.

Figure 12

Total land consumed by the "3-mine" model is 23,213 acres (9,398 ha) or 2.2% of all forested land in the Study Area. This is the amount of forest land which would be consumed by copper-nickel development if all such development displaced forest land. The severity of even such a "worst case" scenario would be dependent on the commercial suitability of the land consumed and the value of the timber production lost to the industry as a result of the occupation of the land for the estimated 25-year life of the mine. Furthermore, it is expected that any resultant impacts could be at least partially mitigated by: 1) the careful

FIGURE 12

# LAND REQUIREMENTS OF THREE HYPOTHETICAL MINE DEVELOPMENTS




SOURCE : REGIONAL COPPER-NICKEL STUDY TECHNICAL ASSESSMENT TEAM siting of mine developments; 2) making additional lands available for commercial forestry; 3) the economic compensation received from the harvest of existing stands of trees on the displaced land; and 4) eventual reclamation of at least some of the consumed land.

6.3.1.1 Impact Assessment--Because of the limitations of the processes presently used by the pulpwood industry, the demand for pines and spruce remains highest. As was discussed in section 6.2.1.3, conifer stands with high potential productivity represent the most desirable lands for the forest products industry. Lands of this type account for only 6% of the Study Area forest lands and 6% of the seven Development Zones (total area), whereas conifers on lands with poor production potential account for 31% of the Study Area forest lands and 29% of the Development Zones (total area) (Tables 3 and 5). The relative scarcity of the high productivity conifer lands enhances their value to the timber industry. Table 5 shows that the largest proportion of these lands is found in Development Zones 5, 6, and 7. In addition, land in the southern zones is generally more accessible and has a higher mill capacity demand than land in the other zones. Impacts to the forest products industry would be the most significant if large amounts of this land were appropriated for mine developments. The distribution of identified mineralization in the Study Area, however, suggests that most extensive mining operations are likely to occur in the northeastern portion of the area, in Development Zones 1-5, and least likely to occur in the southern zones.

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Table 5

As discussed previously, the economic value of forest lands on a per-acre basis varies depending on cover type, productivity, accessibility, and mill capacity

TABLE 5

# A POTENTIAL PRODUCTIVITY OF CONIFER FORESTS BY DEVELOPMENT ZONE

| POTENTIAL PRODUCTIVITY | ACRES OF CONIFER IN STUDY AREA | ACRES OF CONIFERS IN REGION 3 |
|---|---|---|
| GOOD A | 64,520 | 607,280 |
| MEDIUM B | 35,760 | 412,080 |
| POOR C | 317,520 | 2,592,760 |

| POTENTIAL PRODUCTIVITY | DEVELOPMENT ZONE 1 | | | DEVELOPMENT ZONE 2 | | |
|---|---|---|---|---|---|---|
| | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL |
| GOOD | 0 | 0 | 0 | 0 | 0 | 0 |
| MEDIUM | 0 | 0 | 0 | 0 | 0 | 0 |
| POOR | 8,240 | 2.6 | 0.3 | 13,720 | 4.3 | 0.5 |

| POTENTIAL PRODUCTIVITY | DEVELOPMENT ZONE 3 | | | DEVELOPMENT ZONE 4 | | |
|---|---|---|---|---|---|---|
| | ACRES OF CONIFERS | % STUDY ACRE TOTAL | % REGION 3 TOTAL | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL |
| GOOD | 400 | 0.6 | 0.1 | 360 | 0.6 | 0.1 |
| MEDIUM | 0 | 0 | 0 | 0 | 0 | 0 |
| POOR | 7,520 | 2.4 | 0.3 | 5,960 | 1.9 | 0.2 |

| POTENTIAL PRODUCTIVITY | DEVELOPMENT ZONE 5 | | | DEVELOPMENT ZONE 6 | | |
|---|---|---|---|---|---|---|
| | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL |
| GOOD | 2,920 | 4.5 | 0.5 | 3,040 | 4.7 | 0.5 |
| MEDIUM | 0 | 0 | 0 | 0 | 0 | 0 |
| POOR | 9,480 | 3.0 | 0.4 | 2,680 | 0.8 | 0.1 |

| POTENTIAL PRODUCTIV | DEVELOPMENT ZONE 7 | | | ALL DEVELOPMENT ZONES | | |
|---|---|---|---|---|---|---|
| | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL | ACRES OF CONIFERS | % STUDY AREA TOTAL | % REGION 3 TOTAL |
| GOOD | 4,160 | 6.4 | 0.7 | 10,880 | 16.9 | 1.8 |
| MEDIUM | 0 | | 0 | 0 | 0 | 0 |
| POOR | 3,480 | 1.1 | 0.1 | 51,080 | 16.1 | 2.0 |

A. MORE THAN 80 CU. FT./ACRE/YEAR

B. 50-80 CU. FT./ACRE/YEAR

C. LESS THAN 50 CU. FT./ACRE/YEAR

demand with the result that the dollar impact of land losses on the forest products industry cannot be specifically estimated. A simplified analysis conducted by the Regional Copper-Nickel Study takes into account the differential stumpage values of softwoods and hardwoods and the potential productivity of the land but not its accessibility or the mill capacity demand. 1974 stumpage rates, expressed in terms of dollars per cord, were used to estimate the value of annual timber production per acre by converting the annual growth increments used to define the potential productivity of the land (expressed in terms of cu ft of production/acre/yr) into cords/acre/year by assuming 79 cu ft/cord (Table 6). The resultant estimated annual value of timber production per acre was used to calculate: 1) the annual value of production over all 23,213 acres of development for various combinations of forest cover types and land productivity; 2) the estimated value of production lost on 23,213 acres over 25 years of mine operation; 3) the estimated maximum value of timber production lost if the timber which must be cleared from the 23,213 acres before mining may begin has not reached minimum harvest age; 4) the estimated value of mature timber by acre and the acres of such timber which would be necessary to replace timber production lost due to mining developments; and 5) the value of annual timber production on land reclaimed following mining.

Table 6

It must be noted that the figures in Tables 6-8 are rough maximizations of impacts and costs and are based on the unlikely eventuality that all 23,213 acres of mine development will displace and/or disrupt commercial forest lands over 25 years of operation. Furthermore, it is unlikely that land appropriation of this magnitude would consume land of only one cover type and one level of productivity

FIGURE 13

# POTENTIAL DISRUPTIONS OF TIMBER HARVEST CYCLES RESULTING FROM COPPER-NICKEL MINE DEVELOPMENT

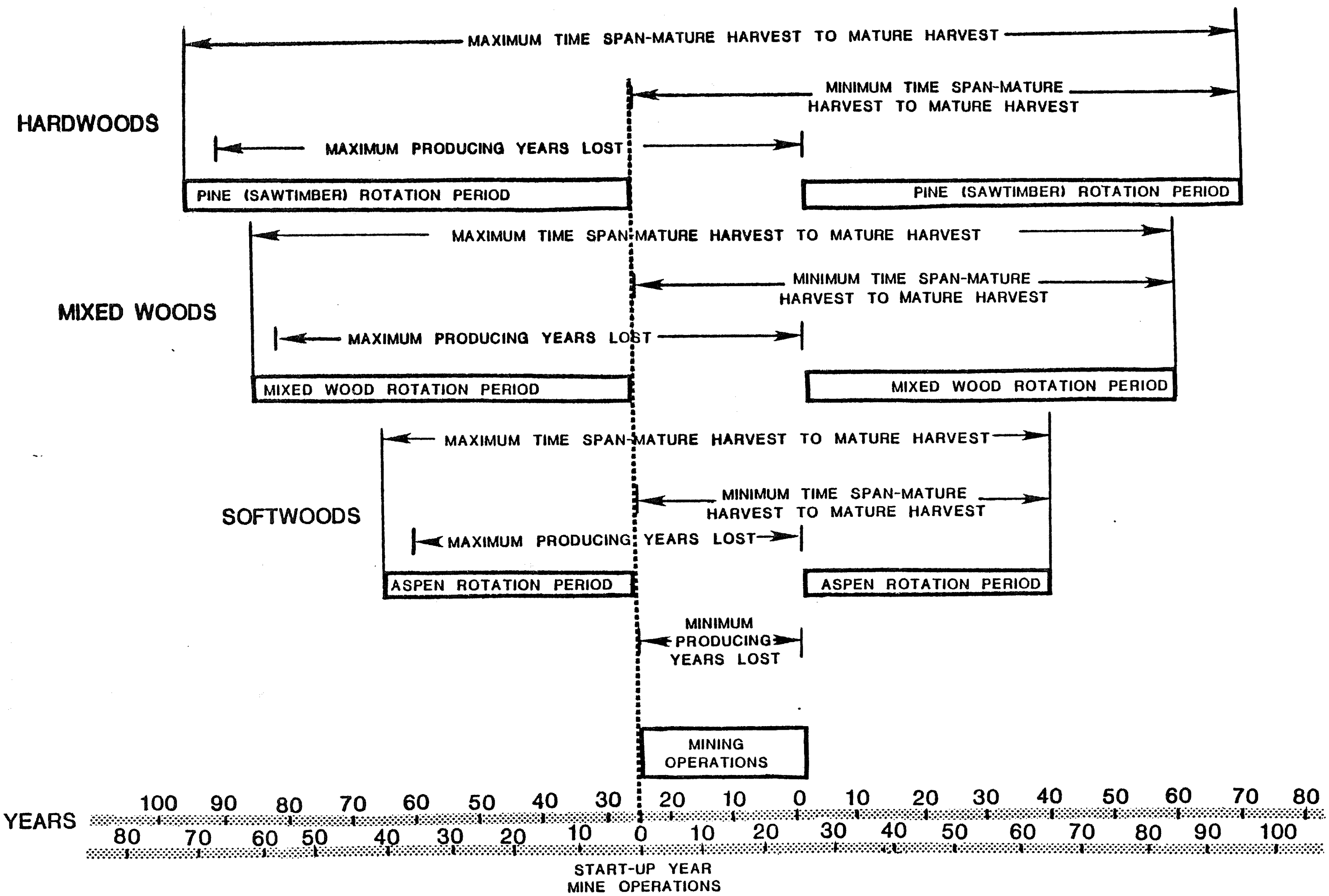

Table 6. Estimated maximum values of impacts on timber production resulting from three hypothetical copper-nickel mine developments.

| | POTENTIAL PRODUCTIVITY | STUMPAGE PRICE PER CORD[a] | VALUE (dollars 1974) OF ANNUAL TIMBER PRODUCTION: Per Acre[b] | VALUE (dollars 1974) OF ANNUAL TIMBER PRODUCTION: On 23,213 Acres | VALUE (dollars 1974) OF PRODUCTION LOST ON 23,213 ACRES: Over Life of Mine[c] | VALUE (dollars 1974) OF PRODUCTION LOST ON 23,213 ACRES: Over Life of Mine & From Premature Harvest[d] |
|---|---|---|---|---|---|---|
| Softwood[e] | Good | $6.00 | 6.08 | 141,100 | 3,527,500 | 12,699,000 |
| | Medium | $6.00 | 4.94 | 114,700 | 2,867,500 | 10,323,000 |
| | Poor | $6.00 | 3.80 | 88,200 | 2,205,000 | 7,938,000 |
| Hardwood[f] | Good | $3.00 | 3.04 | 70,600 | 1,765,000 | 4,236,000 |
| | Medium | $3.00 | 2.47 | 57,300 | 1,432,500 | 3,438,000 |
| | Poor | $3.00 | 1.90 | 44,100 | 1,102,500 | 2,646,000 |
| Mixed-Wood | Good | $4.50 | 4.56 | 105,900 | 2,647,500 | 8,472,000 |
| | Medium | $4.50 | 3.70 | 85,900 | 2,147,500 | 6,872,000 |
| | Poor | $4.50 | 2.85 | 66,200 | 1,655,000 | 5,296,000 |

SOURCES: NCFES 1977, MLMIS 1977.

[a]From North Central Forest Experiment Station (NCFES) 1974.

[b]$\frac{\text{(1974 stumpage price/cord)}}{\text{79 cu ft/cord}}$ X productivity rate*

*Good productivity = 80 cu ft/acre/yr
Medium productivity = 65 cu ft/acre/yr
Poor productivity = 50 cu ft/acre/yr

[c]Life of the mines assumed to equal 25 years.

[d]Includes maximum value of production lost due to premature harvest of standing timber (see Figure __); calculated by:

(Estimated value of timber production lost on 23,213 acres over the life of the mine) + (Estimated value of timber produced annually on 23,213 acres) X (Minimum rotation age of forest cover type* -5 yrs)

*Softwood rotation age = 70 years
Hardwood rotation age = 40 years
Mixed-wood rotation age = 60 years

[e]Pine sawtimber.

[f]Aspen pulpwood.

as is assumed in Tables 6-8. Nevertheless, these tables are useful for illustrating general levels of economic impact to the forestry industry in terms of both time and dollars and the economic feasibility of various forms of impact mitigation as well as the overall value of a relatively small amount of renewable resource compared to the value of the non-renewable mineral resource.

Disregarding any of the forms of impact mitigation listed previously, maximum estimated dollar values for the production potential of various types of forest land over the life of the mine (25 years) and over the maximum number of growing years for each timber type prior to the minimum harvest age for that type (minus a five-year buffer period), are presented in Table 6. The chronological relationship of mine development to forest production is presented in Figure 13. This simplified analysis supports the contention that softwoods (conifers) on highly productive land are the most valuable to the forest products industry. Production of softwoods on 23,213 acres of highly productive land (more than 80 cu ft/acre/yr) over the 25-year life of mining operations is estimated to be worth approximately $2.9 million (based on 1974 prices) compared to the $1.8 million that production of hardwoods on the same amount and type of land is estimated to be worth. The lowest estimate of production lost due to the occupation of 23,213 acres of forest land by mining land uses for 25 years is the $1.1 million that 25 years growth of hardwoods on low productivity land (50 cu ft/acre/yr) is estimated to be worth. These figures represent the minimum amount of Study Area commercial forest production lost in each category of forest type/land productivity if 23,213 acres of forest land is withdrawn from production for 25 years.

Additional lost production could occur if mine development dictates that immature stands of timber be cleared. The amount of such losses is dependent on the number of years of production (i.e. the age of the stand) on the land consumed. Since the minimum harvest age of pine sawtimber (the forest type used to estimate softwood costs) is 70 years as compared to the 40-year minimum harvest age of aspen pulpwood (representing hardwood costs), potential lost production as a result of the premature harvest of softwoods is much greater than potential losses due to the premature harvest of hardwoods. This difference is further augmented by the greater value of softwood production per acre/year. Thus, if in addition to the 25 years of lost production as a result of occupation of the land for mining purposes, 65 years of pine sawtimber production is wasted as a result of the premature harvest of 23,213 acres of highly productive softwoods, the total loss to the forestry industry would be roughly $12.7 million or 90 years worth of softwood production on highly productive land (assuming other uses for this timber, such as fuel, are not practicable). In comparison, the maximum value of hardwood timber production on high productivity land lost over the life of the mine and in the 35 years before the earliest harvest is approximately $4.2 million and these same 60 years of production on low productivity land is worth roughly $2.6 million. By comparison, anticipated gross revenues of the three mine models over 25 years is approximately $19,500 million.

It is important to note that while these figures do represent production considered permanently lost in terms of overall Study Area production, the land involved is only 2.2% of Study Area forest land and timber resources on the remaining commercial forest land are considered ample enough to make lost production insignificant to the forest products industry. Furthermore, intensified management of areas most suitable for commercial forestry could eventually recoup this lost production.

6.3.1.2 Impact Mitigation--Table 6 estimates that "worst case" economic losses (the removal of 23,213 acres of highly productive softwoods from production for 90 years) would be in the neighborhood of $12.7 million. Careful siting of mining facilities so as to avoid the most highly valuable forest land could effectively reduce this loss, and, if even moderately effective reclamation of the consumed land occurs, overall permanent impacts to Study Area forest land and the forest products industry would be minimal. In addition, some land currently unavailable for logging could be made available. Depending on the suitability of the land made available relative to the land consumed for mining, this could effectively eliminate any impact to the forest products industry.

Regardless of the site of any future mine developments and barring land consumption on a far greater scale than that assumed for the three hypothetical developments described previously, it is expected that initial impacts will be compensated for by the opening up for harvest of additional forested lands in the area (similar to state and federal plans to mitigate losses resulting from the withdrawal of BWCA lands from commercial forests). Table 7 presents figures which estimate the number of acres of mature timber of various types needed to replace the production lost over the life of the mine or to replace the estimated maximum lost production. It can be seen that by combining careful siting of the mine so that the land consumed is of low productivity levels with compensatory harvests on land of high productivity levels, the number of acres required to mitigate the direct impacts of mining decreases. For example, if 23,213 acres of highly productive conifer forests were removed from production for the 25-year life of the mine, 8,300 acres of mature timber on highly productive land would replace the lost production, whereas only 5,200 acres of mature timber on highly productive land would be required to replace 25 years worth of production on

Table 7. Acres of mature timber needed to compensate for timber production lost as a result of three hypothetical mine developments.

| | POTENTIAL PRODUCTIVITY | VALUE (dollars 1974) OF PRODUCTION LOST ON 23,213 ACRES: Over Life of Mine[a] | VALUE (dollars 1974) OF PRODUCTION LOST ON 23,213 ACRES: Over Life of Mine & From Premature Harvest[b] | VALUE (dollars 1974) OF MATURE TIMBER: On 23,213 Acres[c] | VALUE (dollars 1974) OF MATURE TIMBER: Per Acre | ACRES OF MATURE TIMBER NEEDED TO REPLACE LOST PRODUCTIVITY: Over Life of the Mine w/same[d] Productivity | ACRES OF MATURE TIMBER NEEDED TO REPLACE LOST PRODUCTIVITY: Over Life of the Mine w/"good"[e] Productivity | ACRES OF MATURE TIMBER NEEDED TO REPLACE LOST PRODUCTIVITY: Over Life of Mine & From Premature Harvest[f] |
|---|---|---|---|---|---|---|---|---|
| Softwood | Good | $3,527,500 | 12,699,000 | 9,877,000 | 425 | 8,300 | 8,300 | 29,900 |
| | Medium | $2,867,500 | 10,323,000 | 8,029,000 | 346 | 8,300 | 6,700 | 29,800 |
| | Poor | $2,205,000 | 7,938,000 | 6,174,000 | 266 | 8,300 | 5,200 | 29,800 |
| Hardwood | Good | $1,765,000 | 4,236,000 | 2,824,000 | 122 | 14,500 | 14,500 | 34,700 |
| | Medium | $1,432,500 | 3,438,000 | 2,292,000 | 99 | 14,500 | 11,700 | 34,700 |
| | Poor | $1,102,000 | 2,646,000 | 1,764,000 | 76 | 14,500 | 9,000 | 34,800 |
| Mixed-Wood | Good | $2,647,500 | 8,472,000 | 6,354,000 | 274 | 9,700 | 9,700 | 30,900 |
| | Medium | $2,147,500 | 6,872,000 | 5,154,000 | 222 | 9,700 | 7,800 | 31,000 |
| | Poor | $1,655,000 | 5,296,000 | 3,972,000 | 171 | 9,700 | 6,000 | 31,000 |

SOURCES: NCFES 1977, MLMIS 1977.

[a] & [b]See Table 7.

[c]Minimum value of mature timber calculated by:

(Estimated value of timber produced annually on 23,213 acres*) X (Forest cover type minimum rotation age**)

*See Table 7

**Softwood rotation age = 70 years
Hardwood rotation age = 40 years
Mixed-wood rotation age = 60 years

[d] $\left(\dfrac{\text{Estimated value of timber production lost on 23,213 acres over the life of the mines}}{\text{Estimated value of mature timber per acre}}\right)$

[e] $\left(\dfrac{\text{Estimated value of timber production lost on 23,213 acres over the life of the mines}}{\text{Estimated value of mature timber on land w/good productivity}}\right)$

[f] $\left(\dfrac{\text{Estimated maximum value of timber production lost}}{\text{Estimated value of mature timber per acre}}\right)$

23,213 acres of land with low productivity. Accordingly, the number of acres of mature timber required to compensate for production losses increases as those losses increase. If production losses are equivalent to production greater than which occurs in the minimum rotation period (the minimum length of time to harvestable maturity), the number of acres required to compensate for that loss exceeds the actual number of acres consumed. For instance, if mining development consumes 23,213 acres of 35-year-old hardwoods and then occupies the land for another 25 years, the acreage of mature hardwoods needed to compensate for the total 60-year loss of production (compared to the minimum hardwood rotation period of 40 years) would be roughly 34,700 acres. The analysis suggests, therefore, not only that careful siting of mine developments so as to avoid high value forest lands coupled with compensatory harvests in other parts of the Study Area could, at the very least, partially mitigate the economic losses to the forest products industry, but that the <u>older</u> the stand of timber harvested <u>prematurely</u>, the greater the lost production and the greater the number of acres necessary to mitigate the loss. This fact highlights the importance of the age of the timber removed from land to be used for mining in determining the amount of production lost or, in the case where mature timber can be harvested from future minelands, in determining the mitigation achieved by offsetting the lost production with the value of the timber harvested.

## Table 7

Table 7 shows not only the number of acres of mature timber required to compensate for production lost over the 25-year life of the mine (the minimum amount of production lost if no production were wasted due to premature harvest) and the acres required to compensate for maximum production losses but shows also estimated value for 23,213 acres of mature timber for each type and productivity level. This represents the maximum level of mitigation possible if all acres consumed for mining are covered in mature timber. For example, if the land consumed for mining was moderately productive hardwood covered land and was covered with mature timber, the value of the timber that would be harvested prior to the commencement of mining would be roughly $2.3 million while the production lost on that land over the 25 years that the mine was in operation would be approximately $1.4 million. The figures presented previously describing the acreages of mature timber necessary to compensate for lost production apply equally as well to timber harvested from the mine site prior to the commencement of mining.

Of the 23,213 acres of land consumed by mining, it is expected that all but 996 acres (403 ha) will be reclaimed to at least low potential productivity (see Volume 2-Chapter 2, section 2.9 for a detailed discussion of reclamation). Table 8 presents the effects of reclamation in terms of the value of annual production lost due to land being permanently withdrawn from commercial forestry and, where applicable, the lowering of the productivity level. The greatest decrease in the estimated annual value of timber production as a result of reclamation restoring land to low productivity levels occurs in the case of highly productive, softwood covered land. The the estimated value of annual production lost due to the permanent withdrawal of 996 acres of land and the restoration of the remaining land to low productivity levels is $56,700 (40% of original production). It can be seen in Table 9 that the percentage decrease in the estimated value of annual production resulting from less than totally effective reclamation is significantly less for that land which was low in productivity to begin with. This suggests, again, that permanent losses to the productivity of commercial forest lands in the Study Area could be minimized by, wherever possible, avoiding

Table 8. Estimated value of timber production on land reclaimed after mining ceases.

| | | VALUE (dollars 1974) OF ANNUAL TIMBER PRODUCTION | | | | | |
|---|---|---|---|---|---|---|---|
| | | At Original Productivity | | | At Low Productivity on 22,217 Reclaimed Acres(B) | Lost in Partial Reclamation (A)-(B) | PERCENT DECREASE (A)-(B) |
| | POTENTIAL PRODUCTIVITY | On 23,213 Acres (A) | On 22,217 Reclaimed Acres | On 996 Acres[a] No Reclaimed | | | |
| Softwood | Good | $141,100 | 135,100 | 6,000 | 84,400 | 56,700 | 40 |
| | Medium | $114,700 | 109,800 | 4,900 | 84,400 | 30,300 | 26 |
| | Poor | $ 88,200 | 84,400 | 3,800 | 84,400 | 3,800 | 4 |
| Hardwood | Good | $ 70,600 | 67,500 | 3,100 | 42,200 | 28,400 | 40 |
| | Medium | $ 57,300 | 54,900 | 2,400 | 42,200 | 15,100 | 26 |
| | Poor | $ 44,100 | 42,200 | 2,100 | 42,200 | 2,100 | 5 |
| Mixed-Wood | Good | $105,900 | 101,300 | 4,600 | 63,300 | 42,600 | 40 |
| | Medium | $ 85,900 | 82,200 | 3,700 | 63,300 | 22,600 | 26 |
| | Poor | $ 66,200 | 63,300 | 2,900 | 63,300 | 2,900 | 4 |

SOURCES: NCFES 1977, MLMIS 1977.

[a]996 acres of open pits were not considered likely to be reforested.

highly productive and commercially suitable forest lands.

Table 8

### 6.3.2 Indirect Impacts

6.3.2.1 Air Quality--While previous studies of the economic impact of air pollution on commercial forestry are not directly applicable to projected pollution levels caused by a copper-nickel smelter located in the Study Area, the evidence does suggest that widespread air quality changes will not be large enough to cause visible damage to commecial forest species except in the case of accidental fumigations caused by the breakdown of smelter pollution controls. The impacts of expected changes in air quality on the terrestrial ecosystems of the Study Area are discussed more completely in Volume 4-Chapter 2 of this report.

Studies in Sweden (Tamm and Aronson 1972) suggest a reduction in the annual growth rate of 3% where ambient $SO_2$ concentrations range between 39 and 52 $ug/m^3$ monthly (see Volume 4-Chapter 2). Such levels of $SO_2$ are far in excess of the anticipated annual ambient levels of 2.5 $ug/m^3$ in the Study Area during normal smelter operation (see Volume 3-Chapter 3). Impact analysis presented in Volume 3-Chapter 3 indicated that $SO_2$ levels of about 1,000 $ug/m^3$ can be expected within 8 km of a smelter under breakdown conditions of three hours duration. Such levels are above the injury threshold for all commercial forest species in the Study Area and, therefore, may result in visible injury downwind of the source. Regardless of cover type, impacts caused by repeated accidental fumigations would probably not exceed a distance of 8 km.

The deposition of heavy metals and resultant increased loading of soils probably represents the most severe terrestrial impact of air pollution that can be expected from a smelter in northeastern Minnesota. Heavy metal loadings decreases the rate of litter decomposition and may produce deep litter layers which are poor seedbeds for species such as red and jack pine that require mineral soil for establishment. In addition, reduction in litter decomposition rates reduces nutrient recycling in forest ecosystems (Volume 4-Chapter 2, section 2.9.1.1). Avoiding the use of a spray drier for concentrate drying in the smelter and/or using state-of-the-art particulate control systems could reduce the areal extent of slowed decomposition to within a distance of 2 km of the smelter.

### 6.3.3 Secondary Impacts

6.3.3.1 Consumption of Forest Land for Residential Settlement--Future residential settlement in the Study Area has been projected based on land availability and past settlement patterns (Volume 5-Chapter 7). The total amount of rural land estimated to be consumed by residential settlement is 5,053 acres (2,046 ha) or 0.5% of all Study Area forest land. If this settlement displaced the most valuable forest land (softwoods on highly productive land), the estimated permanent loss in terms of annual production of timber (dollars 1974) would be approximately $30,700. As discussed in section 6.3.1, annual lost production of this amount could be mitigated by making additional forest areas available for the industry or by intensifying management of certain stands.

Impacts as a result of the consumption of forest land for residential settlement which are potentially more serious than the rather small production losses are impacts to certain management practices and to the accessibility of the commercial forests. Management practices such as airborne chemical spraying and fire control are most efficient when they can be instituted over large, unbroken tracts of land. Isolated residences scattered through commercial forest lands could make such management practices difficult and inefficient.

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