

# Cloquet Forestry Center Forest Management Report (1981–1986)

Ronald W. Severs  
Alvin R. Hallgren  
A. Scott Reed



Station Bulletin 591–1989 (Item No. AD–SB–3766)  
Minnesota Agricultural Experiment Station  
University of Minnesota





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**St. Paul, Minnesota**

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# CLOQUET FORESTRY CENTER FOREST MANAGEMENT REPORT (1981-1986)

Ronald W. Severs, Alvin R. Hallgren and A. Scott Reed

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## INTRODUCTION

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The Cloquet Forestry Center, a field campus of the College of Natural Resources of the University of Minnesota, is the oldest experimental forest under continuous operation by a university in the United States. The Center is an enduring institution, having lasted through several sets of war years, recessions and the great depression.

The 1980s, however, posed new management problems for the forest.

With most of the forest originating from natural fires in the late 1800s and early 1900s, much of the forest was mature and overmature timber. Losses through mortality were exceeding annual growth in many stands.

The Center needed to establish a management program that would provide a healthy state-of-the-art forest for the Center. For this reason the 1980s have been one of the most productive and interesting periods for forest management at the Center.

In July, 1981, a newly revised forest management program was put into effect at the Cloquet Forestry Center. Its purpose was to intensify the development of the Center's forest, to optimize opportunities for research, teaching and demonstrations.

The forest management program is guided by three plans--a Ten-Year Forest Management Plan, a Five-Year Forest Management Plan and a Road Plan.

The ten-year plan outlines management goals to be met during the period 1981 through 1990. That plan concentrates its efforts on the management of the upland forest types. Those are the more productive forest lands, and they support the largest area of mature and over-mature stands, and younger stands in need of improvement.

The five-year management plan was site-specific, outlining management treatments for specific areas on an annual basis for 1981-1986. A second five year forest management plan, carrying management treatments forward through the end of the ten year period, has been developed for 1986 through 1990.

The road access and maintenance plan was developed to complement the forest management plans.

This report summarizes and documents the forest management activities for July 1, 1981 through June 30, 1986. As with its predecessors, this report attempts to convey insights regarding the level of harvesting during the period and the

effect of that harvesting on cover type and age class distribution. It documents income and expenditures related to the forest management program, silvicultural practices, regeneration efforts and costs, and the road maintenance and

access control program. Research projects conducted at the Center during that period are listed. Teaching and demonstration projects related to the management of the forest are also discussed.

## HISTORY

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The Cloquet Forestry Center, which was activated in 1910 as an experimental and demonstration forest, is administered by the University of Minnesota's College of Natural Resources (formerly known as the College of Forestry) in St. Paul.

The Center resulted from the vision and enthusiasm of Professor Samuel B. Green, the founder and first head of the University's forestry school. He advocated establishing a forestry field station as early as 1896.

Green also felt that a forestry field station should be located in the vicinity of an important sawmill center. The town of Cloquet at that time easily met those requirements, but it was the opening of land in the Fond du Lac Indian Reservation for disposal to outsiders that provided the opportunity to establish the research forest.

Green received a friendly reception and strong support from the sawmills in Cloquet for creating of a school forest. It was the kind of support that brought together, in 1909, the necessary federal and state legislation and sufficient funding to permit the federal government to deed 2,215 acres of unallotted Indian lands directly to the University of Minnesota.

The Reservation land was sold at \$1.25 per acre, plus the value of the timber on it. Several Cloquet sawmills were involved in the arrangements which transferred the Reservation land into University ownership, and their interest and cooperation were important to the establishment of the Cloquet Forestry Center.

The initial block of 2,215 acres was paid for by the St. Louis River Mercantile Company with the

understanding that while title to the land would go to the University, timber rights would be retained by the Company. St. Louis River Mercantile cut most of the white and red pine on the tract in 1910, under the supervision of the Indian Service.

The Northern Lumber Company, which owned the timber rights on several smaller tracts of land deeded to the University, at the request of the University agreed to not cut several stands, groups of trees, and scattered seed trees. The uncut wood amounted to 109,000 board feet of white pine and 1,188,000 board feet of red pine. Northern was reimbursed by the University for the price that was paid to the Reservation for that timber. An additional 447 acres were purchased from Indian allotments.

The purchase of several more small tracts over the years, and the acquisition of several gifts of land, have increased the Center ownership to its present size.

The Center has experienced several name changes since its establishment. In chronological order, it was the Forestry Station, Forest Experiment Station, Experimental Forest, and Forest Research Center before receiving its current name, Cloquet Forestry Center (B. A. Brown 1960).

There are currently 15 permanent employees assigned to the Center. They are two professors, an assistant professor and extension specialist (currently serving as Center coordinator), tree improvement specialist, vegetation management specialist, forest soil scientist, associate scientist, two research plot technicians, four secretaries, and two laborers.

## LOCATION, AREA AND DESCRIPTION

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The Cloquet Forestry Center consists of 3,738 acres of forest and associated lands in Carlton County (Univ. of MN, 1987). Its administrative

headquarters are located on a tract of 3,340 contiguous acres of forest land in the northeastern part of the county. That tract, while

It is within the boundaries of the City of Cloquet, is in a rural setting approximately four miles southwest of the city's business district. It falls within the St. Louis River drainage of the Lake Superior basin.

Upland forest types cover about two-thirds of its contiguous tract. These are mainly red, white, and jack pine; spruce-fir; and aspen-birch. The remaining acreage is predominantly low-land forest types, black spruce and tamarack, with a small portion of northern white cedar.

By some quirk of nature the Center was not burned in a disastrous 1918 Cloquet fire. Its age classes of timber and other ecosystems are 20-25 years older than those of adjacent lands. That fact, plus its high percentage of upland conifer types, make it appear an oasis within the surrounding forest area.

The Center's large 3,340 acre tract, and the small scattered tracts containing 398 acres, have the following legal land descriptions in the University's Real Estate Inventory, 1987:

Parts of Sections 1 and 6, Township 48 North, Range 17 West;

Parts of Sections 28 and Sections 29-32 inclusive, Township 49 North, Range 17 West;

Parts of Sections 18-20, inclusive, Township 48 North, Range 18 West; and Section 36, Township 49 North, Range 18 West, Carlton County, Minnesota.

Geographical locations are shown on maps in Figures 1 and 2.

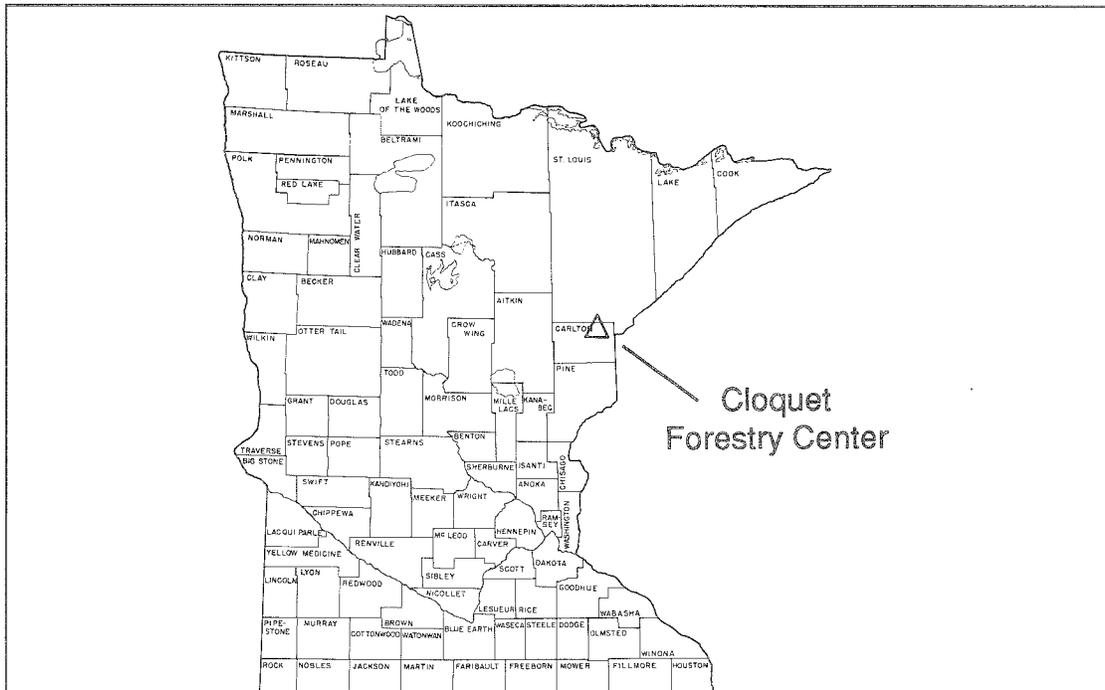
## HARVESTING

### ACRES HARVESTED

Over the past five years, 32 areas consisting of a total 426.5 acres have received intermediate or final harvesting treatments. All but 26 of those

acres represent upland vegetation types. Harvesting was done for one of three reasons: research, demonstration or management. Twenty of the 32 areas were harvested primarily for management purposes. The remaining 12

Figure 1. Location of Cloquet Forestry Center in Minnesota.



were harvested in association with research and demonstration projects. Most of the harvesting was accomplished by contract logging. Harvesting associated with research projects was accomplished by Cloquet Forestry Center personnel and equipment.

harvested by vegetation type and type of cutting is shown in Table 1.

**INTERMEDIATE CUTTING**

Figure 3 shows a vegetation map of the Cloquet Forestry Center which indicates areas that have received harvesting treatment. Numbers next to each area represents the fiscal year in which the treatment occurred. The distribution of acres

Approximately 117 acres received various types of intermediate cutting (Figure 1). Intermediate cuts were primarily prescribed for overstocked high value areas that had not yet reached rotation age. All of that kind of cutting occurred

Figure 2. Location of Cloquet Forestry Center in Carlton County.

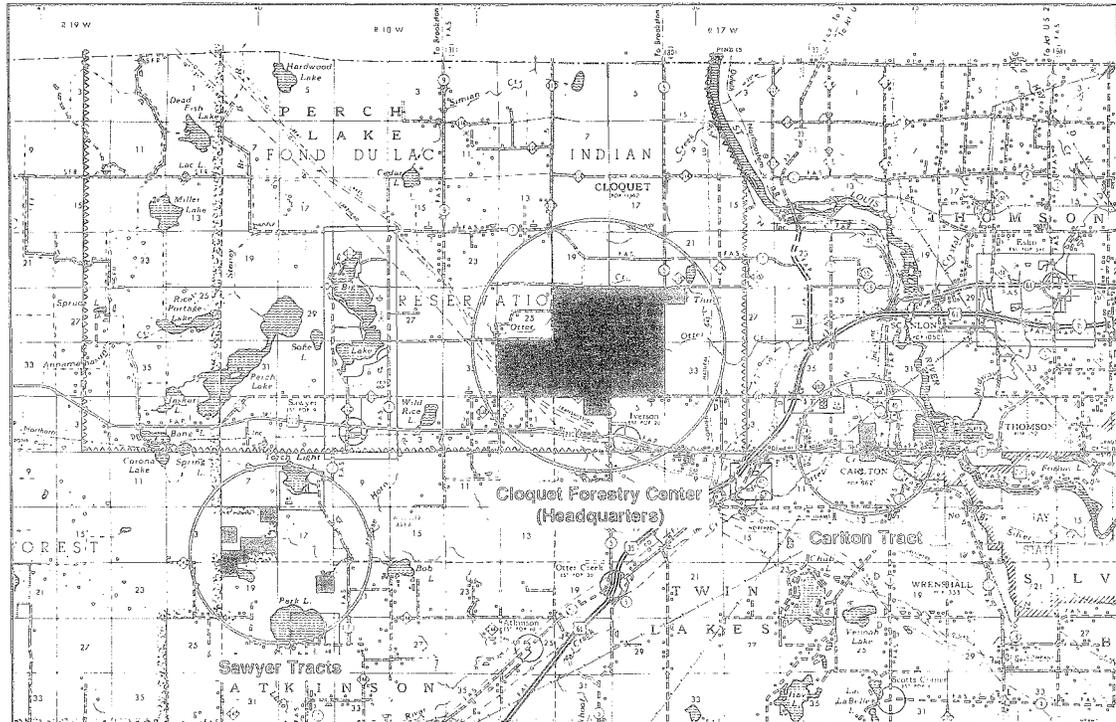


Table 1. Acres harvested—by harvesting treatment and vegetation type for the period July 1981 through June 1986.

Acres by Harvesting Treatment	Acres by Vegetation Type								Annual Average
	Aspen	Birch	Spruce Fir	White Pine	Red Pine	Jack Pine	Black Spruce	Total	
Clearcut	129.0	32.0	38.7	7.5	23.7	53.1	25.8	309.8	62.0
Intermediate Cut	0	0	0	5.0	79.9	31.8	0	116.7	23.3
<b>Total Acres</b>	<b>129.0</b>	<b>32.0</b>	<b>38.7</b>	<b>12.5</b>	<b>103.6</b>	<b>84.9</b>	<b>25.8</b>	<b>426.5</b>	<b>85.3</b>

Source: Moeur, M., Ek, A. R., Rose, D. W. 1980. Vegetation Types Based on Predominate Overstory.

in the pine types, primarily in red pine.

Some intermediate cutting was done in the healthier, mature jack pine types. That was done to lengthen the rotation age for some stands.

A majority of the jack pine type is, however, still classified as mature or over-mature (Table 3). Carrying some of those jack pine stands past the normal 60-70 year rotation will provide a better age class distribution in the jack pine type.

### CLEARCUTTING

Approximately 310 acres were harvested by clearcutting (Table 1, Figure 3). Clearcuts were primarily prescribed for areas past desired rotation age, poorly stocked, or occupied by poor quality, low value timber.

Clearcutting occurred in all of the commercial upland types. As shown in Table 1, the aspen type received the most clearcutting. The 129 acres of aspen represents about 42 percent of all acres clearcut. Relatively heavy cutting in the aspen type results from both the need for management and a strong aspen market.

### HARVESTING EFFECTS ON FOREST TYPES AND SIZE CLASS DISTRIBUTION

One objective of the management program has been to develop a better age class distribution in

the forest types while maintaining the approximate existing acreage of each type. Until recently, most of the forest types consisted primarily of mature to over-mature stands. There was little acreage in the young stand category (i.e., seedling-sapling).

The past five years of harvesting and regenerating has begun to establish a better distribution of size classes within the types. Although most of the acreage harvested was in the pine and aspen types, the largest percentage changes occurred in the spruce-fir and black spruce types. That was because of the smaller acreage those types occupy in relation to the acres harvested in them.

Table 2 shows the number of acres that were in each of the seedling-sapling, pole, and sawtimber size classes for the years 1977 and 1986. The 1977 cover type acreage shown in Tables 2, 3 and 4 was taken from Zasada, 1981. There were seven forest types affected by harvesting.

Table 3 shows the percentage of each type of size class that the acres occupied for the years 1977 and 1986.

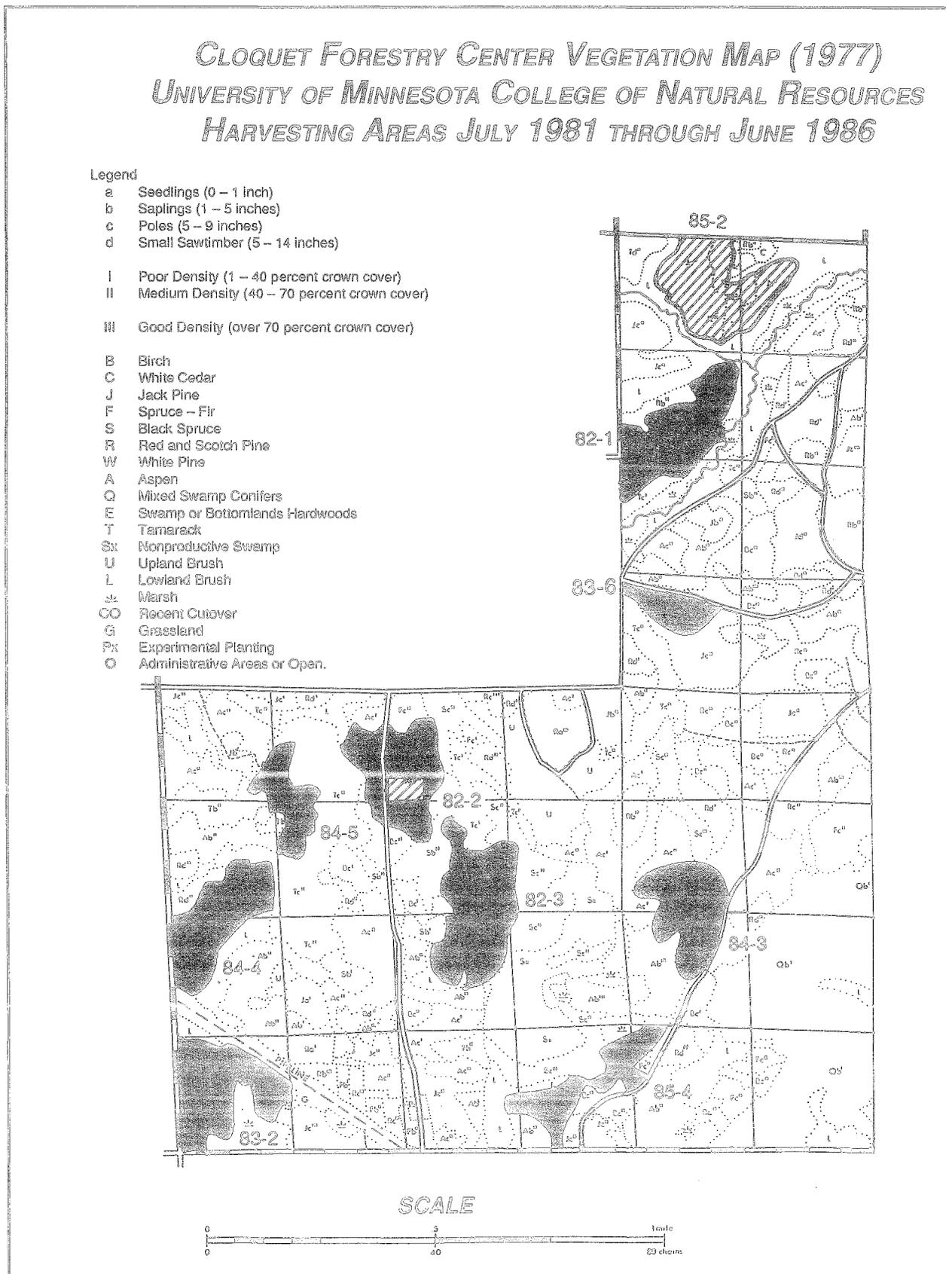
Because of available data, the years 1977 and 1986 are compared in the tables. However, most of the change has occurred during the period 1981 through 1986. It is during this shorter period that 90 percent of the harvesting has taken place.

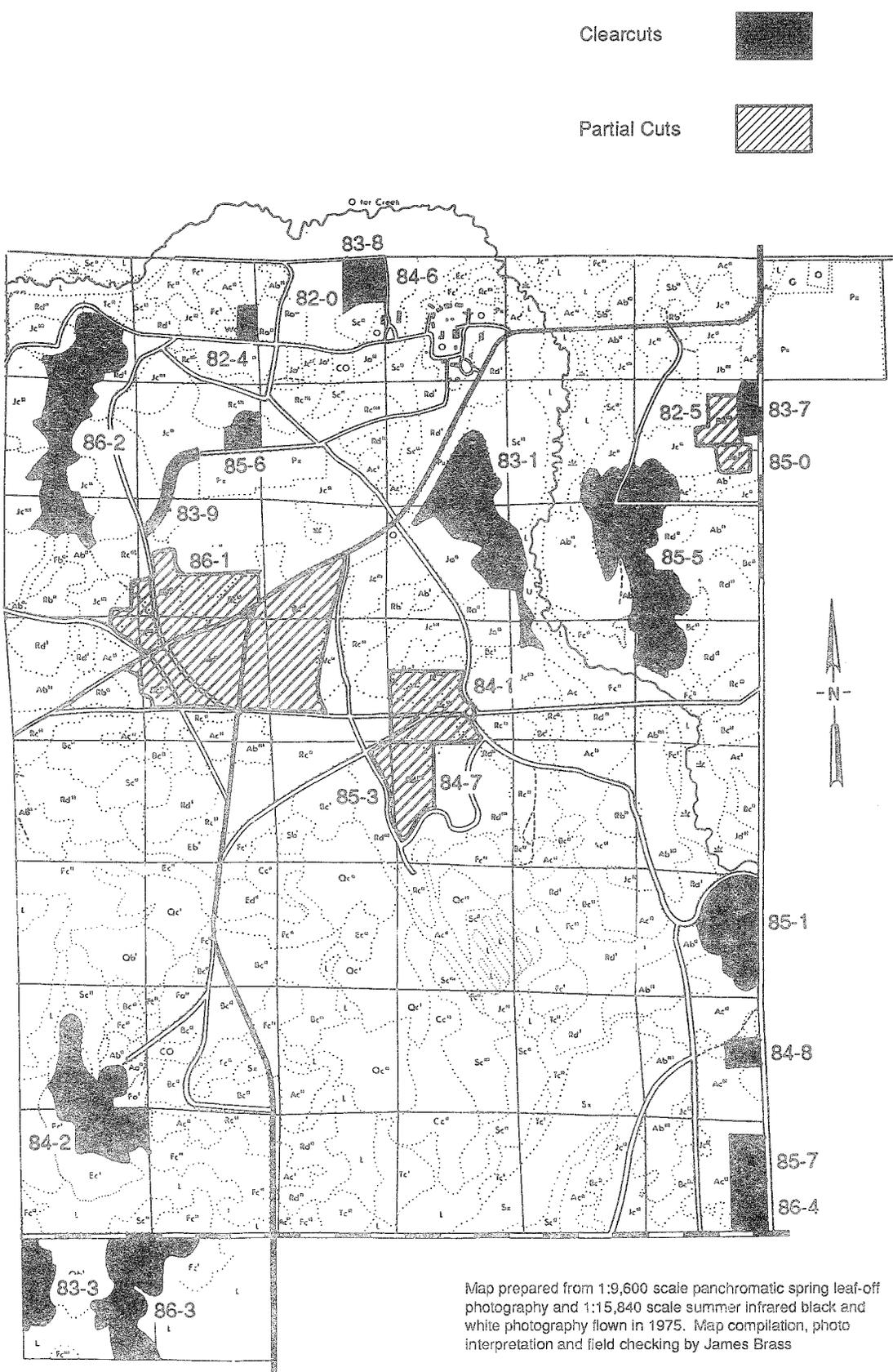
The Center's forest has a good representation of

Table 2. Distribution of cover types by size class acres—1977 vs 1986.

Cover Type	Seedling-Sapling		Pole		Sawtimber		Total Acres	
	1977	1986	1977	1986	1977	1986	1977	1986
Jack pine	49	61	385	336	40	21	474	418
Red pine	80	181	270	290	267	246	617	717
White pine	0	2	10	8	10	5	20	15
Spruce fir	20	68	222	186	0	0	242	254
Black spruce	28	62	180	151	0	0	208	213
Birch	0	10	208	174	0	0	208	184
Aspen	266	264	396	366	0	0	662	630
Total	443	648	1671	1511	317	267	2431	2431

Figure 3. Harvesting area locations by year and type of harvest.





the forest types that exist throughout northern Minnesota. As stated earlier, a goal of the management program is to maintain the approximate acreage of each type that existed prior to the initiation of the program.

Table 4 shows the acreage of the various forest types and the percent of the total forest that each type occupied in 1977, prior to this program, and the acreage and percent of the total forest they occupied in 1986, five years into the management program.

The largest change occurred in the red pine type, which had a 3 percent increase in the total forest area. The largest loss of area, 1.7

percent, was in the jack pine type. That was followed by aspen, which lost 1 percent of its forest area. Gains and losses in the other forest types were less than one percent. That effort in control-of-type maintenance has continued to be an objective during the second period of the ten year management program.

*TIMBER VOLUMES HARVESTED*

Harvesting on the Center's forest was accomplished either by Center personnel and equipment or by contract loggers.

Table 3. Percent distribution of cover types by size class—1977 vs 1986.

Cover Type	Seedling-Sapling		Pole		Sawtimber	
	1977	1986	1977	1986	1977	1986
Jack Pine	10	15	31	30	9	5
Red Pine	13	25	44	41	43	34
White Pine	0	13	50	53	50	54
Spruce Fir	8	27	92	73	0	0
Black Spruce	13	29	67	71	0	0
Birch	0	5	100	95	0	0
Aspen	40	42	60	58	0	0

Table 4. Total forest area by acres and percent of forest type—1977 vs 1986.

	1977		1986		Percent of Forest Difference
	Acres	Percent of Forest	Acres	Percent of Forest	
<b>Upland Forest</b>					
Jack Pine	474	14.1	418	12.4	-1.7
Red Pine	617	18.3	717	21.3	+3.0
White Pine	20	0.6	15	0.4	-0.2
Spruce-Fir	242	7.2	254	7.6	+0.4
Birch	208	6.2	184	5.5	-0.7
Aspen	662	19.7	630	18.7	-1.0
Upland Brush	31	0.9	31	0.9	0
<b>Lowland Forest</b>					
Black Spruce	208	6.2	218	6.4	+0.2
Northern White Cedar	31	0.9	31	0.9	0
Tamarack	131	3.9	131	3.9	0
Mixed Swamp Conifers	218	6.5	218	6.5	0
Lowland Hardwoods	37	1.1	37	1.1	0
Non-productive Lowland	484	14.4	484	14.4	0
<b>Total</b>	<b>3363</b>	<b>100.0</b>	<b>3363</b>	<b>100.0</b>	

Areas harvested primarily for research purposes were harvested by Cloquet staff. These research areas usually had insufficient volumes and/or special harvesting requirements that prevented economical harvesting by contract loggers. Contract logging was used on areas harvested primarily for management purposes. Those areas usually had unique harvesting requirements that made them useful for teaching or demonstration purposes. However, to reduce the economic impact on the operation, restrictions were kept at a minimum.

All contract sales provided a one year period in which to complete the harvesting. To date, all harvesting operations have met that requirement. Other requirements included 100% clearcuts with random skidding. That meant that all standing trees, whether or not they were

merchantable, had to be felled. Random skidding was used to break down the brush and slash for site preparation purposes. That also left felled timber more visible, thereby increasing utilized volumes from those areas.

Volumes varied widely by species, product, and year. Market conditions greatly influenced the salability of some tracts. Spruce, fir, tamarack, birch and maple species had sporadic markets while aspen and pine had strong steady markets.

Table 5 summarizes volumes harvested by product species and year.

The conversion of board feet to cords (500 bf/cd) gives a total of 8,343 cords harvested during the five-year period. That breaks down to 15% of

Table 5. Product volume summary by species and year.

Year	White Pine	Red Pine	Jack Pine	Scotch Pine	White Spruce	Tamarack	Balsam Fir	Cedar	Black Spruce	Birch	Aspen	Maple	Ash	Total
<b>Board Feet-Sawlogs<sup>1</sup></b>														
1982	41,420	15,980			22,036	1,200	0,385							81,021
1983	1,400	26,299												27,699
1984	38,500	266,235			46,600	0,800	100			1,750				355,985
1985	18,650	124,645			10,500		1,130							154,925
1986	1,400	20,280				0,760								22,440
<b>Total</b>	<b>101,370</b>	<b>453,439</b>			<b>81,136</b>	<b>2,760</b>	<b>1,615</b>			<b>1,750</b>				<b>642,0</b>
														(Total Cords Equivalence of Total Volume: 1284.14CD)
<b>Cords-Boltwood<sup>2</sup></b>														
1982	30.91	6.20	235.78		33.95	0.6				23.10				330.54
1983		64.71	479.41		4.20		12.18			12.50				573.00
1984		66.00	14.11				26.00			10.00				118.11
1985	4.00	19.00	97.88		7.00		1.30							129.18
1986	9.00	105.00	39.00				5.00							158.00
<b>Total</b>	<b>43.91</b>	<b>262.91</b>	<b>866.18</b>		<b>45.15</b>	<b>0.6</b>	<b>44.48</b>			<b>45.60</b>				<b>1,308.83</b>
														(Total Board Feet Equivalence of Total Volume: 654.415BF)
<b>Cords-Pulpwood<sup>3</sup></b>														
1982	42.32	47.00	267.85	15.2	42.95	20.76	141.36		69.48	221.20	402.64	59.72		1,335.48
1983		6.12	525.26				91.77		81.60	97.60	357.48			1,159.93
1984	10.41	95.16	77.14		75.08		104.00	5.00	19.00	503.50	221.00	90.20	2.00	1,202.49
1985		36.44	147.32		5.00		21.00			358.20	225.00	16.00		808.96
1986		203.40	7.00		6.60	93.00	231.00	5.00	483.00	189.00	71.00	4.00		1,243.00
<b>Total</b>	<b>57.73</b>	<b>388.12</b>	<b>1,024.57</b>	<b>15.2</b>	<b>129.63</b>	<b>113.76</b>	<b>599.13</b>	<b>5.00</b>	<b>608.08</b>	<b>1,369.50</b>	<b>1,277.12</b>	<b>169.92</b>	<b>2.00</b>	<b>5,749.76</b>
														(Total Cords Equivalence of Total Volume: 8,342.73)

<sup>1/</sup> Merchantable 100-inch length roundwood having top diameter greater than 14 inches or roundwood having a top diameter greater than 8 inches and length longer than 100 inches. 500bf/cd conversion factor. <sup>2/</sup> Merchantable 100-inch length roundwood having top diameter range of 7 inches to 14 inches. 500bf/cd conversion factor. <sup>3/</sup> Merchantable 100-inch length roundwood having top diameter range of 3 inches to 7 inches.

the total volume being sawlogs, 16% boltwood, and 69% pulpwood. In terms of total acreage of the forest (3,340 ac), harvesting is taking place at the rate of .5 cd/ac/yr. In terms of upland management (2,223 ac) harvesting is taking place at the rate of .75 cd/ac/yr. Harvesting during the next five-year period is expected to progress at nearly the same rate.

**INCOME FROM HARVESTING**

Several procedures were used to derive income from the timber harvested on the Center. Timber sale contract logging, which was the method most commonly used on areas harvested for forest management purposes, made up the largest part of the harvesting income. Those contract sales which specified conventional harvesting techniques were sold lump sum by sealed bids and/or oral auction. When the contract sale had unique harvesting requirements, the timber was sold at a negotiated price using consumer scaling.

For tracts harvested by Center personnel the timber was either hauled to a mill with the Center receiving the F.O.B. mill price or it was sold on the landing to the general public by sealed bid.

Flexibility in selling timber was key both to the success of selling all tracts put up for sale and

receiving high stumpage prices for the wood. Table 6 shows income by year generated from the sale of timber.

Major factors influencing stumpage values are species, market demand, accessibility, quality, quantity, market distance and logging conditions. The Center has many of these factors in its favor, and in combination with strategic timber sale design and innovative sale procedures, has been able to receive high stumpage prices for its wood.

Table 7 compares Forestry Center stumpage prices with the average for all public agencies selling timber in the State. Softwood sawtimber prices for the Center averaged 56 percent higher than the average for all public agencies.

**Table 6: Harvesting Income.**

Fiscal Year	Income
7/81 - 6/82	\$ 25,812
7/82 - 6/83	30,359
7/83 - 6/84	50,042
7/84 - 6/85	9,662
7/85 - 6/86	25,725
Total	\$141,600

**Table 7. Weighted stumpage price comparisons for primary species.**

	1982			1983			1984			1985			Four Year Average
	All Public Agencies	Cloquet Forestry Center	% Diff	All Public Agencies	Cloquet Forestry Center	% Diff	All Public Agencies	Cloquet Forestry Center	% Diff	All Public Agencies	Cloquet Forestry Center	% Diff	
<b>Sawtimber</b>													
Dollars Per MBF													
Red & White Pine	65.00	90.00	+23	58.59	92.00	+54	60.29	97.00	+61	62.34	116.00	+86	+56
Jack Pine	47.00	55.25	+15	39.00	59.00	+50	45.40	--	--	39.84	64.00	+64	+42
Spruce	30.29	44.00	+45	26.95	--	--	31.43	52.00	+65	35.74	73.00	+104	+71
<b>Pulpwood</b>													
Dollars Per Cord													
Aspen	3.11	3.10	0	3.08	2.78	-11	3.41	2.94	-20	3.44	3.42	-1	-8
Birch	2.15	3.02	+40	2.33	2.71	+16	3.91	2.63	-49	2.18	4.16	+91	+24
Pine	10.97	11.23	+2	9.51	13.39	+41	9.98	10.76	+8	9.20	14.04	+51	+25
Spruce	14.20	--	--	12.87	19.83	+54	12.69	16.41	+29	9.29	20.65	+122	+68
Balsam	4.02	4.23	+5	3.55	4.16	+17	3.62	3.42	-6	2.97	4.44	+49	+16
Source for "all Public agencies" data: DNR Annual Stumpage Price Reports.													

Softwood pulpwood prices averaged 36 percent higher and hardwood pulpwood prices averaged 8 percent higher than the average for all public agencies.

### EXPENDITURES FROM HARVESTING INCOME

Income from timber sales and various logging projects is used mainly to support the management program. Money needed for items directly related to management, such as seedling purchases, fuel, herbicides, etc., take

priority over indirectly related items, such as typewriters, copier, insurance, etc.

Table 8 separates expenditures into four categories: contract hauling, supplies, wages and miscellaneous. Expenditures are also shown by the year they occurred.

The Center's management program has been supporting a share of the wages for one full-time employee. It has also funded several assistantships for students working on projects that relate to management of the forest. Some short-term and part-time positions have also been supported.

## FOREST REGENERATION

### REGENERATION ESTABLISHMENT

Since the establishment of the Center, regeneration of the forest has been a continuing effort with varying degrees of success. J. H. Allison et al (1946) indicated that 484,500 seedlings were planted on 620 acres during the period 1933-1937. Done by Civilian Conservation Corps workers, that planting was of unusually high caliber. Early survival checks showed a high degree of success. However, because resources to control competing vegetation were lacking, survival decreased with time. Later checks indicated survival ranged from complete failure to 60% success. By 1944 overall planting success was estimated to be about 30 percent.

During the past five years, major efforts have been made to regenerate areas being harvested. Conifer clearcuts and hardwood conversion areas were regenerated artificially by machine or hand planting. Hardwood areas were restocked with natural regeneration.

Approximately 136,000 trees were planted during this period. Twenty areas were planted, ranging in size from two to 30 acres. Spacings ranged from 6x8 feet to 10x10 feet. Standard field planting was 6x8 feet (908 trees per acre). Average spacing for all plantings was about 7x7 feet (830 trees per acre).

A plantation is considered successful when the

Table 8. Management income and expenditures—July 1, 1981 vs June 30, 1986.

Year	Income	Contract Hauling <sup>1</sup>	Supplies <sup>2</sup>	Wage	Miscellaneous <sup>3</sup>	Balance
1981-82	\$ 25,812	\$ 1,005	\$ 5,350	\$ 1,315	\$ 31	\$ 18,111
1982-83	30,359	454	3,107	8,131	191	18,476
1983-84	50,042	861	12,382	12,910	2,193	21,696
1984-85	9,662	974	17,625	24,219	3,204	- 36,360
1985-86	25,725	630	11,952	19,096	6,722	- 12,675
Totals	\$141,600	\$3,924	\$ 50,416	\$65,671	\$12,341	\$ 9,248
Percent of Total Income		3%	36%	46%	9%	6%

<sup>1/</sup> Contract hauling is money paid for hauling of wood produced by center personnel to local mills by independent truckers. <sup>2/</sup> Supplies include: diesel fuel, equipment, equipment repairs, herbicides, seedlings, site preparation, computer, gates, gravel, etc. <sup>3/</sup> Miscellaneous includes: travel, lunches, workshops, typewriters and copier, vehicles, insurance, etc.

area is 100 percent stocked, with at least 400 planted trees per acre, five years after the date of planting .

Though most areas planted during this management period are still in the establishment phase, preliminary plantation results are favorable. The entire planting program averaged 830 planted trees per acre. Average survival has been 508 trees per acre with 96 percent stocking. That gives an average survival of 61 percent for the planting program. Surviving trees per acre range from 390 to 680, with stocking ranges of 85 to 100 percent.

Natural conifer regeneration on planted areas range from 100 trees per acre at 25 percent stocking to 1,250 trees per acre at 100 percent stocking. When planted and natural figures are combined, all areas now appear to be well stocked with conifers.

Because of the important role plantations have in future research, teaching, demonstration and management programs at the Center, they will continue to be monitored closely.

### *REGENERATION COSTS*

Regeneration costs varied depending on treatments. As stated earlier, hardwood areas were left to regenerate naturally. The only regeneration costs associated with those areas would have been reflected in lower stumpage prices due to the removal of all trees as a clearcut harvesting requirement.

Clearcut harvesting was required to obtain maximum sunlight on the forest floor to stimulate sprouting. The estimated extra cost for cutting the unmerchantable trees was approximately ten dollars per acre.

Conifer regeneration was more varied and more expensive. A large portion of this conifer regeneration was done to accommodate research and/or for demonstration projects. Requirements of that accommodation inflated the costs above what would be normally incurred in planting such sites. It was thus difficult to establish what the basic regeneration cost would have been.

The two treatments used for regenerating conifer areas harvested at the Center show the range of costs. The first and more commonly used method has lower site preparation requirements and uses bare-root planting stock. The second treatment, seldom used, has high demands for

site preparation, and uses containerized planting stock.

Center personnel and equipment are used on most regeneration projects. Since costs are complicated in many cases by the requirements of research, and other needs, no attempt is made here to reduce the costs to a per acre basis. Dollar expenditures shown are only for items which are not available from existing Center resources and must be purchased on the outside market.

### **LOW TREATMENT--MINOR SITE COMMONLY USED PREPARATION REQUIREMENTS**

1. Harvesting requirements: total clearcut and random skidding to prepare site for brush raking site preparation.
2. Brush raking with Center equipment and staff.
3. Purchase bareroot planting stock. Cost of seedlings--\$50 per acre.
4. Planting with Center staff and public work program personnel.
5. Purchase herbicide for release spraying. Cost of herbicide--\$40 per acre.
6. Herbicide application with Center equipment and staff. Total extra expenditures of \$90 per acre are in addition to the cost of Center personnel, equipment, and other overhead costs.

### **HIGH TREATMENT--MAJOR SITE SELDOM USED PREPARATION REQUIREMENTS**

1. Root raking following harvesting. Cost per acre for outside contractor--\$150 per acre.
2. Purchase containerized planting stock. Cost of seedlings--\$127 per acre.
3. Plant containerized stock with Center staff and public work program personnel.
4. Purchase herbicide for release spraying. Cost of herbicide--\$40 per acre.
5. Herbicide application with Center equipment and staff. Total extra expenditures of \$317 per acre are in addition to the cost of Center personnel, equipment, and other overhead costs.

## ROADS

### ROAD ACCESS

The City of Cloquet maintains 10.5 of the 27.3 miles of roads bordering and traversing the Center (Figure 3). The remaining 16.8 miles of roads are the responsibility of the Center.

Prior to 1981, the public had access to all roads on the Center. The increased use of those roads by the public was creating safety, security, and road maintenance problems. In 1980 a road access and maintenance plan was developed to address those problems.

The road access and maintenance plan identified projects to reduce vehicular hazards, security and maintenance problems. Those included road construction, reconstruction and betterment, and access control.

In 1981 a project request for funding was submitted through the University to the State Legislature. Though resubmitted several times since, it has yet to be funded. Because of the potential liabilities resulting from the safety and security problems, money from timber harvesting income was used to fund some priority projects.

### ACCESS CONTROL

Access control was the road plan's top priority. Controlling the access of motorized vehicles on forest roads improved the safety, security and maintenance conditions.

Locked gates at all entrances to the forest roads have controlled motorized vehicle access. That control on the Center forest has reduced the number of blind corner confrontations between University vehicles and public cars or motorcycles. It has also reduced potentially hazardous contacts between the public and forest harvesting operations.

Security for buildings, equipment, research projects, and the forest in general, especially during high fire danger periods, was also a major factor in controlling access.

Other benefits have been reduced maintenance problems and costs, especially as a result of keeping vehicles off the roads during the spring thaw and during rainy periods.

All permanent Forestry Center personnel have a

key allowing them through all gates. Keys have also been issued to selected personnel at local Minnesota Department of Natural Resources, fire department and law enforcement offices.

A major concern at the beginning of establishing the access control program was the reaction of the public. The public's unrestricted access to the forest had existed since the Center's establishment in 1910. To minimize the reaction, small portions of the forest were gated off each year beginning in 1981 until the entire forest had access control in 1984.

Public reaction to access control has been surprisingly minimal, and there have been few attempts to forcibly gain access through the gates. Most of the reaction received from the

Figure 4. Rigid iron pipe gate.

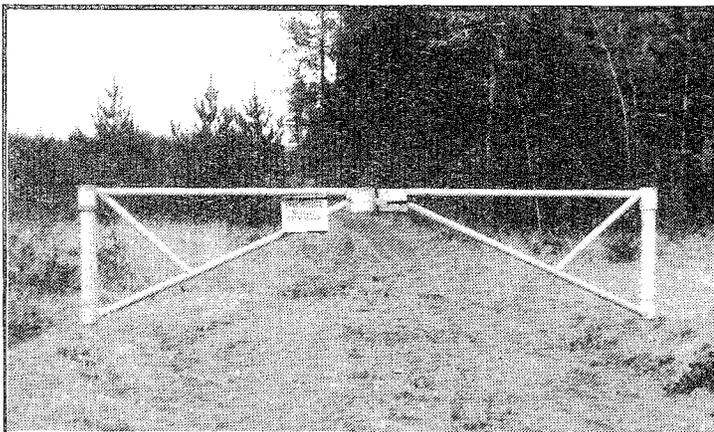
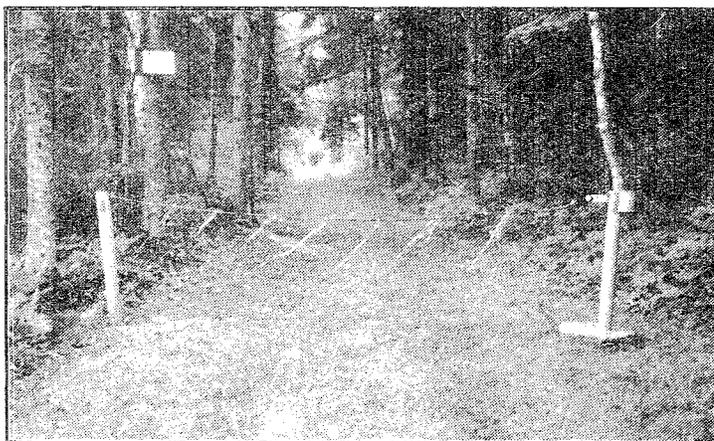


Figure 5. Cable gate.



public has been positive and in favor of the access control, from non-motorized users of the forest, such as hikers, berry pickers, etc.

The two types of gates that were erected are shown in Figures 4 and 5. Ridged iron pipe gates were erected at primary forest road access points. Cable gates were installed at secondary access points.

Weed control is done annually around the gates. Gates are also painted with fluorescent orange paint and have reflector tape applied to them, to improve safety by maximizing night and day visibility of the gates.

Implementation of access control has reduced many forest management problems and has been well worth the effort.

## RESEARCH

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As indicated in the management plans, a major purpose of the forest management program was to encourage and better serve the research and demonstration programs at the Center. To a large degree, the management program has been successful in providing that stimulation.

During the period July 1981 through June 1986, twenty-five new research projects were established on the Center's forest, and many existing projects continued. The following list shows the variety of research being done on the Center and the principal investigators.

1. Association of Pinewood Nematode with Stressed Trees--M. J. Wingfield.
2. 1981 Red Pine Spacing Study--Dr. A. Alm.
3. Hydrologic and Water Quality Consequences of Timber Harvesting on Small Northern Minnesota Waterlands--Dr. K. Brooks, Dr. E. Bergland.
4. Plot, stand and cover type aggregation effects on projections with an individual tree based stand growth model--M. Moeur, Dr. A. R. Ek.
5. Outplanting Blister Rust Resistant White Pine--C. Ahlgren.
6. Culture of Balsam Fir Christmas Trees--Dr. A. Alm.
7. Development and evaluation of forest change estimation methodology Dr. T. Burk, Dr. A. R. Ek.
8. Use of Artificial Reforestation and Site Preparation Techniques--Dr. A. Alm.
9. A Study of Techniques for Managing Red Pine for Seed Production--Dr. C. Mohn.
10. Ecological Studies of Production, Regeneration and Succession of Wet Mesic Forest--Dr. V. Kurmis.
11. Red Pine Seed Orchard Management--R. Stine.
12. Case Study Direct Seeding of White Spruce Following Prescribed Burning-- Dr. A. Alm.
13. Rainfall Interception in Red Pine Plantations--Dr. K. Brooks.
14. Growth Response of White Spruce Following Release from Aspen with Roundup Herbicide--M. Butler-Fasteland.
15. Evaluation of Arsenal Herbicide for Site Preparation after Fall Application--M. Butler-Fasteland.
16. Manipulating Jack Pine Crowns for Easy Cone Collection--R. Stine.
17. Pathogenicity Tests of Hypoxylon, Cenangium and Cryptosporia Inoculations on Populus Sp.--Dr. D. French.
18. Evaluation of Arsenal Herbicide for Release Treatments in Red Pine and White Spruce--M. Butler-Fasteland.
19. Growth Enhancement of Red Pine Resulting from Application of Velpar L--Dr. A. Alm.
20. Site Preparation Comparisons With the Use of Pronone Herbicide--M. Butler-Fasteland.
21. Food Resource Management for Grouse in Aspen Clearcuts--G. Gullion.
22. Chemical Site Preparation Trials of

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| <p>Various New Herbicides--M. Butler-Fasteland, Ann Wiese.</p> <p>23. Progeny Tests of White Spruce--Dr. C. Mohn.</p> <p>24. Evaluation of Chopper Herbicide for Basal and Stump Applications in Northern Hardwoods and Brush Species--R. Iverson.</p> <p>25. Use of Mycorrhizal Symbiosis in Reforestation Programs in Minnesota--Dr. R. Dixon, M. Sword.</p> <p>26. Use of Artificial Reforestation and Site Preparation Techniques--Using Bracke Moulder--Dr. A. Alm.</p> <p>27. Use of Artificial Reforestation and Site Preparation Techniques--Test Red Pine Safety with Velpar L and various Combinations of Other Herbicides--Dr. A. Alm.</p> | <p>program. Newly harvested and regenerated areas are intensively used by researchers. Those types of areas were decreasing in supply prior to initiating the current management program.</p> <p>College of Natural Resources faculty and other potential users of the Center are kept apprised of forest management activities on the Center, ongoing and planned. Most activities can be stopped or modified on request to accommodate a researcher's needs.</p> <p>Many of the research projects are long-term. They must be monitored for twenty years or more and, therefore, need to be well documented to protect them from damage by other users. To assure protection of both short and long-term research, a research project record is filed with the forest manager.</p> <p>Research Project Record documentation is designed to reduce conflicts between an established research project and forest management activities or other research. The record keeping system has worked well and is currently being computerized.</p> |
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- The opportunities for many of the research projects are a result of the forest management

## TEACHING

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Undergraduate field training sessions for forestry students have been held at the Cloquet Center since 1924. These sessions give the students formal field training in managing forests. The management program recognizes the importance of these sessions and makes every effort to accommodate the teaching program.

There are many examples of how the management program has complemented the teaching program:

1. Inventory instructors use existing timber sales to teach timber sale appraisal. Newly established plantations are used for plantation inventory design exercises and, when available, roundwood products are used for scaling and grading exercises.
2. Recently harvested areas are used in hydrology course work for soil compaction and infiltration exercises.
3. Harvesting operations are being conducted on the Center approximately seventy percent of the time during the

year. The harvesting course uses those operations as a demonstration and information source for student tours.

4. Silviculture instructors use planted areas for plantation assessment exercises. Thinned and unthinned stands are used for marking exercises and stand characteristic comparisons. Recent site prepared areas and plantation release areas are used for regeneration demonstrations and course discussion. The entire Cloquet forest is used for compartment examination and prescription exercises.

In addition to onsite use of management areas, management data such as growth measurements, stumpage prices, timber sale establishment costs, site preparation costs, herbicide application cost, etc., are used by various instructors to keep lecture information current.

As with the research program, the forest management activities are guided by and can be modified to accommodate the teaching program.

## DEMONSTRATION PROJECTS

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In addition to the regular forest management activities, special projects arise that help the College and the Center with its educational and research mission. Such projects include the rejuvenation of the arboretum, restoration of the Camp 8 Stand, and the establishment of a self-guided forest management tour route.

### *ARBORETUM*

The arboretum was established in 1922. At one time it had 68 different tree and shrub species from North America, Europe and Asia. Over the past 63 years, many plots have deteriorated or failed. Recently, the arboretum was renovated by removing dead and dying trees, planting new seedlings in failed plots, erecting new identification signs, improving the walkway, and establishing a regular maintenance schedule.

### *CAMP 8*

The Camp 8 Stand is the Center's 165-year-old stand of Norway Pine. The 44-acre tract was reserved at the request of the University in negotiation with one of the logging companies when the Center was first established. The stand was named after a logging camp located in the area.

The Camp 8 restoration project is designed to restore the characteristics once common to Minnesota's old growth Norway pine forests. The stand's current understory is the result of fire protection. It is very different from the structure

of the stand prior to fire protection, as evidenced by photographs taken in the 1920's.

One-half of the 44-acre stand will be left as is. The understory will be removed on the other half and that area will be periodically burned to remove understory vegetation. The two portions of the stand will be used as a comparison demonstration. They will show the characteristics of the old-growth pine stand before the time of fire protection and the understory development and fuel loading resulting from the exclusion of fire.

### *TOUR ROUTE*

Persons in forestry related occupations recognize the need to better inform the public about forest management. The intensive management program on the forest provides an excellent opportunity to educate the public about the need for good forest management and how to accomplish it. To do that, a self-guiding tour route was established in 1986. The tour is about 1.6 miles long. Stops cover topics such as forest management benefits for wildlife, water, timber, and the economy. Other stops show various harvesting methods, methods of regeneration, the need for release, and intermediate stand management.

The tour is designed for the general public and can serve as an excellent educational tool for primary and secondary school teachers. The tour route is one of several efforts made to increase the public's awareness of the Center and of its contributions to the region.

## ADDITIONAL READINGS

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