# Minnesota Wood Residue Studies

## One Man's Trash is Another Man's Treasure



Minnesota
DEPARTMENT OF NATURAL RESOURCES

# FOREWORD

This project was conducted by the Minnesota Department of Natural Resources, Division of Forestry with the support of the Great Lakes Governor's Council.

The Division of Forestry expresses their appreciation to Thompson-Anderson Forestry Consultants who were responsible for the collection of information, organizing, and coordinating the data to satisfy the goals and objectives of the projects. They are responsible for the contents of the report.

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The Minnesota Department of Natural Resources (DNR), Division of Forestry, in cooperation with the Great Lakes Governors' Council, conducted a comprehensive study of wood residue currently and potentially available for wood fuel. All identifiable sources of residue were studied.

## STUDY DESCRIPTION AND HIGHLIGHTS

A brief description of the four projects and a highlight of each is included below:

1) BIOMASS ASSESSMENT

The biomass analysis considers three land classes capable of providing wood energy. They are commercial forest land, unproductive forest land, and nonforest land with trees.

The total tree biomass growing on these three land classes amounts to nearly 350 million cord equivalents (804 million green tons). This total represents the above ground volume, including bark, but excluding foliage, of all live trees. It is desirable to harvest part of this volume each year to properly manage the forest.

In 1988, using the most efficient recovery systems, 1.8 million cord equivalents of wood biomass were available for energy purposes. Projections for 1990 and 1995 predict increases of 9 percent and 25 percent, respectively. Many environmental factors need to be carefully evaluated to determine if it would ever be desirable to utilize all the biomass available annually.

2) PRIMARY WOOD PROCESSORS' RESIDUE SURVEY

A survey was conducted during the February and March of 1989 to determine the location, volume, and type of residue material available for fuel from wood processing. In 1988, over 700 wood processors in the state processed 2.7 million cords of wood. They generated 1.5 million green tons, or 750,000 cord equivalents of residue. Only 13 percent, or 100,000 cord equivalents, of residue generated was unused and available for energy. Two-thirds of the residues generated are currently used for fuel.

3) URBAN WOOD WASTE SURVEY

Significant waste is generated from sources other than the primary wood industry. The majority of these wood wastes originate in urban areas. The Twin Cities generate a little more than half of the state's urban wood waste. Wood waste composition is about the same for the outstate and the Twin Cities areas.

This report discusses residential/commercial/industrial wood wastes, tree removals, and railroad tie wastes. Approximately 529,000 tons of residential/commercial/ industrial wood waste are generated annually. Most of this is demolition wood. It accounts for 65 percent of the annual volume of wood waste. Only 75,000 tons of these wood wastes are currently utilized.

Tree waste volume can fluctuate wildly from year to year. Insect or disease outbreaks, changing levels of construction activity, and the occurrence of damaging storms influence it. Approximately 125,000 tons of urban tree waste were generated in 1988; 85,000 tons were unused and available for energy use.

Railroad ties account for 2 percent of the urban waste wood (40,000 tons). Over half is currently used for energy.

Minnesota's urban wood waste is expected to grow at about 0.3 percent per year between now and the year 2000.

4) RESIDENTIAL FUELWOOD SURVEY

During the 1988-89 heating season, about 1.039 million cords of fuelwood were burned by private households. Since the 1984-85 heating season, fuelwood consumption has decreased by 26 percent.

Currently, 33 percent of Minnesota households use fuelwood for some or all of their heating needs. Housholds using fuelwood as their major source of heat make up 28 percent of all fuelwood consumers. Oak makes up nearly one-third of the fuelwood consumed by all types of users. Approximately 17 percent of the fuelwood is imported from outside Minnesota.

Figure 1 summarizes the wood and wood residues produced in Minnesota that are currently unused and available for wood energy.

These studies show that in 1988 there were 3.6 million tons of wood residues available for use as wood fuel.

As the demand for Minnesota's wood resource continues to increase, the volume of residues generated will also increase. However, changes in the technology of harvesting and processing will probably lead to greater use of these additional residues by the wood products industries. Therefore, little change in the volume of surplus residues will be noted over the next five years.

Significant additional volumes of residues from yard waste and waste paper are available and could be utilized along with these wood wastes for energy.

## Total Wood and Wood Residues Available for Energy in 1988

| | Total Available Using Mechanical Harvest | Volume Used | Net Available For Energy |
|---|---|---|---|
| Forest Residues | | | |
| Commercial Forest Lands | | | |
| Harvest Residues | 2,622,000 tons | | |
| Surplus Species | 487,000 tons | | |
| Mortality | 258,000 tons | | |
| Low Productivity Lands | 269,000 tons | | |
| Unproductive Forest Lands | 285,000 tons | | |
| Non-Forest Land with Trees | 192,000 tons | | |
| **Total Forest Residues** | **4,113,000 tons** | **1,315,000 tons** | **2,799,000 tons** |
| **Primary Processor Residues** | **1,512,000 tons** | **1,309,000 tons** | **203,000 tons** |
| Bark | 753,000 tons | 718,000 tons | 35,000 tons |
| Course | 520,000 tons | 435,000 tons | 85,000 tons |
| Fines | 239,000 tons | 156,000 tons | 83,000 tons |
| **Urban Waste Wood** | **694,000 tons** | **140,000 tons** | **554,000 tons** |
| Demolition Debris | 342,000 tons | 0 tons | 342,000 tons |
| Pallets | 74,000 tons | 0 tons | 74,000 tons |
| Secondary Manufacturing | 113,000 tons | 75,000 tons | 38,000 tons |
| Tree Waste | 125,000 tons | 40,000 tons | 85,000 tons |
| Railroad Ties | 40,000 tons | 25,000 tons | 15,000 tons |
| **Total** | **6,319,000 tons** | **2,764,000 tons** | **3,556,000 tons** |

1

Note: Forest Residues, Primary Processor Residues, and Tree Wastes are listed in green tons. 1 green ton ≅ 0.43 cord equivalents. Other residues shown in dry tons. 1 dry ton ≅ 1 cord equivalent.

TABLE 1

# Total Wood and Wood Residues Available for Energy 1988

(thousand tons)

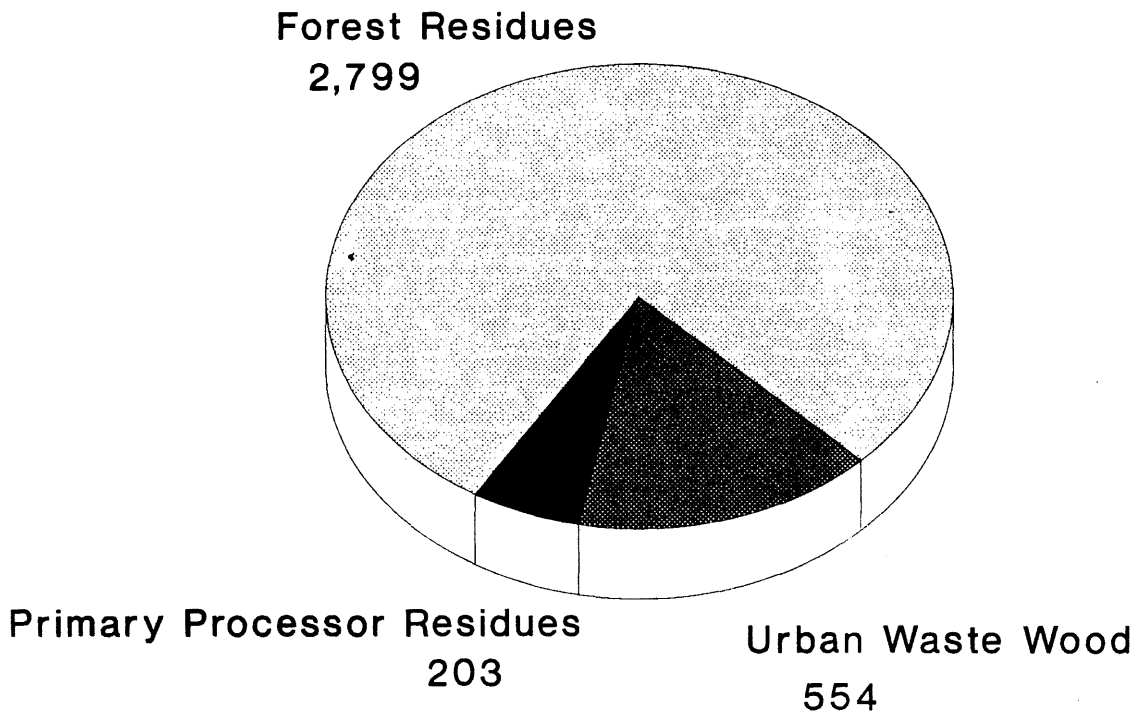


FIGURE 1

# FOREST BIOMASS ASSESSMENT

- 1988 -


## ABSTRACT

Three classes of land in Minnesota can provide biomass for energy. The total tree biomass growing on these lands amounts to 346,400,000 cord equivalents. This represents the above-ground volume of all live trees, excluding foliage.

It is desirable to harvest part of this volume each year, to manage the forest to meet the demands of society for products, recreation, wildlife and environmental quality. This harvest is accomplished through commercial timber sales. Such harvest leaves significant quantities of biomass unused and available for energy use. These are the most economical volumes to recover for energy.

Other sites produce wood generally unsuitable for commercial harvesting. However, biomass could be recovered during various land management activities, such as reforestation or land clearing. Finally, some lands, as a last resort, might produce biomass specifically for energy.

If all these sources were utilized in 1988, using the most efficient recovery system available, 1,773,000 cord equivalents could have been recovered for energy.

## INTRODUCTION

Minnesota's forest resources have been and will continue to be looked at as a renewable source of biomass for energy. The increasing demand for industrial wood products, lumber, paper, etc., will both compete with and provide access to wood for energy use. The increasing demand for wood products, including energy, combined with a heightened awareness of environmental issues by natural resource professionals and the general public has stimulated debate about Minnesota's forest resources. The utilization of forest biomass for energy must be carefully evaluated and balanced within the context of this economic, environmental, and social framework.

## MINNESOTA'S FOREST LAND BASE

According to the 1977 Statewide Forest Inventory, the land classes that are available to provide wood for energy total 16,140,000 acres, or about 32 percent of the total state land base. These land classes are:

1. Commercial Forest Land - Land producing or capable of producing crops of industrial wood and not withdrawn from harvest by statute or administrative regulation.

2. Unproductive Forest Land - Forest land incapable of producing crops of industrial wood due to adverse site conditions.

3. Non-forest Land with Trees - Land dedicated to non-forest uses, such as pasture, idle farm land, windbreaks, etc., which contain trees of at least five inches in diameter.

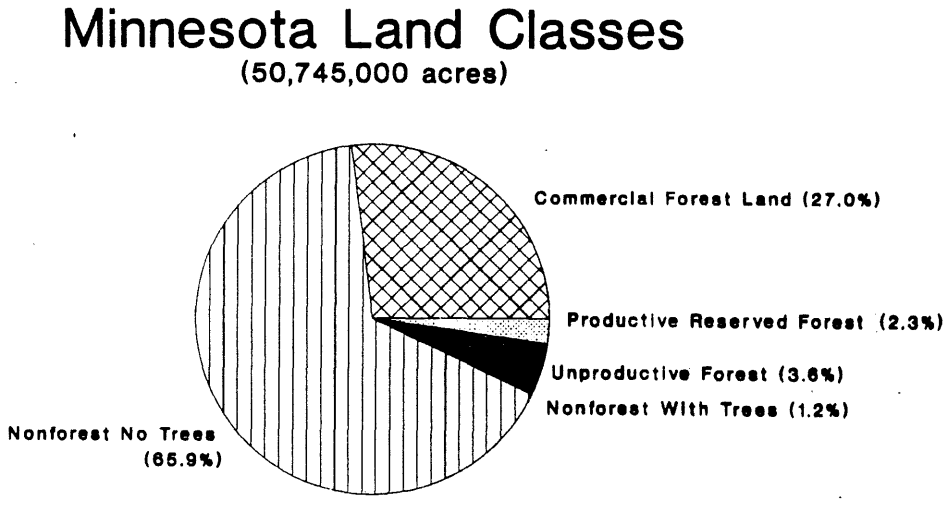


FIGURE 2

## TOTAL BIOMASS

These three land classes currently support a total tree biomass equivalent to 346,400,000 cords. This represents the total above-ground volume, excluding foliage, of all live trees.

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TOTAL WOOD BIOMASS

| Forest Land Class | Thousand Cubic Feet | Thousand Cord[1] Equivalents | Thousand[2] Green Tons |
|---|---|---|---|
| Commercial | 30,580,271 | 336,047 | 779,797 |
| Unproductive | 629,508 | 6,918 | 16,052 |
| Nonforest with Trees | 313,429 | 3,444 | 7,992 |
| Total | 31,523,208 | 346,409 | 803,841 |

1 One cord equivalent is equal to 91 cubic feet of solid wood and bark.
2 One green ton is equal to 51 pounds per cubic foot divided by 2000 pounds, or 0.0255 tons per cubic foot.

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TABLE 2 - Based on 1977 Statewide Inventory Data

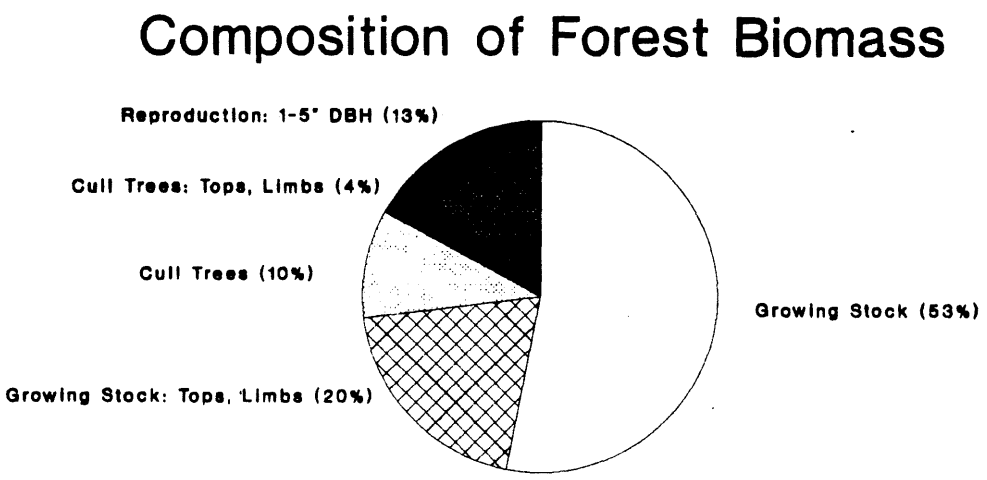



FIGURE 3 - Minnesota's Forest Statistics, 1987: An Inventory Update, page 40, Table 19

Growing stock volume includes the main stem or the merchantable volume of all trees of commercial species more than 5 inches in diameter from a one-foot stump to a 4 inch-diameter top.

Growing stock top and limbs is the biomass of a growing stock tree above a 4 inch top diameter and all limbs below the 4 inch top.

Cull trees are the main stem of live, deformed, diseased, or otherwise undesirable trees.

Cull trees' tops and limbs are the biomass of a cull tree above a 4 inch-diameter top and all limbs below the 4 inch top.

Reproduction trees are 1 to 5 inches in diameter at breast height and are not merchantable at their present size.

All the growing stock volume is recoverable for energy or industrial wood products. Most of the remaining forest residue is not recoverable due to its small size and crooked form. Using current available technologies, it is estimated that the following percentages of forest residues can be recovered:

1. Mechanical systems - full tree chipping - 40 percent
2. Manual systems - conventional roundwood logging - 25 percent

Economic factors will determine if it is practical to recover these residue volumes. Environmental factors must be carefully evaluated to determine if it is desirable to recover them on any given site.

## BIOMASS FROM COMMERCIAL FOREST LANDS

Most of the biomass available for energy is located on commercial forest lands. Biomass recoverable from these lands is available from four different sources:

1. Harvest Residues - the portions of marketable live trees left on a site after the removal of the usable industrial wood.
2. Surplus Species - the volume from live trees which contain usable industrial wood that currently lacks a market.
3. Mortality - the volume of sound wood in merchantable-size trees that die annually.
4. Low Productivity Stands - the volume in hardwood forest types growing on sites that would be more productive for other species, site index less than 40.

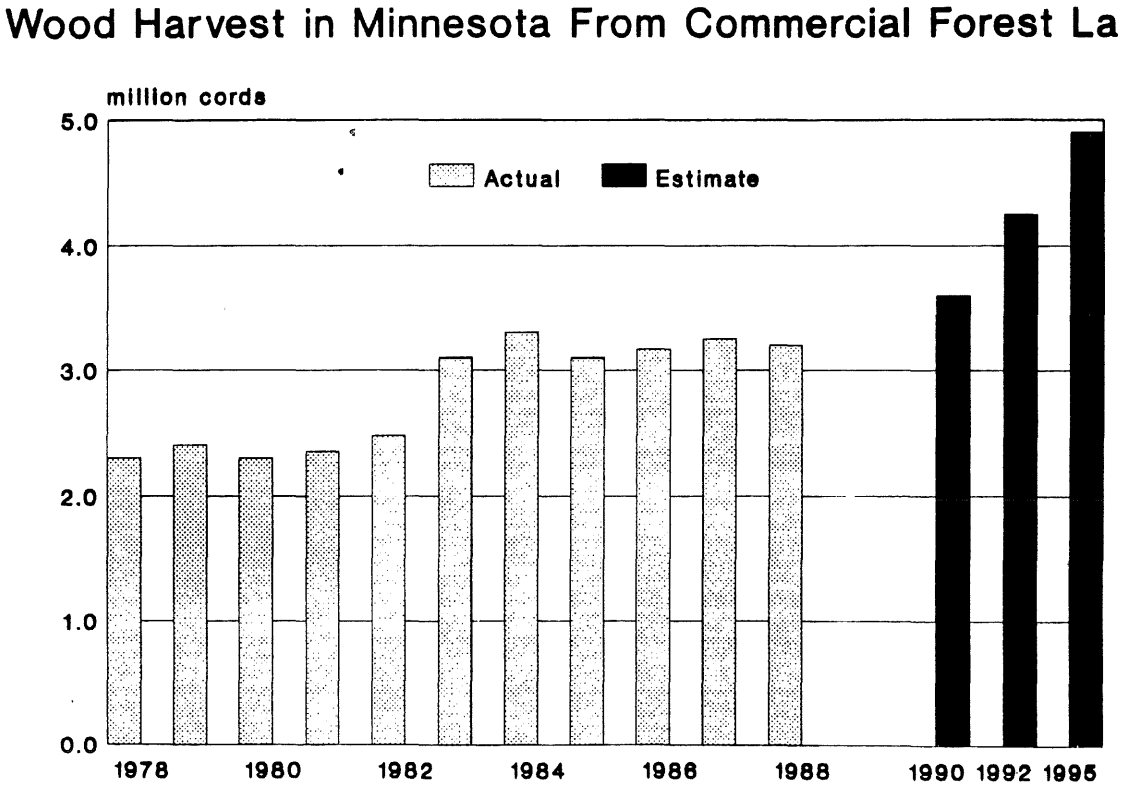



FIGURE 4 - Wood Harvest in Minnesota from Commercial Forest Land

Note: Total wood consumption exceeds actual harvest volume for several reasons, including utilization of forest and processing residues.

Harvest Residue: Harvest residue is the biomass left on a site after the harvest of live trees for industrial wood products. As the harvest of industrial wood increases, the volume of harvest residue will increase.

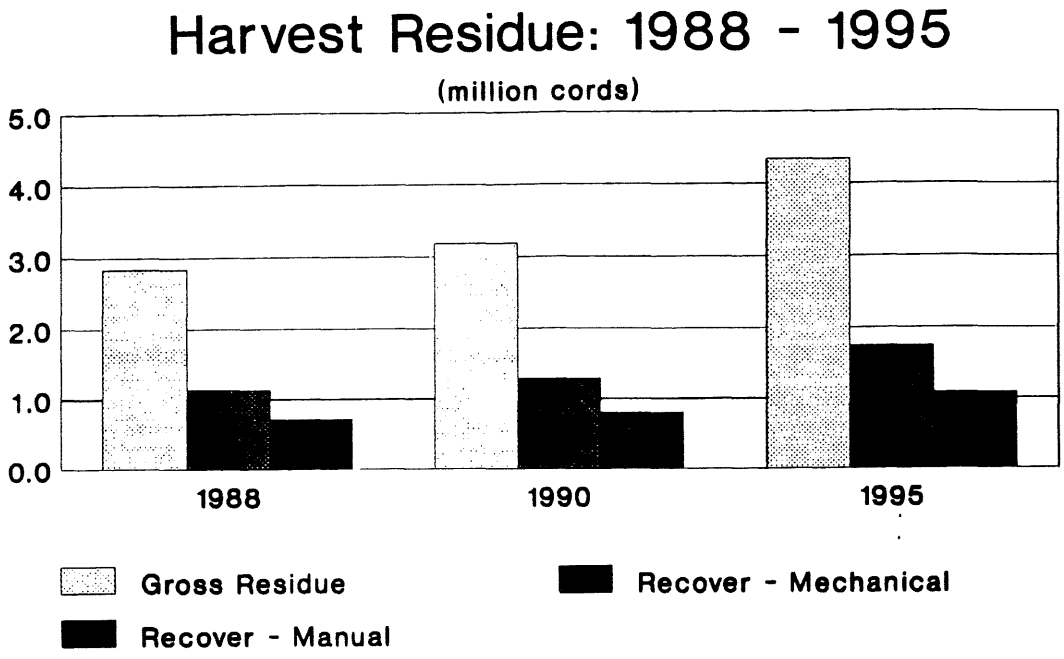



FIGURE 5 - Harvest Residue 1988-1995

* Gross residue based on growing stock (harvest volume) and residue ratios as shown in Figure 3.

Surplus Species: For many years, timber harvest has been well below the level desirable to maintain the current forest-type composition in Minnesota. This will remain true for the near future, despite the tremendous increases in harvest that have occurred in the last ten years and the additional increases anticipated through 1995.

Two species--paper birch and Balm-of-Gilead--represent the majority of the surplus wood available. Current and projected demand for these species, compared to their recommended harvest levels, are:

| | Recommended Harvest | 1988 Harvest | 1995 Harvest |
|---|---|---|---|
| Paper Birch | 500,000 cords | 138,000 cords | 303,000 cords |
| Balm-of-Gilead | 260,000 cords | 49,000 cords | 121,000 cords |

TABLE 3

Approximately 45 percent of the paper birch and Balm-of-Gilead volume occurs in the aspen, balsam fir, and pine types, where significant harvest does occur. If recovery of the paper birch and Balm-of-Gilead surpluses are confined to the harvest occurring in these three types and 90 percent of the current and anticipated harvest of these two species will occur in these same locations, the following biomass volumes could be recovered for energy or other uses:

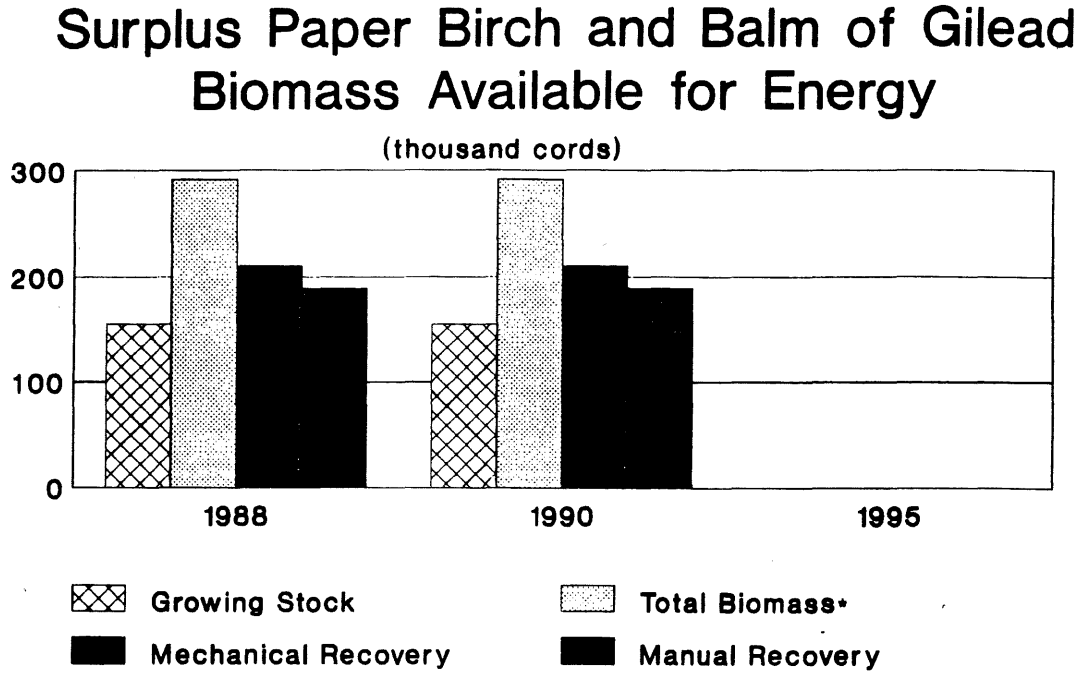



FIGURE 6 - Surplus Paper Birch and Balm-of-Gilead Biomass Available for Energy

* Total Biomass based on the ratio of growing stock to residue shown in Figure 3.

Mortality: Approximately 1 percent of the growing stock volume on commercial forest land dies each year.* It is assumed these dead trees are suitable for energy use for about three years. Due to their scattered distribution, they can only be economically recovered during a commercial harvest operation.

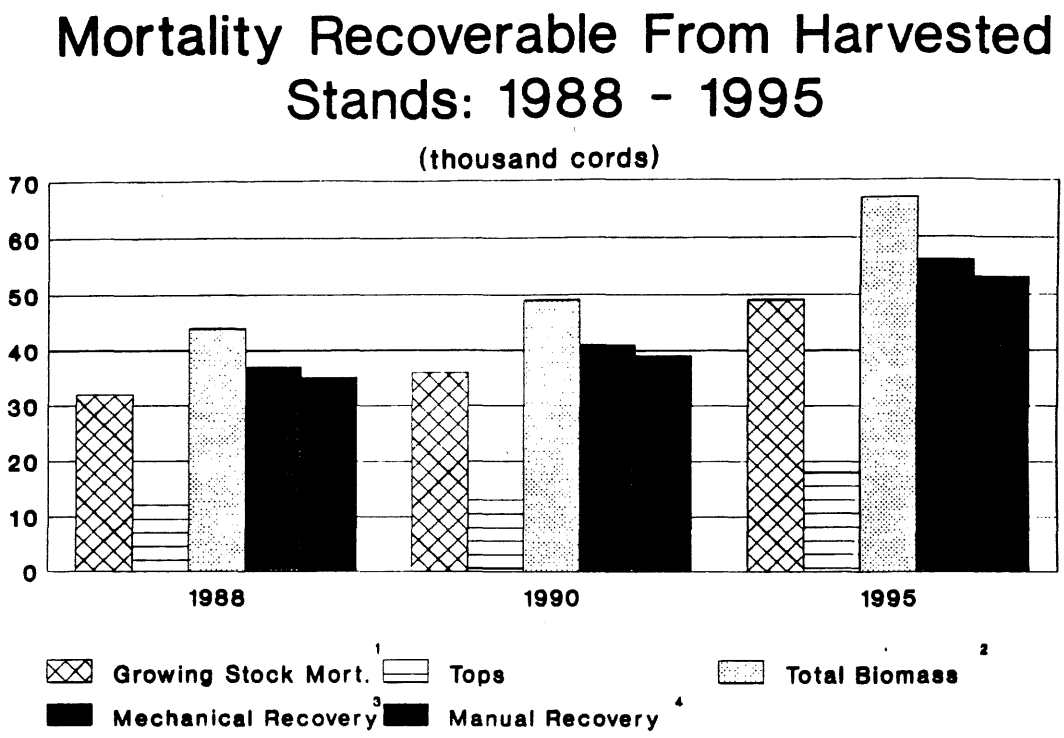



FIGURE 7

1 Growing Stock Volume = 3 percent of current year's harvest
2 Total Biomass = 73 percent growing stock mortality + 27 percent tops
3 Mechanical Recovery = 100 percent growing stock mortality + 40 percent top volume
4 Manual Recovery = 100 percent growing stock mortality + 25 percent top volume

* Minnesota's Forest Statistics, 1987: An Inventory Update, page 24, Table 9

Low Productivity Stands: Low productivity stands are hardwood types growing on poor sites, many of which are better suited to other tree species. These stands generally cannot be economically managed for industrial wood products due to slow growth and poor quality. These stands occupy 536,900 acres in Minnesota:

**Low Productivity Hardwood Stands***

| | |
|---|---|
| Aspen/Balm-of-Gilead | 112,200 acres |
| Birch | 50,000 acres |
| Lowland Hardwoods | 139,500 acres |
| Northern Hardwoods | 63,400 acres |
| Oak | 171,800 acres |
| Total | 536,900 acres |

TABLE 4 - *Stands with site index of 40 or less.

Much of this acreage is inaccessible or environmentally important in its current condition. It would be desirable, though, to establish more productive forest cover on a significant portion of these acres. Utilizing this low-quality biomass for energy, or some other product, would help reduce the cost of these reforestation efforts.

If it is assumed that it is desirable to reforest 50 percent of this acreage over the next 20 years, the total biomass available annually would be 162,000 cord equivalents.

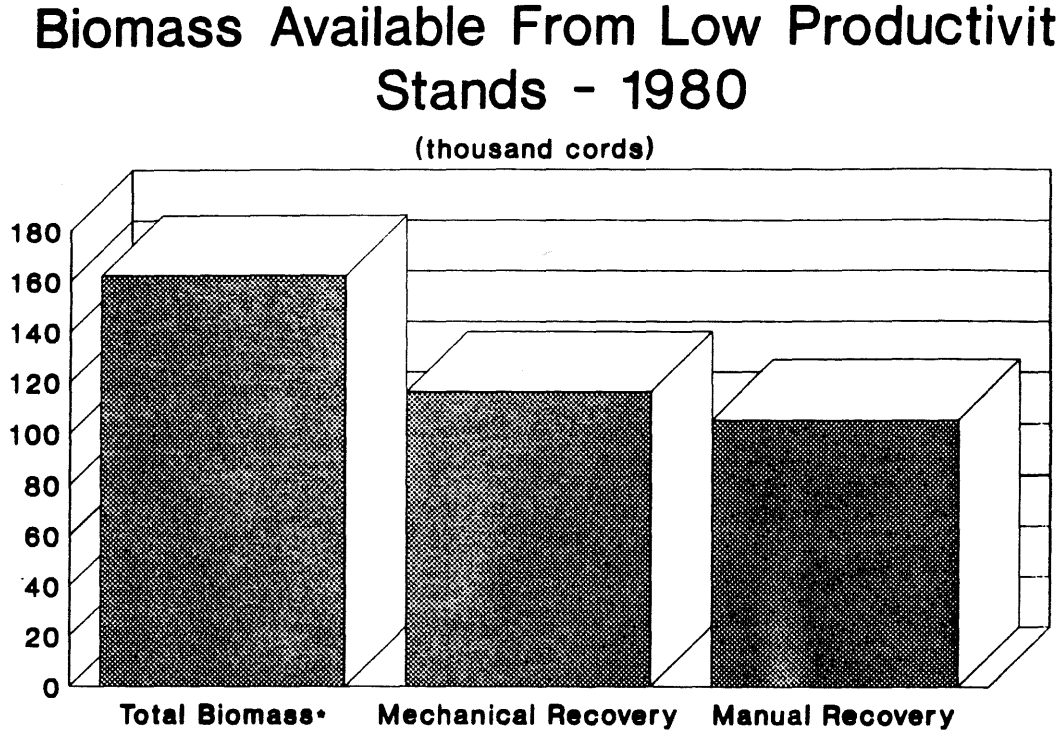



FIGURE 8 - Biomass Available From Low Productivity Stands

* From Minnesota Wood Residue Studies, 1980, Appendix A, Table 22 and the biomass composition ratios shown in Figure 3.

## BIOMASS FROM UNPRODUCTIVE FOREST LANDS

Unproductive forest lands will not produce wood usable for industrial products due to adverse site conditions, regardless of which tree species might be selected to grow there. These sites are fragile and very slow to recuperate from disturbance. Very careful study should be conducted before these sites are exploited to produce biomass for energy. Few, if any of these stands can be economically harvested for energy at the present time.

Should these lands be found suitable for producing energy biomass, the annual growth could be harvested on a sustained-yield basis.

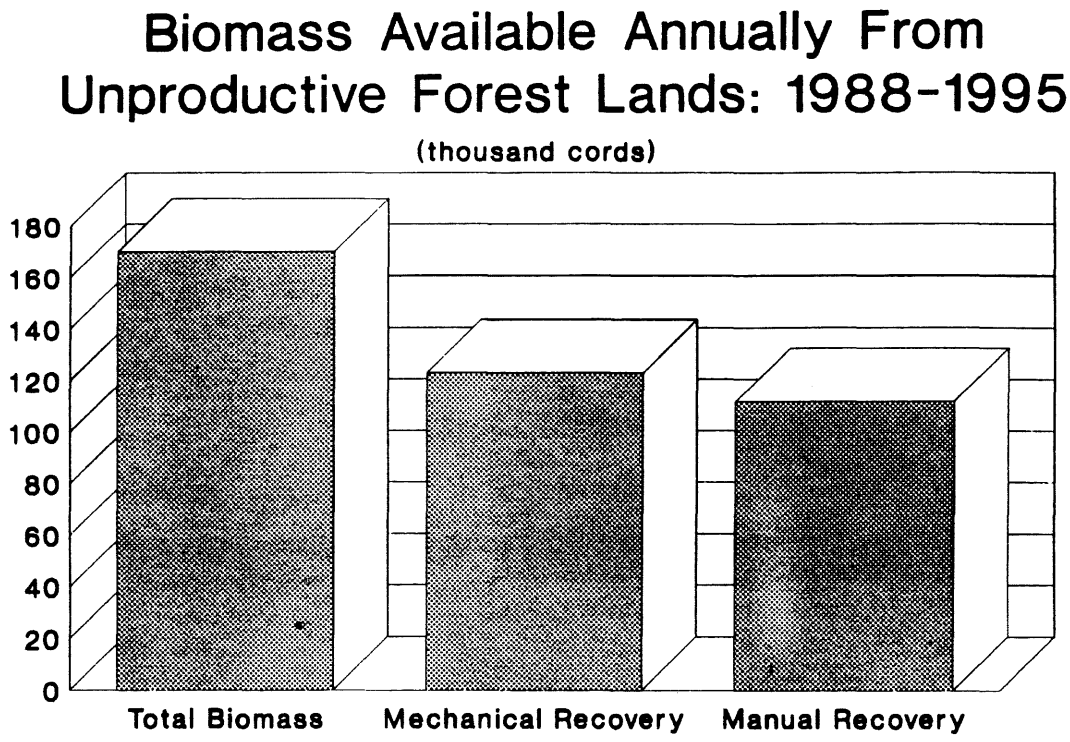



FIGURE 9 - Biomass From Unproductive Land

## BIOMASS AVAILABLE FROM NONFOREST LAND WITH TREES

There are approximately 610,000 acres of nonforest land with trees in Minnesota. Some clearing for agriculture, roads, residential, and industrial development does occur on these lands. Some harvest for firewood and industrial use also occurs. No precise estimate is currently available on the level of this activity, but biomass suitable for energy is available. If it is assumed that volume equal to the annual growth on these lands is removed each year, a total biomass of 115,000 cord equivalents is available.

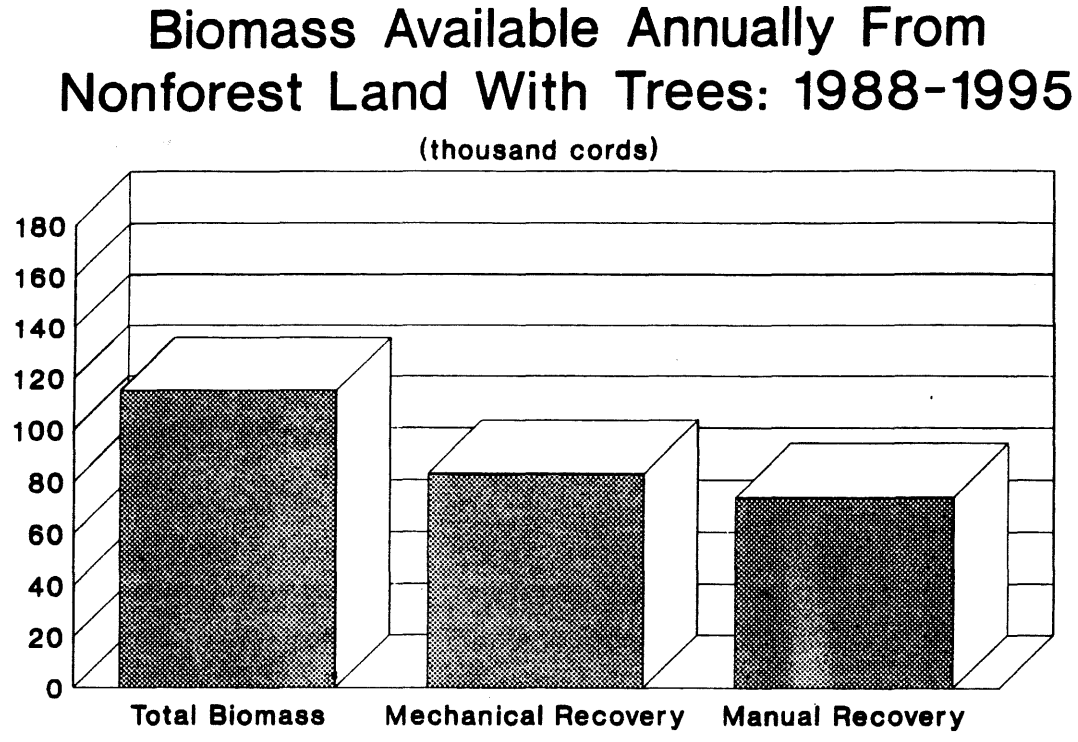



FIGURE 10 - Biomass From NonForest Land With Trees

## TOTAL BIOMASS RECOVERABLE FOR ENERGY

Should large-scale recovery of biomass from forest lands for energy become a reality, the most economic technology to accomplish this would be mechanical, whole-tree logging and chipping. Based on mechanical recovery, the volume of biomass available for energy in 1988 was 1,773,000 cord equivalents. Projections for 1990 and 1995, based on current industry expansion and modernization plans, indicate increases of 9 percent and 25 percent, respectively, over 1988.

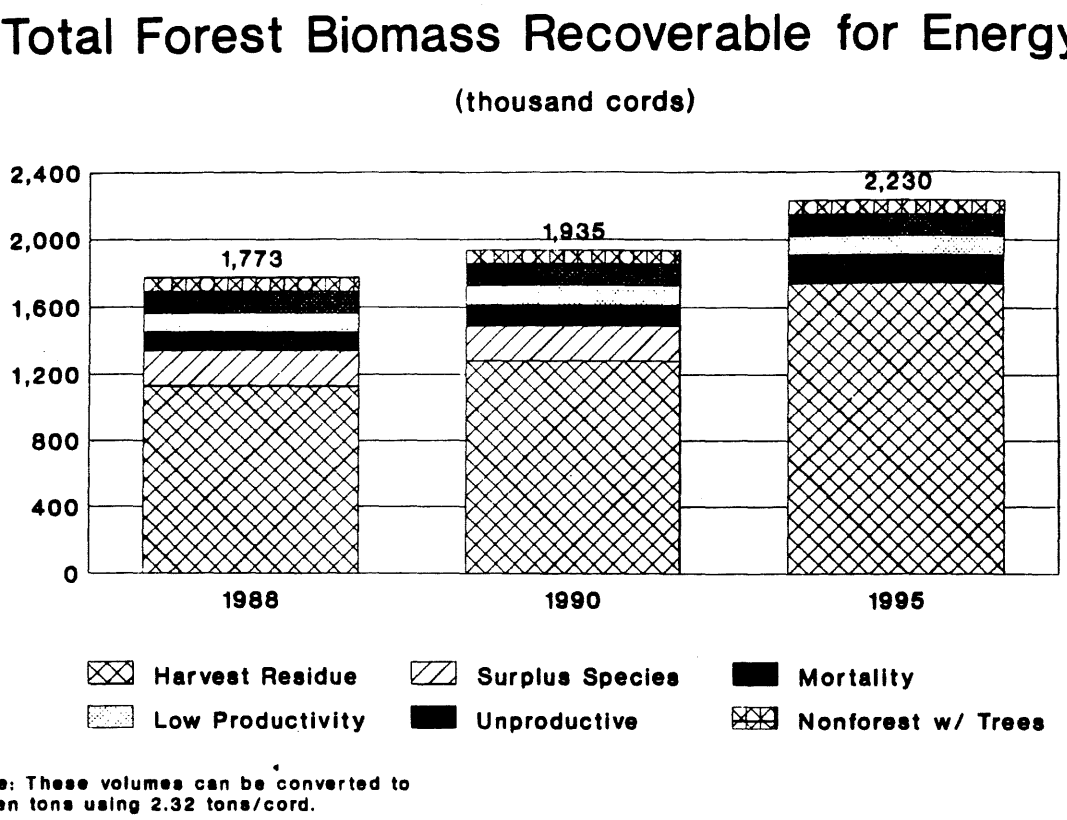



FIGURE 11 - Total Biomass Recoverable for Energy (Cord's Equivalents)

Note: These volumes can be converted to green tons using 2.32 tons/cord.

# PRIMARY WOOD PROCESSORS' RESIDUE SURVEY


## ABSTRACT

A survey was conducted during the winter of 1989 to determine the location, volume and type of residue material available for fuel following wood processing. In 1988, more than 700 wood processors in the state processed 2.7 million cords of wood. They generated 1.5 million green tons, or 750,000 cord equivalents of residue. Only 13 percent, or 100,000 cord equivalents, of residue generated was unused and available for energy. Two-thirds of the residues generated are currently used for fuel or wood fiber products.


| | Total Available Using Mechanical Harvest | Volume Used | Net Available For Energy |
|---|---|---|---|
| **Primary Processor Residues** | **1,512,000 tons** | **1,309,000 tons** | **203,000 tons** |
| Bark | 753,000 tons | 718,000 tons | 35,000 tons |
| Course | 520,000 tons | 435,000 tons | 85,000 tons |
| Fines | 239,000 tons | 156,000 tons | 83,000 tons |

TABLE 5

# PRIMARY WOOD PROCESSORS' RESIDUE SURVEY

## INTRODUCTION

Primary wood processors are those industries that use roundwood or chips from roundwood. They manufacture products such as lumber, posts and poles, chips, paper, waferboard, and oriented strand board (OSB). The wood residues generated by these industries can be grouped into three categories. They are: 1) bark; 2) coarse residues, such as slabs, edgings, and veneer cores; and 3) fine residues, such as sawdust and shavings. The wood used by these industries is from recently harvested, live trees, so residue volumes are in green tons.

## STUDY OBJECTIVES

This study had three objectives:

1. Identify and contact all primary wood product manufacturers in the state;

2. Determine the volumes and types of residues generated; and

3. Determine the current uses and/or methods of disposal of residues.

All residue volume calculations are based on 1988 production figures.

## STUDY METHODS

Data collection for the 1988 primary processor survey began in March 1989 and took five months to complete. The survey was conducted in three parts. The first was a one-page survey mailed to mills processing less than 100,000 board feet or two hundred cords of wood in 1988. In the second part, personal interviews were conducted by DNR Forest Products Utilization Specialists at each mill processing 100,000 or more board feet annually, excluding the pulp and paper, waferboard and OSB mills. (See Appendix F for copies of the survey forms used.) Part three of the survey was conducted by the U.S. Forest Service. They collected data from the 15 pulp, paper, and waferboard/OSB manufacturers in the state.

The survey identified 771 active primary wood processors (Table 1). These mills represent about 90 percent of the primary processors in Minnesota. Approximately 95 percent of the wood residue generated in Minnesota in 1988 is accounted for by these active mills. Data collected includes the type of mill, processing equipment, annual production, species utilized, location of harvest, and disposition of residues.

## ACTIVE WOOD PROCESSORS
## 1988

| Processor Type | Number | Cords Consumed |
|---|---|---|
| Sawmills | 719 | 592,500 |
| Veneer Mills | 4 | 22,000 |
| Post & Pole Operations | 9 | 16,500 |
| Shaving/Specialty Mills | 14 | 26,000 |
| Whole-Tree Chippers | 10 | 10,000 |
| Pulp & Fiberboard Mfg. | 15 | 1,977,000 |
| Total | 771 | 2,644,000 |

TABLE 6

Volumes of bark, coarse, and fine residues were determined by applying appropriate conversion factors to each processor's 1988 production figures.

* Bark residues were reported only if the bark was removed from the roundwood by a debarking process.

* Coarse residues include slabs, edgings, and chips, and contain bark unless it was removed by a debarker.

* Fine residues include sawdust, sander dust, and shavings. Conversion factors are in Appendix H.

Several categories of **residue uses** were identified:

1. Industrial fuel that is used either at the site where generated or at another processing site.

2. Domestic fuel that is sold or given away for residential heating use.

3. Processed fuel that includes charcoal, briquettes, and pellets.

4. Manufactured fiber products that include pulp, hardboard, oriented strand board, and roofing felt.

5. Other uses that include bedding, mulch, landscape chips, and specialty items, and

6. Unused residues that might end up in landfills, be burned as waste, or stockpiled at the mill site.

## SUMMARY OF FINDINGS

### VOLUME OF ROUNDWOOD PROCESSED

Two basic types of primary wood processors operate in Minnesota. The first type includes stationary and portable sawmills, post and pole operations, shavings and specialty mills. In 1988, 667,000 cords of wood were processed by these mill types. The second type, pulp and paper, OSB/waferboard and hardboard industries, reported processing 1,977,000 cords (Figure 12).

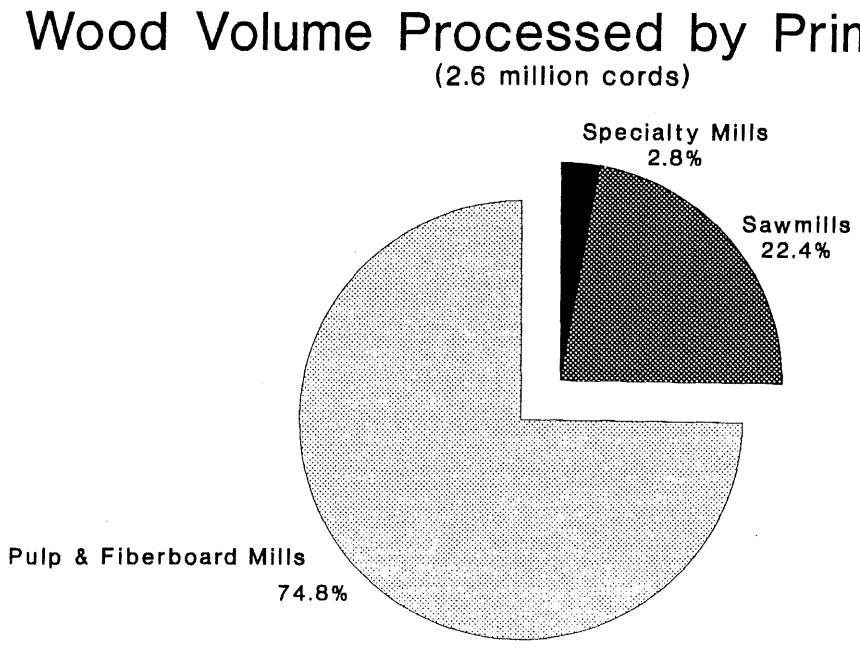


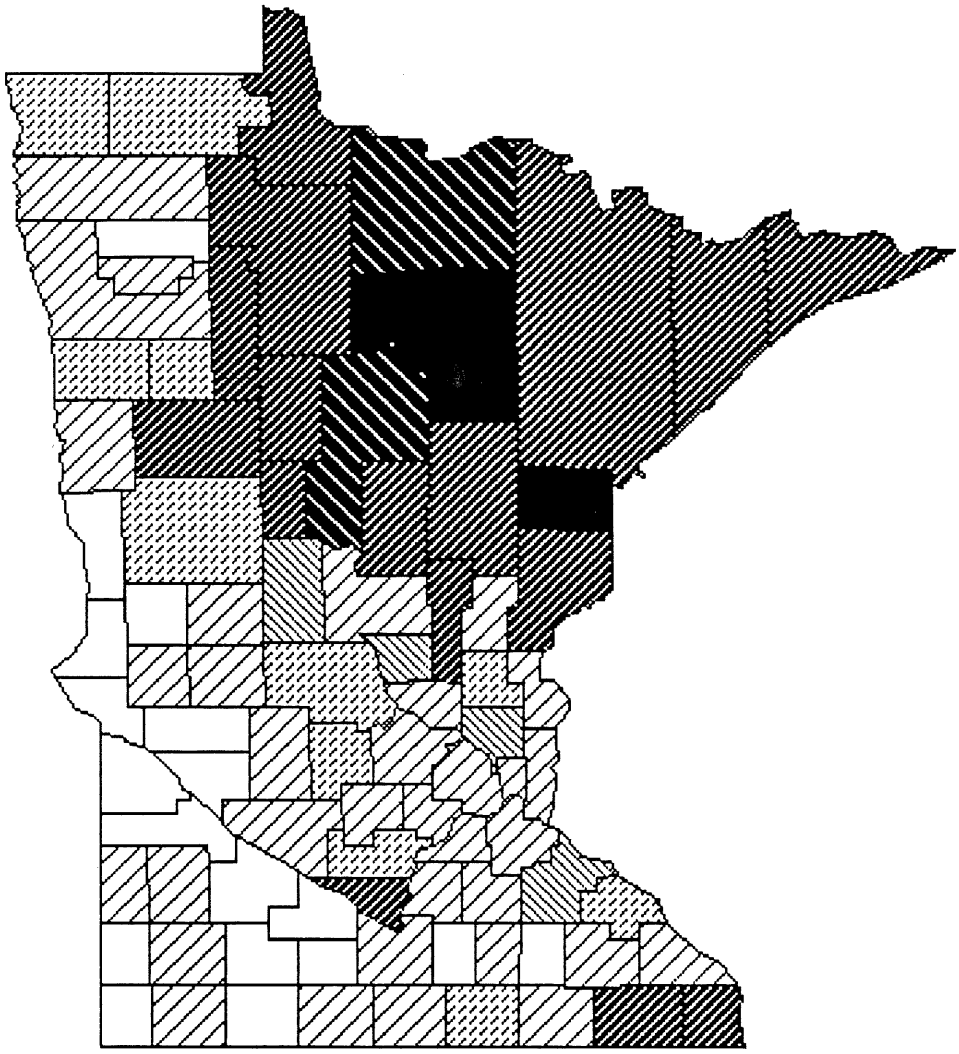

FIGURE 12

### VOLUME OF RESIDUES GENERATED

The 1988 residue survey shows 1.5 million green tons of residue generated by 771 wood processing facilities in the state. Maps 1 and 2 show the amount of residue generated in each county and the amount of unused residue by county. Three-fourths of the residue generated was in the northern third of the state where 61 percent of processors and most of the state's timber resources are located.

# RESIDUE VOLUME DISTRIBUTION BY COUNTY

## (BASED ON MN 1988 SURVEY)



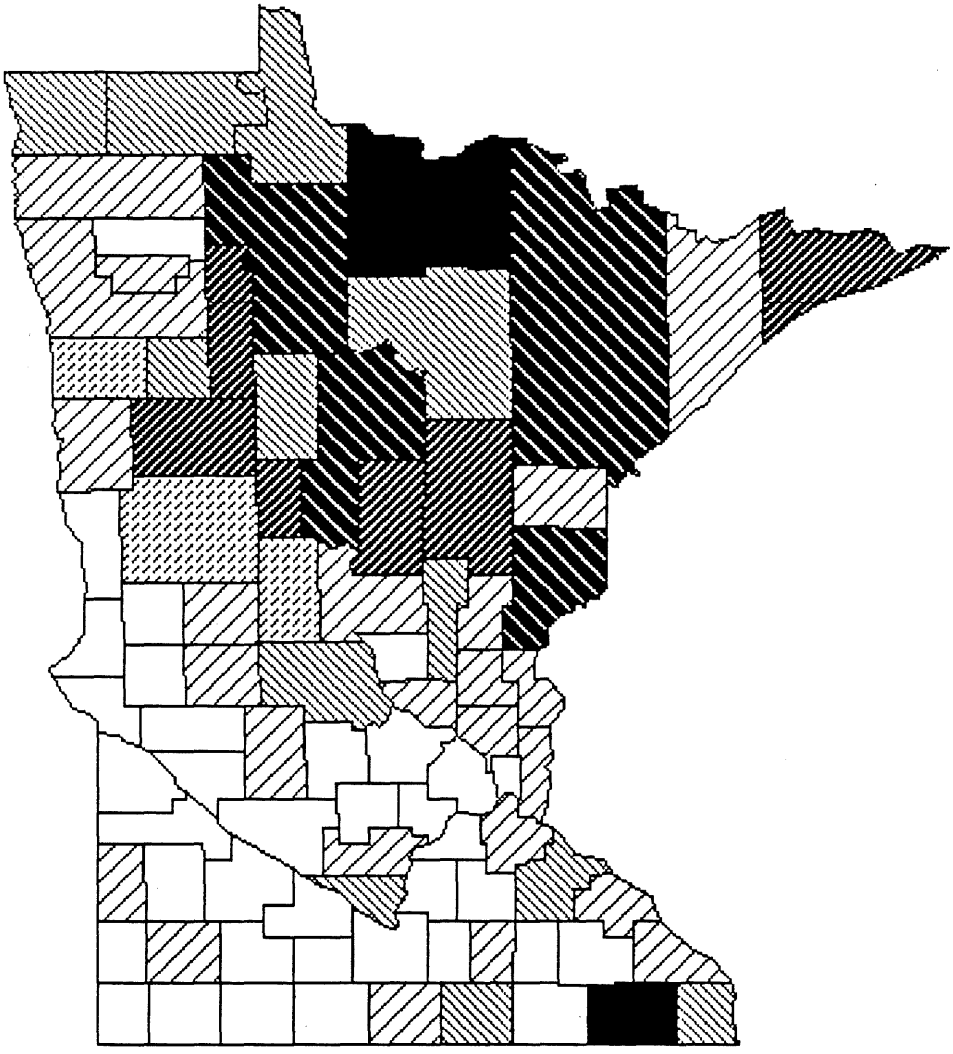
IN GREEN TONS:

- up to 1,000
- 1,000 to 5,000
- 5,000 to 10,000
- 10,000 to 50,000
- 50,000 to 100,000
- 100,000 or more

MAP 1

# SURPLUS RESIDUE VOLUME BY COUNTY

## (BASED ON MN 1988 SURVEY)



IN GREEN TONS:

- 1 to 500
- 500 to 1,000
- 1,000 to 5,000
- 5,000 to 10,000
- 10,000 to 20,000
- 20,000 to 30,000

MAP 2

Bark residue accounts for one-half of all residues generated, but only 17 percent of the unused residues. In contrast, coarse residues only account for 35 percent of total residues generated, but make up 42 percent of the unused residues. Fine residues make up only 15 percent of total residues generated, but 41 percent of the unused residues (Figures 13 and 14).

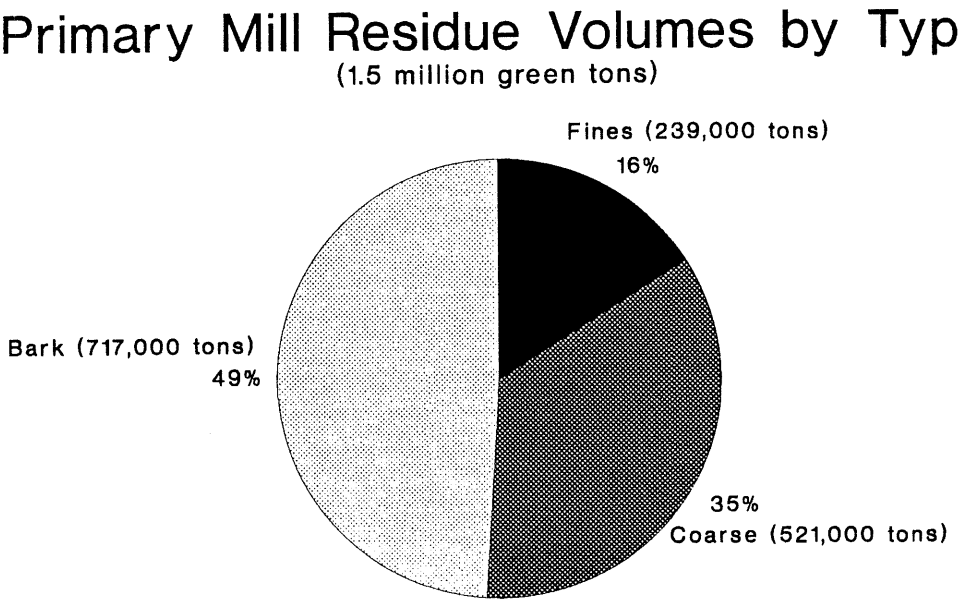



FIGURE 13

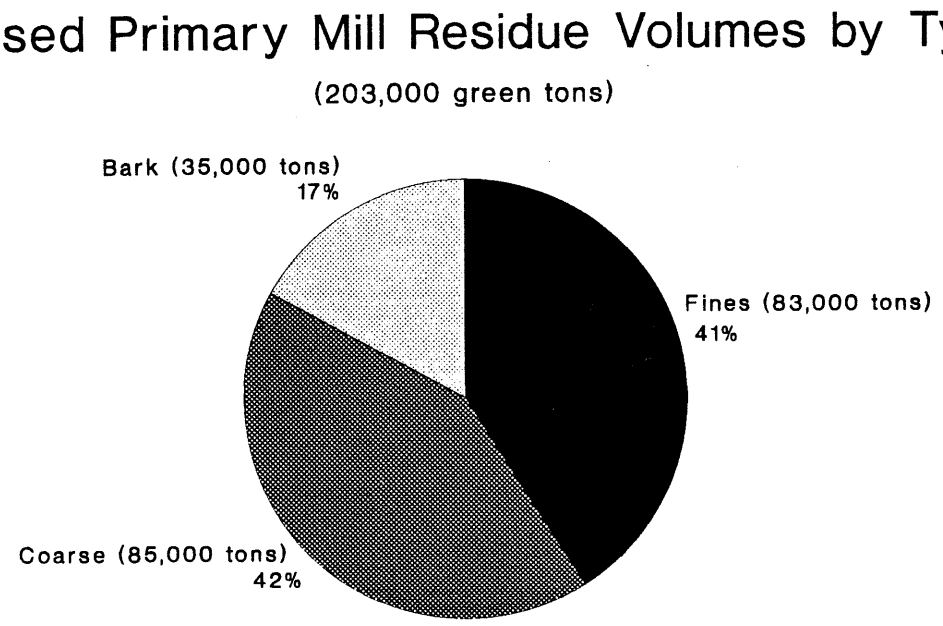



FIGURE 14

## USE OF RESIDUES

Statewide, only 13 percent, or 203,000 green tons, of the residues generated by primary processors, go unused. The largest use of residues is for industrial fuel. Residues from Minnesota's 15 pulp and fiberboard industries accounted for 40 percent of the total residue generated. All these residues are used for fuel or fuel products at the processing sites (Figure 15).

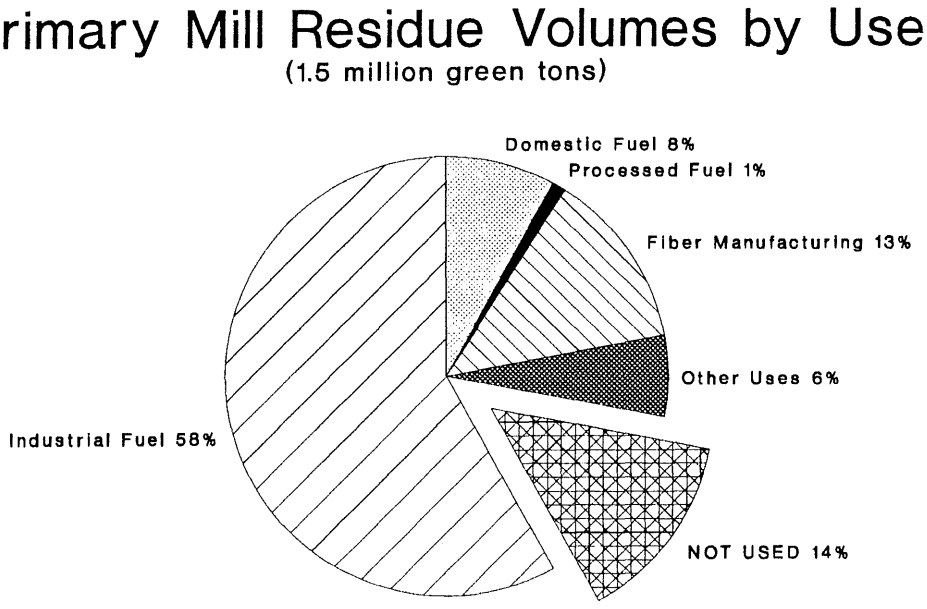



FIGURE 15

## BARK RESIDUES

Bark accounts for 753,000 green tons, or 50 percent, of the total primary processor residues. Eighty-seven percent of all bark residues were used for industrial fuel. Only 35,000 tons of the bark residues were not used.

The pulp, waferboard, and OSB industries use debarked chips in manufacturing and generated 80 percent of the total bark residues.

Approximately 35,000 tons of bark are consumed in the manufacture of fiberboard and roofing felt (Figure 16). These products are made from whole-tree chips that include the bark. Bark is not added from other sources.

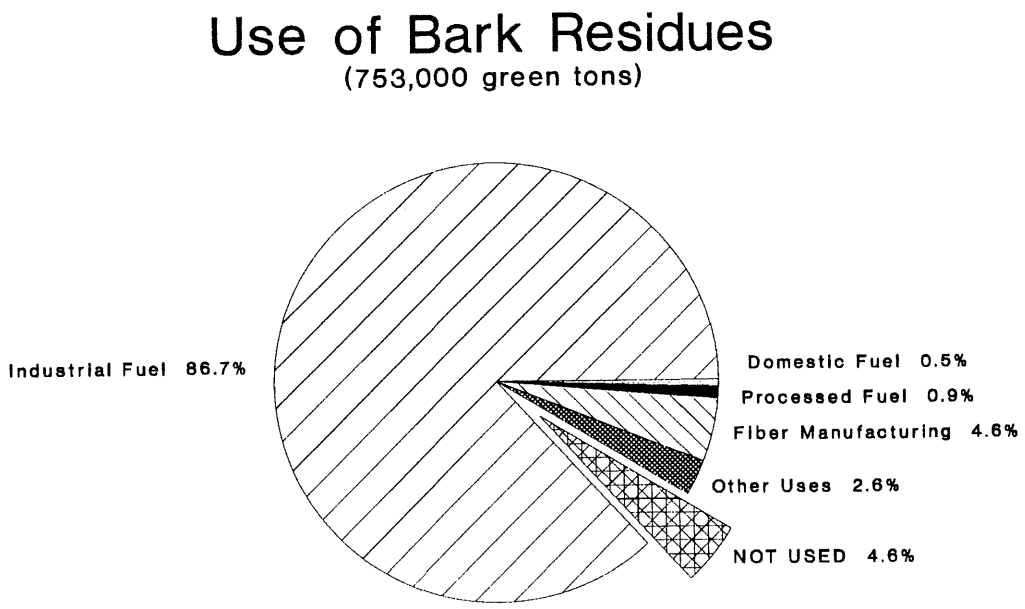



FIGURE 16

## COARSE RESIDUES

A total of 521 greens tons of coarse residue materials were generated by the sawmill, veneer and chipping industries. Sawmills sold 36 percent of the coarse residues (chips from debarked slabs) to the pulp and fiberboard industries for manufacturing fiber products. Forty-two percent were used for fuel or fuel products. Only 16 percent, or 85,000 tons, of the course residues were not used (Figure 17).

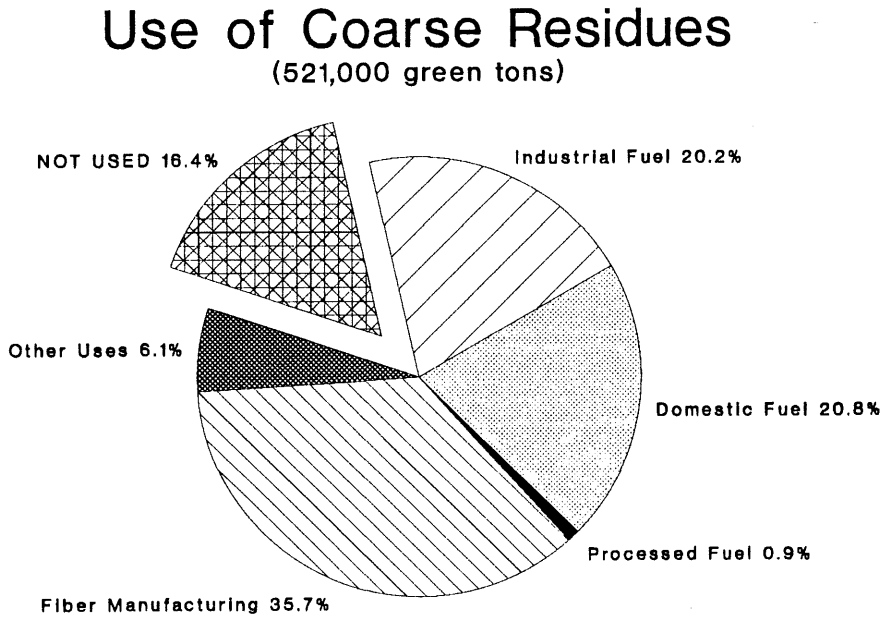



FIGURE 17

## FINE RESIDUES

There were 239,000 green tons of fine residues generated by wood processing industries. Thirty-five percent, or 83,000 tons, were unused (Figure 18). The largest volume, 102,000 tons, of fine residues were used at the processing site or sold to other processors for industrial fuel. Eighteen percent was used for products such as animal bedding and mulch.

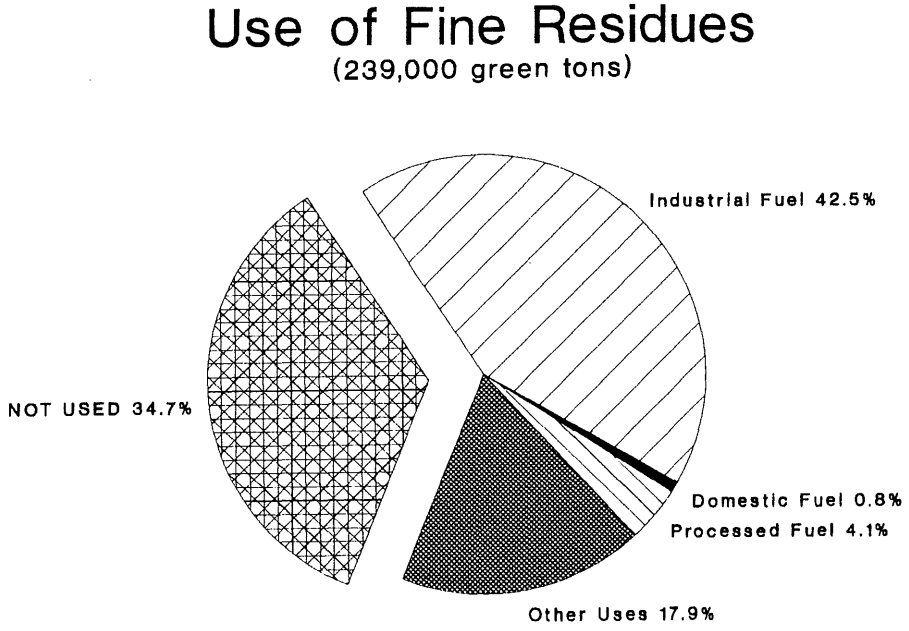



FIGURE 18

## TRENDS IN PRIMARY MILL PRODUCTION AND RESIDUES

In 1979, 1.9 million cords of wood were processed by the wood products industries. In 1988, wood consumption increased to 2.6 million cords. By 1995, consumption is expected to increase to 4.3 million cords.

The number of pulp and fiberboard processors increased from 8 to 15 between 1979 and 1988. The volume of wood consumed by the pulp and fiberboard industry increased from 1.3 million cords in 1979 to 2.02 million cords in 1988. By 1995, an estimated 3.5 million cords will be processed by pulp-using industries in Minnesota.

Wood processed by sawmills and related wood industries increased 27 percent from 520,000 cords in 1979 to 665,000 cords in 1988. Demand is expected to rise to 605,000 cords by 1995.

Over the past decade, the volume of unused residues has declined, especially in northern Minnesota. In 1979, 270,000 cord equivalents of residues were not used. In 1988, only 203,000 tons, the equivalent of 100,000 cords, of residues were unused. Many wood products industries in northern Minnesota buy residues for energy consumption. Expansion of the pulpwood-using industries in this part of the state has and will contribute to the increased volume of residue used.

A decade ago, two-thirds of the residue generated by the pulp and fiberboard industry was used for industrial fuel. Only 13 percent of residues generated by these industries was unused. In 1988, none of the residues generated by the pulp and fiberboard industries, except pulp sludges, were unused. Ninety-three percent was burned for fuel and the remaining 7 percent was recovered for use in their production.

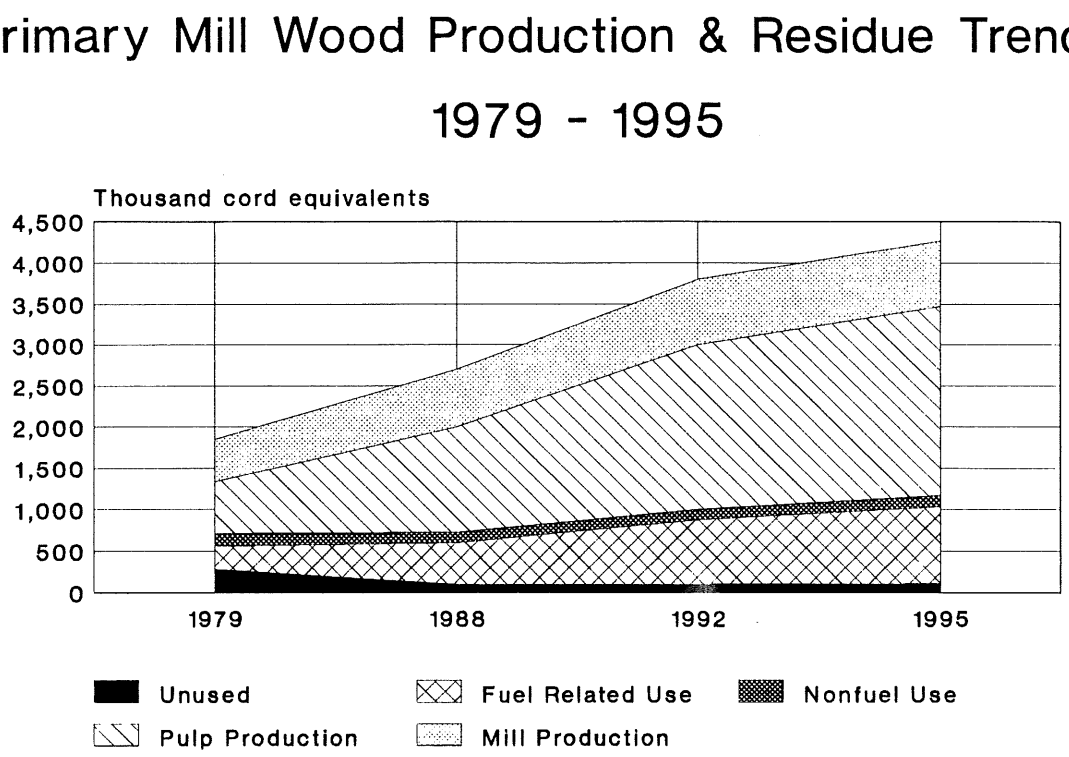



FIGURE 19

In 1979, 37 percent of all residue generated was consumed for fuel. Twenty-two percent was consumed by the wood products industry. Residential users consumed the remaining 15 percent. In 1988, use of residues for fuel and manufacturing increased. Consumption of residues for residential home heating declined.

One form of residue not identified in our current or past surveys is pulp and paper sludge. This sludge is largely wood fiber that is lost in the paper-making process. Much of it is flushed into sewage disposal systems, burned or disposed of in some other manner. Most is deposited in landfills. The Minnesota Waste Management Board estimates that 211,000 tons of pulp and paper sludge were dumped in Minnesota landfills in 1986.

# URBAN WOOD WASTE ANALYSIS


## ABSTRACT

Significant waste is generated from sources other than the primary wood industries. The majority of these wood wastes originate in urban areas. The Twin Cities generate a little more than half of the state's urban wood waste. Wood waste composition is about the same for the outstate and the Twin Cities areas.

This report discusses residential/commercial/industrial wood wastes, tree removals, and railroad tie wastes. Approximately 529,800 tons of residential/commercial/industrial wood waste are generated annually. Approximately 75,000 tons of this are currently recovered for energy.

Tree waste volume can fluctuate wildly from year to year. It is influenced by insect or disease outbreaks, changing levels of construction activity, and the occurrence of damaging storms. In 1988, nearly 125,000 green tons of tree waste were generated. Approximately 85,000 tons was unused. The rest went for boiler fuel, firewood or mulch.

Railroad ties account for 40,000 tons of waste wood annually. A significant portion is burned as industrial fuel.

Minnesota's urban wood waste is expected to grow at about 0.3 percent per year between now and the year 2000.

Yard and paper waste total 1.8 million tons a year in Minnesota. Yard waste and waste paper are closely related to wood wastes. Theyare handled at many of the same locations and be utilized for energy in much the same way.


| | Total Available Using Mechanical Harvest | Volume Used | Net Available For Energy |
|---|---|---|---|
| **Urban Waste Wood** | **694,000 tons** | **140,000 tons** | **554,000 tons** |
| Demolition Debris | 342,000 tons | 0 tons | 342,000 tons |
| Pallets | 74,000 tons | 0 tons | 74,000 tons |
| Secondary Manufacturing | 113,000 tons | 75,000 tons | 38,000 tons |
| Tree Waste | 125,000 tons | 40,000 tons | 85,000 tons |
| Railroad Ties | 40,000 tons | 25,000 tons | 15,000 tons |

TABLE 7

## URBAN WOOD WASTE ANALYSIS

### INTRODUCTION

Significant volumes of waste wood are generated from several sources unrelated to the primary wood industries or forest and rural lands. The majority of these wood wastes originate in urban areas and create significant disposal problems. The increasing costs of disposal and rapidly dwindling available landfill space provide strong incentives to make these materials usable for other purposes. These wood wastes fall into three major categories:

1. Residential/commercial/industrial wood waste is wood and dimensional lumber from new construction, remodeling, or demolition. It also includes wood from furniture, tools, and other durable product manufacture.[1]

2. Urban and residential tree removals include trees and stumps removed from yards, construction sites, boulevards, and urban parks.

3. Railroad ties include old, used, and discarded ties from railroad beds.

Two additional categories of waste, closely related to wood, will also be briefly discussed:

1. Yard waste is naturally occurring vegetative and woody material from garden, park, and lawn maintenance.

2. Waste paper.

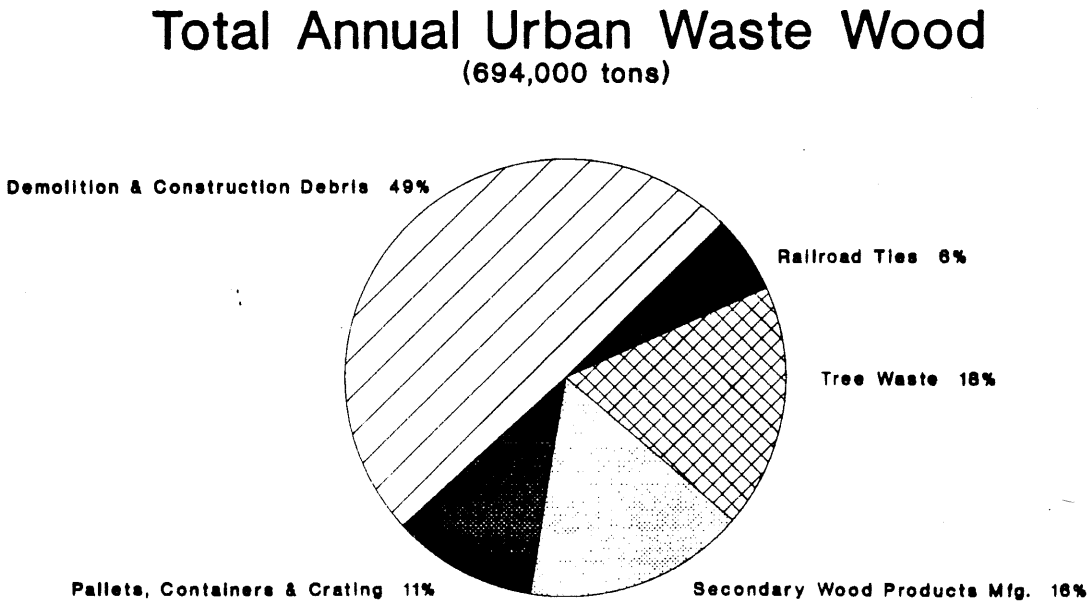



FIGURE 20

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[1]Cal Recovery Systems, Inc. 1988. "Waste Generation and Composition Study, Volume 2: Waste Composition." Metro Council, St. Paul, MN.

## Residential/Commercial/Industrial Wood Waste

A 1977 estimate by the U.S. Environmental Protection Agency (EPA) indicated that 13.7 million tons of waste timber products were included in the national municipal solid waste stream. This volume was broken down as follows:

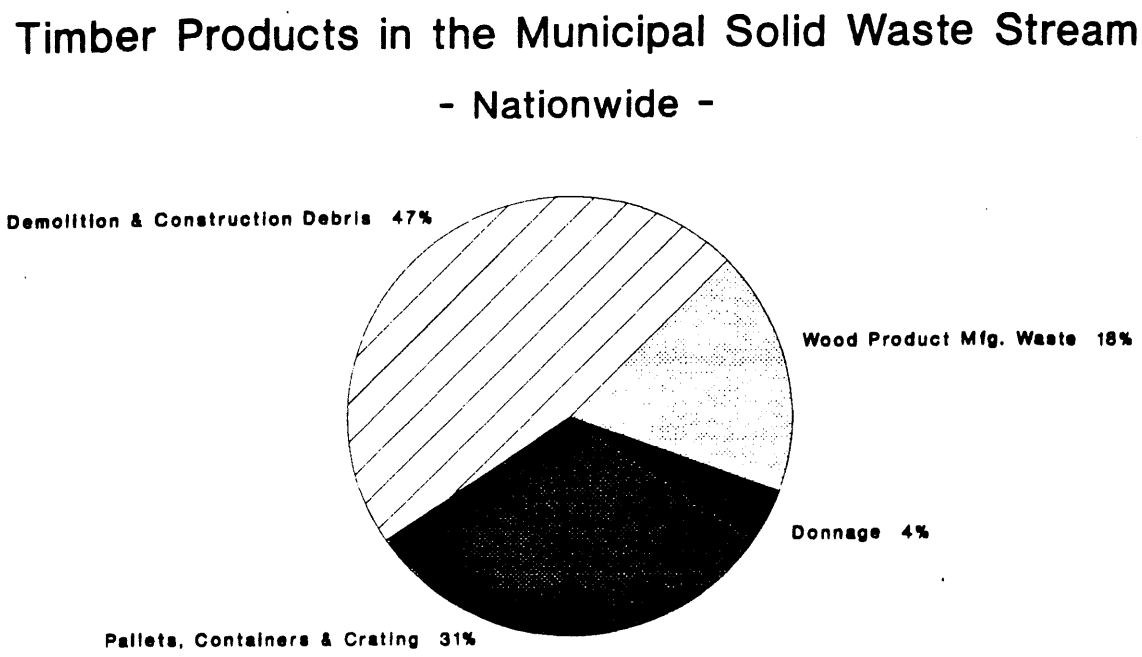


FIGURE 21

Another study prepared for the EPA estimated that demolition and construction debris alone totaled 21.9 million tons. Since the first estimate only included the volume delivered to sanitary landfills and associated waste-processing facilities, it appears that 15.5 million tons, or 71 percent, of the demolition and construction debris was disposed of somewhere else. This would most commonly be at separate demolition and construction debris landfills. This information will be used to evaluate estimates of Minnesota's solid waste.

A 1988 report, prepared by the Minnesota Pollution Control Agency, estimates Minnesota's annual municipal solid waste volume to be 3.4 million tons: 1.5 million for outstate and 1.9 million for the Minneapolis/St. Paul metropolitan area. Approximately 6.2 percent, or 210,000 tons, of this volume is wood waste.

Wood waste is defined in this report as:

> "Wood and dimensional lumber from new construction, remodeling, or demolition. Also includes wood from furniture, tools, and other durable products."

This is very similar to the breakdown of waste timber products referred earlier for the EPA's national solid waste analysis. If we use the same proportions the EPA developed, Minnesota's wood waste can be categorized as follows:

| | Percent | Outstate Minnesota | Twin City Metro Area | Total |
|---|---|---|---|---|
| Demolition & Construction Debris | 47 | 43,700 tons | 55,400 tons | 99,100 tons |
| Pallets & Containers | 35 | 32,500 tons | 41,200 tons | 74,700 tons |
| Wood Products Mfg. Waste | 18 | 16,800 tons | 21,200 tons | 38,000 tons |
| Total | 100 | 93,000 tons | 117,800 tons | 210,800 tons |

TABLE 8

The 99,100 tons of demolition wood shown here is only that volume going to sanitary landfills. If 71 percent of the demolition wood is going somewhere other than sanitary landfills, as was the case in the 1977 EPA report, then the total demolition wood volume could be as high as 342,000 tons.

The 38,000 tons of waste from wood products manufacturers represent unused residues from secondary wood processing companies. This compares to approximately 32,000 tons of unused residues, out of a total 95,000 tons of residue generated, according to the 1980 residue report. If the same ratio holds, 113,000 tons of residue were generated by secondary wood processors in 1988.

Secondary wood processing companies are those that further manufacture the products produced by primary processors. They produce products such as furniture and cabinets, windows, envelopes, flooring, pallets, etc.

## Residential/Commercial/Industrial Wood Waste in Minnesota

(thousand tons)

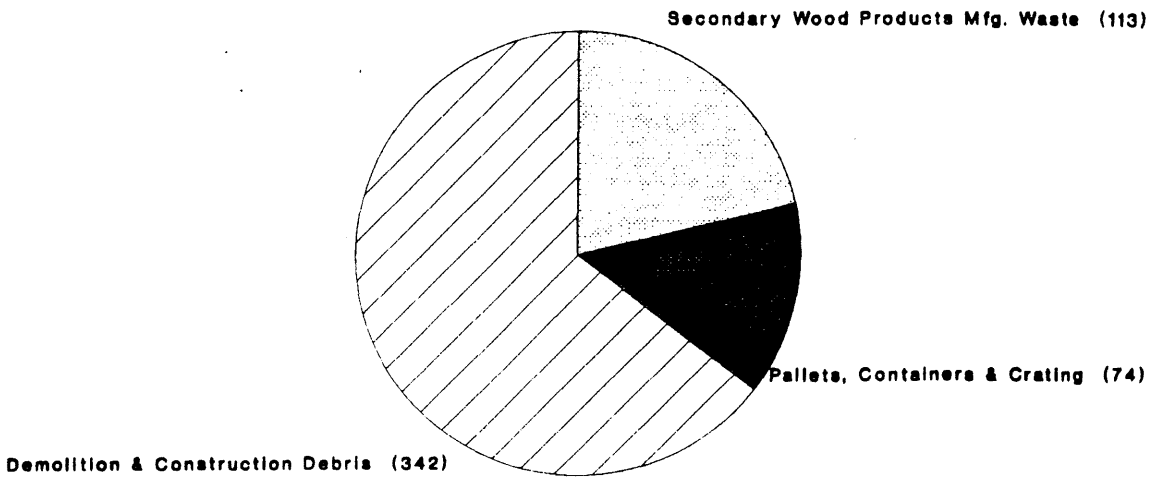


FIGURE 22

### Urban and Residential Tree Removals

Tree waste volume can fluctuate wildly from year to year. Insect or disease outbreaks, changing levels of construction activity, and the occurrence of damaging storms influence tree waste volume.

Tree limbs and trunks can be cut up or chipped for firewood, boiler fuel, landscaping chips, and sawlogs. Much of this material is used for these purposes. However, a 1989 Minnesota Department of Agriculture study estimates that 84,960 tons still go to landfills or are burned (see Figure 20). An informal survey of cities and tree services indicates the total volume generated in 1988 may have been approximately 125,000 tons. The remaining 40,000 tons was used for boiler fuel, firewood or mulch.

### Railroad Ties

Railroad ties account for 2 percent of the urban waste wood (see Figure 20). They present a significant disposal problem because of the number of ties disposed of yearly and because of the toxic chemicals with which they are treated. An estimate from the Minnesota Department of Public Service indicates that 300,000 to 400,000 railroad ties are discarded annually in Minnesota. At 10 ties per ton, this represents about 40,000 tons per year.

## Yard Waste

Yard waste is defined as:

> "Naturally occurring vegetative and woody material from gardens, parks, and lawn maintenance. Includes lawn clippings and trimmings from trees, bushes, shrubs, and other plants. Includes tree branches up to a maximum of two inches in diameter."

Yard waste represents 401,000 tons of residues available for energy lawn maintenance.

Yard wastes are not all woody residues, but are required to be removed from the solid waste stream, beginning in 1991. Some are already being separated and are frequently handled at the same site tree wastes are processed.

## Paper Waste

Paper waste is the single largest segment of the municipal solid waste stream. While it is not solid wood, it is a wood fiber waste which has many of the same recycling potentials as solid wood. Based on waste composition prepared in 1988 for the Metropolitan Council, Minnesota's paper waste breaks down as follows:

| | Percent | Outstate Minnesota* | Twin City Metro Area | Total |
|---|---|---|---|---|
| High Grade Paper | 11.4 | 70,500 tons | 89,200 tons | 159,700 tons |
| Newspaper | 14.0 | 86,500 tons | 109,600 tons | 196,100 tons |
| Corrugated | 37.4 | 231,100 tons | 292,800 tons | 523,900 tons |
| Other Paper | 37.1 | 229,900 tons | 291,200 tons | 521,100 tons |
| Total | 100 | 618,000 tons | 782,800 tons | 1,400,800 tons |

TABLE 9

## URBAN WASTE UTILIZATION

In the Twin City metro area, much of the tree waste is chipped and used for fuel or landscaping. Some leaves and other yard wastes are being composted for soil conditioner. Plans are to recycle and use even more.

A Twin Cities company is currently plans to build a wood-shredding facility that will process over 100,000 tons annually of demolition wood and tree waste. Northern States Power tentatively plans to purchase 40,000 tons or more of this wood waste annually. Other facilities in Minnesota might be interested in burning for energy if dependable supplies can be found. For example numerous RDF and mass-burn operations are in or near starting operation. Others are likely to be proposed.

Blandin Paper Company in Grand Rapids, Minnesota, is currently permitted to burn 200 tons of shredded railroad ties per day. Braxton Industries, currently the only tie processor operating in Minnesota, is supplying Blandin with less than 100 tons per day.

Paper recycling to produce cardboard and other products is receiving increased emphasis. Yet there remains considerable opportunity to salvage wood and paper for energy and a variety of other uses. And, as technologies and demands change, the level and type use of these salvageable materials will change.

## FUTURE TRENDS FOR URBAN WOOD WASTE

Minnesota's urban wood waste is expected to grow at about 0.3 percent per year between now and the year 2000 (Flesland 1988). This growth will occur despite increasing efforts at recycling. This is because the state's population will continue to grow by 0.7 percent per year while per capita waste generation will likely increase by more than 10 percent by the year 2000.[1]

As policy changes and new technologies evolve, sanitary landfill composition will change. The combustible component, including urban wood wastes, in Twin Cities landfills is expected to increase from 88 percent in 1987 to 91 percent by the year 2000.[2] Paper and plastics will likely show the greatest increases.

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[1]Flesland, Jan. 1988. "State Solid Waste Policy Report. A Focus on Greater Minnesota. Background Paper V: Amount of Waste Generated." MPCA, St. Paul, MN.

[2]Cal Recovery Systems, Inc. 1988. "Waste Generation and Composition Study, Volume 2: Waste Composition." Metro Council, St. Paul, MN.

# RESIDENTIAL FUELWOOD SURVEY

**1988 - 1989**


ABSTRACT

During the 1988-89 heating season, about 1.039 million cords of fuelwood were burned by private households. This is a 26 percent decrease from the 1984-85 heating season.

Currently, 33 percent of Minnesota households use fuelwood for some or all of their heating needs. Households using wood as their major source of heat make up 28 percent of all fuelwood consumers. Nearly one-third of the fuelwood consumed is oak.

# RESIDENTIAL FUELWOOD SURVEY: 1988 - 1989

## INTRODUCTION

During the spring of 1989, the Minnesota Department of Natural Resources conducted a survey to determine the volume of residential fuelwood burned during the 1988-89 heating season. Similar surveys had been conducted in 1979-80 and 1984-85.

The purpose of this study is to determine if current consumer use patterns for residential fuelwood have changed or remained the same.

## STUDY OBJECTIVES

The objectives of this study are to:

1. Determine the total volume of fuelwood consumed in Minnesota during the 1988-89 heating season,

2. Determine the volume of fuelwood cut from growing stock trees,

3. Identify types and geographic distribution of households burning fuelwood,

4. Identify trends in residential fuelwood consumption, and

5. Compare and contrast household fuelwood consumption during the 1988-89 heating season with the 1979-80 and 1984-85 seasons.

## STUDY METHODS

A telephone survey was selected as the most cost-efficient method for gathering household fuelwood use data. The survey sample was drawn from the total number of households in Minnesota. A listing of households by county was obtained from the Minnesota State Demographer's office. Each county was placed in one of five categories based on the U.S. Forest Service Survey Unit in which it was located. The total number of households was tallied for each survey unit.

The 1979-80 survey data showed that one-third of all Minnesota households burned wood. However, the percent of households burning wood within a survey unit varied from 28 to 54 percent. To assure a representative sample, household telephone numbers were chosen using the same sampling design logic as the 1979-80 and 1984-85 studies. Fuelwood consumption data from the earlier studies was also used to select sample households. A total of 1,853 sample households were needed (Table 8). Telephone numbers for the sample were generated by Survey Sampling, Inc. of Fairfield, Connecticut.

## HOUSEHOLDS SAMPLED

| Survey Unit | # | % |
|---|---|---|
| Aspen-Birch | 300 | 16 |
| Northern Pine | 250 | 13 |
| Central Hardwoods | 386 | 21 |
| Prairie | 482 | 26 |
| Metro | 435 | 24 |
| Total | 1,853 | 100 |

TABLE 10

The telephone survey was conducted over a five-week period beginning May 8, 1989. To assure a high response rate, telephone calls were made primarily during evening hours. Telephone numbers that were busy or where no one answered, were redialed on successive days until a response was obtained. After the tenth call-back, if there was no response, the number was treated as a nonresponse. The response rate was 80 percent.

As in the 1979-80 survey, households responding were classified by: a) location by county, b) population-size class, and c) fuelwood-use class.

Four population size classes were defined:

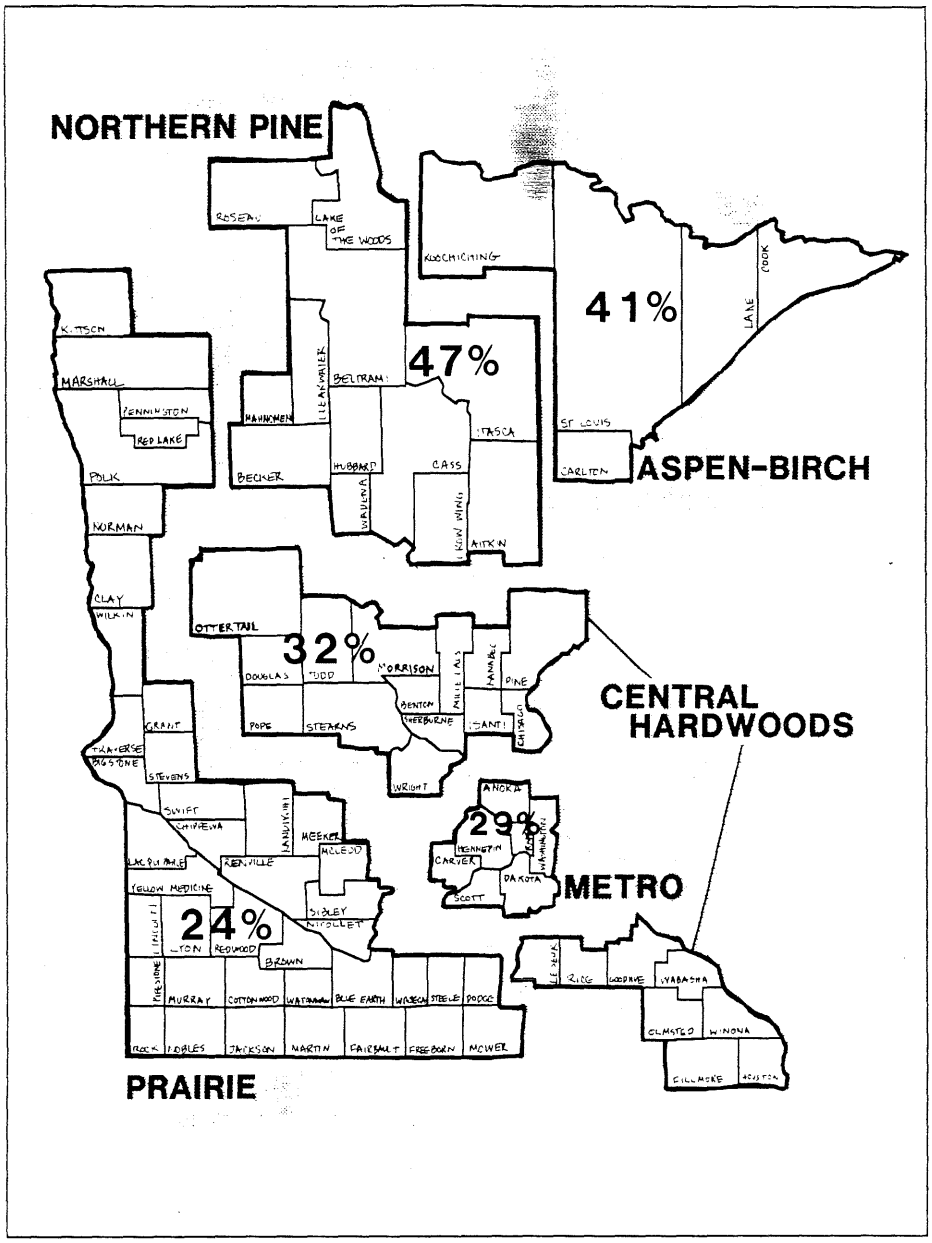
1. RURAL - households located in population centers of less than 2,500 people.
2. SMALL TOWN - households located in population centers of 2,500 to 10,000 people.
3. LARGE TOWN - households located in population centers of 10,000 to 100,000 people.
4. VERY LARGE TOWN - households located in population centers of 100,000 or more people.

Four fuelwood use classes were also identified:

1. NONUSER - households that do not burn fuelwood.
2. MAJOR - fuelwood provides the main source of heat in the home, the user may have another fuel system for back-up purposes. More than 50 percent of the household heat is from wood.
3. SUPPLEMENTARY - fuelwood is used as a back-up heating system, with another fuel providing the major source of heat. Less than 50 percent of the household heat is from wood.
4. PLEASURE - fuelwood is burned for pleasure only. Some heating benefit may result, but fuelwood is not relied on as a heating system.

## CHARACTERISTICS OF FUELWOOD USERS:

Statewide, 33 percent of the households burn fuelwood, the same as in the previous two surveys. As shown on the map, the percent of households burning fuelwood within each survey unit varies from 24 percent to 47 percent (Map 3). Major users make up 18 percent of the households burning fuelwood. Forty-six percent of the households burn wood as a supplementary source of heat, and 36 percent burn wood for pleasure only (Figure 23). Seventy-three percent of all households using fuelwood have done so for more than five years.




MAP 3 - Percent of Households Burning by Survey Unit

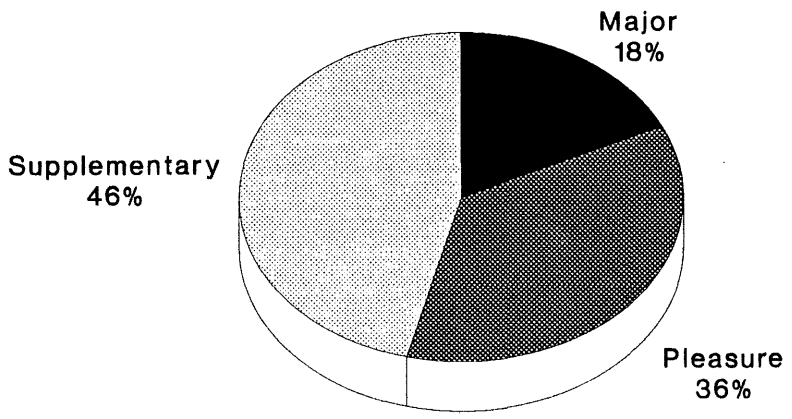



FIGURE 23

The percent of households in each user class varies among survey units (Figure 24). The percentage of households burning wood as their major source of heat, is highest in the aspen-birch and northern pine units of the state. The highest proportion of households burning fuelwood as a supplementary heat source are in the central hardwoods and prairie units of the state. Households burning primarily for pleasure are most heavily represented in the metro unit.

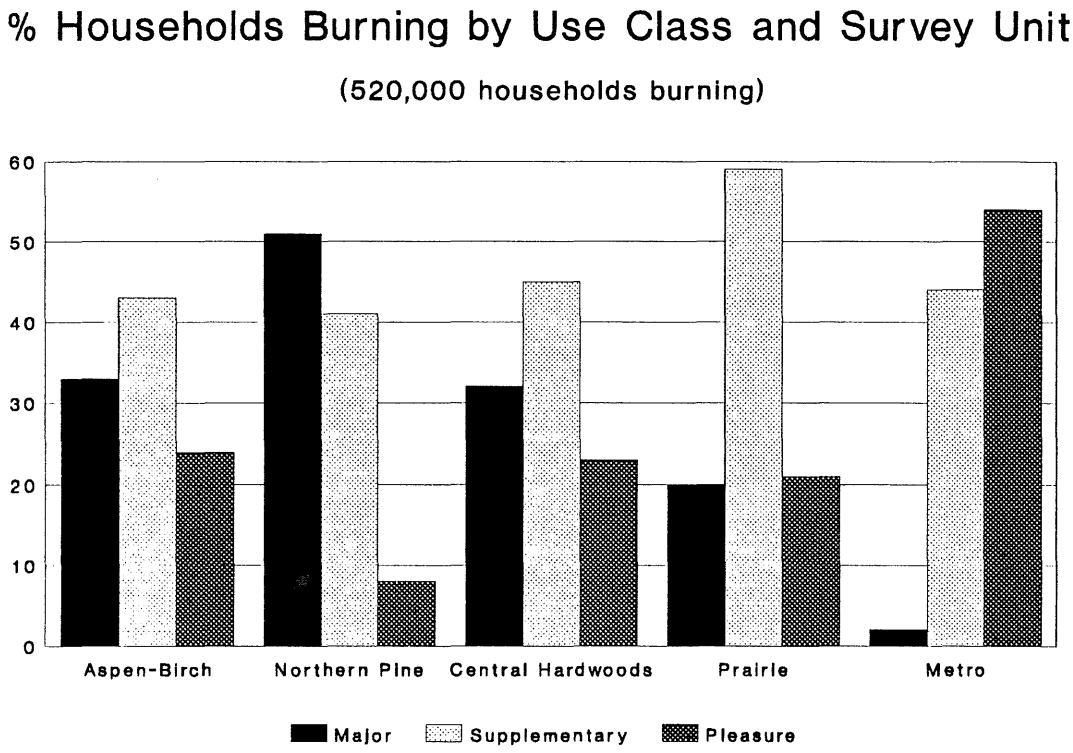



FIGURE 24

Major fuelwood consumers are more likely than other consumers to live in rural areas or small towns. Consumers burning primarily for pleasure are more likely than others to live in large towns or metro areas (Figure 25).

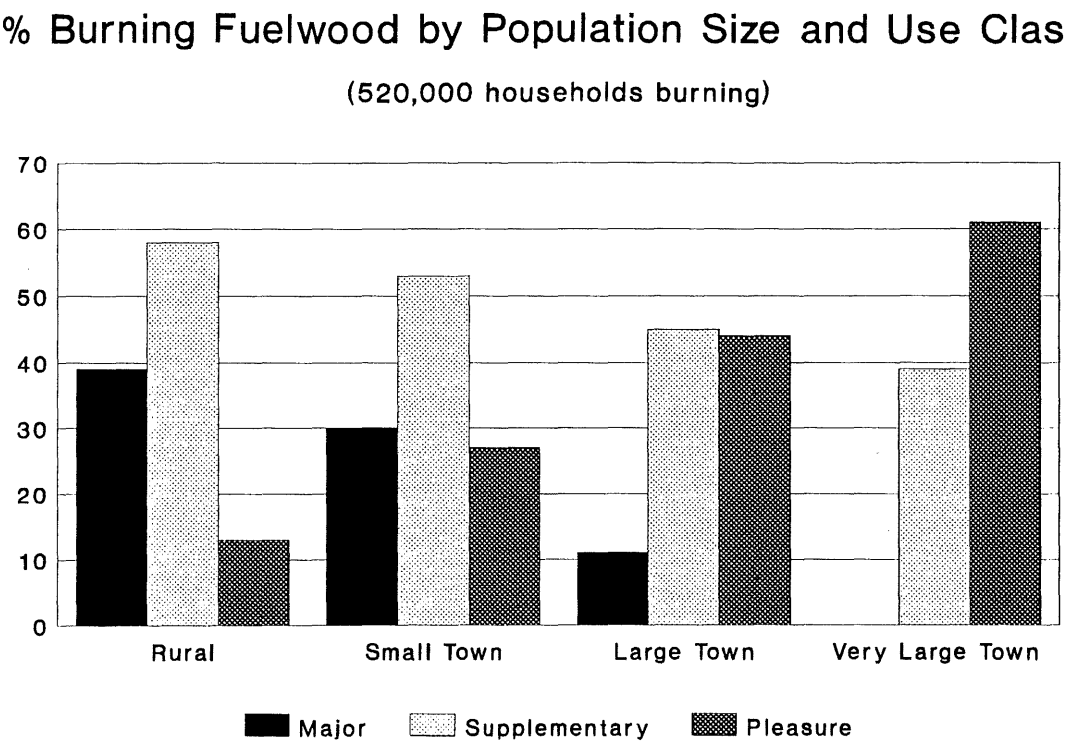



FIGURE 25

Households burning fuelwood as a supplementary heat source are about equally distributed across the state, though a slightly higher proportion are located in rural areas.

Households surveyed identified six major kinds of facilities used for wood burning (Figure 26). The volume of wood burned in each kind of facility varies (Figure 27).

Within each survey unit, households in similar fuelwood use classes use similar types of woodburning facilities. Households, in areas other than the metro unit, are more likely to use woodburning stoves than any other type of facility. At least 50 percent of the households burning wood as a major source of heat use stoves, furnaces, or both (Figure 28). Excluding the metro unit, half of the households burning wood as a supplementary heat source use woodburning stoves (Figure 29). In the metro unit, more than one-third of the households that burn wood as a supplementary heat source use regular fireplaces. Finally, statewide, households that burn primarily for pleasure are more likely to have regular or modified fireplaces than any other type of facility (Figure 30).

# % of Households Using Various Facilities
(520,000 households)

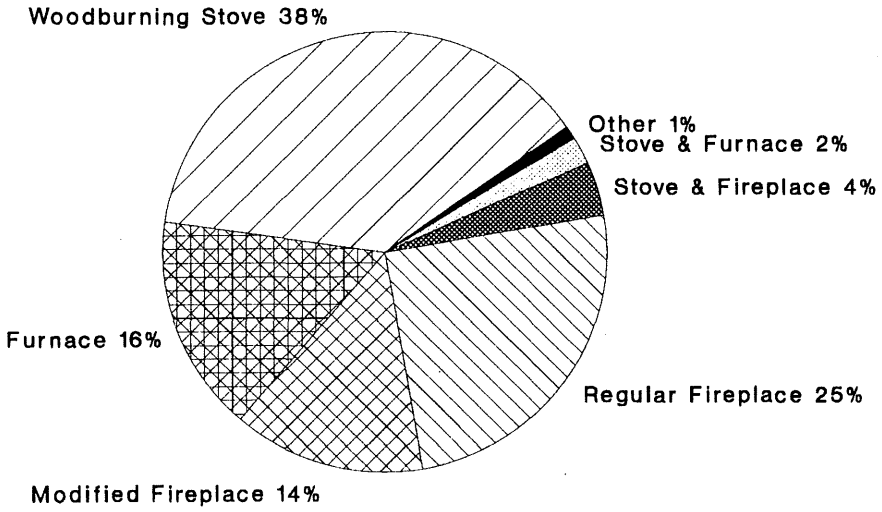



FIGURE 26

# % Volume Burned by Type of Facility
(1.039 million cords)

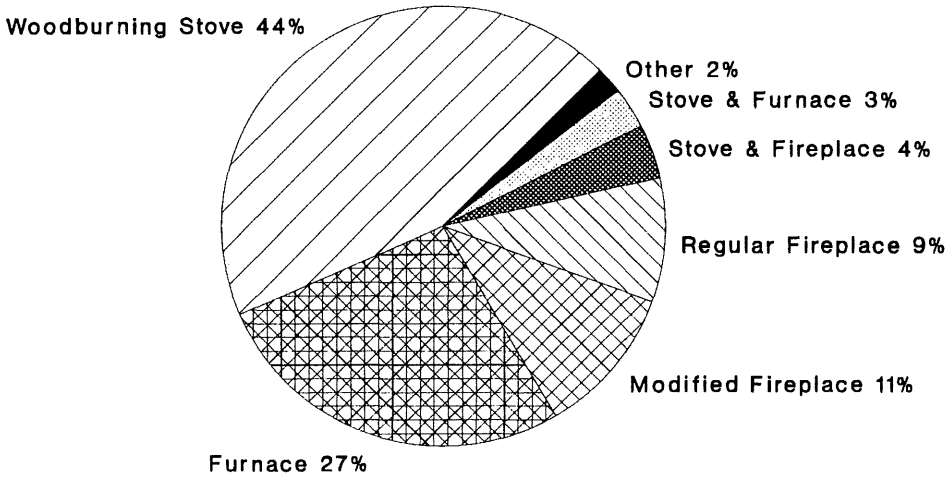



FIGURE 27

## Commonly Used Facility by Major Users and Survey Unit

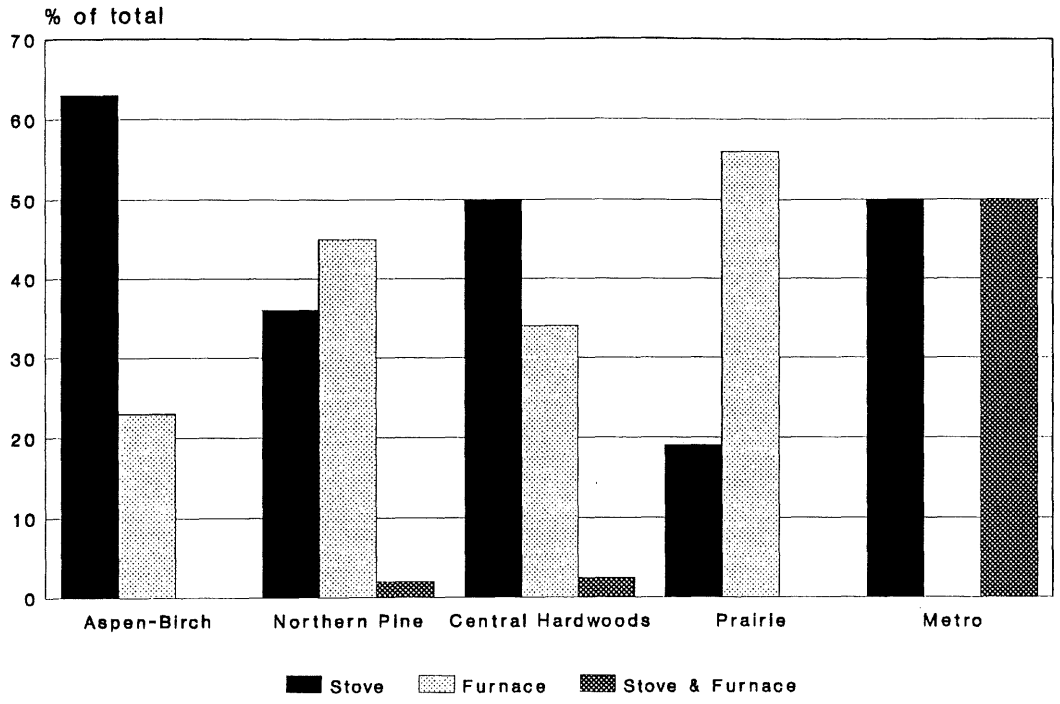



FIGURE 28

## Commonly Used Facility by Supplemental Users and Survey Unit

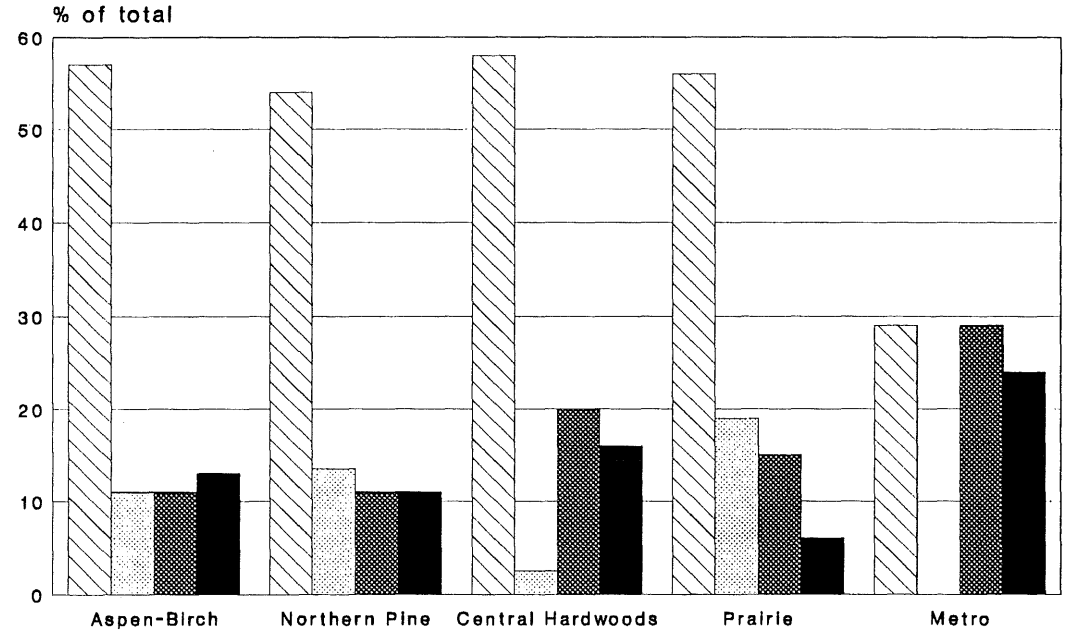



FIGURE 29

## Commonly Used Facility by Pleasure Users and Survey Unit

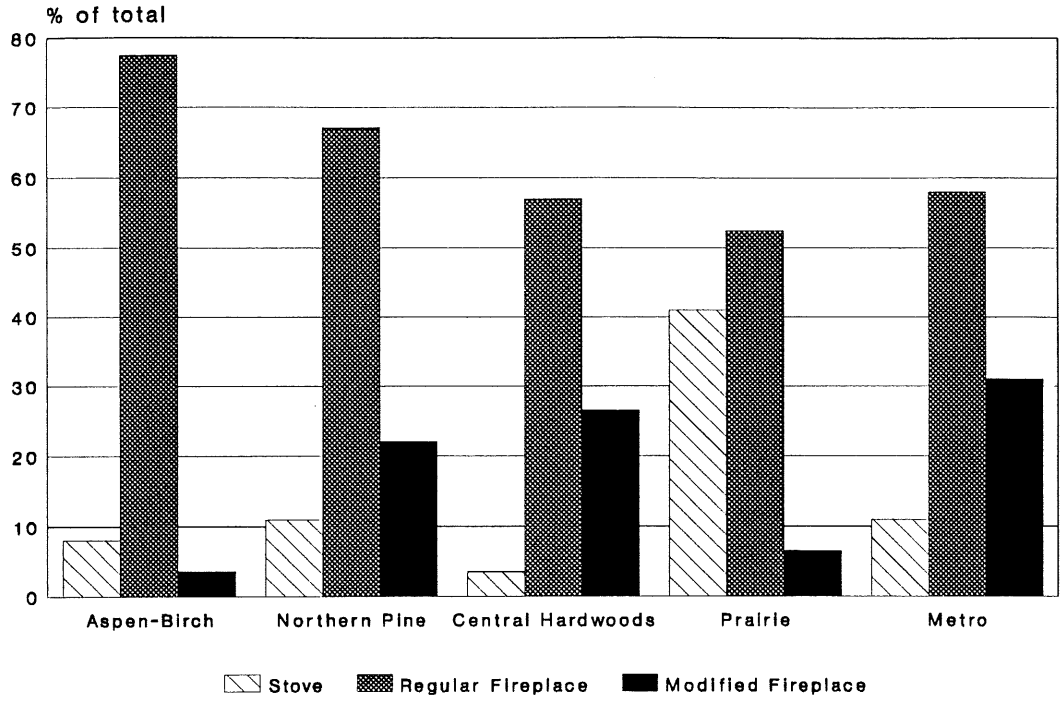



FIGURE 30

## VOLUME OF FUELWOOD BURNED

The estimated number of cords of wood burned statewide for heating residential homes and second buildings is 1.039 million cords.[1] Primary residences account for 950,000 cords. The remaining 90,000 cords are consumed in second homes and outbuildings. Statewide, about 92 percent of the fuelwood is burned for major and supplementary heating of homes and second buildings (Figure 31).

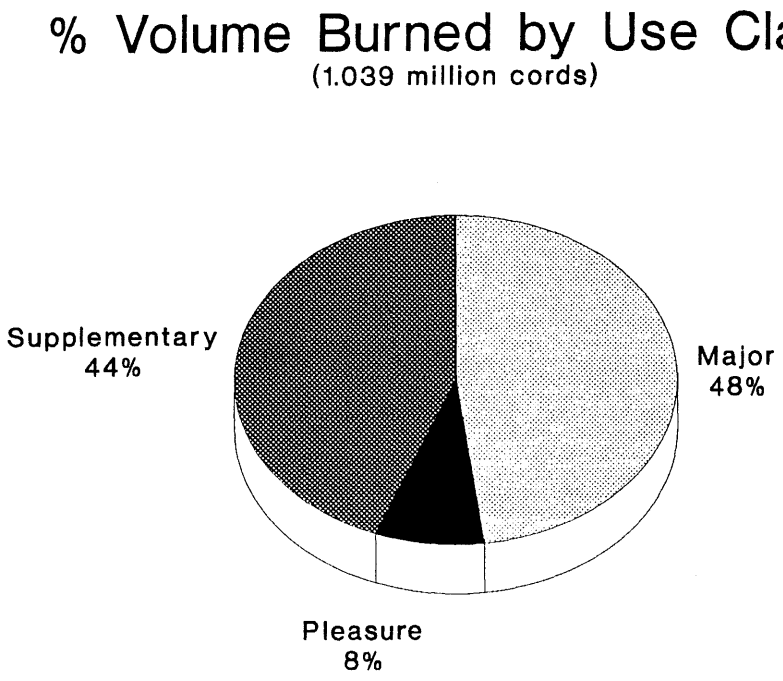



FIGURE 31

[1]One standard cord is equal to 128 cubic feet of wood or a stack of wood 4 feet high by 4 feet deep by 8 feet long.

The central hardwoods unit reported the greatest volume of fuelwood burned, 280,000 cords or 28 percent. The aspen-birch and prairie units reported the least volume of wood burned (Figure 32).

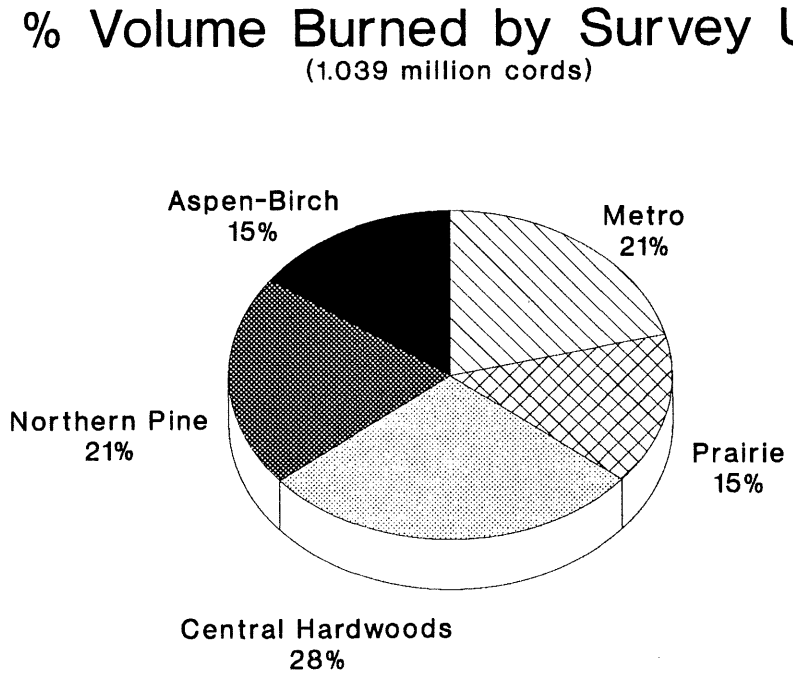



FIGURE 32

The greatest volume of fuelwood is burned by major users except in the metro and prairie units (Figure 33).

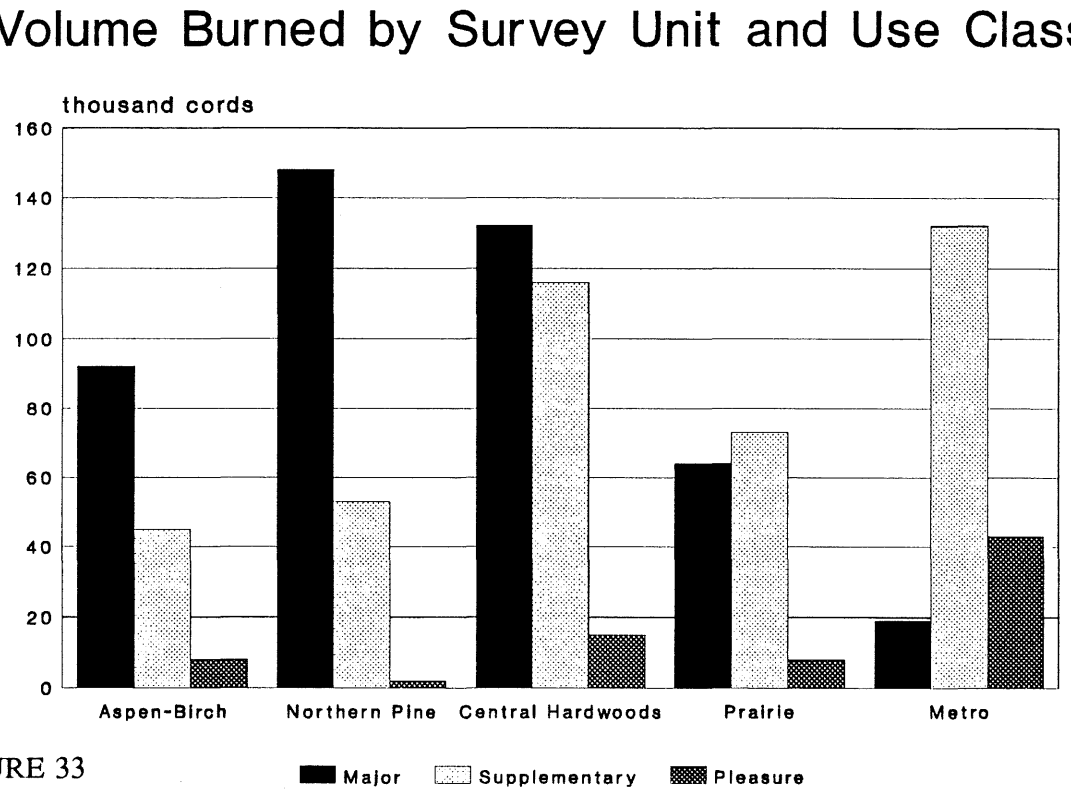



FIGURE 33

The average number of cords burned per household varies by use class (Figure 34). Major users average about six cords burned during a heating season. Other users average less. By survey unit, major woodburning households in the aspen-birch and northern pine units burn more wood per household than those in the other survey units.[2]

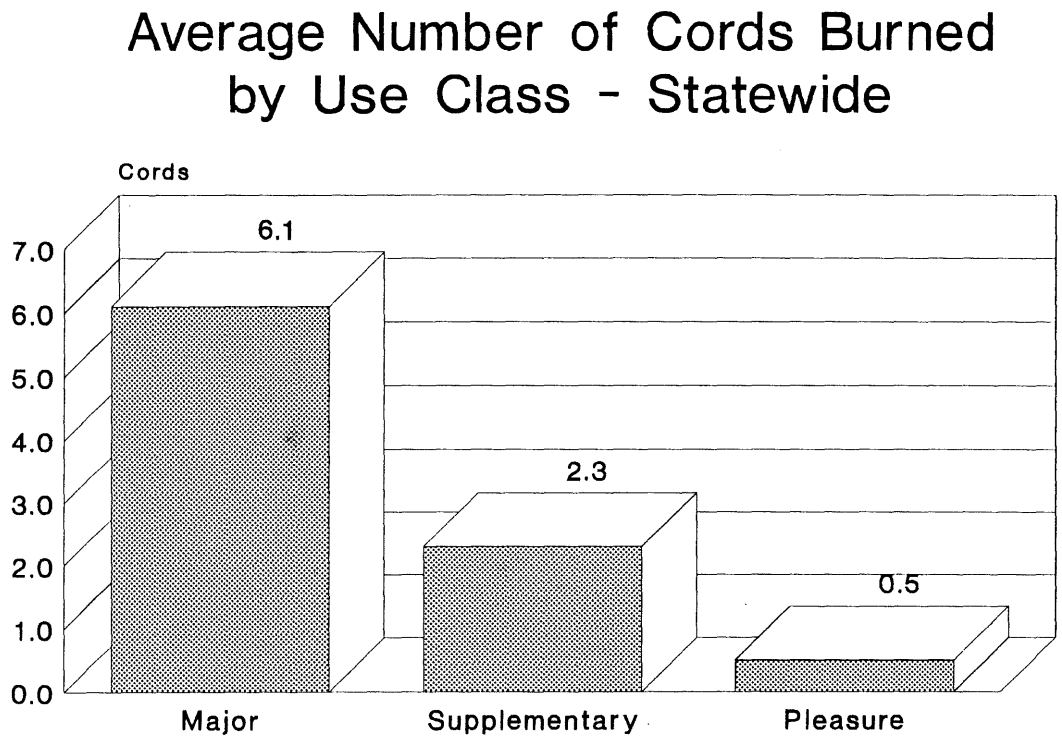



FIGURE 34

[2]Because the sample size for major users in the metro area was so small (n=2), we are not able to make definitive statement about the average number of cords burned. However, the metro unit is located within the central hardwoods area, so major metro users probably burn an average of four cords per season.

## Average Number of Cords Burned by Use Class and Survey Unit

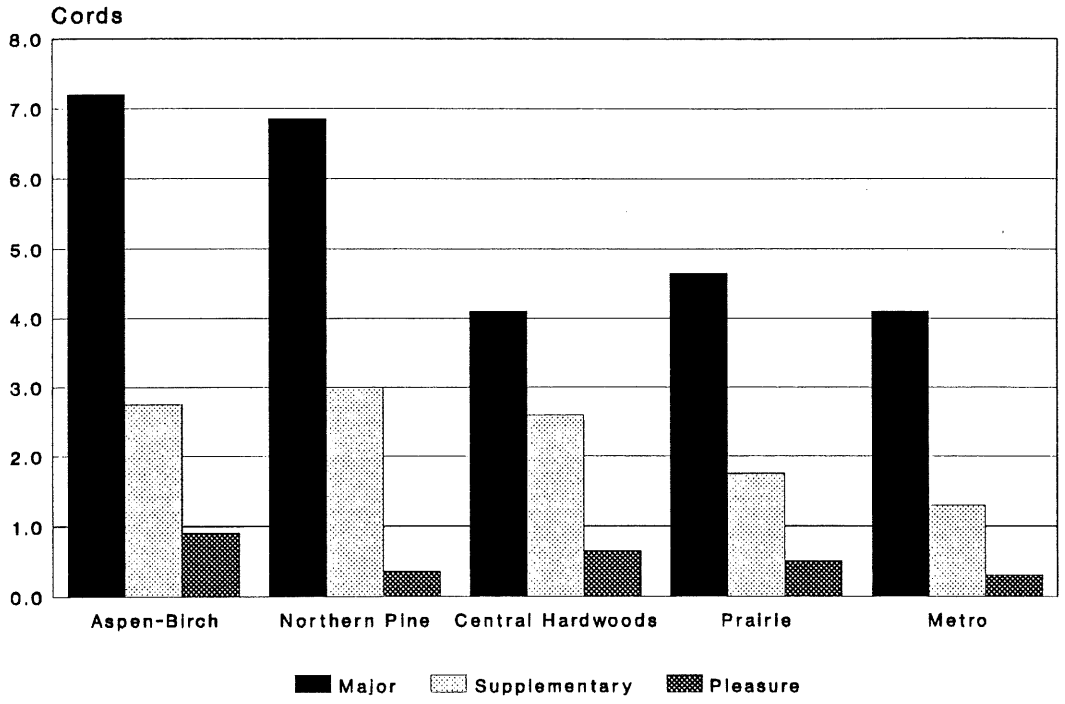



FIGURE 35

### Fuelwood Species

Approximately 830,000 cords, or over 80 percent, of the wood consumed for heating is accounted for by six species. Of the total, oak makes up nearly one-third. Other important fuelwood species for residential heating include elm, birch, maple, ash, and aspen (Figure 36). Only 52,000 cords of lumber scraps, log slabs, and other industrial wood wastes were consumed.

## % Volume Burned by Species
(1.039 million cords)

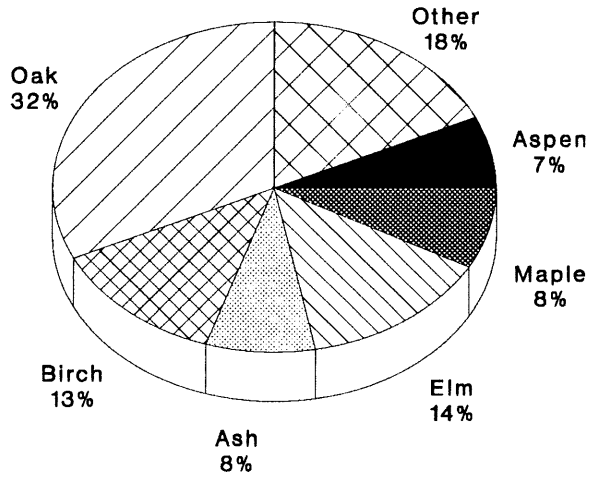



FIGURE 36

Note: Slabs and scrap lumber are included in this species breakdown.

Regional differences in the volumes and species available, as well as consumers' preferences, greatly influence the choice of species burned.

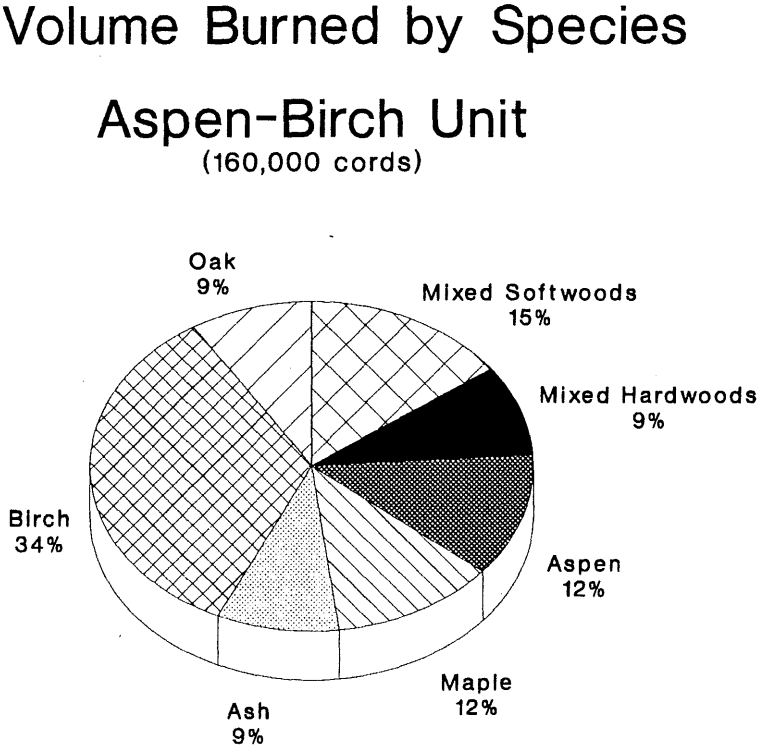



FIGURE 37

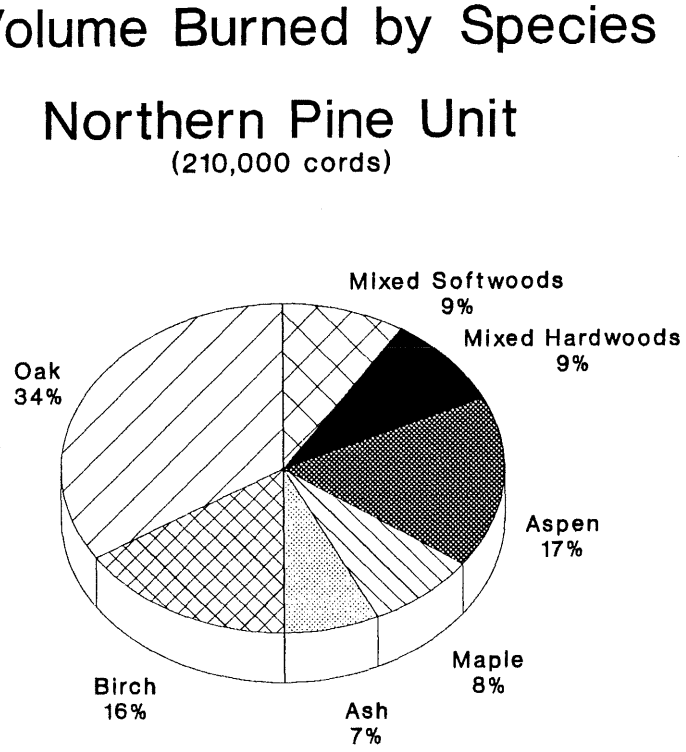



FIGURE 38

# % Volume Burned by Species

## Central Hardwoods Unit

(280,000 cords)

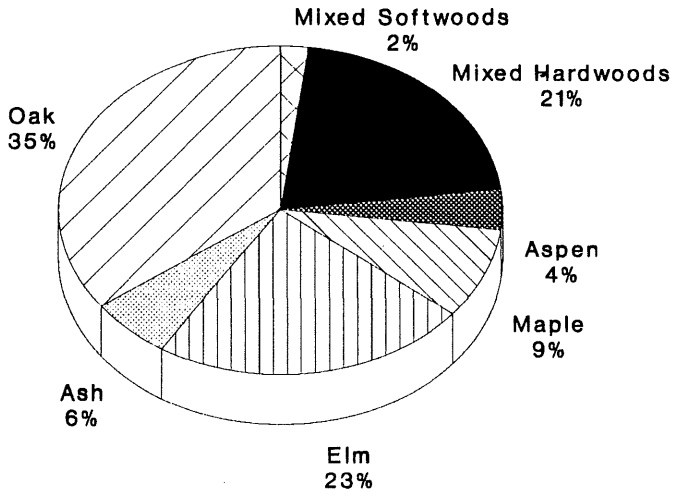



FIGURE 39

# % Volume Burned by Species

## Prairie Unit

(150,000 cords)

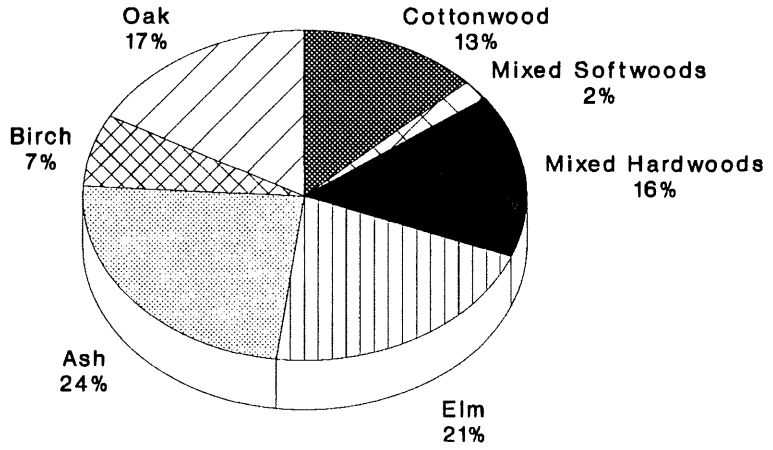



FIGURE 40

# % Volume Burned by Species

## Metro Unit

(240,000 cords)

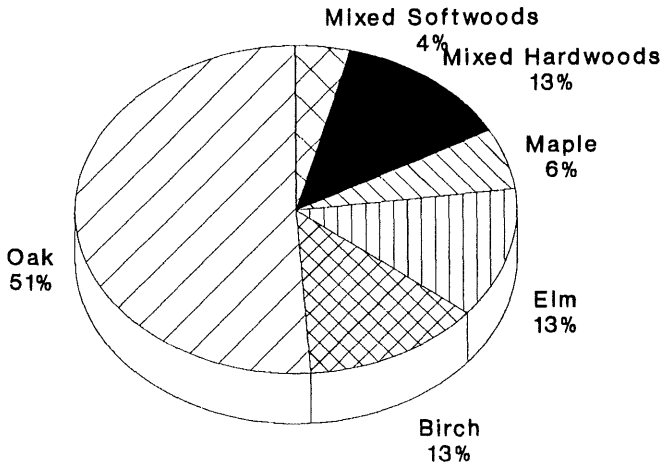



FIGURE 41

VOLUME OF FUELWOOD CUT

Individual households cut 630,000 cords of wood for their own use, about 51 percent of the fuelwood burned. The number and percent of households cutting wood, the volume of wood cut and the reason for cutting their own wood varies by survey unit. For example, compared to their counterparts, a greater proportion of households in the central hardwoods unit cut their own wood. They also cut more wood per household than other units (Figure 42). The metro unit has the fewest households that cut wood.

# % of Households Cutting Fuelwood by Survey Unit

(265,000 households)

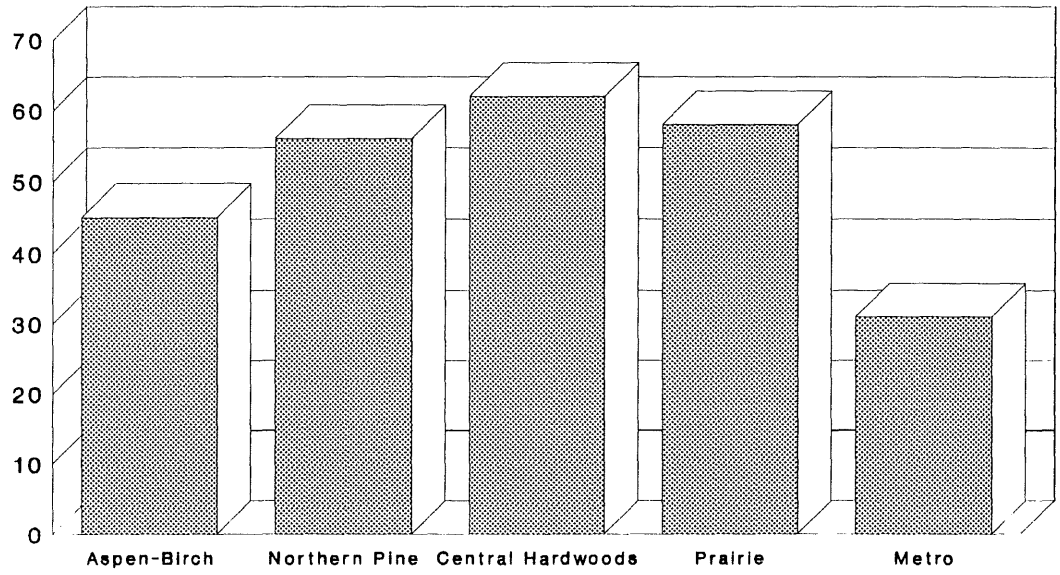



FIGURE 42

In general, households cutting their own fuelwood are major users (Figure 43). The exception to this pattern is the metro unit, where fewer than 25 percent of the households cutting their own fuelwood are major users.

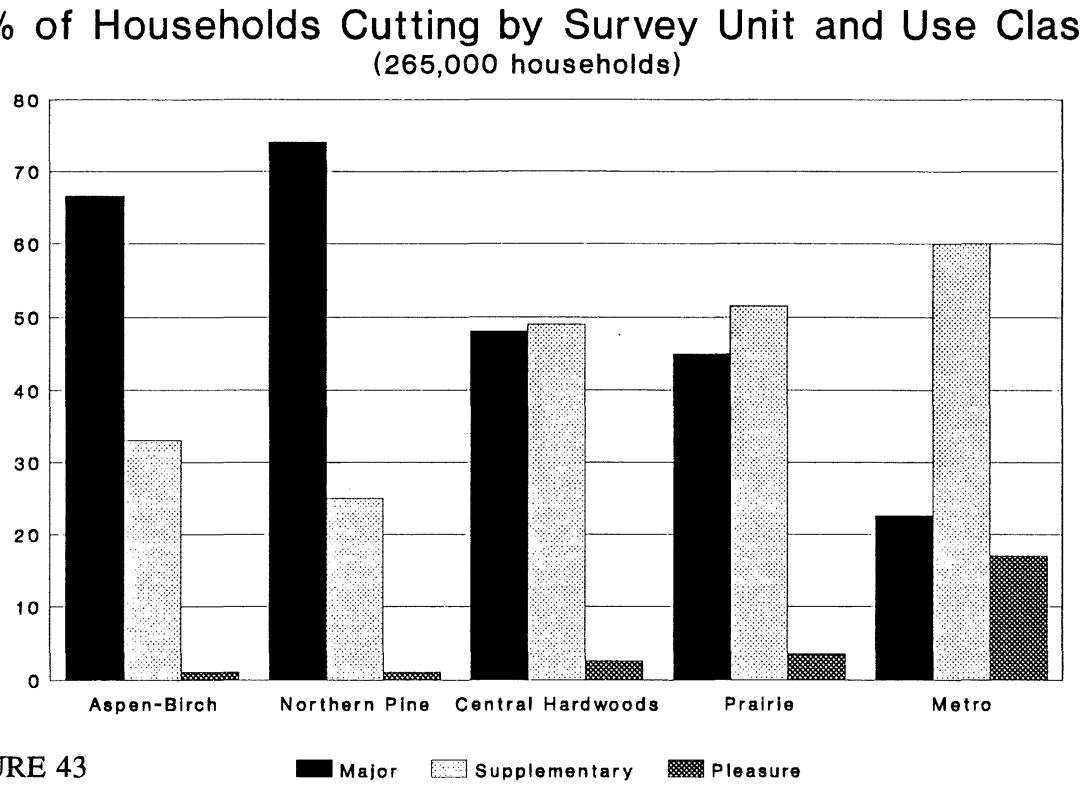



FIGURE 43

## Volume of Fuelwood Cut By Land Ownership

Ninety-four percent, or 590,000 cords, of fuelwood is cut from private land (Figure 44). When looked at by survey unit, a few distinctions can be made (Figure 45). In the prairie unit, all the households sampled cut from private lands. Only households in the aspen-birch unit cut from federal lands, and these households cut more of their fuelwood from state and county lands than others.

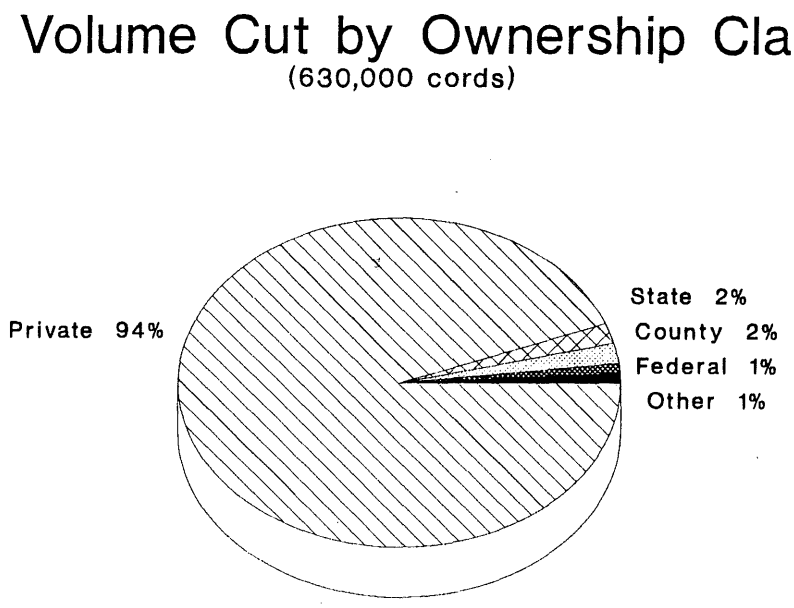



FIGURE 44

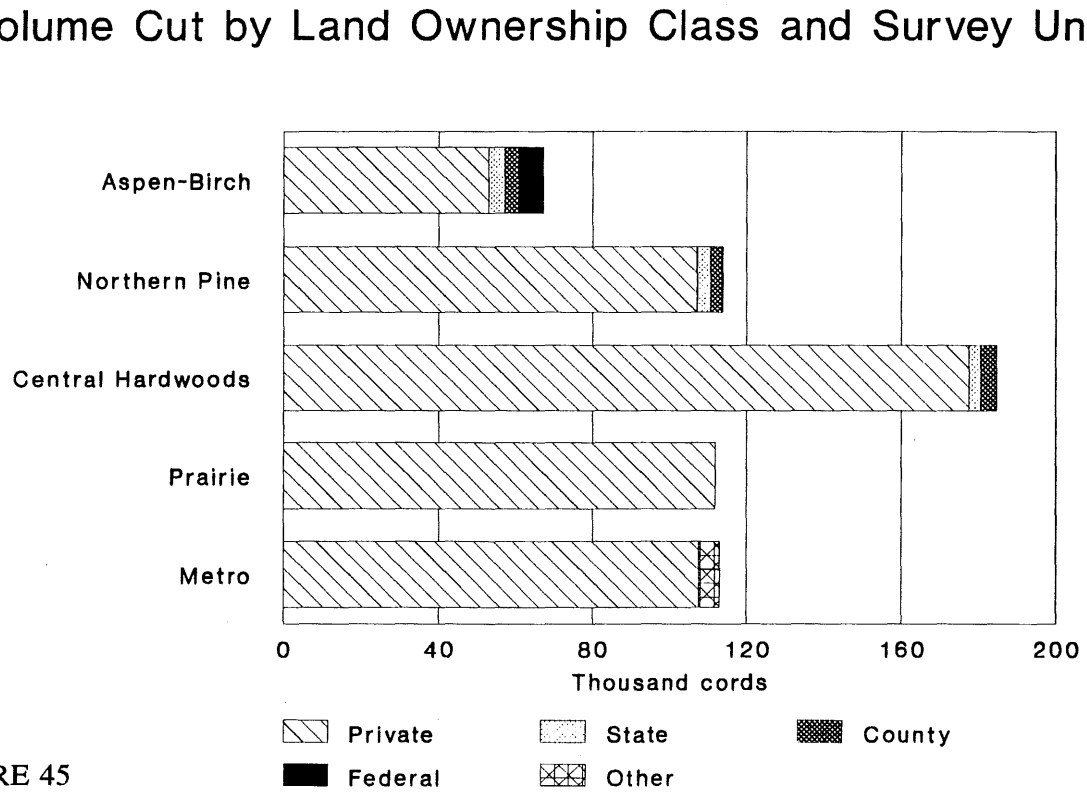



FIGURE 45

## Volume of Fuelwood Cut By Type of Removal

Most of the wood cut, 330,000 cords, by residential households comes from dead or downed trees (Figure 46). Very little, 90,000 cords, comes from live trees. Significant volumes are harvested from nonforest lands as part of urban and rural land-clearing projects.

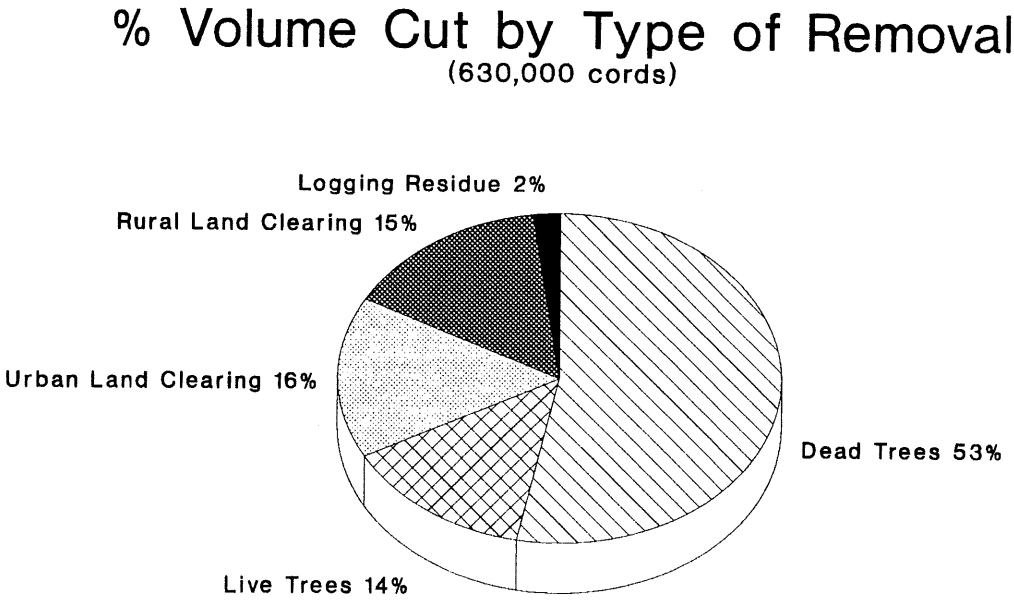



FIGURE 46

At the survey unit level, some differences exist. Compared to other units, households in the aspen-birch and northern pine units cut more fuelwood from live trees in woodland areas (Figure 47). Most of the trees cut by households in the central hardwoods unit are dead trees. Slightly more than two-thirds of the trees cut by metro unit households come from urban and residential land clearings.

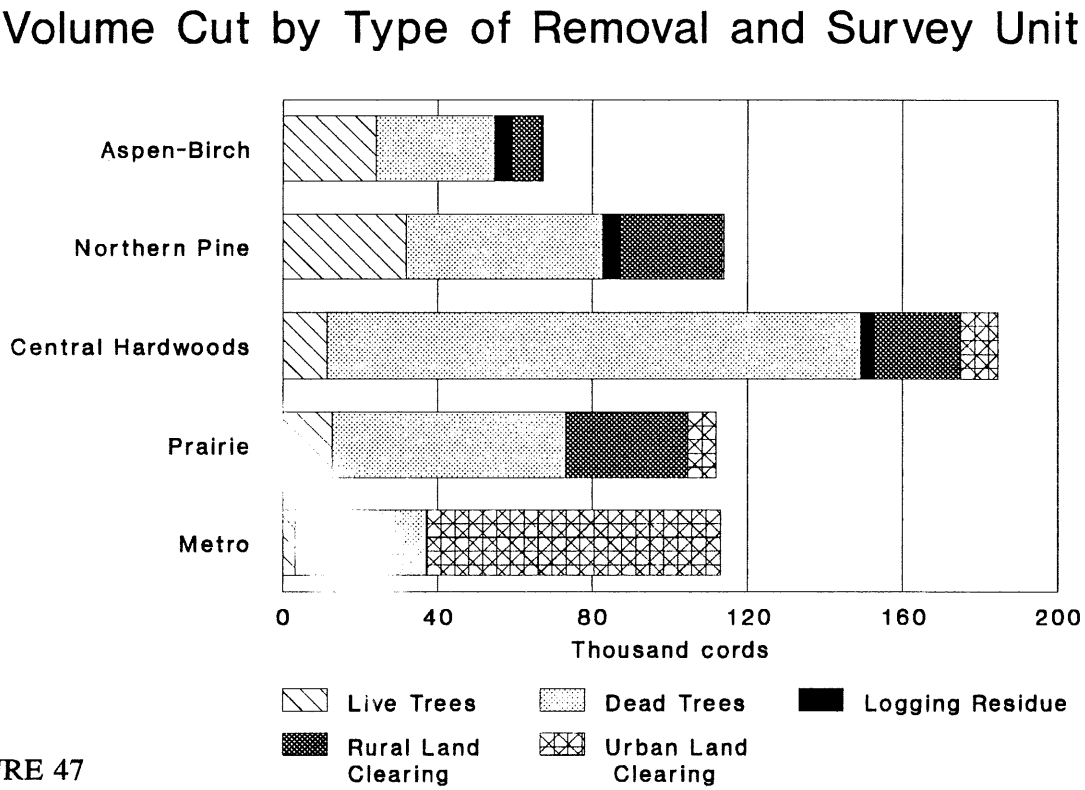



FIGURE 47

## PURCHASED FUELWOOD

Much, but not all, of the fuelwood purchased for residential use was produced by Minnesota loggers. Minnesota loggers produced 174,000 cords of fuelwood in 1988. Nearly 85 percent of this came from live trees and more than 40 percent was harvested from state-administered lands.

This indicates that as much as 180,000 cords of fuelwood may be being imported into Minnesota, primarily from Wisconsin, for residential use. This figure should be viewed cautiously. Use it as indicator of magnitude only.

## FUELWOOD HARVEST IMPACT ON COMMERCIAL HARVEST

The total harvest for fuelwood removes 237,000 cords of growing stock from commercial forest land. The remaining 567,000 cords of harvested fuelwood comes from dead trees, logging slash, and trees on noncommercial forest land.

## TRENDS IN HOUSEHOLD FUELWOOD CONSUMPTION

Since the 1984-85 heating season, the volume of fuelwood burned by Minnesota households declined 26 percent. During the 1984-85 season 1.4 million cords were burned. In 1988-89, only 1.039 million cords were burned (Figure 48). But, over the same period the total number of households burning wood increased (Figure 49). This seeming discrepancy can be explained by at least three observations:

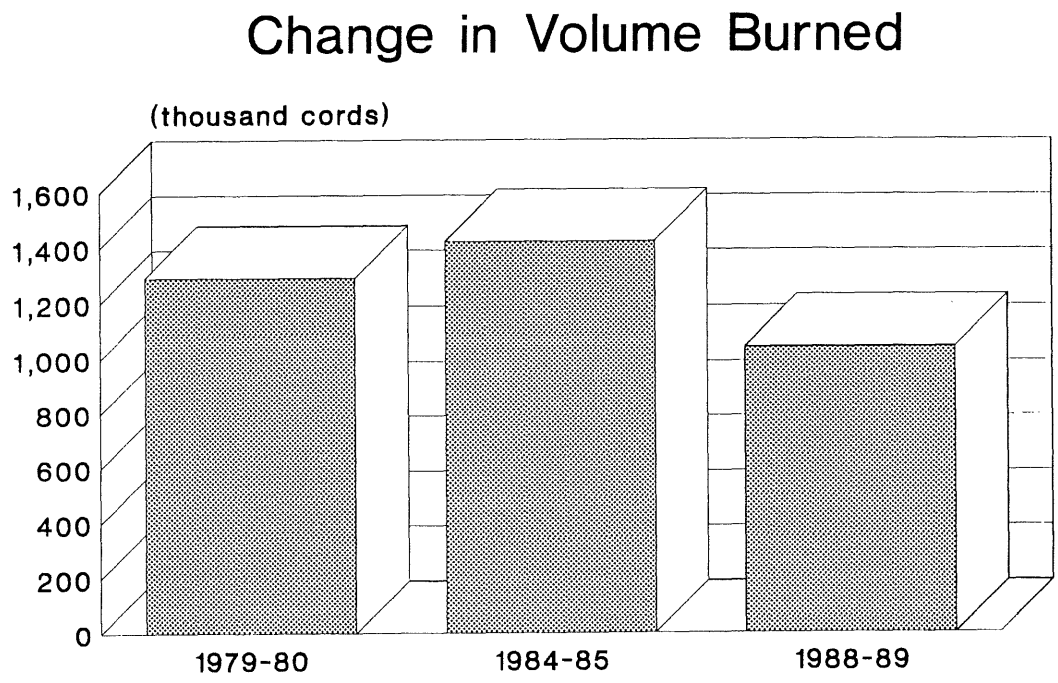



FIGURE 48

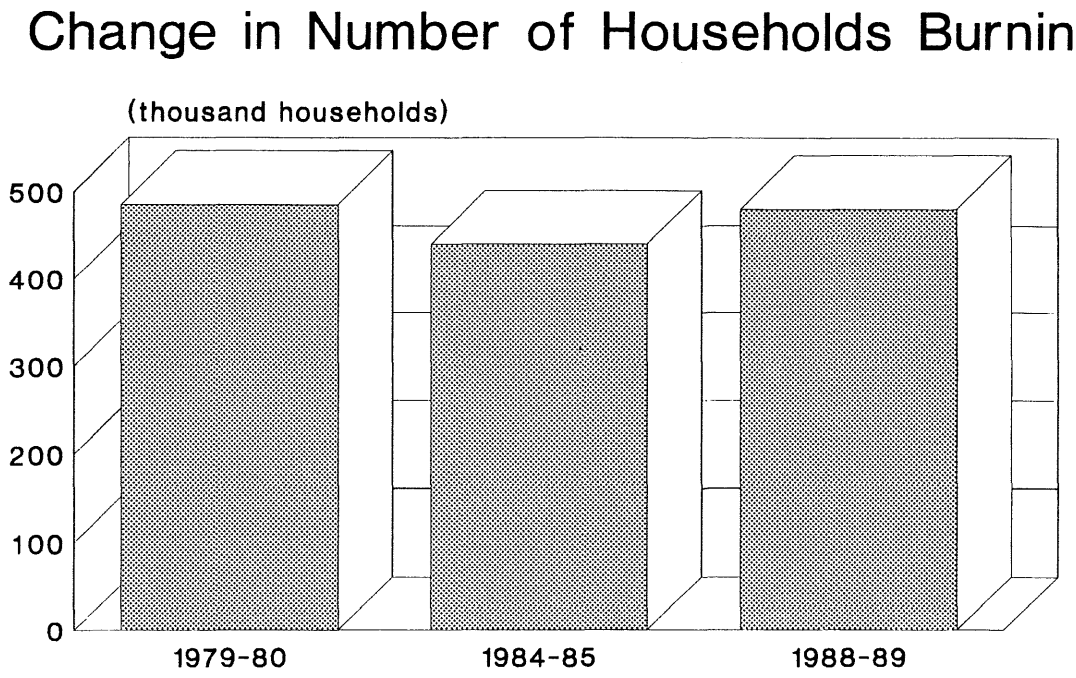



FIGURE 49

First, because of a mild winter, there were fewer heating days during 1988-89 than in 1978-79 or 1984-85.

Second, people may be burning wood more efficiently than in the past.

The combined effects of these two factors can be seen in all the survey units. Households heating primarily with wood burn fewer cords now than in the past. For example, major fuelwood consumers in the central and southern parts of the state burned about seven cords in 1984-85, but burned fewer than five cords during 1988-89 (Figure 50).

## Change in Average Number of Cords Burned by Major Users

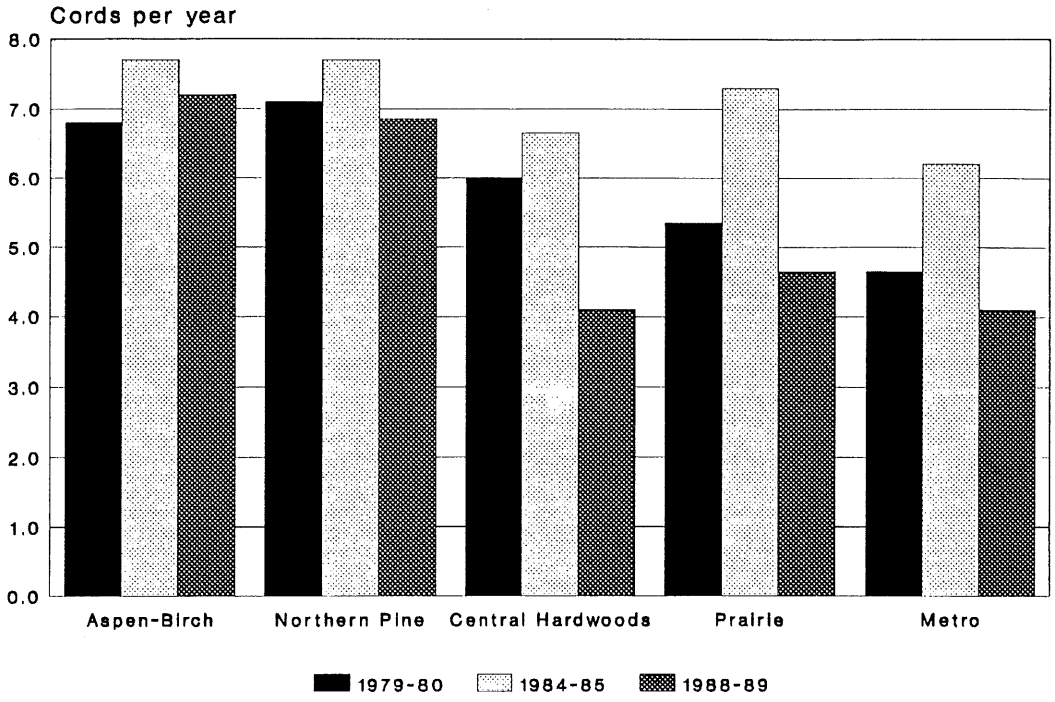



FIGURE 50

Similar decreases in the average number of cords burned are noted for supplemental heat and pleasure users (Figures 51 and 52).

## Change in Average Number of Cords Burned by Supplementary Users

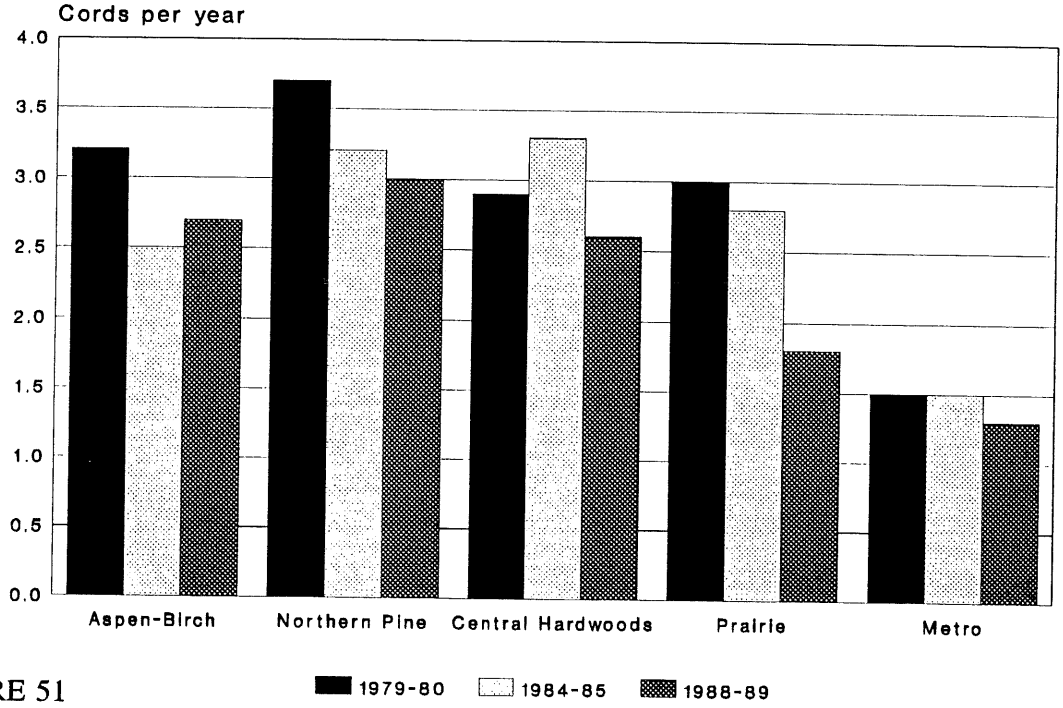



FIGURE 51

## Change in Average Number of Cords Burned by Pleasure Users

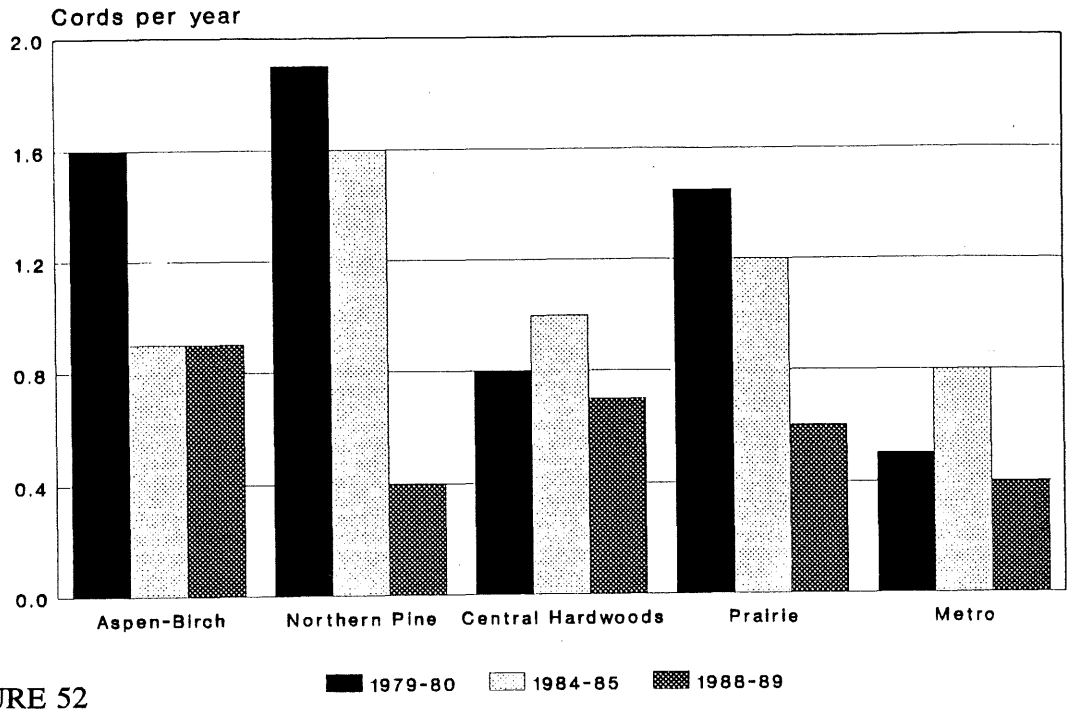



FIGURE 52

Third, and perhaps most significantly, fewer people burn wood as a major heat source. As other heating fuels have become more readily available and cheaper to obtain, the use of fuelwood as a major source of heat has declined. The increase in the number of households burning wood has come in those supplementing other heating fuels and those burning fuelwood just for pleasure (Figure 53).

## Households Burning Fuelwood by Use Class

### 1984/85 vs 1988/89 Heating Seasons

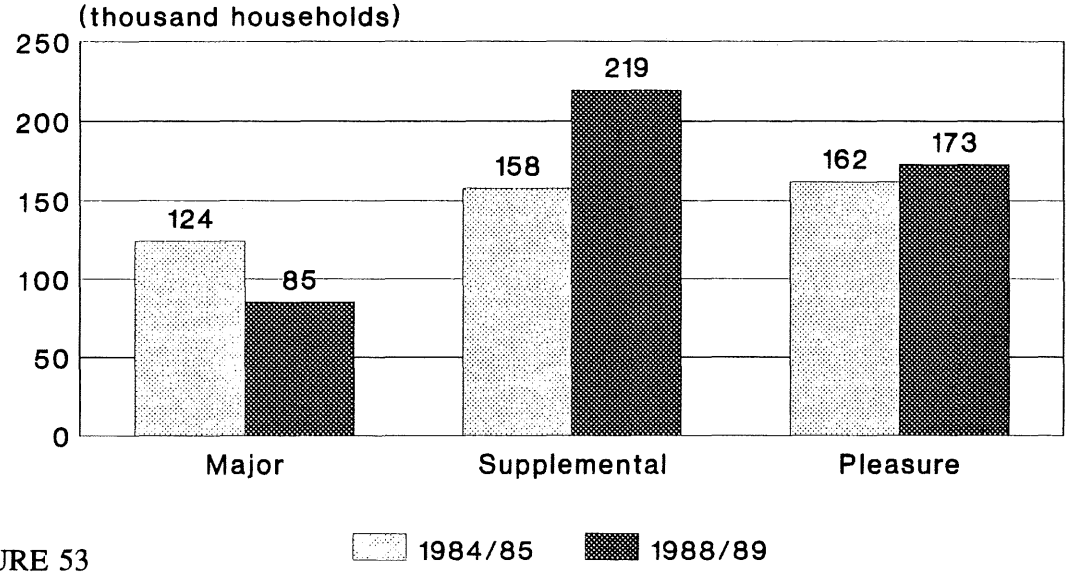



FIGURE 53

# APPENDIX A

## BIOMASS TABLES

TABLE 1: Wood Harvest in Minnesota from Commercial Forest Land

| YEAR | CORD EQUIVALENTS (Millions) |
|---|---|
| 1978 | 2.31 |
| 1979 | 2.42 |
| 1980 | 2.32 |
| 1981 | 2.35 |
| 1982 | 2.47 |
| 1983 | 3.09 |
| 1984 | 3.34 |
| 1985 | 3.07 |
| 1986 | 3.15 |
| 1987 | 3.24 |
| 1988 | 3.17 |
| 1990 (a) | 3.57 |
| 1992 (a) | 4.24 |
| 1995 (a) | 4.90 |

(a) Estimated harvest volumes

TABLE 2: Minnesota Land Classes and Acreages

| LAND CLASS | ACRES (Thousands) |
|---|---|
| Commercial Forest Land | 13,695.1 |
| Productive - Reserved | 1,178.6 |
| Unproductive | 1,835.3 |
| Subtotal: Forest Land | 16,709.2 |
| Nonforest with Trees | 608.6 |
| Nonforest without Trees | 33,427.0 |
| Subtotal: Nonforest Land | 34,035.6 |
| TOTAL | 50,744.8 |

TABLE 3: Wood Biomass Composition

| COMPONENT | PERCENT |
|---|---|
| Growing Stock (Merchantable) | 53 |
| Growing Stock - Tops and Limbs | 20 |
| Cull Trees | 10 |
| Cull Trees - Tops and Limbs | 4 |
| Reproduction Trees - 1-5" DBH | 13 |
| TOTAL | 100 |

TABLE 4: Biomass Available for Energy

| SOURCE | Year 1988 | 1990 (cords) | 1995 |
|---|---|---|---|
| Commercial Forest | | | |
| Harvest Residue | 1,130,000 | 1,280,000 | 1,740,000 |
| Mortality | 37,000 | 41,000 | 56,000 |
| Low Productivity Stands | 116,000 | 116,000 | 116,000 |
| Surplus Species | 210,000 | 210,000 | 0 |
| Subtotal - CFL | 1,493,000 | 1,647,000 | 1,920,000 |
| Unproductive | 123,000 | 123,000 | 123,000 |
| Nonforest with Trees | 83,000 | 83,000 | 83,000 |
| TOTAL | 1,699,000 | 1,853,000 | 2,118,000 |

TABLE 5: Actual and Estimated Harvest Residues: 1988-1995

(thousand cord equivalents)

| COMPONENT | Year 1988 | 1990 | 1995 |
|---|---|---|---|
| Total Residue | 2840 | 3190 | 4340 |
| Recoverable Residue: | | | |
| Chipping | 1130 | 1280 | 1780 |
| Manual/Roundwood | 710 | 800 | 1080 |

TABLE 6: Actual and Estimated Mortality Generated from Harvested Stands: 1988-1995

(thousand cord equivalents)

| COMPONENT | Year 1988 | 1990 | 1995 |
|---|---|---|---|
| Total Residue | 132 | 147 | 201 |
| Recoverable Residue: | | | |
| Chipping | 111 | 123 | 168 |
| Manual/Roundwood | 105 | 117 | 159 |

TABLE 7: Low Productivity Hardwood Stands

| TREE TYPE | ACRES (thousands) |
|---|---|
| Aspen / Balm-of-Gilead | 112.2 |
| Birch | 50.0 |
| Lowland Hardwood | 139.5 |
| Northern Hardwood | 63.4 |
| Oak | 171.8 |
| TOTAL | 536.9 |

TABLE 8: Actual and Estimated Volume from Low Productivity Stands: 1988-1995

(thousand cord equivalents)

| COMPONENT | YEAR 1988 | 1990 | 1995 |
|---|---|---|---|
| Total Volume | 162 | 162 | 162 |
| Recoverable Volume: | | | |
| Chipping | 116 | 116 | 116 |
| Manual/Roundwood | 105 | 105 | 105 |

TABLE 9: Actual and Estimated Volume of Surplus Paper Birch and Balm-of-Gilead Biomass Available for Energy: 1988-1995

(thousand cord equivalents)

| COMPONENT | YEAR 1988 | 1990 | 1995 |
|---|---|---|---|
| Growing Stock | 155 | 155 | 0 |
| Total Biomass* | 292 | 292 | 0 |
| Recoverable Residue: | | | |
| Chipping | 210 | 210 | 0 |
| Manual/Roundwood | 189 | 189 | 0 |

*Total Biomass based on the ratio of growing stock to residue shown in Figure 3.

TABLE 10: Actual and Estimated Volume of Unproductive Forest Land Residues: 1988-1995

(thousand cord equivalents)

| COMPONENT | YEAR 1988 | 1990 | 1995 |
|---|---|---|---|
| Total Residue | 170 | 170 | 170 |
| Recoverable Residue: | | | |
| Chipping | 123 | 123 | 123 |
| Manual/Roundwood | 112 | 112 | 112 |

TABLE 11: Actual and Estimated Volume of Nonforest Land Residues: 1988-1995

(thousand cord equivalents)

| COMPONENT | YEAR 1988 | 1990 | 1995 |
|---|---|---|---|
| Total Residue | 115 | 115 | 115 |
| Recoverable Residue: | | | |
| Chipping | 83 | 83 | 83 |
| Manual/Roundwood | 74 | 74 | 74 |

TABLE 12: Energy Potential from Commercial and Unproductive Forest and Nonforest Lands

| YEAR / METHOD OF RECOVERY | THOUSAND CORD EQUIVALENTS | THOUSAND GREEN TONS[1] | FUEL VALUE MILLION BTUs[2] |
|---|---|---|---|
| **1988** | | | |
| Total Residue | 3623 | 8405 | 71,442 |
| Recoverable Residue: | | | |
| Chipping | 1399 | 3246 | 27,591 |
| Manual/Roundwood | 1225 | 2842 | 24,157 |
| **1990** | | | |
| Total Residue | 3531 | 8192 | 69,632 |
| Recoverable Residue: | | | |
| Chipping | 1853 | 4299 | 36,542 |
| Manual/Roundwood | 1319 | 3060 | 26,010 |
| **1995** | | | |
| Total Residue | 4854 | 11,261 | 95,718 |
| Recoverable Residue: | | | |
| Chipping | 2118 | 4914 | 41,769 |
| Manual/Roundwood | 1424 | 3304 | 28,084 |

1 Calculated based on 2.32 green tons per cord.
2 Calculated based on 8.5 million BTUs per green ton.

# APPENDIX B

## RESIDUE TABLES

TABLE 1: Residue Volume Distribution by County

(in green tons)
(does not include pulp-using industries)

| COUNTY | BARK | SLABS/EDGINGS & CHIPS | SAWDUST/EDGINGS (FINE RESIDUE) | TOTAL TONS |
|---|---|---|---|---|
| Aitkin | 151.1 | 14,834.1 | 6,008.0 | 20,993 |
| Anoka | 2120.4 | 107.2 | 2,901.6 | 5,129 |
| Becker | 1368.0 | 8,225.5 | 3,650.4 | 13,244 |
| Beltrami | 5873.8 | 19,912.6 | 12,093.9 | 37,880 |
| Benton | 0.0 | 888.2 | 4,922.7 | 5,811 |
| Blue Earth | 11.4 | 26.8 | 7.8 | 46 |
| Carlton | 5281.5 | 81,706.8 | 34,964.7 | 141,953 |
| Carver | 90.3 | 213.1 | 124.0 | 427 |
| Cass | 3724.9 | 39,352.8 | 13,233.5 | 56,311 |
| Chisago | 124.8 | 71.3 | 38.2 | 234 |
| Clay | 0.0 | 191.0 | 35.1 | 226 |
| Clearwater | 4075.5 | 9,142.9 | 6,591.0 | 19,809 |
| Cook | 9342.3 | 909.9 | 12,910.6 | 23,163 |
| Crow Wing | 0.0 | 10,019.9 | 4,193.3 | 14,213 |
| Dakota | 19.9 | 33.5 | 15.6 | 69 |
| Douglas | 0.0 | 594.0 | 214.5 | 809 |
| Faribault | 74.1 | 174.2 | 54.6 | 303 |
| Fillmore | 8050.1 | 22,947.7 | 11,029.6 | 42,027 |
| Freeborn | 757.4 | 1,775.5 | 1,033.5 | 3,566 |
| Goodhue | 1115.5 | 3,137.1 | 1,518.7 | 5,771 |
| Hennepin | 8.5 | 402.1 | 167.7 | 578 |
| Houston | 8097.4 | 23,113.4 | 11,080.7 | 42,291 |
| Hubbard | 34.2 | 9,990.3 | 4,005.3 | 14,030 |
| Isanti | 142.5 | 828.9 | 338.5 | 1,310 |
| Itasca | 556.6 | 90,984.6 | 39,118.1 | 170,659 |
| Kanabec | 0.0 | 639.8 | 261.3 | 901 |
| Kandiyohi | 57.6 | 113.9 | 66.3 | 238 |
| Kittson | 0.0 | 955.0 | 390.0 | 1,345 |
| Koochiching | 4113.2 | 32,035.4 | 13,612.6 | 59,761 |
| Lake | 3452.5 | 11,992.6 | 4,906.2 | 20,351 |
| Lake of the Woods | 1168.5 | 7,829.2 | 3,159.0 | 12,157 |
| Le Sueur | 114.0 | 382.0 | 156.0 | 652 |
| Lincoln | 142.5 | 335.0 | 195.0 | 673 |
| Lyon | 0.6 | 1.3 | 0.8 | 3 |
| McLeod | 28.5 | 67.0 | 39.0 | 135 |
| Mahnomen | 5.7 | 2,416.7 | 987.5 | 3,410 |
| Marshall | 0.0 | 128.0 | 11.7 | 140 |
| Martin | 114.0 | 268.0 | 156.0 | 538 |
| Meeker | 285.0 | 670.0 | 390.0 | 1,345 |
| Mille Lacs | 1995.0 | 10,136.7 | 4,438.2 | 16,570 |
| Morrison | 45.6 | 294.1 | 107.6 | 447 |
| Mower | 57.0 | 134.0 | 78.0 | 269 |
| Murray | 57.0 | 100.5 | 39.0 | 197 |
| Nicollet | 3162.1 | 7,410.2 | 4,270.5 | 14,843 |
| Nobles | 0.0 | 143.3 | 58.5 | 202 |
| Norman | 0.0 | 1,967.3 | 803.4 | 2,771 |

TABLE 1 (continued): Residue Volume Distribution by County

(in green tons)
(does not include pulp using industries)

| COUNTY | BARK | SLABS/EDGINGS & CHIPS | SAWDUST/EDGINGS (FINE RESIDUE) | TOTAL TONS |
|---|---|---|---|---|
| Olmsted | 91.2 | 302.2 | 132.6 | 526 |
| Ottertail | 344.3 | 1,969.8 | 828.4 | 3,142 |
| Pine | 0.0 | 19,797.2 | 8,045.7 | 27,843 |
| Polk | 11.4 | 105.1 | 32.0 | 148 |
| Pope | 0.0 | 238.8 | 93.6 | 332 |
| Renville | 6.3 | 14.7 | 8.6 | 30 |
| Rice | 0.0 | 382.0 | 156.0 | 538 |
| Roseau | 7.4 | 3,249.5 | 1,375.1 | 4,632 |
| St. Louis | 5520.5 | 25,974.4 | 10,970.0 | 42,465 |
| Scott | 176.7 | 415.4 | 234.0 | 826 |
| Sherburne | 3.8 | 301.8 | 123.2 | 429 |
| Sibley | 490.2 | 1,098.8 | 670.8 | 2,260 |
| Stearns | 0.0 | 3,248.9 | 1,312.2 | 4,561 |
| Steele | 0.0 | 286.5 | 117.0 | 404 |
| Stevens | 0.0 | 19.1 | 4.7 | 24 |
| Todd | 598.5 | 2,730.3 | 1,700.6 | 5,029 |
| Wabasha | 702.2 | 2,370.7 | 1,005.8 | 4,079 |
| Wadena | 769.5 | 16,478.8 | 6,924.5 | 24,173 |
| Washington | 84.4 | 255.3 | 106.1 | 446 |
| Winona | 179.0 | 497.2 | 276.1 | 952 |
| Wright | 0.0 | 215.8 | 88.1 | 304 |

TABLE 2: Volume by Fuel Use Class by Residue Category

(in green tons)

| FUEL USE CLASS | BARK | SLABS/EDGINGS & CHIPS[1] | SAWDUST/EDGINGS (FINE RESIDUE) | TOTAL TONS | PERCENT |
|---|---|---|---|---|---|
| Industrial Fuel | 652,420 | 105,161 | 101,485 | 859,066 | 56.8% |
| Domestic Fuel | 3,629 | 108,049 | 1,810 | 113,489 | 7.5% |
| Processed Fuel | 7,151 | 4,587 | 9,750 | 21,488 | 1.4% |
| Fiber Manufacture | 34,936 | 185,807 | 0 | 220,743 | 14.6% |
| Other Uses | 19,901 | 31,513 | 42,847 | 94,261 | 6.2% |
| Not Used | 34,607 | 85,442 | 82,814 | 202,864 | 13.4% |
| TOTAL VOLUME | 752,644 | 520,560 | 238,706 | 1,511,910 | 100.0% |
| | 49.8% | 34.4% | 15.8% | 100.0% | |

1 Includes bark, unless bark is separated from roundwood by debarking process.

Conversion Factors Used for Tables 2 and 3:

(L) (Large Pulp Mills: bark = figures from J. Blyth, coarse = 0.00, fines = 0.00)
(S) (V) (Sawmills & Veneer Mills: bark = .57, coarse = 1.34/1.91, fines = .78)
(P) (Post & Pole Processors: bark = .57, coarse = 1.34/1.91, fines = 0.00)
(C) (Chippers: bark = .57, coarse = 0.00, fines = 0.01)
(W) (Whole Tree Chippers - est. 10,000 cords: bark = 0.00, coarse = 2.3 ton/cd, fines = .01)
(O) (Shavings & Other Mills: bark = .57, coarse = 0.00, fines = 0.57)

TABLE 3: Volume by Fuel Use Class by Residue Category

| FUEL USE CLASS | | BARK | SLABS/EDGINGS & CHIPS | SAWDUST/EDGINGS (FINE RESIDUE) | TOTAL TONS | % OF CLASS | % OF TOTAL |
|---|---|---|---|---|---|---|---|
| Industrial Fuel | (L) | 566,946.0 | 0.0 | 0.0 | 566,946 | 66.0 | 37.5 |
| Industrial Fuel | (S) | 58,574.2 | 71,441.4 | 90,579.8 | 220,595 | 25.7 | 14.6 |
| Industrial Fuel | (V) | 6,270.0 | 10,720.0 | 5,460.0 | 22,450 | 2.6 | 1.5 |
| Industrial Fuel | (P) | 320.6 | 0.0 | 0.0 | 321 | .0 | .0 |
| Industrial Fuel | (C) | 19,380.0 | 0.0 | 215.0 | 19,595 | 2.3 | 1.3 |
| Industrial Fuel | (W) | 0.0 | 23,000.0 | 100.0 | 23,100 | 2.7 | 1.5 |
| Industrial Fuel | (O) | 929.1 | 0.0 | 5,130.0 | 6,059 | .7 | .4 |
| | | 652,420.0 | 105,161.0 | 101,485.0 | 859,066 | | (56.8) |
| Domestic Fuel | (S) | 3,543.7 | 107,466.2 | 1,810.4 | 112,820 | 99.4 | 7.5 |
| Domestic Fuel | (V) | 0.0 | 191.0 | 0.0 | 191 | .2 | .0 |
| Domestic Fuel | (P) | 85.5 | 392.0 | 0.0 | 478 | .4 | .0 |
| | | 3,629.0 | 108,049.0 | 1,810.0 | 113,489 | | (7.5) |
| Processed Fuel | (S) | 7,150.6 | 4,587.0 | 9,750.0 | 21,488 | 100 | (1.4) |
| Fiber Manufacture | (L) | 34,936.0 | 0.0 | 0.0 | 34,936 | 15.8 | 2.3 |
| Fiber Manufacture | (S) | 0.0 | 185,806.9 | 0.0 | 185,807 | 84.2 | 12.3 |
| | | 34,936.0 | 185,807.0 | 0 | 220,743 | | (14.6) |
| Other Uses | (L) | 5,883.0 | 0.0 | 0.0 | 5,883 | 6.2 | .4 |
| Other Uses | (S) | 13,732.8 | 25,782.8 | 39,938.9 | 79,455 | 84.3 | 5.2 |
| Other Uses | (V) | 0.0 | 5,730.0 | 2,418.0 | 8,148 | 8.6 | .5 |
| Other Uses | (P) | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 |
| Other Uses | (O) | 285.0 | 0.0 | 490.2 | 775 | .8 | .0 |
| | | 19,901.0 | 31,513.0 | 42,847.0 | 94,261 | | (6.2) |
| Not Used | (S) | 27,725.6 | 85,442.3 | 82,213.0 | 195,381 | 96.3 | 12.9 |
| Not Used | (V) | 22.8 | 0.0 | 31.2 | 54 | .0 | .0 |
| Not Used | (P) | 4,025.6 | 0.0 | 0.0 | 4,026 | 2.0 | .3 |
| Not Used | (C) | 2,223.0 | 0.0 | 0.0 | 2,223 | 1.1 | .1 |
| Not Used | (O) | 609.9 | 0.0 | 570.0 | 1,180 | .6 | .0 |
| | | 34,607.0 | 85,442.0 | 82,814.0 | 202,864 | | (13.4) |
| TOTAL : | (L) | 607,765.0 | 0.0 | 0.0 | 607,765 | 40.2 | |
| TOTAL : | (S) | 110,727.0 | 480,526.7 | 224,292.0 | 815,546 | 53.9 | |
| TOTAL : | (V) | 6,292.8 | 16,641.0 | 7,909.2 | 30,843 | 2.0 | |
| TOTAL : | (P) | 4,431.8 | 392.0 | 0.0 | 4,824 | .3 | |
| TOTAL : | (C) | 21,603.0 | 0.0 | 215.0 | 21,818 | 1.4 | |
| TOTAL : | (W) | 0.0 | 23,000.0 | 100.0 | 23,100 | 1.5 | |
| TOTAL : | (O) | 1,824.0 | 0.0 | 6,190.2 | 8,014 | .5 | |
| GRAND TOTAL: | | 752,644.0 | 520,560 | 238,706 | 1,511,910 | 100.0 | 100% |

# APPENDIX C

## URBAN TABLES

TABLE 1: Types of Wood Wastes

| TYPE | OUTSTATE MINNESOTA | | TWIN CITY METRO AREA | | TOTAL | |
|---|---|---|---|---|---|---|
| | TONS | PERCENT | TONS | PERCENT | TONS | PERCENT |
| Paper | 618,000 | 59 | 782,800 | 62 | 1,400,800 | 58 |
| Wood[1] | 240,000 | 22 | 217,800 | 17 | 457,800 | 19 |
| Yard | 177,000 | 16 | 224,200 | 18 | 401,200 | 17 |
| Tree Removals | 53,460 | 5 | 31,500 | 3 | 84,960 | 4 |
| Railroad Ties | -- | -- | -- | -- | 40,000 | 2 |
| TOTAL | 1,088,460 | 100 | 1,256,300 | 100 | 2,384,760 | 100 |

[1] Wood = Residential, industrial, commercial, demolition wood, and/or secondary crating.

TABLE 2: Residential/Commercial/Industrial Wood Waste

| TYPE | OUTSTATE MINNESOTA | TWIN CITY METRO AREA | TOTAL |
|---|---|---|---|
| | TONS | TONS | TONS |
| Demolition Wood | 150,800 | 191,200 | 342,000 |
| Pallets, Dunnage | 32,500 | 41,200 | 73,700 |
| Secondary Wood Products Waste | 16,800 | 21,200 | 38,000 |
| TOTAL | 200,100 | 253,600 | 453,700 |

TABLE 3: Disposal of Demolition Wood Waste

| TYPE | TONS |
|---|---|
| Sanitary Landfill | 99,100 |
| Demolition Landfill | 136,800 |
| Other Methods | 106,100 |
| TOTAL | 342,000 |

TABLE 4: Paper Waste Found in Landfills

| TYPE | OUTSTATE MINNESOTA | | TWIN CITY METRO AREA | | TOTAL | |
|---|---|---|---|---|---|---|
| | TONS | PERCENT | TONS | PERCENT | TONS | PERCENT |
| Corrugated | 231,100 | 37 | 292,800 | 37 | 523,900 | 37 |
| Newspaper | 86,500 | 14 | 109,600 | 14 | 196,100 | 14 |
| High Grade Paper | 70,500 | 12 | 89,200 | 12 | 159,700 | 12 |
| Other Paper | 229,900 | 37 | 291,200 | 37 | 521,100 | 37 |
| TOTAL | 618,000 | 100 | 782,800 | 100 | 1,400,800 | 100 |

# APPENDIX D

## WOOD PROCESSORS QUESTIONNAIRE

Form Approved
OMB No. 0596-0010

# LOGS AND OTHER WOOD PROCESSED IN 1988
Minnesota

This form is for reporting the quantities and kinds of logs and other wood processed by this plant in 1988, and the disposition of wood residues resulting from this operation.

All replies will be held confidential and used only for statistical reports.

☐ Check here if you wish to receive a copy of the report resulting from this study.

Plant or Company Name: _____

Mailing Address: _____

Plant Location: _____ County

Person to contact about this report _____
Name Title Phone No.

Types of wood processed in 1988. Check only one kind of wood product. If more than one kind was received, fill out a separate form for each.

14 -15

| | | |
|---|---|---|
| 01 | ☐ | Saw logs & bolts - includes veneer logs sawn |
| 02 | ☐ | Veneer logs & bolts cut into veneer |
| 03 | ☐ | Cooperage logs & bolts |
| 06 | ☐ | Piling |
| 07 | ☐ | Poles |
| 09 | ☐ | Fuelwood - industrial use |
| 10 | ☐ | Posts |
| 11 | ☐ | Charcoal wood |
| 12 | ☐ | Other (specify) _____ |

☐ Check here if no wood was processed in 1988 and return the form.

Total volume of above-checked product that was processed in 1988.

Conifer (pine, spruce, etc.) _____ (27-36) Hardwood (includes aspen) _____ (37-46)

Do not write in this block
Cols. 1-5 = 61100

| Mill | State | County |
|---|---|---|
| XXX | XX | XXX |
| | | |
| 6-8 | 9-10 | 11-13 |

Do not write in this block

| Factor |
|---|
| XXX |
| |
| 47-49 |

Mill size class ___ (50)

A self-addressed stamped envelope is provided for your convenience.

This survey is authorized by PL 93-378 as amended by PL 94-588. Your cooperation is appreciated and needed to make the results of this survey comprehensive, accurate, and timely, although you are not required to respond.

LOGS and OTHER WOOD PROCESSED IN 1988. Do not include logs or bolts sold or transferred to other companies. Enter quantity processed opposite species in appropriate county or state column showing where the logs and bolts were harvested. State map on page 4 shows county boundaries. If unit of measure is board feet, indicate log rule or lumber tally. ☐ Doyle ☐ International ☐ Scribner ☐ Lbr. Tally. If cords, specify size _____ If weight, specify pounds per thousand board feet _____ or pounds per cord _____

Cols.1-5=612xx or 613xx

| SPECIES | | Unit of Measure: Board ft. ☐ Cords ☐ Cubic ft. ☐ Lineal ft. ☐ Pieces ☐ Weight ☐ Other ☐ | FROM MINNESOTA — ENTER NAME OF COUNTY IMMEDIATELY BELOW | | | | | | | | OTHER STATES AND CANADA — ENTER STATE NAMES AND CANADA BELOW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX | XXXXX |
| Cedar | 01 | | | | | | | | | | | |
| Fir, Balsam | 02 | | | | | | | | | | | |
| Hemlock | 03 | | | | | | | | | | | |
| Pine, Jack | 04 | | | | | | | | | | | |
| Pine, Red | 05 | | | | | | | | | | | |
| Pine, White | 06 | | | | | | | | | | | |
| Spruce | 07 | | | | | | | | | | | |
| Tamarack | 08 | | | | | | | | | | | |
| Ash | 09 | | | | | | | | | | | |
| Aspen (popple) | 10 | | | | | | | | | | | |
| Balm of Gil. | 11 | | | | | | | | | | | |
| Basswood | 12 | | | | | | | | | | | |
| Beech | 13 | | | | | | | | | | | |
| Birch, White | 14 | | | | | | | | | | | |
| Birch, Yellow | 15 | | | | | | | | | | | |
| Cottonwood | 16 | | | | | | | | | | | |
| Elm | 17 | | | | | | | | | | | |
| Hickory | 18 | | | | | | | | | | | |
| Maple, Hard | 19 | | | | | | | | | | | |
| Maple, Soft | 20 | | | | | | | | | | | |
| Oak, Red | 21 | | | | | | | | | | | |
| Oak, White | 22 | | | | | | | | | | | |
| Walnut | 23 | | | | | | | | | | | |
| Other (specify) _____ | 24 | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | |

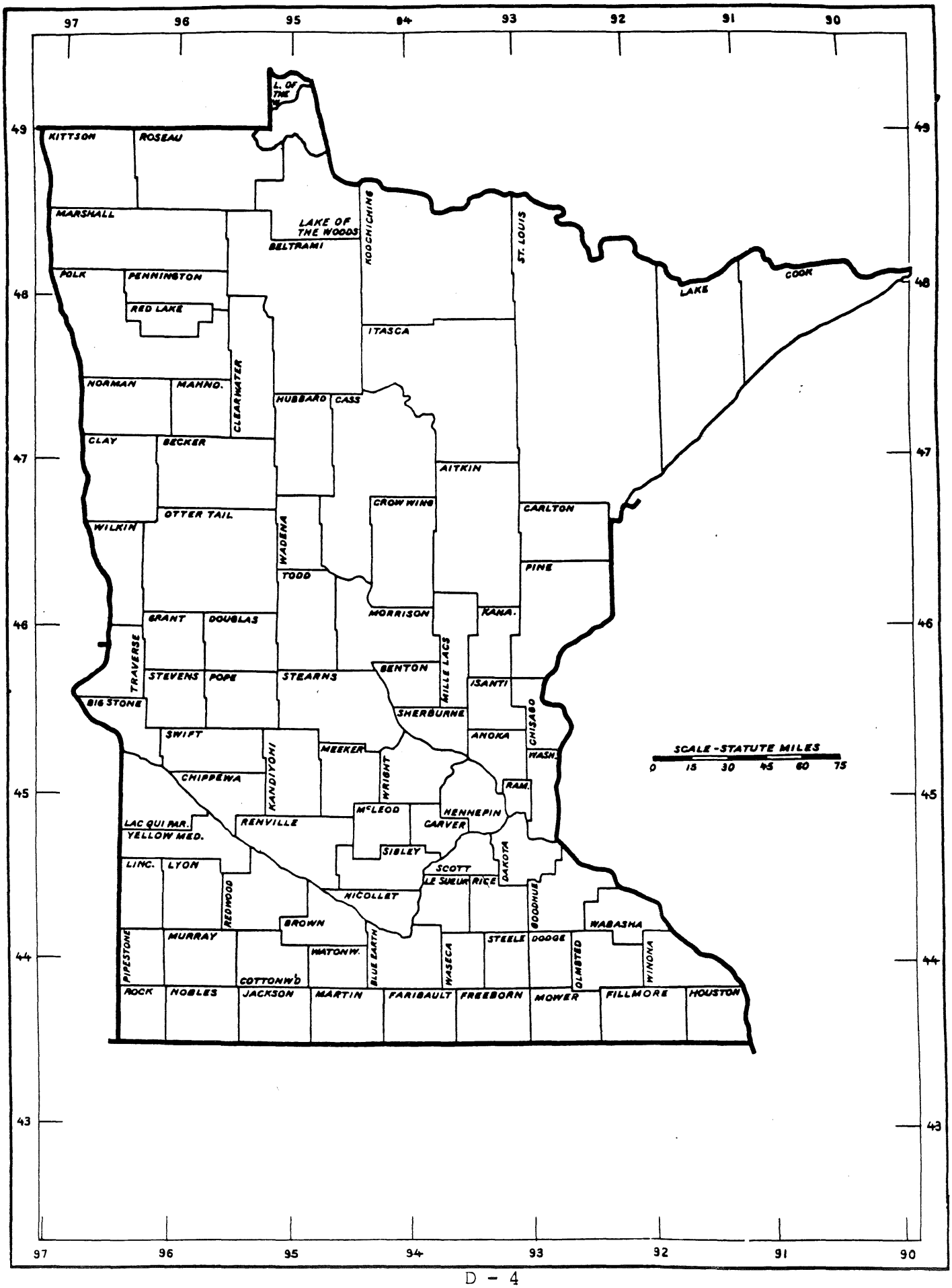
DISPOSAL OF MILL RESIDUES IN 1988 BY TYPE AND USE, FOR PRODUCT CHECKED ON PAGE 1.

Instructions: Please enter your best estimate of the percentage of each type of mill residue that was used for the various purposes indicated.

Cols 1-5 = 615xx

| Disposal of residue | | BARK | | COARSE RESIDUES (Suitable for chipping such as slabs, edgings, etc.) | | FINE RESIDUES (Sawdust, veneer clippings, etc. not suitable for chipping) | |
|---|---|---|---|---|---|---|---|
| | | 1 XX | 2 XX | 3 XX | 4 XX | 5 XX | 6 XX |
| | | Conifers | Hardwood | Conifers | Hardwood | Conifers | Hardwood |
| 1. USED FOR: | | | | | | | |
| a. Manufacture of fiber products such as pulp, hardboard, or roofing felt | 1 | % | % | % | % | % | % |
| b. Charcoal or chemical wood | 2 | % | % | % | % | % | % |
| c. Industrial fuel at this or other mills | 3 | % | % | % | % | % | % |
| d. Domestic household fuel--sold or given away | 4 | % | % | % | % | % | % |
| e. Miscellaneous uses such as livestock bedding, mulch, small dimension, and specialty items | 5 | % | % | % | % | % | % |
| 2. NOT USED (including land fill and residues burned as waste) | 6 | % | % | % | % | % | % |
| 3. TOTAL | | 100% | 100% | 100% | 100% | 100% | 100% |

# MINNESOTA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L. OF THE
KITTSON
ROSEAU
MARSHALL
LAKE OF THE WOODS
BELTRAMI
KOOCHICHING
ST. LOUIS
LAKE
COOK
POLK
PENNINGTON
RED LAKE
ITASCA
NORMAN
MAHNO.
CLEARWATER
HUBBARD
CASS
CLAY
BECKER
AITKIN
CROW WING
CARLTON
OTTER TAIL
WILKIN
WADENA
TODD
PINE
MORRISON
KANA.
GRANT
DOUGLAS
TRAVERSE
STEVENS
POPE
STEARNS
BENTON
MILLE LACS
ISANTI
BIG STONE
SHERBURNE
CHISAGO
SWIFT
ANOKA
MEEKER
WASH.
KANDIYOHI
WRIGHT
CHIPPEWA
RAM.
McLEOD
HENNEPIN
LAC QUI PAR.
YELLOW MED.
RENVILLE
CARVER
SIBLEY
LINC.
LYON
SCOTT
DAKOTA
LE SUEUR
RICE
REDWOOD
NICOLLET
GOODHUE
BROWN
WABASHA
PIPESTONE
MURRAY
WATONW.
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
COTTONWD
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
SCALE - STATUTE MILES
0 15 30 45 60 75

# APPENDIX E

## CONVERSION FACTORS

# PRIMARY PROCESSOR RESIDUE CONVERSION FACTORS

Tons of Residue:

| | | |
|---|---|---|
| Bark | = | .57 green tons/1,000 boardfeet International Rule |
| Coarse | = | 1.34 green tons/1,000 boardfeet International Rule |
| Fine | = | .78 green tons/1,000 boardfeet International Rule |

Cubic Feet of Residue:

| | | |
|---|---|---|
| Bark | = | 31 $ft^3$/1,000 boardfeet International Rule |
| Coarse | = | 48 $ft^3$/1,000 boardfeet International Rule |
| Fine | = | 28 $ft^3$/1,000 boardfeet International Rule |

Cubic Feet to Green Tons:

| | | | | green tons/$ft^3$ | $ft^3$/gr ton | lbs/$ft^3$ |
|---|---|---|---|---|---|---|
| Bark | = | $\frac{.57 \text{ gr tons/M}}{31 \text{ ft}^3\text{/M}}$ | = | .018 | 54.4 | 36 |
| Coarse | = | $\frac{1.34 \text{ gr tons/M}}{48 \text{ ft}^3\text{/M}}$ | = | .028 | 38.8 | 56 |
| Fine | = | $\frac{.78 \text{ gr tons/M}}{28 \text{ ft}^3\text{/M}}$ | = | .028 | 35.9 | 56 |

An average for total residue: 38.5 $ft^3$/ton

# APPENDIX F

## FUELWOOD QUESTIONNAIRE

OFFICE USE ONLY

PHONE #_____

INTERVIEWER_____

DATE_____

# RESIDENTIAL FUELWOOD DEMAND ASSESSMENT

Q. Number_____

| burn season (year) | | State ID # | | survey unit | pop unit | County # | | | survey number within a County | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 9 | 2 | 7 | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

1. Do you have facilities to burn wood? (1=YES, 2=NO) . . . . . [ ] 13

2. Did you burn fuelwood last year? (1=YES, 2=NO). . . . . [ ] 14

3. Do you plan to burn fuelwood this winter? (1=YES, 2=NO) . . . . . [ ] 15

4. Have you recently installed or do you plan on installing wood burning facilities? (1=YES, 2=NO) . . . . [ ] 16

5. Over the last 12 months did your household cut or collect fuelwood or POSTS in Minnesota on land where it was grown? . . . . . [ ] (69)

(1=CUT/COLLECT FUELWOOD, 2=NO, 3=DON'T KNOW)

**IF RESPONDENT ANSWERS "NO" TO QUESTIONS 1 THRU 5, END INTERVIEW**

---

6. What type of facility do you have to burn wood? . . . . . [ ] 17

1=STOVE 2=REGULAR FIREPLACE 3=MODIFIED FIREPLACE (eg., insert) 4=FURNACE
5=1 & 2 6=1 & 3 7=1 & 4 8=2 OR 3, & 4

7. How many years ago did you first burn wood? . . . . . [ ] 18

1=LAST YEAR 2=2 YEARS AGO 3=3 YEARS AGO 4=4-5 YEARS AGO 5=MORE THAN 5 YEARS AGO

8. Do you burn wood as: (Code ONE response only). . . . . [ ] 19

1=MAJOR SOURCE OF HEAT (Primary heat source with another fuel for backup)
2=SUPPLEMENTARY SOURCE OF HEAT (used as backup system)
3=FOR PLEASURE ONLY

9. If you burn wood for BOTH heating and pleasure, what % of the volume of wood is burned strictly for pleasure? (leave BLANK if burn for PLEASURE ONLY). . . . . [ ][ ] 20-21

10. What species did you burn and what percent of the total volume BURNED was each?
(Round to nearest tenth. Blank=0%, 1=10%, 2=20%,...9=90-100%)

| oak | birch | ash | elm | maple | aspen | bass-wood | mixed hrdwd | other hrdwd #1 | other hrdwd #2 | other hrdwd #3 | pine | spruce /fir | mixed sftwd | other sftwd #1 | other sftwd #2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |

11. For your **RESIDENCE**, what volume of **roundwood** did you burn?
**(Give volume to nearest 1/10th standard cord)** . . . . . [ ][ ].[ ] 57-59

volume of **roundwood:**_____

12. For your **RESIDENCE**, what volume of **industrial residue** (eg. pallets, crates, lumber) did you burn?
**(Give volume to nearest 1/10th standard cord)** . . . . . [ ][ ].[ ] 60-62

volume of **industrial residue:**_____

13. Do you have a second home or other building where you burn wood?

If **NO** leave **blank** and **SKIP QUESTIONS 14 AND 15**

If **YES**, what county is the second home or other building located in?
**County name:**_____ . . . . . [ ][ ][ ] 54-56

14. For your **SECOND HOME** (other building), what volume of **roundwood** did you burn?
**(Give volume to nearest 1/10th standard cord)** . . . . . [ ][ ].[ ] 63-65

volume of **roundwood:**_____

15. For your **SECOND HOME** (other building), what volume of **industrial residue** (eg. pallets, crates, lumber) did you burn?
**(Give volume to nearest 1/10th standard cord)** . . . . . [ ][ ].[ ] 66-68

volume of **industrial residue:**_____

16. If you purchase fuelwood, what length is the wood? . . . . . [ ] 24

1=16" 3=48" 5=8 feet (or 100") 7=random/mixed roundwood 9=did **NOT** purchase
2=24" 4=6 feet 6=tree length 8=random/mixed slabs, edgings

**********
* *
* IF ANSWER TO QUESTION 5 IS "NO", THANK RESPONDENT AND END THE INTERVIEW *
* *
**********

17. What percent of your fuelwood does your household cut? **(Blank = 0%, 99 = 100%)** . . . . . [ ][ ] 22-23

18. If your household cut or collected fuelwood in Minnesota during the last 12 months on land where where it was grown, about how much was cut or collected?
Code the **AMOUNT** in tenths. . . . . [ ][ ].[ ] (70-72)

Code **MEASUREMENT UNITS**: . . . . . [ ][ ] (73-74)

| | | | | |
|---|---|---|---|---|
| 01 = 3/4 ton pickup | 08 = small van | 15 = dry wood, tons | 22 = bundles | 30 = 50 pieces |
| 02 = 1/2 ton pickup | 09 = full size station wgn | 16 = cubic feet | 23 = 5" trees | 31 = 100 pieces |
| 03 = small pickup truck (Toyota, Nissan, etc.) | 10 = small station wgn | 17 = face cord, 4'x 8'x 12" | 24 = 10" trees | 32 = 150 pieces |
| 04 = full size car trunk | 11 = small hatchback | 18 = face cord, 4'x 8'x 16" | 25 = 15" trees | 33 = 200 pieces |
| 05 = sml size car trunk | 12 = green wood, lbs. | 19 = face cord, 4'x 8'x 18" | 26 = 20" trees | 34 = 300 pieces |
| 06 = suburban carryall | 13 = dry wood, lbs. | 20 = face cord, 4'x 8'x 24" | 27 = 25" trees | 66 = other _____ |
| 07 = full size van | 14 = green wood, tons | 21 = **STD. CORD**, 4'x 8'x 4' | 28 = 30" trees | 99 = don't know |
| | | | 29 = 40" trees | |

19. If your household cut fuelwood, what percent of the volume was cut from: (Blank=0%, 1=10%, 2=20%, .... 9=90-100%)

Woodland areas outside city or village limits (if 0% GO TO QUESTION 21) . . . . . [ ] (75)

What percent of the fuelwood cut in woodland areas was from: . . . . . [ ][ ][ ] 25-27

a) live standing trees (IF > 0%, GO TO QUESTION 20)
b) dead trees, standing or down (GO TO QUESTION 21)
c) tops and trees remaining after logging (GO TO QUESTION 21)

a b c

20. After live, standing trees were harvested, was the fuelwood cut from the trees:. . . . . [ ] (76)

1 = trunk 2 = tree limbs 3 = trunk and tree limbs

21. If your household cut fuelwood, what percent was cut from:
(Blank=0%, 1=10%, 2=20%, 3=30%,...9=90-100%) [ ][ ][ ] (77-79)

d1) fence rows, windbreaks, or yards of homes outside city and village limits
d2) scattered trees on pasture or cropland
e) trees inside city or village limits

d1 d2 e
28 29

22. If your household cut fuelwood what percent was harvested from: . . . . . [ ][ ][ ][ ][ ]
(Round to nearest tenth. Blank=0%, 1=10%, 2=20%, 3=30%,...9=90-100%)

A1(80) B-31 C-32 D1(81) D2(82)
30 33

(A) private land (B) state land (C) county land
(D1) National Forest land (D2) other federal land, agency_____
(A2) land owned by a forest industrial company that produces lumber, pulp, and paper, or veneer (E) other, don't know

[ ][ ]
A2(83) E-34
30

23. If your household cut fuelwood, what counties was it cut from AND what percent was cut from each county?
(LIST UP TO 3 COUNTIES) (100% = 99)

County name: % cut from county:

_____ _____
_____ _____
_____ _____

COUNTY PERCENT

[ ][ ][ ] [ ][ ]
35 36 37 (84) (85)

[ ][ ][ ] [ ][ ] (86-90)
[ ][ ][ ] [ ][ ] (91-95)

24. What species did you cut and what percent of the total wood your household CUT was each?
(Round to nearest tenth. Blank=0%, 1=10%, 2=20%,...9=90-100%)

| oak | birch | elm | aspen | maple | other | other | other |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

(96-103)

[ ][ ] [ ][ ] [ ][ ]
(104-5) (106-7) (108-9)

25. Did you or anyone in your household cut wood for POSTS in Minnesota during the last 12 months? . . . . . [ ] (110)
( 1 = YES, 2 = NO)

**********
* If answer to question 25 is NO, thank respondent and end interview. *
*
* If answer to question 25 is YES, continue with interview. *
**********

# APPENDIX G

## FUELWOOD TABLES

TABLE 1: Volume of Fuelwood Burned by Use Class and Survey Unit

(in cords)

| SURVEY UNIT | USE CLASS MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL 1ST HOME | TOTAL 2ND BLDG. | TOTAL |
|---|---|---|---|---|---|---|
| Aspen-Birch | 92,641.3 | 44,926.8 | 8,275.2 | 145,843.3 | 13,697.1 | 159,540.4 |
| Northern Pine | 148,241.2 | 51,773.1 | 1,533.1 | 201,547.4 | 19,176.4 | 220,723.8 |
| Central Hardwoods | 132,220.1 | 114,964.1 | 14,947.3 | 262,131.4 | 25,567.9 | 287,699.3 |
| Prairie | 63,809.3 | 72,713.1 | 8,040.7 | 144,563.0 | 13,697.1 | 158,260.1 |
| Metro | 19,364.0 | 130,995.4 | 43,195.6 | 193,555.0 | 19,175.7 | 212,730.7 |
| TOTAL | 456,275.9 | 415,372.4 | 75,991.9 | 947,640.1 | 91,314.2 | 1,038,954.3 |

TABLE 2: Households Burning Fuelwood by Use Class and Survey Unit

| SURVEY UNIT | MAJOR | | USE CLASS SUPPLEMENTAL | | PLEASURE | | TOTAL WITHIN SURVEY UNIT | | TOTAL ACROSS SURVEY UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Percent |
| Aspen/Birch | 12,816 | 33 | 16,843 | 43 | 9,154 | 24 | 38,813 | 100 | 9 |
| Northern Pine | 21,621 | 51 | 17,297 | 41 | 3,538 | 8 | 42,456 | 100 | 9 |
| Central Hardwoods | 32,102 | 32 | 45,143 | 43 | 23,073 | 23 | 100,318 | 100 | 21 |
| Prairie | 13,834 | 20 | 41,501 | 59 | 14,698 | 21 | 70,033 | 100 | 15 |
| Metro | 4,695 | 2 | 98,599 | 44 | 122,075 | 54 | 225,369 | 100 | 47 |
| TOTAL | 85,068 | 18 | 219,383 | 46 | 172,538 | 36 | 476,989 | 100 | 100 |

TABLE 3: Households Burning Fuelwood by Population Unit and Use Class

(sample statistics)

| POPULATION UNIT | USE CLASS | | | TOTAL |
|---|---|---|---|---|
| | MAJOR | SUPPLEMENTAL | PLEASURE | |
| Rural | 105 | 130 | 37 | 272 |
| Small Town | 23 | 33 | 21 | 77 |
| Large Town | 3 | 12 | 50 | 49 |
| Very Large Town | 0 | 12 | 19 | 31 |
| TOTAL | 140 | 225 | 126 | 491 |

TABLE 4: Volume Burned (in cords) by Population Unit and Use Class

(sample statistics)

| POPULATION UNIT | USE CLASS | | | TOTAL |
|---|---|---|---|---|
| | MAJOR | SUPPLEMENTAL | PLEASURE | |
| Rural | 646.7 | 351.6 | 21.8 | 1020.1 |
| Small Town | 159.5 | 80.8 | 12.1 | 252.4 |
| Large Town | 48.5 | 68.6 | 30.7 | 147.8 |
| Very Large Town | 0.0 | 7.9 | 4.5 | 12.4 |
| TOTAL | 854.7 | 508.9 | 69.1 | 1432.7 |

TABLE 5: Average Number of Cords of Fuelwood Burned by Use Class and Survey Unit

| SURVEY UNIT | USE CLASS | | |
|---|---|---|---|
| | MAJOR | SUPPLEMENTAL | PLEASURE |
| Aspen-Birch | 7.23 | 2.67 | 0.90 |
| Northern Pine | 6.86 | 2.99 | 0.43 |
| Central Hardwoods | 4.12 | 2.55 | 0.65 |
| Prairie | 4.61 | 1.75 | 0.55 |
| Metro | 4.12 | 1.33 | 0.35 |

TABLE 6: Total Volume Burned by Species and Use Class

(estimated statistics--in cords)

| SPECIES NAME | USE CLASS - MAJOR | USE CLASS - SUPPLEMENTAL | USE CLASS - PLEASURE | TOTAL* 1st HOME |
|---|---|---|---|---|
| Oak | 110,948.5 | 154,574.9 | 32,830.9 | 298,354.2 |
| Birch | 61,963.7 | 50,876.8 | 10,669.6 | 123,510.0 |
| Ash | 44,654.8 | 34,511.1 | 2,585.7 | 81,751.5 |
| Elm | 76,036.0 | 47,025.0 | 4,552.8 | 127,613.8 |
| Maple | 36,392.8 | 34,943.5 | 2,609.2 | 73,945.4 |
| Aspen | 44,724.5 | 19,923.3 | 7,334.5 | 71,982.3 |
| Basswood | 1,533.1 | 601.9 | 643.8 | 2,778.9 |
| Mixed Hardwoods | 62,900.2 | 57,097.5 | 13,774.4 | 133,771.8 |
| Pine | 14,040.7 | 5,106.8 | 52.2 | 19,199.7 |
| Spruce/Fir | 0.0 | 2,746.9 | 141.0 | 2,887.9 |
| Mixed Softwoods | 3,506.9 | 7,516.1 | 822.4 | 11,845.3 |
| TOTAL | 456,701.1 | 414,923.2 | 76,016.0 | 947,640.3 ** |

* An additional 91,314 cords were burned to heat second homes and out buildings. It is assumed that the species breakdown for this volume is the same as that shown for first-home use.

** See Table 12 of this appendix.

TABLE 7: Total Volume Burned by Species and Use Class: Aspen-Birch

(in cords)

| SPECIES NAME | USE CLASS - MAJOR | USE CLASS - SUPPLEMENTAL | USE CLASS - PLEASURE | TOTAL 1st HOME |
|---|---|---|---|---|
| Oak | 6,427.8 | 6,504.7 | 1,135.4 | 14,067.9 |
| Birch | 31,846.0 | 14,188.8 | 3,050.9 | 49,085.7 |
| Ash | 10,401.7 | 2,637.1 | 282.0 | 13,320.8 |
| Elm | 439.5 | 2,106.0 | 0.0 | 2,545.5 |
| Maple | 7,691.4 | 8,002.7 | 2,303.8 | 17,997.8 |
| Aspen | 11,866.7 | 5,054.3 | 1,175.7 | 18,096.7 |
| Mixed Hardwoods | 20,327.3 | 2,380.6 | 329.6 | 23,037.6 |
| Pine | 3,662.6 | 1,281.9 | 0.0 | 4,944.5 |
| Spruce/Fir | 0.0 | 2,746.9 | 0.0 | 2,746.9 |
| TOTAL | 92,662.9 | 44,903.1 | 8,277.4 | 145,843.1 |

TABLE 8: Total Volume Burned by Species and Use Class: Northern Pine

(in cords)

| SPECIES NAME | USE CLASS - MAJOR | USE CLASS - SUPPLEMENTAL | USE CLASS - PLEASURE | TOTAL 1st HOME |
|---|---|---|---|---|
| Oak | 43,438.7 | 24,058.3 | 137.6 | 67,634.6 |
| Birch | 20,107.6 | 6,820.5 | 302.7 | 27,230.7 |
| Ash | 13,444.4 | 629.0 | 7.9 | 14,081.2 |
| Elm | 13,904.3 | 1,965.6 | 0.0 | 15,869.9 |
| Maple | 8,845.0 | 2,889.4 | 0.0 | 11,734.3 |
| Aspen | 24,738.4 | 8176.7 | 967.1 | 33,882.2 |
| Basswood | 1,533.1 | 0.0 | 0.0 | 1,533.1 |
| Mixed Hardwoods | 8,746.7 | 6,682.9 | 117.9 | 15,547.5 |
| Pine | 10,378.1 | 550.4 | 0.0 | 10928.5 |
| Mixed Softwoods | 3,105.6 | 0.0 | 0.0 | 3,105.6 |
| TOTAL | 148,241.6 | 51,772.6 | 1,533.1 | 201,547.3 |

TABLE 9: Total Volume Burned by Species and Use Class: Central Hardwoods

(in cords)

| SPECIES NAME | USE CLASS - MAJOR | USE CLASS - SUPPLEMENTAL | USE CLASS - PLEASURE | TOTAL 1st HOME |
|---|---|---|---|---|
| Oak | 39,936.8 | 46,046.1 | 6,711.3 | 92,694.1 |
| Birch | 4,032.8 | 5,968.9 | 1,314.2 | 11,315.9 |
| Ash | 2,156.8 | 12,138.5 | 762.4 | 15,057.8 |
| Elm | 37,037.6 | 20,234.2 | 2,166.9 | 59,438.7 |
| Maple | 19,160.8 | 3,671.7 | 0.0 | 22,832.5 |
| Aspen | 6,380.3 | 3,350.6 | 1,865.9 | 11,596.8 |
| Basswood | 0.0 | 601.9 | 0.0 | 601.9 |
| Mixed Hardwoods | 23,113.4 | 19,532.0 | 2,126.8 | 44,772.1 |
| Pine | 0.0 | 611.9 | 0.0 | 611.9 |
| Mixed Softwoods | 401.3 | 2,808.9 | 0.0 | 3,210.2 |
| TOTAL | 132,219.5 | 114,964.7 | 14,947.4 | 262,131.6 |

TABLE 10: Total Volume Burned by Species and Use Class: Prairie

(in cords)

| SPECIES NAME | USE CLASS MAJOR | USE CLASS SUPPLEMENTAL | USE CLASS PLEASURE | TOTAL 1st HOME |
|---|---|---|---|---|
| Oak | 11,443.3 | 12,130.2 | 904.3 | 24,477.9 |
| Birch | 3,260.8 | 5,947.7 | 1,208.7 | 10,417.2 |
| Ash | 18,651.9 | 14,712.8 | 1,086.9 | 34,451.6 |
| Elm | 17,669.3 | 10,712.9 | 1,469.5 | 29,851.7 |
| Maple | 695.6 | 6,634.7 | 0.0 | 7,330.3 |
| Aspen | 1,739.1 | 2,260.8 | 130.4 | 4,130.4 |
| Basswood | 0.0 | 0.0 | 173.9 | 173.9 |
| Mixed Hardwoods | 10,712.9 | 18,704.1 | 3,000.0 | 32,416.9 |
| Pine | 0.0 | 313.0 | 52.2 | 365.2 |
| Mixed Softwoods | 0.0 | 947.8 | 0.0 | 947.8 |
| TOTAL | 64,172.9 | 72,363.9 | 8,026.0 | 144,562.7 |

TABLE 11: Total Volume Burned by Species and Use Class: Metro

(in cords)

| SPECIES NAME | USE CLASS MAJOR | USE CLASS SUPPLEMENTAL | USE CLASS PLEASURE | TOTAL 1st HOME |
|---|---|---|---|---|
| Oak | 9,702.0 | 65,835.4 | 23,942.3 | 99,479.6 |
| Birch | 2,716.5 | 17,950.9 | 4,793.1 | 25,460.5 |
| Ash | 0.0 | 4,393.7 | 446.4 | 4,840.1 |
| Elm | 6,985.4 | 12,006.4 | 916.3 | 19,908.1 |
| Maple | 0.0 | 13,745.1 | 305.4 | 14,050.5 |
| Aspen | 0.0 | 1,080.8 | 3,195.4 | 4,276.2 |
| Basswood | 0.0 | 0.0 | 469.9 | 469.9 |
| Mixed Hardwoods | 0.0 | 9,797.8 | 8,200.1 | 17,997.8 |
| Pine | 0.0 | 2,349.6 | 0.0 | 2,349.6 |
| Spruce/Fir | 0.0 | 0.0 | 141.0 | 141.0 |
| Mixed Softwoods | 0.0 | 3,759.3 | 822.4 | 4,581.7 |
| TOTAL | 19,403.9 | 130,918.7 | 43,232.4 | 193,555.0 |

TABLE 12: Total Cords Purchased by Survey Unit and Use Class

| SURVEY UNIT | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Aspen-Birch | 48,392.1 | 22,773.9 | 7,390.5 | 78,556.5 |
| Northern Pine | 64,009.6 | 22,515.8 | 1,258.0 | 87,783.4 |
| Central Hardwoods | 44,100.6 | 25,254.6 | 8,198.9 | 77,554.0 |
| Prairie | 13,056.6 | 15,670.3 | 3.977.0 | 32,703.9 |
| Metro | 19,013.9 | 62,880.6 | 23,898.6 | 105,793.1 |
| TOTAL | 188,572.8 | 149,095.2 | 44,723.0 | 382,390.9 * |

* A total of 52,400 cords of the purchased wood is derived from industrial residues such as slabwood from sawmills. A total of 31,300 cords were used in first homes and 21,100 cords were used in second homes and outbuildings.

TABLE 13: Total Volume Cut by Survey Unit and Use Class

| SURVEY UNIT | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Aspen-Birch | 44,249.2 | 22,153.0 | 884.7 | 67,286.7 |
| Northern Pine | 84,231.6 | 29,257.2 | 275.2 | 113,763.9 |
| Central Hardwoods | 88,119.5 | 89,709.5 | 6,748.4 | 184,577.4 |
| Prairie | 50,752.7 | 57,042.7 | 4,063.7 | 111,859.0 |
| Metro | 25,588.6 | 68,114.7 | 19,297.0 | 113,000.2 |
| TOTAL | 292,941.4 | 266,277.1 | 31,268.9 | 590,487.3 |

TABLE 14: Total Cords Cut by Survey Unit and Type of Removal

| SURVEY UNIT | LIVE STANDING TREES | DEAD TREES STAND/DOWN | TOPS/LOGGING RESIDUES | RURAL/AGRI LAND CLEAR | RESIDENTIAL/URBAN LAND CLEAR | TOTAL VOLUME |
|---|---|---|---|---|---|---|
| Aspen-Birch | 23,983.4 | 30,682.5 | 4,663.0 | 7,577.8 | 379.9 | 67,286.7 |
| Northern Pine | 31,770.8 | 50,856.7 | 4,505.7 | 26,207.9 | 422.9 | 113,763.9 |
| Central Hardwoods | 11,335.4 | 137,846.6 | 3,671.6 | 22,078.3 | 9,645.3 | 184,577.2 |
| Prairie | 12,658.5 | 60,577.4 | 0.0 | 31,462.8 | 7,160.3 | 111,858.9 |
| Metro | 3,196.3 | 33,734.0 | 47.2 | 262.4 | 75,760.3 | 113,000.2 |
| TOTAL | 82,944.3 | 313,697.1 | 12,887.6 | 87,589.2 | 93,368.7 | 590,486.9 |

TABLE 15: Total Cords Cut by Survey Unit and Land Ownership

| SURVEY UNIT | PRIVATE | STATE | COUNTY | FEDERAL | OTHER | TOTAL |
|---|---|---|---|---|---|---|
| Aspen-Birch | 53,039.2 | 4,167.8 | 3,653.7 | 6,426.1 | 0.0 | 67,286.7 |
| Northern Pine | 107,047.4 | 3,399.7 | 3,316.8 | 0.0 | 0.0 | 113,763.9 |
| Central Hardwoods | 177,385.9 | 3,082.0 | 4,109.4 | 0.0 | 0.0 | 184,577.2 |
| Prairie | 111,859.0 | 0.0 | 0.0 | 0.0 | 0.0 | 111,859.0 |
| Metro | 107,486.1 | 0.0 | 551.4 | 0.0 | 4,962.7 | 113,000.2 |
| TOTAL | 556,817.7 | 10,649.5 | 11,631.2 | 6,426.1 | 4,962.7 | 590,487.0 |

TABLE 16: Type of Facilities Used by Use Class: Statewide

| | USE CLASS | | | |
|---|---|---|---|---|
| FACILITY | MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
| Stove | 36,911 | 93,408 | 22,266 | 152,585 |
| Regular Fireplace | 3,657 | 56,439 | 100,566 | 160,662 |
| Modified Fireplace | 6,295 | 37,255 | 45,597 | 89,147 |
| Furnace | 31,573 | 12,974 | 2,372 | 46,919 |
| Stove/Regular Fireplace | 1,152 | 6,609 | 1,369 | 9,130 |
| Stove/Modified Fireplace | 0 | 2348 | 366 | 2,714 |
| Stove/Furnace | 3,744 | 6,240 | 0 | 9,984 |
| Fireplace/Furnace | 732 | 1,396 | 0 | 2,128 |
| Unknown | 1,003 | 2,714 | 0 | 3,717 |
| TOTAL | 85,067 | 219,383 | 172,536 | 476,986 |

TABLE 22: Number of Households Planning to Install Facilities

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 5,637 | 9,687 | 4,077 | 19,401 |
| Regular Fireplace | 0 | 2,732 | 3,107 | 5,839 |
| Modified Fireplace | 786 | 9,060 | 4,695 | 14,541 |
| Furnace | 2,732 | 1,125 | 0 | 3,857 |
| Stove/Regular Fireplace | 366 | 759 | 0 | 1,125 |
| Stove/Modified Fireplace | 0 | 2,348 | 0 | 2,348 |
| Stove/Furnace | 393 | 366 | 0 | 759 |
| Fireplace/Furnace | 366 | 1,003 | 0 | 1,369 |
| TOTAL | 10,280 | 27,080 | 11,879 | 49,239 |

TABLE 23: Households Planning to Install by Use Class: Aspen-Birch

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 2197 | 732 | 0 | 2929 |
| Regular Fireplace | 0 | 0 | 366 | 366 |
| Modified Fireplace | 0 | 366 | 0 | 366 |
| Furnace | 0 | 732 | 0 | 732 |
| Stove/Regular Fireplace | 366 | 366 | 0 | 732 |
| Stove/Furnace | 0 | 366 | 0 | 366 |
| Fireplace/Furnace | 366 | 0 | 0 | 366 |
| TOTAL | 2929 | 2562 | 366 | 5857 |

TABLE 24: Households Planning to Install by Use Class: Northern Pine

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 1572 | 0 | 0 | 1572 |
| Regular Fireplace | 0 | 0 | 393 | 393 |
| Modified Fireplace | 786 | 786 | 0 | 1572 |
| Furnace | 0 | 393 | 0 | 393 |
| Stove/Regular Fireplace | 0 | 393 | 0 | 393 |
| Stove/Furnace | 393 | 0 | 0 | 393 |
| TOTAL | 2751 | 1572 | 393 | 4716 |

TABLE 25: Households Planning to Install by Use Class: Central Hardwoods

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 1003 | 4013 | 0 | 5016 |
| Regular Fireplace | 0 | 1003 | 0 | 1003 |
| Furnace | 1003 | 0 | 0 | 1003 |
| Fireplace/Furnace | 0 | 1003 | 0 | 1003 |
| TOTAL | 2006 | 6019 | 0 | 8025 |

TABLE 26: Households Planning to Install by Use Class: Prairie

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 865 | 2594 | 1729 | 5188 |
| Regular Fireplace | 0 | 1729 | 0 | 1729 |
| Modified Fireplace | 0 | 865 | 0 | 865 |
| Furnace | 1729 | 0 | 0 | 1729 |
| TOTAL | 2594 | 5188 | 1729 | 9511 |

TABLE 27: Households Planning to Install by Use Class: Metro

| FACILITY | USE CLASS - MAJOR | SUPPLEMENTAL | PLEASURE | TOTAL |
|---|---|---|---|---|
| Stove | 0 | 2,348 | 2348 | 4,696 |
| Regular Fireplace | 0 | 0 | 2348 | 2,348 |
| Modified Fireplace | 0 | 7,043 | 4695 | 11,738 |
| Stove/Modified Fireplace | 0 | 2,348 | 0 | 2348 |
| TOTAL | 0 | 11,739 | 9391 | 21,130 |