

Information for Timber Management and Planning: An Assessment of Availability and Adequacy in Minnesota

**Bernard J. Lewis
Paul V. Ellefson**

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Bernard J. Lewis

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Bernard J. Lewis, Research Fellow and Paul V. Ellefson, Professor, Forest Economics and Policy, Department of Forest Resources, College of Forestry, University of Minnesota, St. Paul, MN 55108.

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I. INTRODUCTION

In attempting to identify the most effective course for the management of Minnesota's forest lands, policy makers and resource managers in the state's public and private sectors are confronted with a variety of problems. The continual shrinkage of the forest land base is accompanied by an escalation in the demand for wood fiber and other forest-based goods and services. Proponents for various forest outputs often express their desires to elected officials, who in turn must rely upon resource managers and administrators for effective methods of responding to these increasing demands. From a statewide perspective, the problem becomes one of how the state may best assure that the demands of its citizens are addressed and at the same time provide for the stability of the state's forest resource through responsible management.

Responses to these problems by public officials and forest managers require adequate information describing the existing resource base, present and future demands for forest-based goods and services, as well as measures of the effectiveness of current and potential management programs in providing these outputs while assuring forest stability.

Purpose

This report describes the existing information resource for forest management in Minnesota. In addition to examining the various kinds of information available, the report also addresses the adequacy of existing information for management decisions. Potential steps to improve the quality of information for forest management are also suggested. Emphasis is given to information required for the production of timber from the state's forests; however, the importance of nontimber management goals, both in and for themselves as well as with respect to their impacts on timber management, is also addressed from the standpoint of information availability and adequacy.

Scope

The report focuses on information for the management of public forest lands in Minnesota. Federal, state, and county agencies manage 10 million acres of forest land in the state, approximately 60 percent of the state's forest resource. These organizations are the primary institutional means through which government attempts to respond to the variety of demands placed upon Minnesota's forests.

Specific topics considered in this report are concerned with the following questions:

- . What is the nature of information and its relationship to forest management?
- . What information is available for the management of public forest lands in Minnesota?

- . What agencies or organizations within the state are responsible for gathering and/or maintaining this information?
- . In what form do these agencies maintain this information?
Discussion in this area will be by no means exhaustive; it is, however, intended to provide a foundation for future work concerning the variety of methods by which agencies organize and distribute information both internally and externally.
- . How adequate is existing information for public forest management?
Based upon responses to a questionnaire distributed to individuals in forest land management agencies within the state (including the wood-based industry), a discussion of information adequacy and needs is presented.
- . What are the opportunities for improving the information base for forest management in Minnesota?

In focusing on public forest lands, the important role of the private sector in the management of the state's forests is not ignored. Private individuals and corporations control 6.7 million acres or approximately 40 percent of all acres classified as forest land within the state. From the standpoint of information, there exists a relationship of mutual interdependence between the public and private forestry sectors in the state. For example:

- . Information regarding private sector management goals and intensities is important for public agencies in assessing their overall objectives and management strategies for public forests.
- . Information concerning public forest management policies and programs is critical to forest industries dependent upon the public sector for raw materials, as well as for indications of the status of the resource as well as current economic and social conditions.
- . Nonindustrial private landowners can utilize information from both the public sector and forest industry to help better achieve their forest management objectives while contributing to the economy via enhanced forest outputs.
- . The general public utilizes information regarding the use of public forests for a variety of recreational and aesthetic experiences. These very uses in turn generate information needs for public managers, in order that they may help maintain a viable forest resource base within the state.

A variety of uses for the state's public forests are both possible and compatible, but the degree to which they may be simultaneously achieved is greatly influenced by the amount and quality of information public forest managers have at their disposal.

Perspective

It is important at the outset to accurately describe the perspective from which information for forest management in Minnesota is being considered in this report. Such a perspective is from the state of Minnesota as a whole, which is representative of all its citizens. The combination of forest management activities undertaken by both the public and private forestry sectors in the state contributes significantly to the welfare of citizens with varying perceptions of and expectations from state forest lands (Figure 1).

The framework within which forest management activities in the state can contribute to enhancing the welfare of its citizens is embodied in state forest resource goals. Establishing and refining such goals is a complex and continually evolving process. It is not the purpose of this report to attempt to define these goals; this document is intended, rather, to provide a better understanding of the information through which effective policy formulation and resource management may be achieved.

As noted previously, emphasis will focus upon information availability and adequacy for public forest management in the state. Clearly the ability of federal, state and county agencies to: a) define their goals; and b) achieve them through effective forest management policies; is to a large extent dependent upon the information resource which individuals within these agencies have at their disposal.

Utility

This report summarizes Minnesota's forest and timber management information resources and is reflective of the time and resources available for its preparation. It is hoped that the report will enable resource managers in both public and private sectors, as well as other concerned individuals, to:

- . better assess the current information resource for public forest management in Minnesota in terms of kinds of information available and problems which may arise in its use for management decisions;
- . more clearly define information resources which are critical to the development of effective forest policies and which are limited in their availability;
- . obtain a better understanding of the complex social, economic and institutional aspects of the forest resource community in the state.

This in turn may result in the enhanced role of the forestry sector in contributing to the achievement of state forest resource goals.

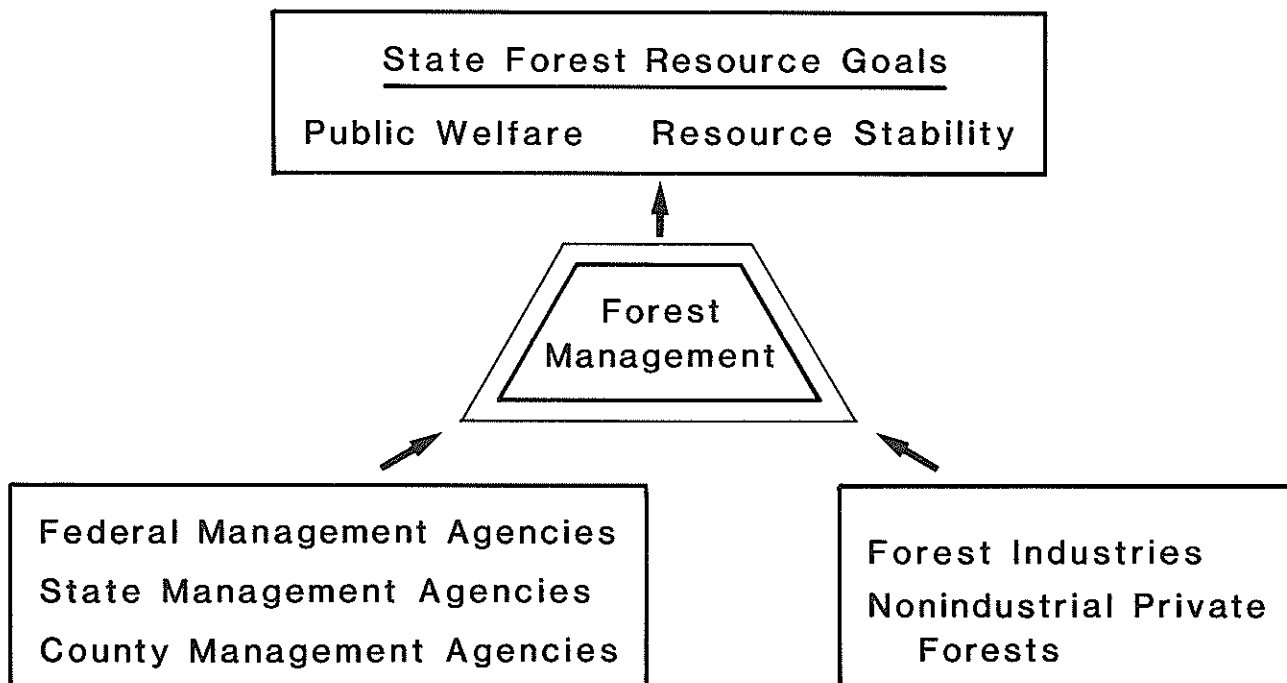


Figure 1. Perspective of forest management's contribution to statewide forest resource goals.

II. A BRIEF OVERVIEW OF FOREST MANAGEMENT IN MINNESOTA

Forest Resource

Minnesota, the nation's tenth largest state, contains 53.8 million acres within its boundaries. In 1981 forest land comprised approximately one-third of the total state land area, some 16.7 million acres. Of this, 13.7 million acres, or 82 percent is classified as commercial forest land (CFL), or that capable of producing at least 20 cubic feet per acre per year of industrial wood and not withdrawn by statute or administrative regulation for other uses (Table 1). Four-fifths of the commercial forest land in Minnesota is located in the 17 northern counties of the state.

Table 1. Minnesota forest area by forest land classes, 1962 and 1977.

Forest Land Class	1977 (in thousands of acres)	1962	Percent Change
Forest Land	16,709.2	18,445.0	- 9
Commercial Forest Land	13,693.1	15,411.8	-11
Noncommercial Forest Land	3,014.1	3,033.2	- 1
Unproductive	1,835.5	2,563.1	-28
Productive-Reserved	1,178.6	479.1	+151

Source: (Jakes 1980b).

In addition to commercial forest land, an additional 11 percent of the total forest land within the state, some 1.8 million acres, is classified as unproductive forest land. Various adverse site conditions prevent these lands from producing crops of industrial wood. The remaining 7 percent of the state's forest area consists of those lands withdrawn from commercial timber use through legal or administrative mandates--parks, wildlife refuges, etc.--as well as all private Christmas tree plantations within the State.

Hardwood types predominant throughout Minnesota, comprising almost three-fifths of the state's commercial forest area. Aspen is by far the most prevalent species (Table 2). Softwoods account for

Table 2. Composition of commercial forest land in Minnesota, 1977.

Forest Type	Acres (in thousands)	Percentage of Total Commercial Forest Land
Aspen	5,302.3	38.7
Other Hardwoods	3,913.5	28.6
Pine	816.9	6.0
Other Softwoods	3,493.0	25.5
Nonstocked	169.4	1.2
Total	13,695.1	100.0

Source: Modified from (Jakes, 1980b).

less than one-third of the state's growing stock, and the three major species of pine occurring in Minnesota--red, white, and jack pine--represent only 6 percent of the state's total commercial forest resource.

Forest Ownership

Public land ownership in Minnesota is substantial, accounting for almost 60 percent of all forest land in the state. The private sector, nonetheless, does control almost half of the state's commercial forest lands (Table 3), the majority of which belongs to farmers and other nonindustrial private landowners. Almost 90 percent of the state's 1.8 million acres of unproductive forest lands are under public ownership, with state and county agencies managing 1.3 million acres of these lands.

A closer look at the 10 million acres of Minnesota's forests under public management reveals that state, county, and municipal agencies manage approximately two-thirds of these lands, while the USDA Forest Service manages one-fourth and other federal agencies administer the remaining 9 percent. Commercial forests account for 7.3 of the 10 million public acres, and management of these lands is fairly evenly divided among the U.S. Forest Service (23.4 percent), the Department of Natural Resources of the State of Minnesota (36.2 percent), and county land departments (32.0 percent); other federal agencies, primarily the USDI Bureau of Indian Affairs account for the remaining 8.4 percent of the public commercial forest resource.

The diversity of public forest management agencies in Minnesota presents a unique picture of resource management found in few other states. All agencies contribute significantly to the stability and productivity of the state's forests. Yet each agency undertakes its management activities from a slightly different perspective; this is reflected in the particular structure and organization of a given agency for the purpose of addressing its specific tasks and responsibilities.

The U.S. Forest Service, through the two national forests in Minnesota, conducts management activities in accordance with federal legislation enacted in the mid-1970s. In addition to managing these forest lands with the needs of Minnesota citizens and forest industries in mind, the national forests also must fulfill their mission as components of the federal National Forest System.

The Division of Forestry within the Minnesota Department of Natural Resources manages the state forest system under guidelines established in the Statutes of the State of Minnesota. In addition to these responsibilities, the Division also assists county land management agencies with their forestry programs and activities.

Minnesota counties and municipalities own 43.5 percent of all of the forest land owned by counties and municipalities in the United States (Minnesota State Planning Agency 1978). County

Table 3. Minnesota forest resource: classification and ownership (in thousands of acres), 1977.

Minnesota Forest Land	Total Forest Land	Percent of Total Forest Land	Commercial Forest Land	Percent of Total CFL	Non-commercial Forest Land	Unproductive Forest Land	Pro-ductive Forest Reserved	Percent Total NCFL
Public	10,026.8	59.9	7,328.4	52.6	2,698.4	1,531.4	1,167.0	89.5
Private	6,682.4	39.9	6,366.7	46.5	315.7	304.1	11.6	10.5
TOTAL	16,709.2	99.8^{a/}	13,695.1	99.1^{a/}	3,014.1	1,835.5	1,178.6	100.0
National Forest System	2,599.4	15.5	1,715.1	12.5	884.3	125.6	758.7	29.3
Bureau of Land Management	875.0	5.2	43.9	0.05	253.8	127.1	126.7	8.4
Bureau of Indian Affairs			466.8	3.4				
Other Federal			110.5	0.1				
State County and Municipal	6,552.4	39.2	2,650.5 2,341.6	19.4 17.1	1,560.3	1,278.7	281.6	51.8
Forest Industry	807.2	4.8	772.0	5.6	35.2	35.2	--	1.2
Nonindustrial Private Forestry	5,875.2	35.1	5,594.7	40.9	280.5	268.9	11.6	9.3
TOTAL	16,709.2	99.8^{a/}	13,695.1	99.1^{a/}	3,014.1	1,835.5	1,178.6	100.0

^{a/} Percentages do not equal 100 due to rounding.

Source: Modified from Jakes, 1980b.

forests are administered by land departments within each individual county; generally these departments are not able to maintain the number of staff positions characteristic of state and federal agencies. Despite this handicap, it is the consensus among the forestry community within the state that the counties have made significant progress within the last decade in managing their forests for a variety of uses.

When other public forest management agencies and forest industry are considered along with the aforementioned organizations, it becomes apparent that a variety of forest management programs are being conducted concurrently within the state. As noted previously, understanding how all of these activities combine to contribute to the well-being of Minnesota citizens is a difficult task, particularly because the overall state goals for forestry have not been clearly defined in the past. A recent enactment of legislation by the Minnesota Legislature defines forest policy goals for the state and helps to alleviate this problem (Senate File 1859 and House File 1982, as amended; Seventy-second Minnesota Legislative Session, 1982).

As this process of goal definition evolves, important implications arise regarding the information resource for forest management in the state. More specifically, information concerning the activities of all forest management agencies must be identified, collected, organized, summarized, and disseminated in such a way that it will be both useful to decision makers in various forestry managerial positions and also helpful in ascertaining overall progress toward state forestry goals. As various agencies respond to their particular missions, they may collect and/or organize specific

kinds of information in similar or perhaps slightly different ways. A useful step within this overall process, therefore, would involve a systematic assessment of what information is available for forest management in the state and where it may be located. The following sections of this report will address this question, and also take an initial look at how decision makers judge the adequacy of different kinds of information for forest management.

Timber Resource Characteristics

In 1977, commercial forest lands in Minnesota contained a growing stock of 11.45 billion cubic feet or almost 145 million cords of timber. This represents a 21 percent increase in growing stock volume from 1962. Almost 7 million acres, or 51 percent of the state's commercial forests are of pole timber size, with the remainder relatively evenly divided among seedling, sapling, and saw-timber stand-age classes. There is, however, a substantial amount of aspen acreage in mature and overmature age classes; these represent the maturation of extensive areas in northern Minnesota which succumbed to forest fires in the early part of this century.

Net growth on commercial forest land in 1976 amounted to nearly 349 million cubic feet or 6.1 million cords. This represents 71.4 percent of total annual growth and 3 percent of current inventory. As depicted in Table 4, net growth for commercial forests is fairly evenly balanced between public and private ownerships; this balance is also maintained among forests under jurisdiction of different agencies within the public sector.

Table 4. Minnesota timber net growth, mortality and removals, by ownership class, 1977.

	<u>Cubic Feet</u>	<u>Cords</u>	<u>Cubic Feet per Acre</u>	<u>Cords per Acre</u>
Total Annual Growth (1976)	488,072,414	6,178,132	35.6	0.45
Net Annual Growth (1976)	348,920,000	4,416,710	25.5	0.32

Net Growth is 71.4 percent of Total Growth

	Commercial Forest Land in Thousands of Acres	Percent of Commercial Forest Land	Growth		Mortality		Removals	
			Net Annual Growth in Cubic Feet (all species)	Percent of Total Net Annual Growth	Average Net Annual Growth per Acre in Cubic Feet	Annual Mortality in Cubic Feet	Removals in Cubic Feet (all species)	Percent of Total Removals (all species)
Public	7,328.4	52.6	186,844	53.5	25.5	72,150	74,102	38.3
Private	6,366.7	46.5	162,076	46.5	25.5	69,541	119,498	61.7
TOTAL	13,695.1	99.1^{a/}	348,920	100.0	25.5	141,541	193,600	100.0
National Forest System	1,715.1	12.5	50,903	14.6	29.7	14,272	16,423	8.5
Bureau of Land Management	43.9	0.05	1,727	0.5	39.3	--	0	0.0
Bureau of Indian Affairs	466.8	3.4	12,548	3.9	29.0	4,029	5,202	2.7
Other Federal	110.5	0.1	3,411	1.0	30.9	861	0	0.0
State	2,650.5	19.4	63,052	18.1	23.9	20,998	34,123	17.6
County & Municipal	2,341.6	17.1	54,203	15.5	23.1	31,990	18,354	9.5
Forest Industry	772.0	5.6	15,899	4.6	20.6	12,680	15,165	7.8
Nonindustrial Private Forestry	5,594.7	40.9	146,177	41.9	26.1	56,711	104,333	53.9
TOTAL	13,695.1	99.1^{a/}	348,920	100.1^{a/}	25.5	141,541	193,600	100.0

^{a/} Percentages do not equal 100.0 percent due to rounding.

Source: Modified from Jakes 1980a.

Mortality of growing stock on Minnesota commercial forest land in 1976 averaged 1.2 percent of inventory and 29 percent of total annual growth. This amounted to 141 million cubic feet (1.79 million cords) or 0.13 cords per acre. Within the public sector, county forests experienced a slightly higher rate of mortality than did other public forests (Table 4). However, when contrasting public and private lands as a whole, overall mortality as a percent of growth was slightly higher on private lands.

Removals from Minnesota's commercial forests in 1976 totaled 193.6 million cubic feet or 2.45 million cords, a 33 percent increase since 1962. Most of this gain was from increases in hardwood removals; softwood removals in 1976 were very close to those which occurred in 1962. There is substantial evidence, moreover, that significantly greater removals can be safely absorbed by the hardwood forest component, primarily within the aspen forest type.

On a statewide basis, almost 62 percent of total removals came from the private sector; about seven-eighths of these removals were from nonindustrial private ownerships. Removals from public forests constituted 38 percent of the state's total. Approximately one-half of public removals were

effected from state-managed lands, while federal and county commercial forests accounted for the other 50 percent in relatively equal proportions.

Timber Production and Consumption

In 1975, Minnesota produced approximately 30 percent of the industrial roundwood generated within the Lake States. This is reflected by the status of forest industries as the third largest industrial sector within the state. The public sector, consisting of 54 percent of the state's commercial forests, furnished approximately half of the state's total industrial roundwood output (Figure 2).

Softwoods represent a substantial element (44 percent) within overall state industrial roundwood harvest; however, in 1975 overall pine harvest within the state fell below the previous modern-day minimum set in 1949. Approximately 46 percent of roundwood production consisted of aspen, while spruce and jack pine accounted for about 12 and 15 percent of total harvest, respectively (Figure 3). Pulpwood constituted the major element within overall roundwood harvest (73 percent in 1975), and 1.46 million cords were produced in 1979.

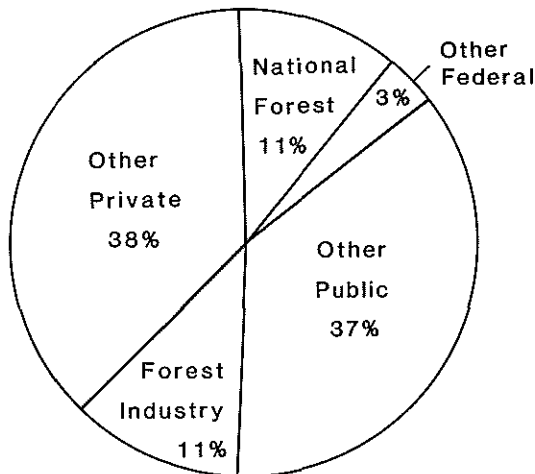


Figure 2. Minnesota industrial roundwood production by ownership class, 1975. (Source: Blyth *et al.* 1980).

Production figures for selected timber products from Minnesota forests in 1975 are summarized in Table 5. These contribute to the following trends in value added in manufacture by primary forest industries within the state from 1970

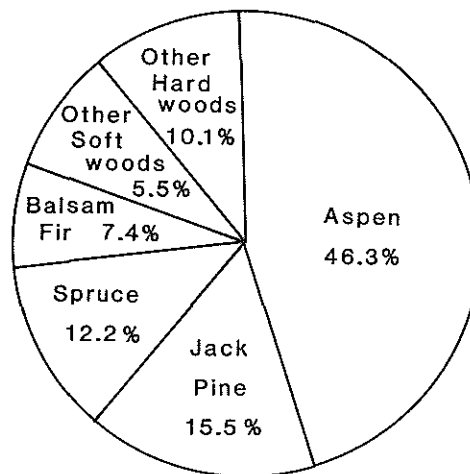


Figure 3. Minnesota industrial roundwood production by species, 1975. (Source: Blyth *et al.* 1980).

through 1990 (Deene and Gregersen 1975):

- 1970 : \$184.4 million
- 1980 : \$270 million (projected figure)
- 1990 : \$375 million (projected figure)

Table 6 depicts industrial roundwood production by ownership class with Minnesota for 1975.

Table 5. Production (1975) and consumption (1970 through 1990) of selected timber products in Minnesota.

Product Category	Units	1975 Production ^{1/}	Source	Trends: Percent Increase or Decrease		Source
				State Production 1970-1990	State Consumption 1970-1990	
Industrial Roundwood Production	Thousand cubic feet	135,713	A	Not Available		
Pulpwood Production (1975)	Standard cords,unpeeled	1,359,000	A	+ 31	+ 73	D
Pulpwood Production (1979)	Standard cords,unpeeled	1,340,166	B	Not Available		
Sawlog Production	Thousand board feet	156,123	A	+ 9	+ 17	D
Veneer Log Production	Thousand board feet	3,216	A	Not Available		
Fuelwood Production	Cords	302,000	C	Steady	+ 1	D
Post Production	Pieces	2,781,000	C	+ 2	- 3	D
Pole Production	Pieces	103,000	C	- 8	- 9	D

^{1/} Except where noted.

Sources: A = Blyth *et al.* 1980
 B = Blyth and Smith 1981
 C = Jakes 1980a
 D = Deene and Gregersen 1975

Table 6. Minnesota industrial roundwood products output by forest ownership class (in thousands of cubic feet), 1975.

Ownership Class	Total (all species)	Percent of Total (all species)	Softwoods	Percent of Total Softwoods	Hardwoods	Percent of Total Hardwoods
National Forest	15,166	11.2	7,912	13.4	7,254	9.5
Other Federal	4,338	3.2	2,504	4.2	1,834	2.4
State and County ^{1/}	49,945	36.8	24,211	40.9	25,734	33.6
Forest Industry	15,331	11.3	7,627	12.9	7,704	10.1
NIPF	50,933	37.5	16,897	28.5	34,036	44.4
All Owners	135,713	100.0	59,151	100.0	76,562	100.0

^{1/} Municipalities included in counties.

Source: Blyth *et al.* 1980.

The pulp and paper industry consumes approximately four-fifths of total production from forests within the state. In 1975 this amounted to 1.36 million cords (Table 5). Wood pulp demand is expected to increase dramatically by 1990, and demand for other pulp (including recycled paper) is expected to show even greater increases (143 percent). The construction of three new waferboard plants in northern Minnesota is also expected to contribute significantly to a 408 percent predicted increase in the production of particleboard in the state for the period of 1970 through 1990.

In 1975, pulpwood imports into Minnesota were estimated at somewhere between 5 and 15 percent of total demand. This percentage may rise due to the expected large increases in demand for both pulp-paper and fiberboard-waferboard. The current shortage in softwoods within the state is expected to persist through 1990. This combination of softwood shortage and projected increases in demand will result in a 25 percent reduction of net timber exports from Minnesota from 8 million cubic feet in 1980 to 6 million cubic feet in 1990.

Land Use and Ownership Trends

A variety of demands for nonforest uses has resulted in a steady reduction of forested areas in the state over the past 20 years. Such demands are likely to continue to compete for the state's forest lands well into the next century. Total forest land decreased by 9 percent during the period from 1962-1977, with an average loss of 114,000 acres per year (Table 1). Commercial forest area declined at a rate of 0.8 percent per year, resulting in an 11 percent decrease during the 15-year period between surveys conducted by the U.S. Forest Service. Approximately 19,600 acres of non-commercial forest land were converted to commercial lands during this time via natural and/or artificial regeneration techniques.

Only minor changes occurred in the distribution of commercial forest land among ownership classes in Minnesota from 1962 to 1977 (Table 7). In both years, public ownership accounted for 54 percent of the total state CFL. Five percent of total losses came from the nonindustrial private sector, although the largest percentage loss (19.9 percent) within a single ownership class was absorbed by the National Forest System. This reflects the transfer of extensive acreages of the Superior National Forest into the Boundary Waters Canoe Area, as well as the inclusion of substantial areas within Voyageur's National Park. These forest lands are now classified as productive-reserved, and these transfers have resulted in a 151 percent increase in lands of that category over the 15 year period from 1962 to 1977 (Table 1). The majority of commercial forest land losses absorbed by counties in Minnesota were a result of the sale of tax-forfeited lands to the private sector. As indicated in Table 7, the only ownership class to show an increase during this period was that of industrial forest ownership, which acquired an additional 56,000 acres.

Such losses from the state's commercial forest base are likely to continue, though at a slightly slower rate than has occurred in the past two decades. Within the next 20 years, land use fluctuations in Minnesota are projected to be most evident in the transitional area between forest and agricultural land which stretches diagonally from the northwest to the southeast corners of the state (Minnesota State Planning Agency 1978). This broad belt includes about 32 percent of the state's total area.

The primary impetus for the continuing decline in commercial forest land within Minnesota will be the conversion of such lands to agricultural uses (Table 8). It is possible that the state could lose as much as 1-1/2 million acres of commercial

Table 7. Area of Minnesota commercial forest land by ownership class (in thousands of acres), 1962 and 1977.

Ownership Class	1977	Percent of Total	1962	Percent of Total	Change	Percent Change
National Forest	1,715.1	12.5	2,142.0	13.9	-426.9	-19.9
Other Federal	621.3	4.5	676.1	4.4	-54.8	-8.1
State	2,650.5	19.4	2,685.2	17.4	-34.7	-1.3
County and Municipal	2,341.6	17.1	2,683.2	17.4	-341.6	-12.7
Forest Industry	772.0	5.6	715.5	4.6	+56.3	+7.9
NIPF	5,594.6	40.9	6,509.6	42.2	-915.0	-14.1
All Owners	13,695.1	100.0	15,411.8	99.9	-1,716.7	-11.1

Source: Jakes and Vasilevsky 1980.

Table 8. Projected loss of Minnesota commercial forest land base by land use, 1980 through 2000.

Land Use	Low (acres)	Percent of Commercial Forest Land 1977	High (acres)	Percent of Commercial Forest Land 1977
Agricultural	735,000	5.4	1,050,000	7.7
Urban	147,000	1.0	147,000	1.0
Iron Ore	21,000	<1.0	31,500	<1.0
Copper/Nickel	10,500	<1.0	21,000	<1.0
Peat	21,000	<1.0	210,000	1.5
Energy	10,500	<1.0	15,750	<1.0
Transportation	6,300	<1.0	6,300	<1.0
Preservation	42,000	<1.0	105,000	1.0
Total Projected Losses	993,300	7.3	1,586,550	11.6
Total Average Annual Loss	47,300	--	75,550	--

Source: Modified from G. Banzhaf Co. 1980.

forest land to other uses by the year 2000, or 11.6 percent of all such land existing in 1977. Agriculture could claim two-thirds of this total. Projections of average annual losses for the next 20 years range from a low of 47.3 thousand to a high of 75.5 thousand acres per year.

A critical factor in the retention of the state's forest base lies in the ability of the forestry community to confirm the importance of these lands to the well being of the citizens of the state. A valuable tool for doing so is accurate, reliable information documenting the multifaceted contributions of the forest resource to the welfare of all Minnesotans. Lack of such concrete information makes the task of retaining land in forest cover all the more difficult, especially when proponents of alternative non-forest uses present detailed information to support their claims. Thus, the need has never been

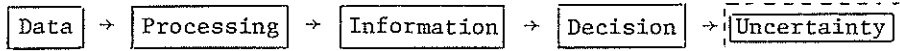
greater for a systematic process for the identification, collection, and dissemination of relevant information concerning the existing status of Minnesota's forests, the goods and services they currently provide, and the variety of future demands which will be placed upon them. The following sections of this report will contribute to this important process of information identification and management.

III. INFORMATION AND DECISIONS IN FOREST MANAGEMENT: A FRAMEWORK FOR ANALYSIS

The Nature of Data and Information

It is worthwhile to briefly examine some general concepts regarding the nature of data and information prior to a discussion of their relationship to forest management in Minnesota. There exist numerous definitions for information. Two representative ones are those proposed by Lucas (1978) and Davis (1974) (Figure 4).

A data set or file represents a collection of related records. Records for all plots in a particular stand may be kept in the form of a file for access and processing. Data is also organized for processing purposes into data structures, file structures and data bases; the last of which are specifically organized to facilitate computerized processing. Data may describe a characteristic of an object at a particular point in time (condition data), or it may represent a situation occurring over a period of time (operating data).



Lucas: Information is a tangible or intangible entity which serves to reduce uncertainty about some future state or event.

Davis:^{a/} Information is data that has been processed into a form that is meaningful to the recipient, and is of real or perceived value in current or prospective decisions.

^{a/} A number of basic definitions in this section concerning data and information have been adapted from Davis (1974).

Figure 4. Relationship of data, information, and decisions.

The degree to which uncertainty is reduced depends upon both the quality of the information and the nature of the decision for which it is used. For example, information that a particular forested tract contains a large volume of marketable timber reduces the uncertainty that the decision to harvest that particular tract is a feasible one. But additional information may be required before such a decision can be made. How accessible are the stands in question? What are the current market conditions for the timber which would be produced? And so forth.

In most cases, the uncertainty regarding selection of a particular course of action is never actually eliminated. There will always be "what if" considerations regarding the potential selection of other alternatives. However, the reduction of uncertainty concerning the feasibility of a particular choice (which quality information provides) may greatly increase the probability that the alternative selected is the best course of action under the given set of circumstances.

The basic raw material from which information is formed is data. Data are individual facts which must be combined or "processed" in some fashion in order to give them meaning. A particular data element describes some characteristic of the object under consideration. The diameter-breast-height (dbh) of a particular tree is a simple example. A number of data elements describing this particular tree (height, age, merchantable volume, etc.) may be combined to form a record for that specific object.

Different mechanisms exist by which data may be processed into information useful for decisions. Processing need not necessarily occur through formal external (i.e., extra-individual channels); it may in fact be processed by the decision maker himself. In everyday decisions we often assemble a number of facts (data) and organize them in a particular manner; such a synthesis results in one item of information which, along with any other relevant information we may possess, may be utilized in making a particular decision. Such "internal" processing is an integral part of human nature.

Within formal organizations many decisions must be made on a regular basis using a defined set of data elements as inputs. In these cases standardized procedures are usually established for the processing of data into decision-relevant information. Processing may take the form of a routine by which data from files or records are manually manipulated into the proper form, or the processing mechanism may be automated via a computerized data processing system. The set of logically related data files organized for computer processing is referred to as a data base. The combination of the data base with software programs to facilitate its processing on the computer results in a complex, functional data base management system.

Within a particular organization, one consequence of this relationship between data and information is that the same item which is information for one level of the organization may be data at another level. Annual timber harvest from a particular district is undoubtedly an important piece of information to the district forester for use in deciding upon his future harvesting strategies. This same figure, however, may represent one data element in control analysis calculations by agency central staff analysts concerned with overall agency harvest levels. In this latter instance, the data element "t. harvest" has been processed (and in the process has been assimilated)

Dist A

$$\begin{array}{cccc}
 t. \text{ harvest} & + & t. \text{ harvest} & + & \dots & + & t. \text{ harvest} & = & T. \text{ Harvest} \\
 \text{Dist A} & & \text{Dist B} & & & & \text{Dist N} & & \text{Agency}
 \end{array}$$

$$\begin{array}{ccc}
 \text{Projected (t. harvest)} & - & \text{Actual (t. harvest)} & = & \text{Harvest} & \text{or Harvest} \\
 \text{Agency} & & \text{Agency} & & \text{surplus} & \text{deficit}
 \end{array}$$

into information useful for a particular decision of a different nature at a higher level of management.

One might wonder whether this distinction between data and information is merely a matter of semantics. This might be the case were it not for a problem which is particularly bothersome for large organizations--the accumulation and storage of data that has very little probability of being used. It can happen that massive amounts of data are collected and stored but never organized and/or processed into information of utility for decisions. Having a large data resource concerning a particular subject therefore, does not automatically ensure a large information resource on that subject. When the time and costs of data acquisition are considered, this difficulty may become even more significant. This provides further support for the necessity of a well-defined system--understood by all organizational employees--for collecting, organizing, and transferring data within the organization. Such a system must be geared towards the various decisions made at different levels of management, a topic which will be considered more explicitly in the following section.

The most formalized and automated mechanism for the transformation of data into information required for various decisions is referred to as an information system. This is a set of organized procedures, which when executed, provides information to support decisionmaking (Lucas, 1978). Such systems invariably rely upon a computer for performing the bulk of the processing tasks. Information systems may vary in size and function from those which process production, sales, and inventory transactions for a small firm to the

multi-million dollar systems for planning and control which are characteristic of executive departments at state and federal levels of government.

When such an information system is integrated within the management framework of an organization, it is referred to as a management information system. Davis (1974) defines this as a "computer-based information processing system which is designed to support the operations, management and decision functions of an organization." Figure 5 illustrates the dynamic process through which data is converted to information which in turn is synthesized within the framework of a management information system.

From the previous discussion, it is evident that quality information is essential to effective management. The value of information results from the fact that for any decision, there are a number of alternative choices which may be made, and there is always a degree of uncertainty regarding the best course of action to be taken. By reducing such uncertainty, information enhances decision-making at all levels of management. Data, the raw material of information, does not necessarily have information value unless it is processed into a form useful for decisions. Thus, Davis (1974) notes that information, with its utility for decisionmaking, may be considered as at a higher, more active level than data.

With respect to effective forest management, therefore, information is as vital a resource as the forest itself. Data must be collected, stored, and processed into information which in turn must be analyzed, summarized, and disseminated. Moreover, each of these activities involves a concrete cost in capital investment and labor. The management of the information resource has a significant impact on efficient and effective management of the organization, and thus on the ultimate achievement of organizational goals.

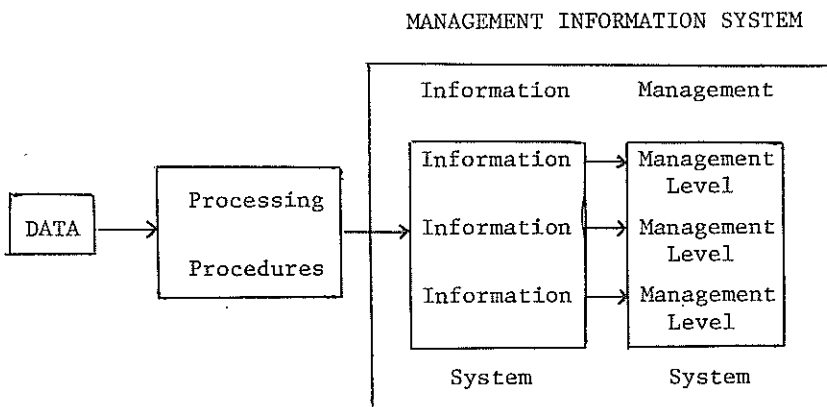


Figure 5. Conversion and synthesis of data into a management information system.

Information for Decision Processes Within
Forest Management Organizations

Adequate information is a vital ingredient for effective decision making within forest management organizations. Despite this well recognized fact, it is a difficult task for an individual within any organization to identify and obtain the optimal amount of information to allow him to carry out his management responsibilities most effectively.

The manager requires information for a variety of different decisions. The precise nature of a particular decision depends upon both the individual's management task within the organization and upon the scope of the decision itself. The field forester may be concerned with selecting the best method of reforestation for a particular tract from among a number of possible alternatives. On the other hand, the forester may wish to identify the optimal level for integrating timber and recreational management activities over his entire district.

At the other end of the management spectrum, the agency supervisor or director^{1/} may need to determine the annual expenditure for reforestation for the entire organization; or may wish to select from among several scenarios the program with the greatest potential for achieving organizational objectives over the next five, ten, or even fifty years. Each of these decisions requires information of specific content organized in a form appropriate for the scope of the particular decision to be made. Such information may pertain to people, equipment, output levels of goods and services, markets, budgets, and so on. This implies the need for a perspective which systematically links information requirements and characteristics with management decisions at all organizational levels. In order to facilitate this, it is useful to briefly examine the process of decision making within forest management organizations and the kinds of decisions which are made at different levels of management.

Within the management context, decision making is the process of selecting, from a number of alternatives, that course of action which will lead to the most effective solution to a problem, resolution of an issue, or actualization of an opportunity for improving management efficiency or effectiveness. There

^{1/} Within this report the position descriptors of supervisor and director will be used interchangeably to represent the top or strategic level of organizational management.

exists a wealth of literature concerning decision making within organizations, and it forms one of the key components in the field of management science.

In the process of decision making, the manager examines the environment both internal and external to his organization for circumstances which suggest that either a problem exists or an opportunity for improvement in performance is available. The classic model of this decision process is described by Simon (1960). In this representation, any decision consists of three phases (Figure 6). The process of arriving at a decision is relevant to all activities at all management levels, whether the decision concerns ordering more tally sheets for inventory crews or allocating a budget among different functions within the organization.

Decisions, therefore, pertain to opportunities, problems, and issues (which for our purposes may be considered as special types of problems). Opportunities for public forest management agencies in Minnesota relate to improved performance of management tasks. A general description of such opportunities is provided by Davis (1974):

- . Better definition of goals and objectives
- . Improved quality of products and services
- . Improved efficiency of production processes
 - cost reduction
 - proper product mixes
 - risk reduction in management decisions
- . Better definition of markets for goods and services
- . Improved job definitions and working conditions
- . Avoidance of undesirable environmental effects from operations
- . Enhanced educational and cultural contributions to society

If forest industry within the state is also considered, the above list of opportunities may be expanded to include the important organizational objectives of increased profits and expansion of market share.

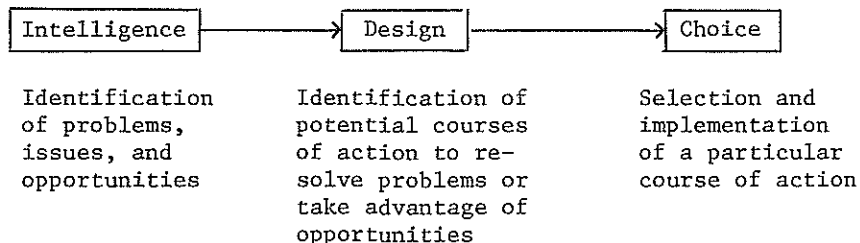


Figure 6. The Simon model of decision making and description of the three-stage process. (Source: Simon, 1960).

Within public forest management agencies, a variety of problems may arise at all levels of management which require some form of managerial decisions and subsequent action. These may be arbitrarily divided into two major categories:

- . Identification of demand patterns for goods and services
 - determination of demand levels
 - implementation of procedures for assuring the proper mix of goods and services to meet demand
- . Problems with organizational performance
 - increased costs of production
 - decrease in quantity or quality of goods and services produced
 - problems with financial management and budget allocations
 - ineffective decision procedures
 - deterioration in quality of working conditions

Important additional problems of particular relevance to forest industry include:

- . Acquisition of wood resources for the production process
- . Increased competition for market share

The above listing is by no means exhaustive; opportunities and problems arise within virtually every phase of forest management. A certain portion of these problems surface as a result of disagreement among various groups, both internal and external to the organization, concerning policy goals, methods for implementing the production process, product mixes, and the like. Resolution of internal issues regarding organizational performance is essential for ensuring continuity both within and among different functional groups of the organization.

Those issues arising from extra-organizational sources occur when different groups within society advocate varying and often conflicting output levels of goods and services (Figure 7). These issues are then interpreted by the organization at various levels depending on the nature of the issue. For example, concerns voiced by interest groups regarding the extent of aerial spraying activities by the agency would be evaluated and ultimately resolved by strategic management (after consultation with other management levels). Issues may also arise within the area of a particular administrative district should local residents disagree on some aspect of management within that district. In this case, ultimate responsibility for issue resolution lies with the district forester.

Issues which originate in the environment external to the organization invariably have a political dimension, adding further impetus to the need for organizational decisions leading to issue resolution. This is due to the fact that interest groups and/or individuals often address their concerns to elected officials as well as to

forest management organizations (Figure 7). A quick and satisfactory resolution is of obvious benefit to legislators and officials dependent upon popular support for survival in a fluctuating political arena. To ensure this, these officials request action, generally from the strategic management level of the forest management organization. The implications of this process for forest administrators is two-fold--a decision towards issue resolution is required both to satisfy action requests of elected officials and to resolve the conflicting desires of interest groups whose dissatisfaction gave rise to the issue in question.

The common thread throughout the preceding discussion of issues, problems, and opportunities is that each requires some type of decision by managers at relevant levels within the organization. In order for the correct decision to be made, three events must occur:

- . Managers within the organization who are responsible for the decision must be identified.
- . Information of sufficient quantity and quality must be available to the decision maker(s).
- . The decision maker must carry out the decision process in the correct manner so that the best course of action is selected from among the alternatives identified.

The ability to carry out decisions depends to a large extent upon the experience and management proficiency of the individual decision maker. While admittedly a crucial ingredient to effective decision making, this subject per se does not fall within the realm of this report. The primary focus of the following sections will be the availability and adequacy of information for forest management decisions. Prior to a discussion of the nature and quality of information available, however, some attention must be directed to the kinds of decisions which managers within public forestry organizations must make at different levels of management.

Organizational Structure and Types of Decisions in Forest Management Organizations

It is obvious that decisions are made by every individual within an organization. The intent here is not to consider every possible decision, but to recognize that certain kinds of decisions contribute in varying degrees to the achievement of organizational objectives. As noted previously, the impact of a given decision on organizational performance depends both upon the level of management at which the decision is made and on the scope of the decision itself. It follows, therefore, that any effort at identifying information requirements for decision making must consider both of these dimensions--management

External Socio-Political Environment

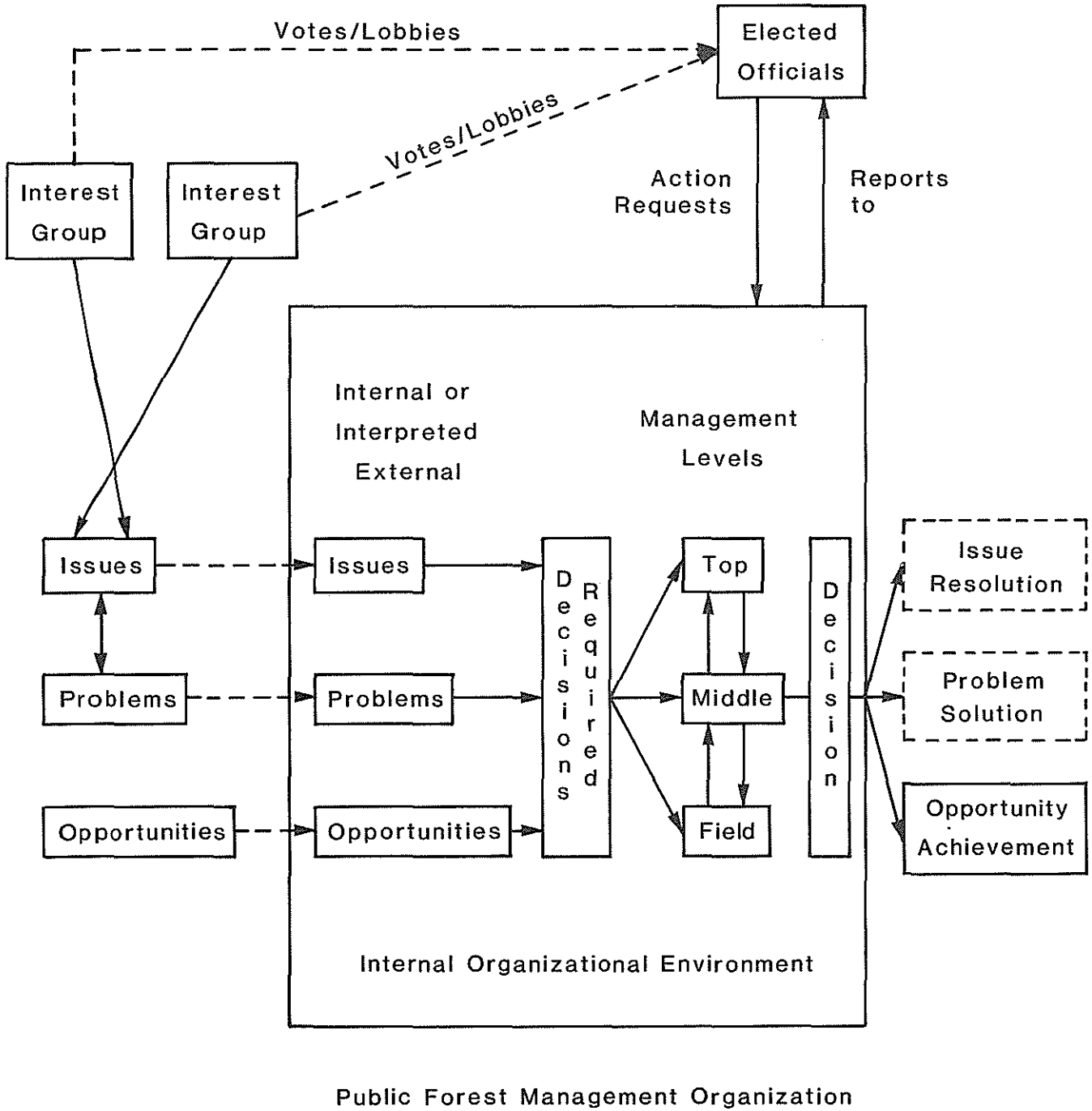


Figure 7. The decision process within a public forest management organization: A macro viewpoint.

level and decision scope--as a basis for pinpointing the nature and characteristics of information required.

With respect to public forest management organizations in Minnesota, it will be useful to examine the general divisions of management tasks within such organizations as well as the kinds of decisions required at each level. This will facilitate subsequent discussion of the relationship of information to decision-making at different levels of management.

There are a variety of ways in which the structure of an organization may be considered. One method commonly adopted by management science describes the organization in terms of three essential levels of management. These form what may be referred to as a management hierarchy within the organization, and may be represented by a pyramidal structure (Figure 8).

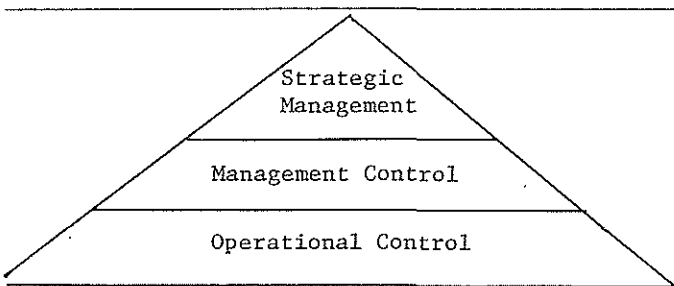


Figure 8. Management hierarchy within an organization.

Strategic management is concerned with the establishment and modification (if need be) of organizational goals and objectives and of the policies which will guide the organization in its attempt to meet those goals and objectives. Inherent in this process is a definition of the relationship between the organization and the socio-political environment within which it functions.

Management control is concerned with the acquisition and allocation of resources for and within the organization and with monitoring the performance of all operational units. Operational control involves the organization and monitoring of daily activities for different functional units within the organization. The pyramidal structure reflects the relative proportion of organizational resources which must be devoted to management activities at each level. Operational control involves a substantially larger amount of resources, in terms of manpower, equipment, etc., than does middle or top management.

When this concept is applied to public forest management agencies in Minnesota (and elsewhere, for that matter), the management hierarchy may be described as in Figure 9.

The field operations level is concerned with the day-to-day administration of forestry activities for the basic administrative management units. Disregarding the obvious differences in size and organizational complexity among federal, state, and county forestry agencies in Minnesota, this level of management would typically consist of the district forester or ranger and his management staff and assistants.

At the level of central management control, organizational resources are allocated to the various operational units whose performance is also monitored to assure that outputs of goods and services are meeting required organizational standards. Those involved at this level of management might typically include central staff concerned with various organizational functions such as timber, wildlife, recreational land management, land acquisition and disposal, etc. As with the structure of field operations, overall agency size and complexity influences the degree of specialization possible at the central staff level.

The top management or supervisory level includes the organizational director along with the heads of central management control functions described above. Activities involved at this level include defining both the role of the organization as a vehicle of government and its relationship to the socio-political environment, particularly those

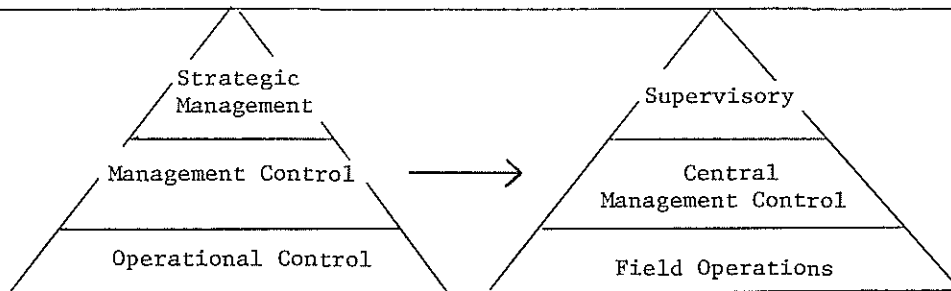


Figure 9. Management hierarchy for public forestry organizations.

elements of society to whom public forest management is of great importance (i.e., forest industry and various interest groups). Analysis of these relationships leads to the establishment of organizational goals and objectives. Strategic planning is an integral part of the above activities. The efficiency and effectiveness with which the organization as a whole operates to achieve these objectives is also of major concern to the supervisory level of management.

It should be apparent that this description of the management hierarchy is of a general nature. The degree of complexity and differentiation characteristic of these three levels of management varies depending upon the particular agency involved. Management hierarchies for individual agencies in Minnesota will be described briefly in subsequent sections of this report. Despite obvious differences in the goals and objectives of forest industries within the state (when compared with public forest management agencies), the general characteristics of the management hierarchy also apply to corporate organizations (O'Laughlin and Ellefson, 1982).

While the management hierarchy represents one way of describing the apportionment of tasks within the organization, a more explicit description of the kinds of decisions made by each level of management is warranted if information requirements are to be pinpointed accurately. Organizational decisions may be subdivided into three general classes: strategic, tactical, and technical (Table 9).

The traditional approach of management science is one of linking particular decision types to specific levels of management. Strategic decisions, concerned with objectives and policies, are often associated exclusively with strategic (i.e., top) management. Technical decisions may be described exclusively with respect to the operational control (or field) management level. One result of this approach is that certain types of decisions are excluded from the management responsibilities of various management levels. With this approach, for example, one would not expect to find a manager at the operational control level making strategic management decisions.

When decisions and levels of management are related within the context of forestry organizations in Minnesota, the one-to-one correspondence between decision type and management level does not satisfactorily describe all of the situations in which decisions must be made at each management level, particularly at the level of field operations. It is obviously true, for example, that the district ranger must make a large number of technical decisions, far more than middle or top management. Deciding which compartments within the district to harvest, administering timber sales, drawing up logging contracts, etc., are all basic technical decisions. Yet in addition to these, the district ranger is also vitally concerned with the relationship of his district

Table 9. Decisions within forest management organizations, by decision type.

Type of Decision	Decision Opportunities
Strategic	Forest management goals and objectives of the organization or autonomous management unit; Organizational policies for goal achievement; Relationship of organization to other forest management agencies (public sector) and to private organizations and interest groups; Representation of agency accomplishments and funding requirements to legislative bodies.
Tactical	Allocation of budget within the organization or autonomous management unit; Task definition and performance monitoring for functional areas within the organization; Expenditure tracking for management activities; Determination, coordination and evaluation of specific projects.
Technical	Implementation of management programs: Timber harvesting and reforestation Timber sales administration Recreation and wildlife management Inventory operations Forest fire prevention and control.

as a whole both to the rest of the organization (in terms of obtaining a share of the overall budget appropriate to his district's contribution to the organization), and external to the organization (ensuring work for local loggers, addressing concerns of private groups regarding various aspects of his management policy, etc.). These are strategic decisions which are required at the field (or operational control) level of management. They result from the fact that the district (or any higher field level organizational unit) represents both the operational control level of management within the entire agency, and yet at the same time is a semi-autonomous unit with important decision-impelling linkages to the socio-political environment external to the organization.

This same diversity of decision-making is true (probably to a lesser extent, however) at the supervisory level of management. While the majority of decisions at this level are of the strategic nature described above, involving the relationship of the organization to its environment via objectives, goals, and policies, other decisions are inherently tactical in nature. For example, the

strategic decision establishing a goal of multiple-use management for the organization may involve the tactical question of what proportion of the overall agency budget should be allocated to wild-life and recreation. It should be noted that the specific allotments to individual management activity operational units would be performed by the level of central management control.

The important point here is that, although a particular kind of decision may be more characteristic of a given level of management (for example, tactical decisions for central management control), under certain circumstances any one of the three decision types may be required at a particular management level. The relative proportion of decision types which must be made at each level of management may be more accurately represented as in Table 10. Within the context of forest management organizations in Minnesota, the general importance of various kinds of decisions to each level of management along with representative examples of the types of decisions which might be made at each level are represented in Figure 10.

Table 10. Relative frequency of decisions made at levels of management within forestry organizations.

Type of Decision	Level of Management		
	Supervisory	Central Management Control	Field Operations
Strategic	Majority	Some	Many
Tactical	Some	Majority	Some
Technical	Very few	Some	Majority

This diversity of decision making at all management levels has important implications when considering the nature and quality of information required for effective decision making at different levels of management. Information content and characteristics must be appropriate to both the level of management at which the decision occurs and the particular type of decision required. With this in mind, a closer look at the information resource for forest management in Minnesota and the problems with which managers are confronted when attempting to use this resource most effectively is now in order.

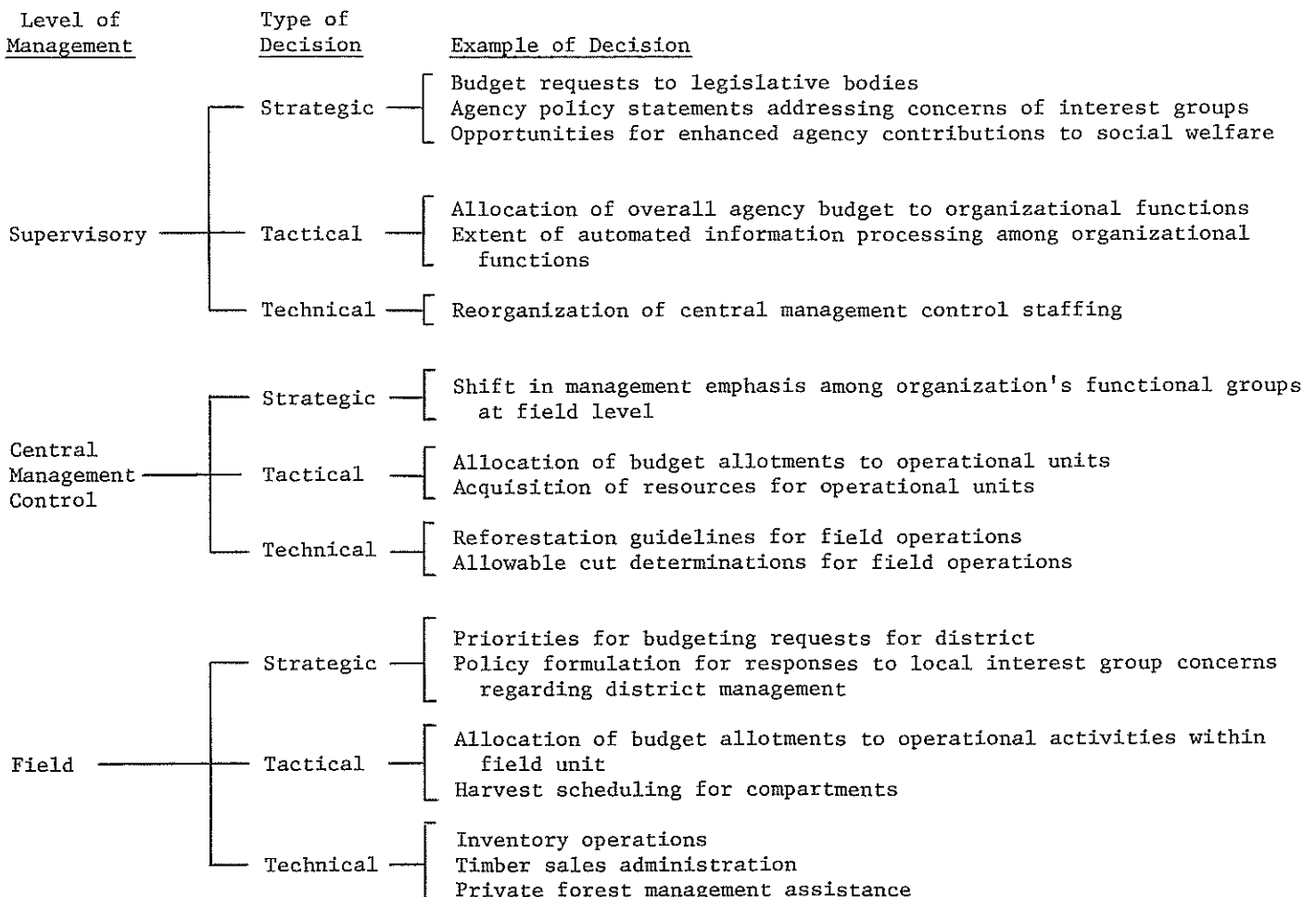


Figure 10. Types of decisions within the management hierarchy of forest management organizations.

IV. INFORMATION FOR FOREST MANAGEMENT: CONTENT AND CHARACTERISTICS

Managers and the Proliferation of Information

The decade of the eighties will be one of continued change within all elements of our society. The days of unlimited natural resources have vanished, and the impact of their increasing scarcity for a society built upon mobility and unrestrained consumption will be profound. Despite the fact that the rate of technological growth for some processes within society has slowed due to a shrinkage of resources, certain fields continue to evolve at a rapid rate. Foremost among these is the realm of communications.

The sophistication of the computer and of electronic data processing has made possible the transmission of enormous amounts of "information" across great distances with incredible speed. No part of society has been immune to this revolution in communications. Of interest here is its implications for public (and private) organizations concerned with forest management in Minnesota. This is but one aspect, albeit a major one, of the more general consideration of the role of information as a resource for forest management.

It has been emphasized that individuals at all levels within forest management organizations perform a variety of activities requiring decisions that vary in scope and importance. It has become increasingly difficult for managers to effectively utilize all of the information required for carrying out these managerial activities. Like people, information comes in all shapes and sizes; identifying and collecting the information necessary for a particular decision has become a managerial art.

The contrast between past and present, with respect to forest management, is most apparent in the use of information for management decisions. In the past, a primary factor contributing to difficulties in effective decision making was often the lack of relevant data or information. Frequently, information essential for a particular decision simply did not exist. This situation undoubtedly occurs today as well, as any manager who needs to evaluate market demand trends, land use projections, wildlife values, and so on, will readily testify.

Within the past 15 years, however, forest managers have found themselves swept headlong into the current of what has now been called "the information age." The old problem of lack of relevant information still persists; but now managers are faced with the additional problem of being inundated with massive amounts of information. The information may be so diverse in quantity and detail as to represent just as great, if not greater, an impediment to effective decision making than did the lack of pertinent information in the past. This rapid proliferation of information has been continuing now for more than a decade and Ackoff's (1969) summarization of the situation for

management in general is even more relevant today than it was more than 10 years ago.

My experience indicates that most managers receive much more data (if not information) than they can possibly absorb even if they spent all of their time trying to do so. Hence they already suffer from an information overload. They must spend a great deal of time separating the relevant from the irrelevant and searching for the kernels in the relevant documents.

Those within forest management organizations in Minnesota might feel a touch of sympathy for their beleaguered colleague were it not for the large stack of reports, bulletins, and the like awaiting their attention in some remote corner of their office.

The roots of this information explosion are twofold. One cause of the phenomenon stems from the continuing proliferation of information sources. Holm (1968) traced the increase in the number of scientific journals on a worldwide basis over the course of the last two centuries. He noted that while at the beginning of the 19th century there existed about 100 such journals, that number had increased to 10,000 by 1900 and was approaching 100,000 at the time of his work in 1968. Even identifying the journals of potential relevance to forest management is a major chore, much less taking time to select and examine those articles, reports, etc. of particular importance to specific managerial decisions.

The second cause of the information overload lies in the expansion of opportunities for information generation resulting from technological advances in computers and data processing. Sophisticated analytical techniques for data manipulation and analysis which were nonexistent several decades ago are commonplace today. The resultant opportunities for the generation of relatively new kinds of information--optimum output mixes, production and market forecasts, etc.--has provided managers with even more potential information for decision making, should they be fortunate enough to become aware of its existence.

These trends have obvious implications for the individual at any level within forest management organizations who wishes to keep abreast of his field. As if these problems were not enough, another difficulty arises from the fact that information rapidly becomes obsolete as new facts are discovered. C. H. Waddington (1977) describes this phenomenon in terms of a "coefficient of immediacy," which is the ratio of the increase in a variable (such as information) over a period, to its value at the end of that period. He notes that, were the amount of information to double in a period (say 10 years), then the coefficient of immediacy would be:

$$\frac{\text{Amount of information at beginning of period}}{\text{Amount of information at end of period}} = \frac{A}{2A} = 1/2$$

This implies that after 10 years, one-half of the current information resource will have been discovered during that 10-year period itself. In this light, the difficulties with "keeping up with what is going on" are readily apparent.

The forest manager who desires information for a technical, tactical, or strategic decision must be able to do two things. He must first accurately identify the nature of the decision to be made and the relevant information required for that decision. Second, he must be able to obtain the needed information within a period of time that assures its availability for the particular decision to be made. He may seek this information from established locations within his own agency (data bases, files, etc.), if they exist; or he may refer to his colleagues who are knowledgeable about the subject in question. At times, moreover, he may need to contact individuals within other agencies or organizations who may possess the required information resources. After all of these efforts, he may ultimately end up with information, data, a mixture of the two, or nothing at all.

Although any manager within forest management organizations in Minnesota will rarely be able to have at his fingertips all the information required for decisions of various types, answers to the following questions would be most helpful:

- 1) What kinds of information are available for forest management in Minnesota?
- 2) What agencies and/or organizations collect or maintain this information?
- 3) How adequate are these different kinds of information for forest management in the state?
- 4) In what form are different kinds of forest management information maintained? More specifically, what is the influence of how information is organized upon its utility for different forest management decisions?

The following pages address the first three of these questions in some detail, and also examine several important aspects of information organization for management decisions within forestry organizations in Minnesota.

Forest Management Information:
Content Identification

Forest management is a multi-faceted activity. Depending upon one's responsibilities within a particular organization, the forest manager must continually identify and evaluate a variety of management options and associated constraints in order to select courses of action for achieving various management objectives. In doing so, the manager is concerned with events both internal and

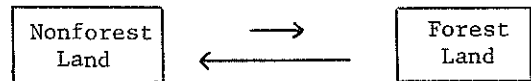
external to his organization. Identifying the diverse kinds of information required for this process of managerial decision making is a complex task.

How would one go about identifying the kinds of information relevant to forest management in Minnesota? Consider information in terms of what it is about (i.e., subject or content), and according to the specific ways in which it may be organized with respect to its subject matter (i.e., information characteristics). The former is essentially a descriptive process; it involves identifying relevant types or "categories" of forest management information. Analysis of information characteristics involves both content identification and a consideration of the dynamic processes through which data and information are generated, organized, and transferred. Decision-relevancy is one such information characteristic. Further elaboration of specific information characteristics for forest management decisions follows this discussion of information content.

A description of the subject matter of information for forest management in Minnesota permits identification of the "raw material" upon which individuals must rely for the performance of their management tasks. An initial framework for deriving different types of forest management information is presented in Figure 11. This depicts the forest resource as the focus of management activities designed to produce timber and other forest-based goods and services.

An obvious requisite for these activities is information regarding the natural qualities of the land itself: vegetation, soils, minerals, waterways, and the like. Such forest resource information comprises an important, though certainly not exclusive, element within the information base for forest management.

The forest land base, moreover, is not a static entity. There is a constant state of flux between forest and nonforest land; moreover, this interchange is by no means balanced. As noted previously, it is estimated that between the years



1980 and 2000 approximately 1.5 million acres of forest land in Minnesota could be converted to other uses and thus permanently removed from the forest base. Although a certain amount of marginal agricultural land will revert to forests during this period, additions to the forest base will be far outstripped by removals through permanent conversion. In order to effectively combat this trend and thus preserve the state's forest lands for management, both current and predictive land use information is an essential ingredient for strategic forest management.

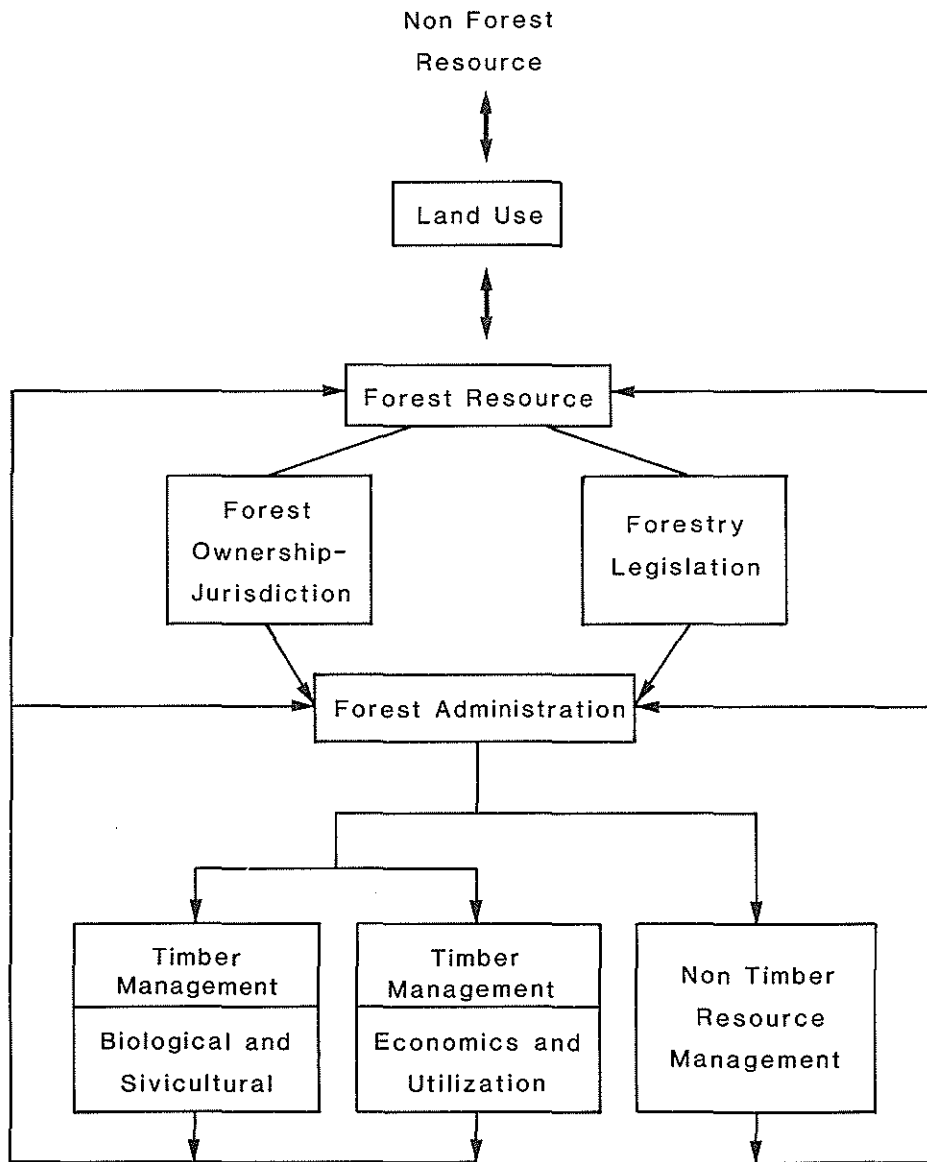


Figure 11. Framework for content identification of forest management information.

Forest lands in Minnesota are under the control of private individuals or groups (i.e., corporate management), or they may be managed by various governmental organizations for the benefit of all citizens within the state. Society formally recognizes this distinction through its legal system by the establishment of ownership or jurisdictional rights or mandates. It follows that any organization engaged in forest management must possess accurate, up-to-date ownership/jurisdictional information defining that part of the forest base to which such management may be applied. Although this information pertains to the forest resource, it actually arises from within the socio-political environment within which all forest management organizations coexist.

A different kind of information which stems from the political environment concerns the legal basis which enables organizations to carry out their specific management responsibilities.^{2/} Other relevant legal information consists of the body of laws and regulations which clarify agency objectives and impose various management constraints. Such information must be accessible to

^{2/} Technically the ownership-jurisdictional information described above is legal in nature, but for descriptive purposes this is considered as a distinct body representing the legal basis for jurisdictional authority (as opposed to that for management responsibility).

those both within and external to forest management organizations for assessing the effectiveness of their management tasks. An important type of legal information for the private sector concerns the tax system for the ownership and management of forest lands.

The activity of forest management may be viewed in many ways; for purposes of this report, the distinction between management of forest lands for the production of timber and nontimber goods and services is most appropriate. Various kinds of information, some of which have been described above, are important for timber and nontimber forest management. Each type of management has both a biological and economic dimension for which specific kinds of management information are relevant.

In addition to the basic forest resource information previously described, timber management requires information on how the forest grows and how it is changed by and responds to the removal of timber over time. Thus, a variety of biological-silvicultural information is needed pertaining to timber growth, methods of harvesting, regeneration and treatment responses, insect and disease levels, and so on.

Physical timber management activities may influence or in turn be influenced by local, regional, or national economic conditions and associated management constraints. Some important kinds of economic information for timber management include short- and long-run timber supply and demand patterns, market prices for timber and wood products, financial accounting procedures for timber sales, and criteria for determining the feasibility of various levels of investment for timber management.

In a similar fashion, both biological and economic information are essential for effective management of forest lands for nontimber outputs. Biological nontimber management information includes: (1) estimates of wildlife populations and the capability of the forest resource to sustain them, (2) assessments of the effects of timber harvests on forest water resources, (3) estimates of potential impacts of mineral extraction upon forest resource stability, and (4) information concerning the capability of the forest resource to provide various kinds of recreational experiences. Economic information for nontimber forest management includes wildlife and recreational value assessments and estimates of patterns and projections of demand for these outputs.

It is important to note that timber and nontimber management information are by no means separate and isolated entities. Effective forest management involves the integration of these two kinds of information for management decisions. Defining the linkages between the two can be a difficult task, particularly in light of the fact that important economic information regarding nontimber forest outputs (e.g., wildlife and recreational values and demand trends) is in many instances lacking or extremely hard to obtain.

Every forest management organization is characterized by an administrative framework that embodies both its approach for managing the forest resource and the processes through which it formulates and executes its mission. Certain elements of these administrative structures may stem from the agency's legally-mandated mission. For example, the establishment of organizational functions for wildlife and recreation management by the U.S. Forest Service reflects the agency's response to its mandate for multiple-use management in the Multiple-Use Sustained Yield Act of 1960. Other structural administrative characteristics reflect the particular approach of an organization (or administrative unit within that organization) for carrying out its mission. Both cases require administrative information that enables managers within the organization to understand and carry out their missions. Such information also enables those external to the organization to better understand the methods and procedures through which the agency fulfills its management responsibilities. A similar situation exists for corporate ownership, with the exception being that the source of administrative information stems from company goals and objectives rather than legislative mandates. In a rather unique way, the above situation might also be said to be characteristic of nonindustrial private forest landowners. In assessing the potential of this ownership class for contributing to timber supply, public and corporate organizations can benefit from information on how landowners "administer" their household resources, which may or may not lead to a concurrent opportunity for investing in forest management.

The schematic representation in Figure 11 is intended to provide an initial framework for identifying the kinds of information that forest managers require to effectively carry out their management tasks. A substantial amount of this information relates to the nature of forest resource itself. Only marginally represented in this diagram, however, is the important fact that much of the information relevant to forest management arises from the socio-political environment within which forestry organizations function (Figure 7). Political influences strongly affect the nature and content of legal, jurisdictional, and administrative information for forest management. Moreover, much important economic information arises from the social environment in which demand patterns, price relationships, and values for forest outputs are ultimately decided. Although it is not within the scope of this report to identify all of the linkages between forest management organizations and their socio-political environment, this environment as an important source of management information is implicitly recognized in the institutional and economic information classes depicted in Figure 11.

These classes of information may be viewed as "macro-categories" of information relevant to forest management in Minnesota. A more detailed picture of specific kinds of information required

by managers may be obtained by subdividing each broad class into a number of more detailed categories. Such a breakdown is displayed in Table 11.

The types of information depicted therein are for the most part self-explanatory. However, several important points merit attention with respect to the nature and detail of these categories. First, the nine broad classes of forest management information could in theory be subdivided into whatever degree of detail is desired, certainly to a finer degree than is represented in Table 11. For example, although forest land cover (category number 1) represents a particular type of forest resource information (i.e., a finer resolution of the overall information class), this category could easily be further subdivided into overstory and understory vegetation, certainly a relevant distinction for management decisions. Similarly, timber harvests could be described separately in terms of past and future activities; and these in turn could be further broken down into categories such as allowable cut, actual cut, or even "desirable cut" considering market conditions.

The objective of the subdivisions in Table 11 is to remain relatively comprehensive without generating an excessive number of information categories. The need for a manageable number of categories also stems from their subsequent use within a questionnaire for assessing of the adequacy of different kinds of information for forest management in Minnesota (see Section VI).

With respect to administrative information for forest management, it is assumed that all forest management organizations maintain detailed information regarding their organizational structure, administrative channels, etc.^{3/} The proficiency with which any organization is able to define and describe its structure and functions is an important factor in its ability to meet its management goals. Since all organizations maintain such information, however, this is not represented as a distinct information category in Table 11. Aspects of the relationship between organizational structure and information requirements will be considered in more detail in the following section.

It should also be noted that much of the information described under the classes of timber and nontimber management in Table 11 has administrative dimensions as well (e.g., timber sales, timber harvesting, etc.). For purposes of information content identification, however, this distinction could not be explicitly represented.

Another important consideration with respect to the information categories depicted in Table 11 concerns information for nontimber forest resource management. Obviously, many types of information exist, both biological and economic in nature,

^{3/} The same is true, of course, for nonland management agencies, although for those with broad responsibilities much of this information would not be concerned with forest management.

Table 11. Information classes and categories for forest management.

FOREST RESOURCE INFORMATION	
1.	Forest land cover/forest types
2.	Forest land cover/aerial photographs
3.	Forest soils/geomorphic regions
4.	Forest mineral deposits: Nature/location
5.	Forest waterways/watersheds
6.	Forest inventory systems
LAND USE INFORMATION	
7.	Current land use
8.	Land use projections
9.	Regional development
FOREST OWNERSHIP AND JURISDICTIONAL INFORMATION	
10.	Forest ownership/jurisdiction: Location/acreages
11.	Statutory land class
12.	Forest mineral ownership
13.	Forest land acquisition/disposal
LEGAL INFORMATION	
14.	Forest management legislation: Enabling
15.	Forest management legislation: Regulatory
16.	Forest land taxes
FOREST ADMINISTRATIVE INFORMATION	
17.	Forest fire protection and control
18.	Forest road systems
19.	Nonindustrial private forestry assistance
TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL	
20.	Timber growth projections
21.	Timber harvests: Past/projected
22.	Timber harvesting permits
23.	Reforestation
24.	Nursery operations
25.	Intermediate silvicultural activities
26.	Forest insect and disease levels
27.	Herbicide/pesticide usage
TIMBER MANAGEMENT INFORMATION: ECONOMICS AND UTILIZATION	
28.	Timber/pulpwood supply-demand
29.	Timber sales
30.	Stumpage prices
31.	Forest products prices
32.	Fuelwood: Supply/demand
33.	Wood residue: Supply/utilization
34.	Imports/exports: Wood products (state level)
35.	Wood processors: Primary/secondary
36.	Independent loggers
37.	Forest sector labor/employment
38.	Logging/wood processing technology
NONTIMBER FOREST MANAGEMENT INFORMATION	
39.	Forest wildlife: Habitat/populations
40.	Forest recreation: Facilities/users
41.	Forest soil and water conservation
FOREST MANAGEMENT RESEARCH INFORMATION	
42.	Program content
43.	Funding and grants

which are important for managing forest lands for nontimber goods and services. The scope of this report precludes a detailed breakdown of such information into biological and economic categories. Rather, nontimber management information is considered in three categories: forest wildlife, forest recreation, and soil and water conservation for forested lands. This limited breakdown does not minimize the necessity for detailed analysis of the many kinds of information which contribute to each of these broad categories. Such analyses are a key ingredient in the effectiveness of multiple-use forest management.

A final note is in order regarding the general information class identified in Table 11 as forest management research. Research activities may pertain to all aspects of forest management and thus may involve any of the kinds of information described in this section. For that reason, research information is not specifically represented within the overall framework of Figure 11. Research information is, however, included within the categories listed in Table 11, since adequacy assessment of current and prospective research programs plays an important role in confirming their value to improved forest management.

This content identification of forest management information is designed to be as comprehensive as possible within the limits of adaptability for adequacy assessment. The framework represents a starting point for analysis of information for forest management by describing its content. The ultimate goal of such an analysis involves a "re-representation" of these categories, incorporating relevant information characteristics, within the dynamic framework of the decision process for forest management.

Information Characteristics for Forest Management Decisions

Identifying the subject matter of forest management information is the first requisite for its eventual use in management decisions. In the previous section, the identification of information concerning a variety of subjects was derived from an unsophisticated model depicting the activity of managing the forest resource for the production of timber and other forest-based goods and services. However, while this description of information content is important for defining information as a "raw material" for management, it reveals relatively little about the processes involved in relating such information to specific management decisions.

Any decision requires information on the variety of factors that contribute to or create the need for that decision. A manager who finds himself in a decision-impelling situation needs to know two important things: (1) What information, in terms of subject matter or content, is relevant to the particular decision at hand? (2) How should this information be organized so as to be of maximum utility for the given decision?

Identifying relevant information may or may not be difficult, depending on the nature of the decision that is required. For complex decisions, underlying causal factors and the information pertaining to them are often difficult to identify in a precise manner.

As an example at the supervisory level of management, a forest management organization may be asked to take a position regarding the creation of a nature preserve or park on lands within its jurisdiction. In order for the agency director to decide on a response to such a proposal, information on a variety of topics is required. What is the present and projected demand within the state for such a facility, and how do such demands compare with those related to timber production and utilization? What are the potential effects of park establishment on the ability of the agency to meet its management responsibilities? How will various elements within the forestry community in the state be affected? And so on.

In a similar fashion, the district forester at the field level of management may need to decide upon the method of reforestation to be applied on a particular site that is harvested. Should natural or artificial regeneration techniques be employed, and if the latter, what species should be seeded or planted? For this technical decision, the manager requires resource information concerning soils, adjacent stands, etc.; silvicultural information pertaining to techniques for reforestation; district reforestation targets and any administrative constraints imposed by central management control, and so on.

In both of these decision situations, even if the manager were able to identify the various kinds of information required, the manager invariably needs to know more about how such information is organized before it can be of real utility. Obviously, decisions at the field level require information pertaining to the district (forest) or other such operational management unit; similarly, decisions involving agency policy necessarily involve information that has been summarized from field and management control levels. It would be helpful, however, to describe the relationship of information to decisions at different levels of management in a more precise and informative manner.

A first step in this process involves recognition that certain characteristics of information may indicate its potential utility for management decisions. Identifying these characteristics may allow the manager to:

- . Better describe the information available for a given decision;
- . Establish criteria with which to evaluate the utility of that information for the decision at hand.

Of course, the ultimate criteria for the utility of information is its contribution to an effective decision. While such a post hoc evaluation is of unquestioned value for future decisions of a

similar nature, the better the tools a manager has for evaluating available information prior to making a decision, the higher the probability that the alternative selected will be the most appropriate course of action. At this point, therefore, it is worthwhile to examine those characteristics of forest management information which will aid in the process of managerial decision making.

The relationship of forest management information to decisions involves the synthesis of information content (subject) with the variety of characteristics describing where the information is generated, how it is organized, the point or points in time to which it pertains, and how it is transferred. The result represents an indicator of the relevancy of the information to a particular decision.

This synthesis of information content and characteristics is depicted in Figure 12. Characteristics of information may arbitrarily be divided into four groups relating to: source, time frame, organization, and dynamics. Each of these groups may be further subdivided into a number of specific information characteristics.

Source

The source of information for forest management decisions is the basis for the first group of characteristics. Since the manager who makes a decision does so within the context of his organizational setting, source characteristics are best described in terms of whether the relevant information arises from within or external to his organization. Internal sources of information may be superiors or subordinates, reports issued from other organizational divisions, or the data base within the organization (computerized or manual files, records, etc.). Information may also be acquired from sources external to the organization such as individuals within other agencies, reports or publications from these agencies, inter-agency meetings or conferences, and so on. Obviously the source of information strongly affects its accessibility; the greater the amount of information that can be obtained from internal sources, the faster it may be evaluated for use in decisions.

Time Frame

Another group of information characteristics pertains to the time frame to which the information applies. Certain kinds of information describe past conditions or activities, and thus are essentially descriptive-historical in nature. Such information is useful in formulating strategies for responding to management problems; it is also important for monitoring performance. On the other hand, for evaluating the potential effectiveness of such strategies, predictive or future-oriented information is required. A common method for projecting future management strategies and alternatives is through the use of information obtained from simulations of future conditions which

might result from adopting such strategies. The long time span typical of forest management planning and programs necessitates the use of both historical and predictive information for managerial decision making.

Many forest management activities, particularly at the field level, require information that describes the present management situation. Such performance-current information is an important ingredient in the effective implementation of management programs, the monitoring of current performance, and in the detection of existing or potential management problems.

A primary determinant of performance-current information is the frequency with which it is revised or updated. Such updating may or may not occur on a regular basis. Regular updating is often achieved through the generation of periodic reports. These in turn are characterized by a reporting interval which reflects the period of time between the issuance of each report. Without other influences, this would permit determining the age of the given information at any particular point in time. However, the actual processing of data or information itself consumes a certain amount of time. This results in a "reporting delay," which Davis (1974) defines as the delay in processing between the end of the reporting interval and the issuance of the report for management use. Thus, for example, a nursery may issue a monthly inventory report for stock levels that exist at the end of each calendar month. It may, however, take four days to process the report, resulting in its issuance on the fourth day of each month. At that time, the information is already four days old; moreover, on the third day of each month the manager is essentially dealing with information that is (one month and three days) old. This situation becomes even more complicated when the data or information pertains not to a point in time (such as inventory levels on a given date), but to a period of time in which operations are changing on a daily basis (for example, timber sales accounting). Lag times in data processing, along with the continued influx of new data, could cause delays in the generation of needed information as well as uncertainty regarding its applicability to a precise point in time. While a detailed analysis of these time-related information processing problems is not possible within this report, such difficulties can and do affect the quality of information available to a manager in a decision situation at a given point in time.

It is noteworthy in describing information characteristics that different kinds of information, depending on their nature, exhibit several of the information characteristics described herein simultaneously (although certain characteristics, of course, are mutually exclusive). Timber supply, for example, may be described for historical, current, or future time periods. Depending on the type of decision and management level, information requirements for timber supply may manifest one or more of these characteristics.

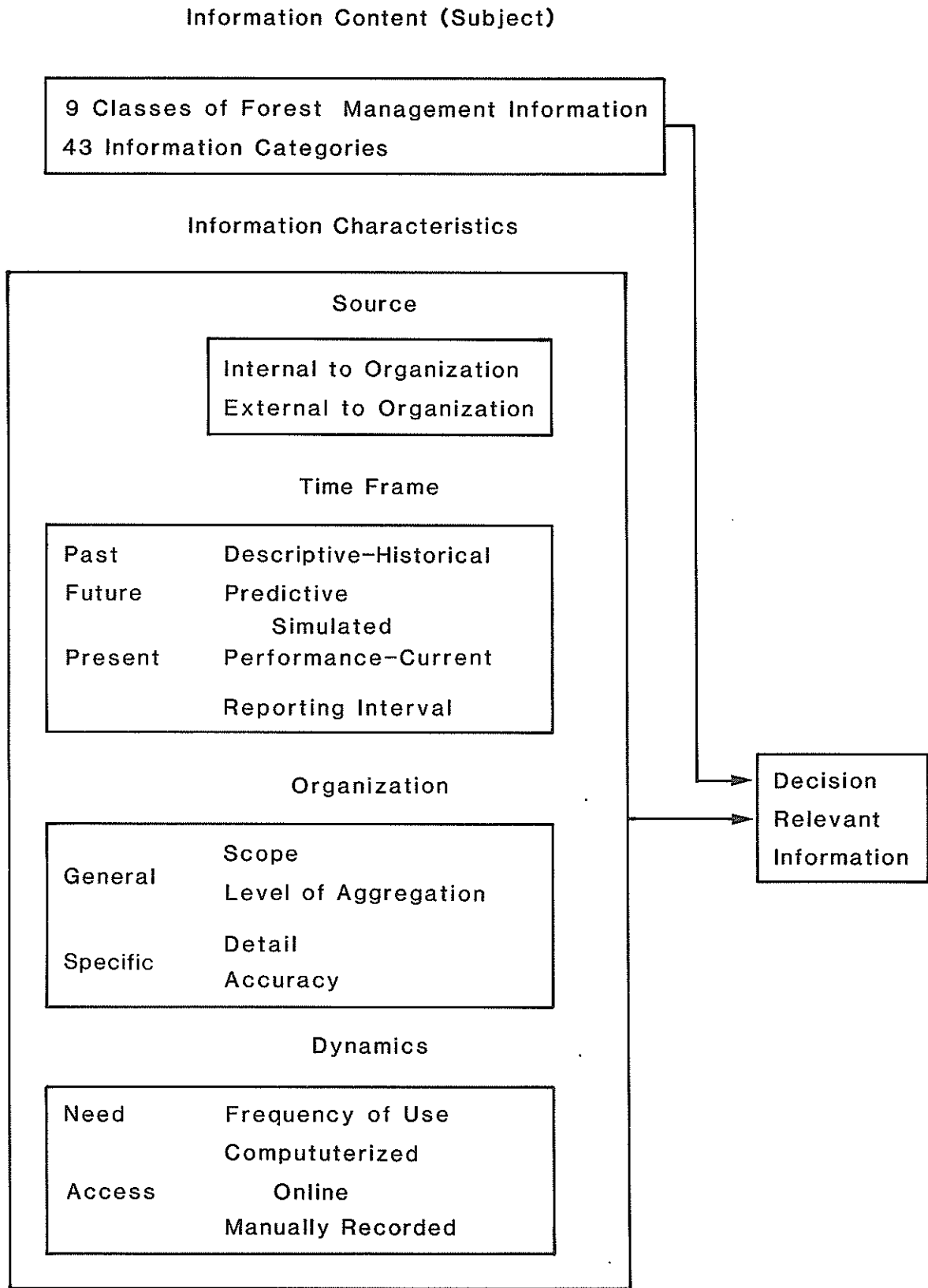


Figure 12. Relevancy of Information for Decisions: Synthesis of Content and Characteristics. (Source: Adapted from Lucas, 1973; Gorry and Morton, 1971).

Organization

The manner in which information is organized is of obvious importance with respect to how it will be used. One of the basic characteristics of information organization which a manager first examines (assuming subject matter is identified) is its scope or domain of relevancy. Forest insect and disease information, for example, may be described with reference to all forest land within the state, or it may pertain to a single stand or management unit. Broad level summary information, moreover, is often obtained by aggregating information pertaining to smaller subdivisions of various kinds (stands, districts, counties, etc.), depending upon the nature of the information and type of aggregation required. Information for forest management may be aggregated in a variety of ways (Table 12). The particular method of aggregation required is determined by the management responsibilities of the user and also by his perception of how the information will be utilized.

Table 12. Methods of aggregating forest management information.

<u>Systems of Information Aggregation</u>	<u>Examples of Aggregate Units</u>
Geographic-based	Section, township, etc.
Vegetational/Geomorphic	Forest types, ecological land types
Forest Characteristics	Condition classes
Ownership/Jurisdiction	Federal, state, county, private
Administrative Unit	Compartment, district, forest
Legislative/Political Unit	County, zoning/congressional district

Aggregating information is a necessity for any large organization; this is particularly important at the level of strategic management, where information must be sufficiently broad in scope to allow for agency-wide planning and decision making.

Other characteristics of information organization, which closely correspond with scope and level of aggregation, concern the extent to and manner in which information is broken down for different management decisions. The detail of forest management information is closely related to its structure. Highly structured information is characterized by clearly defined categories and/or parameters; ownership or jurisdictional information described via U.S. Geological Survey geographic coordinates is one such example. In some cases, either the nature of the subject or the lack of refined methods of data collection result in rather loosely structured information. Recreational demand patterns or land use projections are generally of this nature.

All information can be envisioned as residing along a continuum of detail and degree of structuralization. In general, less detail or structure is adequate for detecting management problems and identifying potential methods of problem resolution. Conversely, information for the implementation of programs and the monitoring of performance usually requires a greater degree of detail and structure.

The accuracy of forest management information is another characteristic of obvious importance. Greater detail of information may often tend to increase its accuracy, but this is not always the case. This is due in part to the fact that bias and/or errors in data and information generation cannot be corrected by merely increasing detail or number of structural categories. Clear definition of data parameters and corresponding tolerance limits for their measurement are the best assurances that they will contribute to accurate information for the decision maker. Although some inaccuracies may occur and often are tolerated with respect to

problem identification and the design of alternatives for resolving such problems, accurate information is usually essential for program implementation and control activities.

Dynamics

A fourth group of information characteristics pertains to the dynamics of information use. Whatever the source, organization, or time frame of information may be, it still must be available to the decision maker when needed or it will be of little value. Thus, the media by which information is stored and the ease with which it may be obtained when needed greatly influence the potential utility of information for decisions.

One indication of utility is the frequency with which information is used. Within forest management organizations, a certain amount of information, much of which is administrative in nature, is required on a frequent or even daily basis in order for operations to run smoothly. Much of this information is relevant for routine operational decisions. Indeed, some of this information becomes noticeable only when it is lacking, thereby causing administrative difficulties. Employee time sheets, for example, are generally not of major concern unless some error arises in their tabulation or processing.

While the forest administrator or manager may use such information on a daily basis for routine operational decisions, he may be faced with tactical and/or strategic decisions on a less frequent basis, all of which require information in the proper form at the right time. In general, therefore, it can be said that frequent use of information is a good indication of its relevance for the continuity of daily operations. Infrequent use may or may not indicate relevance for strategic or tactical decisions.

This latter point is of great importance to forest management organizations that are invariably concerned about the amount of resources that should be allocated to the acquisition of information. It has been noted earlier that within large organizations, it often happens that much data is collected that has very little probability of being used, i.e., converted into information for decisions. This underscores the need for evaluating the potential utility of all data that is collected. It may well be that collection of certain data contributes little to the effectiveness of management and decision making and in fact represents a drain on agency resources--resources that could be expended on more worthwhile activities. Thus, the infrequent use of information, though not automatically indicative of its low value to the organization (recalling that strategic decisions occur infrequently), can serve as a warning signal that management effectiveness may be being compromised through collection of nonproductive data or information.

Information that is used often by the manager should be readily accessible. The capability for quick retrieval and updating of such information depends to a large extent upon the manner in which the information (or data) is stored. Storage may involve the use of computerized files, generally organized within the framework of a data base management system; or it may consist of manually recorded files or records. Electronic data processing is particularly efficient for large volumes of highly structured data, such as forest inventory tallies, financial accounting records, and the like. If such data is frequently utilized in generating information for decisions, the process of retrieving it from computerized files can be further accelerated through the use of interactive computer terminals. This results in online data and information retrieval (as opposed to that retrieval via batch processing, often done at the end of one working day and retrieved the next day).

Computerized generation of information is a particularly efficient process for certain kinds of management decisions that can be clearly described in terms of a set of values or decision procedures. Since these programmed decisions are completely defined by the set of decision rules, the only inputs required are values for specific variables in the decision process. Data for programmed decisions can easily be computerized, resulting in an overall acceleration in the production of decision-relevant information.

A familiar example in forest management at the field level is the AFFIRMS information system for establishing fire danger ratings. AFFIRMS is a nationwide computerized information system which provides fire weather information to resource management organizations based on localized weather condition data. Data for relevant weather parameters are processed into fire danger information which would be of use to the district ranger who may need to decide, for example, whether to allow campfires on forest recreation sites. An obvious benefit of computerized data processing for programmed decisions is that they permit the manager to devote more of his time to less routine, more unstructured decisions. The implications and potentials of computerized information processing for forest management in Minnesota are extensive.

Information Characteristics and Decision Types

It is apparent that many of these characteristics of forest management information are inter-related. The particular description presented here is but one of many possible ways in which the diverse nature of information may be represented. Each characteristic may be viewed as a gauge or clue to the potential utility of a particular item of information for a given management decision. Relating these characteristics to specific decisions may enable the manager to better assess what kind of information is required for a given decision and what form it should be in. It would be helpful, therefore, to briefly examine the relationship of these characteristics of information to the three kinds of decisions which forest managers must make. Table 13 summarizes this relationship.

Strategic decisions at various levels within forest management organizations require information regarding the relationship of the organization to the economic, political, and social environments within which it functions. A significant amount of this information must be obtained from sources external to the organization. In charting long range courses of action, strategic decision making requires information broad in scope for use in identifying potential opportunities and problems related to the future forest management responsibilities of the organization.

At the supervisory level of management, information for strategic decisions must aid in identifying the potential contributions the agency may make to forest management within the state in future years. The district forester also has strategic decisions to consider, however, when evaluating how the district might be able to meet potential demands for forest goods and services in the future.

Table 13. Degree to which information characteristics meet decision requirements.

Information Characteristic	Type of Decision		
	Strategic	Tactical	Technical
Source			
External	VH	M	VL
Internal	M	H	VH
Time Frame			
Descriptive-Historical	L	M	H
Predictive-Future	VH	H	L
Simulated	VH	H	L
Performance-Current	M	H	VH
Reporting Interval	L	H	VH
Organization			
Scope	H	M	L
Level of Aggregation	VH	M	L
Detail	L	M	VH
Accuracy	L	M	VH
Dynamics			
Frequency of Use	L	H	VH
Computerized	M	H	VH

VH = Very High; H = High; M = Moderate; L = Low.

In addressing these strategic concerns, information of a highly aggregate nature is generally required,^{4/} and since such decisions do not occur on a daily basis, such information need be used only periodically. Excessive detail and accuracy are generally not required for strategic decisions. It should again be emphasized that, while strategic decisions comprise the bulk of those made at the supervisory level of management, such decisions are also made at the field level, and to a much lesser extent, at the central management control level within the organization.

Information for technical decisions within forest management organizations is essential to the effectiveness of day-to-day operations. Such information is obtained from sources within the organization, and it is primarily descriptive or historical in nature. The information must be performance-current and since it is used quite often, the reporting interval must be quite short.

Since technical decisions pertain to specific aspects of daily operations, they require information rather narrow in scope and at a low level of

^{4/} In referring to the relevance of highly aggregate information for strategic decisions, it is obvious that such information at the supervisory level is more highly aggregated than that at the field level of management. But for strategic decisions at the field level, operational and control information still must be aggregated to the level of the district as a whole. Thus, from the perspective of the district forester, this is aggregate information.

aggregation. The information must be highly detailed and very accurate. It is often highly structured in nature, and thus adaptable for computerized processing. This in turn facilitates both standardization of data collection and rapid retrieval of data or information when needed.

Tactical decisions require information with characteristics generally intermediate to those of information for strategic and technical decisions. Central management staff, for example, may need to decide on the allocation of timber harvesting targets to the various districts or areas within the agency. Information for this decision is required from sources within the organization in the form of estimates by district foresters regarding the amount of timber their district will be able to provide. However, factors external to the organization, such as the current market demand for timber, demand levels for particular species, etc. may also exert an influence upon this allocation decision. Both descriptive and predictive information is required for such a decision, and although the information must be accurate within certain limits, excessive detail and accuracy are not critical.

This overview of information and its relationship to forest management represents a perspective within which to review the following description of the information resource for forest management in Minnesota. It has been noted that the ability of any manager to describe the kinds of information required for decisions, although certainly important, is not a guarantee that the manager will be able to obtain or utilize that information effectively. The required information must also be organized in such a manner that it corresponds to the nature of the decision to be made. Of course, any decision ultimately rests with the individual and reflects his particular blend of managerial skills and ability. Having the best information available in the proper form may allow individuals to better exercise their managerial skills and thus more effectively contribute to the management of Minnesota's forest resource.

V. INFORMATION RESOURCES FOR PUBLIC FOREST MANAGEMENT IN MINNESOTA

The discussion of forest management information in terms of content and characteristics establishes the framework within which to address other important questions regarding information utilization. In addition to knowledge of the kinds of information which may exist for forest management, the manager within any forestry organization must be able to determine where needed information is located, in what form it exists, and ultimately how adequate it will be for management decisions.

This section identifies public organizations and agencies within Minnesota responsible for the collection or maintenance of forest management information. In addition to identifying the kinds of information that are available, certain characteristics pertaining to the potential utility of such information for management decisions is also considered.

A discussion of the collection and organization of information by groups within the private forestry sector in Minnesota, such as forest industry, interest groups, and individual forest landowners is not within the scope of this report. However, the importance of information arising from public forestry agencies to forest industries within the state is addressed in Section VI.

The amount of forest management information collected by a public organization is obviously influenced by whether that organization is actively involved in managing public forest lands. Land management agencies of necessity generate and use large amounts of information pertaining to the characteristics of, demands upon, and potential uses of that part of the forest resource under their jurisdiction.

The activities of organizations not involved in land management^{5/} may be viewed as:

- . Resource-related: Primary function of the organization involves some aspect of natural resources; depending upon specific function, the organization may generate or use forest management information. Example: USDA Soil Conservation Service.
- . Nonresource-related: Major organizational responsibilities may not pertain to natural resources, but in the process of carrying out its mission, the organization may generate or use information relevant to forest management. Example: Minnesota Department of Transportation.

^{5/} These will subsequently be referred to as nonland management organizations.

- . Combination: Organizations may have both resource-related and nonresource functions. Example: Minnesota Department of Energy, Planning, and Development.

The approach for describing organizations and their information resources for forest management will be in terms of:

- . Forest land management organizations
- . Nonland management organizations (representing a synthesis of the last two groups described above).

Public Organizations

Public organizations in Minnesota whose responsibilities include the management of forest lands are represented below. Resource and ownership characteristics pertaining to these agencies have been previously described.

I. Federal Executive Agencies

- A. U.S. Department of Agriculture
 - 1. Forest Service
 - a) National Forest System
 - b) State and Private Forestry (Northeast Area)
 - c) North Central Forest Experiment Station
 - d) Renewable Resources Evaluation Unit
- B. U.S. Department of the Interior
 - 1. Bureau of Indian Affairs
 - 2. Bureau of Land Management
 - 3. National Park Service
 - 4. U.S. Fish and Wildlife Service

II. State Executive Agencies

- A. Department of Natural Resources
 - 1. Division of Forestry
 - 2. Division of Fish and Wildlife
 - 3. Division of Parks and Recreation
 - 4. Division of Minerals
 - 5. Division of Waters
 - 6. Bureau of Lands
 - 7. Office of Planning
 - 8. Legal Bureau

III. County Governmental Agencies

- A. County Land Departments

The Forest Service is represented by three functional branches.^{6/} The National Forest System administers the national forests in Minnesota; the North Central Forest Experiment Station conducts research programs within the Forest Service; State and Private Forestry coordinates federal forestry assistance programs with states and private forest landowners.

^{6/} The Renewable Resources Evaluation (RRE) project is actually under the administration of the North Central Forest Experiment Station. Due to the importance of the forest resource information generated by RRE, it is represented as a separate entity in the above listing.

Of the four agencies depicted above within the U.S. Department of the Interior, only the Bureau of Indian Affairs (BIA) and the National Park Service manage extensive areas of forest land; the BIA is the sole agency which conducts timber management activities on lands within their jurisdiction.

The Division of Forestry manages the vast majority of forest lands under the jurisdiction of the Minnesota Department of Natural Resources. The Divisions of Fish and Wildlife and Parks and Recreation do administer certain forested lands in wildlife areas and state parks. Other departmental divisions, bureaus, and offices do not actually administer forest lands; however, they are responsible for the management of water and mineral resources on state forest lands, and provide support services and planning direction.

Several agencies within both the U.S. Departments of Agriculture and Interior gather information and provide services which are important for certain aspects of forest management. However, since these agencies do not actively manage forest lands, they will be considered with the nonland management organizations described below.

A large number of organizations and agencies which are not actively engaged in forest management do collect and disseminate data and information of utility to managers within forest-administering agencies in Minnesota.^{7/} These nonland management organizations are depicted below.

- I. Federal Executive Agencies
 - A. U.S. Department of Agriculture
 - 1. Agricultural Stabilization and Conservation Service
 - 2. Soil Conservation Service
 - 3. Agricultural Research Service
 - B. U.S. Department of the Interior
 - 1. Geological Survey
 - C. U.S. Department of Defense
 - 1. U.S. Army Corps of Engineers
 - D. Independent Agencies
 - 1. Environmental Protection Agency
- II. State Executive Agencies
 - A. Department of Energy, Planning, and Development
 - 1. Office of Physical Planning Resources
 - 2. Land Management Information Center
 - 3. Energy Division
 - 4. Community Development Division
 - 5. Office of Local Government
 - B. Department of Agriculture
 - 1. Agricultural Protection Service

^{7/} For a state-level perspective of the departments and agencies within the Minnesota government, see Appendix B.

- C. Department of Transportation
 - 1. Office of Surveying and Mapping
 - 2. Office of Environmental Services
- D. Department of Economic Security
 - 1. Research and Statistical Services Office
- E. Department of Revenue
 - 1. Division of Local Government Aids and Analysis
- F. Pollution Control Agency
- G. Environmental Quality Board
- H. Iron Range Resources and Rehabilitation Board
- I. Conservation Boards
 - 1. Soil and Water Conservation Board
 - 2. Minnesota Environmental Education Board
 - 3. Water Resources Board
 - 4. Southern Minnesota Rivers Basin Board
- J. Regional Development Commissions
- K. University of Minnesota
 - 1. College of Forestry
 - 2. Other University Departments
 - 3. Agricultural Experiment Station
 - 4. Agricultural Extension Service
 - 5. University F.I.R.E. Center
 - 6. Center for Urban and Regional Affairs
 - 7. Minnesota Geological Survey

Information-Agency Matrix

The relationship of the various kinds of forest management information to the organizations that collect or use such information may be represented in the form of a matrix in Figure 13. The vertical axis consists of the classes and categories of forest management information which were described earlier; the horizontal axis contains the organizations and agencies that generate, collect, or use these kinds of information. For ease of reference, this will subsequently be referred to as the information-agency (I-A) matrix.^{8/}

Each cell within this matrix represents the fact that a particular organization collects or maintains a certain category of forest management information. This represents a linkage between information subject (content) and location--i.e., where certain kinds of forest management information can be found.

It would also be helpful to represent various characteristics of the information gathered by a particular organization. Recalling from previous sections that information has different characteristics pertaining to source, time frame, organization, and dynamics, it would be useful to be

^{8/} This is actually an information-organization matrix, but this slight inaccuracy may be tolerated for the sake of avoiding the use of I/O (the common designation for input-output) as a matrix descriptor.

able to represent such characteristics within a given matrix cell. This would enable one to determine not only which organizations possess a certain kind of information, but also how that information is organized.

The application of all of the information characteristics previously described to the forest management information collected by organizations within the state is beyond the scope of this report. This would require an intensive investigation linking organizations and types of information they maintain to decision situations and levels of management of the users of such information. This analytical framework does, however, permit the inclusion within each cell of designators representing two characteristics of information collected by the organization. These pertain to the manner in which the information is acquired and to the media or manner in which it is maintained.

Table 14 contains the characteristics and designators used in the matrix to describe information collected or maintained by public organizations in Minnesota. The first matrix characteristic represents the source of the information collected by the organization. This may be either internal or external to the given organization. The second characteristic depicted in the matrix indicates the method by which the information is stored, whether in computerized or manually-recorded form.

Table 14. Information characteristics and designators within information-agency matrix.

Information Characteristic	Designator
Source	G: majority of information maintained is <u>generated</u> within the organization. S: majority of information maintained is acquired from <u>secondary</u> sources, i.e., those external to the organization.
Storage	C: majority of information maintained by the organization is <u>computerized</u> . M: majority of information maintained by the organization is in the form of <u>manually-compiled</u> files, records, or reports.

G-S / C-M

Individual Matrix Cell

The presence of these variables within a matrix cell, therefore, indicates three things: first, that the given agency collects a particular kind of forest management information; second, whether the majority of that information is generated within that organization or obtained from other sources; and third, whether the given information is computerized or manually recorded and maintained.

The information-agency matrix is intended to provide an overall perspective within which to consider a more detailed description of information for forest management in Minnesota. In the following pages, the information resources and information-collecting functions of the major forest land management organizations in the state are considered in detail. Forest management information collected by those agencies and organizations whose functions do not involve actual management of forest lands are then briefly documented.

Land Management Agencies

U.S. Forest Service

Mission and Organization

The United States Forest Service (USFS) was created in 1905 for the purpose of managing the forest reserves of the United States government. It operates within the U.S. Department of Agriculture under the administrative jurisdiction of the Assistant Secretary for Natural Resources and Environment. The primary activities conducted by the Forest Service include:

- . Management of 184 million acres of forest lands within the National Forest System
- . Operation of cooperative forestry assistance programs with states and private forest landowners
- . Operation of a comprehensive program of forestry research

The forest land management responsibilities of the Forest Service, within which the task of collecting and disseminating forest management information is integrated, have been established through three major legislative mandates of the U.S. Congress (Table 15).

The functional organization of the Forest Service is represented in Figure 14. Of the five major functional areas, one provides cooperative assistance to states and private forest landowners, another provides forestry research, and three are organized to address the legally-mandated activities of National Forest management.

Table 15. Legal bases for collection of forest management information by U.S. Forest Service.

Legislation	Activities Mandated
Multiple Use-Sustained Yield Act (1960) (74 Stat. 215; 16 U.S.C. 528-531)	Integrated management of national forests for multiple outputs of timber, wildlife, water, forage crops, and recreational opportunities.
Forest and Rangeland Renewable Resource Planning Act (RPA) (1974) (88 Stat. 476; U.S.C. 1601-1610)	National forest management, forestry assistance for states and private landowners, research; assessment of supply and demand of the nation's renewable natural resources and methods for development of a management program for national forests.
National Forest Management Act (NFMA) (1976) (90 Stat. 2947)	Land management planning, silvicultural practices, and public participation mechanisms for national forest management.

National Forest System

The National Forest System (NFS) is divided into nine regions which together encompass all of the continental United States and Alaska. Some

154 National Forests comprising more than 184 million acres are located in 41 states throughout the United States. Minnesota, located in NFS Region 9, contains two National Forests in the north

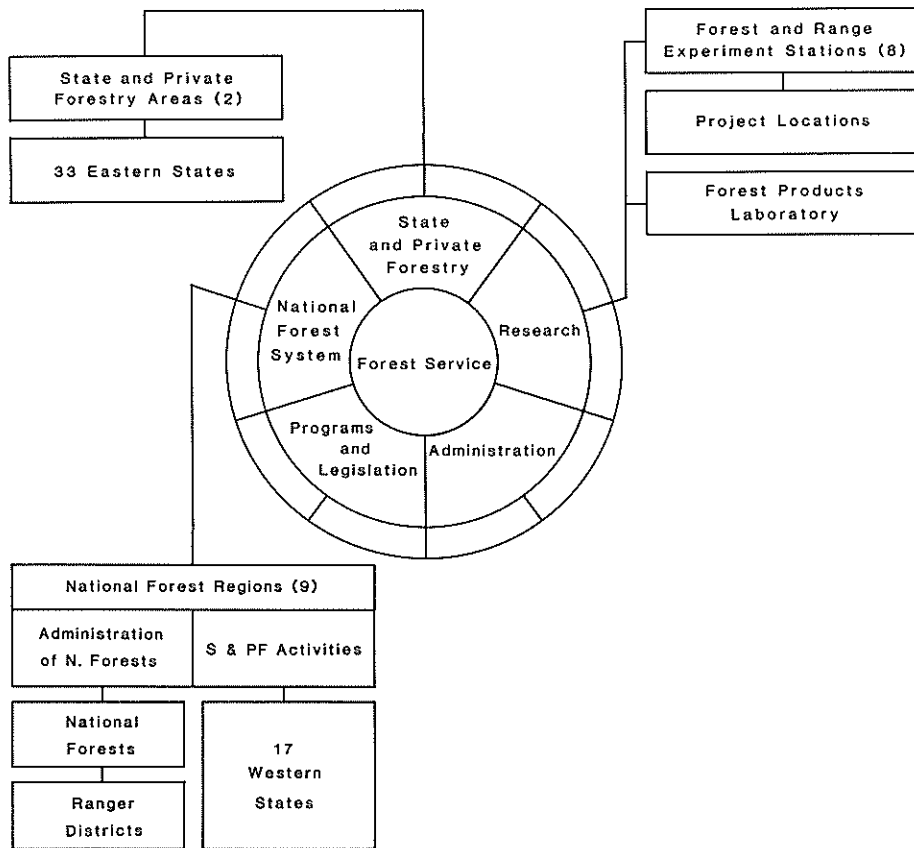


Figure 14. Functional organization of the U.S. Forest Service.

central and northeastern part of the state (Figure 15).

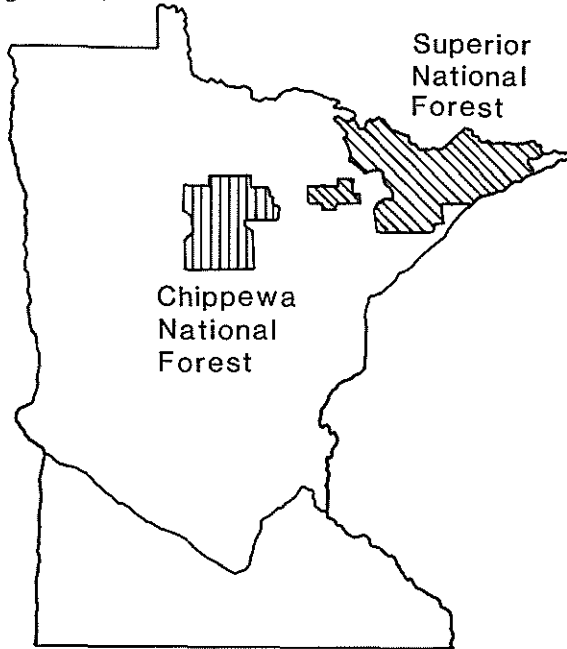


Figure 15. Minnesota National Forests.

The Chippewa National Forest administers 661,000 acres in north central Minnesota, approximately 87 percent of which is commercial forest land (Table 16). Topography is generally level, and most areas within the Forest are readily accessible by road.

Table 16. Forest lands administered by U.S. Forest Service in Minnesota in acres, 1982.

National Forest	Area within Boundaries (including water)	USFS Owned Forest Land	Commercial Forest Land (USFS)	Wilderness (USFS)
Chippewa	1,599,649	661,259	577,382	--
Superior	3,865,976	2,135,132	1,162,964	792,510

Source: USDA Forest Service, 1982.

The Superior National Forest is responsible for the management of more than 2.1 million acres of forest lands in northeastern Minnesota, making it the largest National Forest in the continental United States. Included within its jurisdiction are 792,000 acres within the Boundary Waters Canoe Area, a wilderness preserve originally established by Congress in 1964. Topography on the Superior National Forest is gently rolling to level, with elevations ranging from a low of 600 feet on the shores of Lake Superior to a high of 2300 feet on Eagle Mountain, the highest point in Minnesota. Most areas, particularly in the southern part of the Forest, are accessible by road; some of the more remote areas in the north, however, are characterized by limited accessibility.

It is apparent from Table 16 that a substantial amount of lands within National Forest boundaries are not under Forest Service jurisdiction. Within the boundaries of the Chippewa National Forest, for example, ownership of the land base is divided approximately as follows: 50 percent National Forest; 20 percent State; 15 percent County; 15 percent Private. Ownership patterns are often checkerboard in nature. This has important implications regarding aspects of information collection and utilization for management decisions. For example, where such fragmented ownership patterns occur, an agency may be able to determine its present recreational facilities and perhaps even obtain a fairly accurate measure of overall recreational demand for a given area. It still may be difficult, however, for that agency to determine what its actual share in meeting such demands for that area should be. What should the Forest Service contribution be as opposed to that of the state and counties, and vice versa? Such problems indicate that, in addition to collecting information regarding its own management activities, an agency needs information concerning the activities of other organizations, both public and private, in order to be able to better assess its current management situation and potential management strategies.

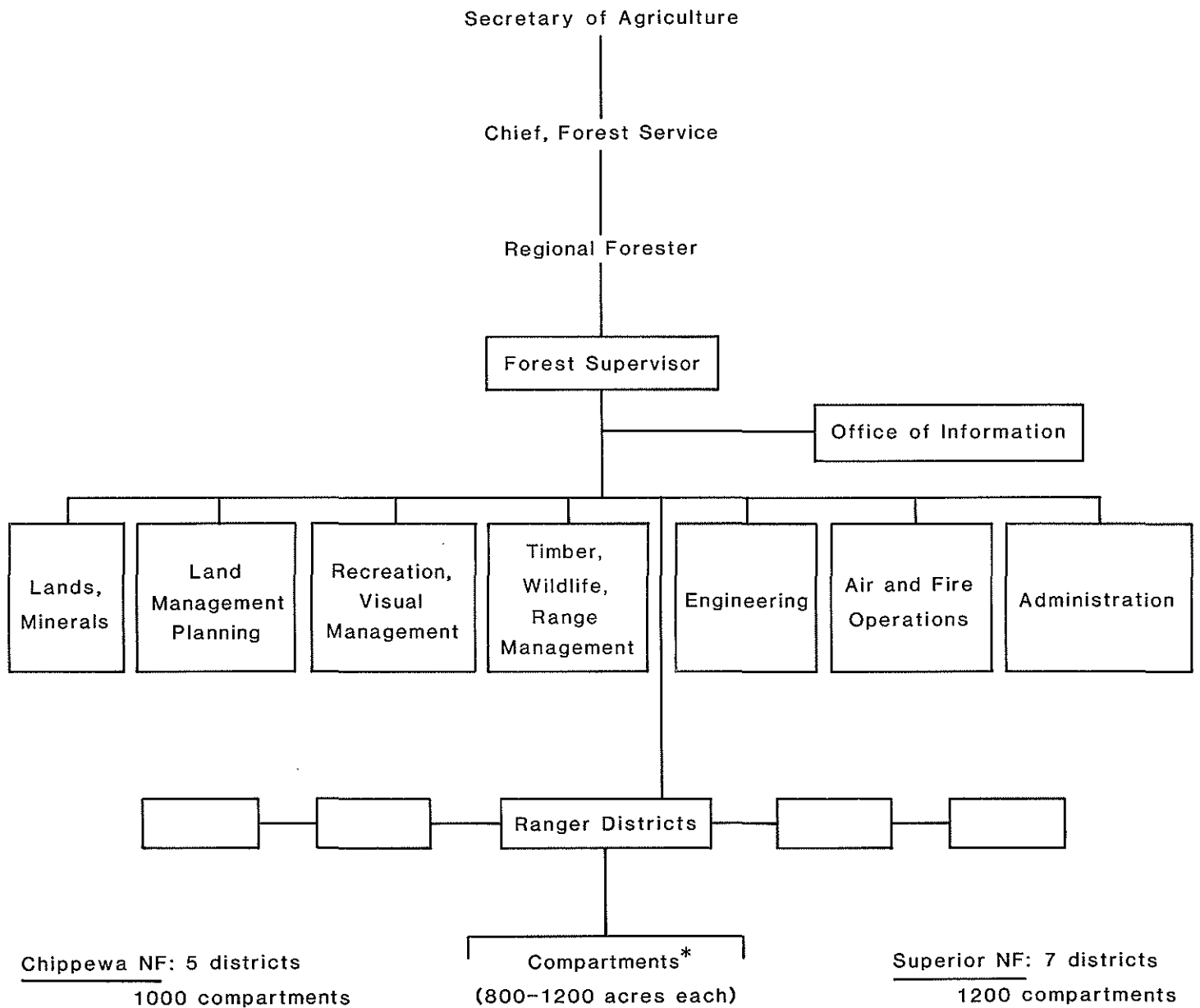
In carrying out the Forest Service multiple use mandate, the National Forests in Minnesota operate within a functional organizational framework such as that represented in Figure 16. Staffing limitations and resource-related considerations dictate that each Forest adopt its own

specific approach for administering lands within its domain. Figure 16, therefore, represents a general functional approach from which each National Forest varies to a certain degree as forest land characteristics dictate particular areas of management emphasis. The specific functional structure adopted by each National Forest strongly influences the nature and structure of information collected for forest management.

collected for forest management.

Forest Resource Information--The primary instrument through which data concerning the physical characteristics of National Forest lands in Minnesota is collected is the Timber Management Information System (TMIS). This is an extensive,^{9/} continuous forest inventory on a 10-year cycle which contributes to a data base containing forest land characteristics and timber management information.

^{9/} An extensive inventory might consist of, for example, 3 to 7 plots per stand as opposed to 20 to 40 plots per stand (intensive survey).



*Basic management, as opposed to administrative, units.

Figure 16. National Forest organizational structure in Minnesota, 1981.

TMIS is essentially an autonomous inventory system which controls stand acres and forest types. Each district conducts inventory operations, and tally sheets are forwarded to central timber management staff at Forest Headquarters. Actual processing of TMIS data occurs at the Forest Service Computer Center at Fort Collins, Colorado, which is linked to Forest Headquarters via remote terminals. The TMIS data base is not only the central data core for Forest-wide timber management activities, but it also supplies essential data for wildlife and recreation management, as well as land use analyses. TMIS-derived inventory figures are also forwarded to the Renewable Resources Evaluation (RRE) unit at the North Central Forest Experiment Station, and form the basis for National Forest System data contributions to the statewide Forest Survey.

The basic kinds of forest resource data collected in TMIS (excluding timber and nontimber management data to be subsequently described) include:

- . Compartment number
- . Stand number
- . Elevation
- . Aspect
- . Slope
- . Watershed
- . Type size density
- . Stand condition
- . Stand size
- . Average DBH
- . Total basal area
- . Basal area by species and DBH
- . Radial growth
- . Stocking percentage
- . Seedling/sapling count
- . Stand year of origin
- . Site index
- . Type of products
- . Product groups
- . Fuels data
- . Insect/disease damage

TMIS data also forms the basis for the establishment of ecological land types (ELTs) and land-type associations, which are important elements within the forest planning system of the Forest Service (FORPLAN). This information is obtained by synthesizing basic data pertaining to soils, land form, climate, forest types, etc. into a composite indicator of the ability of forest land to produce timber and a variety of other forest-based goods and services. Forest soils data, while not extensive nor TMIS-derived, will also be incorporated within FORPLAN land type information. FORPLAN packages for both National Forests in Minnesota are currently being developed.

Data regarding minerals on National Forest lands is of greater importance to the Superior than to the Chippewa National Forest, due to the geological nature of the lands under their jurisdiction. The primary form in which such data is represented is via mineral maps. Information regarding water resources on National Forests

consists of lakes inventories and land use designations for wetlands described below under Land Use Information. The Forest Service also collects data on water quality, and National Forests have access to the STORET analysis system for statistical water quality analyses. Each of the National Forests in Minnesota maintains an extensive set of aerial photographs for their lands at both the field and central management control levels. Photos are updated approximately every 10 years.

In considering the variety of resource information collected by the Forest Service and other land management organizations, it is worthwhile to recall that the same types of data may be collected (and aggregated) with different end uses in mind. Thus the data described above may be organized by species (for timber and wildlife), by compartment, and/or by land type association. While most of the information generated by the National Forests is organized by compartment, the particular uses to which the information will be put (e.g., on-the-ground management, planning, budgeting), and thus the decisions for which such information will be utilized, are the ultimate determinants for the mode of information collection and organization.

Land Use Information--Land use information maintained by the National Forests pertains exclusively to lands under Forest Service jurisdiction. The classification scheme is designed to identify potential management uses based upon physical and biological forest resource characteristics. With respect to timber production from the forested land component, land use classes are designed to identify any physical, biological or administrative factors that would make such lands unsuitable for timber production. Wildlife resources and recreational opportunities are considered within this framework.

The major types of land use information for the National Forests consist of TMIS-derived land use classes. For each plot,^{10/} the following types of land uses are evaluated:

- . Water--Lakes, streams
- . Nonforest--Upland openings, wetland type, nonvegetated areas, powerlines, roads
- . Productive-reserved--Legislatively withdrawn from timber production
- . Productive-deferred--Administratively withdrawn for further study, ex. RARE II (Roadless Area Review and Evaluation)
- . Standard Component--Commercial forest land
- . Special Components--Visual sensitivity, specialized wildlife habitat
- . Marginal Components--Adverse slopes, soils, drainage

^{10/} The precise subdivisions within each class may vary between the two National Forests in the state.

- . Unregulated Component--Scenic corridors, developed recreation sites, research areas
- . Unproductive Component--Visual sensitivity, specialized wildlife habitat

The National Forests also have access to a Land Use Reporting System at the Forest Service Computer Center in Fort Collins, Colorado, for reporting and monitoring of TMIS-derived special use lands data.

Forest Ownership and Jurisdictional Information and Legal Information--Information identifying lands under National Forest jurisdiction in Minnesota is maintained in the form of a Land Status Atlas. This handbook is generated at the Forest Service Regional Office in Milwaukee, Wisconsin, for use on National Forests within the region. In addition to ownership information, the Atlas contains information on special land uses, existing rights of way and long-term road permits. The Atlas is an important information source for short-term (i.e., 5 to 10 year) timber management planning activities of the National Forests.

Each National Forest in Minnesota also maintains manual records identifying lands under their jurisdiction. These records are updated as needed, but due to various planned or ongoing land exchanges with other ownership classes, it is difficult to keep such records completely up-to-date for a particular point in time. Detailed records pertaining to the acquisition and disposal of National Forest lands are also maintained.

The National Forests, as do all public forest management organizations, maintain documentation of all legislation, both enabling and regulatory, that relates to their mission as an agency of the United States Government. Since the Forest Service is a federal land management agency, little information regarding taxes on forest lands is kept by the National Forests in the state. Although Minnesota counties do receive payments in lieu of taxes from the Forest Service (25 percent of all receipts from National Forest timber sales), such transactions are processed at the Regional Office in Milwaukee.

Forest Administrative Information--All of the information-generating activities for National Forests are conducted within an administrative framework that strongly influences the collection and organization of data for conversion into information. The specialized administrative activities of fire protection^{11/} and forest road system design and maintenance^{11/} are arbitrarily described as a

^{11/} Also included within the class of information described as pertaining to Forest administration (see Information-Agency matrix) are administrative activities designed to provide management assistance to private nonindustrial forest landowners. The National Forests, however, are not involved with these programs.

separate class of information to reflect their pervasive influence upon all other management activities within forest management organizations, whether related to timber, wildlife, recreation, etc.

Information pertaining to forest fire protection and control activities is maintained by the National Forests in both computerized and manual form. Such information may be described in terms of that which pertains to fire occurrence and that which describes current weather and fuel conditions as they relate to degree of fire hazard.

National Forests obtain fire danger ratings from the Administrative and Forest Fire Information Retrieval and Management System (AFFIRMS). This user-oriented interactive computer program permits simultaneous entry of fire-weather observations from field stations over a large network (Helfman, *et al.*, 1975). Input includes fuels and weather information, which is processed into information in the form of fire weather forecasts including burn indices, risk ratings, ignition components, and predictions of burning time for fuels.

TMIS-derived fuels data is utilized in locating specific sites on which potential fire hazards may exist. Information concerning actual number of fires which occur and their locations, along with suppression activities and associated costs, are maintained in the form of manual files. Annual reports summarize all such information.

Each National Forest maintains an inventory of all existing roads on their lands by road class and location. Such information is updated on an annual basis. Forests also have access to a computerized Road Design System (RDS) to aid in road planning and location. Locations for proposed forest roads, along with soil suitability analyses and construction specifications, are contained within district timber sales packages for each year of the five-year timber sale planning period (to be subsequently described).

Timber Management Information: Biological and Silvicultural--The majority of information pertaining to the biological and silvicultural aspects of timber management is generated via TMIS. The system is designed to function at the compartment level, with data inputs recorded for stands averaging 15 to 20 acres in size. In addition to data on stand characteristics, described previously, the following prescriptive information for timber management is obtained through field inventory operations:

- . Priority of cultural activities by stand
- . Management objective by stand
 - harvest
 - reforestation
 - intermediate silvicultural activity

Timber management operations on National Forests in Minnesota are conducted within the framework of a 10-year timber management plan. This

represents the basic time frame within which timber management information is collected and organized. Output goals for this planning period will be derived from the forest-wide plan (FORPLAN), which is currently being developed on each National Forest in the state. On the basis of FORPLAN output goals, each forest develops a five-year sales plan.

The variety of biological-silvicultural timber management information (see Figure 13) collected by the National Forests is accompanied by a continuous interaction between Forest and Regional Headquarters, and in turn between Forest-wide central management staff and individual ranger districts. This process is represented in a simplified form in Figure 17. Such an interaction in effect establishes the framework for information generation and organization at all levels of management within the National Forests.^{12/}

Each National Forest generates its own allowable cut information, representing a best estimate of how much timber is and will be physically available within the next 10 years. This information, organized by volumes and acres, is forwarded to the Regional Office, which after analyzing potential timber availability from the Forests within the Region as it relates to regional targets received from Washington, furnishes the Forests with allowable cut targets.

A similar process occurs with respect to timber sales; sales goals from each National Forest, representing the amount of timber that Forest would like to advertise, are accompanied by a budget request for appropriate funding to match expected output levels. The Regional Office, after analyzing these requests in terms of sales goals and funding allocations from Washington, allocates budgets and sales targets to each National Forest. This budget process is conducted three years prior to actual implementation of harvest because Forest Service budget requests must be submitted to Congress (via the Office of Management and Budget) three years in advance. Thus, for example, each Forest would forward information on potential sales and budget requests for fiscal 1986 to the regional office at the end of 1983. It is apparent, therefore, that not only economic sales information but also biological information regarding

timber availability are tied closely to the budgeting process, since allowable cut information is needed three years in advance to accompany budget requests for sales.

The formal representation of this process in Figure 17 may convey the impression that interactions between Forests and Region occur only at the time of submitting and receiving timber production and budgeting information. Actually, the ultimate figures for goals and outputs are the result of constant communication between the Forests and the Regional office.

A similar relationship occurs with respect to the transfer of information between central management staff at the National Forest level and individual districts within that National Forest (Figure 17). After harvesting targets are received from the region, the Forest-level FORPLAN model generates and allocates timber harvesting goals (in volumes and acres) to individual districts. This also is a two-way process; each district submits information on potential timber availability and sales goals, along with a corresponding budget request to Forest headquarters.

Upon receiving targets from central management staff, each district utilizes TMIS to develop its sales packages. This Forest-district information transfer occurs within the five-year framework of the timber sales plan. Since Forest-level budget requests are submitted to the region three years in advance, the district sales packages for the first three years (of the five-year plan) must be relatively firm; some flexibility is maintained, however, for prospective sales packages for the fourth and fifth years of the on-going plan.

Information pertaining to the five-year timber sales plans is maintained in the form of:

- . Sales maps
- . Soil examination records
- . Total acres/volumes to be harvested
- . Volumes to be harvested: hardwood/softwood
- . MBF (thousand board feet): sawtimber/pulp by species
- . Right-of-ways
- . Miles of specified road
- . Lines of land-line location
- . Cruise records

Each district maintains one such package of all sales for each year of the five-year plan.

These records are also forwarded to Forest-level central management staff where they are synthesized with similar information from other districts to obtain Forest-wide information concerning annual volume cut (monthly reports) and cumulative difference between actual and planned sell. Other important kinds of information, derived from planning and budgeting processes as opposed to timber sales packages, maintained at Forest Headquarters include:

^{12/} In order to facilitate the identification and analysis of different kinds of timber management information, this report has arbitrarily separated biological and economic information into two broad classes. It is obvious, however, that the two are closely interrelated, and this relationship is readily apparent in the operation of the 5-year timber sales plans of the National Forests. Thus, when economic factors determine or influence the organization of biological-silvicultural information, they will be discussed in this subsection as well as the following one related to economic timber management information.

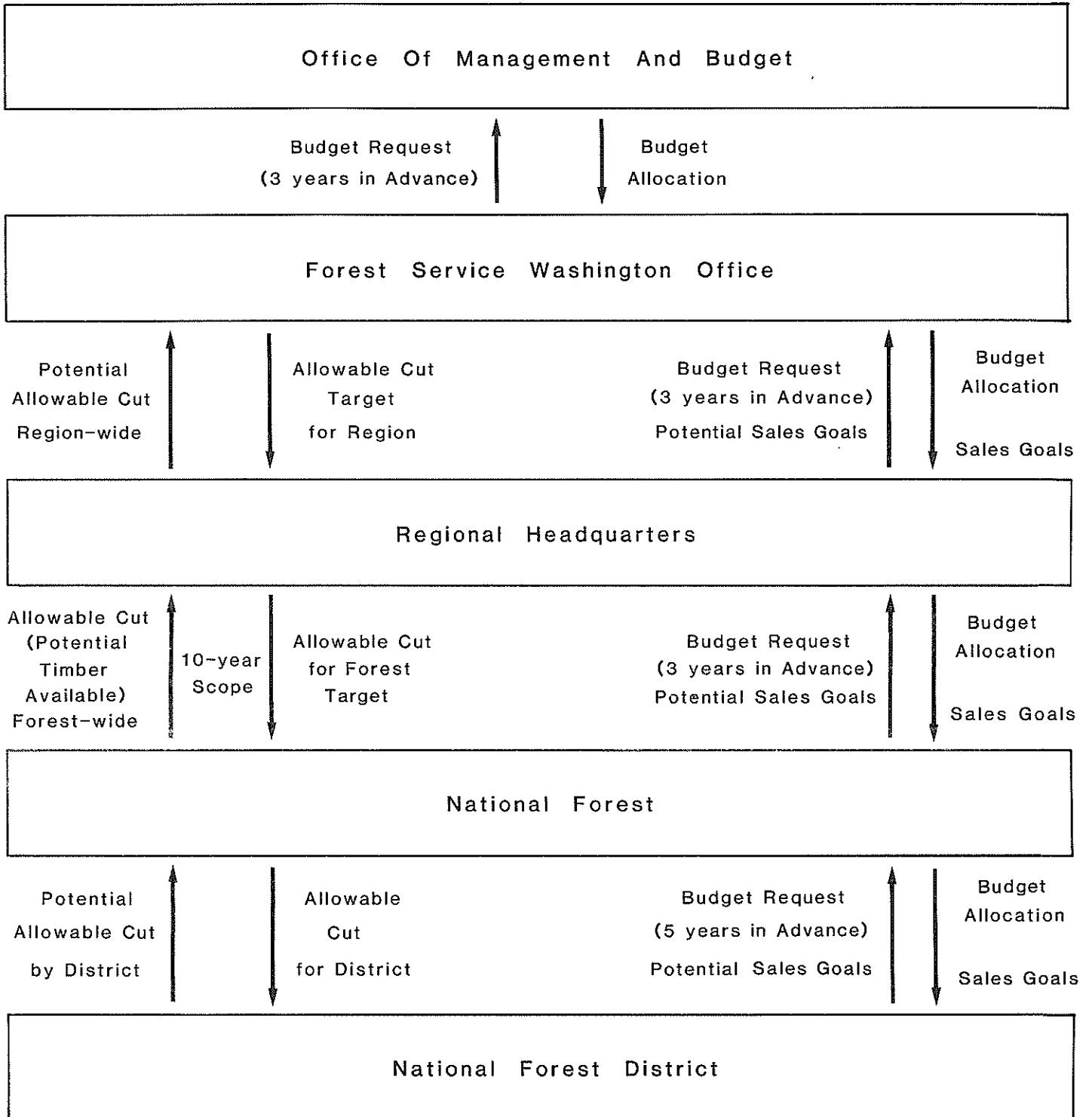


Figure 17. Framework for flow of timber management information within U.S. Forest Service, 1981.

- . Annual potential yield
- . Annual allowable cut
- . Annual planned sell

Reforestation of harvested sites is required within five years of harvesting. Information is maintained both at the field and Forest level regarding total acres reforested by species. At the district level, TMIS-generated information regarding intermediate silvicultural treatment needs is synthesized into silvicultural stand prescriptions. This information is then incorporated within the 10-year timber management plans.

Growth projections for timber on National Forest lands in Minnesota are obtained through the use of FREP and STEMS growth projection models.^{13/} Outputs from these forecasts will be used to construct yield tables for input into the Forest-wide FORPLAN model when it becomes fully operational. STEMS also serves as a useful check on the outputs generated by the extremely sophisticated FORPLAN model.

The National Forests maintain information regarding insect and disease problems affecting lands under their jurisdiction. The majority of such information is kept in the form of manual records and files pertaining to specific problems and/or outbreaks. A limited amount of data is generated through TMIS in the form of codes for damage agents on individual plots and a measure of the severity of damage in terms of percent of trees affected within a particular plot. Records on herbicide and pesticide usage by the agency are also maintained via manual records identifying stands treated, applications applied, and treatment costs.

Timber Management Information: Economics and Utilization--Several kinds of economic information of relevance to timber management are maintained by National Forests in Minnesota (see information-agency matrix). Timber supply estimates are geared toward providing information for the 10-year timber management plans. Additional estimates of future timber availability are also generated through the use of the growth projection models previously described. Demand information is not extensive, and most is obtained from secondary sources such as the Forest Service North Central Forest Experiment Station and the Minnesota Department of Natural Resources.

Information on stumpage prices is maintained by central timber management staff in the form of appraisal prices, advertised prices and bid prices. Some data regarding advertised and bid prices is computerized. Stumpage price information is

maintained for a period of three years following the year to which it pertains. Such information forms the basis for the transaction timber sales process utilized by the National Forests, in which appraised prices are based on the average market price during the previous four quarters, minus cost averages.

Timber sales information is maintained within the framework of the five-year timber sales plan and the budgeting process previously described. As noted previously, information kept at the Forest level includes actual and planned sales volume by timber type groups, total sales receipts from all districts, and actual and planned cost estimates. Cost information may be further subdivided into the following categories:

- . Sale preparation costs
- . Harvesting costs
- . Road costs
- . Regeneration costs
- . Site preparation costs
- . Cultural treatment costs

For the Forest-wide FORPLAN model, such costs must be represented on a per acre basis. Both National Forests in Minnesota have recently incorporated timber sales information within an automated system for Forest-wide timber sales accounting, the Timber Sales Preparation and Report System (TSSPR). This contains both appraisal and transaction evidence information. Initial results from the implementation of this system have been quite favorable.

As noted previously, an important consideration for National Forest timber management involves the relationship of biological allowable cut information and economic information relating to timber sales. The actual amount of timber harvested during a given year depends upon market conditions at that time. However, timber sales for that year depend on the allowable cut. Since a purchaser of timber has five years within which to harvest the timber bought, in years of weak market demand harvesting may be deferred until market conditions improve, provided the timber is harvested within five years after the date of purchase. High allowable cut figures allow for more advertising, but at a cost of approximately \$6/MBF for putting timber up for sale, there exists a potential for counter-productive investment of financial resources in putting up sales for which no bids are received.

This highlights the important need for synthesizing both biological and economic information in any timber management activities. National Forests (and other forest management agencies) must not only possess information on the biological production potential of their forests, but must also obtain accurate information on market conditions and trends to avoid unnecessary financial losses from over-advertising. This latter requirement necessitates a close coordination with forest industries in the state regarding their

^{13/} The Stand and Tree Evaluation and Modeling System (STEMS), formerly known as the Forest Resources Evaluation Program (FREP) (Lundgren and Essex, 1979), is a forest growth model designed to describe stand development, with or without management activities.

perceptions of current market conditions and their concurrent expectations for timber procurement.

Information regarding fuelwood on National Forests exists primarily in the form of individual studies regarding supply and demand which are obtained from other agencies or organizations. Each National Forest does keep records of permits issued for fuelwood harvesting. National Forests actively strive to maintain working familiarity with wood processors who have an interest in National Forest operations; however, no information regarding structural characteristics of wood processors is kept by the Forests. This is also the case regarding independent loggers; much of the information concerning loggers is obtained via daily interactions at the district level, where lists of loggers are maintained in manual files.

Nontimber Forest Management Information: Wildlife and Recreation--The primary mechanism through which data regarding wildlife habitat information on National Forest lands is generated is the Wildlife Management Information System (WMIS). This system is designed to interface with TMIS, and data for WMIS is actually collected as part of TMIS inventory operations. The data elements for WMIS which are recorded at the stand level include:

- . Community type
- . Habitat type
- . Nontimber community type
- . Stand structure
 - overstory: height, density
 - understory: height, density
 - shrubs (31 types)
 - forbs (36 types)
- . Within stand features
 - den trees
 - openings
 - unique plant communities
 - forest trees
- . Special management areas
 - endangered species
 - deer yards
 - old growth stands
- . Water types
- . Eagle/osprey habitat

Information regarding wildlife population levels is also maintained in the form of census figures for the following species:

- . White-tailed deer
- . Ruffed grouse
- . Woodcock
- . Eagle
- . Osprey

The minimum size mapping unit for representation of wildlife information is two acres. The synthesis of resource and habitat data into land type associations and ecological land types in the FORPLAN process provides an additional analytical tool for wildlife management at the National Forest level.

Information concerning recreation on National Forest lands is collected in the following forms:

- . Recreation facilities
 - trails and portages: numbers, types, distances
 - campsites: developed, dispersed
 - boat launching sites
- . Recreation usage
 - recreation types and numbers of participants at the district level, generally based on estimates by district personnel

The Superior National Forest also maintains a large amount of information on recreational activities within the Boundary Waters Canoe Area. This includes types of recreational use and numbers of users (from user permits). Recreational use types are based primarily upon mode of travel: canoe, motorboat, or hiking.

TMIS-generated recreational data consists of visual sensitivity levels, views of corridors, riparian influence descriptors and developed recreational sites. For Forest-wide planning activities, FORPLAN requires information for landscape characteristics and resource prices for wildlife species and recreational experiences. Such information is compiled to the extent possible in light of the rather limited state-of-the-art for determining wildlife and recreational values.

Annual summaries for forest-wide recreational activities are compiled and forwarded to the Washington Office for incorporation with the Forest Service Recreation Information Management System (RIMS). RIMS utilizes the Recreational Opportunity Spectrum (ROS) analytical framework requiring a synthesis of data such as recreational visitor days, roading costs, etc. Computer print-outs are then furnished to individual National Forests. While RIMS provides a standardized mechanism for recreational accounting of Forest Service activities at the national level, to date it has not been particularly useful for National Forest level recreational land management activities.

North Central Forest Experiment Station

The U.S. Forest Service conducts an extensive program of research related to the management of the nation's forests and rangelands. Within the multiple-use framework embodied in Resources Planning Act (RPA) legislation, Forest Service research is concerned with such activities as timber management; range management and conservation practices; wildlife and fisheries management and habitat evaluation; protection and management of water resources on forest lands; and provision of recreational experiences in National Forests and wilderness areas. Other areas of research emphasis include economic analysis of supply and demand for forest-based goods and services; marketing and utilization of wood products; forest engineering technology; and the protection of forest lands

from threats posed by fire, disease, and insect infestation. Table 17 contains the legal basis for research activities of the U.S. Forest Service.

Table 17. Legal basis for research activities of the U.S. Forest Service.

Legislation	Activities Mandated
Forest and Rangeland Renewable Resources Research Act (1978) (16 U.S.C. 1641 note, 1641-1647)	Execution, support and cooperation in activities deemed necessary to obtain, develop, and disseminate scientific information concerning the protection, management, and utilization of forest and rangeland renewable resources.

Research work unit descriptions for the 23 units within the North Central Forest Experiment Station (Figure 18) are presented in Appendix A. The specific kinds of forest management information generated from unit projects is summarized in Table 18 according to information classes described in the information-agency matrix (Figure 13).

Among the research work units described above, the Renewable Resources Evaluation (RRE) unit at St. Paul, Minnesota, is of particular importance with regard to assessing the status of the forest resource for the state as whole, i.e., for all public and private ownerships combined. RRE units at six regional experiment stations across the nation conduct periodic inventories of the Nation's forests to provide current information on forest area, timber volume, growth, mortality, depletions, potential productivity, and forest ownership. These activities represent a continuation and expansion (via passage of the RPA^{14/} in 1974) of what was formerly the Forest Survey.^{14/}

The goal of each RRE unit is to provide a survey of each state within its domain of responsibility on a 10-year cyclical basis. The most recent forest survey for Minnesota is dated 1977, for which fieldwork occurred over a four year period from 1974 through 1978. All lands were surveyed within the state except those under jurisdiction of the National Forests, from which survey data was obtained directly. A representative list of data elements tallied for the RRE forest survey is presented in Table 19.

This data is then processed into approximately 100 kinds of information pertaining to the forest resource. Processing is achieved by means of the Forest Information System (FINSYS). A summary of forest survey information is depicted in Table 20.

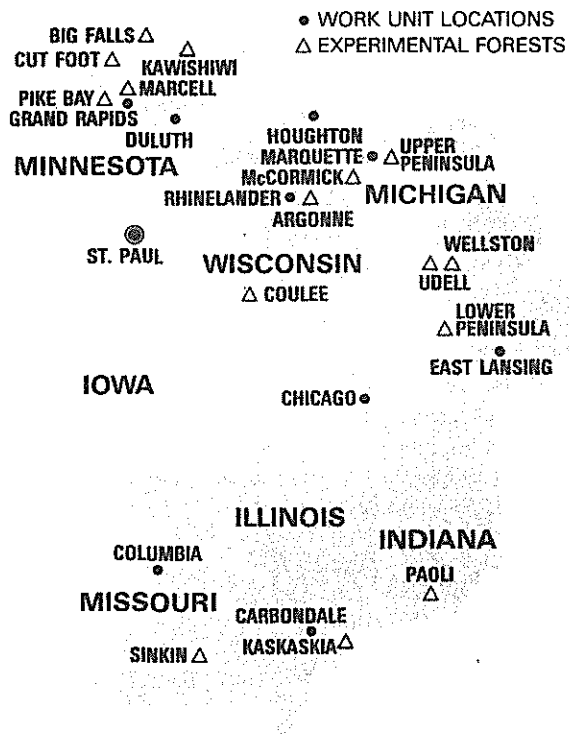


Figure 18. Work unit locations and experimental forests of the North Central Forest Experiment Station. (USFS, 1982).

^{14/} Authorized by the McSweeney-McNary Act of 1928.

Table 18. Information for forest management generated from research projects of the U.S. Forest Service, North Central Forest Experiment Station, by information class; September, 1982.

FOREST RESOURCE INFORMATION

Statewide forest survey
 Inventory design and operation
 Ecological site classification system design
 Species composition and nutrient cycling
 Peatland hydrology
 Acidic precipitation: impacts on soil, forest, and water resources

LAND USE INFORMATION

Wastewater treatment potential of peatlands
 Forest land treatment of sewage effluent and sludge

FOREST OWNERSHIP AND JURISDICTIONAL INFORMATION

Statewide forest survey

FOREST ADMINISTRATIVE INFORMATION

Minnesota counties: forest management and financial support
 Effectiveness of fire prevention programs
 Meteorological influences on forest fire occurrence
 Fire management planning for the Northeastern United States
 Air tanker systems
 Fuel characteristics for fire danger ratings
 Nonindustrial private landowners: perceptions of forest management

TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL

Genetic parameters of jack pine and white spruce
 Genetic modeling for Lake States tree breeding
 Rooting techniques for mature tree cuttings
 Seed orchard management
 Genetic variation and flowering biology in black walnut and ash species
 Physiology of wood formation in Populus deltoides
 Growth and mortality modeling for Lake States forests
 Managed-stand yield tables for northern hardwoods
 Effects of harvesting intensity on site productivity: aspen, birch, and conifers
 Northern hardwood regeneration systems
 Oak-hickory regeneration systems: seedling establishment and growth
 Oak responses to silvicultural treatments
 Site productivity and black walnut establishment
 Site, insect, and management effects on black walnut growth
 Plantation propagation systems
 Silvicultural spacing and harvesting techniques for high yield management
 Irrigation and fertilization of Populus
 Crown structure and canopy density and Populus plantation yields
 Physiological influences for high yield plantations

TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL (continued)

Biomass yields from short rotation intensive cultural systems
 Host tree influences on insect outbreaks
 Meteorological influences on insect populations
 Host tree genetics and insect outbreak potential
 Stand density and insect population levels
 Insect control in Christmas tree plantations
 Integrated pest management for forest plantations
 Effects of insects on intensive Populus cultures
Scleroderma canker control
 Diseases of short-rotation poplar plantations
 Diseases of conifer nurseries and plantations
 Diseases of juvenile aspen
 Oak wilt transmission
 Diseases of black walnut

TIMBER MANAGEMENT INFORMATION: ECONOMICS AND UTILIZATION

Timber supply potential in North Central Region
 Timber and pulpwood production in North Central Region
 Timber availability from Lake States nonindustrial private forests
 Economics of short-rotation Populus cultures
 Timber demand forecasting for Lake States
 Stumpage markets for Lake States wood products
 Forest products prices for Minnesota and Wisconsin
 Wood residue utilization and recovery
 Log sorting and merchandising systems
 Quality and product potential of intensively cultured Populus and Larix
 Lumber drying technology
 Machining of wood surfaces
 Economic and technical analysis of wood harvesting and processing systems

NONTIMBER FOREST MANAGEMENT INFORMATION

Habitat evaluation: timber wolf, Kirtland's warbler, white-tailed deer, beaver, black bear
 Impact of aspen succession and conversion on birds and small animals
 Habitat capability modeling
 Sensitive plant and animal species: oak-hickory ecosystem
 Nongame bird habitat and silvicultural activities
 Fire and grazing impacts on nongame wildlife
 Management of water impoundments for wildlife
 Timber harvesting effects on water quality
 Stream sediment management for improved fisheries
 River use and user characteristics
 River user perceptions of recreational experiences
 River recreation management techniques
 Urban forestry and recreation management

FOREST MANAGEMENT RESEARCH INFORMATION

Evaluation of productivity of forest management research

Table 19. Data elements collected by RRE forest survey.

Land use class	Land use edge data
Owner class	Percent occupancy by plant life forms
Forest type	Number of seedlings and saplings by species
Stand size class	Distance from plot center
Stand area class	Azimuth
Stand age class	Species
Harvest history	Diameter breast height
Operability	Merchantable heights
Distance to nearest road	Log grade
Elevation	Merchantability class
Slope	Cull percents
Aspect	Crown ratio
Terrain position	Crown class
Soils data	Damage
Site index data	Cause of death
Percent crown closure	Cavities

Table 20. Information generated by RRE forest survey.

Area by ground land use
Area (CFL) ^{a/} by forest type and 7 ^{b/} stand and site characteristics
Area (CFL) by ownership and 5 stand and site characteristics
Area (CFL) by owner-forest type and 7 stand and site characteristics
Average annual area (CFL) change by 10 causes for change
Area of unproductive forest land by owner and forest type
Volume of growing stock by 31 descriptors
Growth by 8 descriptors
Mortality by 4 descriptors
Removals (average annual cubic feet) by species group and 2-inch DBH class
Volume and numbers of diseased species by DBH class

^{a/} CFL - commercial forest land.

^{b/} Actual number of classification modes may vary slightly from those represented.

State and Private Forestry

The State and Private Forestry (S&PF) branch of the U.S. Forest Service coordinates the administration of federal assistance programs designed to aid states in addressing the needs of nonindustrial private forest landowners. It provides technical assistance for industrial elements within the private sector, and is responsible for ensuring that federal lands are protected from potential damage from insects and disease. S&PF also provides guidance for state programs relating to forest insect and disease control.

The legal basis for the activities of State and Private Forestry, which provides impetus for the collection and dissemination of forest management information, is the Cooperative Forestry Assistance Act of 1978 (Table 21).

At the national level of organization, State and Private Forestry is divided into two broad areas that include 33 states in the eastern U.S. (see Figure 15); S&PF activities for the remaining

17 states in the West are integrated within the administrative framework of the National Forest System.

Minnesota and the other Lake States fall within the Northeast Area of S&PF, with headquarters located at Broomall, Pennsylvania. The Northeast Area also has three field offices, one of which is located at St. Paul, Minnesota. It is through the St. Paul office that most S&PF programs and activities which have an impact upon forest management in Minnesota are conducted. The St. Paul field office is organized into four functional areas (Figure 19) which are subordinate to two broader functions at Northeast S&PF headquarters.

Table 21. Legal basis for collection of forest management information by State and Private Forestry branch of U.S. Forest Service.

Legislation	Activities mandated
Cooperative Forestry Assistance Act (1978) (92 Stat. 365; 16 U.S.C. 2101 note, 2101-2110, 1606, 2111)	USDA-authorized financial, technical and related assistance to state foresters for rural forestry assistance, private forestry incentives, insect and disease control, urban forestry assistance, rural fire protection and control, planning, and technology implementation.

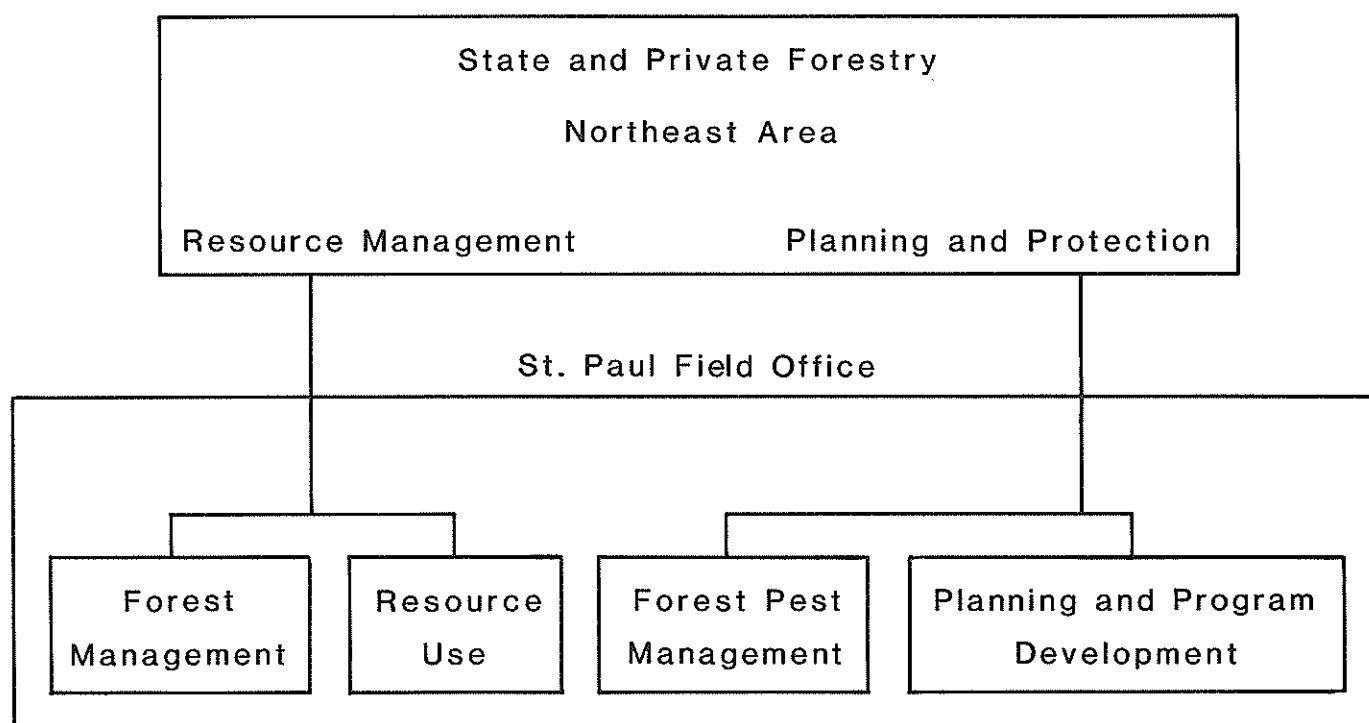


Figure 19. Organization of State and Private Forestry branch of U.S. Forest Service, Field Office, St. Paul, MN, 1982.

The primary activities of S&PF which contribute to forest management in Minnesota are:

- . Financial and technical assistance to states for rural fire protection programs
- . Technical assistance funding and federal-state program coordination for state-level implementation of federal cost-share programs for private nonindustrial forestry; and other state-administered assistance to nonindustrial private forest landowners

- . Actual provision of technical assistance to private forestry firms regarding wood harvesting, processing, and utilization technology
- . Forest insect and disease protection for all federal lands in Minnesota and technical assistance funding for state insect and disease control programs
- . Coordination of information exchange and linkages between state and Forest Service nation-wide forest planning activities

- . Technical assistance for special projects related to the conservation of Minnesota's soil and water resources

Programs that provide aid to states for rural fire protection activities are coordinated at S&PF Northeast Area Headquarters in Broomall, Pennsylvania. Two primary programs are involved. The Rural Fire Prevention and Control Program provides both financial and technical assistance to state forestry agencies (through the State Forester) to coordinate prevention programs and provide specialized fire training. Coordination efforts involve such areas as aerial detection, law enforcement, fire suppression, development and testing of fire equipment, and fire planning. The Rural Community Fire Protection Program provides grants (distributed by the State Forester) to local fire departments in communities with a population of less than 10,000 residents. Grant monies are utilized for training, equipment acquisition, and fire suppression operations.

Activities other than fire protection assistance are conducted in accordance with the functional S&PF field office structure depicted in Figure 19. A brief overview of the information collected by the four functional sections as it pertains to forest management in Minnesota is now provided.

Forest Management--This section maintains information regarding federal programs which provide funds to the state for supporting cooperative forest management (CFM) field foresters. Technical expertise for program administration is also provided in the resource areas of hydrology, soils, and silviculture. The primary mechanisms through which federal funding is provided to the states for cooperative forest management include:

- . Activities authorized under the Rural Development Act of 1974, which authorizes S&PF guidance to accompany federal funding for forestry, land use, and fire protection programs in rural areas
- . Cost-shares for private nonindustrial forest management available under the Agricultural Conservation Program (ACP) and the Forestry Incentives Program (FIP)

S&PF provides technical forestry assistance for these latter two programs, which are actually administered by the USDA Agricultural Conservation and Stabilization Service.

The majority of information collected by the Forest Management section pertains to the administration of these programs and the technical forestry-related aspects of program implementation.

Resource Use--The Resource Use section provides technical expertise to individuals and firms within the state who are engaged in the harvesting and processing of forest products. Information is maintained with respect to the following kinds of technical assistance programs and the subject areas to which they pertain:

- . Timber harvesting technology--harvesting practices, utilization, logging systems analysis
- . Primary processing--sawmill operations technology, sawmill efficiency analysis, residue marketing
- . Secondary processing--wood procurement, product yield recovery, equipment selection, quality control and product standards

Harvesting specialists within the section provide assistance to loggers and offer training sessions to interested individuals or firms. The section also provides support for utilization specialists at the state level.

Forest Pest Management--The S&PF Pest Management section is responsible for the detection, evaluation, and suppression of problems related to insects and disease on all federal lands within Minnesota. The section conducts surveys to determine the existence and magnitude of insect infestations on these lands and is responsible for all control activities which are initiated. The section also coordinates the distribution of federal funds to the Minnesota Department of Natural Resources to support insect and disease suppression activities on state lands. Technical assistance for state control activities is also provided.

S&PF Pest Management synthesizes the information from Minnesota insect and disease reports into status reports for the entire 20-state Northeast Region. The section also maintains and disseminates the following information:

- . Current insect and disease levels in Minnesota
- . Analyses of specific pests, such as the spruce budworm
- . Insect and disease suppression techniques

Planning and Program Development--This section has the responsibility for coordinating the collection and transfer of federal and state natural resource information within the framework established by the Renewable Resources Planning Act (RPA) of 1974. It also administers federal funds to Minnesota and other states for forest planning activities as authorized by the Cooperative Forestry Assistance Act of 1978.

One program with significant impact on Minnesota resulted from the passage of the Boundary Waters Canoe Area (BWCA) Wilderness Act of 1978. Concurrent with the enactment of the 1978 law was Congressional authorization of \$3 million annually to the state of Minnesota for the intensification of timber management activities on nonfederal forest lands. S&PF administers this program, which is authorized from 1980 through 1991. Funding must be appropriated annually by Congress.

The majority of information maintained by Planning and Program Development relates to the above programs. The section also maintains information regarding cooperative projects with other agencies, the most notable of which is a current

study, conducted in conjunction with the USDA Soil Conservation Service, concerning cropland and soil erosion along river basins in southern Minnesota.

Bureau of Indian Affairs

Mission and Organization

The Bureau of Indian Affairs (BIA) was created in 1824 and was subsequently incorporated within the United States Department of the Interior at the time of its establishment in 1849. The basic responsibility of the Bureau is to assist Indian tribes (and native Alaskans) in the management of their natural resources and the income derived from these assets in a manner that provides maximum social and economic benefits. As an agency of the federal government, the Bureau of Indian Affairs occupies a unique position in its role as trustee for Indian lands. These lands belong to the individual tribes, and as such they are not part of the public domain; the Bureau is, therefore, a public agency actively engaged in the management of private lands. As trustee of the resources for the various tribes, the agency also attempts to improve their social welfare by assisting tribes in obtaining and administering community development programs and services.

The Indian tribes within the state are the Minnesota Chippewa and the Minnesota Sioux. The Sioux land holdings consist of four small reservations along the Minnesota and Mississippi Rivers (Figure 20). The Chippewa tribe is divided into two tribal units, the Minnesota tribe and the Red Lake tribe; their lands are located on seven reservations, some of substantial size, in the northern part of the state. More than 600,000 acres of forest land, or approximately five percent of the state's forest resource, are located on Indian lands.

The nature of Indian land ownership in Minnesota is essentially two-fold. Indian lands are either owned by the tribe as a whole (tribal lands) or by individual Indians (allotted lands). All lands are held by the federal government in trust for the tribe or individuals within the tribe. Approximately 75 percent of Indian land in Minnesota is tribal, while the remaining 25 percent is allotted, i.e., actually owned by individuals with title held by the government.

The current organizational structure of the Bureau of Indian Affairs is depicted in Figure 21. The Minneapolis Area is one of 12 such administrative units designed to provide social and resource management assistance to Indian tribes (and Alaskan natives) throughout the country.

The Minneapolis Area consists of reservations in four states of the upper Midwest. Within the state of Minnesota itself, management responsibilities are divided among three agencies. The Minnesota Sioux Agency provides assistance to the four small Sioux reservations in the southern part of the state. Responsibilities for the Chippewa tribe are allocated between the Red Lake and

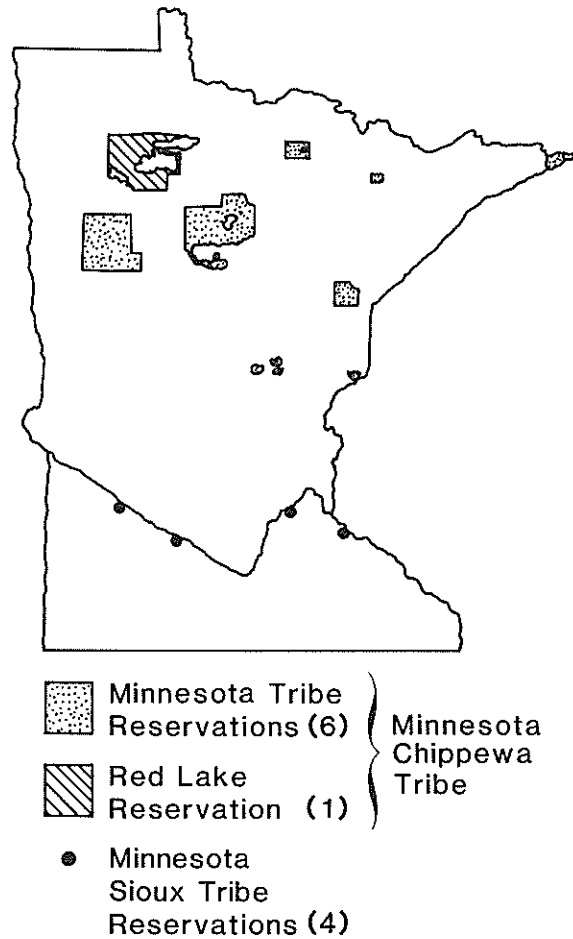


Figure 20. Indian lands in Minnesota.

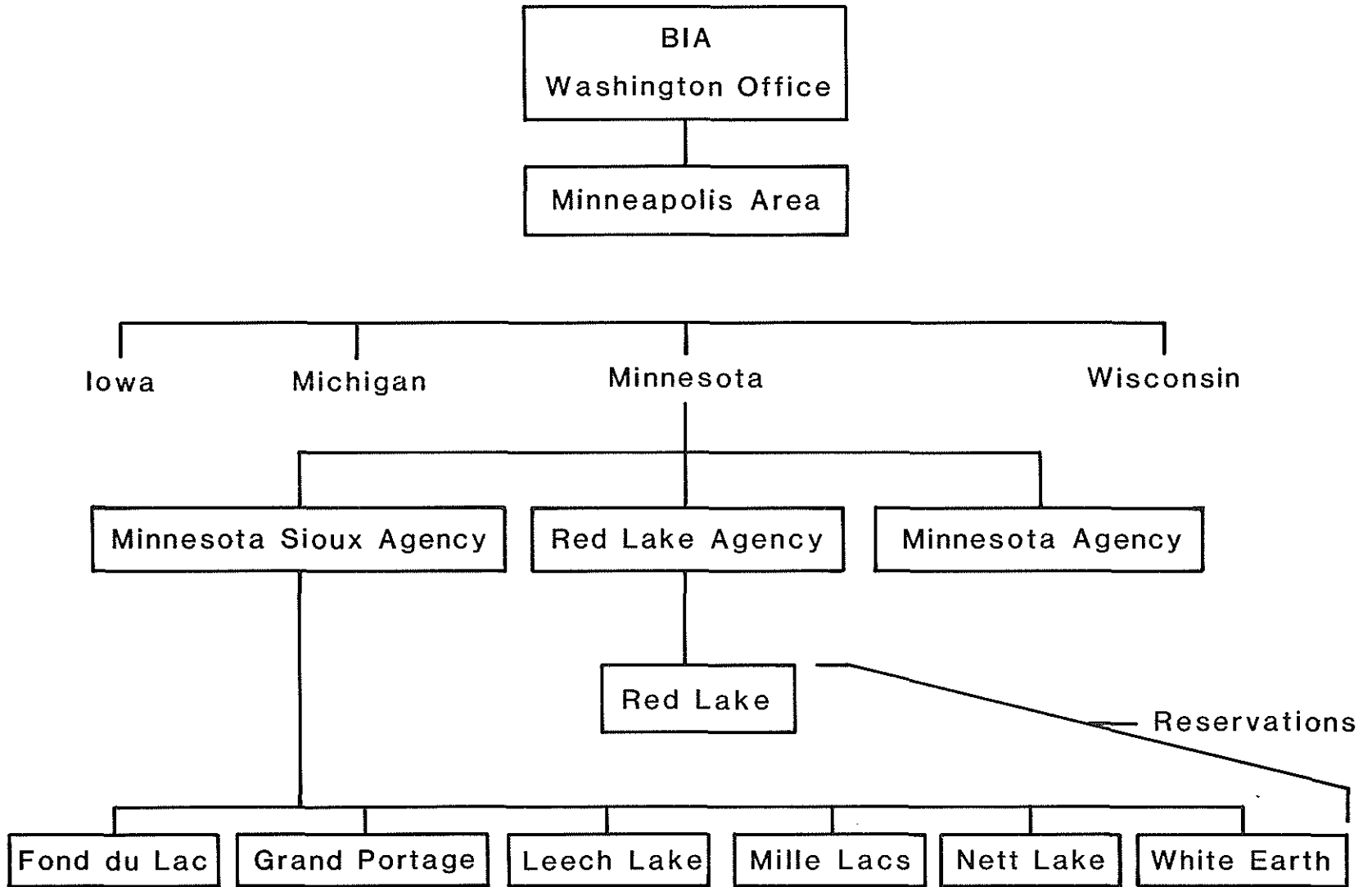
Minnesota Agencies, the latter of which is concerned with the six reservations comprising the Minnesota Chippewa Tribal unit (Figure 20).

Organizational functions of the Minneapolis Area are depicted in Figure 22. Forestry activities constitute an individual section within the Division of Trust and Resources Development.

Information Resources for Forest Management

The Bureau of Indian Affairs is trustee of the resources for the various tribes within the state. Foremost among natural resources are forest lands, from which the tribes derive about three-fourths of all resource-generated income. Fisheries are also an important natural resource, although their precise value to the tribes is difficult to ascertain since not all tribal fishing activities are commercial in nature. Resource-related management activities for which the Bureau provides assistance to the tribes include timber management, fuelwood utilization, trapping, fishing, a maple syrup enterprise, and wild rice management. The legal basis for forest management activities of the Bureau is represented in Table 22.

Figure 21. Organization of the Bureau of Indian Affairs, Minneapolis area, 1981.



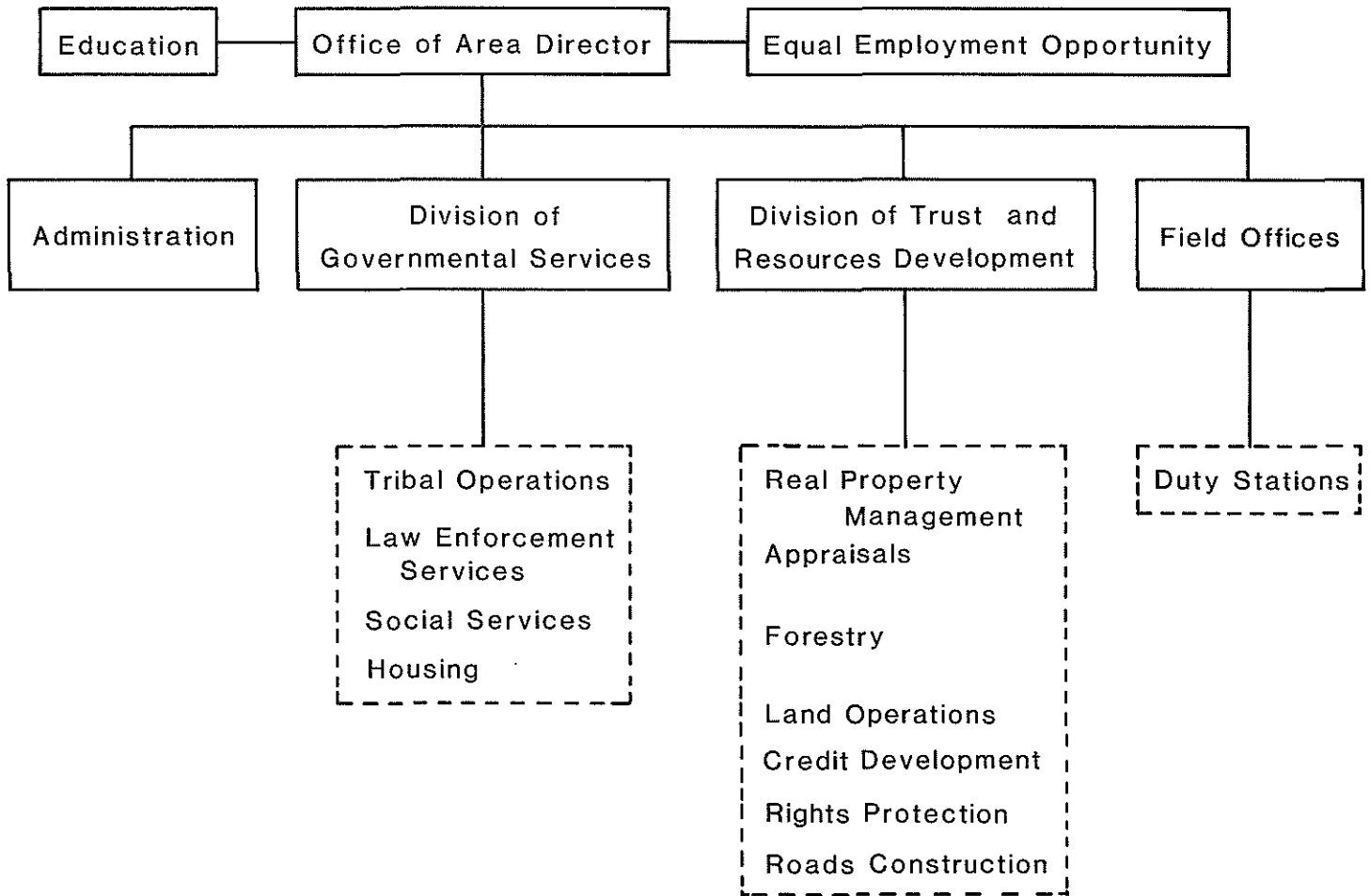


Figure 22. Structure and Management Activities of the Bureau of Indian Affairs, Minneapolis Area Office, 1982.

Table 22. Legal basis for collection of forest management information by Bureau of Indian Affairs.

Section 7 of the Act of June 25, 1909 (25 U.S.C. 407)	Cooperation with tribal governments in the development and implementation of programs for natural resource management on Indian lands.
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Tribal governmental structure has important implications for the forest management activities and programs of the Bureau. Reservations have the power to "manage, lease, permit or otherwise deal with tribal lands, and to engage in any business that will further the economic well being of members of the tribe" (Article IV: Revised Constitution and Bylaws of the Minnesota Chippewa Tribe, Nov. 23, 1963). Thus all forest management activities prescribed by the Bureau must be approved by the reservation on which they are to be implemented.

The basic management unit for the Bureau's forest management activities is the reservation. A number of reservations have established a formal management plan for their forest lands, while others utilize what might best be described as a plan of operations for harvesting activities. Timber management activities conducted by the Bureau include a continuous forest inventory (CFI) which has been in place since 1956; plots are currently remeasured every 10 years. Data elements collected in forest inventory operations include:

- . Soil type
- . Site productivity
- . Forest cover type
- . Stand age class
- . Stand size class
- . Stand density class
- . Stand reproduction
- . Harvest recommendations and priorities
- . Harvesting operability
- . Silvicultural recommendations

CFI-derived data from all reservations is synthesized by central management staff at the Area Headquarters to generate the following kinds of forest management information:

- . Cover type per reservation by acres
- . Volume per reservation by species and product class
- . Annual cuts by reservation by volume and value
- . Annual cuts per reservation by sawtimber and cordwood
- . Timber permits and contracts by reservation
- . Timber sales by reservation
- . Allowable cut information
- . Reforestation priorities
- . TSI and silvicultural priorities
- . Forest development scenarios

Records from the Minnesota Agency are then summarized with those of other agencies within the Area and forwarded to the Bureau's Washington office.

The Bureau estimates that reservations in Minnesota have the potential for generating five to nine times the income currently derived from timber harvesting operations. All timber sales on tribal lands must be approved by the tribe (or by 50 percent of allottees, for sales from allotted lands). It is generally the policy of reservations to sell timber to Indian loggers only; this is one factor which contributes to the difference between actual and potential harvest income noted above.

The division of Indian ownership into lands owned by the tribe as a whole and those allotted to individual tribal members has resulted in certain management problems for the Bureau, particularly with respect to allotted lands. Titles to such lands have been passed on from generation to generation; the large number of heirs has resulted in the fragmenting of allotted lands into many small segments. Thus, the Bureau's forest management programs, while able to take advantage of economies of scale associated with large contiguous blocks of tribal forest lands, must address allotted lands much as other public agencies would deal with nonindustrial private forests. Not surprisingly, the design of management programs for allotted lands is described as one of the biggest "management headaches" by Bureau officials. An additional problem which influences forest management capabilities of the Bureau is the limited size of the forestry staff both at the area and field levels. Currently there exists only one

staff forester for coordinating management activities at the Minneapolis Area level. Staff positions for tribal operations in Minnesota have been reduced by 20 percent. These cutbacks are but one element of an overall BIA budget for FY 1984 that has not kept pace with inflation. Many BIA foresters find the logic underlying recent comments by the Secretary of the Interior that Indian reservations have been the victim of gross federal mismanagement over the years hard to fathom in light of these substantial budget cuts.

Most information concerning wildlife on Indian lands is maintained by the tribes, and since tribal lands are in essence under private ownership, the Bureau maintains little information regarding recreational activities on these lands.

In addition to resource and timber management information described above, the Division of Governmental Services maintains information regarding Indian employment opportunities, providing reservations with advice for coordinating programs for Indian loggers. Depending on the availability of funding, the Bureau also provides technical assistance for wood processing operations on tribal lands.

Although at present almost all forest management information maintained by the Bureau is in the form of manual records, plans for computerizing inventory and some timber management information are underway. The establishment of a central Forestry Field Staff Assistance Office for the Bureau in Denver, Colorado, will concurrently involve the establishment of a forest management information system for coordinating forestry activities of the Bureau on a national basis. The lack of a staff position for computerized information processing at the Minneapolis Area level will substantially hinder the ability of the Area to effectively utilize this automated information system.

In considering problems which affect the Bureau's forest management activities in Minnesota, it is also important to recognize that the agency has specific social as well as resource-related objectives, and that management problems which arise often manifest both a social and a resource dimension. Indian lands and tribes are not under state jurisdiction; they are in many ways federal islands existing within the state. This can sometimes result in conflicts between the tribes and local or state governments regarding aspects of natural (and human) resource management. Fishing rights and enforcement of hunting regulations on reservations are but two examples, the latter issue having recently been at the root of some controversy in Minnesota. The recognition and resolution of such legal and jurisdictional issues is important for maintaining an atmosphere in which the Bureau can most effectively provide forest management (and other) assistance to tribes within the state.

In a similar vein, pressing social inequities still plague many Indians in Minnesota. Although the Bureau is doing what it can with resources available, there is still a critical lack of adequate housing on many reservations, and Indian unemployment remains at high levels. Effective forest management on Indian lands can aid in generating much-needed income for the tribes, but it is too much to expect that this alone will result in resolution of many of these major socioeconomic problems.

Bureau of Land Management

The Bureau of Land Management of the U.S. Department of the Interior manages 417 million acres of public lands in the United States, primarily in the western states and Alaska. The Bureau was established in 1946 and its land management responsibilities were subsequently updated and classified by the Federal Land Policy and Management Act of 1976 (90 Stat. 2743). The Bureau is charged with comprehensive management of lands under its jurisdiction for the outputs of timber, minerals, range vegetation, wildlife, and recreation.

The Bureau manages approximately 45,000 acres of public lands in Minnesota. Slightly more than one-half of these lands are forested; however, only 3,000 forested acres qualify as commercial forest lands. Much of the Bureau's land in Minnesota consists of a 33,000 acre tract of peat bog land in Koochiching County. The rest is scattered on 1700 parcels throughout the state, including 1171 islands averaging 1.9 acres in size.

The Bureau is in the process of disposing of all lands under its jurisdiction in Minnesota. This is part of a larger plan in which the Bureau will divest itself of all land holdings east of the Mississippi River. The U.S. Forest Service will act as an agent for the Bureau in transferring these lands to other ownerships, but due to the small and scattered nature of most tracts, the Forest Service has no plans for assuming ownership or long-term control of them. The Minnesota Department of Natural Resources has applied for approximately 7300 acres of lands currently under jurisdiction of the Bureau of Land Management.

The Bureau maintains an area office in Duluth, Minnesota. Information resources regarding the Bureau's forest lands are not extensive, as forest management has not been a major priority in the past. Forest resource information maintained by the agency is primarily in the form of acreages by county, forest land class (i.e., commercial, noncommercial, nonforest), forest lands by stocking level, and commercial forest land by stand size classes. The Bureau does maintain management plans for its forest lands, but no timber sales have occurred within the last 10 years. The agency conducts fuelwood sales, and it keeps records of fuelwood harvested on an annual basis.

The Bureau also maintains a limited amount of aerial photographs for lands under their jurisdiction.

National Park Service

The National Park Service, established in the Department of the Interior in 1916, administers more than 300 units within the National Park System, including national parks and monuments, scenic riverways, and historic sites. Among these areas is Voyageurs National Park, which is comprised of 205,000 acres of land and water in northern Minnesota along the United States-Canadian border. The park was authorized, pending purchase of required lands, in 1971 (PL 91-661; 84 Stat. 1971, U.S.C.) and was officially established by the Secretary of the Interior in 1975.

Forested lands constitute 134,000 acres within Voyageurs National Park, all of which fall within the forest land use category of productive-reserved. The primary function of the National Park Service is to ensure that such lands remain in their natural state for the use of all citizens of the United States. Information collected by the Service reflects this role.

The Park Service maintains some limited information on forest land cover within the park, all of which was furnished from the original report on fire and logging history. It does collect extensive information on park lakes and waterways, which account for almost 35 percent of total park area--approximately 72,000 acres. The Service also maintains aerial photographs of park lands and waters, tentatively scheduled for updating on a 10-year interval.

Extensive ownership records are kept by the Park Service; the need for detail in this area reflects the fact that five percent of lands within park boundaries are not under public ownership. The policy of the Park Service has been to attempt to acquire any lands with a willing seller; at present, however, funding for the purchase of such lands appears tentative at best.

No timber management activities occur within Voyageurs National Park, and little information concerning such activities is maintained. The Park Service does collect information regarding fire protection and control, and it has the capability for accessing the Forest Service AFFIRMS fire danger information system. The primary kinds of information collected by the Park Service pertain to wildlife resources and recreational activities. Park Service staff contains two wildlife biologists, who maintain information on terrestrial and aquatic wildlife habitat as well as wildlife and fish population trends. Yearly reports on loon counts and wolf populations are also issued.

Recreational use and trends are compiled monthly in the form of a Public Use Report. The park has no campgrounds; however, approximately 100 primitive campsites exist, accessible only by

water, about which information on user intensity is maintained. Very limited information on park roads is collected, reflecting the fact that at present only 4.8 miles of roads exist within the entire park area. The Park Service has recently purchased a small computer on which much of the previously described information will be maintained; at present, however, all information exists in the form of manual records and files.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) of the Department of the Interior was established in its current form by the U.S. Congress in 1974 (88 Stat. 92), and it represents the synthesis of several federal agencies involved with fisheries and biological surveys dating back to the 1870s. The Service has management responsibility for 398 National Wildlife Refuges in the United States comprising more than 34 million acres, as well as for 88 fish hatcheries and 58 research laboratories and cooperative research units nationwide.

The Fish and Wildlife Service is organized into six regions encompassing all 50 states; the Great Lakes Region is comprised of six states in the Upper Midwest, with the regional office located in Minneapolis, Minnesota. The USFWS manages^{15/} approximately 443,000 acres of land in Minnesota. Among these are nine wildlife refuges accounting for 202,000 acres; and 159,000 acres of waterfowl production areas. Primary management activities conducted on these lands include dike construction for waterfowl migration and nesting sites, native grass establishment, woody plant and noxious weed control, and nesting habitat establishment. The USFWS also administers the New London National Fish Hatchery, established in 1939 for the production of various cool water fishes.

The Tamarac, Sherburne, and Rice Lake wildlife refuges in Minnesota do contain contiguous tracts of forested lands and have had commercial logging operations at some time in the past. The agency has one forester in the state stationed at Tamarac. In all, wildlife refuges in Minnesota contain approximately 46,000 acres of forest lands. Management information concerning the timber characteristics of these tracts is quite limited, being based on an extensive prescriptive inventory conducted approximately 16 years ago. The Service does hope to eventually establish a continuous forest inventory for these lands should funds become available in the future. Limited cutting of firewood is permitted in forested areas of certain refuges.

^{15/} Some of these lands are under primary jurisdiction of other agencies. For example, 15,400 acres of the Upper Mississippi River Wildlife and Fish Refuge is administered by the U.S. Army Corps of Engineers. Also, 35,000 acres consist of easements of leases.

The primary kinds of information collected by the U.S. Fish and Wildlife Service depend on refuge management objectives, but all pertain to populations of wildlife species and habitat characteristics conducive to maintaining these populations. Particular emphasis is placed upon rare or endangered wildlife species, most notable of which are the bald eagle and peregrine falcon.

Department of Natural Resources

Mission and Organization

The Minnesota Department of Natural Resources (DNR) is responsible for the management of more than one-half of nonfederal public lands in Minnesota. Management responsibilities include the development and conservation of the state's forest resources for the production of timber and minerals; the establishment and maintenance of viable wildlife populations; the protection of the state's water resources; and the provision of recreational opportunities to Minnesota citizens through a system of parks and trails on state-owned forest lands.

The Department also has the authority to sell, lease, or otherwise dispose of state lands. Other responsibilities include the regulation of hunting and fishing activities within the state, coordination of state forest fire protection programs with federal and county governments, and providing residents of the state with educational opportunities regarding the use and conservation of state lands.

The organizational structure of the Minnesota DNR is presented in Figure 23. Department operations contains six divisions, three of which have land management responsibilities. The Division of Forestry manages the vast majority of DNR-administered forest lands; the Division of Fish and Wildlife is responsible for state wildlife management areas; state parks and recreational trails not on State Forest lands are administered by the Division of Parks and Recreation.

Two divisions have functions related to specific resources located on all state-owned forest lands. The Division of Minerals coordinates the development of the state's mineral resources, and the Division of Waters administers the general water conservation program for the state's water resources.

The DNR Division of Enforcement enforces all natural resource laws within the state of Minnesota. Other departmental boards, offices, and bureaus provide technical and planning support and guidance for operational divisions within the Department.

Since the Division of Forestry is the primary manager of DNR-administered forest lands, the following pages examine the information resources of the Division in some detail. Other divisions and departmental units are briefly described, primarily with respect to the information they collect that is of importance for forest management activities.

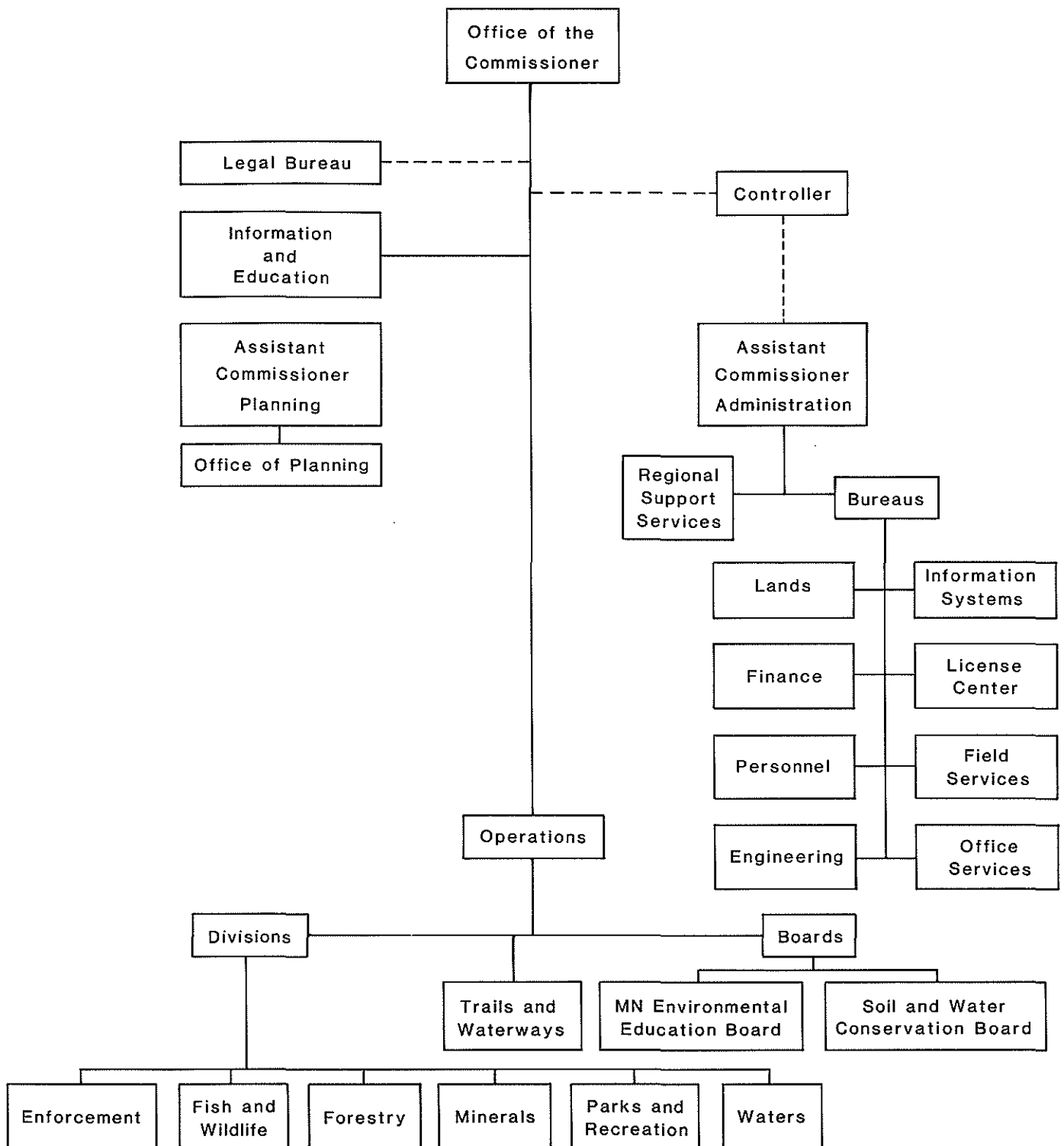


Figure 23. Organizational structure of the Minnesota Department of Natural Resources, 1981.

Division of Forestry

The Division of Forestry is responsible for the management of 4.6 million acres of state forest land in Minnesota. The Division develops and administers programs related to a variety of forest-based goods and services. Important activities include timber management, nursery operations, insect and disease control, fire protection, utilization and marketing programs related to forest products, recreation management on State Forests, and the provision of technical advice and assistance to private nonindustrial forest landowners in Minnesota.

The management responsibilities of the Division pertain to 3 million acres of designated State Forests and an additional 1.6 million acres of state-owned forest land not within State Forest boundaries (Table 23).

Table 23. Forest lands under the jurisdiction of the Department of Natural Resources, Division of Forestry, 1981.

Forest Lands	Acres (millions)
Total forest land	4.6
Commercial forest land	2.6
State Forests (55)	3.0
Forest land outside State Forest boundaries	1.6

Source: Division of Forestry, Minnesota Department of Natural Resources, 1981.

The legal basis for important forest management activities of the Division, and for the collection of information relevant to these areas, is presented in Table 24.

Table 24. Legal basis for collection of forest management information by DNR Division of Forestry.

Legislation	Activities Mandated
MN Statutes 1980, Chapter 88	Forest fire protection and control, nonindustrial private forestry assistance.
MN Statutes 1980, Chapter 89	Management and control responsibilities, forest land acquisition, reforestation, nursery operations.
MN Statutes 1980, Chapter 90	Timber production, timber sales.
MN Statutes 1982 ^{a/}	Forest planning, tree improvement program, continuing education, forest management fund, forest road planning.

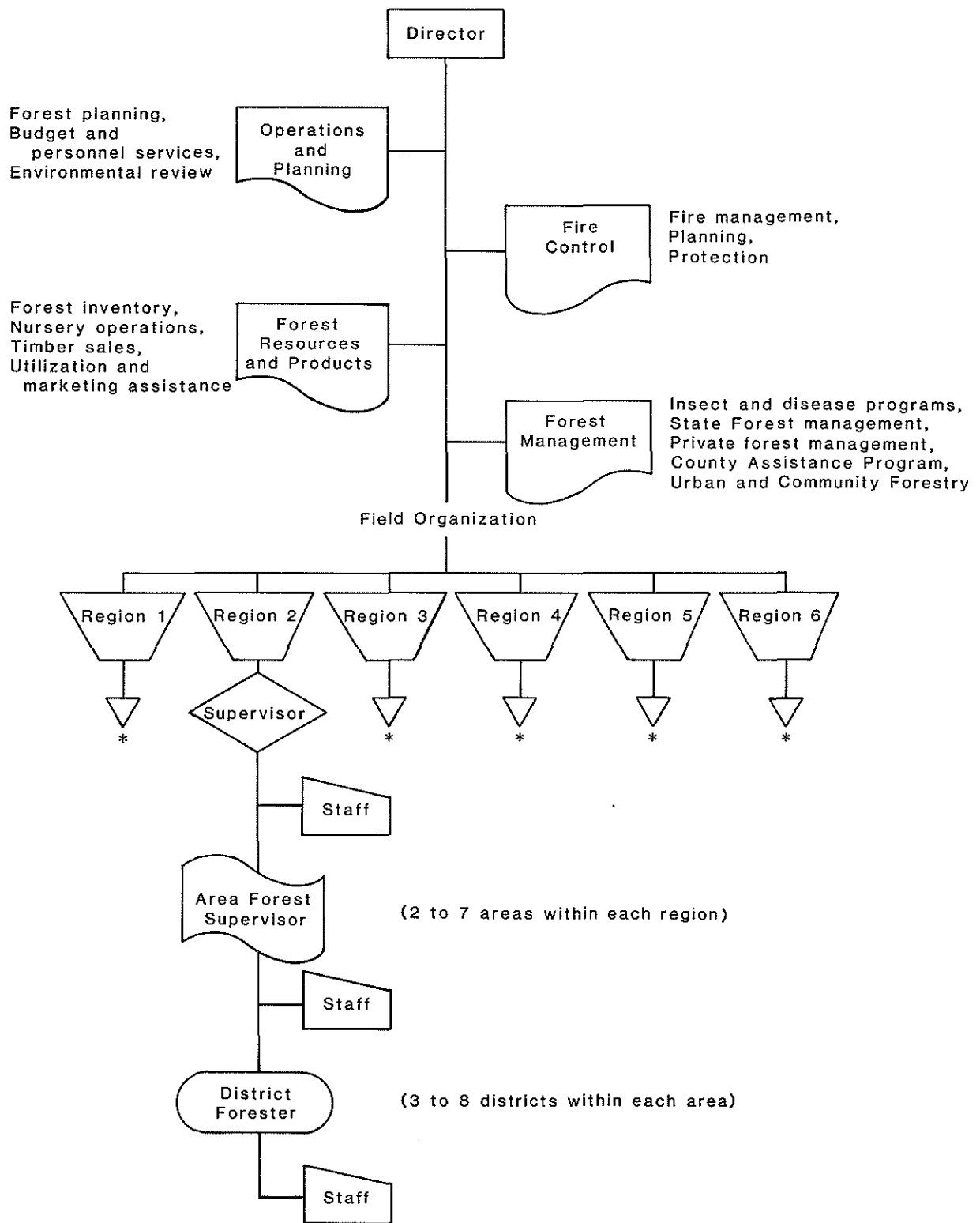
^{a/} See Chapter 511, Laws of 1982. Seventy-second Minnesota Legislative Session, 1982.

The organizational structure of the Division of Forestry consists of four functional staff sections and a field organization as depicted in Figure 24. At the departmental level, the state is subdivided into six regions. However, DNR regions 4 and 5 are combined for forestry programs. Activities within each of the five field-level regions within the Division of Forestry are conducted under the direction of a regional supervisor and staff. Each region is further subdivided into from two to seven areas, with similar supervisory and staff arrangements. The smallest organizational unit is the individual district.

The Division of Forestry is currently intensifying its efforts in several important areas of forest management. The development of a Minnesota Forest Resource Plan, scheduled for completion in 1983, is intended to provide a framework for coordinating all management programs within the Division. The plan consists of a series of six documents, including an assessment of the current status of the forest resource in Minnesota and a program and budget for management activities for fiscal years 1984-1989. The program will be updated every four years, while the assessment document will be revised at ten year intervals. The plan will also enhance the ability of the Division to provide data and information on forest management in Minnesota for input into the national Resources Planning Act (RPA) planning process conducted by the U.S. Forest Service.

The Division's Forest Intensification Program has targeted several additional areas for increased management emphasis. These include reforestation activities on state and county lands, State Forest nursery management, fire protection activities, forest inventory operations, and the State Forest road system. Reforestation efforts have also been greatly aided by the annual provision of \$3 million in federal funds resulting from the passage of the BWCA Wilderness Act of 1978, as well as \$1 million annually in state forest management intensification funds.

Each section within the Division of Forestry has a variety of management responsibilities which require the generation and utilization of information for management decisions. Descriptions of these information resources are now presented.



*Each Region has like structure as exemplified.

Figure 24. Organizational structure of the DNR Division of Forestry. (Source: G. Banzhaf and Co., 1980.)

Forest Resource Information--At present, the Division utilizes information from two distinct forest inventory systems within the state. The statewide forest survey conducted by the Renewable Resources Evaluation Unit of the U.S. Forest Service is based upon randomly-selected permanent plots throughout the state, each representing approximately 1400 acres. Data elements for this forest inventory, termed Phase I by the Division, have been previously identified.

The Division is presently involved in implementing a second forest inventory, termed Phase II, for every forest type of five acres or greater in size on all state and county lands in Minnesota. The Division's Forestry Inventory Unit is located at Grand Rapids, Minnesota. Inventory operations are conducted on a section-by-section basis, utilizing four crews per section. The data elements collected in Phase II operations are listed below.

- . Stand acres
- . Forest cover type
 - Overstory
 - Understory: type, size, density
- . Cover size
- . Cover density
- . Main species in type
- . Topography
- . Physiographic class
- . Site index
- . Stand age
- . Stand origin
- . Condition class
- . Average height
- . Basal area per acre
- . Volume per acre
- . Thousand board feet per acre
- . Cords per acre
- . Percent mortality
- . Timber harvest restrictions
- . Harvest recommendation
- . Damage: percent of stand affected
 - Insect
 - Disease
 - Animal
 - Environment
- . Reconnaissance level
- . Distance to all weather road
- . Method of land acquisition
- . Geographic identifiers

In addition to the above data elements, more detailed elements pertaining to shrub characteristics have also been added. Phase II operations also include extensive field checking and quality control activities. Average cost of operations is approximately \$1 per acre. For some areas characterized by extremely low productivity, inventory operations are conducted by helicopter. This increases cost efficiency when inventorying large areas of off-site spruce (ex., site index: 20-30) in some parts of northern Minnesota.

All of the data generated by Phase II is stored within the Division's computerized information system. At present, the Forest Inventory Project utilizes base maps for depicting inventory information. Reproduction capacity for such maps is available. The eventual acquisition of computerized graphics equipment will provide additional capabilities for analysis of inventory information. Some of the Phase II inventory work is conducted by counties under contract with the Division of Forestry. In such instances, county crews perform inventory work on both county and state-owned lands in the particular area.

The inclusion of geographic identifiers in the form of U.S. Land Survey coordinates helps make the Phase II system compatible with the statewide Minnesota Land Management Information System (MLMIS) maintained by the State Department of Energy, Planning, and Development. This enhances the potential utility of Phase II data for linkages with other kinds of resource and nonresource related data bases maintained by MLMIS. The Phase II inventory, targeted for completion in 1985, will also provide a more detailed gauge for the accuracy of the highly extensive Phase I (Forest Survey).

Land Use Information--Information concerning land use for Division of Forestry land is maintained by the Department's Bureau of Lands. This information constitutes one element of a broader Land Ownership Information System which pertains to all DNR-administered lands. Within this system, land use information is organized according to the following format:

Acres of Land

- Forestry lands (outside state forest)
- Forestry lands (inside state forest)
- Wildlife lands
- Fisheries lands
- Parks and Recreation lands
- Law Enforcement lands

by

Land Use Classes

- Urban
- Agricultural
- Mining
- Recreation or aesthetic
- Multiple use and conservation
- Fish and Wildlife
- Peat or gravel
- Access

This information is represented in aggregate form for all DNR lands state-wide; it is also organized on the basis of individual counties. Recommended land uses for all Department of Natural Resources Lands are maintained within the Minnesota Land Management Information System at the Department of Energy, Planning, and Development.

Forest Ownership and Jurisdiction and Legal Information--The Division of Forestry maintains references to all legislation pertinent to its mission within the Department of Natural Resources. All other legal matters relating to the Division are handled through the Department's Legal Bureau, which is actually part of the Office of the Attorney General. The primary function of the Legal Bureau with respect to activities of the Division of Forestry is twofold:

- . The Bureau represents the Division as their attorney in lawsuits, legal disputes, contracts drafted, and at public meetings regarding Division-related issues.
- . The Bureau acts as a general advisor to the Division on internal matters such as interpreting statute language; drafting rules, contracts, and cooperative agreements; and drafting legislation. By law, the Legal Bureau is required to formally review all contracts and timber permits (MN Statutes, Ch. 16.09).

Most of the information maintained by the Bureau is for internal use within the Department of Natural Resources.

The majority of ownership and jurisdictional information pertaining to lands administered by the Division of Forestry and other Divisions within the Department is maintained by the Department's Bureau of Lands. This includes records concerning the percent of ownerships within State Forest boundaries and the method of acquisition of trust lands in State Forests. The Bureau handles all records for DNR land acquisitions, as well as sales, leases, exchanges, licenses, and special permits. It also maintains a record for each parcel of DNR-administered land, including records of mineral ownership on these lands. The above kinds of ownership information are organized in the following manner:

Acres of Land

- Forestry lands (outside of forest)
- Forestry lands (inside of forest)
- Wildlife lands
- Fisheries lands
- Parks and Recreation lands
- Law Enforcement lands

by

<u>Land Status</u>	<u>Means of Acquisition</u>
School	Land exchange
Indemnity school	Gift
Swamp	Condemnation
Other trust	County board resolution
Volstead	Purchase
Conservation area	Transfer
Acquired	Federal deed and patent
	Land utilization
	Other

Recommended Retention or Disposal

- Retention for conservation
- Retention for other
- Provisional
- Disposal by sale
- Disposal by exchange
- None

Mineral Acreage

- State owns surface and minerals
- State owns surface only
- State owns surface: mineral ownership uncertain

All ownership information is stored via the Bureau's Land Ownership Information System, which is accessible to Division of Forestry staff and field personnel.

Forest Administrative Information--The Division of Forestry collects information concerning such administrative matters as fire protection and control, forest roads and forest land taxes, and financial accounting and budgeting for all operations within the Division. The Forest Management section also provides assistance to nonindustrial private forest landowners in Minnesota, and keeps records of these activities and accomplishments.

Information regarding the 1800 miles of forest roads serving Division-administered lands is maintained within the recently-completed State Forest Road Plan. This contains an assessment of the current status of all forest roads, a discussion of major issues related to the use and maintenance of such roads, and a program to facilitate road improvements and issue resolution. The plan includes an inventory of all roads in the State forest road system, which are identified by locational descriptors and according to five classes representing intensity of use and road design criteria. The inventory also includes a list of road project priorities for each region within the Division. Other information maintained by the Division includes costs of road establishment and maintenance, road standards, and identification of ownerships served by individual roads.

The Division maintains information concerning property taxes for forested lands within the state. Tree Growth Tax information is collected in the form of annual rates for all counties. The Division also keeps records pertaining to the Auxiliary Forest Tax in terms of acres enrolled and resultant revenues generated.

The Department of Natural Resources has the responsibility for fire protection and control on more than 20 million acres of forest land in Minnesota. Some of these activities are achieved through cooperative programs with rural fire departments. Statewide fire protection responsibilities are administered by the Division's Wildfire Protection section in St. Paul; field operations are coordinated by the Northern Fire Center in Grand Rapids. Information maintained by the Division concerning fire protection and control activities includes:

- . AFFIRMS program
- . Fire report summaries
- . Interactive daily fire summaries
- . Precipitation map
- . Individual fire reports
- . Fire history statistics
- . Wildfire situation update
- . Fire action plans
- . Fire equipment and manpower: other agencies
- . Fire planning information

Northern Fire Center

- . Equipment needs for rural fire departments
- . Fund shares for rural fire departments
- . Air base tanker program
- . Fire overhead functions
- . Prescribed burning records
- . Fire-related lawsuits
- . Hand maps

Central management staff in St. Paul maintains individual fire reports concerning every fire on which action is taken. Fire report summaries are issued biannually at the end of each fire season. Appendix C contains a detailed list of information contained in these reports. Wildfire situation updates are generated daily during nonwinter months. These provide information on fire status (example, warnings), along with number of fires and acres burned to date.

Central staff and field operations also have access to the nationwide AFFIRMS (Administrative and Forest Fire Information Retrieval and Management System) fire danger rating system. Data inputs and resultant fire-related information generated by the program have been described previously (see U.S. Forest Service).

Fire planning activities are conducted both at Division headquarters in St. Paul and at the Northern Fire Center. These involve analyses of the interrelationships of past fires, such as size, fuel types, suppression time and methods, etc., to aid in the formulation of future protection and control activities. The ultimate goal of fire planning is the establishment of fire plans for each area within the Division of Forestry.

The Northern Fire Center administers the air base tanker program, and maintains information regarding tanker and helicopter contracts, types of retardants, mixing ratios, and coordination of personnel for fire suppression activities. The Center provides training for fire suppression crews, and is responsible for their maintenance and deployment. Information on prescribed burns is maintained in the form of project costs, evaluations and crew deployments. The Center also keeps records of all fire-related lawsuits.

Division of Forestry regions, in addition to receiving fire summaries and AFFIRMS-derived fire danger ratings, maintain fire action plans and records of fire equipment possessed by other federal, state, and local agencies. The Division also administers matching (50-50) grants of up to \$1500 per year to rural fire departments for the purposes

of purchasing equipment and improving their fire suppression capabilities. Information concerning fire departments that apply for such grants is obtained from the University F.I.R.E. Center (see University of Minnesota).

The responsibility for the enforcement of fire regulations on state-owned forest lands rests with the DNR Division of Enforcement. This is part of the broader mission of the Division involving the enforcement of all natural resource laws within the state. To that end, the Division maintains records related to timber trespassing, fish and game law violations, and violations of other laws pertaining to the recreational use of state lands and waters.

The Forest Management section within the Division of Forestry also conducts several programs designed to provide assistance to nonindustrial private forest landowners in Minnesota for approved forest management practices. Technical assistance is provided to landowners by private forest management (PFM) specialists at the area level; monthly PFM accomplishment reports are maintained by Division of Forestry regions. Information regarding nonindustrial private forest landowner assistance is summarized by central Forest Management staff in the form of:

- . Landowners assisted
- . Acres harvested
- . Acres planted
- . Timber stand improvement: accomplishments
- . Forestry Incentives Program (FIP): acres and funds involved
- . Agricultural Conservation Program (ACP): acres and funds involved
- . Private plantation survey
- . Acres in management plans

The Division assists landowners in developing a management strategy for their forests and provides type maps and silvicultural recommendations by forest type. Copies of plans for specific tracts are kept at the district level, while areas maintain records of all landowner contacts within their jurisdiction.

Despite accelerated efforts on the part of the Division to increase forest productivity from the nonindustrial private sector within the state, the Division is involved with only about 10 percent of private landowners in Minnesota. This is in part due to the magnitude of time required for developing even unsophisticated management plans for each individual landowner. When time requirements are considered along with the fact that a certain proportion of these landowners are not actively interested in forest management an involvement figure of 10 percent is not entirely unexpected.

The Division has intensified its private forest management activities within the past two years, and it is hoped that such efforts may aid in overcoming some of the above-mentioned problems. A recent tool that has been added to the Division's

private forest management program is the Timber Inventory and Management Planning Information System (TIMPIS). This is a computerized package designed to breakdown management information for small forested tracts into a number of components (example, present stand, harvest level, residual stand, etc.). This may then allow landowners to examine the effects of various harvesting schedules on growth and yield potentials for their lands. While still in experimental stages, the program marks an important initial step in the application of automated information processing technology to aid in the management of private nonindustrial forest lands in Minnesota.

The Division of Forestry also assists in the administration of federal cost-share programs designed to stimulate productivity on nonindustrial private forest lands. The Forestry Incentives Program and the Agricultural Conservation Program provide cost shares to landowners for approved silvicultural and reforestation activities. These programs are funded through the Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture. Division of Forestry foresters provide technical advice and assistance to landowners for the implementation of these management activities. The Division also maintains records on the status of all projects funded by these programs.

The State and Private Forestry (S&PF) branch of the U.S. Forest Service cooperates with the Division of Forestry in monitoring the effectiveness of private forestry assistance programs in Minnesota. S&PF also provides training sessions for state personnel regarding specific Divisional activities which pertain to nonindustrial private forest management problems and opportunities.

The Division of Forestry provides substantial assistance to Minnesota counties for the management of tax-forfeited lands under county jurisdiction. The Division's County Assistance Program provides 50 percent of the financial support for nine forester positions within the Land Departments of eight counties in northern Minnesota. These foresters assist with the coordination and implementation of all aspects of county forest management programs. The supervisory office of the County Forestry Assistance Program (Grand Rapids, Minnesota) collects and summarizes information regarding county forestry operations. Since such information is highly relevant to forestry activities at the county level of government, it will be considered within the context of information resources for county forest management.

Timber Management Information: Biological and Silvicultural--Much of the biological and silvicultural forest management information within the Division of Forestry is collected by the Forest Management section in coordination with field operations. Responsibilities of this section include State Forest management, forest insect and disease control, and management assistance to counties and private forest landowners. The

Division maintains biological and silvicultural information in the form of:

- . Allowable cut
- . Recommended harvest by cover type
- . Acres harvested
- . Timber permits
- . Timber scaling reports
- . Nursery production by species
- . Acres planted
- . General reforestation by species
- . Forest development records
- . Silvicultural projects
- . Insect and disease population levels
- . Infestation maps
- . Insect outbreak files
- . Herbicides and pesticide utilization

Allowable cuts are computed for major forest cover types. Central management staff utilize Phase I inventory information to set allowable cuts for Division areas statewide. Areas then allocate allowable cuts to individual districts. The state's Phase II inventory is providing Division areas with better tools for setting district allowable cuts, and eventually it will be the basis for allowable cut determinations at the Division-wide level. Allowable cut information is also maintained on a statewide basis in terms of marketable and nonmarketable volumes.

Harvest scheduling plans are compiled by the districts based upon allowable cut figures they receive; these must be approved by the area before being forwarded to regional headquarters, where they are maintained as a list of cutting plans by district. Acres harvested are also maintained in this fashion.

The Division utilizes the FREP and STEMS models in obtaining growth projections for timber management. It also maintains a Red Pine Management Model (REDPMGT) as part of its computerized information system. The model provides optimum rotation ages, thinning intensities and projects growth responses to different management options.

Two forest tree nurseries are operated by the Division of Forestry. Information maintained regarding nursery operations includes number of trees produced and sold (by species), current inventory figures, location of seed beds, and various cost accounting information. In spring of 1983, approximately 28 million seedlings were available for distribution. Approximately one-half of seedlings produced go to public reforestation programs.

The Division of Forestry maintains forest development records for individual State Forests, which include information regarding management activities, costs, site preparation, current species ratios, and the like. Within the framework of the Minnesota Forest Resource Plan, the Division is currently in the process of synthesizing forest development and other information into specific forest management plans for the five land administration areas within the Division. Such plans will include information on soil and water

characteristics, timber, minerals, wildlife, and ownership.

Division of Forestry Regions maintain files regarding all silvicultural projects within the region, while central staff receives summaries of these activities. The Division has three regional and five area silviculturalists whose approval is required for all timber sales, as well as for all reforestation, site preparation, and intermediate silvicultural projects originating at the district level. Current plans by the Division have targeted approximately 16,000 acres of State Forest lands for reforestation in 1983.

The Forest Management section utilizes aerial and ground surveys in collecting information regarding insect and disease problems. Infestation maps for major pests are compiled indicating acres affected and volume and value loss to standing timber. Files pertaining to specific outbreaks include information on acres affected, control activities and degree of success of control operations. Pest specialists at the regional level coordinate silvicultural and insect and disease control management within their respective regions.

Timber Management Information: Economics and Utilization--A variety of economic information related to timber management and utilization is collected by the Division of Forestry. Much of this information is concerned with the efficiency of management operations, and this type of operational information is maintained within the Operations and Planning section. The Division also conducts an extensive utilization and marketing program, 50 percent of which is financed with federal funds provided by the State and Private Forestry branch of the U.S. Forest Service.

The Division collects the following kinds of economic information related to timber management and wood products utilization:

- . Timber production: statewide
- . Pulpwood production
- . Demand projections: wood products
- . Market outlooks by industrial consumer
- . Stumpage market prices: all public agencies
- . Forest products prices
- . Timber sales: volume and value
- . Timber sales: type of sale
- . Timber scaling reports: state sales
- . Nursery cost accounting
- . Fuelwood supply
- . Fuelwood demand and consumption
- . Fuelwood sales
- . Wood residue supply
- . Pulpwood exports
- . Wood processors: primary and secondary
- . Sawmill surveys
- . Logging efficiency analyses
- . Sawmill improvement programs
- . Log area analyses
- . Yield analysis program

The Division maintains records of timber production by product and species for all ownerships within the state; it also receives and utilizes pulpwood production reports from the North Central Forest Experiment Station. Statewide demand projections for forest products are compiled by the Forest Resources and Products section. These include demand forecasts for all wood products, pulpwood, waferboard, hardboard, fuelwood, lumber, and others. The section also compiles market outlooks (by hardwoods and conifers) for pulp, waferboard, and hardboard industries for certain areas within the state.

The Division of Forestry keeps detailed records of stumpage prices for all timber sold from state lands. Figure 25 exemplifies the manner in which much of this information is organized. Division central management staff sets base stumpage prices for each region, after consultation with field personnel. The Division also compiles information on stumpage prices for all other public forest management agencies in the state.

The Division administers the sale of timber from state lands by means of informal (noncompetitive) sales and through two types of auction sales. Informal sales have accounted for the majority of total annual sales volumes within the past decade; however, the proportion of auction sales is expected to increase since the establishment by the Legislature of a new class of intermediate auction sales. The state's market share of the wood resource is approximately 20 percent.

A general description of the generation and flow of timber sales information within the Division of Forestry may be found in Figure 26. District sales plans are formulated on the basis of allowable cut figures obtained from central Forest Management staff via Division areas. Upon approval of the sales plans, districts proceed with sales administration, maintaining detailed sales records, permits, appraisal records, and scaling sheets. Areas condense such information into files containing appraisals, scaling reports, and individual sales records. Regions approve permits and keep summary copies of sales before forwarding them to central staff; they also compile scale summaries from area reports. All information described thus far is kept in the form of manual files and records.

Sales information transmitted by the regions to central staff management is computerized at the Division level. Such information is organized in terms of volume and value of timber sold by species, and volume and value by type of sale. Timber scaling reports are also maintained at this level according to volume scaled by species and volumes by method of scaling (i.e., regular, consumer-scaled, or lump sum^{16/}).

^{16/} The lump sum is timber sold on the basis of Division appraisal value only.

Type	Timber	Production	Sale	Average Price of Timber Sold by DOF		
				Region	Area	District
						Informal sales
						Auction sales
						Intermediate auction sales

Figure 25. Example of organization of stumpage price information, Department of Natural Resources, Division of Forestry, 1982.

The Division's Forest Resources and Products section conducts biannual statewide surveys to determine price levels for forest products in the state. This information is maintained by species and by product categories of sawlogs, pulpwood, and fuelwood. The section also derives estimates of fuelwood supply within the state as well as information regarding fuelwood consumption in terms of volumes consumed by species and facility use classes. Fuelwood sales information for state-owned lands is organized in the form of total value and volume sold by species and district.

The Division gathers information on the supply of wood residues in Minnesota and summarizes this information in terms of volumes and weights, by county, by hardwoods and conifers, and in the form of total volumes and weights generated by primary and secondary users. Much of the information on wood residues is collected at the regional level.

The state of Minnesota imports a large amount of wood for building material from the western United States; much of this lumber is utilized by the pallet industry within the state. Detailed information on wood imports for Minnesota is, however, quite scarce. The Division does collect data pertaining to pulpwood exports from the state, although information concerning lumber exported from Minnesota is very limited.

The Division of Forestry maintains records of both primary and secondary wood processors for certain counties in Minnesota. The Forest Resources and Products section conducts sawmill surveys to identify types of activities and individual needs. This has resulted in the compilation of a directory of primary and secondary mills within the state. Both central management staff and Division regions have access to a number of computerized analytical packages designed to increase the efficiency of sawmill operations and wood utilization. These packages include sawmill improvement programs, log area analyses for biomass utilization, yield analysis programs for relating wood inputs and processing costs to types of products desired, and logging efficiency studies.

Nontimber Forest Resource Information: Wildlife and Recreation--The Division of Forestry manages the forest lands under its jurisdiction within the multiple-use framework, mandated by Minnesota Statutes (M.S. 89.021).^{17/} The maintenance

^{17/} Also Ch. 511, Laws of 1982, as amended. Seventy-second Minnesota Legislature, 1982.

of viable wildlife habitat and populations, provision of a variety of recreational opportunities, and protection of soil and water resources are integral parts of the Division's multiple-use approach to forest management.

In order to enhance wildlife management opportunities for both the Division of Forestry and the Division of Fish and Wildlife, Phase II forest inventory operations were expanded to include the collection of additional data pertaining to understory vegetation and other site characteristics. Data elements added to Phase II include:

- . Shrub composition
- . Shrub density
- . Shrub distribution
- . Shrubs: browse
- . Shrubs: ground cover

Significant Condition

- . Botanical
- . Geological
- . Historical
- . Scenic
- . Wildlife species

Within the past two years, the two Divisions have initiated efforts to increase the degree of cooperation for the purpose of implementing multiple-use forest management on Division of Forestry lands. Mutual input for management projects of each Division has been encouraged. The potential of such efforts will be better realized when the newly-added Phase II data elements are analyzed and evaluated.

The Division of Forestry is responsible for the management of 61 campgrounds within State Forests as well as several hundred campsites on State Forest lands. Trails within State Forests and other Division-administered lands are managed in cooperation with the Department's Trails and Waterways Unit. The Division collects recreational information pertaining to State Forest campgrounds and use intensity levels; hiking, snowmobile, and other recreational trails on State Forest lands; public accesses to lakes and waterways; and BWCA State Forest canoe stops. Limited access to many of these forested areas makes this information-collecting task a significant one with respect to state recreational opportunities.

Division of Fish and Wildlife

The Division of Fish and Wildlife is responsible for the management of wildlife and fisheries resources on all lands administered by the Department of Natural Resources (MN Statutes, 97.48). The Division administers more than 900 wildlife management areas within Minnesota, approximately 100 of which are located on forested lands. It also manages the state's extensive water resources

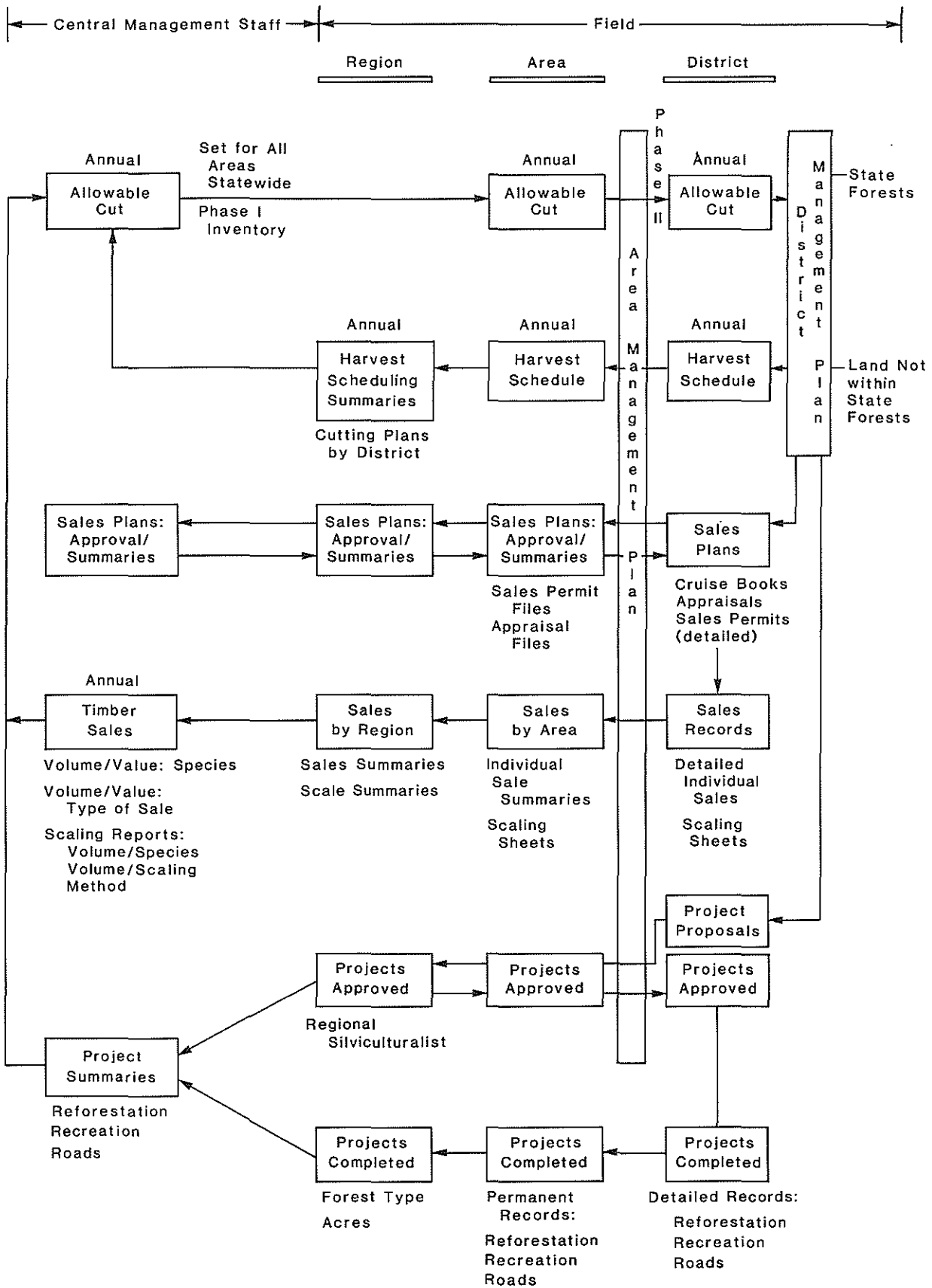


Figure 26. Information flow within Department of Natural Resources, Division of Forestry, for timber sales information.

for the establishment and maintenance of fish populations, and to provide habitat enhancement for other forms of aquatic wildlife. The Wildlife section within the Division is currently in the process of conducting an inventory of all state-owned wildlife management areas in Minnesota. The section also utilizes information from the Phase II forest inventory to conduct intensive analyses of four square-mile blocks within state-owned forest lands.

The Division has developed a forest habitat classification system to aid in defining the relationship between timber species and age classes and wildlife diversity. The primary focus of the Division's input to forest management activities of the Division of Forestry relates to the distribution of timber harvesting operations and resultant effects upon wildlife habitat variability. Wildlife specialists at the regional level review proposed timber sales by the Division of Forestry and provide advice concerning potential impacts of timber management activities on wildlife and fish populations.

The Division of Fish and Wildlife maintains information concerning acreages and costs of all lands acquired for wildlife management areas. Wildlife information collected pertains to habitat types and population levels. Population census are conducted for deer, moose, beaver, and bear; deer and bear population data are maintained at both statewide and county levels.

The Forest Wildlife Population Research group in Grand Rapids is currently engaged in projects related to white-tailed deer habitats, forest predator ecology, and deer and timber wolf interactions. Other research groups within the Wildlife section conduct surveys and census of wildlife populations in the state's agricultural and wetland areas. The Division also conducts an innovative program to preserve and multiply Minnesota's 490 species of nongame wildlife. Taxpayer donations from income tax refunds generated \$523,000 and \$619,000, respectively, during the first two years of the program's operation in 1981-1982. This has enabled the Division to develop a formal plan, to be completed in 1984, for nongame wildlife management on state-administered lands.

Information regarding fish habitats and population levels in Minnesota's lakes and waterways is maintained by the Division's Fisheries section. The section performs stream and lake surveys, gathering information on vegetation, fish and animal species present, and potential mitigation techniques should they be necessary. Other responsibilities include the distribution of approximately 190 million fish per year to Minnesota's lakes, rivers, and streams.

Potential impacts of water and land development projects upon fish and wildlife populations are investigated by the Division's Ecological Services section. The section performs habitat studies for small watershed improvement projects

as mandated by federal law (Public Law 566). It also collects information concerning the potential effects of herbicides and other methods of vegetation control on fish and wildlife populations.

Division of Parks and Recreation

The Division of Parks and Recreation manages approximately 200,000 acres within Minnesota's 65 state parks, in accordance with criteria established in the Minnesota Statutes (CR. 85; 86A). Within the past three years, the Division has stationed park resource managers at each of the six Department of Natural Resources regional headquarters, with responsibilities for supervising the management of all parks within their respective regions.

Management of each state park occurs within the framework of a park management plan. Information for park plans is synthesized from forest type maps, park attendance and income data, information on past and prescribed vegetational management activities, and data on unique or unusual park resource characteristics. In the development of park plans, the Division also utilizes forest resource information generated by the Division of Forestry.

Park site maps constitute an important element within park management plans. These indicate areas of primary usage, existing or required easements for park lands, and present or planned structures such as bridges, culverts, etc. Attendance data gathered by the Division includes figures on overnight campers, day visitors, total visitors, vehicle usage and permits issued. Annual summaries are compiled by the Division's central staff. Financial records indicating all expenses and income derived from park operations are also maintained.

A variety of recreation-related information is also maintained by the Department's Office of Planning (see following pages); this includes the State Comprehensive Outdoor Recreation Program (SCORP) and other programs related to forested (and other) areas of high recreational potential in Minnesota.

The harvesting of timber is permitted in state parks for the purposes of promoting regeneration of tolerant tree species or the removal of dead or diseased trees to prevent the spread of disease. The Division of Forestry coordinates these activities, as well as providing additional support for insect and disease control, fire protection, and prescribed burning activities.

Information regarding the status and management activities of state parks does have implications for state forest management programs. Transition zones are often desirable between park boundaries and active timber management zones. Furthermore, park expansion necessarily impacts other aspects of forest management. This suggests that the Division of Forestry must possess accurate information regarding the forest resource

and concurrent forest management activities not only in the vicinity of existing parks, but also for any areas where the potential for park development may exist. This will facilitate the evaluation of potential benefits and costs of allocating these lands to different management alternatives, i.e., timber or wildlife production, or recreational land use.

Much of the information collection and organization capabilities of the Division of Parks and Recreation are limited by the lack of an automated system for the processing of data collected by the Division. This difficulty is particularly bothersome with respect to the identification of operating costs for park management and maintenance activities. The computerization of management information collected by both the Division of Parks and Recreation and the Division of Fish and Wildlife is one alternative for enhancing the resource management capabilities of these respective divisions.

Division of Minerals

The Division of Minerals collects information concerning the state's mineral resources, many of which are located on forested lands in northern Minnesota. The Division administers mineral rights on 12 million acres of state lands (MN Statutes, CR. 93), and gathers information on iron mining, copper-nickel resources in northeast Minnesota, uranium-mining potentials, and the state's peatland resources.

The Division of Minerals is responsible for the registration of all mineral exploration operations in the state, and is the regulatory agency for all mineland reclamation activities. The Division issues permits for mining on DNR-administered lands and ensures compliance with all standards related to mineral extraction. It also supervises the management and leasing of all state-owned peatlands.

An extensive amount of information pertaining to mineral resources and opportunities for their development is gathered by the Division. Core samples from all drilling operations are maintained in a core library in Hibbing, Minnesota. The Division also collects all of the technical data generated from drilling operations within the state, both from on-going and exploratory activities. It conducts geo-chemical surveys and stream sediment analyses to identify trace metals deposited within watersheds over time. An inventory of the state's peatland resources has also been completed.

The Division is extensively involved in mineral planning activities; one result of this emphasis has been the establishment of the IRIS (Iron Range Information System),^{18/} a computerized information

system containing resource and land use data on approximately 2100 square miles of the Mesabi Iron Range. The Division's MINESITE information system contains data on the potential for copper-nickel development in the Minnesota Arrowhead Region.

Other planning information results from analyses of basic exploratory drilling data. The Division prepares maps indicating potential mineral development areas for individual counties. Geological maps are also produced, as well as maps identifying locations of all current mining operations within the state. For certain localized areas, the Division prepares maps indicating future land use potentials; variables explicitly considered include existing mineral resources, significant mineral ownerships, and units of government involved.

Much of the information collected by the Division of Minerals is highly relevant to forest management organizations whose jurisdictional responsibilities include lands rich in mineral resources. The ability to synthesize the above kinds of mineral information with that pertaining to timber, wildlife, and recreational development potentials may provide forest managers and administrators with better criteria for judging potential consequences of decisions involving competing forest land uses.

Division of Waters

The Division of Waters is responsible for the management and protection of the state's water and shoreland resources. The Division collects information concerning the nature, uses and development of Minnesota's waters as authorized by the Minnesota Statutes (CR. 105.39). Several functions of the Division involve the collection of certain information pertaining to state waters in forested areas.

The Division monitors rainfall at 1500 locations throughout the state, and also collects data on soil moisture from 50 sites statewide, several of which are located on forest lands. The Division identifies all waters within the state that are subject to protected waters status; most lakes and streams within forested areas fall within this category. The construction of bridges, culverts or logging roadways across protected waters requires a permit from the Division, which maintains records of these and any other activities that involve altering the course or currents of protected waters.

Water appropriation permits must be obtained from the Division of Waters for any withdrawals of more than 10,000 gallons of water per day from state surface or ground waters. With respect to the forestry sector within the state, this primarily affects pulp and paper and other wood processing industries.

^{18/} Funding provided by the Legislative Commission on Minnesota Resources and the Iron Range Resources and Rehabilitation Board.

The Division of Waters provides technical assistance to local governments throughout the state to ensure flood plain and shoreland protection. A classification list for shorelands is maintained for all counties and municipalities. Shoreland use for lands under the state's Wild and Scenic Rivers Program is also monitored by the Division. The Division is not involved extensively in the monitoring of water quality; such activities within Minnesota are carried out by the state Pollution Control Agency, or should the waters to be monitored include those stocked with fish, by the Department's Division of Fish and Wildlife.

Trails and Waterways Unit

The responsibility for the administration of the recreational trail system within the Department of Natural Resources is assumed by the Trails and Waterways Unit. Since the 1200 miles of state recreational trails cross lands administered by several divisions within the Department,^{19/} this Unit was established in 1979 to coordinate trail management for all Department lands (MN Stat. 85.015).

The Unit also administers a water access program designed to ensure public access to all rivers and to the 15,000 lakes within the state. The canoeing river program within the Unit utilizes SCORP recreational information to identify, develop and maintain canoeing routes on Minnesota rivers.

The primary information related to forest management that is collected by the Unit pertains to trail planning on forested lands. Files are maintained concerning all existing and proposed trails. Information is collected concerning habitat, soils, geology, forest cover, slope, and orientation to population centers. Much of this information is obtained from secondary sources and synthesized within the context of trail management planning. Corridors for trails are an important concern, particularly regarding areas where trails may cross parcels of privately-owned land.

The Unit reviews all trail plans within State Forests, and provides funding to the Division of Forestry for the development, maintenance and rehabilitation of trails on Division of Forestry-administered lands. The Unit also publishes maps of state trails, rivers, and access points to public waters.

Office of Planning

The Office of Planning coordinates planning and policy analysis at the departmental level for the Department of Natural Resources. The Office

^{19/} Divisions of Forestry, Parks and Recreation, and Fish and Wildlife.

facilitates the integration of goals and objectives of all divisions within the overall framework of the Department's mission and responsibilities.

The Office's Research and Policy section promotes interdisciplinary approaches to natural resource management. Information-gathering efforts within the department are analyzed with respect to strategic departmental goals by the Natural Resource Data Systems Unit. This unit also relates information management systems within departmental divisions to those maintained by other state and federal agencies, most notably the Minnesota Land Management Information System (MLMIS) of the State Department of Energy, Planning, and Development.

The Office of Planning maintains information concerning recreational and other special land uses, some of which may influence forest management decisions. The Office assists in the preparation of park management plans for the Division of Parks and Recreation, as well as land use and management plans for the Department's Trails and Waterways Unit. It also maintains the State Comprehensive Outdoor Recreation Plan^{20/} (SCORP), a computerized information system pertaining to recreational facilities maintained by the Department throughout the state. Types of data elements maintained within the SCORP system are summarized in the subsequent description of the Minnesota Land Management Information System.

Utilizing the MLMIS system, the Office is capable of generating a variety of graphical representations and maps for special analyses. A number of these may be adapted to the forest resource. Forest productivity maps may be assembled based upon soil associations and geomorphic characteristics. Computerized mapping which incorporates forest cover, land use, and soils may also be generated, as well as maps depicting suitability of forest soils for road construction. The standard cell size for such maps is 40-acres, although higher degrees of resolution are also possible.

The Office of Planning conducts programs for computerized mapping of major and minor watersheds within the state, and is in the process of producing a systematic identification of all watersheds and streams in Minnesota. The Office also assembles information on the intensity of trail use and performs analysis designed to identify areas with high potential for recreation within the state.

The Office is currently involved in the final phase of an 18-month study concerning the suitability of all DNR-administered lands for a variety of uses. Such uses include timber production, mineral extraction (including peat harvesting), outdoor recreation, and wildlife management. The analytical process for timber production involves utilization of inventory data (Phase I and II) and

^{20/} This information is stored in the Minnesota Land Management Information System (MLMIS).

mill locations; these are related to site factors such as soil types, road access, and land use patterns. Results of the study will be submitted to the Minnesota Legislature in June of 1983.

Special programs undertaken by the Office of Planning include the implementation of the Minnesota Wild and Scenic Rivers Program (MN Statutes CR. 104.31 - 104.40). This involves the collection of data pertaining to shorelands adjacent to approximately 130 miles of state rivers, and synthesis of such data to produce maps and management plans for specific river areas. The Natural Heritage Program involves a statewide inventory of rare and unique wildlife and natural areas. Six major categories of information are collected: plant species, animals, plant communities, geologic features, aquatic environments, and other unique natural phenomena. The system, maintained on MLMIS, provides maps of natural area locations and computerized information abstracts.

County Land Departments

Mission and Organization

Approximately 2.8 million acres of forest lands in Minnesota are administered by county governments. The majority of these lands are located within 16 counties in the north central and northeastern regions of the state. In the past much of these lands were owned by private individuals, but they reverted to state control when landowners failed to meet property tax requirements (Lothner et al., 1978). While the state holds the title to these tax-forfeited lands, they are administered by local governments.

Counties also maintain substantial acreages as memorial forest lands. Most memorial forests have been established for some time, and ownership composition is much like that of the National Forests within the state--both public and private lands intermingled in parcels of various sizes. In addition, about 400,000 acres of county forest lands are managed by the state and classified as "state lands held without encumbrance of trust"^{21/} on behalf of the owners (G. Banzhaf & Co., 1980). Both state and counties share equally in any income generated from these 50-50 lands.

Each county within Minnesota is governed by a County Board of Commissioners, which is comprised of from five to seven individuals elected from districts within the county. The board performs both legislative and executive functions, and has the power to appoint a number of officials for the administration of various programs within the county. The County boards have the authority to enact legislation concerning, among other areas,

^{21/} These lands are distinct from county memorial forests but do include tax-forfeited lands at one time exclusively managed by the counties.

land use and zoning policy. Other county executive offices such as county auditor, treasurer, attorney, recorder, etc., are usually filled via local elections. County Advisory Committees provide input to county boards and offices regarding various county programs, some of which may involve land administration and forest management.

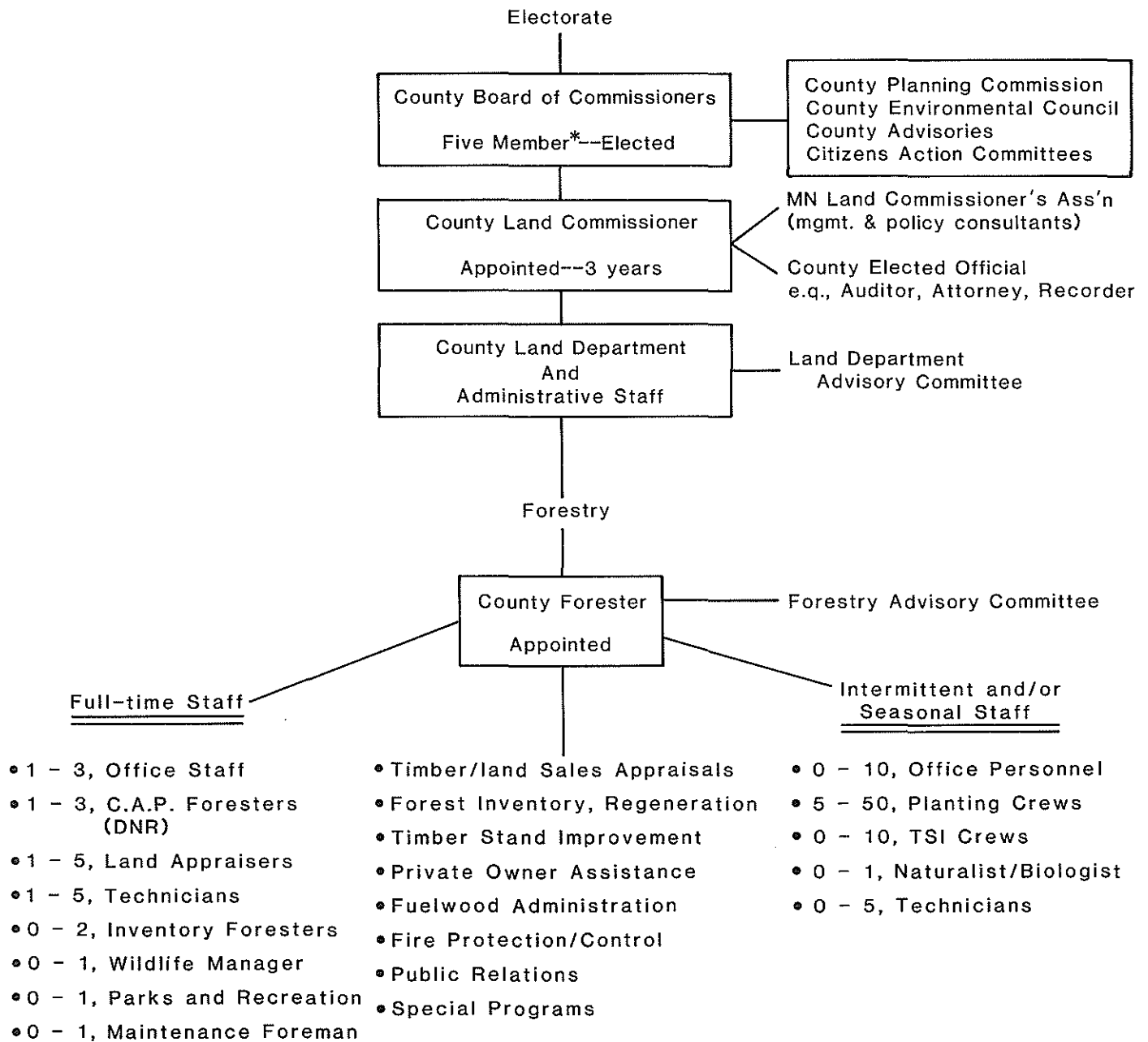
Counties are empowered to establish Land Departments for the purpose of administering lands within their jurisdiction. All of the major forested counties in the state now have land departments. Departmental activities are coordinated by a land commissioner, who is appointed by the county board for a term of three years. The commissioner administers all county land sales and exchanges, leases, land surveys, and land use classification programs. In counties where no land department exists, these functions are performed by the county auditor. The land commissioner also supervises all programs related to the management of county forest lands.

The structure of a typical county land department is depicted in Figure 27. Departmental staffs range from three to 24 full-time professionals. The land commissioner has the authority to appoint a forester to oversee the coordination and administration of county forest management programs. Not all counties have foresters, however, and for those that do not, the Department of Natural Resources assumes the administration of county forest management programs.

Additional assistance for county forest management is provided by the Department of Natural Resources's County Assistance Program (CAP). Through this program, nine Department foresters work with county land departments in eight northern Minnesota counties. Funding for these positions is provided jointly by the Department and the counties, with each assuming 50 percent of the costs. The CAP foresters are responsible for coordinating the administration of all county forest management activities related to tax-forfeited lands. A further discussion of this program with respect to information for county forest management will follow an examination of information resources collected by individual counties.

Legislative authority for county forest administration, with implicit authorization for the collection of information to that end, is described in Table 25.

Funds for forest management activities of an individual county are obtained from sources both internal and external to the county. Revenues from Land Department operations, including land and timber sales, accrue to the general county fund; from this fund, annual appropriations for Land Department activities are allocated. Although not formally prescribed, in most instances allocations for operations approximate income generated by the Land Department (Baughman 1982).



*Except for St. Louis and Ramsey Counties where the board is composed of seven members.

Figure 27. Administrative and organizational structure of county land departments. (Source: McCann and Ellefson, 1980).

Table 25. Legal basis for collection of forest management information by County Land Departments.

Legislation	Activities Mandated
MN Statutes, Chapter 282	County boards may sell lands or retain them for management; they are also empowered to appoint a Land Commissioner and assign duties to him for the purposes of land management and administration.

Counties also receive funding for forest management activities from external sources. The Omnibus Tax Bill of 1979 authorized yearly payments from the state to the counties as reimbursement for state benefits received from county land management. These state payments-in-lieu-of-taxes provided \$4.7 million to counties in fiscal 1980, a substantial amount of which was utilized for forest management. Such payments have had a significant impact on county programs (Rowe and Ellefson 1980).

The BWCA Wilderness Act of 1978 resulted in the authorization of \$500,000 annually for Minnesota counties^{22/} for the purposes of timber development and forest road improvements. The forest intensification and CAP programs of the Department of Natural Resources have also provided valuable assistance to county forestry operations.

It is the goal of Minnesota counties to conduct forestry operations within the framework of a county forest management plan. Stages of development for such plans vary with individual counties; some counties have established formal management policies while others have not. Certain counties depend heavily upon input from county advisory boards for the direction and emphasis of forestry programs. In addition, many of Minnesota's counties are awaiting the completion of the Division of Forestry's Phase II inventory before developing county-wide forest management plans. Those developed thus far are generally rather broad in nature, intending to provide counties with direction in the management of their tax-forfeited forest lands.

Each county in Minnesota develops its own unique approach to the management of its forest resources. This may involve different systems for the generation and utilization of information for forest management. Many counties are still developing methods for summarizing the data and information they collect into a form useful for management decisions.

A great deal of information is exchanged between counties and the state regarding county forest management activities, but counties are by no

means tied to the state in every phase of their forestry operations. Through the Division of Forestry's CAP program, data supplied by the various counties is synthesized into information representing overall county forest management activities within the state.

It is worthwhile to examine information for county forest management

both in terms of information resources of the individual counties, and also with respect to how that information is summarized (by the CAP supervisory office) to represent statewide forest management activities for all counties. Forest management information collected by individual counties is discussed in terms of information classes within the Information-Agency matrix (Figure 13). Information resources collected by three of the four largest forest-landholding counties in the state^{23/} form the basis for this discussion; it should be recognized, however, that the information situation for smaller counties may vary somewhat from that described in this report.

Forest Resource Information

As noted previously, the vast majority of counties within Minnesota will utilize the data and information obtained from the Department of Natural Resource's Phase II forest inventory as a basis for their forest management programs. Data elements for the Phase II inventory have been previously described. Both St. Louis and Itasca counties initiated inventory operations prior to the advent of Phase II, and these counties rely upon their own systems for inventory information. Some counties collect additional data regarding forest soils, primarily in conjunction with timber harvesting activities. Such data is generally maintained in the form of broad soil types.

Counties maintain aerial photographs for all forest lands under their jurisdiction. Photos are updated on an average of every 10 years. The majority of aerial photographs are obtained via contracts with private firms. In addition, some counties plan to utilize 35mm photography for the purpose of updating inventory information for recently harvested areas.

Land Use Information

The state requires counties to formally classify each 40-acre parcel according to highest and best use. Counties generally do so by utilizing the format of the Land Ownership and Classification System developed by the Department of Natural

^{22/} For 11 years, pending annual appropriation by Congress.

^{23/} Cass, Itasca, and St. Louis counties.

Resources. This results in the following organization of land use information for county lands:

Acres of Land
 County lands (not dedicated)
 County forest lands
 County park lands

by

Land Use Classes
 Urban
 Agricultural
 Mining
 Recreation or aesthetic
 Multiple use conservation
 Fish and wildlife
 Peat or gravel
 Access

While most counties utilize this classification scheme, some county boards prefer to utilize their own system of land use identifiers. Counties for which inventory records are computerized generally incorporate this information on land use within their inventory records.

The Minnesota Legislature in 1959 granted counties the general authority to regulate land use and development through adoption of zoning ordinances and other controls. The body involved with discretionary county zoning administration in Minnesota is a citizen board statutorily called the County Planning Commission (Synder, 1980). While a discussion of the criteria for ordinance enactment and of the administrative procedures for issuing zoning variances is not possible in this report, it is important to recognize that these activities of the County Planning Commission can strongly influence land use and development patterns within the counties. Depending on specific circumstances, zoning ordinances and/or variances can exert an impact on long-term county forest management programs.

Forest Ownership and Jurisdiction and Legal Information

Counties maintain records regarding jurisdictional control of all state-owned lands within their territorial boundaries. This information is generally kept in manually-recorded files and is organized according to acreages, method of land acquisition, and administering agency (Department of Natural Resources or county). For county-administered lands, jurisdictional information is organized within the format of the Department of Natural Resources Land Ownership and Classification System as depicted below.

<u>Management</u>	<u>Tax-Forfeited</u>	<u>Acquired and Other</u>	<u>Total</u>
County lands (not dedicated)			
County forest lands	- - - -	Acreages - - - -	
County park lands			

Counties generally maintain information regarding plans for retention or disposal of county lands. This is often represented by a designator within land ownership records. Options for disposal include sales or exchanges. Counties with more developed procedures for ownership accounting may include descriptors of date of acquisition and purchase price for each 40-acre parcel under their jurisdiction. All counties must certify their acreages with the DNR Bureau of Lands as a requisite for receiving payments-in-lieu of taxes.

County Land Departments also maintain records of all land sales and exchanges. Sales of tax-forfeited lands to private individuals are processed through the Division of Forestry for approval by the Department of Natural Resources; land exchanges with private individuals are also checked by the Division to ensure their adherence to law. State and county land exchanges are processed by the Division, and are accomplished through the Bureau of Lands.

The disposal of county lands to private individuals has been an issue of major importance in the past, when large amounts of county lands were sold for the purpose of returning them to the tax rolls. In recent years, however, the number and size of such sales has decreased dramatically (Ellefson, Palm, and Lothner, 1980). Although some county boards still are inclined towards land disposal, most counties have begun to view their forest lands as an asset that may both generate income for counties and provide a variety of other highly desirable goods and services for county residents. In addition, recent changes in state law direct the state to "... encourage the best use of tax-forfeited lands, recognizing that some lands in public ownership should be retained and managed for public benefits...."^{24/} This reflects a major change from previous policies advocating disposal of tax-forfeited lands.

Forest Administrative Information

Land Departments maintain a limited amount of information concerning forest road systems on county lands. Most of this is related to access to forested areas. In addition to access codes furnished by Phase II inventory, some counties derive figures for area-by-access from allowable cut calculations. All counties maintain information regarding the number of forested acres in roads, as well as number and costs of road construction projects.

^{24/} See Senate File 1859 and House file 1982, as amended. Seventy-second Minnesota Legislative Session, 1982.

The DNR Division of Forestry has primary responsibility for fire protection on county-administered forests. County Land Departments assist Division personnel and have specific duty assignments in the event of fire-related emergencies. Counties themselves, however, collect very little information relative to fire control activities.

Land Departments keep records regarding tax rates for the Tree Growth Tax Law, which is implemented at the county level of government. Rates are calculated and distributed to the counties by the Division of Forestry.

Forest management information is collected by counties in a variety of ways. In order for the overall status of county forestry within the state to be accurately described, some degree of information synthesis is essential. The Division of Forestry of the Department of Natural Resources assumes the task of organizing the information gathered by counties into a form representative of the contribution of all counties to forest management within the state. This is achieved through the Division's County Assistance Program (CAP).

The CAP supervisory office in Grand Rapids, Minnesota, is responsible for coordinating and monitoring the distribution and utilization of state in-lieu of tax payments to individual counties. The office also coordinates the distribution of funds allocated to counties under the BWCA Wilderness Act of 1978, and ensures that such funds are utilized for activities authorized under that law. In order to facilitate the accomplishment of these tasks, the CAP supervisory office requests annual information from counties and summarizes that information for the purposes of administering the above programs. This also provides a better picture of the overall status of county forestry in Minnesota. Information collected by the CAP supervisory office may be found in Table 26.

Counties do not collect all of this information in the exact manner in which it is requested by the CAP office. They must often "dig the information out" from their own particular organizational framework for collecting and storing information. All counties have reacted favorably to this process, however, and it represents an important information linkage between county and state levels of forest management in Minnesota.

Timber Management Information: Biological and Silvicultural

The collection and organization of timber management information by County Land Departments is dependent to a great extent upon the number of staff specialists available and the degree of automatization of data processing facilities. These vary greatly by county, and the description herein is representative of counties with greater resources in both of these areas.

Table 26. Forest management information for county lands collected by the Department of Natural Resources, County Assistance Program by information class, 1981.

OWNERSHIP-JURISDICTIONAL INFORMATION

- County forest land ownership: acres by land status--tax-forfeited, Memorial Forests, DNR 50-50, consolidated conservation areas
- County land sales: type, acres, timber on land sold, total sales values
- County land leases: type, cost, annual fee

FOREST ADMINISTRATIVE INFORMATION

- County acres by taxing category: tree growth, auxiliary forest, 3E property
- County projects on tax-forfeited lands
- County projects by funding source: BWCA, RDF, IRRB
- County ACP projects
- Total annual income: Land Departments
- Total annual operating costs: Land Departments
- Forest development fund balances
- Road construction/maintenance: miles, costs
- Easements, rents: number, fees
- County forest development needs: by priority

TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL

- Tree growth rates: by forest type (10-year intervals)
- Timber drain: species/volume (cords)
- Timber harvests: by species
- Desirable cuts: species/volume (cords)
- Timber development projects: funds, acres
- Reforestation: acres, species, costs, methods
- Site preparation: acres, costs
- Timber stand improvement: activity, acres, costs
- County Memorial forest projects

TIMBER MANAGEMENT INFORMATION: ECONOMICS AND UTILIZATION

- County stumpage prices
- Timber sales: volume/value, type of sale
- Auction sales purchasers
- Auction sales: percent of parcels bid
- Timber scaling summaries
- Fuelwood sales
- Total county development costs

NONTIMBER FOREST MANAGEMENT INFORMATION: WILDLIFE AND RECREATION

- Wildlife projects: acres, costs, funding
- Recreation and park projects: sites, uses costs
- L.A.W.C.O.N. projects (Land and Water Conservation Fund)
- Trail grants projects (DNR)

In general, counties maintain the following kinds of biological and silvicultural information for timber management:

- Allowable cut: species and volume
- Condition class information
- Timber growth projections
- Active timber permits
- Areas and volumes by cover type and species

Timber harvests: species and volume
Tree planting: acres and species
Site preparation: acres and species
Insect control activities

The particular degree to which this information is organized varies considerably by county. Figure 28 represents a general overview of the manner in which such information is interrelated by counties within the context of a program for timber management.^{25/}

Allowable cut information at the county level is allocated among several large forest management districts within the county; some counties may further allocate these figures to the township level. Harvesting records are maintained by species, volume and value, and all such information is summarized to provide input, along with timber growth projections, for current inventory adjustments.

Counties keep manual records of all reforestation, thinning and release, and site preparation activities. They also maintain a limited amount of information relating to insect and disease control, generally with regard to specific problems which may occur in localized areas.

Timber Management Information: Economics and Utilization

The majority of economic information kept by counties with respect to timber management relates to stumpage prices and timber sales accounting. Counties obtain base stumpage prices from the DNR Division of Forestry; actual prices for timber sold are reported semi-annually to the Division.

Almost 90 percent of all timber sales on county lands are informal; remaining sales are conducted via sealed bid or oral auction. For each sale, counties maintain a record of the total volume and value of wood sold. Units of measurement, however, may not be identical. For example, volume may be represented in cords while value is calculated in board feet. Scaling reports are maintained, and these are utilized to determine timber drain. Sales are generally less than 40 acres in size and usually \$750 or less in total value; low quality hardwoods are often sold by area estimates. Contracts for timber sales average from one to three years in length. The Division of Forestry must approve all sales of timber from county lands, and the Division generally performs a field check of appraisals for larger sales.

Information regarding timber supply and demand is obtained by counties from secondary sources such as the Division of Forestry and the North Central Forest Experiment Station of the U.S. Forest Service. Counties are not able to maintain extensive information on the utilization of wood

^{25/} This is representative of counties with a relatively well developed timber management program.

produced from their lands, nor do they keep records of loggers or wood processors within their marketing areas. If such information is required, most counties generally contact wood industries in the area.

Nontimber Forest Management Information: Wildlife and Recreation

The limited size of county Land Department staffs does not permit the collection of extensive amounts of information regarding nontimber forest resources. However, most counties do attempt to structure their timber management programs to accommodate nontimber forest uses.

Land departments of some counties are staffed with a wildlife specialist, generally with a background in forest management. Management efforts for wildlife are often concentrated on the manipulation of aspen stands in terms of providing openings and establishing a diversity of age classes for that species. The predominance of large amounts of mature aspen on county and other forest lands in Minnesota complicates this latter task. Some counties have established demonstration areas for deer and grouse management, and some have constructed water impoundments to facilitate manipulation of water levels for duck populations. Generally, counties attempt to identify critical habitat areas on their lands for such species as osprey and bald eagle. A limited amount of information is maintained by most counties on the status of these and other wildlife-related projects. Wildlife specialists from the Department of Natural Resources assist counties in the implementation of some of these projects.

The majority of counties collect some information regarding recreational use and facilities on forest lands such as cabin sites and public access areas. County Parks and Recreation commissions also provide input to forest management activities, and some commissions have well-established recreational programs. A few counties have devoted extensive acreages to preserves and interpretive centers designed to provide education in the management and conservation of county forest resources.

Nonland Management Agencies and Organizations

A variety of federal and state organizations that do not administer public forest lands in Minnesota do collect information that is of potential utility for the management of these lands. The following pages contain brief descriptions of each of these organizations, focusing upon information gathered to carry out their particular responsibilities that is also relevant to public forest management in the state.

Each organization is described in terms of its overall mission, legal authorization for information collection, and information resources for forest management. Six executive departments

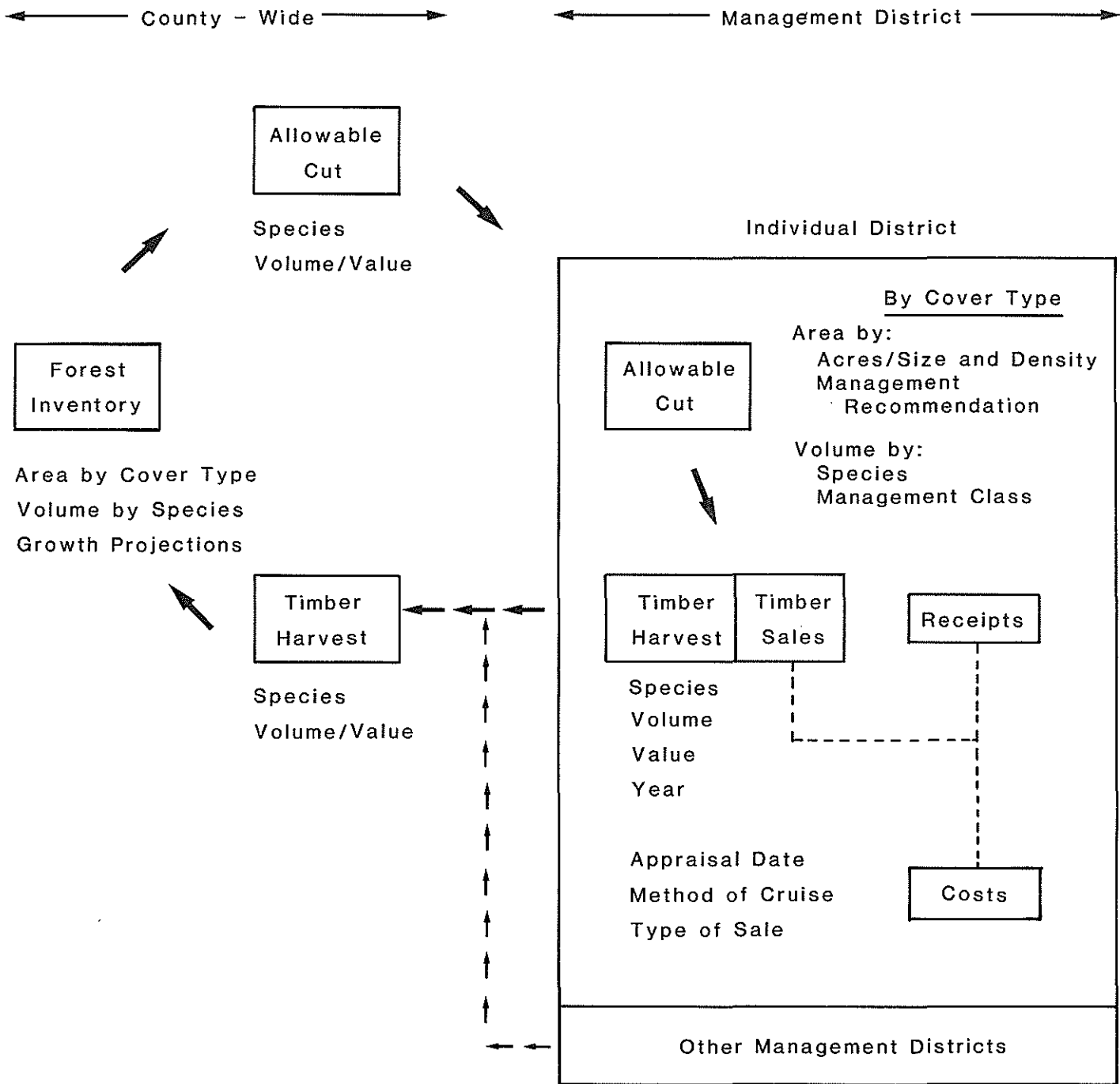


Figure 28. Information flow for a county timber management program.

and/or agencies at both the federal and state level are discussed, with several described in terms of divisions or sections within the organization that collect forestry-relevant information. Other State organizations, including five conservation boards and six organizational units within the University of Minnesota, are also described. All such agencies and organizations are represented within the Information-Agency (I/A) matrix for forest management (see Figure 13).

Federal Executive Agencies

U.S. Department of Agriculture

Agricultural Stabilization and Conservation Service--The Agricultural Stabilization and Conservation Service (ASCS) administers farm commodity and related resource conservation and environmental programs for the purposes of promoting voluntary adjustments in production, resource protection and farm income stabilization. The Service designs and administers commodity support programs, grain reserve and acreage set-aside programs, and disaster relief efforts. It also encourages resource conservation and environmental protection through cost-share programs with private landowners. The Service's legal mandate for information collection may be found in 5 U.S.C. 301.

The Service administers a variety of programs designed to stimulate agricultural productivity. Two programs which focus upon the forest resource are the Agricultural Conservation Program (ACP) and the Forestry Incentives Program (FIP). These provide cost shares to farmers and other private landowners for the purposes of improving forest productivity through the adoption of approved forest management practices. Forestry-related activities authorized under these programs include tree plantings and timber stand improvement practices such as site preparation, release or precommercial thinnings, and pruning of crop trees.

Programs are administered through ASCS county committees consisting of three members of the local agricultural community; the county Agricultural Extension agent is a nonvoting advisory member to the local committee. ASCS offices maintain information regarding the administration of these programs in the form of funds available for cost shares, program participants, acres planted, and acres treated by various timber stand improvement practices. Technical assistance for implementing these practices is available to landowners and is provided by the Forest Management section of the Department of Natural Resource's Division of Forestry.

Soil Conservation Service--The Soil Conservation Service (SCS) is responsible for administering a national program for the conservation of soil and water resources in the United States. The Service provides technical assistance to locally organized and operated soil conservation districts encompassing more than 2 billion acres nationwide. It also assists governmental agencies

and private individuals concerned with ensuring the stability and productivity of soil and water resources. Such activities, along with implicit authorization for the collection of information related to them, are authorized by the Soil and Water Resources Conservation Act (1977) (91 Stat. 1407; 16 U.S.C. 2001).

The Soil Conservation Service provides assistance to counties through local soil and water conservation districts. These districts are local subdivisions of the state; each has a nonpaid, elected director who coordinates district conservation efforts. The Service enters into a memorandum of understanding with local districts to provide technical assistance for the administration of local conservation programs.

An important type of information collected by the Service with potential relevance to forest management in the state is the public soil survey. Efforts to accelerate the Cooperative Soil Survey in Minnesota were initiated in 1977 with the establishment of a 12-year program with the goal of providing soil surveys and maps for all Minnesota counties. The program originated within the framework of a cooperative agreement between five agencies: the Soil Conservation Service and the Forest Service, both within the U.S. Department of Agriculture; the Minnesota Soil and Water Conservation Board; and the Agricultural Experiment Station and Agricultural Extension Service of the University of Minnesota. The Minnesota Department of Natural Resources plans to join the agreement in mid-1983. Additional support is provided by the Legislative Commission on Minnesota Resources.

With respect to forested areas within the state, the Survey plans to provide soil interpretations for specific cover types on various kinds of soils. In implementing this program, a forester and soil scientist evaluate individual sites, collect stand information such as site index, and describe soil profiles. An important goal of the program is to facilitate a better understanding of the relationship between forest cover types, as identified by current inventory data, and basic soil characteristics. This may in turn allow a more accurate identification of the most productive forest sites.

Contractual agreements for soil survey work are made with individual counties, generally for a three to four-year period. Overall funding for this program is divided on approximately a 1/3 basis among the Soil Conservation Service, the State of Minnesota, and individual counties.^{26/} As of mid-1983, approximately one-half of the program will have been completed, including most of the agricultural regions in the state. Work in northern forested counties is now beginning.

^{26/} In northern counties of the state, these percentages are modified to reflect the large amount of land under federal and state jurisdiction.

In addition to its involvement in the above program, field offices of the Soil Conservation Service help develop conservation plans for private landowners within Minnesota, generally by describing land use alternatives based on soil survey information. Technical assistance in the implementation of ACP cost share programs is also provided. Although these efforts are undertaken primarily within the agricultural regions of the state, some activities are conducted in areas with mixed forestry and agricultural land uses. The Service also provides technical assistance for the establishment of farmstead windbreaks; funding for these programs is administered by the ASCS.

Several national SCS programs provide mechanisms for soil and water conservation projects in Minnesota. The Resource Conservation and Development Program (RC&D) helps provide technical and financial assistance for addressing such problems as soil erosion and sedimentation, flooding, loss of wildlife habitat and lack of markets for farm and forest products. Local sponsors such as state soil and water conservation districts and county boards provide the initiative for participating in RC&D projects.

The Watershed Protection and Flood Prevention Act (PL-566) authorizes projects designed to provide watershed protection, flood prevention, water supply access and fish and wildlife development for watersheds larger than 250,000 acres in the state. Twenty-eight projects have been authorized in Minnesota, with 13 completed to date.

The Soil Conservation Service is also involved in the development of a national assessment and program for soil and water conservation in the United States. The Soil and Water Resources Conservation Act of 1977 (RCA) provides the basis for this national project, which is the equivalent of the Resources Planning Act (RPA) assessment and program currently being implemented by the U.S. Forest Service. All states will contribute information on their soil and water resources as part of this national planning effort.

Agricultural Research Service--The Agricultural Research Service^{27/} (ARS) has the responsibility for national coordination of research efforts related to food and agricultural sciences. Among its goals for increasing the productivity of research in these areas is the support and promotion of information systems and libraries to aid in the establishment and implementation of research programs. Through the National Agricultural Research, Extension, and Teaching Act of 1977 (91 Stat. 981-1019; 7 U.S.C. 3101-3316) the Agricultural Research Service is authorized to initiate cooperative agreements with state

organizations engaged in agricultural research and provide funding for these research programs.

The Service is the major research arm of the U.S. Department of Agriculture. Research funds are appropriated to the Department and allocated by the Service to individual states through state Agricultural Experiment Stations.

The Service has been only minimally involved in forestry research projects in Minnesota. This has consisted of a cooperative project with the U.S. Forest Service for analysis of water runoff from forested lands. The majority of research projects currently being funded are concerned with enhancing crop productivity, soil and water conservation in agricultural areas of the state; and projects related to crop disease and weed control. The Service maintains information related to the nature, status and funding levels of these projects.

U.S. Department of the Interior

Geological Survey--The Geological Survey classifies lands within the United States according to their geologic and topographic characteristics, and with respect to their mineral and water resources. The Survey also conducts research in these areas and disseminates information by means of an extensive series of maps and publications. Legal mandates for information collection and generation are represented by a number of legislative acts, most notable of which may be found in 43 U.S.C. 41-45 and 44 U.S.C. 260-262.

The Geological Survey is divided into four regions encompassing the northeastern, southeastern, central, and western portions of the United States. The Minnesota District of the central region, with headquarters at St. Paul, Minnesota, is responsible for coordinating all activities of the Survey within the state.

The Water Resources Division monitors surface and ground water quantity and quality throughout the state, conducts flood plain research, performs studies of Minnesota's lakes, streams and peatlands, and issues hydrologic atlases of the state's watersheds. A list of ongoing projects related to Minnesota's water resources is presented below:

<u>Statewide Projects</u>	<u>Number of Elements</u>
Surface water stations	126 continuous; 407 partial
Groundwater stations	382 wells
Water quality stations	12
Sediment stations	27
Small stream flood monitoring	110 gauges
Flood plain studies	Minnesota River; 16 lakes
<u>Projects in Northern Minnesota</u>	
Groundwater appraisals	
Lake water balance studies	
Sand plains studies	
Peat mining studies	
Water quality monitoring (Voyageurs National Park)	
Acid precipitation effects	

^{27/} Formerly the Science and Education Administration.

Information concerning Minnesota's water resources is also forwarded to Reston, Virginia, for inclusion in two national water data base systems.

Geologic mapping and mineral assessments for certain areas in Minnesota are performed by the Survey's Geologic Division. The Survey issues topographic maps for the state at several standard scales.

The Geological Survey also administers the Earth Resources Observations Systems (EROS) program, which develops techniques to obtain and analyze remotely-sensed satellite and aircraft images.

U.S. Department of Defense

U.S. Army Corps of Engineers--The U.S. Army Corps of Engineers is responsible for the management and development of all navigable rivers in the United States. It also is the regulatory agency for enforcement of laws related to the protection and preservation of these waterways. The Corps initiates projects for flood control and hydroelectric power generation, regulates navigation of commercial vessels, and issues permits for river structures or for the discharge of dredged material into rivers or wetlands. Legal authorization for these activities is, in part, provided by the Federal Water Pollution Control Act of 1972, as amended.

The St. Paul District of the Corps administers agency programs for all navigable waterways in Minnesota. The primary kinds of information collected by the Corps that may potentially influence forest management in the state pertain to Corps activities which monitor discharges into navigable waters, and to outdoor recreational facilities constructed by Corps projects.

The Corps maintains records of all permits for the discharge of dredged or other materials into waters under its jurisdiction. The goal of this activity is the prevention of unregulated dumping or other disturbances which may degrade water quality or destroy wildlife habitat.

Recreation areas have been established at the Mississippi Headwaters lakes, and at various other locations on the Mississippi River. The Corps collects information on visitor use for day areas, as well as for primitive and developed campsites. Such information contributes to a better understanding of recreational demand patterns in these forested areas of the state. In cooperation with the U.S. Fish and Wildlife Services, the Corp of Engineers is currently preparing a management plan for approximately 133,000 acres of federally-owned shoreland along a 250-mile segment of the Mississippi River from Minneapolis to Guttenberg, Iowa. Almost 98 percent of these lands will be available for public recreation.

Environmental Protection Agency

The United States Environmental Protection Agency (EPA) was created for coordinating actions of the federal government with respect to the natural environment (Reorganization Plan No. 2 (1970)). The Agency seeks to promote a stable environment through the monitoring of activities which may lead to potential environmental degradation and by enforcing those laws enacted to ensure environmental stability. The EPA also coordinates and supports research activities aimed at the abatement and/or prevention of environmental pollution.

The activities of the Agency are subdivided into five major program areas: air, noise, and radiation; water and waste management; pesticides and toxic substances; enforcement; and research and development programs. The Agency administers these programs through 10 regional offices nationwide; Minnesota is located in Region V, for which the regional office is Chicago, Illinois.

The majority of information maintained by the Agency affecting forest management in Minnesota pertains to environmental regulatory legislation. The Agency monitors the state's adherence to Section 208 of the Federal Water Pollution Control Act of 1972 concerning nonpoint sources of water pollution. Improper forest management practices are one potential source of such pollution. The Minnesota Pollution Control Agency has developed a Water Quality Management Plan to ensure state adherence to this law; this plan is currently being adapted with EPA assistance.

Other environmental regulatory legislation affecting Minnesota forest industries includes point source water pollution laws and air quality standards. Extensive documentation of all such legislation is maintained by the Agency. The Agency also registers and regulates all pesticides for use in agricultural and forestry operations and in the past has assumed primary responsibility for enforcement of pesticide usage. Much of the enforcement duties have now been taken over by the states with federal financial assistance.

State Executive Agencies

Department of Energy, Planning, and Development

The Department of Energy, Planning, and Development was created in 1981 through the merger of four previously autonomous governmental organizations: the State Planning Agency, the Department of Economic Development, the Energy Agency, and the Crime Control Planning Board. The functions of these state agencies were at that time incorporated within the new Department. A comprehensive package of enabling legislation, including authorization for the collection of a variety of information of relevance to forest management within the state, may be found in the Minnesota Statutes 116J.01 - 116J.04.

The organizational structure of the Department is presented in Figure 29. It is likely, however, that this structure will be maintained only through July 1983. The current administration has proposed disaggregating the department in such a way that the Planning Division would again become the State Planning Agency; the Energy Division would be returned to its previous status as the Energy Agency; the Community Development Division would be absorbed within the Department of Commerce; and the Tourism Division would either be elevated to status of a separate department or incorporated as a division within another governmental department. Activities of the organizational units within the existing departmental structure which have a bearing upon forest management in Minnesota are now described.

Office of Physical Planning Resources--The Office of Physical Planning Resources is responsible for coordination of state, regional, and local planning efforts to achieve the best use of Minnesota lands. It also houses the Land Management Information Center, a resource-based information bank for utilization by legislative and executive branches of state government, as well as by any nongovernmental organizations that require information concerning the state's natural resources. The Office is responsive to the research needs of all government agencies and legislative commissions. It is also concerned with integrating the management plans of various state agencies with those of local governments and communities.

Information regarding statewide land use changes and trends is collected by the Office, which also monitors local governmental procedures in land use decisions. All management plans for state recreational areas, including recreational development within state forests, must be reviewed by the Office before state funds may be allocated for use in recreational programs.

The Office also investigates long-term implications of land and resource use changes in Minnesota through its trend analysis program. Computerized data bases are maintained for six aspects of the state's natural and human resource development: agriculture, forestry, minerals, wetlands, land ownership, and urban development.

Forestry-related information is assembled with the goal of identifying trend lines for long-term changes in the forest land base, and in the volume and value of forest products produced in the state. Much of this information is taken from existing sources and organized within a classification scheme useful to decision makers at the state level. This aggregate perspective is intended to complement the data-gathering activities of the Land Management Information Center (see following discussion), for which data is organized according to 40-acre land parcels for the entire state.

In addition to forestry, the program contains data bases for the following subjects, generally organized on a county and statewide basis:

- Agriculture: Farm income, acres harvested, acres planted
- Minerals: Raw prospects, past prospects, ownership, production levels, value of minerals produced
- Wetlands: Acreages
- Land Ownership: Summaries
- Urban Development: Rural subdivisions, building permits, land annexation

The information system for the trend analysis program is accessible to the general public via telephone hook-up, and the system is user-friendly. The Office encourages other organizations to enter data into these profiles in order to enhance their utility to prospective users.

Land Management Information Center--The Land Management Information Center (LMIC) was established in 1977 for the purpose of collecting and organizing information on Minnesota resources in a manner accessible to both governmental agencies and interested private organizations. The Center utilizes a computerized information system to provide information services tailored to individual needs. It also identifies sources of resource information within the state, and conducts analyses related to special projects, generally in conjunction with other state departments or agencies. Activities of the Center will be described in terms of the above functions.

The Minnesota Land Management Information System (MLMIS) is a computerized information system designed for storage and analysis of geographically-based data concerning Minnesota resources. The primary purpose of the System is to maintain and perform analyses of data relevant to:

- . Decisions of the State Legislature
- . Decisions of state agencies responsible for the management of the natural and human resources of the state

The System is an outgrowth of a computerized information system developed at the University of Minnesota through a joint project of the State Planning Agency and the Center for Urban and Regional Affairs. In 1977 the system was incorporated by the State Legislature into the newly-formed Land Management Information Center within the State Planning Agency. The analytical framework of MLMIS is based upon work conducted in 1967 by the Department of Geography at the University of Minnesota, in which 38,000 forty-acre cells were identified and computerized during the course of a study of nonpublic lakes in Minnesota. The concept was subsequently expanded to include the mapping of the entire state in this fashion.

The underlying philosophy of the System involves taking primary data collection programs wherever they occur and summarizing and integrating these programs into one common data base. The

Organizational Chart: Department of Energy, Planning, and Development

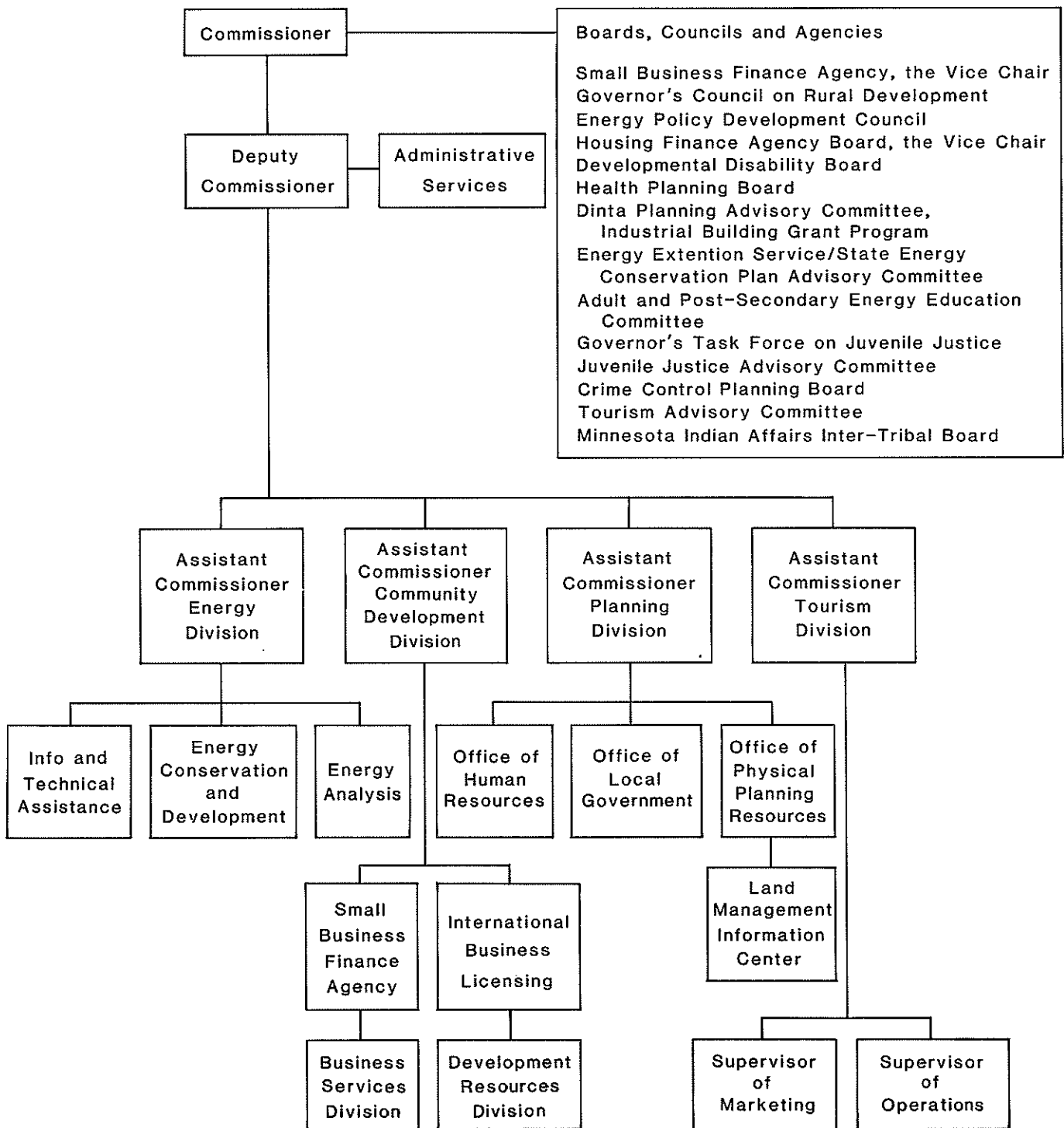


Figure 29. Organizational chart: Department of Energy, Planning, and Development. 1983.

MLMIS data base contains elements of four basic kinds:

- . Geographic and political identifiers
- . Resource data
- . Ownership data
- . Recreation data

Representation of this data base in terms of classes described in the Information-Agency matrix (Figure 13) is depicted in Table 27. These data elements exist for every 40-acre parcel in the state of Minnesota. Due to the diversity of data sources which are represented within the System, it is neither possible nor feasible to totally standardize all data collections. The goal of the System is basically one of filtering data in any form so that it may be represented in a systematic, readily accessible fashion.

As noted previously, data storage for MLMIS is via a geographic-based aggregation system. Each of the 1.4 million 40-acre parcels within the state

is described according to the data elements in Table 27. The System also has the capability of resolution to 2.5 acre cells; this is utilized primarily for intensive analyses of small areas for specialized land use studies, unique habitat evaluation, and the like. For studies of a very broad scope, data may be generated for a cell size equivalent to approximately 10 square miles.

The analytical capabilities of the System include:

- . File manipulation: extraction of information from existing data files at various scale resolutions (primarily 40 acres)
- . Map compositing: merging data elements to provide comprehensive resource description for a given 40-acre cell
- . Analysis of geographical relationships for a given land area (i.e., a particular group of 40-acre cells)

Table 27. Data elements of the Minnesota Land Management Information System by information class.^{28/}

Information Class	Data Type
FOREST RESOURCE INFORMATION	Forest Types
	Soil landscape units
	Geomorphic regions
	Watersheds
	Water orientation
	Irrigation source
	Lakeshore inventory
	Soils Atlas data
	Landforms
	Landscape position
LAND USE INFORMATION	Existing land use
	Recommended land use (Department of Natural Resource lands)
OWNERSHIP AND JURISDICTIONAL INFORMATION	Public land survey designations
	Minor civil divisions
	<u>Department of Natural Resources</u>
	Administering agency(s)/division(s)
	Statutory land class
	Acreages
	Means of acquisition
	Recommended disposition
	Mineral ownership(s)
	Forest administrative units
NONTIMBER FOREST RESOURCE MANAGEMENT INFORMATION	Park administrative units
	Wildlife management area administrative units
	Resorts
	Campgrounds
	Water access
	Athletic facilities: Picnic areas, beaches, etc.

^{28/} A number of data elements in this table are maintained in a finer degree of detail than is represented herein.

The system is also provided with sophisticated computer mapping capabilities for generating high quality color mapping depicting resource or other characteristics for a given area of land.

In addition to use of this System for storage, retrieval, and analysis of geographic-based data, the Land Management Information Center conducts other activities pertaining to the identification of various sources of information concerning natural resources in Minnesota. The Center maintains extensive documentation of aerial photography sources within the state in the form of a catalogue which indexes all existing photos by county and collecting agency. The Center also possesses a complete set of contact prints of all photos obtained from statewide high altitude flights in 1968, 1969, 1977, and 1978. Dial-up capability exists for ^{29/} accessing computer files of the EROS Data Center for all LANDSAT, NASA, and USGS images available for Minnesota. Information furnished from LANDSAT photographs collected between 1978 and 1982 is currently being utilized to complete a new land cover classification of Minnesota. Cover types being classified include: deciduous forest, coniferous forest, pasture, cultivated land, water, urban, and marsh land. In addition to aerial photographs, the Center maintains a complete set of all USGS topographic maps available for Minnesota.

The Land Management Information Center also houses the Minnesota Environmental Resources Information and Data Exchange (INDEX), a computerized catalogue containing sources of resource-related information within the state. The catalogue is designed to enable the user to relate more than 60 kinds of resource data (not the actual data elements themselves, however) to agencies within which such data is maintained. It is updated on a

continual basis as new sources of resource information are identified. Data types and source organizations are described in the manual Catalog of Data Sources: Land Use in Minnesota (Minnesota State Planning Agency, 1981).

In addition to the above catalogue, the INDEX project also maintains information in the form of files relating to the following areas (Table 28).

A recent addition to INDEX consists of a software package for searching data files of client organizations or individuals to identify a wide variety of resource-related data elements. The Text Entry Retrieval Information and Searching (TERMS) system provides free text searching for user data bases according to single or multiple keywords. Data files may be constructed and maintained by users.

The Systems for Water Information Management (SWIM) is also administered by the Land Management Information Center. This is the result of a joint effort funded by the Legislative Commission on Minnesota Resources (LCMR) and coordinated with the Water Planning Board. SWIM is designed to identify all data bases in the state pertaining to the state's water resources, along with the agencies within which such bases are maintained.

Current SWIM activities include demonstration projects for relating data sources to water-related issues, and the development of an automated Catalog of Water Data Sources in Minnesota. The Catalog is available in published form (Minnesota State Planning Agency, 1981), and describes approximately 80 programs in state agencies which regularly accumulate data on water and/or related land resources as part of their ongoing activities. A number of these data bases pertain in part to forested areas within the state.

Table 28. Information files maintained by the INDEX project of the Land Management Information Center.

File Name	Description of File
Map File	Sources: MN Geological Survey; MN Department of Energy, Planning, and Development; MN Soils Atlas; Hydrologic Investigation Atlas
Publications File	MN soil surveys, meetings and conferences regarding MN natural resources, Metropolitan Council publications, MN Geological Survey, MLMIS publications, North Central Forest Experiment Station publications, and others.
EIS File	All state and federal environmental impact statements prepared since 1975: draft and final.
Technical Person File	Individuals with knowledge, experience or expertise in water resources and environmental education.
Research Project File	Ongoing resource-related research projects: water, land use, peat, bioenergy, acid precipitation.
Data File	Data elements within Research Project File

^{29/} Part of the USGS National Cartographic Information Center (NCIC).

An automated reference file to 150 data collections is maintained by the Planning Division of the Department of Energy, Planning, and Development. This file provides more detailed information concerning the purpose, content, geographical relevance, and availability of the water-related data files described in the SWIM catalogue.

The Land Management Information Center has and is currently conducting a variety of other analyses which have resulted in information of potential utility for forest management in Minnesota. These include:

- . Aspen Market Study: supply scenarios by mill demand and distance to market
- . Acid Rain Study
- . Mineral Resource Study
- . Trail Development Potential Study
- . Population Distance Bands: for any point in state
- . National Wetlands Inventory: digitizing and mapping of wetlands data collected by U.S. Fish & Wildlife Service

Energy Division--The Energy Division, formerly the Minnesota Energy Agency, collects information on current energy use in the state, analyzes historical trends, and forecasts future energy demand. It also encourages and assists in the development of alternatives to fossil fuels as sources of energy development within Minnesota. The office provides funding and technical assistance for alternative energy projects, and the District Heating and Biomass Program seeks to encourage the use of alternative fuels, including wood and wood residues, in the generation of electrical power. The Energy Information Center issues publications outlining options for the development of both fossil fuel and alternative energy systems. The Division also maintains a library with numerous publications concerning energy problems, as well as projects conducted by other federal and state agencies.

The Division performs economic analyses of alternative energy resources and technologies. In doing so it collects the following kinds of forestry-related information:

- . Timber supply and demand projections
- . Fuelwood supply information
- . Residential fuelwood consumption in Minnesota: current and projected
- . Wood residue utilization by Minnesota industries
- . Wood imports and exports for Minnesota
- . Fuelwood price data
- . Special crop sources for woody biomass; example, cattails
- . Fuel use by public utilities in Minnesota
- . Potential conversion of boilers to fiber fuel utilization in northern Minnesota

The Division has evaluated the feasibility of industrial use of wood residue as a source of energy in Minnesota. It has also examined how

the potential availability of fuelwood in the state will be affected after all new waferboard plants in Minnesota have become fully operational. Information regarding fuelwood prices is maintained on a continuing basis in terms of dollars per cord for residential use. Most of the pricing information is obtained from the Division of Forestry of the Minnesota Department of Natural Resources. The Division also conducts feasibility studies regarding the utilization of fuelwood for district heating groups in rural areas of Minnesota.

The Minnesota Tradeoff Model (MINTOM) is an input-output model utilized by the Division in analyzing statewide economic impacts of changes in energy consumption by Minnesota industries. Three sectors within the model pertain to forest industries in the state.

Community Development Division--The Community Development Division performs many of the functions of the Department of Economic Development prior to its incorporation within the Department of Energy, Planning, and Development. The Division aids small businesses throughout the state through financial and marketing assistance, and provides grants and loans for area redevelopment.

The Division is primarily a business advocacy agency; it interacts with businesses on a daily basis, from very large to very small firms. The Division collects little primary data; however, since it is concerned with issues of importance to forest industries, its activities do have an impact on the forestry sector within the state. In 1980, a task force comprised of individuals from both large and small firms within the wood-based sector was formed for the purpose of defining the structure and status of the industry and identifying issues which should be addressed. The recommendations of the task force have served as a broad framework within which the Division administers loans to wood-based industries.

The Division on occasion assembles position papers for forest industry and has represented the interests of industry before the Minnesota legislature. It works with industrial representatives in presenting testimony concerning laws affecting forest industrial operations, often for the purpose of achieving policy changes without the need for legislative action.

Some information, generally not available to the public, is collected by the Division regarding corporate income tax returns for forest industries in the state. Through a contract with the Minnesota Department of Revenue, the Division maintains information regarding the number of forestry-related industrial establishments in the state, as well as the value and volumes of industrial production.

Office of Local Government--The Office of Local Government performs many of the functions of the former Office of Local and Urban Affairs prior to departmental reorganization. The Office coordinates the administration of federal and state grants to local units of government throughout the state and provides information and assistance to these governments for addressing rural and urban problems. The activities of the office have a substantial, though often indirect, impact upon forest management in Minnesota.

The Office coordinates activities of the Governor's Council on Rural Development, comprised of 29 members representing the state's regional development commissions and post-secondary educational systems, as well as other state and federal agencies. While the council performs no information-collecting activities, it does provide a forum for addressing issues of significance to rural communities in Minnesota.

The Land and Water Conservation Fund (LAWCON) of the U.S. Department of the Interior provides grants to states for the development of parks and other outdoor recreational facilities. Within Minnesota, one-half of these funds are allocated to the Department of Natural Resources for development of the state park system. Through the Office of Local Government, the remaining half is distributed as grants to local governments for park and recreational development. The Office maintains information regarding these grants in terms of identification of recipients, funding provided and projects accomplished. The forested counties of northeastern Minnesota have not participated in the LAWCON program to the extent that other areas within the state have utilized the program.

The Office of Local Government also provides technical assistance and funding to regional development commissions within Minnesota through the allocation of block and other development grants. Information on the availability of federal and state programs is also furnished. Although the Office collects little information on a regional basis, it maintains the following kinds of information with respect to these programs:

- . Annual reports prepared under Grant programs
- . Audit reports
- . State grants allocated to Regional Development Commissions (RDC's)
- . Other developmental grants (example: HUD 107 grant program)

Although the Office collects little information directly related to forest management, it has investigated methods by which forest products may be processed within the state as an alternative to their export to other areas. One of the primary means by which the Office influences forestry within Minnesota is through its coordinating role in the establishment of forestry-related programs by regional development commissions.

Department of Agriculture

The Department of Agriculture is the major farm-food regulatory and promotion agency in Minnesota. The Department enforces laws regarding the manufacture and distribution of foods, animal feeds, fertilizers, pesticides, and other commodities in accordance with legal mandates represented in the Minnesota Statutes (CR 17-34, 41-42, 308, 500, and other specific sections). It also encourages enhancement of the state's agricultural industry through market development and product promotion.

The Department performs two functions, primarily regulatory in nature, that pertain to specialized aspects of forest management. The activities of pesticide regulation and nursery inspection are carried out within the Department's Agricultural Protection Service.^{30/} The Agronomy Services section is responsible for the regulation of all feed, fertilizer, herbicides, and pesticides sold in Minnesota. Regulatory functions are executed primarily through the enforcement of truth-in-labeling laws. Periodic samples of all pesticides, herbicides, and fertilizers are taken to ensure that labels and contents conform to existing laws. The section collects the following kinds of information in carrying out these and other pesticide-herbicide related tasks:

- . Registrations of all pesticide^{31/} products by company
- . Samples of pesticide products
- . Licenses for commercial applicators by type of application
- . Accidents/spills involving pesticide usage

With respect to aerial applications of chemicals in forest management, few problems exist within the state regarding the regulatory aspects of these activities. They do, however, remain an important issue for some groups from the standpoint of whether such applications should be allowed. Most Departmental contacts with the Department of Natural Resources concern the latter's requests for information on whether specific herbicides/pesticides may be used in a certain manner.

The Plant Industry section within the Department regulates the nursery industry within Minnesota. The section inspects and certifies all nurseries within the state. Inspection efforts are designed for the detection of disease and insect pests. The section inspects DNR-operated nurseries on an annual basis, as well as all of the approximately 350 private growers within the state, the majority of which are involved almost exclusively with the production of ornamental species. All dealers who buy and sell nursery

^{30/} The equivalent of a departmental division.

^{31/} In this list, pesticide also applies to herbicides.

products are also inspected and certified, and the section maintains records of all such inspections and certifications.

The Department's Shade Tree Program was eliminated by the Minnesota State Legislature in 1982. The Program had coordinated the administration of state grants to local governments for the purposes of shade tree disease control and reforestation activities. This included the support and training of tree inspectors to ensure sound tree disease control programs. The primary kinds of data generated by the program pertained to urban sanitation and reforestation expenditures for Dutch elm disease control. Such data is organized in terms of number and costs of trees removed and planted. These figures provide the basis for information concerning disease tree loss as percent of total inventory for municipal areas. In addition to the above information, the Program assembled an extensive number of research and other publications concerning both Dutch elm and oak wilt tree diseases.

Information previously described is now maintained by other sections within the Department. Records pertaining to program administration extend through 1982. The Plant Industry section will continue to provide cultures for elm and oak. Despite the elimination of funds in 1982, this program was well received by municipalities throughout the state.

Department of Transportation

The Department of Transportation is charged with providing the state of Minnesota with a balanced system of all forms of public transportation. It is also responsible for the development and maintenance of statewide transportation plans, and is authorized to construct, maintain, and regulate transportation facilities in accordance with Minnesota laws (MN Statutes, Ch. 16, 104-106, 167).

The Department has jurisdiction over almost 250,000 acres of Minnesota lands. These greenbelts are areas which, while not covered by paved roads, are still parts of rights-of-way. The Department manages such lands through its Office of Environmental Services, which is responsible for landscaping and vegetational manipulation of greenbelts bordering primary and secondary roads in Minnesota. In the process, the Office collects information regarding the condition of any forested lands within these greenbelts. The Office cooperates with the DNR Division of Forestry in the event of insect or disease problems arising from or affecting Departmental lands. Landscape unit files are maintained concerning vegetational characteristics of greenbelt lands. The Office also classifies all lands under its jurisdiction by eight classification designators, two of which indicate lowland or upland forests. Any forested lands are identified by forest type. An average of approximately 40,000 trees per year are planted by the Office on greenbelt lands.

An extensive library of transportation maps and aerial photographs^{32/} for the entire state of Minnesota is maintained by the Office of Surveying and Mapping. In addition to statewide maps at various levels of resolution, county road maps are compiled with roads identified according to the following classifications:

- . Protected road
- . Primitive road
- . Unimproved road
- . Graded and drained road

Other maps maintained by the Office of potential utility for forestry include townships, bridges, and corporate limits.

Information concerning spring road use restrictions for state highways is issued by the Department's Office of Maintenance through its 16 maintenance areas within the state. The Office also issues policies and instructions on permitted axle weights on state highways.

Department of Economic Security

The Department of Economic Security has broad responsibilities for income and employment policies in Minnesota and for the establishment and administration of economic development programs within the state. The Department coordinates vocational and post-secondary job training and placement programs (including CETA), providing linkages for these programs with state goals for economic development. Specialized training and vocational rehabilitative assistance are also provided. The Department's legal mandate for information collection is contained in Minnesota Statutes 1977, Chapter 430.

A variety of information pertaining to employment within the forestry sector in Minnesota is collected and maintained by the Department's Research and Statistical Services Office. The Economic Conditions and Industry Studies section within the Office collects and analyzes data pertaining to the labor force in Minnesota, including industry structure and employment. It also utilizes time series data for Minnesota industries (from 1960) to develop projections for industry and occupational employment. Current projections extend through 1985; 1980 will serve as the base year for 1990 projections.

The section collects information on employment/unemployment both at the statewide and county level. Information is summarized under nine macro-categories, three of which are relevant to forest management in Minnesota. These are:

- . Number of employees by occupation
 - Laborers except farm
 - (a) timber cutting and log workers
 - (b) sawmill and planing mill work
 - (c) other sub-categories

^{32/} Flights occurred in 1977.

- Operatives
 - (a) survey helpers; chain, rod, axe workers
 - (b) other sub-categories
- Other occupations (7)
- . Number of employees by manufacturing industry
 - Lumber and wood products
 - (a) logging
 - (b) sawmills, planing, millwork
 - (c) miscellaneous wood products
 - (d) furniture
 - Other major subdivisions (8)
- . Number of employees by Agriculture, Forestry, and Fisheries
 - Agriculture
 - Forestry
 - Fisheries

Data in these categories are collected at the statewide level. The section also collects unemployment figures by geographical areas, primarily on a county basis.

Data regarding number of employees by industry is also collected by the Labor Market Studies section. Such data is generally summarized according to classification codes of the Standard Industrial Classification System (SIC). Categories relevant to forest industries include:

- . SIC 24--Lumber and Wood Products
- . SIC 25--Furniture and Fixtures
- . SIC 26--Paper and Allied Products

Reports are issued at the two-digit (e.g., SIC 24) SIC level, which represents a summarization of more detailed data regarding industry employment and structure that is generally confidential property of specific industries. The Regional Labor Market Information System section coordinates activities and data collection of the Department's six regional labor market information centers. The center in Duluth gathers data and information similar to that collected by the two sections described above from counties in the north central and northeastern regions of the state.

Department of Revenue

The Department of Revenue administers the state tax system. It also makes special state aid payments to cities, towns, and counties, and proposes and evaluates the revenue impacts of proposed tax law changes from both a statewide and local perspective. The Department is responsible for the supervision of local property tax administrators and agencies, and issues guidelines for the administration of property tax laws. It also ensures that counties and cities remain within their legally-authorized limits for public spending. The legal mandate for the variety of responsibilities assumed by the Department may be found in Minnesota Statutes, Ch. 270-299.

Privately owned forest land in Minnesota is currently taxed under one of three alternative methods: the General Property Tax; the Tree Growth Tax; or the Auxiliary Forest Tax Law.^{33/} For the General Property Tax, a full and true market value is established for each forest property. An assessed value is determined based on the classification assigned the property. The classes in which forest land may be placed, and the percentage of market value applied to determine assessed value are (Skok 1983):

<u>Class</u>	<u>Percentage of Market Value</u>
3e Timberland	19
Seasonal Recreational-Residential	21
Agricultural-Nonhomestead	19
Vacant Land	40

The mill rate for the taxing units in which the property is located is applied to the resulting assessed value. 3e Timberland class can be assigned only to properties used exclusively for timber growing.

Within the Department of Revenue, the Local Government Aids and Analysis Division maintains forest land taxation and valuation information generated from annual abstracts of tax assessments of real and personal property from individual counties. Separate abstracts are collected from counties every six years for all real property of tax-exempt status (example: publicly-administered forest lands). Data from these abstracts is processed by the Division to yield the following kinds of forestry-related information:

- . Land classification for tax purposes
- . Assessed values for 3E tax law by county, city-township
- . Market values for 3E tax law by county, city-township
- . Market values of tax-exempt forest lands by county, city-township
- . Gross taxes by county, city-township, school district
- . Net taxes by county, city-township, school district

The Department also keeps records pertaining to use of the Tree Growth Tax law. In 1981-82, ten counties within the state utilized this form of assessment.

Pollution Control Agency

The Pollution Control Agency (PCA) administers and enforces all laws related to water and air pollution in Minnesota, and regulates the collection, transportation, and disposal of solid and hazardous wastes within the state. The Agency ensures state adherence to federal pollution control

^{33/} As noted previously, a variety of information regarding the latter two of these taxing mechanisms is maintained by the Division of Forestry, Minnesota Department of Natural Resources.

regulations in cooperation with the U.S. Environmental Protection Agency. Legislative authorization for the collection of information pertaining to the regulatory functions of the PCA is contained in Minnesota Statutes, Ch. 115, 116.

The Division of Water Quality collects an extensive amount of information pertaining to water quality of lakes and streams in Minnesota. Some of this information has implications for forest management, primarily as it relates to the impacts of silvicultural activities upon water resources on forested lands. Some of the more important kinds of information collected by the Division includes:

- . State water quality standards
- . Water quality sampling program: lakes and streams
 - biological monitoring parameters
 - toxicity monitoring parameters
- . Groundwater quality monitoring program
- . Lake classification system
- . Permits for effluent discharges: treatments, limits, deviations

Biological and toxicity data from monitoring programs are analyzed via the STORET information system, a computerized system used by state water quality agencies nationwide and by the U.S. Environmental Protection Agency (EPA). All bodies of water within the state are also classified by the Pollution Control Agency according to water quality standards defined by the EPA. Most waters in northern Minnesota fall within two standard classes: cold water fishing (standard 2A) and warm water fishing (standard 2B).

State law requires a disposal permit issued by the PCA for any effluents discharged into public waters. The Division of Water Quality maintains records of all such permits in terms of treatments applied, limits or deviations regarding disposal standards, and final disposal of wastes. The Division also conducts a Clean Lakes Program to identify lakes within the state that need restoration or other remedial management activities.

The federal government requires a number of reports, both permanent and periodic in nature, regarding the status of Minnesota waters. The Division of Water Quality has adopted a Water Quality Management Plan for the state in accordance with guidelines outlined in Section 208 of the Federal Water Pollution Control Act of 1972. With respect to the forestry sector within the state, this has involved the monitoring of non-point source pollution from forested areas in the state. As input to the PCA's Water Quality Management Plan, the Minnesota Department of Natural Resources has conducted extensive activities concerned with the identification of existing and potential sources of nonpoint pollution within the state. In 1981, the Department received a grant to develop a methodology to incorporate the silvicultural portion of the "208" law within the soil and water sections of the Minnesota Forest

Resource Plan. The primary role of the Pollution Control Agency with respect to these activities involves periodic monitoring to ensure adherence to all guidelines described in the legislation. In 1985, the Agency plans to evaluate the effectiveness of the Water Quality Management Plan with respect to forestry activities in the state. The PCA also submits periodic reports to the U.S. Congress describing state progress in implementing federally-mandated pollution control activities.

The Division of Air Quality monitors air pollution concentrations, ensures compliance with air emission limits, and inspects and issues permits for facilities with operating processes that affect air quality. The Division maintains comprehensive documentation relating to air quality standards within the state, and also collects information regarding specific emission levels from industrial facilities.

Special issues which arise relating to air or water quality within the state are reviewed by the Agency's Office of Planning and Review. The Office oversees contracts for any environmental impact statements which may be required in connection with these issues, and provides technical assistance to the State Environmental Quality Board to aid in their decisions regarding potential environmental consequences of such activities. The Office also maintains an extensive information base concerning the effects of acid rain on Minnesota waters. Water samples are collected and analyzed for a variety of chemical components associated with this phenomenon. In January 1983, the Office released a map outlining acid-rain sensitive areas in the State.

Environmental Quality Board--The Environmental Quality Board (EQB) was established to promote and ensure coordination among agencies on matters significantly affecting the natural environment in Minnesota (MN Stat. (1976) 116C.01). The board consists of the heads of six state agencies,^{34/} a representative of the Governor's office, and five citizens appointed by the Governor. The Board has the responsibility for promulgating rules which implement mandates set forth in the Environmental Policy Act of 1976 (MN Stat. CR 116.D). The Act established goals and guidelines for maintenance and, if necessary, restoration of the quality of the natural environment within the state. In carrying out its mission, the Board identifies environmental problems of concern to various departments within the Minnesota state government. The Board may initiate studies by inter-agency or citizen task forces, or it may hold hearings on environmental issues of concern to Minnesota citizens. In addition to initiating studies on environmental problems, the Board also reviews major legislative proposals and departmental

^{34/} State departments represented include: Agriculture; Energy, Planning, and Development; Health; Natural Resources; Transportation; and the State Pollution Control Agency.

programs to ensure that all relevant environmental safeguards have been considered in their development.

The Board maintains the following kinds of information related to the above activities:

- . Management plans for critical areas within the state
- . Environmental development permits
- . Existing and potential power line routes
- . Environmental impact statement guidelines
- . Environmental assessment worksheets

The Critical Areas Program is essentially a planning-oriented activity concerned with the coordination of land development activities on or around sensitive and/or threatened resource areas within the state. Some such areas include the Mississippi and St. Croix Rivers, and several of the larger lakes in Minnesota. Potential impacts on the forestry sector relate to mill sitings and other industrial-related activities which may impact the natural environment in these areas. Special environmental development permits may be required in certain instances, and the Board maintains records of all such permits as well as applications for future permit acquisitions.

The Power Plant Siting Section has the responsibility of ensuring that large electric power facilities are located in an orderly manner compatible with environmental conservation and the efficient use of resources. The Section has prepared an inventory of study areas pertaining to potential plant sitings and power line transmission routes. A number of these routes cross substantial portions of the forest resource within the state.

The Environmental Quality Board maintains an extensive documentation of guidelines for the preparation of environmental impact statements in connection with economic or other developmental activities on Minnesota lands. With respect to public forestry organizations in the state, the Board may mandate the preparation of environmental assessment worksheets for certain forest development projects. These are brief documents prepared by state governmental agencies in order to evaluate the necessity for an environmental impact statement for particular development projects. Three categories of worksheets pertain to forestry, and worksheets are generally prepared by the particular department or agency that is undertaking the specific development project (ex. Department of Natural Resources, County land department, etc.). The Board reviews all such worksheets for environmental implications of projects and determines whether further documentation in the form of environmental impact statements are required.

The Board also is responsible for the preparation of the annual Governor's Report on Environmental Quality which describes important issues, programs, and agencies that have an impact on the state's natural environment.

Iron Range Resources and Rehabilitation Board

The Iron Range Resources and Rehabilitation Board was established in 1943 (MN Statutes, Section 298.22) for the development of natural and human resources in counties of the Iron Range where mineral and other resources had been depleted. The Board provides vocational training to residents within these areas, and administers a variety of programs to promote resource utilization and economic development.

The primary information collected by the Board that is of relevance to forestry within the state pertains to reforestation and other activities associated with mineland reclamation. Between 1978 and 1981, approximately 700,000 seedlings were planted by the Board on the Mesabi and Cuyuna Ranges in northern Minnesota. The Board maintains the following kinds of information regarding these reclamation activities:

- . Acres reclaimed
- . Reforestation by species
- . Reforestation by state/county ownership
- . Reclamation legislation

Other reclamation projects undertaken by the Board include revegetation and erosion control projects and hydromulching of mine sites. The Board gathers information regarding rock, surface, and lean ore stockpiles, as well as pits and tailing basins in need of revegetation throughout the Iron Range. Funds for reclamation activities are derived from taxes on taconite industries. Reclamation projects are conducted primarily on state, county, and municipal lands.

In conjunction with the Minnesota Department of Natural Resources, the Board provides 50 percent of the funding for the support of nine foresters within county land departments in northern Minnesota. As part of the DNR County Assistance Program (CAP), these foresters provide technical advice and assistance for the administration of county forest management programs. The CAP program was formerly administered by the Board, but was transferred to the Department of Natural Resources in 1978.

The Board's Research and Beautification Division collects a variety of information concerning woody biomass and other aspects of vegetational production on peatlands. The Division also provides maintenance support for several extensive snowmobile trails on the Iron Range, and it produces and publishes land ownership maps for 20 counties in northern Minnesota.

The Board provides grants to municipalities and non-profit organizations for campground and other recreational development projects at the community level. It also administers emergency public works assistance programs designed to provide aid to local governments and school districts where unemployed workers have exhausted all other forms of unemployment assistance. Vocational training for handicapped residents in these communities is also provided.

In addition to the issuance of brochures and other publications designed to stimulate tourism within the region, the Board operates the Iron Range Interpretive Center at Chisholm, Minnesota. The Center is designed to acquaint visitors with the culture and history of the people and industry of northeastern Minnesota.

Soil and Water Conservation Board

The Minnesota Soil and Water Conservation Board is the administering agency for 92 soil and water conservation districts within Minnesota. The districts are legal subdivisions of state government, and each is governed by a local board comprised of five elected officials. Districts provide landowners with cost shares and other assistance for erosion control and soil stabilization practices. The Soil and Water Conservation Board provides state-level administration and coordination of district programs. Legal authorization for information collection activities of the Board is contained in MN Statutes, ch. 40. The Board is affiliated with the Minnesota Department of Natural Resources for administrative purposes.

The Board does conduct certain forestry-related activities, primarily through administration of its Private Forest Management Program. Through this program, cost shares are provided to nonindustrial forest landowners for the purposes of improving forest productivity, as well as encouraging erosion control and concurrent preservation or improvement of water quality. Information collected in connection with the program pertains to forestry improvement activities on private non-industrial lands. The following information, organized on a county basis, is maintained by the Board:

- . Management practice: TSI, artificial regeneration, improved harvesting
- . Practice costs
- . Technical assistance costs
- . Work years

The program is administered jointly by the Soil and Water Conservation Board and the Minnesota Department of Natural Resources; funding is provided by the Legislative Commission on Minnesota Resources. The program has been well received, primarily in the central and southern regions of the state where the majority of erosion control efforts are focused. More than 90 percent of funds appropriated for the 1980-81 biennium were utilized prior to the end of 1980.

The Board also conducts a variety of programs concerned with flood plain management; streambank, lakeshore, and roadside erosion control; issuance of water permits; rainfall monitoring; and wildlife habitat improvement on private lands. Erosion and water quality programs are conducted in close coordination with the USDA Soil Conservation Service. Information gathered by the Board through

administration of these programs is maintained in the form of:

- . Acres needing protection: by county
- . Acres needing treatment: by county
- . Soil erosion data by county:
 - cropland
 - pasture
 - urban
 - streams and lakeshore
 - roads
- . Water quality parameters by county
- . Costs for wetland preservation
- . Erosion control installation costs

As noted previously, (see USDA Soil Conservation Service) the Soil and Water Conservation Board is a participant in a cooperative agreement with five other federal and state agencies in which efforts to complete the Cooperative Soil Survey in Minnesota are being accelerated. The Board has also entered into an agreement with the Soil Conservation Service for the purpose of preparing a state program to address the soil, water, and related resource concerns of Minnesota. Information generated from the implementation of this program will comprise the state's input into the national Resources Conservation Act (RCA) plan of the USDA Soil Conservation Service.

Minnesota Environmental Education Board

The Minnesota Environmental Education Board initiates and administers programs related to environmental education throughout the state. Affiliated with the Minnesota Department of Natural Resources, the Board provides statewide coordination for the administration of such programs by the 13 regional environmental councils throughout Minnesota. Programs pertain to a wide variety of activities which impact the state's natural environment. The Board also assists in the coordination of federal and state environmental education activities within Minnesota, and provides advice to the state legislature concerning state needs for environmental education. Legal authorization for information collection and dissemination activities of the Board is contained in Minnesota Statutes, Ch. 558.

The educational aspects of forest management are the primary focus of the Board's forestry-related activities. The Board develops an annual program of educational events, many of which are in the form of workshops, tours, and recreational outings. Regional councils provide input for the development of the Board's annual program. Information collected by the Board pertains to individual events which comprise the annual program. Some of the more recent educational events sponsored by the Board which relate to forest management in Minnesota include:

- . Interpretation of forest ecosystems
- . Wood residue utilization: homes, schools, small businesses
- . Recreational uses of forest land

- . Current issues in forest resource management: acid rain
- . Aspen resource and its value to private nonindustrial forest landowners

The Board conducts an extensive program for the dissemination of environmental information via publications, slide shows, and radio and television programs. Two regional councils in northern Minnesota have also recently sponsored a series of educational programs for realtors, focusing upon the compatibility of forest resource management with various objectives for land ownership.

Southern Minnesota Rivers Basin Board

The Southern Minnesota Rivers Basin Board was established in 1971 (MN Statute Ch. 114A) to provide regional coordination and planning assistance for water conservation in the river basin area of southern Minnesota. On the basis of a comprehensive conservation plan published by the Board in 1980, the Board provides information and assistance to residents of the area concerning local, state and federal programs for water conservation. Some of the more important areas of emphasis which have been identified within this plan include flood control and water quality. An important problem recently addressed by the Board concerns the potential effects of landfills on water quality.

The Board has also been involved in promoting a pilot program to provide cost shares and technical assistance to nonindustrial private forest landowners in southern Minnesota. Funding for this program is provided by the Minnesota legislature; it is jointly administered by the Minnesota Department of Natural Resources and the Soil and Water Conservation Board.

Future goals that have been identified by the Board include the acquisition of more detailed information regarding costs, benefits, and kinds of incentives required for enhanced productivity on private lands within southern Minnesota river basins. The Board is also monitoring the progress of an erosion control ordinance recently adopted by Fillmore County, Minnesota, the first such ordinance of its kind in the state. Potential utility of such an approach for other Minnesota counties will be examined.

Water Resources Board

The water Resources Board is responsible for the establishment of watershed districts within Minnesota, and it coordinates the planning processes for all districts within the state (MN Statutes, ch. 112). Watershed districts are local units of government, i.e., political subdivisions of the state, with boundaries approximating those of natural watersheds. The Board oversees the operation of such districts and also conducts hearings when disputes arise concerning the formulation or interpretation of state water policy. Watershed districts cover approximately 22 percent of the state, and are located primarily in

agricultural and metropolitan areas. District management activities, therefore, are only of marginal importance with respect to forest management within the state.

Information gathered by the Water Resources Board relates primarily to issues of concern to individual districts. The Board provides assistance to districts in obtaining project permits from the Department of Natural Resources; many such projects are concerned with matters related to water quality. Although few districts are directly involved with forestry activities, forest waterways may be affected indirectly through land management activities within watershed districts bordering forested areas.

Regional Development Commissions

The Regional Development Act of 1969 authorized the organization of regional development commissions (RDC's) to facilitate intergovernmental coordination of state, federal and local comprehensive planning and development programs (MN Statutes Sect. 462.383). These commissions, while not parts of state government *per se*, represent organizations of general local governments through which elected officials work together to address problems that transcend individual jurisdictions.

The entire state of Minnesota now has fully operational regional development commissions (12 RDC's and the Metropolitan Council). Serving on these commissions are elected officials representing counties, cities, townships, school districts, soil and water conservation districts, and representatives of business community organizations. Two RDC's in the state have been particularly active with respect to forestry.

The Arrowhead Regional Development Commission consists of representatives of seven counties in the arrowhead region of northeast Minnesota. These counties contain almost one-half of all commercial forest land in the state. The Commission collects a variety of information concerning the potential for economic development in the region. It performs industrial and commercial analyses, helps define regional planning criteria, and identifies opportunities for future development. The Commission also makes recommendations to the state legislature concerning a number of areas of importance to the region, one of which is forestry.

Within the Commission, guidance for the development of the region's forest resources is provided by the Forestry Advisory Committee. Committee members include individuals from federal, state, and county forestry organizations; forest industries; and other nonpublic organizations concerned with enhancing economic development of the forestry sector within the region. The Committee provides guidance for regional forestry programs, identifies forestry-related problems and opportunities, and provides advice to the Commission for program direction and funding proposals. The majority of information collected by the Commission

with respect to regional forestry activities results from individual studies and special analyses. Recent projects have provided information regarding such topics as the economic potential of non-merchantable hardwoods, marketing areas for wood industries, and management activities undertaken by nonindustrial private forest landowners within the region.

The Southwest Minnesota Regional Development Commission is also quite active in matters relating to forest management. Most of the activities described above with respect to the Arrowhead Commission are also undertaken in this region as well.

University of Minnesota

College of Forestry

The College of Forestry is an educational and research institution established in 1903 to promote the effective management and conservation of Minnesota's forests. The College provides professional and graduate education in forestry with opportunities for specialization in forest science, forest resource management, forest products, and recreational resource management. It also conducts an extensive program of basic and applied research in all areas of forestry and forest resource management. Through its activities in continuing education and forestry extension, the College provides information and instruction in forest management and utilization to public agencies, forest industries, and private individuals throughout Minnesota.

Legal mandates for the educational, research, and extension activities of the College of Forestry are contained in Table 29.

The organizational structure of the College of Forestry is presented in Figure 30. The Department of Forest Resources provides a background in basic sciences, forest resources applications, and managerial sciences for students interested in forest management or with career objectives in teaching or forestry research. The Department of Forest Products encourages students to synthesize studies of the nature of wood and processing technology with courses in science/engineering or business/management to prepare for careers in production

management, product development, and marketing. For students interested in the planning and management of recreational resources, the Recreation Resource Management program is coordinated by faculty within the Department of Forest Resources.

The College of Forestry has an explicit mandate to conduct research on problems and opportunities related to forest resource management in Minnesota. It is also concerned with forestry research with both national and international dimensions, and provides educational opportunities to individuals from other countries and cultural backgrounds. In 1982, international students comprised approximately 13 percent of the graduate student enrollment within the College.

Some of the more important areas of research emphasis within the College include silviculture, tree genetics and improvement, quantitative analysis, forest ecological systems, timber management, forest economics and policy, forest hydrology, remote sensing and aerial photography, forest products marketing and utilization, wood structure analysis, and recreational land management.

Research activities at the College result in a broad array of information applicable to forest management in Minnesota. Table 30 summarizes current research efforts by information classes identified in the Information-Agency matrix (Figure 13).

The College has established field centers for programs in education and research. The Cloquet Forestry Center is a 3720-acre field unit operated for the purposes of educational instruction, research, and continuing education for professional foresters, loggers, and others working in forestry-related occupations. Workshops, short courses, and conferences are often held in cooperation with the Agricultural Extension Service.

The College conducts research under auspices of the University's Agricultural Experiment Station and in coordination with other public and private research agencies such as the Forest Service's North Central Forest Experiment Station and Forest Products Laboratory. Funding for research activities is obtained from federal, state, and private sources. Federal funds are received in the form

Table 29. Legal basis for the collection of forest management information by the College of Forestry, University of Minnesota.

Legislation	Activities Mandated
Minnesota Constitution, Article VIII	Broad mandate for the educational responsibilities of the University of Minnesota.
Minnesota Statutes 1982, Ch. 89.66, section 19, subd. 1	Authorization for the University of Minnesota to conduct, support, and cooperate in research activities deemed necessary to obtain scientific information about forest resources.
Minnesota Statutes 1982, Ch. 89.66, section 19, subd. 2	Authorization for the University of Minnesota to conduct, support, and cooperate in forestry extension activities and to cooperate with the commissioner of the Minnesota Department of Natural Resources in the development and implementation of the state's forest resources management policy and plan.

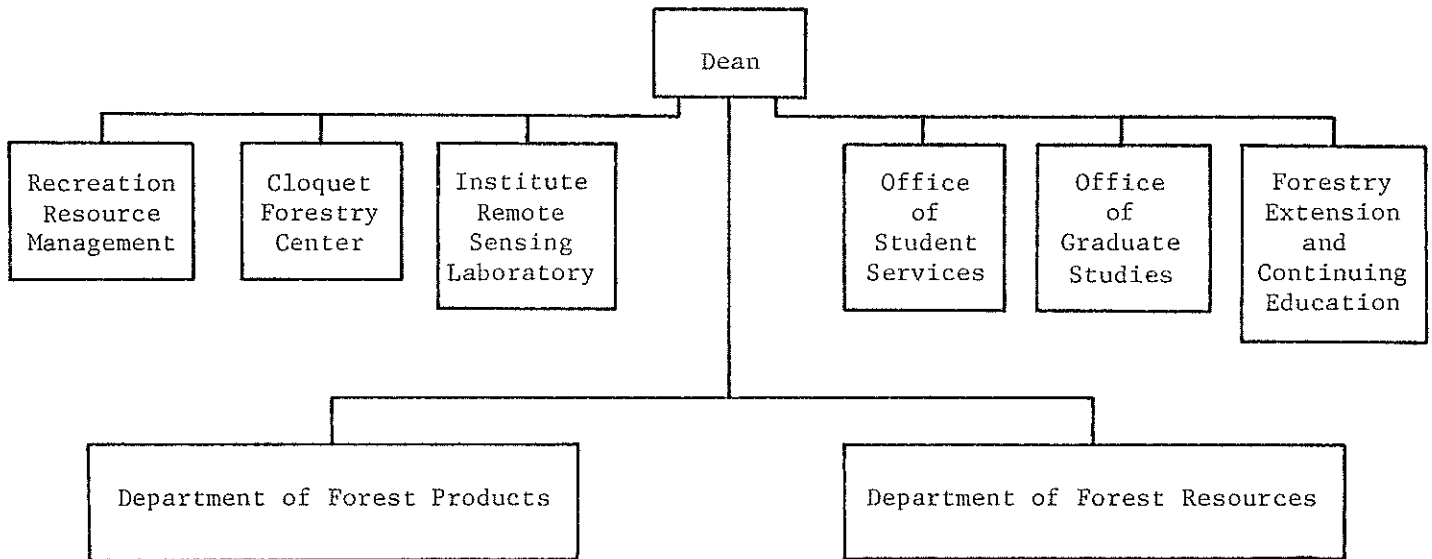


Figure 30. Organization of the College of Forestry, University of Minnesota, 1982.

of continuing appropriations and periodic grants. The former category includes funds allocated to states by the U.S. Department of Agriculture under authority established by the McIntire-Stennis Cooperative Forestry Research Act of 1962 (P.L. 87-788). Such funds are distributed to individual states for the purposes of forestry research according to a formula based upon forest land acreages and other factors. Grants and cooperative agreement funds are also received by the College from federal, state, and private organizations such as the U.S. Forest Service, the National Science Foundation, the Minnesota Department of Natural Resources, and the Blandin Foundation. These latter grants and agreements are generally for the purposes of conducting specific forestry-related studies.

The Remote Sensing Laboratory is another component of the College which provides instruction and research. Instruction is offered in air-photo interpretation, remote sensing techniques, digital image processing, and other specialized interpretation procedures. The Laboratory maintains a wide variety of information related to aerial photography including a data reference library, aerial images, Landsat and meteorological satellite tapes, and various resource maps. Remote sensing research at the College of Forestry was initiated in 1952.

Activities conducted by the Laboratory include photographic and densitometric analyses, image interpretations, and digital image processing. Current research projects of the Laboratory are represented within Table 30. The Laboratory furnishes technical assistance to the user community, often through contracts for services with a variety of federal, state, and private agencies to obtain mapping-format precision photography.

Through the University's Agricultural Extension Service, the College of Forestry disseminates results of ongoing research programs to forest resource managers, nonindustrial private forest landowners, and forest industries throughout Minnesota. College extension specialists in forest resources and forest products provide educational opportunities and information through workshops, conferences, tours, publications, and mass media communications. Five extension specialists are stationed at the College of Forestry in St. Paul; one is located at the Cloquet Forestry Center. In addition, two county agents, one area agent, and one technician in northern Minnesota have assignments primarily related to forestry or forest products. Areas of special emphasis in extension programs include forest management; timber harvesting operations; forest products processing, with particular emphasis on sawmill operations; marketing of forest products;

Table 30. Forest Management Research Projects, by Information Class, College of Forestry, University of Minnesota. October, 1982.

FOREST RESOURCE INFORMATION

Forest area change estimation
 Design of sampling unit clusters in forest resources surveys
 Functions of forest ecosystems
 Ecological foundations of forest production
 Multiple resources ecosystem modeling
 Long-range ecological change on Superior National Forest
 Productivity and succession in wet-mesic forests
 Relationship of black spruce growth to organic soils in northern Minnesota
 Nutrient requirements of selected forest tree species
 Root dynamics and their relationship to forest soils
 Forest productivity in relation to soil mapping units
 Hydrologic processes of forested watersheds
 Water resources of peatlands
 Revegetation of mined peatland
 Forest reclamation of peatlands
 Vegetation management on parks and wilderness areas
 Digital image processing and forest resource management
 Remote sensing data analysis for natural resource inventories
 Remote sensing applications for forest and range management

FOREST ADMINISTRATIVE INFORMATION

Control and use of fire in land management
 Minnesota county forest resources: policy and program options
 Information availability for forest and timber management planning
 Evaluation of the Forestry Incentives Program
 Use of economics in planning public forestry projects and investment budgets

TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL

Selection and breeding for blister rust resistance in white pine
 Selection, breeding and seed production for forest tree improvement
 Hybridization in Populus
 Physiological conditions of tree growth
 Moisture factors in aspen productivity
 Carbonhydrate reserves of Populus cuttings during dormancy and cold storage
 Growth regulators in Christmas tree development
 Cellular membranes and winter hardening in tree seedlings
 Tree and plot data aggregation for STEMS projection model
 Growth and yield data development for forest type, stand condition and treatment

TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL (continued)

Artificial reforestation and site preparation techniques
 Forest reproduction and growth following clearcutting
 Intensive silvicultural practices: field investigations
 Growth and yield of Populus coppice stands
 Harvesting and regeneration effects on nutrient release in aspen-birch litter
 Nutrient and sediment production from logging operations
 Logging and herbicide effects on forest ecosystems
 Windbreak, shelterbelt and small woodland studies
 Infrared aerial photography for detection of Dutch elm disease

TIMBER MANAGEMENT INFORMATION: ECONOMICS AND UTILIZATION

Analysis of regional timber supplies in Minnesota
 IMAGE model analysis of economic timber supply in Minnesota
 Integrated analysis of wood production, transport and handling
 Economic structure of the wood-based industry
 Productivity change in selected U.S. forest industries
 Problem analysis of world trade models
 Economic implications of managing nonpoint forestry sources of water pollutants
 Policy options for wood residue management and use
 Economic evaluation of potential improvements in timber utilization
 Hardwood utilization for structural panel products
 Improved wood products and manufacturing processes
 Time-dependent properties of composite-wood-base materials
 Energy conservation through improved lumber drying technology
 Highest value uses for total tree biomass
 Systems for drying and processing of fuel-wood chips
 High temperature drying for white birch studs
 Engineering and economic analysis of conversion of space and process heating equipment to wood residue fuels
 Interfacial chemistry in solvent extraction systems
 Capillary wave propagation and damping
 Weight-volume relationships in aspen
 Birch panels for fine woodworking

Table 30. (continued)

NONTIMBER FOREST RESOURCE INFORMATION: WILDLIFE AND RECREATION

Analysis of recreation opportunities: Minnesota State Outdoor Recreation System
 Choice of and satisfaction with river recreation experiences
 Wilderness campsite impacts caused by recreation use
 Communication and decision processes in recreational resource allocation

FOREST MANAGEMENT RESEARCH INFORMATION

Assessment of alternative approaches to forestry research evaluation
 Evaluation of decisions in short rotation forestry research
 Technology transfer for planning and organizing research programs
 Planning and budgeting in forestry research programs

establishment and maintenance of shelterbelts and windbreaks; use of wood for energy; and consumer selection and use of wood products.

Other University Departments

In addition to research activities at the College of Forestry, other departments within the University's Institute of Agriculture, Forestry, and Home Economics conduct research programs which yield information of utility for forest management. The primary departments involved in these research activities are the Department of Entomology, Fisheries, and Wildlife; the Department of Plant Pathology; and the Department of Agricultural and Applied Economics. A listing of forestry-related research projects for these departments is presented in Table 31.

The Department of Soil Science does conduct research concerning the nature and properties of soils on forested lands in the state. Current projects related to forest soils, which are generally coordinated with the College of Forestry, are included within Table 30. Certain projects of the Department of Entomology, Fisheries, and Wildlife involve the collection of information regarding the use of herbicides and pesticides in Minnesota. The majority of such projects pertain to usage of these agents on agricultural lands within the state.

Agricultural Experiment Station

The Agricultural Experiment Station coordinates and administers a major program of research in Minnesota related to agriculture, forestry, natural resources, and rural and community development. The Station is headquartered in St. Paul, Minnesota, with field stations at six locations throughout the state. As mandated by the Minnesota Statutes (1982 ch. 89, sect. 19), the Station is authorized to promote and administer research

Table 31. Forestry-related research projects of resource-related departments, University of Minnesota, October, 1982.

Department of Entomology, Fisheries, and Wildlife

Management of pest problems in spruce plantations
 Integrated pest management of the yellowheaded spruce sawfly
 Survey and quantification of insect damage
 Management of beneficial forest insects, with special references to pheromones
 Native elm bark beetle biology and control
 Resistant varieties of birch to bronze birch borer
 Impacts of birch leaf miner on birch vigor
 Relative habitat use in response to forest harvesting
 Effects of aspen clearcut size/age on song bird populations
 Impacts of silvicultural practices on quality of moose habitat
 Patterns of movement in white-tailed deer populations
 Foraging behavior in beaver populations
 Lead toxicity involving bald eagles and Canada geese
 Fall behavior and harvest of Canada geese

Department of Plant Pathology

Control strategies for Dutch elm disease
 Epidemiology and control strategies for oak wilt
 Strategies for preventing the spread of oak wilt to Europe on logs and lumber
 Dwarf mistletoe biology and control in black spruce, white spruce, jack pine
 Ecology of pine wilt nematode and related root invading fungi
 Aspen canker diseases and their control
 Combining trees and mycorrhizal fungi with emphasis on revegetation
 Systematics of fungi on stored raw wood products
 Role of fungi and their control in wood fiber products and wood structures
 Development of jack pine resistant to 5 stem rust fungi
 Selective degradation of wood by microorganism

Department of Agricultural and Applied Economics

Application of SIMLAB computer model for study of timber dependent communities
 Data base development and users manual for SIMLAB computer model
 Recreation industry-activity cluster assessments for recreation resource management
 Market characteristics within BWCA area of northeastern Minnesota
 Land valuation, transfer, and planning processes

activities in the areas of forest resource assessment, forest management, utilization of forest products, forest protection, and environmental management on forest lands. The College of Forestry conducts many of these research activities.

The Agricultural Experiment Station administers federal and state research funds to all organizational units within the University's Institute of Agriculture, Forestry, and Home Economics. The Station maintains information regarding the current nature, status, and funding levels of all projects for which Station funds are allocated. This includes all funds for forestry research provided by the Minnesota State Legislature as well as funds authorized to states under a variety of programs administered by the federal government. Projects funded through the Agricultural Experiment Station which have a bearing on forest management in the state have been included within Tables 30 and 31. The Station also issues a variety of reports, bulletins, and other publications of interest to Minnesota citizens regarding the nature and results of Station projects.

Agricultural Extension Service

Within the University of Minnesota, the Agricultural Extension Service is the primary organization for the dissemination of research-generated information pertaining to agriculture, natural resources, home economics and family living, 4-H youth activities, and community development. The Extension Service has offices in all Minnesota counties. More than 250 county extension agents and 40 area extension agents are stationed throughout the state, in addition to 160 extension specialists working within academic departments of the University of Minnesota. The typical county extension office has three agents, one each in agriculture, 4-H programs, and home economics/family living.

The Extension Service cooperates with the College of Forestry in disseminating information for forest management and conservation throughout the state (MN Statutes, Ch. 89, sect. 19). Forestry extension specialists organize numerous workshops, conferences, and tours throughout Minnesota, providing information to foresters, nonindustrial private landowners and forest industries. Areas of expertise have been described previously (see College of Forestry).

The Agricultural Extension Service also houses the Minnesota Analysis and Planning System (MAPS), a computer-based information system for the storage and retrieval of data from the U.S. Bureau of the Census. The system is designed for massive storage of socioeconomic data. An extensive data base contains the complete censuses of Population and Housing from 1960, 1970, and 1980 for the entire United States. Specialized economic, fiscal, and demographic files pertaining to the state of Minnesota are also maintained. Although not directly related to forestry within Minnesota, much of the data stored within the

system are measures of economic and social factors--e.g., employment, trade, and regional development--which do have implications for the forestry sector within the state. Table 32 summarizes data maintained within the MAPS system.

Table 32. Data files maintained or accessible by the Minnesota Analysis and Planning System.

National files:

Access to all data files generated by U.S. Bureau of the Census, including:

Census of Population (1980)

Census of Housing (1980)

Economic Census (1977)

Census of Manufacturers

Census of Retail Trade

Census of Wholesale Trade

Census of Service Industries

Census of Mineral Industries

Census of Construction Industries

Census of Transportation

Census of Agriculture (1978)

State files:

Population projections (to year 2010)

Farm income: 1926 to present

Housing data: 1960 to present

Annual demographic files

County business patterns: industries, employment

Migration data

State auditor reports

Human resource data base

Equal Employment Opportunity (EEO): occupational employment by county

The system provides a variety of analytical techniques for data analyses, among which are the creation of special files and specific aggregations of the data base. System terminals are located on the University's St. Paul Campus.

University FIRE Center

The University Fire Information, Research, and Education (FIRE) Center was established to use the University's extensive information resources to improve the level of fire protection throughout Minnesota. The Center works directly with fire departments, local and state officials, educators, industry, and the private sector.

The Center performs important functions with respect to the coordination of fire protection programs in forested areas of the state. The first of these involves the identification of areas within the state not protected by recognized municipal or township fire departments. Also identified in this process are those areas where forest management agencies provide the only source

of fire protection. This enables the systematic delineation of fire protection responsibilities for all areas in Minnesota.

The FIRE Center supplies information to the Division of Forestry of the Department of Natural Resources on the status and capabilities of rural fire departments to assist the Division in the allocation of small grants to these departments. The Center also acts as technical consultant on individual problems, and organizes conferences and workshops for fire departments, city officials, and business and industry.

The Center maintains an extensive reference library housing more than 2500 fire-related books, texts, reports, and studies; extensive files of fire-related materials; and indexed fire journals, magazines, and newsletters.

Center for Urban and Regional Affairs

The Center for Urban and Regional Affairs (CURA) promotes utilization of the resources of the University by community and governmental groups. The Center sponsors projects which address major problems facing urban and rural communities in Minnesota. Projects are generally short-term in nature, and are concerned with such topics as housing, employment, business and industry, social services, minority groups, local government organizations, and environmental management.

Several projects conducted by the Center are of relevance to forest management in the state. The Center has been extensively involved with studies focusing on the relationship of soil characteristics to land productivity. Much of the information generated in this work contributed to the development of the Minnesota Soils Atlas. With respect to forested lands in the state, the Center collects and analyzes data on the relationship of soil types, series, etc. to site index and related measures of forest productivity. One purpose of this work is to facilitate identification of key species indicative of forest site productivity. This is part of the broader goal of the project, which is concerned with identifying various areas within the state where intensified resource management efforts may be warranted.

The Center has also been involved with the Shade Tree Program^{35/} of the Minnesota Department of Agriculture. Utilizing information maintained by the Department on current losses to dutch elm disease within Minnesota, the Center has focused on socio-economic factors which contributed to variations in the rates of loss to the disease for different communities within the state. The Center has also investigated the effects of Dutch elm disease in municipalities upon adjacent forested areas surrounding these communities.

^{35/} Eliminated in 1982 due to funding cuts by the Minnesota Legislature.

Recent studies conducted by the Center have also been concerned with potential gains from and impacts of the development of Minnesota wetlands. One such project focused upon options for the use of peatlands in the state, and included a review of the potential economic, social, and environmental impacts of developing such lands as a source of energy. Additional information is gathered by the Center through other projects pertaining to wetland biomass productivity, ownership, and zoning status. Another area of research emphasis during the past year has been concerned with the conversion of farmland within the state to other land uses.

In conducting the variety of research activities with which it is involved, the Center works closely with the Land Management Information Center of the State Department of Energy, Planning, and Development. CURA has terminal hookups to the Minnesota Land Management Information System (MLMIS), which was originally developed at the Center for Urban and Regional Affairs and subsequently transferred to the State Planning Agency in 1977. The Center also has participated with the Minneapolis Public Library in the production of a current directory of environmental organizations and agencies operating in Minnesota. The directory is maintained by the Minneapolis Library as part of its Environmental Conservation Library (ECOL).

Results of research activities conducted by the Center are disseminated via reports on specific programs and projects, as well as through a quarterly newsletter describing current Center activities. A number of special publications are also issued in cooperation with other state agencies. One such document is the "Atlas of Minnesota Resources and Settlement" (Borchert and Gustafson, 1980), containing a wide variety of information on the state's natural resources, population, economic sectors and governmental institutions.

Minnesota Geological Survey

The Minnesota Geological Survey is affiliated with the School of Earth Sciences within the University's Institute of Technology. The Survey conducts research and collects extensive information regarding the geological characteristics of the state as well as the state's sub-surface water resources. Funding for Survey activities is provided through direct appropriations of the Minnesota Legislature, and also via specific grants and contracts through other state and federal agencies.

The Survey maintains an extensive amount of information concerning the sub-surface geology of Minnesota within a computerized data base of water-well drillers logs. In addition, a variety of geological maps are generated from ongoing research activities. One such project involves aeromagnetic mapping, a geophysical technique involving the measurement of minute differences in the earth's magnetic field that result from differences in

rock magnetism. Airborne surveys furnish data which is subsequently represented in a series of color maps, many of which pertain to forested areas in northern Minnesota. Much of the funding for this project, slated to continue at least through 1985, is provided by the Legislative Commission on Minnesota Resources.

Additional mapping projects of the Survey include a series consisting of all geographic sections in Minnesota containing outcrops of bedrock. Other projects are concerned with the geochemistry of groundwaters in the state and the Karst hydrogeology of southeastern Minnesota. The Minnesota Waste Management Board has also provided funding for the Survey to conduct an analysis of geologic and hydrologic conditions relating to hazardous waste disposal in the state. The Survey issues a variety of publications, maps, and atlases which are available to the public through its office at the University of Minnesota.

VI. AN ASSESSMENT OF INFORMATION ADEQUACY AND NEED FOR FOREST LAND MANAGEMENT ORGANIZATIONS IN MINNESOTA

Previous sections of this report have identified organizations and agencies within Minnesota that are responsible for gathering information of potential utility for forest management. However, the fact that data or information is collected by an organization does not necessarily guarantee that it can or will be utilized effectively for management decisions. Information must be accessible to the user, whether it is obtained from within an organization or from extra-organizational sources. Furthermore, each decision situation is unique, and no formal process of information collection and organization can anticipate all of the intricacies inherent in any particular management decision. Adequate information can greatly aid, but never replace, the manager who is ultimately responsible for a given decision.

A logical counterpart to the identification of existing information for forest management is an assessment of the adequacy of such information for situations in which it must be utilized. Information adequacy was addressed through a questionnaire distributed to all of the major forest land management organizations in Minnesota. The following pages discuss this assessment of information needs for forest management as identified by individuals at various levels of management within forestry organizations in the state.

Assessment Design

The primary focus of the questionnaire centered upon the adequacy of information for management decisions. The variety of forest management information to be evaluated was expressed in the form of the information categories represented within the Information-Agency Matrix previously

described (Figure 13). The complete questionnaire may be found in Appendix E.

The questionnaire consisted of three major parts designed to assess the following aspects of information for forest management as it currently exists in Minnesota:

- . Adequacy of information for management decisions (by information category)
- . Priorities for information needs (by information categories)
- . General information problems not definable in terms of information categories (ex. information flows, size of information resource, information systems, etc.).

Assessment of information adequacy involved a listing of the 43 categories of forest management information within the Information-Agency Matrix (Table 11, Section IV). Respondents were asked to evaluate each category in terms of the adequacy of that information (whether obtained from within their own organization or from external sources) for the kinds of management decisions they make. This format permitted the inclusion of individuals with management responsibilities in different functional areas and at various levels of management within forestry organizations in the state. All respondents, whether their missions were exercised at the field, central management control, or supervisory level of management, were requested to evaluate the same kinds of forest management information in terms of its adequacy for their particular management decisions.

A five-point response scale for information adequacy was employed to obtain ratings by information category for both all respondents and various subgroups to be described shortly. Comments were solicited for all information categories, particularly those for which adequacy ratings of "marginally adequate" or "inadequate" were indicated.

It should again be noted that the establishment of classes and categories of forest management information described previously (see Section IV) is obviously not all-inclusive. Each category could be further subdivided into a number of more detailed information and/or data elements. The ultimate selection of the particular classes and categories of information for use in the Information-Agency matrix and questionnaire represents the level of resolution deemed most suitable for the scope of this report and most practical for incorporation within a questionnaire of reasonable length. Thus such categories are by no means cast in stone; one purpose of the questionnaire was to aid in identifying any additional kinds of forest management information that managers considered to be important to the effective execution of their management responsibilities.

After completing the series of scaled-responses concerning information adequacy, respondents were then requested to select and prioritize the five

categories of forest management information for which better information would most benefit their management decision making. Priority rankings for information categories (by all respondents and by individual subgroups) were then obtained.

This assessment of information adequacy and need focused upon the major forest land management organizations in Minnesota. Organizations to whom the questionnaire was distributed included:

- . USDA Forest Service
 - Chippewa National Forest
 - Superior National Forest
- . USDI Bureau of Indian Affairs
- . USDI Bureau of Land Management
- . Minnesota Department of Natural Resources
 - Division of Forestry
- . County Land Departments (3)
- . Minnesota Forest Industries (3)

Although forest industries in Minnesota obviously do not fall within the public forestry sector, they are vitally concerned with the availability and quality of information for public forest management in the state. Their role in both contributing to state timber supplies through forest management and as the processors and distributors of the vast majority of wood harvested in the state make forest industries a vital link in the achievement of state forest resource goals. Hence their input to any assessment of information adequacy and needs for forest management is essential.

Due to the diverse and fragmented nature of the nonindustrial private forestry sector within the state, it was not possible to include this segment of the forestry community within the framework of this report. However, since such landowners do control 35 percent of the state's forest resource, an understanding of their perceptions of information availability and adequacy for forest management is an important element within any comprehensive information assessment. The diversity of landowner objectives for forest management, as well as the elaborate sampling procedures required for obtaining an accurate picture of landowner views on information adequacy and needs, necessitates a separate comprehensive investigation of these areas from an information perspective.

Earlier sections of this report emphasized that within a particular forest management organization information needs may vary according to: (1) level of management, (2) functional area,^{36/} and (3) type of decision required. This assessment incorporated levels of management and two

important functional areas as a basis for selection of questionnaire respondents. Due to the complexities involved, information requirements by decision type were not directly addressed. This would have required substantial additions to the existing questionnaire, resulting in an unwieldy and time-consuming instrument. As an initial effort at information assessment, however, results from this questionnaire will provide the foundation for future work aimed at identifying information needs for various types of forest management decisions at different levels of management.

Within each of the organizations previously described, the questionnaire was distributed to individuals at three levels of management:

- . Supervisory
- . Central Management Control
- . Field Operations

Respondents at the central management control level were selected according to their involvement in two major functional areas:

- . Timber Management
- . Land Management Planning

Obviously, other important functional areas exist within forest management organizations (ex. non-timber forest resource management, fire protection, engineering, etc.). Future work will address information requirements by functional area in more detail.

The variety of organizations from which respondents were selected also facilitated the analysis of questionnaire responses according to the following forestry sectors: federal, state, county, and industry. This analytical framework was desirable in light of the fact that the diversity in staffing capabilities and management responsibilities of these various organizations strongly influences their capabilities for generation and use of information for forest management.

The distributional criteria involving level of management and functional activity, along with the concurrent distinction of sectors of government and private industry, resulted in the analytical framework depicted in Table 33. Certain cells within this framework are not represented by respondents. This was due in part to non-responses; overall response rate for the questionnaire was 85 percent. In other instances, particularly with respect to the Bureau of Indian Affairs and forest industries, field operations perspectives were provided by members of central timber management staffs. In addition, only one of the three county land departments which participated in the study possessed a staff position in land management planning. The large representation of respondents at the level of field operations for the Division of Forestry reflects the Division's three-tiered field organizational structure. Three of these respondents were from Division districts, two from the area level, and one from a Division regional headquarters.

^{36/} Information needs by functional area were not discussed extensively, but will be an important element within future research efforts. Functional information requirements are addressed to some extent within the questionnaire.

Table 33. Structural framework and number of respondents for evaluation of adequacy of forest management information in Minnesota.

SECTOR	LEVEL OF MANAGEMENT		Supervisory	Central Management Control	Field
	FUNCTIONAL AREA		LMP ^{1/}	Timber Management	
	Minnesota Forest Land Management Organization				
F	Chippewa National Forest		1	1	1
E					
D	Superior National Forest		1	2	1
E					
R	Bureau of Indian Affairs		1	--	1
A					
L	Bureau of Land Management		1	1	--
STATE	DNR ^{2/} - Division of Forestry		1	2	3
COUNTY	County Land Departments (3)		4	1	4
INDUSTRY	Forest Industries (3)		4	2	3
Total Number of Respondents			13	9	13
					10

^{1/} Land Management Planning.

^{2/} Minnesota Department of Natural Resources.

It is apparent from the above description of respondents that the questionnaire was not intended for application to a random sample of individuals at each level of management. Respondents were purposely selected on the basis of their familiarity with information-related aspects of forest management. While at the supervisory level the entire "population" of organizational directors is represented, the other three levels of management are represented by select groups of individuals knowledgeable in the areas of concern for this report. Questionnaire results are, therefore, essentially heuristic in nature, i.e., they are suggestive of important aspects of information adequacy and needs for forest management in the state. Detailed statistical analyses were not warranted; results are presented in terms of mean responses (by groups) for information adequacy.

Information Adequacy and Need

In assessing the status of information for forest management in Minnesota, managers both evaluated the adequacy of existing information for management decisions and identified important information priorities. Table 34 contains their evaluations of all information categories within Table 11 (Section IV) by sector and level of management.

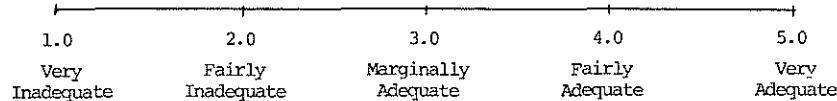
For each information item, the assessments of these groups are presented in three ways:

- Adequacy score: The average adequacy rating for the information item as evaluated according to the adequacy scale displayed beneath the table.
- Inadequacy Rank: The ranking of the information item according to its position among items from lowest to highest adequacy score (i.e., least adequate item -- with lowest adequacy score -- ranked number 1)
- Priority Rank:^{37/} Each information item designated as a high priority need was assigned 5 points when ranked as 1st priority, 4 points for 2nd priority, etc., and 1 point for 5th priority; information priority rankings within a given group were obtained by summing priority points for each item and ranking items from highest to lowest sums; a blank priority ranking indicates that no respondent designated the given information item as a high (top-five) priority need.

^{37/} In order to keep the questionnaire to a reasonable length, respondents were asked to prioritize only the top five information categories for which improved information would be of greatest aid in their management decisions. Priority ranks in Table 34 reflect a summation of the number of times each category was rated within the top-five priorities, as well as the actual positions in which they were ranked (see Table 35). Priority rankings are

Table 34. Information inadequacy and priority rankings by sector and levels of management for forest management organizations in Minnesota.

ITEM	SECTOR												LEVEL OF MANAGEMENT														
	ALL GROUPS			FEDERAL			STATE			COUNTY			INDUSTRY			SUPERVISOR			IMP			TIMBER			FIELD		
	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank	Inadequacy Rank	Adequacy Score	Priority Rank
Mineral Deposits: Kind/Location	1	2.88	12	7	3.25	11	4	2.64	14	4	2.67	5	2	2.89	1	2.69	2	25	3.56	3	2.67	2	2.70	13			
Forest Labor/Employment	2	2.89		2	2.88		9	3.00		1	2.25		13	3.38	11	3.22		1	2.86		4	2.73		3	2.80		
Forest Road Systems	3	2.93	5	22	3.91	21	1	2.23	2	4	2.67	21	3	3.00	3	4.00	11	3	2.88		5	2.93	4	5	2.89	4	
Imports/Exports: Wood Products	4	2.94	32	14	3.63		3	2.58	14	2	2.33		23	3.57	2	2.70		16	3.43	10	8	3.00		3	2.80		
Land Use: Projections	5	3.00	9	4	3.00	3	6	2.83	14	7	2.78	1	16	3.44	4	3.00	4	8	3.22		1	2.64	5	11	3.20		
Forest Soils/Geomorphic Regions	6	3.02	11	25	3.92	14	2	2.40	9	3	2.60	11	3	3.00	8	6	3.08	25	8	3.22	2	12	3.10	14	1	2.67	10
Land Use: Regional Development	7	3.12	20	9	3.31	2	6	2.93		8	2.89		16	3.44	5	3.15	5	28	3.67		1	2.64		9	3.10	16	
Wood Residue: Supply/Demand	8	3.19	13	5	3.08	9	32	3.67	28	6	2.70	11	10	3.22	10	3	2.83	5	17	3.44	5	2.92	11	20	3.70		
Mineral Ownership	9	3.22	23	15	3.64	5	11	3.09		12	3.11		3	3.00	10	7	3.15	14	33	3.75	10	8	3.00		9	3.10	
Forest Land Taxes	10	3.24	15	1	2.75		11	3.09	3	20	3.33		35	3.78	10	23	3.64	9	7	3.14		15	3.22		6	2.90	5
Timber-Pulpwood Supply/Demand	11	3.27	1	6	3.23	1	14	3.25	4	30	3.60	5	3	3.00	1	7	3.15	1	4	2.89	1	18	3.33	2	20	3.70	
Forest Land Acquisition/Disposal	12	3.28	18	18	3.80	21	8	2.91	7	16	3.30	15	9	3.13		16	3.50	17	1	2.86	17	20	3.40	18	11	3.20	8
Forest Soil and Water Conservation	13	3.30	26	10	3.33	11	13	3.17		32	3.70		3	3.00	19	20	3.54	9	11	3.25		5	2.92		15	3.50	
Fuelwood: Supply/Demand	14	3.36	14	8	3.27	5	32	3.67	24	16	3.30		8	3.11	8	12	3.25		8	3.22	5	16	3.27	8	20	3.70	
NIPF Landowner Assistance	14	3.36	32	3	2.89		27	3.50	14	20	3.33		27	3.67		29	3.73		26	3.57		13	3.11	18	7	3.00	16
Herbicide/Pesticide Usage	16	3.39	5	29	4.00	18	5	2.75	6	15	3.22	1	23	3.63	6	10	3.18	7	35	3.78		27	3.64	14	7	3.00	1
Timber Growth Projections	17	3.40	3	12	3.62	9	19	3.38	19	9	3.10	1	16	3.44	3	26	3.69	3	12	3.33	2	10	3.08	22	15	3.50	3
Timber Harvests: Past/Projected	18	3.42	4	25	3.92		31	3.62	9	9	3.10	4	1	2.78	2	15	3.46	13	17	3.44	8	10	3.08	1	26	3.80	13
Intermediate Silvicultural Activities	19	3.49	9	29	4.00	14	19	3.38	4	9	3.10	5	13	3.38	18	14	3.45	11	17	3.44		17	3.31	7	26	3.80	5
Independent Loggers	19	3.49	36	18	3.80		14	3.25	24	26	3.50		15	3.43		13	3.36		14	3.38		34	3.80		14	3.40	13
Forest Wildlife: Habitat/Goals	21	3.50	7	12	3.62	3	9	3.00	7	34	3.80	9	27	3.67	15	32	3.77	17	6	3.11	4	24	3.50	8	15	3.50	7
Forest Recreation: Facilities/Users	22	3.57	27	11	3.38	14	22	3.42	28	34	3.80		35	3.78	18	35	3.85	17	12	3.33	13	14	3.17	22	30	3.90	
Forest Waterways and Watersheds	22	3.57	37	22	3.91		17	3.27	28	29	3.56		21	3.56		16	3.50		17	3.44		30	3.67		20	3.70	16
Logging/Wood Processing Technology	24	3.58		16	3.75		27	3.50		13	3.20		38	3.89		31	3.75		28	3.67		21	3.42		15	3.50	
Land Use: Existing	24	3.58		17	3.77		22	3.42		24	3.44		27	3.67		22	3.62		17	3.44		19	3.36		30	3.90	
Forest Management Research	24	3.58	22	37	4.17	24	14	3.25	11	16	3.30	15	21	3.56		26	3.69	14	27	3.63		30	3.67	14	13	3.30	
Reforestation	27	3.66	2	25	3.92	5	26	3.46	1	30	3.60	11	27	3.67	7	25	3.67		17	3.44	13	25	3.54	2	35	4.00	1
Nursery Operations	28	3.67	23	22	3.91	13	24	3.45	24	24	3.44	21	37	3.88		29	3.73		33	3.75		27	3.64	14	19	3.56	10
Wood Processors: Primary/Secondary	29	3.69	30	20	3.82		40	4.00	19	22	3.40		16	3.44	18	16	3.50		35	3.78	17	33	3.73	18	26	3.80	
Forest Insect/Disease Information	30	3.71	23	25	3.92		18	3.33	11	37	3.89		33	3.57	10	23	3.64	17	35	3.78		23	3.45	12	35	4.00	
Statutory Land Class	30	3.71	34	36	4.13		30	3.60	19	26	3.50		26	3.63		16	3.50	23	28	3.67	20	37	3.89		25	3.78	
Forest Management Laws: Enabling	32	3.74	27	29	4.00		32	3.67	14	16	3.30	19	40	4.00		41	4.08	25	14	3.38	6	27	3.64		20	3.70	
Forest Management Regulations	32	3.74	27	40	4.18		19	3.38	19	26	3.50	15	40	4.00		40	4.00	23	24	3.50	13	26	3.58		26	3.80	
Forest Land Cover/Forest Types	34	3.77	16	29	4.00	18	42	4.08	28	13	3.20	9	27	3.67	15	32	3.77	17	28	3.67	10	30	3.67	12	35	4.00	16
Forest Products Prices	35	3.79	34	37	4.17		38	3.83		22	3.40	19	27	3.67		37	3.92		41	4.00		21	3.42	18	30	3.90	
Timber Harvesting Permits	36	3.81		35	4.08		36	3.69		34	3.80		23	3.57		21	3.58		39	3.88		36	3.83		35	4.00	
Timber Scaling Reports	37	3.86		42	4.33		29	3.58		32	3.70		40	4.00		28	3.70		38	3.86		40	4.00		30	3.90	
Forest Ownership/Jurisdiction	38	3.88	20	21	3.83	14	37	3.82	19	41	4.10	15	33	3.75		43	4.15	16	5	3.00	13	42	4.10		35	4.00	10
Stumpage Prices	39	3.93	30	41	4.23		40	4.00	24	38	4.00		11	3.33	15	37	3.92	17	40	3.89	17	38	3.92		35	4.00	
Timber Sales	39	3.93	18	37	4.17	18	39	3.92	28	38	4.00		20	3.50	5	37	3.92	25	41	4.00		38	3.92	5	30	3.90	
Land Cover: Aerial Photographs	39	3.93	8	29	4.00	5	24	3.45	11	43	4.40	11	38	3.89	19	32	3.77	7	28	3.67	6	43	4.30		35	4.00	8
Forest Inventory System Information	42	3.95	16	29	4.00	21	43	4.33		38	4.00	5	11	3.33	10	41	4.08	25	17	3.44	8	40	4.00	10	42	4.20	
Fire Protection and Control	43	4.02		42	4.33		32	3.67		42	4.13		40	4.00		36	3.91		41	4.00		35	3.82		43	4.40	
Overall Mean Response		3.50			3.74			3.36			3.37			3.50			3.53			3.48			3.42			3.56	



The following pages discuss information adequacy and priorities according to the classes of forest management information previously described (Table 11 in Section IV). Brief summaries of information adequacy and priorities by level of management and sector then follow.

From an overall perspective, individuals within Minnesota forest management organizations judged that most information ranged from being marginally adequate to fairly satisfactory for their management decisions.

Overall adequacy scores for all but five of the information categories fell within the 2.00 - 3.00 interval on the scale depicted in Table 34. All levels of management within forestry organizations displayed this evaluative pattern while among the four forestry sectors in the state, managers within federal organizations expressed slightly greater satisfaction with the general adequacy of forest management information than did those within other sectors. For specific information items, variations in evaluations of individual groups displayed wider fluctuations than they did for aggregate information ratings.

Managers also felt that there was much room for improvement in the quality of information currently available for forest management in the state. However, managers at all levels often differentiated between information judged to be inadequate for management decisions and that considered to be of highest priority for improved decision making. In some instances, certain kinds of information were rated as inadequate but were not designated as important priorities and vice versa. For example, among the ten kinds of information regarded by all respondents as least adequate for management purposes (Table 34, Column 1), only information on land use projections and forest road systems were rated among the ten most important priority needs from this aggregate standpoint. Conversely, although existing information on forest-sector employment and imports/exports for wood products were regarded as inadequate for decision making, these items were assigned low priorities relative to other types of management information. Appendix D contains a summary of important information characteristics, problems and opportunities cited by managers with respect to selected information categories.

Forest Resource Information

Managers regarded information pertaining to characteristics of the forest land resource in Minnesota as differing widely in utility for management decisions. While generally satisfied with

^{37/} of heuristic value in obtaining a better view of the most important information needs as identified by individuals within forest land management organizations.

the quality of inventory-generated information, they were far less content with the adequacy of specific kinds of resource information such as that related to forest minerals and soils.

Managers were least satisfied with information concerning forest mineral deposits.^{38/} There was general consensus that this information is very difficult to obtain, and that it is often inferred for many decisions. This was attributed in part to the confidential nature of some mineral-related information, as well as to the fact that not all areas in the state have been explored for their mineral resources. Among managers at various organizational levels, only forest planners considered this information to be more than marginally adequate for their uses. This may indicate, however that such information is not represented within current planning processes in any great detail.

Supervisors identified information on forest minerals as an extremely high priority need. Some noted that the availability of information showing areas of probable mining development for the next several decades would be of great aid for strategic decisions charting long-term organizational goals. Field managers, although indicating that their immediate demand for mineral information was generally not critical, felt that having such information would enhance management capabilities and be of practical utility as well; for example, as an aid in locating gravel deposits for use in road construction.

While those at the timber management staff level considered forest mineral information least adequate for decisions relative to all other types evaluated, none rated this as one of their five most important information needs. This situation, which occurs in several additional instances, may in general be indicative of two things. It is possible that such information is a relatively high priority need for some individuals (for example, sixth or seventh in importance), but not ranked as a top-five priority need. It also may be that, although this information is perceived as highly inadequate for decisions, timber staff personnel regard other kinds of information as more crucial for the majority of their management decisions.

All forestry sectors in the state expressed dissatisfaction with existing mineral information; state and county agencies were particularly emphatic in this regard. County personnel, moreover, expressed the strongest desire for improved information in this area.

Another type of forest resource information which managers perceived to be only marginally adequate for management decisions was that related

^{38/} Specific information categories from Table 11 (Section IV) are underlined within the following discussion.

to forest soils/geomorphics. They emphasized the agricultural orientation of existing soils classification systems, and many felt that such systems will have very limited value with respect to forest management until they are able to be effectively linked with characteristics of forest growth and productivity. Soil types were noted as being accurate to the 40-acre level at best, and often based upon only one sample plot within a given 40-acre parcel.

Forest soils information was rated as that least adequate for management decisions by managers at the field level. They expressed the desire for better information on a site-specific basis, i.e., expressed in terms of site-index and/or related measures of tree growth potential. This would be of great aid for decisions regarding management intensification strategies, plantation establishment, and other field-level activities. Planners identified forest soils information as an extremely important priority. This may reflect the fact that in designing plans for long-term forest management based upon inventory and other tree-related data, they have not been able to incorporate soils information of equivalent geographical specificity. Supervisors also recognized the limitations of this information, although they did not identify it as a high priority need.

Among forestry sectors, federal managers displayed much more satisfaction with forest soils information than did their counterparts within other sectors. All others rated it as marginal to inadequate, with state personnel particularly emphatic in this regard.

Although all respondents expressed the need for better soils information for forest management, they recognized that the costs of obtaining such information may be substantial and must be carefully weighed against the benefits received from its acquisition. Most favored incorporating the collection of soils data within forest inventory operations. There was also strong agreement on the need for intensified research in the areas of forest soils identification and forest soil-site relationships.

The related category of information^{39/} concerning forest soil and water conservation was considered by forest managers as not entirely satisfactory for management decisions. Many observed that soil-water interrelationships on forested lands are not very well defined. Managers generally expressed a desire for more documentation on the impacts of various forest management practices upon soil and water resources on forest lands. They noted that information in the form of values, valuation schemes, or joint production functions for timber, water and soils is essentially non-existent.

Timber management staff were least satisfied with the overall adequacy of this information; however, only supervisors indicated it to be a priority need. Among sectors, forest industries expressed the least satisfaction with the utility of information on soil and water conservation.

With certain exceptions, resource managers indicated that forest inventory information was relatively adequate for their management decisions. The same was true of related information concerning forest land cover/forest types. However, the desire for continued improvement in the quality of these kinds of information was reflected in moderately high priority rankings for each by certain sectors and levels of management. Forest planners were less enthusiastic regarding the adequacy of inventory information for their management tasks, while both planners and timber management staff accorded relatively high priority to improved information in these areas.

Forest industries displayed far less satisfaction with inventory information for their uses than did organizations within the public sector. This may reflect complexities inherent in the use of such information by industries that are not as pronounced within public forestry agencies. Whereas within the public sector, each agency collects and utilizes inventory information (and also obtains information from other agencies) for the purposes of determining agency allowable cuts, volumes to be offered for sale, etc., industries must synthesize inventory data from several public agencies into information to aid in determining when, where, and what volume of timber to acquire from public lands. Of particular concern to industrial managers were problems regarding the timeliness of inventory information. Some managers noted that time lags of four to seven years in inventory data may cloud the effects of changes in inventory levels; others expressed the desire for mini-updates at periods within the 10-year reinventory cycle. These problems may have accounted for the distinctly higher priority rating for inventory information displayed by forest industries in contrast to those indicated by the federal and state sectors.

Counties also assigned a high priority to the acquisition of forest inventory information, while judging existing information to be relatively adequate for management purposes. This likely reflects the fact that the state's Phase II (or, in certain cases, individual county) inventory operations have not been completed for all counties. Thus although information currently being generated may be of fair quality, a completed inventory is obviously an essential ingredient in any comprehensive program for county forest management.

With respect to the Phase II forest inventory system for state and county forest lands, individuals at all levels of management expressed satisfaction with the quality of data/information being generated. Most managers considered the Phase II inventory to be a major step forward for forestry

^{39/} This category is actually classified within the information class of Nontimber Forest Resource Information in the Information-Agency Matrix (Figure 13, Section IV),

in Minnesota, and that many of the current shortcomings of existing inventory data will be substantially reduced when Phase II is completed. Problems will remain, however, with respect to trend analyses and other long-term analytical methods which require substantial use of inventory data collected prior to the implementation of the Phase II inventory. While Phase II provides enhanced opportunities for the utilization of inventory information for intensive forest management, the periodic statewide forest survey (Phase I inventory) will continue to be a valuable source of information for representing long-term statewide trends for all ownerships as well as the state's contribution to forest management goals at the national level.

Forest resource managers considered the existing base of aerial photographs to be relatively adequate for management purposes. On an overall basis, however, they regarded the acquisition of improved aerial photos as a rather high management priority. Among levels of management, timber staff personnel were the only group in which no individuals rated this among their five most important information priorities. Managers at this level also considered aerial photographs to be the most adequate of all information categories evaluated. Several did comment, however, that acquisition of improved aerial photos was a management concern of some importance.

Dissatisfaction which did occur regarding current photos generally pertained to the quality of prints; some managers felt that photos obtained from the more recent statewide flights in 1977 were of inferior quality to those obtained from previous flights in 1968. Others noted that, while time intervals between flights have generally ranged from 8 to 11 years, the continued intensification of forest management activities throughout the state may result in these intervals being a bit too lengthy for effective use of aerial photos for certain management decisions.

Public agencies, particularly at the federal level, assigned high priority to aerial photographs as an aid to future management. While county forestry personnel judged aerial photos as the most adequate of all information categories, they nonetheless rated this as an important information priority.

Land Use Information

Managers within forestry organizations in Minnesota tended to place greater emphasis upon information regarding future, as opposed to current, land uses and their effects upon forest management in the state. While existing land use information was generally judged to be of moderate use for management decisions, information concerning future land use, both in the form of land use projections and that related to regional development, was generally perceived to be only marginally adequate in this regard. Managers cited a lack of information on the extent and location of rural

non-agricultural development as an important factor contributing to uncertainty regarding the future status of many forest lands within the state.

Land use information was of particular importance to timber management staff personnel. Both of the aforementioned categories pertaining to future land use were ranked least adequate for management decisions by this group. The lack of projection data capable of withstanding standard statistical analyses was identified as a key problem contributing to information inadequacy in these areas. The fact that only the category of land use projections was rated as a priority need by this group may reflect their perception of regional development information as a broader type of information not as critical to specific timber management decisions as are more limited projections pertaining to land uses for specific areas.

Supervisors within forest management organizations also considered future-oriented land use information to be only marginally adequate for decisions and a high priority need. Some emphasized the relevance of this information to strategic decisions concerning organizational direction and definition of management goals. Problems associated with projecting land use patterns were particularly bothersome to supervisors of county land departments. One noted that the conflicting demands of various constituencies within counties for different land uses make the reliance on projections for management decisions "a hazardous business at best."

Forest planners considered information on regional development more favorably than that of land use projections. However, no planner listed either of these future-oriented information items as a priority need. More immediate requirements with respect to development and implementation of the planning process may at present take precedence over these considerations. Field personnel, while indicating future land use information to be only marginally adequate for decisions, did not regard it as an important priority need.

Managers within the federal sector assigned extremely high importance to the acquisition of information related to regional development and future land use. Some individuals felt that it will be some time before projections of land use changes will be effectively related to alternative strategies for forest management. State and county forestry personnel were least satisfied with the adequacy of existing information in these areas, while forest industries placed less emphasis on the acquisition of this information than did other sectors within the state.

County forest management organizations identified land use projections as their most crucial information need. This may reflect their efforts to anticipate future demands upon county land resources within the framework of forest management programs which, for the most part, are still in developmental stages. As the quality of inventory information for county forest lands continues to

improve via Phase II and individual county inventory systems, the ability to anticipate future trends in county land uses will assume an increasingly significant role within county forest management.

Forest Ownership-Jurisdictional Information

Information concerning the ownership and jurisdiction of forest lands in Minnesota was considered by most resource managers to be relatively adequate for use in their management decisions. While they generally expressed favorable evaluations of information depicting the overall land ownership situation within the state, managers were much less satisfied with information pertaining to transactions involving changes in ownership status. The ownership of minerals on forested lands was also an information area of some concern.

In sharp contrast to managers at other organizational levels, forest planners rated information related to forest ownership/jurisdiction as only marginally adequate for their management tasks. This may reflect difficulties inherent in the ability of the planning process to accommodate scattered and/or interspersed forest ownership patterns which occur in many areas of the state. Long-term management plans within a particular forestry organization are most easily formulated for large contiguous areas owned or administered by that organization. Scattered ownerships cause substantial problems for planners who attempt to integrate potential future contributions of these spatially diverse parcels within the framework of overall organization goals for the production of forest-based goods and services. Additional ownership accounting procedures are also required. The combined effect of these factors may have contributed to the distinctly lower levels of satisfaction exhibited by forest planners with respect to ownership/jurisdictional information for forest lands.

The variety of statutory land classes for state and county forest lands is one example of the ownership accounting problem referred to above. However, while some managers indicated that such classes (example: state forest land, tax-forfeited land, 50-50 land, etc.) are a nuisance with respect to accounting procedures, this type of information was not considered to be a major hindrance to management decisions.

Another kind of ownership accounting information viewed less favorably than the above mentioned statutory land classes pertained to the acquisition and disposal of forest lands. On an overall basis, managers regarded such information as only marginally adequate for decision making purposes. Planners, moreover, considered this to be the least adequate of all information categories evaluated. This may reflect accounting aspects of the ownership-related information problems described above, notably the difficulties inherent in establishing long-range management plans for which basic ownership data (example: acreages)

is continuously or periodically changing due to acquisition, disposal, or exchange transactions. Despite rating both acquisition/disposal and ownership/jurisdictional information highly inadequate relative to other kinds of management information, planners accorded only moderate priority to information acquisition in these areas. This is perhaps indicative of their feeling that problems with such information are not so much ones of accuracy per se as they are of time lags in accounting procedures.

Field personnel also expressed dissatisfaction with information regarding forest land acquisition and disposal. This may reflect their proximity to on-the-ground management problems related to scattered land holdings which are both difficult and expensive to manage. Opinions regarding the merits of consolidated versus scattered land holdings were remarkably balanced among members within the forestry community in Minnesota. All recognized the enhanced management efficiency for large contiguous blocks of forest lands, and both planners and field managers tended to be more favorable towards this mode of ownership. Others commented on the benefits derived from maintaining scattered parcels of public lands throughout the state, particularly in areas where public ownership would not otherwise occur.

Among forestry sectors in the state, managers at the state level were least satisfied with information related to land acquisition and disposal, and considered this to be a relatively high priority need. Forest industries also expressed some dissatisfaction with the adequacy of this information.

Another specific area of ownership information considered to be of only limited utility for use in decisions pertained to forest mineral ownership. Managers generally felt that this information was available somewhere, but often difficult to acquire and not always comprehensive in nature. Many of the factors contributing to this assessment were related to problems with forest mineral information previously described. Among those at various levels of management, only forest planners were relatively satisfied with the adequacy of mineral ownership information for their management tasks. They did, however, indicate this to be a priority of some importance, in contrast to both timber management and field personnel.

Individuals within the federal forestry sector expressed less dissatisfaction with mineral ownership information than did those within other sectors, although federal managers also accorded highest priority to improved information in this area. Other sectors were relatively consistent in their evaluations of this information as less than satisfactory for management purposes.

Legal Information

The majority of resource managers considered information regarding enabling and regulatory legislation for forest management in Minnesota to be relatively adequate for use in management decisions. Among different levels of management, only forest planners rated information on enabling legislation as approaching marginal adequacy. Their assignment of a high priority need for such information may reflect difficulties caused by legal dimensions of the mixed ownership/jurisdictional patterns for forest lands previously described.

Managers within both the federal sector and forest industries were relatively satisfied with the adequacy of information regarding the legislative aspects of forest management. Those at the state and county levels did indicate that regulatory information was not entirely adequate for all areas in which management decisions are required.

Evaluations of information pertaining to the forest tax system in Minnesota were diverse both at different levels of management and within the various forestry sectors in the state. Overall, such information was considered to be only marginally adequate for management decisions. Field managers were least satisfied with tax information, and designated this as a high priority need. The majority of concern was voiced by field foresters at the state level, who expressed the desire for increased training in tax-related matters, as well as for better information on existing tax rates and rate changes. State personnel in general indicated a strong desire for better tax information with respect to forest lands. This in all likelihood results from the role of the Department of Natural Resources in coordinating the administration of certain state tax laws pertaining to forest lands in Minnesota. It may also reflect the higher degree of involvement with the private nonindustrial forestry sector characteristic of state forestry operations when compared to those of federal and county forestry agencies.

Planners in all sectors indicated that forest tax information was only marginally adequate for use in the planning process. Some noted that improved information would provide them with a better tool for evaluating the socio-economic impacts of the tax structure on current and potential levels of forest investment. A number of individuals at various levels of management felt that the existing tax structure does not encourage forestry investments by the private sector.

Analysis of perspectives on forest tax information by sector reveals some distinct contrasts among evaluations by different sectors of information adequacy and need. Forest industries rated tax information as relatively adequate for management decisions, while all public sectors were substantially less satisfied in this regard. As noted previously, state managers considered such information to be only marginally adequate and a

relatively high information priority. Individuals within federal forestry organizations rated forest tax information as that least adequate of all information types for management decisions. However, no individual in this sector identified such information as one of their five most important information needs. This may be due in part to the minimal involvement by federal forest land-administering agencies in Minnesota with assistance programs for the nonindustrial private sector.^{40/} The low adequacy ranking for tax information, however, may also indicate that federal managers feel that acquisition of better information in this area, while not so crucial a need when compared to other kinds of management information, could nonetheless greatly aid in decisions they make involving the private sector, including both forest industries and private forest landowners. It is also noteworthy that the industrial sector, while regarding tax information as fairly adequate for management purposes, did emphasize the need for continued improvement in the quality of such information as an aid to more effective forest management.

Forest Administrative Information

The three categories of information pertaining to various aspects of forest administration--fire protection, forest road systems, and the specialized area of nonindustrial private forestry assistance--received highly varied evaluations with respect to their adequacy and need for management decisions. Information regarding forest fire protection and control was judged to be the most adequate of all types of information evaluated by respondents. However, the overall adequacy rating of 4.02 is still only slightly above the level of "fairly adequate" according to the rating scale depicted in Table 34.

Elements of fire-related information for which the need for improved information was cited included the assessment of post-treatment results of prescribed burns and the overall effectiveness of prescribed burning as a management tool. The lack of information regarding fire-related damages to nontimber forest resources was also identified. With respect to the coordination of fire control programs, county forest managers generally expressed satisfaction with the increased degree of interaction between federal, state, and county organizations in program administration.

Forest road systems constitute an important aspect of forest management in Minnesota about which managers generally identified information resources as quite limited. This assessment was consistent across all levels of management. Improved information in this area was a high priority need for managers at the field and timber management staff levels.

^{40/} For the U.S. Forest Service, such activities are coordinated by the branch of State and Private Forestry. This branch does not, however, administer National Forest lands.

Dissatisfaction with information on forest road systems focused upon two general areas: lack of data on existing roads, and the coordination of management activities involving road networks serving lands managed by different forest management organizations. Lack of data was identified as a key problem by managers at the state level. This contributed to the extremely low adequacy rating for forest road information by state personnel, as well as their targeting of this information as a high priority need. As described in earlier sections, the recent completion of the State Forest Road Plan by the Division of Forestry of the Department of Natural Resources will do much to improve the quality of information regarding roads on state-administered forest lands. Managers within various organizations also observed that little cost-benefit information exists regarding the establishment and maintenance of forest road networks, and they cited the need for a comprehensive policy on forest roads in the state that includes engineering and equipment specifications as well as a clearly defined system of road standards. The clarification of jurisdictional aspects of forest road networks was also identified as an important information need.

A number of individuals in both county forestry organizations and forest industries voiced the opinion that forest road planning and management coordination among public agencies was inadequate for maximizing opportunities for forest management in the state. County personnel cited the need for organized effort by all agencies involved to establish a comprehensive information base for management of the forest road system in the state. It is noteworthy that, in contrast to other sectors within the state, managers within federal forestry organizations exhibited a much higher degree of satisfaction with the adequacy of forest road information for their management decisions than did managers in state, county, and industrial organizations.

Information pertaining to private, nonindustrial forestry assistance efforts within Minnesota was perceived to be only slightly above marginally adequate for decisions by forest resource managers in the state. On an overall basis, however, it was not identified as a high priority need. Field foresters were least satisfied with the utility of this information; this may in part reflect their close degree of interaction with landowners receiving management assistance. Field managers expressed a desire for improved information on landowner behavior and management goals for localized areas in the state, implying that regional or area emphasis in program design is a key factor in efforts to increase productivity from nonindustrial private lands. Timber management staff personnel cited the lack of data regarding productivity over time for nonindustrial lands as an important factor contributing to information inadequacy. They also were acutely aware that assistance in this area reaches such a small percentage of the total landowner population.

Among forestry sectors, only state managers considered information on private forestry assistance to be a need of moderate priority. This may reflect the greater degree of involvement with these programs at the state level than is characteristic of other forestry sectors. While managers within federal organizations rated such information as inadequate for decisions, none listed it as an important priority. As in other cases where this has occurred, it is possible that, while federal managers felt strongly that they could make more effective decisions with better information in this area, they regarded the opportunity costs for information acquisition too high relative to those for other kinds of information which could be used more frequently or in connection with a wider range of management decisions.

Timber Management Information: Biological and Silvicultural

Forest managers in Minnesota considered information pertaining to biological and silvicultural aspects of timber management to fall within the middle range of all categories evaluated for adequacy in decision making. On an overall basis, with the exception of information regarding timber harvesting permits, no category in this group was rated as one of the 10 kinds of information most or least adequate for management decisions. This was in sharp contrast to the extremely high priority rankings assigned to a number of these information items.

Managers considered timber growth projections to be moderately useful for management purposes; they also expressed a strong desire for better information in this area. Timber staff personnel and forest planners were least satisfied with existing projection information; somewhat surprisingly, the former group did not assign high priority to improved growth projections, in sharp contrast to managers at all other organizational levels.

There was strong consensus among forest managers regarding the crucial importance of information on the potential of managed stands for long-term timber production. Many managers noted that current yield information is based primarily on existing stands; but that effective planning and implementation of comprehensive forest management programs requires managed yield information capable of projecting the impacts of changes in management emphasis and/or policies over time. Managers also cited the need for more emphasis on the problem of projecting timber growth for mixed stands, which are quite prevalent throughout Minnesota. Some individuals found only certain projection systems or methods to be useful for management purposes. Field foresters also cited the lack of projection information for the white spruce/balsam fir forest type. State and county managers did feel that the improved quality of data being generated by the state's Phase II forest inventory will contribute to further improvements in projection capabilities for timber management.

County forest management organizations ranked timber growth projections (along with two other categories) as their most important information priority. Forest industries also expressed strong interest in obtaining better information in this area.

Evaluations by forest managers of information concerning timber harvests in Minnesota mirrored those expressed with regard to timber growth projections. Although managers were relatively satisfied with historical information in this area, concerns related to future harvesting information were much more pronounced. These dealt primarily with difficulties in use of such information, along with association projections and inventory data, for formulating potential management strategies within a harvest scheduling framework. With respect to past harvesting activities, some managers expressed the desire for a more rapid turnaround time between actual harvest dates and the issuance of reports containing harvesting information.

Harvesting information was of particular concern to timber management staff personnel within forestry organizations. They identified this as the area where improved information would most benefit their management tasks. Field managers, on the other hand, expressed far greater satisfaction with harvesting information for their uses than did those at other levels of management. This may reflect their position as the "terminus" of information flow for timber harvesting allocations, receiving harvesting goals (determined in part with their input) from higher management levels within the organization.

Among forestry sectors in the state, a sharp dichotomy emerged regarding adequacy and priority evaluations for information on timber harvests. Managers within county and industrial organizations were far less satisfied with such information than were those within federal and state agencies. Forest industries rated timber harvest information as that least adequate for management decisions, as well as a most important information priority. Counties also considered this information to only marginally adequate and a high priority need. This may again reflect the fact that counties are still in the relatively early stages of implementing comprehensive management programs, for which basic information on past and projected timber harvests is an essential ingredient.

The dissatisfaction with timber harvest information exhibited by forest industries relative to views within federal and state forestry sectors may to some extent reflect aspects of information use by industrial organizations that are not characteristic of public forestry agencies. Some industrial managers noted that it is generally not biological cutting levels that are the crux of the harvesting information problem, but rather the other factors that influence the actual portion of allowable cut that ultimately reaches the market. Problems related to access, personnel, or budget limitations for public agencies offering

timber for sale may not be adequately represented (or even anticipated) in information provided to industry pertaining to future timber harvests on public lands. While adjustments to changes in these factors by public agencies are undoubtedly burdensome, they may generate even greater repercussions for the industrial sector. These problems are compounded for forest industries by the fact that future harvest information must be obtained from several public agencies, each of which operates under varying budgetary priorities and constraints. From an industrial viewpoint, information of a composite nature providing budgeted harvests and sales from all public agencies would be highly desirable.

A sharp contrast was manifest between evaluations of the adequacy of reforestation information by forest managers in the state and their desire for improved information in this area. Although regarded as approaching fair adequacy for management purposes, this information was rated as the second most important priority on an overall basis. This assessment was strongly influenced by the views of timber management and field personnel. The latter group, while relatively satisfied with existing reforestation information, identified it as their highest priority for acquisition. This may indicate that while field managers consider available information to be sufficiently adequate for maintaining current operations, improved information in this area would greatly increase flexibility in decision making. A similar viewpoint was expressed by timber management personnel, although they did not consider existing reforestation information to be as adequate as did managers at the field level.

Managers emphasized the need for incorporating better information on reforestation within comprehensive projects or programs for forest development at both district and agency levels. Some timber staff personnel noted that often such information lacks detail and comparability over time. Planners also voiced time-related concerns, expressing the desire for better information to aid in tracking results of reforestation activities over time in order to monitor success, identify problems, and pinpoint the most common causes of failures. Field managers cited the need for improved information on survival and early growth rates in relation to different methods of site preparation; as well as for better information on the capabilities of equipment used in site preparation activities.

All forestry sectors in the state were relatively consistent in their evaluation of reforestation information as moderately adequate for management decisions, and as an important priority. State forest managers rated this as their most important information need. Some expressed the opinion that as development records for state forests are gradually computerized, albeit a slow process, the availability and potential utility of reforestation information will be greatly enhanced.

Assessments of information concerning intermediate silvicultural activities generally mirrored those of reforestation information, insofar as levels of management within forestry organizations were concerned. Timber staff and field personnel rated this as an important information need, while planners and supervisors were less emphatic in this regard. The latter group, however, did consider the acquisition of silvicultural information to be a need of some importance for management decisions, particularly with respect to understanding the potentials of various intensified management strategies on timber productivity. Specific areas of need cited by field managers included better information on growth responses from hardwood thinnings, and improved information on growth and survival rates following release cuttings. County forestry organizations expressed the least degree of satisfaction with the adequacy of silvicultural information, and both state and county agencies rated this as a high priority need.

Information pertaining to forest nursery operations within the state was viewed as moderately adequate for use by individuals in forest management organizations. Timber staff and field managers did assign a relatively high priority for improved information in this area. While some timber staff personnel at the state level observed that accounting information for state-run nurseries could be greatly improved, this did not seem to cause great difficulties for management decisions for most state managers. Some individuals within county organizations did express a desire to receive more information on state nurseries than that which they are presently able to obtain.

Forest managers in Minnesota considered information related to forest insects and disease to be moderately adequate for their management decisions. Field personnel and planners were most satisfied with current information availability, while timber staff did give some emphasis to information acquisition in this area.

Both the state sector and forest industries accorded relatively high priority to improved insect and disease information. State forestry personnel were least satisfied with current information, although this was not manifest at the field level within the DNR Division of Forestry, where several foresters expressed satisfaction with the increased emphasis on forest insect and disease problems now occurring within the Division. State managers at other organizational levels cited the need for better information on the relationships of historical insect and disease occurrences to the growth of existing stands. Others noted that damage and risk functions in this area are essentially nonexistent. Some industrial managers observed that, while inventory figures indicate large volume losses to insects and disease within the state, there is very little breakdown of such losses in a spatially meaningful way for use in management decisions. The relatively high priority accorded by forest industries to obtaining

improved insect and disease information may also reflect the fact that industries conduct the most intensive levels of forest management in the state, for which disruptions by insect or disease pests could have particularly severe consequences. At the county level, some managers noted that increased levels of cooperation with federal and state forestry organizations has greatly aided their efforts at insect and disease control.

Information concerning herbicides/pesticides and their uses in forest management was perceived to vary in adequacy and need for different decision makers within forestry organizations. Overall, managers regarded such information as only partially adequate for management decisions and as a high priority for enhancing management capabilities.

Herbicide and pesticide usage was of particular concern to managers at the field level, who designated this as their most important information need. They emphasized the need for better understanding of toxicity levels, prescribed uses, impacts on various species, and effective pesticide life and other time-related variables. Additional areas of concern included the need for more documentation on both post-treatment effects and the effects of herbicide applications on seedling growth.

At the other end of the management spectrum, supervisors also considered information on herbicides and pesticides to be of only marginal utility for their management decisions. Their rating of this a high priority need may reflect a concern regarding issues which periodically arise with respect to the use of chemicals for control of vegetation on forested lands. From a public relations standpoint, the dissatisfaction of certain groups with pesticide usage on forest lands requires accurate information pertaining to environmental effects as well as to benefits derived from effective vegetational control. Some supervisors indicated that information on these and other aspects of pesticide usage can be difficult to obtain. They also expressed the desire for more documentation of field tests for new products.

Among forestry sectors within the state, county organizations rated information on herbicides and pesticides as their top priority need. Some county foresters expressed the desire for more guidance from other agencies on the potential uses and effects of pesticides as a tool for forest management. State forest managers considered this information to be both inadequate for management decisions and an important information need. While forest industries were much less dissatisfied with herbicide and pesticide information, they did consider it to be an important need for effective management. In contrast to other sectors, managers in federal forestry organizations rated this information as fairly adequate for management purposes.

Timber Management Information: Economics and Utilization

Information pertaining to the economics of timber management and the utilization of the timber resource in Minnesota was considered by managers to vary significantly in adequacy and importance for management decisions. On an overall basis, managers were dissatisfied with information related to the supply and demand for timber and wood products, whereas price-related information in these areas was considered to be relatively adequate for management purposes. Information concerning wood processors, independent loggers, and wood processing technology was rated as intermediate in adequacy to the above-mentioned groups. Two areas for which managers considered information to be least adequate were those related to forest-sector employment and imports/exports for wood products in Minnesota; however, these items received little emphasis as priority needs.

The availability and adequacy of timber-pulp-wood supply/demand information was of major concern to those within forest management organizations in the state. Most managers judged such information to be only marginally adequate for decisions, and they identified acquisition of better supply and demand information in this area as the highest priority among all categories evaluated. With the exception of field personnel, all levels of management rated this as either first or second priority for acquisition. This viewpoint was also consistent across all forestry sectors within the state.

While both supply and demand information were judged as lacking in adequacy, particular emphasis was placed upon the scarcity of demand information for timber and wood products. Supervisory and staff personnel noted that forecasting techniques have not been able to provide them with the kinds of information they need on which to base decisions concerning future management strategies. Planners considered demand information to be particularly ill-suited for incorporation within the planning process. Some suggested that the best approach to remedying this problem would be to have demand estimates determined by a central research organization (such as the Forest Service's North Central Forest Experiment Station, or the University's College of Forestry), and then to have all forest management agencies utilize this common information base.

Only field managers were fairly satisfied with timber supply and demand information for their management purposes. This may reflect the fact that much aggregate supply and demand information impacts forestry organizations at higher levels of management, where it is then adapted for management purposes (via integration with agency allowable cut and harvest scheduling figures) before being filtered down to the field level. At this point it has been translated into more concrete information (such as cutting budgets, etc.) of more direct utility to field managers. In sharp

contrast to other levels of management, no individual at the field level listed any of the three types of timber supply and demand information as important information priorities.

All forestry sectors strongly emphasized the need for improved information on supply and demand for timber and pulpwood. Federal and industrial managers rated this as their most important information need, while forest industries were least satisfied with the adequacy of current information for management purposes. While counties expressed less dissatisfaction than did other sectors, evidence suggests this was due primarily to stronger confidence in the accuracy of current timber supply information as opposed to that for demand. Despite this more favorable rating, counties did accord high priority to improved information in this area.

Information concerning the supply and demand for fuelwood and wood residues was also judged to be lacking in many aspects. Both were listed as moderately important information needs. Managers again identified the limited availability of demand information as a key factor hindering management decisions.

Among managerial levels, supervisors and timber management staff personnel were least satisfied with information on wood residues. The high priority rating assigned by supervisors to such information may reflect their overall uncertainty concerning potential economic alternatives available to forest management organizations for residue utilization. They expressed the viewpoint that, while this resource may be plentiful, economic factors pertaining to markets, transportation, etc. must be more clearly defined in order for an organization to assess the feasibility of focusing intensified utilization efforts in these areas. With respect to fuelwood, while supply/demand information was considered to be only marginally adequate, no supervisor indicated this as a major information need. Forest planners were less satisfied with the adequacy of fuelwood information for their uses than that pertaining to wood residues. They rated better supply and demand information on fuelwood as an important priority.

State managers considered the quality of fuelwood and residue supply/demand information in a far more favorable light than did those within other sectors. This may reflect intra-organizational access to such information via the Division of Forestry's utilization and marketing program, within which a large amount of utilization-related information is maintained. A number of managers (within all sectors) also cited the North Central Forest Experiment Station as an important source of fuelwood and residue-related information.

Individuals within other sectors were much less satisfied with the adequacy of fuelwood and residue information for their decisions, and generally expressed both as high priority needs. Counties displayed the most dissatisfaction with information regarding wood residues. Some county managers voiced the opinion that residue

utilization will become a much more important component of county forestry programs in the future. At present, however, most are predominantly occupied with more basic program elements such as timber inventory and harvest scheduling.

Information related to timber sales in Minnesota was generally regarded as fairly adequate for management purposes. It is noteworthy, however, that timber management staff still rated improved information in this area as an important priority. This may reflect a situation in which current information is judged to be sufficient for satisfactory achievement of management objectives, but for which improved information might significantly enhance management efficiency. Computerization of the accounting-related elements of timber sales information, recently achieved by the National Forests as well as the DNR Division of Forestry, may help free managers from some of the more tedious accounting aspects of timber sales administration. Industrial managers were far less satisfied with the adequacy of timber sales information than were managers within the public sector. This likely reflects industry concern for accurate information on timber availability for incorporation within short- and long-term management strategies.

A similar situation occurred with respect to information on stumpage prices for timber within Minnesota. This was judged to be fairly adequate for management purposes at all levels and across all public sectors in the state. However, forest industries rated stumpage price information as only marginally adequate for their management needs. They expressed an interest in more detailed trend information in this area, such as rates of appreciation of various products over extended periods of time.

Information on forest products prices was also judged by most managers to be moderately adequate for use in decision making. However, several felt that this information is too broad for application in many decision situations. Major primary sources of forest products prices come from other areas such as Wisconsin, Tennessee, and the West Coast. Timber staff personnel were less satisfied with this information than were managers at other organizational levels. The problem of geographical relevance of price information was voiced most at the county level of government, where managers noted it is difficult to identify specific implications for county forest management from price information generally compiled and summarized over state or regional areas.

Two kinds of socio-economic information for forest management were characterized by low adequacy ratings for use in management decisions, but were not indicated as high priority needs. With respect to information regarding imports/exports for forest products in Minnesota, only forest planners rated this information as even approaching fair adequacy; however, they were also the only group to assign priority for information acquisition in this area. Some managers noted

that information on imports/exports generally lacks detail in terms of source, destination, species, and end uses. Others indicated that they^{41/} do not use such information to any great extent.

Among forestry sectors, county forestry organizations assigned the lowest adequacy rating to this information; however, several managers at the county level observed that it was rather far removed from their management concerns at the current stage of county forestry program development. State managers were the only group to identify this information as a priority of moderate importance.

Another type of information that was viewed similarly by forest managers pertained to forest labor/employment. Although they rated such information as inadequate for management purposes, none listed it as an important information priority. Forest planners considered employment information to be that least adequate for their management tasks relative to all types of information evaluated. They noted that information capable of representing the socio-economic impacts of forest sector employment upon local and regional economies would greatly aid in the planning process. Some timber management staff personnel observed that at the local level much of this information is too transient in nature to be reliable.

Among forestry sectors in the state, county organizations considered information on forest sector employment as that least adequate for use in management decisions. Some county managers expressed the desire for better information on the value of the timber industry to individual counties in the state in terms of number and size of firms, employees, etc.^{42/} Labor/employment information

^{41/} In certain cases regarding the evaluation of information within the questionnaire, there is evidence that low adequacy ratings for a given information item resulted more from lack of information use by the evaluator than from inadequacy of the information per se. This should be considered as a possible explanation for instances where a particular information category was rated highly inadequate for management decisions but not listed as an important priority need. While the phrasing of the assessment question within the questionnaire (Appendix E) was designed under the assumption that if information is never used in decision making it would not be rated as inadequate, in certain instances this may not have been the interpretation of particular respondents. However, as noted previously, other possible reasons may exist for relatively low adequacy ratings not accompanied by priority emphasis.

^{42/} Some of this information is available from the State Department of Economic Security and the Minnesota Analysis and Planning System (MAPS) of the University of Minnesota's Agricultural Extension Service.

was also judged to be only marginally adequate by other public sectors within the state, although forest industries were less dissatisfied in this regard. A number of managers within various sectors cited the need for improved information on labor availability and costs on a regional and local basis.

Information concerning the independent logging community in Minnesota was viewed as only moderately helpful for decision making. Field managers were the only group to assign some priority to information acquisition in this area. While many noted that they attempt to keep accurate lists of loggers within their geographical areas, few considered their information base to be sufficient for all their management needs. Supervisors and forest planners also considered information on the logging community to be not entirely satisfactory for use in their management decisions.

Managers within the state forestry sector were less satisfied than others with the utility of this information, although only at the federal level was it considered to be adequate for decisions. Industrial managers cited numerous difficulties inherent in generalizing about the logging community and logging operations in general. Available capital, productivity and machinery mixes all vary with particular logging situations. The relationships among market conditions, industrial procurement and harvesting activities, and public timber availability combine to make the "independent" logger in actuality dependent upon a number of complex variables over which he has little influence. The availability of improved socio-economic information concerning the nature and status of the logging community, while not a solution to the above puzzle, would permit the impacts of fluctuations in the aforementioned variables upon loggers within the state to be more clearly identified. Many managers within the forestry community felt that this information is evolving, but at a very slow rate.

Information concerning primary and secondary wood processors in the state was considered to be of some, but not extensive aid for decision making within forest management organizations. This viewpoint was relatively consistent across all levels of management. County and industrial managers considered this information to be less adequate for decisions than did their counterparts within the state and federal sectors. There was some feeling within forest industries that information regarding wood processors tends to become obsolete too quickly to allow reliance on this for management purposes. A number of individuals within various sectors cited the Division of Forestry's utilization and marketing program as an important source of this information; however, most noted the need for continued improvement in this area.

Managers regarded information pertaining to logging/wood processing technology as only moderately adequate for management purposes. No individual, however, listed this as an important

information priority. Timber management and field personnel were least satisfied with information on current technology, indicating difficulty at times in keeping up with improvements in logging and harvesting equipment which might aid in efficiency of field operations. Among forestry sectors within the state, forest industries were the most favorable toward technological information, likely reflecting their more intensive application of such information in harvesting and processing activities. Counties, however, did not feel they were effectively able to both identify and implement all improvements which might be of use to their management programs.

Non-Timber Forest Resource Information: Wildlife and Recreation

Forest managers in Minnesota judged information pertaining to forest wildlife resources within the state as only partially suitable to the uses for which it is required. In general, they identified this as an important area where improved information would benefit management decisions. While supervisors did note that wildlife goals at the organizational level are not always clearly defined and at times contradictory, other kinds of information were of higher priority for supervisory decision making. Forest planners were least satisfied with the adequacy of wildlife information for their uses. Lack of production functions and wildlife values were cited by all planners as a major problem complicating the accurate representation of the wildlife resource within the planning process for comprehensive forest management. Population data for species or species groups were also judged to be of questionable merit, particularly for input into planning programs for which quantitative values for timber resources are of much greater, though certainly not ideal, accuracy. For these reasons, forest planners designated improved information regarding forest wildlife as a major information priority.

Timber staff and field personnel also rated wildlife information as a relatively important need. The former group cited persistent difficulties associated with determining the relationships between wildlife populations and various mixes of forest vegetation. Many noted that decisions involving these relationships must often be based upon assumptions and practical judgement, with little concrete information to aid in selecting from various timber management alternatives, all of which would impact wildlife resources to some degree. As was the case with forest supervisors, field managers also emphasized the need for better statements of specific goals with respect to integrating wildlife within the overall context of field operations.

Another important information need identified by those at all management levels concerned the implications for wildlife management resulting from various allocations of forest lands to conifer and hardwood management. Managers focused

upon the need for better information regarding spatially-related responses of wildlife populations to the diversification of cover types (i.e., hardwood vs. softwood). While it was recognized that hardwood forests offer more opportunities for wildlife-related management activities, many managers expressed the desire for improved information concerning wildlife management potentials for conifer forests. Field managers were particularly interested in the relationship between conifer plantations and deer population levels.

In many instances, particularly with respect to nongame wildlife populations, managers noted that information was available on a species-by-species basis in the form of publications describing such variables as habitat requirements, nesting preferences, migration patterns, etc. While recognizing this information to be of great potential value in understanding the wildlife resource, some field foresters observed that this format often does not facilitate information utilization, primarily because they do not have the time required to extract and synthesize relevant information into a form immediately applicable to their management situations. Reflecting upon these difficulties, a number of managers expressed the need for summaries of wildlife management potentials, extracted from more in-depth studies of individual species, and associated with particular forest types and/or conditions in various areas of the state.

Managers within the federal forestry sector accorded extremely high priority to acquisition of improved wildlife information. With respect to U.S. Forest Service personnel, this may reflect their need to respond to explicit wildlife-related information requirements of the Forest Service's planning process. State forest managers also rated wildlife information as an important priority, and were least satisfied among all sectors with the adequacy of available information for management decisions. It should be noted, however, that within the State Department of Natural Resources, the Division of Fish and Wildlife has major responsibility for wildlife management on department-administered lands. Questionnaire respondents from within the Department, however, were exclusively from the Division of Forestry. Their designation of wildlife information as only marginally adequate for decisions does underscore the need for increased cooperation between these departmental divisions. As noted previously, efforts to improve the exchange of forest and wildlife management information between the Divisions have been increasing. County forestry organizations expressed relative satisfaction with the adequacy of wildlife information for their uses, although they did indicate that better information in this area would be of substantial benefit to their management programs.

Information concerning forest recreation in Minnesota was considered by those within forest management organizations to range between marginal

and fair utility for management decisions. On an overall basis, it was not identified as a major information priority. While both supervisors and field managers were fairly satisfied with this information, those at the central staff level considered it to be only marginally adequate for their uses. Forest planners expressed the greatest interest in acquiring improved recreational information.

A number of problems cited by managers with respect to information on forest recreation in the state mirror those previously described for forest wildlife information. The "quantification" of the recreational experience to facilitate multi-resource comparisons for both planning and management purposes remains a difficult task. Many managers felt that demands for recreational use and values for particular recreational experiences continue to elude representation in forms useful for decision making.

Managers did judge that information pertaining to recreational facilities on forested lands in the state is improving in overall quality. With respect to user intensities, they expressed mixed opinions on the ability of current information to represent actual numbers of users and types of uses. This was seen to vary with both type of recreational use and nature of facility used (i.e., pay vs. nonpay, etc.).

When considering information on forest land recreation from a statewide perspective, some managers at the supervisory level expressed the need for better representation of the spatial relationships between population densities and recreational opportunities on forested lands. They noted that improved information regarding aspects of forest recreation such as distances travelled, frequency and length of recreational experiences, etc. would better aid managers in addressing opportunities for recreational development on forest lands within the state. Such information would be of particular utility for strategic planning decisions involving, for example, whether to emphasize recreational development in more remote areas of the state with plentiful resources; or to emphasize development of recreational facilities closer to population centers, with the potential to satisfy a greater proportion of overall demand for recreational experiences. At present, many such decisions must be based upon intuition.

Managers within both federal and state forest management organizations expressed less satisfaction with the adequacy of information on forest recreation than did those within county organizations. With respect to the U.S. Forest Service, this may reflect the necessity to respond to specific information requirements for forest recreation within the planning system for the National Forests.

Forest Management Research Information

A broad range of research activities related to forest management is conducted by various organizations within the state. For purposes of this questionnaire, the information generated from these multi-disciplined research efforts was evaluated under the category of forest management research information. Individuals within forest management organizations in the state regarded research information as not entirely effective in addressing all of their management needs. On an overall basis it was not identified as a high priority need; however, the rather general nature of this category when compared to specific kinds of information represented by other categories may have contributed to lower priority ratings in some instances.

Field managers were noticeably less satisfied with the utility of forest management research information for use in decision making. While not listed as a priority need by any manager, a number of problems were cited with respect to the practical applicability of research results to on-the-ground management. Field foresters felt that research efforts are too often established and carried out without the proper degree of input from field personnel concerning the nature and characteristics of specific management problems they encounter. Others noted that results of research programs and projects are in many instances stated in rather technical fashion, requiring further "translation" by the field manager into a more basic form easier to apply to his particular management situation. They noted that in most instances there is little time for such exercises. Some field personnel expressed the need for more research emphasis on cost-effective techniques for forest management, noting that at times the results of research projects ignore the feasibility of their implementation under budget-constrained management circumstances.

This emphasis on "real-world" management situations was also voiced by individuals at the timber management staff level within forestry organizations. Some observed that research goals are often geared towards finding ideal solutions to various management problems, without recognizing that such solutions must still be applied under a variety of management constraints. Managers emphasized that they were not advocating that research efforts ignore finding the best solutions to management problems, but only that an additional component be included in such studies concerning implementation costs of both "ideal" solutions and others perhaps not as effective but less expensive to implement. A related aspect of "real world" research in forest management concerned the identification and definition of research problems. Managers considered the area of problem definition for research projects to be deficient in some instances, again primarily due to the lack of representation of all management constraints affecting implementation of research results. They also voiced the desire for the concurrent evaluation of biological and

economic aspects of research problems whenever feasible.

Among forestry sectors within the state, federal managers judged forest management research information to be relatively adequate for use in management decisions; forest industries were less enthusiastic in this regard, but no industrial manager rated this as a priority need. Individuals within state and county organizations were least satisfied with the adequacy of research information for their needs, and both sectors regarded this as a need of moderate importance. Some state managers expressed the desire for more emphasis on problems facing county and state agencies, as well as on those unique to the state of Minnesota as a whole. County personnel tended to focus more on the area of problem definition described above.

Information priority rankings were included within Table 34 for all respondents as well as for different levels of management and forestry sectors within the state. It is worthwhile to briefly examine how information priorities for these various subgroups combine to form an overall picture of those kinds of information deemed most important for improved decision making within forest management organizations. Tables 35 and 36 contain the fifteen information items that received the highest overall priority scores from all respondents on the basis of their frequency and positions within the top five information needs solicited from questionnaire respondents. The remaining information categories were not identified as priority needs frequently enough to merit representation within these tables. Priority rankings for levels of management (Table 35) and forestry sectors (Table 36) are also included to facilitate subsequent descriptions of the contributions of individual groups to overall priority rankings.

Timber management information accounted for approximately one-half of the fifteen major information priorities. The strong importance of improved information regarding the supply and demand of timber and pulpwood was reflected in a priority score of 61 for this category, substantially higher than all other types of information evaluated. This assessment was consistent across all forestry sectors within the state, although no field manager within any organization rated this as an important information need.

Several kinds of biological and silvicultural information were clustered near the top of this priority list. The importance of information concerning reforestation and intermediate silvicultural activities reflected the strong concern of timber management and field personnel; these items were also of particular importance to forest managers at the state level. Timber harvesting information was critical to forest industries, as well as to timber staff personnel within all organizations. Supervisors and field foresters contributed heavily to the high priority rating for herbicide and pesticide information.

Table 35. Information need priorities by level of management based upon solicitation of top five priorities from questionnaire respondents.

INFORMATION CATEGORY	ALL RESPONDENTS			SUPERVISORY		CENTRAL MANAGEMENT CONTROL				FIELD	
	Priority	Score	Inadequacy	Priority	Inadequacy	LAND MANAGEMENT PLANNING		TIMBER MANAGEMENT		Priority	Inadequacy
	Rank ^{a/}	Rank ^{b/}	Rank ^{c/}	Rank	Rank	Priority	Inadequacy	Priority	Inadequacy	Rank	Rank
Timber/Pulpwood: Supply/Demand	1	61	11	1	7	1	4	2	18	-	20
Reforestation	2	41	27	-	25	13	17	2	25	1	35
Timber Growth Projections	3	34	17	3	26	2	12	22	10	3	15
Timber Harvests: Past/Future	4	31	18	13	15	8	17	1	10	13	26
Herbicides and Pesticides	5	29	16	7	10	-	35	14	27	1	7
Forest Road Systems	5	29	3	11	4	-	3	4	5	4	5
Forest Wildlife: Habitat/Goals	7	27	21	17	32	4	6	8	24	7	15
Land Cover: Aerial Photos	8	26	39	7	32	6	28	-	43	8	35
Intermediate Silviculture	9	24	19	11	14	-	17	7	17	5	26
Land Use: Projections	9	24	5	4	4	-	8	5	1	-	11
Forest Soils/Geomorphics	11	20	6	25	6	2	8	14	12	10	1
Forest Mineral Deposits	12	19	1	2	1	-	25	-	3	13	2
Wood Residue: Supply/Demand	13	17	8	5	3	-	17	11	5	-	20
Fuelwood: Supply/Demand	14	16	14	-	12	5	8	8	16	-	20
Forest Land Taxes	15	15	10	9	23	-	7	-	15	5	6

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^{a/}Priority Rank: Derived from summation of scores for information items listed as "top 5 priorities" by questionnaire respondents; for each respondent, first priority information item received a score of 5, second priority - 4, etc., fifth priority - 1; priority rankings determined by summing scores for all information items listed within "top 5 priorities" and ranking by total scores.

^{b/}Priority Score: Total score of information item for all respondents based upon above scoring system.

^{c/}Inadequacy Rank: From Table 34.

Table 36. Information need priorities by sector based upon solicitation of top five priorities from questionnaire respondents.

INFORMATION CATEGORY	ALL RESPONDENTS		FEDERAL		STATE		COUNTY		INDUSTRY			
	Priority Rank ^a	Inadequacy Score ^b	Priority Rank	Inadequacy Rank	Priority Rank	Inadequacy Rank	Priority Rank	Inadequacy Rank	Priority Rank	Inadequacy Rank		
Timber/Pulpwood: Supply/Demand	1	61	11		1	6	4	14	5	30	1	3
Reforestation	2	41	27		5	25	1	26	11	30	7	27
Timber Growth Projections	3	34	17		9	12	19	19	1	9	3	16
Timber Harvests: Past/Future	4	31	18		-	25	9	31	4	9	2	1
Herbicides and Pesticides	5	29	16		18	29	6	5	1	15	6	23
Forest Road Systems	5	29	3		21	22	2	1	21	4	3	3
Forest Wildlife: Habitat/Goals	7	27	21		3	12	7	9	9	34	15	27
Land Cover: Aerial Photos	8	26	39		5	29	11	24	11	43	19	38
Intermediate Silviculture	9	24	19		14	29	4	19	5	9	18	13
Land Use: Projections	9	24	5		3	4	14	6	1	7	-	16
Forest Soils/Geomorphics	11	20	6		14	25	9	2	11	3	8	3
Forest Mineral Deposits	12	19	1		11	7	14	4	5	4	-	2
Wood Residue: Supply/Demand	13	17	8		9	5	28	32	11	6	10	10
Fuelwood: Supply/Demand	14	16	14		5	8	24	32	-	16	8	8
Forest Land Taxes	15	15	10		-	1	3	11	-	20	10	35

III

^a/Priority Rank: Derived from summation of scores for information items listed as "top 5 priorities" by questionnaire respondents; for each respondent, first priority information item received a score of 5, second priority - 4, etc., fifth priority - 1; column rankings determined by summing scores for all information items listed as "top 5 priorities" and ranking by total scores.

^b/Priority Score: Total score of information item for all respondents based upon above scoring system.

^c/Inadequacy Rank: From Table 34.

Managers within both the federal sector and forest industries expressed the strongest interest in obtaining better information on fuelwood and wood residues, although no field manager within any organization indicated these to be a high priority need. Forest road systems were of major concern to both state managers and forest industries, as well as to field and timber management staff personnel.

Certain specialized areas of forest land resource information were also identified by managers as important information needs. Supervisors expressed the strongest interest in improved information on forest mineral deposits. All public sectors considered this to be an area of some importance, with county forestry organizations most emphatic in this regard. Forest soils information was of great concern to planners and field managers, while aerial photographs were accorded high priorities by all levels of management, with the exception of timber staff personnel. Acquisition of improved photos was of particular interest to federal organizations.

Land use projections were important to both supervisors and timber management staff. Among sectors, county and federal managers contributed most significantly to the high priority rating for this item. Forest planners expressed the greatest interest in information concerning forest wildlife resources, although this was also important to timber management and field personnel, particularly within federal and state agencies.

It is noteworthy that, with the exception of information on forest road systems, none of the six most important information priorities for managers within forestry organizations were rated as highly inadequate for management decisions. As alluded to previously, this reflects an important distinction between these two modes of information evaluation. While managers may judge certain kinds of information to be unsatisfactory for use in decision making, it may happen that such information may not be used for a great number of decisions, or if it is, such decisions may not be as important as many others which the manager must make. Hence the given information, though judged inadequate from a decision standpoint, may not be identified as a high priority need.

In other instances, while existing information may be regarded as adequate for decisions, the manager may judge that improved information could significantly enhance his ability for effective decision making. It also may be that the particular decision is so important that any improvement in information quality will lead to highly positive repercussions for management. In these situations, information considered to be relatively adequate might still be accorded high priority for acquisition. Both of these cases illustrate the importance of linking information, through its variety of characteristics, with decisions for which it will be utilized. Doing so may greatly

aid in the efficient allocation of organizational resources for information acquisition.

Management Perspectives

Having considered the importance of information to forest managers from the standpoint of specific information classes and categories, it is worthwhile to briefly summarize the perspectives of individuals at various levels of management as well as the implications of these assessments for the four forestry sectors in the state. The particular mission and resources of each organization exert a major influence upon the nature of information acquisition and use within that organization. Hence the following profiles, particularly those describing different levels of management and associated information needs, should be recognized as composites of various organizations, each with its own constituency and management objectives. Nonetheless, it is not unreasonable to expect that within these organizations, information adequacy and needs at equivalent levels of management may have certain common characteristics. Hence an analysis of information from these various perspectives may be beneficial.

Table 37 contains the 10 information categories ranked least adequate and of highest priority for management decisions by each of the four levels of management within forestry organizations in the state.

At the supervisory level, information priorities reflect a future-oriented perspective characteristic of the frequent necessity for strategic management decisions. Supervisors expressed great interest in information on forest minerals, which they felt would exert an increasingly stronger influence on forest management opportunities within the next several decades. Land use information, both in the form of projected uses and from the standpoint of regional development, was also of major importance to managers at the supervisory level. Three kinds of timber management information rated among most important needs--supply and demand estimates for both timber/pulpwood and wood residues, and timber growth projections--all have significant implications for long-term strategies for forest management. With respect to wood residues, supervisors displayed the highest expectation among all levels of management regarding the potential benefits of this resource to forest management organizations. All of these perceptions suggest the strong importance of future-oriented forest management information to aid in strategic decision making.

Among other kinds of information deemed essential for their management decisions, supervisors regarded that pertaining to herbicides and pesticides as particularly important. They cited the lack of information in this area, as well as the need for obtaining better information concerning a topic of high significance to the general public.

Table 37. Top 10 inadequacy and priority rankings for forest management information by level of management.

ALL RESPONDENTS	
<u>Inadequacy</u>	<u>Priority</u>
1. Mineral Deposits: Kind/Location	1. Timber-Pulpwood Supply/Demand
2. Forest Labor/Employment	2. Reforestation
3. Forest Road Systems	3. Timber Growth Projections
4. Imports/Exports: Wood Products	4. Timber Harvests: Past/Projected
5. Land Use: Projections	5. Forest Road Systems
6. Soils/Geomorphic Regions	5. Herbicide/Pesticide Usage
7. Land Use: Regional Development	7. Forest Wildlife: Habitat/Goals
8. Wood Residue: Supply/Demand	8. Land Cover: Aerial Photographs
9. Mineral Ownership	9. Land Use: Projections
10. Forest Land Taxes	9. Intermediate Silvicultural Activities
SUPERVISOR	
<u>Inadequacy</u>	<u>Priority</u>
1. Mineral Deposits: Kind/Location	1. Timber-Pulpwood Supply/Demand
2. Imports/Exports: Wood Products	2. Mineral Deposits: Kind/Location
3. Wood Residue: Supply/Demand	3. Timber Growth Projections
4. Forest Road Systems	4. Land Use: Projections
4. Land Use: Projections	5. Land Use: Regional Development
6. Forest Soils/Geomorphic Regions	5. Wood Residue: Supply/Demand
7. Land Use: Regional Development	7. Herbicide/Pesticide Usage
7. Mineral Ownership	7. Land Cover: Aerial Photographs
7. Timber-Pulpwood Supply/Demand	9. Forest Land Taxes
10. Herbicide/Pesticide Usage	9. Forest Soil and Water Conservation
LAND MANAGEMENT PLANNING	
<u>Inadequacy</u>	<u>Priority</u>
1. Forest Labor/Employment	1. Timber-Pulpwood Supply/Demand
1. Forest Land Acquisition/Disposal	2. Forest Soils/Geomorphic Regions
3. Forest Road Systems	2. Timber Growth Projections
4. Timber-Pulpwood Supply/Demand	4. Forest Wildlife: Habitat/Goals
5. Forest Ownership/Jurisdiction	5. Fuelwood: Supply/Demand
6. Forest Wildlife: Habitat/Goals	6. Forest Management Laws: Enabling
7. Forest Land Taxes	6. Land Cover: Aerial Photographs
8. Land Use: Projections	8. Timber Harvests: Past/Projected
8. Forest Soils/Geomorphic Regions	8. Forest Inventory System Information
8. Fuelwood: Supply/Demand	10. Imports/Exports: Wood Products
	10. Mineral Ownership
	10. Forest Land Cover/Forest Types
TIMBER MANAGEMENT	
<u>Inadequacy</u>	<u>Priority</u>
1. Land Use: Projections	1. Timber Harvests: Past/Projected
1. Land Use: Regional Development	2. Timber-Pulpwood Supply/Demand
3. Mineral Deposits: Kind/Location	2. Reforestation
4. Forest Labor/Employment	4. Forest Road Systems
5. Forest Road Systems	5. Land Use: Projections
5. Wood Residue: Supply/Demand	5. Timber Sales
5. Forest Soil and Water Conservation	7. Intermediate Silvicultural Activities
8. Imports/Exports: Wood Products	8. Fuelwood: Supply/Demand
8. Mineral Ownership	8. Forest Wildlife: Habitat/Goals
10. Timber Growth Projections	10. Forest Inventory System Information
FIELD	
<u>Inadequacy</u>	<u>Priority</u>
1. Forest Soils/Geomorphic Regions	1. Herbicide/Pesticide Usage
2. Mineral Deposits: Kind/Location	1. Reforestation
3. Forest Labor/Employment	3. Timber Growth Projections
3. Imports/Exports: Wood Products	4. Forest Road Systems
5. Forest Road Systems	5. Forest Land Taxes
6. Forest Land Taxes	5. Intermediate Silvicultural Activities
7. NIPF Landowner Assistance	7. Forest Wildlife: Habitat/Goals
7. Herbicide/Pesticide Usage	8. Forest Land Acquisition/Disposal
9. Land Use: Regional Development	8. Land Cover: Aerial Photographs
9. Mineral Ownership	10. Forest Soils/Geomorphic Regions
	10. Nursery Operations
	10. Forest Ownership/Jurisdiction

Supervisors also indicated certain additional areas for which improved information would enhance decision making, including aerial photographs, forest tax information, and that pertaining to soil and water conservation on forest lands. This latter concern, not listed as a priority by other levels of management, may reflect the perceived relevance of this information to broad organizational management objectives.

Forest planners require information that may be organized to aid in formulating future management options for the production of forest-based goods and services. With respect to the timber resource, estimates of supply and demand for timber products are essential elements for the planning process. Planners targeted both timber/pulpwood and fuelwood supply and demand information as critical needs for planning; the absence of wood residue information as a high priority need may result from the fact that it is usually not explicitly represented within existing planning processes. In connection with future timber supply, planners identified improved timber growth projections as a key information need. They were also quite concerned with information related to forest soils and wildlife resources. These represent two areas that are very difficult to effectively incorporate within the planning process.

Planners felt that information related to ownership and jurisdictional aspects of forest management, including the acquisition and disposal of forest lands was often not adequate for planning purposes. Their targeting of information on enabling legislation as an important priority may indicate its potential utility for resolving some of these institutional-related problems. It also implies that planners would greatly appreciate a more clear and concise summary of the legal dimensions of public forest management within which they conduct planning activities.

Planners also considered certain kinds of resource information, though not necessarily unsatisfactory at present, to be important for improved forest planning. These included forest land cover and inventory information, aerial photographs, and information on timber harvests. Tax and employment related information, though considered as inadequate, were not emphasized as crucial needs.

Planners assigned only slight emphasis to mineral-related information, perhaps for reasons noted above regarding its lack of incorporation within the planning framework. While indicating some dissatisfaction with land use projections currently available, forest planners did not rate them as a high priority need. This also occurred with respect to information concerning forest road systems.

Timber management staff personnel require information for decisions involving the coordination of short- and long-term management programs for timber production. Reflecting this concern,

they identified a core of information needs related to various aspects of timber management as important priorities for management decisions. Timber harvesting operations were a major focus for improved information, as were the areas of supply and demand for timber and fuelwood; reforestation; and silvicultural treatments. Timber sales information was a much higher priority for timber staff than for other levels of management. Along with field personnel, they indicated a more pressing need for improved information regarding forest road systems than did managers at the supervisory or planning levels.

Several kinds of information considered to be inadequate for decisions by managers at this level were not accorded so high a priority as the above timber-related items. Land use information represented one area where existing information was viewed to be quite unsatisfactory. Timber staff personnel viewed improved land use projections as having great potential for more effective management decisions. They also expressed dissatisfaction with mineral-related information for forest lands, but did not indicate it as a need of high priority. Although they judged timber growth projections to be rather inadequate for their uses, this was not among the six kinds of timber management information judged to be of highest potential for improved decision making.

At the field level within forest management organizations, managers were concerned with obtaining better information regarding the biological and silvicultural aspects of timber management, forest resource characteristics, and matters related to forest ownership and administration. Land use information and that concerned with the economics and utilization of forest resources were not identified as major information needs, although several kinds of this information were judged to be less than satisfactory for management purposes.

Field managers targeted silvicultural aspects of timber management and timber growth projections as several of the most important areas of information need. Improved information on herbicides and pesticides for forest management was a major priority; this was the only timber-related information category listed among those least adequate for management decisions. Problems with the use of existing ownership records, as well as those pertaining to land acquisition and disposal, were also reflected in the desire for improved information in these areas.

As with timber management staff, field managers regarded forest road systems as a key problem area in terms of management information. They also felt that better tax information with respect to private forest ownerships would enhance their ability to assist these landowners in forestry-related matters. Specific resource-related information needs were also identified in the form of aerial photographs and forest soils data, as well as that pertaining to wildlife resources on forested lands. Managers regarded existing

information on forest soils as particularly inadequate for their uses. Though perceiving available information on forest minerals to be unsatisfactory from a management perspective, they did not consider it to be a critical need for use in management decisions.

Sector Implications

As noted previously, the generation, transfer, and use of information within forest management organizations in the state is dictated largely by particular organizational missions; whether related to enhancing corporate interests, as is the case with private industry, or to serving particular public constituencies, as is characteristic of federal, state, and county forestry agencies. These institutional arrangements strongly influence the structure of organizations, as well as their capabilities for collecting and processing information for use in the achievement of organizational goals. In the case of public agencies, budget allocations and legally-mandated activities affect staffing capabilities and potential areas of management emphasis. Among other influences, forest industries are subject to the fluctuations in markets for forest products, to which they must respond in a quick and efficient fashion. These factors all combine to create different contexts for information use within forest management organizations in the state. Table 38 contains the 10 information categories ranked least adequate and of highest priority for management decisions by individuals within each of the four forestry sectors in the state.

Managers within federal forest management organizations were strongly concerned with supply and demand information for all types of timber products. All three categories of this information were rated as inadequate for management purposes and as important information needs. Land use information was also of greatest immediate interest to those within the federal sector. Federal organizations assigned the highest priority among all sectors to the acquisition of improved information on forest wildlife resources. Reforestation and timber harvest information were also important concerns and federal managers were strongly in favor of acquiring improved aerial photographs for management uses. Among the three kinds of management information rated by federal managers as least satisfactory for decision making, a number of individuals indicated that both forest tax information and that related to private forestry assistance were not used to any great degree for management decisions.

When focusing on the U.S. Forest Service as the major administering agency for federal forest land in the state, it is useful to consider the above assessments in terms of information flow within the agency, as well as in relation to the degree of computerized information processing capabilities for Forest Service operations. An

important dimension of information transfer unique to Forest Service activities consists of the flow of information from National Forests to regional headquarters (located in Milwaukee, Wisconsin). In contrast to state and county forestry agencies, the network of information transfer from district to forest to regional headquarters involves an additional stage of information organization, in which Forest-level information is eventually aggregated for use at the national level. The necessity for national-level aggregation exerts an important influence on information management activities at the central management staff levels within the National Forests. This in turn influences managers' assessments of information adequacy and priorities. It may, for instance, have contributed to the strong emphasis within federal organizations for better supply and demand information, certainly an important element within the Forest Service's nationwide forest resource assessments.

An important characteristic of information use within the Forest Service is the greater degree of computerization of information processing activities relative to other forestry sectors in the state. Although the state has made and continues to make great strides in this area, Forest Service information systems have been in place for a longer period of time, and managers have undoubtedly become more accustomed to their use in management tasks. While new software programs continue to appear, at times being very sophisticated and difficult to implement, the greater overall familiarization with computerized information processing may have contributed to the somewhat higher degree of satisfaction with the overall adequacy of forest management information displayed by managers at the federal level (Table 34).

State forest managers expressed strong interest in improved information concerning silvicultural aspects of forest management, as well as that related to forest road systems. Emphasis on the latter reflected the rather limited amount of information available at the time of this survey regarding existing state forest roads, and the importance of this information relative to other public sectors may also stem from the sheer size of the state forest road system when contrasted to those of the National Forests and individual counties. The importance of reforestation information, though not considered by state managers to be strongly deficient, may result in part from perceived problems in eliminating the current backlog of state-managed acreages targeted for this activity.

In sharp contrast to federal organizations, herbicide and pesticide information was deemed both unsatisfactory for current uses and a high priority need by managers at the state level. As with all public agencies, timber supply and demand information was an important concern, as was that pertaining to forest soils and wildlife resources. The state sector was the only one to indicate the quality of information on forest land acquisition and disposal to be of some concern. The fact that

Table 38. Top 10 inadequacy and priority rankings for forest management information by sector.

ALL RESPONDENTS	
<u>Inadequacy</u>	<u>Priority</u>
1. Mineral Deposits: Kind/Location	1. Timber-Pulpwood Supply/Demand
2. Forest Labor/Employment	2. Reforestation
3. Forest Road Systems	3. Timber Growth Projections
4. Imports/Exports: Wood Products	4. Timber Harvests: Past/Projected
5. Land Use: Projections	5. Forest Road Systems
6. Soils/Geomorphic Regions	5. Herbicide/Pesticide Usage
7. Land Use: Regional Development	7. Forest Wildlife: Habitat/Goals
8. Wood Residue: Supply/Demand	8. Land Cover: Aerial Photographs
9. Mineral Ownership	9. Land Use: Projections
10. Forest Land Taxes	9. Intermediate Silvicultural Activities
FEDERAL	
<u>Inadequacy</u>	<u>Priority</u>
1. Forest Land Taxes	1. Timber-Pulpwood Supply/Demand
2. Forest Labor/Employment	2. Land Use: Regional Development
3. NIPF Landowner Assistance	3. Land Use: Projections
4. Land Use: Projections	3. Forest Wildlife: Habitat/Goals
5. Wood Residue: Supply/Demand	5. Fuelwood: Supply/Demand
6. Timber-Pulpwood Supply/Demand	5. Reforestation
7. Mineral Deposits: Kind/Location	5. Land Cover: Aerial Photographs
8. Fuelwood: Supply/Demand	5. Mineral Ownership
9. Land Use: Regional Development	9. Wood Residue: Supply/Demand
10. Forest Soil and Water Conservation	9. Timber Harvests: Past/Projected
STATE	
<u>Inadequacy</u>	<u>Priority</u>
1. Forest Road Systems	1. Reforestation
2. Forest Soils/Geomorphic Regions	2. Forest Road Systems
3. Imports/Exports: Wood Products	3. Forest Land Taxes
4. Mineral Deposits: Kind/Location	4. Timber-Pulpwood Supply/Demand
5. Herbicide/Pesticide Usage	4. Intermediate Silvicultural Activities
6. Land Use: Projections	6. Herbicide/Pesticide Usage
6. Land Use: Regional Development	7. Forest Land Acquisition/Disposal
8. Forest Land Acquisition/Disposal	7. Forest Wildlife: Habitat/Goals
9. Forest Labor/Employment	9. Forest Soils/Geomorphic Regions
9. Forest Wildlife: Habitat/Goals	9. Timber Harvest: Past/Projected
COUNTY	
<u>Inadequacy</u>	<u>Priority</u>
1. Forest Labor/Employment	1. Land Use Projections
2. Imports/Exports: Wood Products	1. Herbicide/Pesticide Usage
3. Forest Soils/Geomorphic Regions	1. Timber Growth Projections
4. Mineral Deposits: Kind/Location	4. Timber Harvests: Past/Projected
4. Forest Road Systems	5. Mineral Deposits: Kind/Location
6. Wood Residue: Supply/Demand	5. Timber-Pulpwood Supply/Demand
7. Land Use: Projections	5. Intermediate Silvicultural Activities
8. Land Use: Regional Development	5. Forest Inventory System Information
9. Timber Growth Projections	9. Forest Wildlife: Habitat/Goals
9. Timber Harvests: Past/Projected	9. Forest Land Cover/Forest Types
9. Intermediate Silvicultural Activities	
INDUSTRY	
<u>Inadequacy</u>	<u>Priority</u>
1. Timber Harvests: Past/Projected	1. Timber-Pulpwood Supply/Demand
2. Mineral Deposits: Kind/Location	2. Timber Harvests: Past/Projected
3. Forest Road Systems	3. Forest Road Systems
3. Forest Soils/Geomorphic Regions	3. Timber Growth Projections
3. Mineral Ownership	5. Timber Sales
3. Timber-Pulpwood Supply/Demand	6. Herbicide/Pesticide Usage
3. Forest Soil and Water Conservation	7. Reforestation
8. Fuelwood: Supply/Demand	8. Forest Soils/Geomorphic Regions
9. Forest Land Acquisition/Disposal	8. Fuelwood: Supply/Demand
10. Wood Residue: Supply/Demand	10. Wood Residue: Supply/Demand
	10. Mineral Ownership
	10. Forest Land Taxes
	10. Forest Insect/Disease Information

records of land transactions are maintained by the DNR Bureau of Lands as opposed to the Division of Forestry may have contributed to state managers being less familiar with this information than other kinds maintained within the Division. Improved information on forest taxes was also identified as of high priority for state managers; this in all likelihood stems from accounting difficulties associated with the variations in assessment methods for private forest lands; state personnel are involved with such matters to a greater degree than those within federal and county organizations.

Information transfer within the state forestry sector differs in certain important aspects from that within the National Forest System in Minnesota. While central management staff personnel of the Division of Forestry do not encounter problems associated with the need for further aggregation of information within the organization, they are charged with managing the largest data base for forest management in the state. Information flow between the district and central staff levels is achieved through the Division's three-tiered administrative system for field operations.

The development of a comprehensive computerized forest management information system within the state Division of Forestry has rapidly accelerated within the past several years. The recent acquisition of hardware equipment accompanied by increased staffing in the area of information processing will greatly aid in the more efficient transfer of management information within the system. In some respects, state managers are involved in the same large-scale organizational adaptation to comprehensive automated information processing initially experienced at the federal (U.S. Forest Service) level several years ago. The somewhat more concrete (i.e., less future-oriented) kinds of information needs identified by state personnel in contrast to those expressed at the federal level may reflect the immediate priorities of incorporating these more tangible information elements within the state's evolving information system.

Managers within county forestry organizations expressed strong interest in obtaining information that would provide them with a better picture of county forest resources and opportunities for enhanced timber management. They perceived existing information on timber growth, harvests and treatment techniques to be less than satisfactory for current management programs and emphasized the need for better information in these areas. As with all forestry sectors, improved information on the supply and demand for timber and pulpwood was of major concern to county managers. Herbicide and pesticide information was also accorded high priority, although existing information in this area was not considered deficient to the degree indicated by state forestry personnel. The strong desire by county managers for improved information on future land use likely reflects the position of forest management programs as an element within

county land departments, whose mandates include primary responsibility for monitoring land use patterns within county boundaries. In this regard, managers were quite concerned with acquiring better information pertaining to mineral deposits on county forested lands. While they perceived economic information on forest sector employment and imports/exports for wood products to be quite lacking as an aid in decision making, many county managers indicated they used such information very infrequently for management purposes.

Many county forestry programs have undergone major changes within the last several years. A number of counties with large forest resources have initiated major efforts to insure that their forests are managed in the best interest of all county residents. Several of these counties have purchased automated data processing equipment and are in the process of developing rather comprehensive data bases on their timber resources. However, this has often not been accompanied by the acquisition of software programs applicable for county management purposes. Most counties will benefit from the state's Phase II forest inventory system, and in this light it is not entirely unexpected that counties accorded highest priorities among all sectors to improved inventory information along with that related to forest land cover/forest types.

In the past, most counties did not possess the financial resources for sophisticated forest management. Increased funding to counties obtained through the authorization of state in-lieu-of-tax payments and as a result of the enlargement of the Boundary Waters Canoe Area have allowed counties to begin to assemble information to support commitments to more intensified management of their forest resources. While traditionally timber-oriented in program emphasis, counties collectively are beginning to recognize their role in comprehensive forest land management. Most county forest administrators feel, however, that continuation of current funding sources is essential for recent program improvements to become permanent, and to avoid counties falling back to previous levels of custodial forest management. Many are concerned that funding levels may not remain at their current status, and that it may be "difficult to make it under the wire before the crunch comes."

Forest industries within Minnesota were vitally concerned with the ability of information for public forest management in the state to adequately represent the current and future availability of timber to the industrial sector. They identified a number of kinds of management information directly related to timber availability as needs of highest priority. Industries regarded supply and demand information for timber and pulpwood as the critical link between what is available for harvest and that which current markets are able to absorb. Fuelwood and wood residue represented additional areas where supply and demand information was deemed both important and not entirely adequate for management concerns. Industrial

managers identified timber harvest information as another key indicator of the amount of timber available from public lands, and they regarded existing information in this area as that least satisfactory for use in management decisions. Timber sales information was also accorded high importance by forest industries, in contrast to its absence from priority needs of public forestry organizations. Another indirect, although essential, determinant of timber availability is the network of forest roads within the state, about which industrial managers considered information highly important but of limited utility.

Biological and silvicultural timber management information pertaining to growth projections, reforestation, and herbicide and pesticide utilization were all considered by industrial managers to be important information needs. While they also judged several kinds of information related to resource characteristics of forest lands, notably minerals and soils, to be of marginal utility for management decisions, such items were not identified as high priority needs.

The concerns of forest industries reflect a unique perspective regarding forest management information which obviously differs from that of public forestry sectors. Industries attempt to stabilize their purchases of timber from the public and private nonindustrial sectors. To do so they require information on future timber availability from public forestry organizations. Several industrial managers indicated that often such information is not entirely reliable, in the sense that actual availability may be less than stated timber supply. Costs for harvesting, road construction, transportation, etc. often combine to reduce the actual supply of timber when all economic factors are considered.

Timeliness of inventory information was another area of major concern for forest industries. Current intervals between successive inventories were perceived by some managers to hinder their ability to effectively incorporate the impacts of annual harvests within estimates of future timber availability. In addition, the organization of current inventory information was perceived at times as a hindrance to determining the actual availability of timber in a spatially meaningful way (see next section).

Despite these difficulties, managers within forest industries in the state observed that public forest management agencies generally attempt to recognize the needs of the industrial sector. They also indicated that the state's Phase II inventory system for state and county forest lands will aid in addressing some of the problems associated with the availability of timber from public forest lands in the state.

VII. ORGANIZATIONAL PROBLEMS AND OPPORTUNITIES IN THE USE OF FOREST MANAGEMENT INFORMATION

The preceding sections have attempted to provide a better understanding of the kinds of information important for forest management in Minnesota, the organizations that collect such information, its utility for decision making, and its adequacy and need for managers within forestry sectors in the state. In focusing on particular kinds of forest management information, other problems regarding information organization and use, not specifically categorical in nature, were often described by individuals within forestry organizations as important management concerns.

Several of these problems will be briefly highlighted in subsequent pages. Among these are a discussion of the critical linkage between information collection and organization and its final use in management situations; a brief overview of aspects of information use associated with computerized information systems for forest management; and a short discussion of potentials for improving the flow of information within and among forestry organizations in the state. The section concludes with a re-examination of the relationship between information and state forest resource goals, in light of the experience of this report. Throughout this discussion, a number of implications and opportunities for enhancing information management and use within forest management organizations in Minnesota will also be suggested.

Information Organization and Use: The Case of Forest Inventory Information

Although for certain management situations the lack of relevant data can be a limiting factor for effective decision making, managers often observe that while they do possess certain information on a given topic, it is not organized in a manner applicable to the situation for which it is required. The prevalence of this viewpoint is reflected in managers' responses to the first item of a series of statements included as a supplement to the questionnaire previously described (Table 39).^{43/} While there existed a general consensus regarding this problem, timber management staff within forestry organizations were most emphatic regarding the problems associated with information organization. It may be worthwhile, therefore, to briefly examine this phenomenon as it occurs with respect to a particular kind of information of great importance to timber staff personnel--forest inventory information.

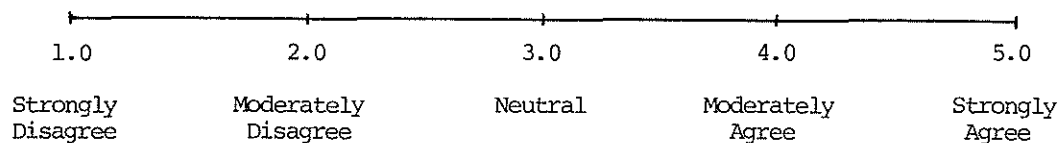
From the time data is collected until it is used, it may be re-organized, combined with other data of a similar nature, or otherwise modified to

^{43/} Other statements in this table will be discussed as they become relevant within the following pages.

Table 39. Evaluation of selected problems with the use of Forest Management Information by level of management and sector.

STATEMENT	RESPONDENTS ALL	LEVEL OF MANAGEMENT				SECTOR			
		SUPERVISOR	IMP ^a	TIMBER	FIELD	FEDERAL	STATE	COUNTY	INDUSTRY
Most information problems are not due so much to not getting enough information, but rather that it's often not organized in a form useful for decision.	4.13	4.08	4.11	4.38	3.90	3.92	4.23	4.20	4.22
The information load is getting too large to manage effectively.	3.80	4.08	3.56	4.00	3.40	4.08	4.15	3.10	3.67
Other agencies generally make the information they collect available to us in a useful fashion.	3.19	3.73	3.33	3.15	2.50	3.15	2.85	3.30	3.71
Hazy organizational goals often make information needs hard to pinpoint.	3.43	3.23	3.67	3.77	3.00	3.46	3.50	3.30	3.44
Our ability to compare timber and non-timber forest resource information for management decisions is quite limited.	3.56	3.77	4.11	3.23	3.20	3.69	3.54	3.60	3.33
What is needed is a single centralized information system for all forest management activities in the state.	3.44	3.62	4.33	2.85	3.20	3.46	3.23	3.60	3.56
I'm not entirely confident that we really understand the desires of the constituency whom our agency serves.	2.71	3.25	3.00	2.25	2.33	2.77	2.58	2.60	3.00
The flow of information within our agency could be greatly improved.	3.80	4.00	4.38	3.69	3.20	3.92	3.62	4.10	3.50
Research in forest management is maintaining a good balance in focusing on the variety of management problems which affect the decisions I make.	2.93	3.23	2.78	3.23	2.30	2.92	2.92	3.00	2.89

^a Land management planning.



fit the needs of the user. Each collector of forest management data does so to achieve specific goals. In doing so, certain assumptions regarding both characteristics of the data and its relevance to end-uses, or more specifically, its processing into information for decisions, are inherent in the collection process. Other users of this data or information, whether from within or external to the collector's organization, may have different goals for its use--goals characterized by their own set of assumptions, which often may not coincide with those of the data collector. These latter assumptions may hinder or even negate the value of such information to these other users. Yet for the collector to alter procedures for gathering data to suit any or all other users generally involves substantial costs, and in many cases is impossible.

Utilizing the Forest Survey conducted by the U.S. Forest Service as a case in point, its purpose is to periodically provide basic information on the nation's forests, including the volumes, condition, growth, and depletions of the timber resource. In turn, such information plays a vital role in timber management activities of both public and private forestry organizations. With respect to areal representation of Survey data, much of it is summarized at the county level. In extrapolating plot information^{44/} to the county level, several necessary assumptions are involved. Characteristics of intensively measured ground plots are extrapolated to similar photo plots (classified according to forest type, stand-size class, and density) and then aggregated to the county level. This is in keeping with the mission of the Survey--to describe the forest resource in the state in a cost-effective manner.

Other users of Forest Survey information, most notably forest industries, rely on this information as an aid in determining the availability of timber for both short- and long-term harvest plans and operations. This involves numerous factors and assumptions which differ from those of the Forest Survey, and certain problems arise when industries attempt to utilize Survey information for their management goals. For example, mixed stands and geographical variations in site quality cause difficulties in the reliability over time of plot information aggregated to the county level. From a long-term perspective, the influences of the above factors do not assure that the composition of many of these stands will remain stable over extended periods. That is, the homogeneity of the aggregate information may be questionable. In addition, important locational and spatial aspects of stands are of necessity clouded when represented within aggregate figures.

^{44/} Approximately 25,000 aerial and 3,100 ground plots on forested lands throughout Minnesota.

The factors can cause actual timber availability to diverge from potential availability as represented in inventory information. One industrial manager noted that the Phase II inventory information had indicated a volume of 1.07 million cords of balsam fir within a particular Minnesota county. Upon investigating the amount actually available for harvest, he found it to be only 2,300 cords per year. The larger the county, the more magnified are the locational and spatial problems associated with the ability of county-level information to represent the availability of stands of specific characteristics. The inclusion of geographic identifiers with inventory information, as is the case with the state's Phase II inventory, is an initial step at providing better locational information, but much more work is required to make inventory information more applicable to the logistical aspects of industrial wood procurement. Again the question of costs arises, as does the consideration that the primary function of the Forest Survey is not to resolve problems associated with logistical aspects of timber harvesting.

Other problems related to the organization of inventory information and its relationship to its end use may perhaps be resolved more easily. For example, one of the most important concerns of forest industries regarding timber utilization relates to the products which may be derived from standing timber. While some industries utilize tree-length logs, the majority of industrial mills are geared for the processing of 8-foot wood. Saw-timber, bolts, and pulpwood are all processed from logs of this length. For a given tree, a mill may utilize that portion of the tree from the base to a 10-inch top to obtain the highest quality sawlog; then attempt to obtain as many 8-foot bolts as possible to a 6-inch top; and finally go to a 3-inch top deriving as many 8-foot segments of pulpwood as possible. This breakout of products is critical for efficient wood utilization.

Inventory information is generally organized in the form of total tree volumes by species and diameter class. This makes it quite difficult for industries to determine the actual product breakouts for individual trees. Bolt breakouts are particularly critical. However, when information is represented by total tree volumes, it is extremely difficult to determine what percent of each tree is pulpwood, bolts, etc. Merchandizing routines (i.e., computerized packages) are available for determining product breakouts, and it is possible that, without the need for the expensive collection of additional data, some of this information could be re-organized to better fit industrial needs. This has led to some criticism on the part of industrial managers that inventory information is compiled without consultation regarding the most effective ways in which it might be utilized. It should again be noted that the primary mission of the Forest Survey is to describe the total volumes and conditions of the forest resource. However, if this can be achieved with

a concurrent provision to industry of information organized to suit their needs, it would seem to be a worthwhile objective.

Recommendation: Continued interaction between Forest Service and State inventory personnel and representatives of forest industries (as well as other interested user groups) to discuss opportunities for enhancing the utility of inventory information should be encouraged. User groups might express their information needs, which could then be reviewed by inventory personnel in terms of their capability to respond to those needs within the framework of their information-gathering missions.

These problems concerning the relationship between information collection and its end use are by no means unique to matters related to forest inventory operations. Numerous other examples, pertaining both to timber and nontimber forest resources, may be cited. In addition, even when uses of information among various groups are consistent, criteria for information organization remains a key determinant of how it may be used. For example, Wiener (1982) presents seven different volume-price combinations said to represent timber sales of the Oregon-Washington region of the U.S. Forest Service in 1979. He then notes that, despite wide variances in both total volumes sold and prices per thousand board feet, all combinations are accurate representations of timber sales for the region. Differences result from the information being organized according to different criteria--fiscal vs. calendar year, timber cut vs. timber sold, sawtimber vs. all timber products, etc. This highlights the importance of a thorough understanding of the way in which any information is organized prior to its utilization, regardless of what purpose the user may have.

Computerized Information Systems for Minnesota Forest Management

The impact of computerized information systems upon the management capabilities of forestry organizations in Minnesota during the last decade has been profound. Such systems have ushered in an explosion in the information resources potentially available to managers within these organizations. Responses to statement 2 (Table 39) confirm that the sheer size of the information base is making it increasingly difficult to manage information effectively. Supervisors and timber staff personnel were particularly bothered by these problems, while managers within federal and state organizations perceived them to be of greater severity than did county forestry personnel. Despite these difficulties, the vast majority of managers recognize the value of computerized information processing as a means of freeing them

from the more tedious and routine aspects of information utilization. They also welcome the improved capabilities for information analysis which automated information processing provides.

Each forest management organization in the state faces challenges which reflect the particular stage of development and degree of integration of its information processing capabilities. Potential problems with respect to the effective implementation of automated information systems can act as barriers to the flow of information within any organization. That these and other barriers actually exist is indicated by the responses of managers to statement 8 (Table 39). It is noteworthy that even county forestry organizations, with substantially smaller staffs than any of the other forestry sectors, acknowledge the need for improved information transfer within their organizations. Several factors related to the use of computerized information systems merit attention in this regard.

Training in Information Use--Automated information systems have the capacity for storage and retrieval of enormously large amounts of data. It is possible for an organization to collect so much data that it becomes difficult to take full advantage of the processing capabilities of the system. In effect, managers may become more involved with adapting the data base to the system than using the data for its intended purposes. Some managers noted the importance of learning how to handle current data resources before being too concerned with generating new programs requiring additions to or modifications of existing data.

There is a natural tendency among users of computerized information systems to regard computer print-outs as invariably accurate and fully representative of the situation which they describe. Some managers indicated that this can lead to too heavy reliance on information which may be defective. This underscores the need for a thorough documentation, accessible to users (perhaps in the form of manuals or guides) of all assumptions which underly data collection and manipulation for particular computer applications. There is nothing inherently invalid about a data processing routine that takes "extensive" inventory data based on three plots per acre and processes it into "intensive" information in the form of timber volumes to cubic feet per acre. It only becomes a hindrance to management when the intensity levels of sampling and volume representation are assumed to be of the same degree. Managers must constantly monitor the quality of any information in terms of the assumptions on which it is based.

It is well known that effective implementation of management information systems requires a continuing program of education and training in the use of those systems to achieve management objectives. This involves a familiarity with not only the technical, but also the logical processes on which the system is built. This is

particularly critical with respect to system models for analysis and planning, though it applies to other system elements as well. It often happens that the more separated individual managers are within the system, the more difficult it becomes to maintain an overall perspective of what that system is designed to accomplish. A knowledge of how information collected at one organizational level is used at other levels--more specifically, an understanding of the types of decisions for which that information will be used and the outputs of those decisions--can serve to enhance the collector's awareness of the real utility of his efforts. At the same time, the collector may be better able to monitor the quality of the information he enters into the system.

The question arises as to the most feasible manner in which the above conditions may be achieved within a particular forest management organization. It is obviously neither possible nor desirable for all managers to learn every aspect of each other's management tasks. Opportunities do exist within organizations, however, for promoting increased awareness of both computer-generated and non-computerized information use. One method is through seminars in which managers within a functional area inform those in other areas of their role in the information network of the organization. This would involve a description of management responsibilities, information needs, adequacy of existing information they receive from other organizational levels, and the kinds of information generated from their management activities. A number of organizations do conduct occasional seminars designed to facilitate inter-organizational communication of management concerns, but the timing and regularity of such presentations is often less than ideal, particularly in light of the time constraints any manager faces in carrying out daily activities. The integration of these sessions within the operational schedule of the organization (i.e., in the form of bi-monthly or monthly meetings on a set day and time) might help overcome some of these difficulties. Supervisory encouragement of such efforts is also essential.

Recommendation: The use of seminars within forest management organizations should be encouraged whereby managers communicate their role in the information network of the organization. Meetings might include descriptions of information both generated and utilized (in both automated and non-automated forms) in carrying out management responsibilities. Incorporating these sessions within the regular pattern of organizational operations would be desirable.

Effective implementation of such a program could do much to alleviate the perception by managers

of problems associated with intra-organizational information flow.

Software Development--In addition to the important aspects of system design and hardware resources for forest management information systems, another element critical to effective system utilization is the software employed in system operations. This consists of computer programs and routines which direct the operation of the computer. Davis (1974) delineates two major categories of software consisting of: (1) systems software--programs which facilitate the adaptation of application programs to system hardware and (2) application software--programs written for an individual management application.

Systems software is obviously closely linked to the type of computer on which the information system is implemented (example IBM-390, Cyber, etc.). Documentation of this software is generally available to all users of the system. The focus of attention here centers upon application software for forest management. Application programs are reflective of an organization's approach to addressing management problems. They contain specific objectives translated into computer-readable language, as well as a framework for representing results of application programs.

A description of the application software utilized by the various forest management organizations in Minnesota might increase the knowledge of all users concerning approaches toward particular management problems. Such information need not be excessively detailed, particularly regarding aspects linking software packages to specific computer systems. Rather, it could be organized to convey the various analytical approaches currently employed in addressing different aspects of forest management. At present there is no systematic description of the application software in use within forestry organizations in the state. Such an information base might aid managers in evaluating the objectives and performance of software packages in use within both their own organizations and other agencies with similar management responsibilities.

Recommendation: A systematic documentation of application software currently in use within forestry organizations in Minnesota (and elsewhere, to the extent feasible) would be of potential benefit to forestry information systems analysts. Important elements which should be considered include problems addressed, data inputs, method of analysis, and outputs generated.

The need for software development, while an important concern within all forestry agencies, is of particular importance to those county forestry organizations that possess automated information

systems. The limited size of Land Department forestry staffs, primarily occupied at present with the development of county forest management programs, hinders their capability to evaluate and incorporate application software within their existing systems. At present, counties also cannot afford to invest extensively in software. While the preceding recommendation would certainly aid counties in evaluating the potential utility of software packages, additional assistance in this regard would be highly desirable.

Recommendation: Increased technical assistance to county forest management agencies from federal and state forestry organizations should be encouraged as an aid to the development and use of application software for county management information systems.

The Cost of Information--An important component of automated forest management information systems is an effective framework for cost accounting and performance evaluation. This applies equally in instances where an organization relies upon a single system to handle all processing activities (ex. County Land Departments); or in the case where an organization has the option of selecting from among several systems, depending upon the nature of the data processing requirements (ex. DNR Division of Forestry: IBM 370--Minnesota Department of Administration; CDC 6000/6000--University of Minnesota; PRIME--Minnesota Department of Energy, Planning, and Development).

The control of information system costs is based upon generally accepted procedures involving budget allocations, performance monitoring and corrective action for variances (Lucas 1978; Davis 1974). These procedures will not be reviewed in this report. However, as an example of cost-related matters that are of importance to forest management organizations, some of the more important considerations of the DNR Division of Forestry in selecting from among alternative systems for storing different kinds of management data will be briefly described.

The storage capacity of an information system reflects its ability to handle large volumes of data. It is more cost efficient for the Division to store the large Phase II inventory data based on the IBM 370 (disk storage capacity: 275 million records) than on either the CDC 6000 (capacity: 38 million records) or PRIME (capacity: 10 million records). The overall system design also has important cost implications for the storage of different types of data bases. The Division stores timber sales data, a large data base subject to extensive transaction processing operations, within the IBM system, a business-oriented system highly amenable to large volumes of transactions data. Conversely, mathematical and statistical program packages are maintained within the CDC 6000, a system geared

much more to research applications than the business-oriented IBM system. Computer mapping information is stored within the PRIME system, which is designed for sophisticated computer graphics applications.

Retrieval time is also an important consideration for certain functional areas within the Division. Daily fire reports must be retrieved quickly during fire seasons. For this reason, the Division maintains such information within the CDC 6000, which is considerably more efficient in this respect than the Division of Administration's IBM 370, primarily due to the large data base from other state departments and agencies which are stored within the latter system. Effective cost monitoring for an integrated management information system such as that of the Division of Forestry requires an ongoing evaluation of these and other cost-related factors to assure the most efficient uses of organizational information processing resources.

Having considered the importance of costs with respect to automated information systems for forest management, brief mention is warranted concerning the extension of these and related concepts to information in general. An important element in evaluating the effectiveness of all types of forest management information, whether obtained from automated processing or by other means, is a determination of the benefits and costs of information acquisition. To focus on information per se, as this report has done, is to recognize that it is a commodity. From an economic standpoint, information may be viewed as a capital good. The rationale for such a viewpoint is provided by Herfindahl (1969):

Since we are asking how much should be spent on information of various types, and since this outlay yields no immediate flow of satisfaction to consumers but will be used in the production of other goods that do yield satisfaction, it is clear that from the point of view of economic analysis we are dealing with capital.... The generalized measure of the productivity of investment is expressed by the percentage rate of return on investment.

The goal of information acquisition, this tells us, is to continue to invest in information until the benefits derived from an additional increment of information become less than the cost to acquire it.

Several factors, however, contribute to make this a most difficult task. Benefits from forest management information are often quite diffuse, and vary in their suitability for quantification. In addition, they are invariably accrued over long periods of time. The necessity for discounting benefits and costs poses additional questions regarding the appropriate rate at which this should be accomplished. In short, all of the elements

of traditional investment analysis are applicable to the area of information, when viewed as a capital good for forest management. As is often the case when inputs are diverse and outputs not easily quantifiable, it is easier to describe problems than prescribe solutions. Analysis of the costs and benefits of forest management information is a most important area for future research efforts.

Information Transfer Among Forest Management Organizations

In light of the previous discussion, it is apparent that automated information processing is a significant determinant of the flow of information within a forest management organization. It is also an obvious fact, however, that such a system is not the only mechanism for intra-organizational information flow. Informal communication channels among managers are also avenues of information transfer, although such a network is most difficult to consider within a formal analytical framework. Nonetheless, even within formal functional channels not all information is transferred via the computer. Much is maintained in various forms within manual records, files, and the like.

There is little documentation of both a systematic and comprehensive nature that describes the actual channels through which information flows within a forest management organization. For example, what happens to inventory information once it is tallied and computerized? How does it travel through the organization and for what purposes is it utilized by managers at different organizational levels? Answers to such questions would not only aid in identifying areas within the organization where problems with information adequacy or flow exist; but would also allow for an analysis of the impacts of remedial actions on all other organizational units that utilize the information in question. This in turn may lead to improved information transfer within the entire organization. A formal examination of these processes would be most helpful.

Recommendation: A comprehensive case study documenting information flow and use within a forest management organization would aid in identifying opportunities for improving the efficiency and effectiveness of information utilization.

Such a study could take the form of either (1) an intensive analysis of the flow of selected kinds of information through the organization in terms of its use and mode of organization within different functional areas (Figure 26 in Section V provides an initial sketch for this type of approach); or (2) a broader investigation of the flow of a wide variety of information through the organization.

The fact that forest management organizations within Minnesota are responsible to different public constituencies often results in various agencies adopting different methods of collecting and/or organizing management information. This can at times lead to a degree of incompatibility when certain kinds of information are transferred among agencies. These same discrepancies can occur when information from various agencies is aggregated to represent a phenomenon at the statewide level.

The responses to statement 3 (Table 39) reveal a wide range of opinion regarding the utility of information managers acquire from agencies other than their own. While supervisors were fairly satisfied with such information, field foresters were of the opposite opinion. It is likely that inter-organizational information transfer occurs much more readily at higher levels of management and is essentially "absorbed" within agencies at those levels. Among forestry sectors in the state, only forest industries were moderately satisfied with the availability of information from other organizations.

Some managers indicated that while other agencies did collect various kinds of information of use to them, it was often collected at different times and under different criteria, and therefore did not merit a great degree of confidence. Almost all agreed that it would be most beneficial to "bring a lot of this information together." When synthesis of information from different sources was required, some noted that it was often necessary to throw in a "haywire factor" to try and get the information into a standardized form useful for analysis. These problems suggest the need for focusing more directly upon the kinds of information amenable to standardization and the potential benefits that might be derived from such an effort.

Recommendation: There is a need for a systematic identification of the opportunities for data/information standardization for forest management in the state in terms of:

- (a) what kinds of information would managers prefer to have standardized;
- (b) which of these might cost effectively be standardized;
- (c) what effects on statewide forest management would result from standardization?

As indicated above, an important aim of information standardization is to facilitate the aggregation of information so that, among other things, assessments of the combined effectiveness of all forestry sectors in the state towards achieving statewide forest resource goals (however they may be defined) may be possible. In addition to examining the potentials for standardization from the standpoint of individual data (information) elements, it may also be worthwhile to

consider such a possibility from a macro standpoint, i.e., in terms of the potential and/or need for the establishment of a centralized information management system for forestry in Minnesota. It may be that, having determined that a certain portion of the current information resource within all forest management organizations in the state exhibits a potential for standardization, there will still exist a need for a set of systematic procedures for achieving this end. Hence the possibility that a centralized system, capable of integrating certain information elements from within each of the state's forestry sectors, may play a positive role in the process of aggregating information to statewide significance. Such a process could not occur, however, without a systematic examination of automated information systems currently in use within forestry organizations in the state.

Recommendation: It would be worthwhile to undertake an identification/documentation of computerized information systems in Minnesota either in use or of potential use for forest management in the state.

Regardless of whether the results of such an endeavor were utilized in forming a centralized system, they would enable managers within different organizations to benefit from knowledge of how others approach the task of automated information processing for forest management.

Managers within forestry organizations exhibited widely varying opinions in considering the potential utility of establishing a centralized forest management information system (statement 6, Table 39). An important concern regarding this approach was that such a system would require an enormous data base, perhaps comprised of substantial portions of existing data bases from within various forestry organizations. Some managers felt that the degree of data standardization necessary to establish a centralized system would be difficult to achieve. Others, however, expressed great interest in such a concept, noting that with a certain degree of "painful effort" this would force agencies to organize their information in a consistent fashion, much like the national RPA program of the U.S. Forest Service imposes the same standardization requirements on all national forests. Several managers within forest industries were particularly emphatic in this regard.

Forest planners were quite receptive to the idea of a centralized system, while timber management staff personnel expressed the strongest reservations in this regard. Assessments of feasibility were relatively consistent across forestry sectors in the state, although state personnel were less enthusiastic than others. This may perhaps reflect their experiences in managing the largest forest management information base in the state; and manifest a concern that were a centralized system to be larger, it would be difficult to

administer. Regardless of managers' specific opinions on this issue, it would seem apparent that any such system would of necessity contain only certain types of management information, preferably those whose representation in standardized form amenable to aggregation would be of most benefit to all forest management organizations in the state.

Other aspects of information transfer among forestry organizations relate to research information and continuing education requirements. As noted previously (Section VI), managers were generally not entirely satisfied with the manner in which much research information is represented. Responses to statement 9 in Table 39 lend further support to this. All forestry sectors expressed similar evaluations, and field managers were markedly dissatisfied with the ability of research information to adequately address their management needs. While many felt that research designs often failed to incorporate relevant management constraints, managers expressed their strongest objections regarding the way research results are organized. Most felt that results were presented in an overly technical manner making it extremely difficult to extract the information they need. This was particularly bothersome when sophisticated computer-based modeling techniques were described. This suggests the need within research organizations to devote more emphasis on the manner in which results of specific projects are described.

Recommendation: Forestry research organizations should devote increased attention to application-oriented writing techniques, whereby research results of a technical nature may be represented in a more simplified format. This would be of great aid to managers with little time to thoroughly read and digest every aspect of research reports.

With respect to continuing education needs for personnel within forest management organizations, several points were emphasized by managers. While they appreciated the value of seminars and workshops presented by forestry research organizations, some felt that such events were often of too short a length to cover the particular topic with which they were concerned. This time constraint often forced those presenting such seminars to describe their results in a manner either too technical, or conversely, too broad to permit an in-depth understanding of the subject. Many managers also expressed the desire for seminars not geared specifically to one topic, but concerned with broad subject areas (ex. resource measurements, silvics, economics, ect.). This would allow them to "brush up" on subjects with which they do not deal extensively in their work, but about which they wish to maintain a working knowledge. In short, while many managers did recognize and appreciate the need for seminars related to

specific problems or management opportunities, many others were just as vitally concerned with remaining well-rounded professionals with a working knowledge of the variety of subject areas which comprise the field of forest management.

Recommendation: Forestry research and educational organizations should stage more "refresher workshops" geared to broad subject areas in forest management. Short-course formats and week-long or several-day sessions might allow managers to concentrate more effectively on particular areas of concern.

The Path to Achievement of State Forest Resource Goals

As a final note, it may be worthwhile to recall the overall perspective from which this study of forest management information has been conducted (Figure 1, page 4). It is generally accepted that the goal of forest management activities in Minnesota is to ensure that the state's forest resources are managed in such a way that citizens of the state derive maximum social benefits from the production of forest-based goods and services. Inherent in this is the continued stability of the forest land base from which these benefits are obtained. The actual definition of such benefits, however, is a difficult task. While theoretically desirable, a number of practical constraints interact to make the actual definition of specific goals and outputs from the forestry sector in Minnesota an elusive task. It may be that a more pragmatic approach is required.

Since the forestry community within the state is comprised of five individual sectors (see Figure 1 in Section I), it is reasonable to assume that the most practical way to ensure that state forest resource goals are achieved is to: (1) facilitate the establishment of effective forest management goals for each of the individual sectors; this is not always an easy task, as indicated by responses of certain groups within forestry organizations to statement 4 (Table 39); and (2) seek to ensure that effective cooperative mechanisms exist among all sectors so that an individual sector, in achieving its own resource management goals, may do so in a way that combines effectively with other sectors and results in contributing to the welfare of all Minnesota citizens.

An important mechanism to aid in achieving the above objectives is the guidance provided by the legislative branch of the state government. Being "outside" of the five forestry sectors in the state, the Legislature is able to undertake activities with the specific aim of helping all sectors work together more effectively to improve forest management in the state. The Legislative Commission on Minnesota Resources took one such step in 1979, when it initiated a major study of

opportunities to enhance economic development of the state's timber resources. Results of this Timber Development Study (G. Banzhaf and Co., 1980) provided a large number of policy options for achieving these objectives. The effectiveness of such an endeavor required the compilation of a large amount of information from among the various forestry sectors in Minnesota. This report has focused on such information as a tool for forest management. A subsequent identification of the specific public organizations with jurisdictional authority to act upon these policies (Ellefson, et al., 1981) provided the foundation for potential implementation of alternatives aimed at enhancing forest management within the state. These events provide concrete evidence that the political process has been and will remain a most important element within the identification and potential achievement of state forest resource goals.

VIII. SUMMARY AND CONCLUSION

This report has examined the role of information as an ingredient to the effective management of public forest lands in Minnesota. In doing so, it focused upon the decision making processes which occur within forest management organizations, and on the kinds of information required to ensure their effective execution. The aim has not been to model every conceivable type of management decision, but rather to gain a better understanding of the nature of particular decisions so that information may be organized in such a way that it will be useful to a decision maker in a given situation.

Public forest management organizations in Minnesota operate within federal, state, and county governments to provide citizens of the state with a variety of forest-based goods and services. Each agency has particular management responsibilities, executed through decisions by managers at all organizational levels, each of whom requires information of a precise nature and form to ensure that effective decisions are made.

In addressing the relationship of information to forest management activities in the state, levels of management within public forestry agencies were first described in terms of supervisory, central management staff, and field operations. Three basic types of decisions were then identified--strategic, tactical, and technical--which occur in varying degrees at all levels of management. The ultimate goal of information analysis, only part of which was able to be examined in this report, was then identified as one of defining the relationship of various kinds of forest management information to specific decisions at different levels of management within forestry organizations. Due to the complex nature of such decisions, the scope of this report was narrowed to an assessment of the availability and adequacy of forest management information for individuals at each level of management within forestry organizations. This research, however, provides a foundation for

future work designed to explicitly relate information needs to specific decisions at various levels of management.

After defining this conceptual framework for analysis, the report examined the nature of forest management information in terms of its: (1) content, i.e., the subject matter to which it pertains and (2) characteristics, i.e., how it is organized and transferred. The relationship of information characteristics to various types of decisions within forestry organizations was also briefly discussed.

Later sections described the availability of information for forest management in Minnesota through a systematic identification of public agencies and organizations within the state responsible for collecting such information. This included agencies both actively involved in forest management and those with no land management responsibilities, but whose missions involved the collection of information of potential relevance to decisions made within forestry organizations. Ideally, it would have been desirable to describe these information resources in terms of the variety of information characteristics described earlier. While the scope of the report did not allow for such an in-depth analysis, information collected by these public organizations was represented in terms of its source and method of storage, two characteristics which were more readily identifiable within the time available.

After identifying the information resources available for forest management in the state, the report described evaluations by individuals within forestry organizations regarding the adequacy of this information for making management decisions. To obtain such evaluations, a questionnaire was distributed to managers at three levels of management within public forestry agencies in Minnesota, as well as to those within the industrial forestry sector in the state. Adequacy assessments were obtained from managers at the supervisory, central management staff, and field levels within these organizations. At the central staff level, respondents were further subdivided according to their involvement in the functional areas of timber management and forest land management planning. Evaluations were obtained concerning the adequacy of different kinds of information for managerial decision making. Important information needs were also prioritized by all respondents.

Questionnaire results were then analyzed to provide information adequacy assessments and priority needs for levels of management within forestry organizations, as well as for each of the four forest management sectors in the state--federal, state, county, and private industry. Certain general problems not related to specific types of information were also discussed and suggestions were offered for enhancing the effectiveness of information use within the forestry community in the state.

This report has provided an initial look, from a statewide perspective, at the complex processes involved in the generation, organization, transfer, and use of information for the management of Minnesota's public forests. Future work will focus on providing a better understanding of relationship of information to the decision making framework within forest management organizations. This may hopefully contribute to the enhanced stability of the state's forest resources and their role as an important element within the quality of life of Minnesota citizens.

With respect to the nature of information itself, one important lesson has been learned that is of great value to those with continuing interests in the importance of information to forest management. It is not a novel idea, however, and was expressed most eloquently by the eminent scientist and philosopher J. Bronowski in discussing information transfer between cells within the body. In reflecting on the general relevance of such processes, he observed that "all information is imperfect--and we must treat it with humility." With well-founded humility, accompanied hopefully by a slightly better understanding of the complex subject of information and forest management, we shall proceed along these lines.

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X. APPENDICES

Appendix A. Research projects and locations for North Central Forest Experiment Station (September 1982).

St. Paul, Minnesota

Resources Evaluation in the North Central Region
Multiple Use Evaluation and Modeling of Forest Ecosystems in the North Central Region
Plant Resistance, Climate, and Genetics as Related to Forest Insect Outbreaks
Canker, Foliar, and Root Diseases of Forests, Plantations and Christmas Tree Plantings
Wildlife Habitat Management Research
Backcountry River Recreation Management Research

Duluth, Minnesota

Economic Analysis of the Changing Demand for Timber in the Lake States

Grand Rapids, Minnesota

Ecology and Culture of Aspen, Birch, and Conifer Forests
Water Quality Management in Northern Lake State Forests

Rhineland, Wisconsin

Genetics of Northern Forest Trees
Intensively Cultured Plantations for Fiber and Energy Production
Physiology and Raw Material Evaluation of Intensively Cultured Plantations
Physiology of Wood Formation

East Lansing, Michigan

Fire Management Planning for the Northeastern United States
Insects Affecting Forest Plantation Ecosystems in the North Central States
Sewage Treatment on Forest and Associated Lands

Houghton, Michigan

Engineering Technology for Managing Northern Forest Stands

Marquette, Michigan

Silviculture and Ecology of Northern Hardwoods in the Lake States

Columbia, Missouri

Silviculture and Ecology of the Oak-Hickory Forest Ecosystem
Land Use Impacts on Wildlife Habitats of the Central Oak-Hickory Ecosystem

Carbondale, Illinois

Culture, Genetics, and Protection of Black Walnut, White Ash, and White Oak
New and Improved Systems, Methods and Techniques for Processing Hardwoods

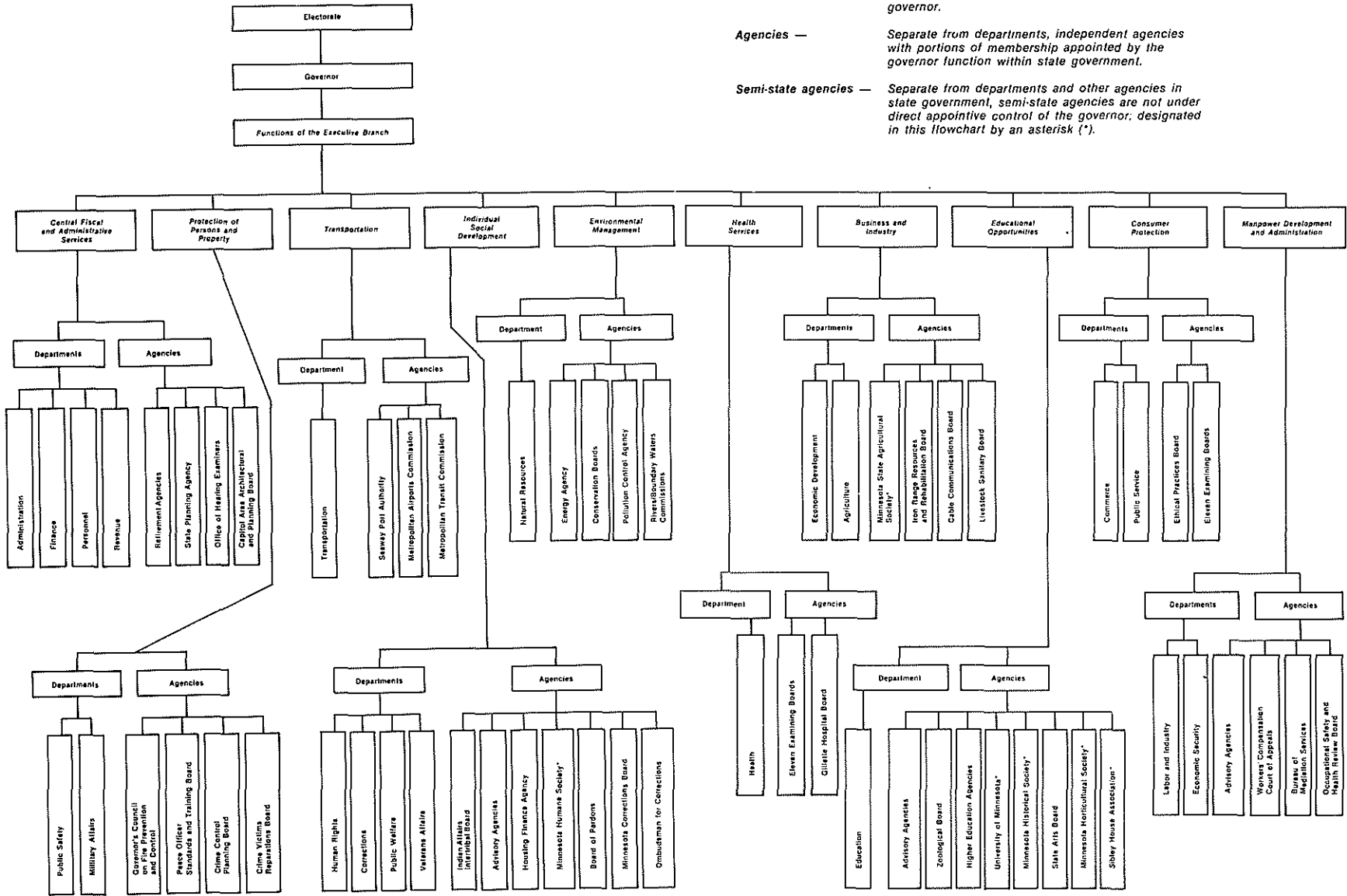
Chicago, Illinois

Enhancing Urban Forest Recreation Opportunities

Source: Research Attainments: FY 1982, North Central Forest Experiment Station.

Minnesota Legislative Manual 1979-1980
 Chapter 4
 EXECUTIVE BRANCH: DEPARTMENTS AND AGENCIES FLOWCHART

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Departments — Twenty executive departments in state government each headed by a commissioner appointed by the governor.

Agencies — Separate from departments, independent agencies with portions of membership appointed by the governor function within state government.

Semi-state agencies — Separate from departments and other agencies in state government, semi-state agencies are not under direct appointive control of the governor; designated in this flowchart by an asterisk (*).

Appendix C. Information Content of Fire Report Summaries, Minnesota Department of Natural Resources, Division of Forestry.

Statewide Summaries

- A-1 Statewide total of specific cause of railroad fire
- A-2 Statewide total by person responsible
- A-3 Statewide total values threatened
- A-4 Statewide total real and personal property damage
- A-5 Statewide total damages
- A-6 Statewide total resource damages
- A-7 Statewide totals of acres burned by ownership and class of land
- A-8 Statewide total of labor hours and number of fires by fuel type
- A-9 Statewide total of cause of month
- A-10 Number of fires by size class (statewide)
- A-12 Number and acres by railroad name (statewide)

Regional Summaries

- B-1 Number of fires by cause by Region
- B-2 Acres burned by cause by Region
- B-3 Number labor man-hours by Region

Area Summaries

- C-1 Total damage by Area
- C-2 Average damage/fire by Area
- C-3 Total hours used by equipment by Area
- C-4 Total chains of line put in by equipment by Area
- C-5 Average chains/hour by equipment by Area
- C-6 Average cost per fire by Area
- C-7 Average size at initial attack by Area
- C-8 Number of fires by violation by Area
- C-9 Number of fires by legal action taken by Area
- C-10 Average percent collection by Area
- C-11 Total person responsible
- C-12 Number labor man-hours by Area
- C-13 Average initial attack elapsed time by equipment used by Area
- C-14 Average control elapsed time by equipment used by Area
- C-15 Average fire size (total) by equipment used by Area
- C-16 Average cost of suppression by equipment used by Area
- C-17 Number acres by fuel type by Area
- C-18 Number fires by fuel type by Area
- C-19 Average control elapsed time by fuel type by Area
- C-20 Number and acres by IC by Area
- C-21 Number and acres by SC by Area
- C-22 Number and acres by BI by Area
- C-23 Number fires by character and SC by Area
- C-24 Number fires by worst behavior and SC by Area
- C-25 Number fires by character and BI by Area
- C-26 Number fires by worst behavior and BI by Area

District Summaries

- D-1 Number of fires by fuel type by District
 - D-2 Number of acres by fuel type by District
 - D-3 Number and acres by cause and township by District
 - D-4 Number by cause and month by District
 - D-5 Number and percent by cause and day of week by District
 - D-6 Number and percent by time of day and cause by District
 - D-7 Summary of fires by District, township, and type of detection
 - D-8 Average figures for initial attack elapsed time by equipment used by District
 - D-9 Average control elapsed time by equipment used by District
 - D-10 Average fire size by equipment used by District
 - D-11 Average fire cost by equipment used by District
 - D-12 Acres burned and average control elapsed time by fuel type
-

Appendix D. Data needs and Problems for Selected Information Classes and Categories.

A. FOREST RESOURCE INFORMATION

Mineral Deposits: Nature and Location

Information very difficult to obtain; some is confidential
Not all areas in state have been explored for mineral resources
On overall basis, least adequate of all information evaluated
Information very important for strategic (i. e., supervisory) management decisions

Forest Soils and Geomorphic Regions

Agricultural orientation of soil classification systems limits utility for forestry
Soil types only accurate to 40-acre level at best
Need soils information related to site index or other measures of tree growth potential
Major priority for planners; least adequate for field managers
Federal managers far more satisfied than those within other sectors

Forest Inventory Systems

Generally regarded as fairly adequate for management decisions
Planners less satisfied than those at other levels of management
Important priority for counties and forest industries
State Phase II inventory operations well received by most managers

Land Cover: Aerial Photographs

High priority for most groups despite relative satisfaction with existing information

B. LAND USE INFORMATION

Statistical validity of land use projections is often questionable
Future-oriented land use information least adequate of all categories for timber management staff
Important priorities for supervisors, particularly at the county level

C. FOREST OWNERSHIP AND JURISDICTION

Far less adequate for planners than for those at other levels of management
Acquisition/disposal information particularly inadequate for planners
Planners and field managers more favorable to consolidating ownerships to eliminate scattered parcels
Acquisition/disposal accounting most bothersome to state managers

D. LEGAL INFORMATION

Forest Land Taxes

Diverse opinions regarding adequacy and priority across all sectors and levels of management
Field foresters least satisfied with information adequacy; more training in tax-related matters considered an important need
Information far less satisfactory for public agencies than forest industry
Least adequate for federal managers, but not an important priority
Marginally adequate and major priority for state managers

E. FOREST ADMINISTRATIVE INFORMATION

Forest Road Systems

Information base quite limited for all levels of management
Key information needs: better data on existing roads; improved coordination for management of road networks serving different ownerships
Cost-benefit analyses for establishing/managing road networks are lacking
State Forest Road Plan will help address existing data deficiencies
Federal managers much more satisfied than others with information adequacy

Private Nonindustrial Forestry Assistance

Landowner behavior and management goals still imperfectly understood
Information lacking on productivity of private nonindustrial lands over time
Relatively important concern for field managers
Inadequate for federal managers, but not an important priority

F. TIMBER MANAGEMENT INFORMATION: BIOLOGICAL AND SILVICULTURAL

Timber Growth Projections

Growth and yield information for managed stands an important need
Projection methodology for mixed stands deserves more emphasis
Major priority for all management levels except timber staff
Important priority for counties and forest industry

Timber Harvests: Past and Projected

Relationship of allowable cut information to actual harvest availability clouded by budgetary/personnel adjustments of public agencies
Access factors increase uncertainty in allowable cut-availability relationship
Most important information need for timber management staff

Timber Harvests: Past and Projected
(continued)

Counties/industry far less satisfied with existing information than federal/state sectors
Critical priority for forest industry

Reforestation

Second highest priority on overall basis despite assessments of moderate adequacy
Improved information required on survival/growth in relation to site preparation methods
Need for better tracking of results of reforestation programs: detail and comparability over time
Major priorities to timber management staff and field managers
Most important information priority for state managers

Forest Insects and Diseases

Historical relationships of infestations to forest growth not clearly defined
Damage and risk functions almost nonexistent
Little spatial breakdown of information on timber losses to insects/ disease
Relatively high priority for state and industrial managers

Herbicide and Pesticide Usage

Better knowledge required on toxicity levels and impacts on various species
Effective life for various pesticides not always clearly defined
Better documentation of herbicide effects on seedling growth required
Highest priority for field managers; also key need for supervisors
Most important information need for county organizations

G. TIMBER MANAGEMENT INFORMATION: ECONOMICS AND UTILIZATION

Timber-Pulpwood Supply and Demand

First or second highest priority for all levels except field managers
Demand information particularly troublesome to planners
Highest priority for all groups in aggregate by wide margin

Wood Residues: Supply and Demand

Need better definition of economic aspects of utilization: markets, transportation costs, etc.
Least adequate and important priorities for supervisors and timber management staff
State managers more satisfied with existing information than other sectors

Fuelwood: Supply and Demand

As with timber/pulpwood, demand dimensions least understood
High priorities for planners and timber staff
Federal and industrial sectors expressed greatest need for improved information

Timber Sales

Information generally adequate but still major priority for timber staff
Far higher priority for timber staff and industrial managers than for other levels/sectors
Recent computerization by federal and state agencies will improve information processing

Forest Products Prices

Generally adequate but difficult to interpret with respect to management situation in Minnesota
Major primary sources come from out-state

Imports/Exports: Wood Products

Inadequate for managers but not an important priority

Forest Labor and Equipment

Inadequate for managers; none rated as a priority need
Information often too transient for application to management at the local level
Labor availability and costs of interest to managers, particularly at the county level

Independent Loggers

Available capital, productivity and machinery mixes vary with different logging situations

Wood Processors

Information tends to become obsolete too quickly to allow reliance upon it for management purposes

H. NONTIMBER FOREST MANAGEMENT INFORMATION: WILDLIFE AND RECREATION

Forest Wildlife Resources

Generally a high priority, although adequacy assessments varied
Inadequate production functions and wildlife valuation methods still a major problem for planners
Determination of population levels and relationships to forest vegetation a key need
Spatial responses of wildlife to diversification of cover types not clearly understood
Integration of species-specific information within particular management context (i.e., cover type, timber species mix) often difficult to achieve
Very high priority for federal managers; important for other public sectors as well

Forest Recreation

As with wildlife, quantification of recreation values remains elusive

Spatial information relating population density to recreational opportunities difficult to synthesize

Planners and timber staff least satisfied with current recreation information

Forest Management Research

Applicability of results biggest problem for field managers

Better descriptions required regarding feasibility of applying research results under management-budgetary constraints

Problem definitions by researchers not always adequately reflective of actual management situations

Federal managers much more satisfied than those at state or county levels

Appendix E. Questionnaire: Information Availability and Adequacy for Public Forest Management in Minnesota.

RESPONDENT ORGANIZATION AND POSITION

Which of the following group of forest land management agencies/organizations in the state are you employed with?

- Federal
- State
- County
- Industry

Which of these organizational areas or positions best describes the nature of your work?

- Supervisor/Director
- Land Management Planning
- Timber Management
- Forest Resource Economics
- Nontimber Forest Resource Management
- Field Operations Supervisor
- Other (specify):

INFORMATION CATEGORY CHECKLIST

For each information category, please check on the following pages how adequate you think existing information is for the forest management decisions you must make. Should you indicate that information is only marginally adequate or inadequate, please feel free to comment on any problems, needs, or potential solutions.

INFORMATION PRIORITIZATION AND NEEDS

From the information categories listed on the following two pages, please select the five information items about which improved information would benefit you most in your forest management decision making. Please prioritize these five information needs in order of importance to you.

- 1)
- 2)
- 3)
- 4)
- 5)

Comments:

What are your thoughts regarding the general availability and adequacy of information for forest management in Minnesota? What problems bother you the most regarding existing information you utilize in making decisions? How might these difficulties be addressed?

A. INFORMATION CATEGORY CHECKLIST

For each information category, please check how adequate you think existing information is for the forest management decisions you must make. Should you indicate that information is only marginally adequate or inadequate, please feel free to comment on any problems, needs or potential solutions.

Information Category	How adequate is this information for forest management decisions you must make?					If information is inadequate or marginally adequate, any comments. (Please use reverse side if you need more space.)
	Very Inadequate	Fairly Inadequate	Marginally Adequate	Fairly Adequate	Very Adequate	
<u>TIMBER MANAGEMENT: SILVICULTURE</u>						
Timber Growth Projections	_____	_____	_____	_____	_____	_____
Timber Harvests: Past/Projected	_____	_____	_____	_____	_____	_____
Timber Harvesting Permits	_____	_____	_____	_____	_____	_____
Reforestation	_____	_____	_____	_____	_____	_____
Nursery Operations	_____	_____	_____	_____	_____	_____
Intermediate Silvicultural Activities	_____	_____	_____	_____	_____	_____
Forest Insect/Disease Information	_____	_____	_____	_____	_____	_____
Herbicide/Pesticide Usage	_____	_____	_____	_____	_____	_____
Fire Protection and Control	_____	_____	_____	_____	_____	_____
<u>TIMBER MANAGEMENT: ECONOMIC</u>						
Timber-Pulpwood Supply/Demand	_____	_____	_____	_____	_____	_____
Stumpage Prices	_____	_____	_____	_____	_____	_____
Forest Products Prices	_____	_____	_____	_____	_____	_____
Timber Sales	_____	_____	_____	_____	_____	_____
Timber Scaling Reports	_____	_____	_____	_____	_____	_____
Imports/Exports: Wood Products	_____	_____	_____	_____	_____	_____
Fuelwood: Supply/Demand	_____	_____	_____	_____	_____	_____
Wood Residue: Supply/Demand	_____	_____	_____	_____	_____	_____
Wood Processors: Primary/Secondary	_____	_____	_____	_____	_____	_____
Independent Loggers	_____	_____	_____	_____	_____	_____
Logging/Wood Processing Technology	_____	_____	_____	_____	_____	_____

GENERAL INFORMATION REQUIREMENTS

1.	Most information problems are not due so much to not getting enough information, but rather that it's often not organized in a form useful for decisions.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
2.	The information load is getting too large to manage effectively.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
3.	Other agencies generally make the information they collect available to us in a useful fashion.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
4.	Hazy organizational goals often make information needs hard to pinpoint.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
5.	Our ability to compare timber and nontimber forest resource information for management decisions is quite limited.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
6.	What is needed is a single centralized information system for all forest management activities in the state.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
7.	I'm not entirely confident that we really understand the desires of the constituencies whom our agency serves.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
8.	The flow of information within our own agency could be greatly improved.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>
9.	Research in forest management is maintaining a good balance in focusing on the variety of management problems which affect the decisions I make.	<u>Strongly Disagree</u>	<u>Moderately Disagree</u>	<u>Neutral</u>	<u>Moderately Agree</u>	<u>Strongly Agree</u>



