Cloquet Forestry Center Forest Management Plan 2002 - 2011

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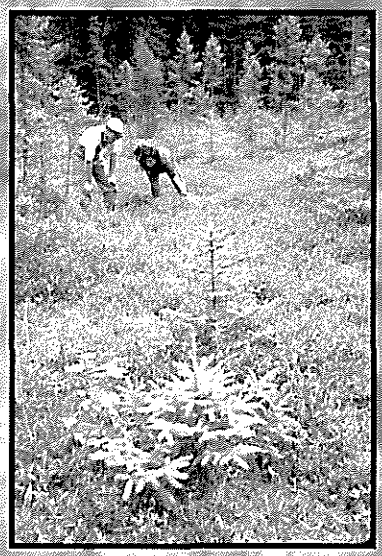

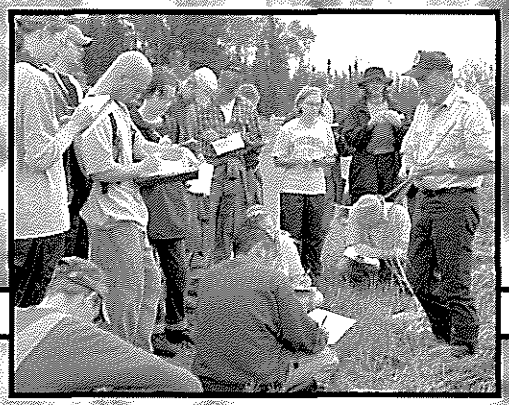

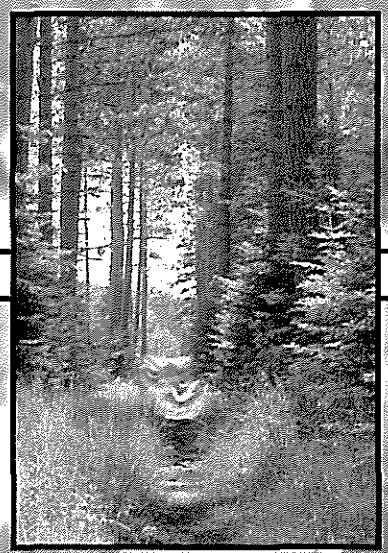

CLOQUET FORESTRY CENTER
UNIVERSITY OF MINNESOTA

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INTRODUCTION

The Cloquet Forestry Center was established in 1909 to provide the University of Minnesota a focal point for research on managing Minnesota's forests. The Center has since grown in size and scope, and now conducts a broad range of activities in education, research, and outreach related to northern forests. The combination of a large forest with a well-documented history, excellent facilities, and on-site professional and support staff make the Cloquet Forestry Center one of the premier experimental forests in the country.

The overall forest management goal for the Cloquet Forestry Center is to provide a well managed forest serving the diverse research, teaching, and outreach programs of the College of Natural Resources of the University of Minnesota and other natural resource related organizations. Those programs are served by:

- Sustaining a forest comprising of a variety of vegetation types, stand age classes, and stand vigor conditions;
- Providing suitable forest road access and maintenance;
- Supporting a centralized research and management information system;
- *Utilizing Minnesota's "Site-level Forest Management Guidelines"* (Minnesota Forest Resources Council 1999);
- Improving and maintaining a variety of wildlife habitats;
- Protecting exiting research and demonstration installations.

To meet its goal, the Center's forests include some areas that are intensively managed, some that remain in a more natural condition, and others that are reserved for teaching, research, or demonstration purposes. Policies are also in place to limit recreational use of the forest. All these actions help maximize research, teaching, and outreach opportunities provided by the Center.

Management activities within the Center's forest are determined at intervals of ten years. This permits sufficient time to plan and conduct the defined activities, and gives researchers ample time to develop projects tied to forest management activities.

The ten-year forest management plan in this document outlines management goals to be met during the period July 1, 2001 through June 30, 2011, for the 3,340 contiguous acres (University of Minnesota, 2001) of the Cloquet Forestry Center. This plan compliments and supports the Center's mission as a unit of the University of Minnesota College of Natural Resources. It serves as a guide that can be adjusted as special conditions warrant during the ten-year period.

RESEARCH AND FOREST MANAGEMENT HISTORY

The Cloquet Forestry Center was established primarily through the efforts of Professor Samuel Green, head of the University of Minnesota Forestry School, Fred Vibert, state senator and publisher of the Cloquet newspaper, and Rudolph and Frederick E. Weyerhaeuser, both of whom had interests in several Cloquet area sawmills, railroads, and logging operations. The primary intent for establishing a research forest was to determine how to best reforest cut-over lands (Carroll 1987).

Reflecting that interest most research and management efforts at the Center were directed toward reforestation through the 1920s. The Center established a seedling nursery in 1915 for both research and seedling production. Two years later the nursery was producing one million seedlings annually for reforestation at the Center and around the state (Kenety 1917).

In the early 1930s, research and management emphasis shifted toward intermediate stand treatments. Center publications during the 1930s and 1940s (Schantz-Hansen 1931, Hansen 1936, Allison 1946) show that much of the management and research work dealt with intermediate stand thinning, primarily with white and red pine, and white spruce. As the pulp and paper industry began to expand in Minnesota, so did the interest in managing other suitable tree species. During this period jack pine, aspen and birch began to receive increased research and management attention.

As the forests of Minnesota, including those at the Cloquet Forestry Center, began to approach maturity, opportunities for research tied to final harvest increased. The period from the 1950s to the 1970s saw the emergence of mechanized timber harvesting and new reforestation methods. Chainsaws, rubber tired skidders, feller bunchers, whole tree processors, and containerized seedlings became commonplace. These new tools and processes raised questions of economic and environmental impact, and fostered research designed to answer them.

This era also marked a change in personnel functions at the Center. During the late 1960s and early 1970s, a shift occurred away from staff that provided primarily woods labor to staff that provided research support. This shift affected management of the forest in several ways. The labor intensive nursery operation that began in 1915 was terminated in 1974. Basic silvicultural activities such as salvage cutting and timber stand improvement work declined sharply as efforts were directed toward research support.

It was during this period of transition that a backlog of mature and over mature timber stands accumulated at the Center. By 1977 mature and over mature stands occupied 80 percent of the upland forest (Zasada 1981). To address the situation the Center adopted an aggressive ten year management plan (Zasada 1981) that proposed a significant amount of timber harvesting to develop better age class distribution and species diversity.

The plan addressed and to a large extent resolved two primary concerns, namely the over-maturing of the forest and the need to stimulate additional field research at Cloquet.

Four hundred twenty six acres received a harvesting treatment between 1981 and 1986 (Severs 1989). Of those acres, 310 were clear-cut. By 1991 a total of 700 acres (21 percent of the contiguous forest) had been treated, with 513 acres (15 percent) being clear-cut. Most of the timber harvesting in the 1980s was accomplished by contract logging (Severs 1989).

The Minnesota Tree Improvement Cooperative was established and located at the Cloquet Forestry Center in 1981. This was followed in 1984 by development of the Forest Vegetation Management Cooperative, also headquartered at the Center. The cooperatives spurred a significant increase in field research at the Center, initiating about a half-dozen new projects annually.

The management plan for the 1990s (Severs et al 1992) continued to address the issue of an over-mature forest and the need to provide opportunities for research. In addition, it addressed the continued evolution of management needs for the Center's forest, particularly those portions where regrowth was occurring after earlier harvests. The plan included reserves and natural areas for research, teaching, and outreach. The 1990s plan also included a formal recreational policy to address increased use of the forest by hikers, cross-country skiers, horseback riders and others.

The 1990s plan provided a formal guide for the management of the Center's forest, emphasizing

the maintenance of a healthy productive forest to demonstrate the benefits of timber production and its compatibility with other uses and values. About 15 percent of the contiguous forest (485 acres) received harvesting treatment. Of that, 319 acres (approximately 10 percent of the forest) were clearcut and reforested and 166 acres received thinning treatments.

Similar to the prior ten-year period, active forest management through the 1990s continued to provide opportunities for research. Sixty-six new research projects were established at the Cloquet Forestry Center during the period 1992 through 2001 (see Appendix A). The most common research areas were pathology, silviculture, ecology, and forest genetics.

The 1990s also saw a strengthening of the Center's mission with additional staff and programs housed at the Center. Although the Vegetation Management Cooperative ceased operating in 1996, the Center added three new staff positions in outreach and continuing education within the next few years. These positions caused increased use of the Center for forest management education and demonstration.

Because the Center is an important field education reseource for the College of Natural Resources, changes in related educational activities are made as the College's programming evolves. The last Fall Quarter forestry student session was held at the Center in 1999. Following the University's switch to a semester calendar, the Cloquet forestry field session was moved to a five-week period just after Spring semester. Beginning in August, 2002, a three and one-half week field session traditionally held at Itasca State Park was moved to the Cloquet Forestry Center. The Forestry Center expects that its forest stands will continue to play a valuable role in undergraduate natural resources educational programs.

The quality and sustainability of management practices has been recognized several ways. The American Forest Council designated the Cloquet Forestry Center as a Certified Tree Farm in 1989. This Certification recognizes active and appropriate forest management and the Center's rich tradition of teaching, research, and outreach conducted since its inception in 1909. In 2000 the University enrolled the Center's lands in the American Forest and Paper Association's Sustainable Forestry Initiative program.

CLOQUET FORESTRY CENTER RESERVE AREAS

Because the Cloquet Forestry Center exists for forest based research, teaching, and outreach, a variety of stands that receive various intensities of management are needed. Management intensity varies from high level, state-of-the-art to natural development. For the latter purpose, 23 areas totaling 319 acres have been designated either as old growth reserve, unique forest type reserves, or instructional and demonstration reserves for the duration of this plan. Reserve areas account for approximately 10 percent of the total forest area.

OLD GROWTH RESERVES

Logging of the forest land that eventually became the Center was underway during the Center's establishment phase in 1909-1910. At that time Professor Samuel Green asked the logging companies to leave certain seed trees, groups, or stands of mature white and red pine for experimental purposes. Green's request was granted and several mature stands scattered around the Center were reserved from cutting.

Over the years, some of the original old growth reserves have been harvested for various research or management purposes. However, the remaining stands provide clear biological, research, teaching, and aesthetic contributions. Using old growth forest guidelines developed by the Minnesota Department of Natural Resources in 1994, five stands continue to be reserved from harvesting in this plan.

The five stands have origin dates that coincide with two natural fires, 1824 and 1842. As of 2002, their ages range from 160 to 178 years. They occupy a total of 101 acres. Although not all the characteristics of old growth pine exist in each of the stands reserved, enough characteristics do exist to treat them as old growth stands. The five stands will be omitted from harvesting considerations, barring natural catastrophe, for the dura-

tion of this plan. Basic descriptions of the stands are included in Table 1. Location of the stands is shown in Figure 1.

CAMP 8 STAND

The Camp 8 Stand is an old growth Norway pine stand named after Northern Lumber Company's Logging Camp Number 8, which operated on the north edge of the stand in the early 1900s. (See Figure 7, Cultural Interest Locations, pg. 16). A management prescription was developed in 1983 to address its special qualities. Following a review of the stand's current condition, the basic 1983 management prescription will continue in effect through this plan.

STAND HISTORY AND DESCRIPTION

This 39 acre, 178-year-old (as of 2002) Norway pine stand is being preserved as an example of the once common virgin Norway pine of Northern Minnesota. It exists today because of the efforts of University Professor Samuel Green.

Logging of the area was already in progress by the Northern Lumber Company during the establishment period of the Cloquet Forestry Center. The Camp 8 Stand was one of several mature tree stands that Professor Green asked Northern Lumber Company to leave for experimental purposes. In return, the University paid the Northern Lumber Company for the value of the timber.

Some individual trees in the stand are nearly 300 years old, but indications are that the major portion of the stand originated following a fire that burned the area in 1824. Five fires, dated by fire scars, have burned the area since then; in 1842 (when the stand was 18 years old), and in 1855, 1864, 1874 and 1894. Until the 1930s, there was little or no underbrush or regeneration in the stand (Figure 2).

There are approximately 75 old red pine trees per acre. The trees have an average diameter at breast height of about 17 inches, and there are approximately 26 thousand board feet of timber per acre. The stand today has a moderate to heavy understory of shrubs, balsam fir, spruce, white pine, and hardwoods. Present tree mortality is moderate in pockets, but light throughout the stand. Because of its age, size, and history, the Camp 8 stand continues to be one of the main interest points of visitors to the Center.

MANAGEMENT PRESCRIPTION

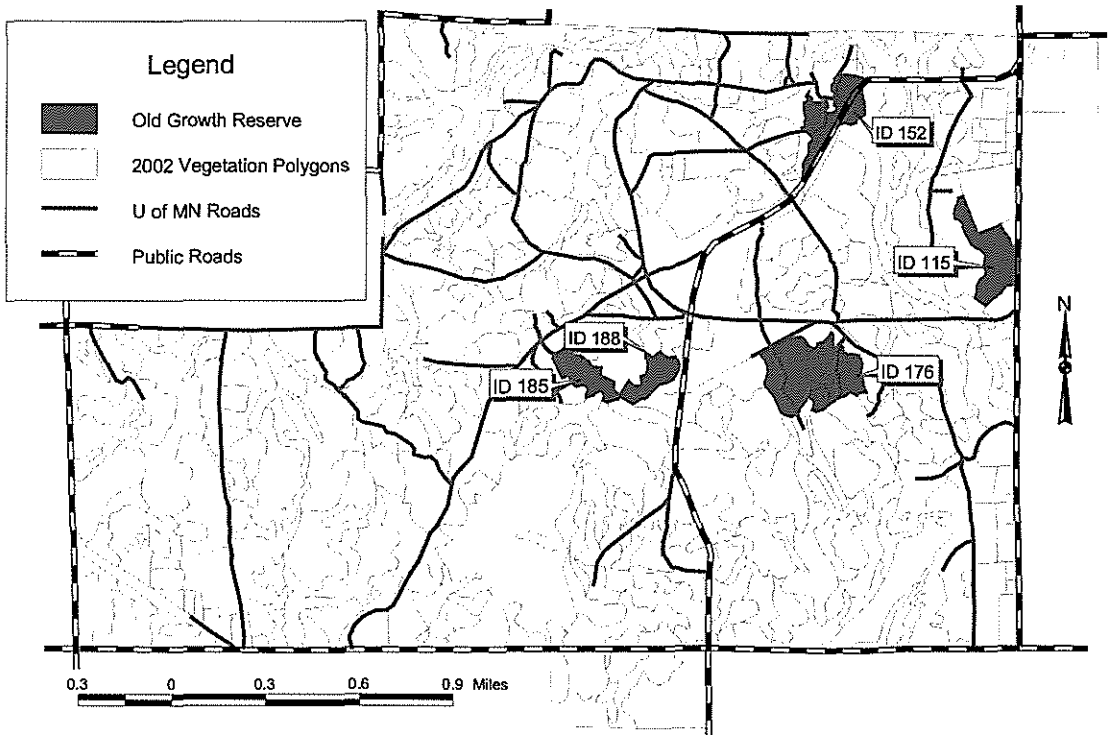
Characteristics of the once common old growth Norway pine stands of Northern Minnesota still

TABLE 1. Old Growth Reserve Stands.

Polygon ID Number*	Cover Type	Stand Origin Year	Acres	Description
176	Red pine	1824	39	Dense red pine, scattered white pine. See Camp 8 management section.
52	Red pine	1824	20	Office area. Scattered old growth red pine, second growth red pine understory.
115	Red pine	1824	20	Mixed red pine, white pine old growth, mixed pine hardwood second growth.
188	Red pine	1844	10	Scattered old growth red pine, balsam, hardwood and brush understory.
185	Red pine	1844	12	Old growth red pine, heavy birch understory.

*Polygon ID numbers refer to 2002 GIS cover type map. See Figure 1 for stand locations.

FIGURE 1. Old growth reserve locations within the Cloquet Forestry Center.



exist in the Camp 8 Stand. These stand characteristics can probably be perpetuated for another 25 to 50 years by applying preservation management techniques.

The stand has been divided into two parts. Approximately half (22 acres), has remained in an unmanaged condition to show the effects of natural succession in the absence of fire and management. This area is useful for demonstration purposes as well as ecological research.

The other half of the stand received a combination improvement and salvage cut in 1985. All of the spruce, fir, white pine and hardwoods in the understory were removed. The old growth was examined and salvageable dead trees and any live trees that showed signs of low vigor were removed.

Because of the age of the trees that make up Camp 8 Stand, salvage evaluations will be made periodically and high risk hazard trees will be removed accordingly. Harvesting will be done in the winter, when tree bark is tight, to minimize scarring of the residual stand and to maximize breakage in the shrub layer of the understory. Full-tree skidding is being recommended to keep fuel loads low for follow-up burning.

FIGURE 2. Camp 8 Stand, 1925.

The stand's current understory is a response to fire exclusion and is very different from the understory

of old growth stands subject to fire. It reflects major shifts in plant species composition and wildlife habitat features. The current understory represents a major deterrent to the success of natural pine regeneration, forcing the use of expensive mechanical and chemical treatments if a next crop is to be established. It also may reduce overstory vigor, growth, and survival through competition for moisture and nutrients during dry periods. Finally, the understory reduces the aesthetic value of the stand.

Periodic fires could be used to control the understory in the managed portion of the stand. This would also serve as a demonstration of the role of fire in old growth stands and help mimic conditions prior to the time of fire suppression. This could be accomplished by first using relatively low intensity spring fires at three to five year intervals to reduce both fuel loading and the height of the understory. Once these cumulative effects of the long period of fire exclusion were removed, burns would be conducted at five to ten year intervals.

FIGURE 3. Instructional activities are conducted in reserved area.

Such a prescription was included in the last plan, but from 1992 to 2002 only two prescribed burns were accomplished. Both burns had minimal effect on reducing woody understory vegetation. A combination of limited personnel and infrequent safe burning conditions were major limiting factors preventing effective and regular burns.

Neither of those factors are expected to change significantly during the next ten years. Therefore, other initial brush reduction methods will be used to create understory conditions that will be more conducive to the use of a regular burn schedule. It is important to manage the Camp 8 Stand in such a manner in order to perpetuate its Norway pine stand characteristics prior to fire suppression. This should keep the stand available for future observation and research.

For two reasons this prescription does not include any specific recommendations for stand regeneration. First, presence of the disease red pine shoot blight *(Sirococcus strobilinus)* on the forest is a concern in trying to establish regeneration under an overstory. Second, and perhaps more importantly, there is a desire to manage the stand in a way that allows natural processes to occur to the extent possible. It is more important to concentrate on getting the stand back into a condition where natural regeneration could occur rather than plan for doing artificial regeneration at some undetermined time in the future.

Under the above management scenario, the Camp 8 Stand will be maintained in its natural condition as long as possible. As always, there is the risk of a major incident that will render the plan moot. Should this occur, the stand will receive priority attention to try and maintain its old growth characteristics.

UNIQUE FOREST TYPE RESERVES

Natural stands and scarce cover types provide many research and teaching opportunities. As the Center's forest becomes more intensively managed, it is important to identify specific stands or areas that will be exempt from intensive management, thereby being left to develop and/or decline naturally.

Many of the Center's older stands were established through natural succession following early logging episodes or catastrophic fires, events that are unlikely to occur on the Center's forest again. Many of these unique natural stands developed

Table 2. Unique Forest Type Reserves.

Polygon ID Number*	Acres	Description
50	1.8	1949 planted white pine, saw log size white pine intermixed with other saw log size conifers
39	8.7	1894 fire origin jack pine, rapidly declining jack pine stand converting to shade tolerant conifers
85	1.3	1920 planted white pine, very little regeneration in the understory
130	6.8	1913 planted white pine, Center's largest white pine type
257	23.9	1889 natural cedar stand, one of two cedar areas on the Center used sporadically for wildlife, silviculture, and ecology research/teaching
218	6.4	1813 natural cedar stand, second of two cedar stands used sporadically for wildlife, silviculture, and ecology research/teaching
261	1.4	1914 natural birch stand, a heavy birch component and one of a few stands in the older age class for birch
295	4.2	1879 natural balsam/red pine stand, one of the few mature balsam stands on the forest, gets high special forest products use for collecting ground pine
310	12.6	1888 natural birch stand, one of the oldest birch stands on the forest, with multiple interest users
186	13.2	1924 aspen stand, determined to have been established predominately by seed
206	4.7	1911 large diameter white pine, origin undetermined
167	8.1	1919 natural aspen stand, mixed age aspen and mixed species, high potential for ecology exercises

*Polygon ID numbers refer to 2002 GIS cover type map. See Figure 3 for stand locations.

with little or no silvicultural management, much different from the more intensively managed plantations and natural stands often established today. Some Center stands, such as mature white pine, are unique in that they represent only 0.4 percent of the Center's cover types. These types of stands will be reserved from harvesting until they are no longer considered unique or it is otherwise determined to be unnecessary to maintain them in their unmanaged condition.

Table 2 identifies twelve selected stands totaling 103 acres that will be exempt from intensive management under this plan. Figure 4 shows the location of these stands on the Center.

INSTRUCTIONAL AND DEMONSTRATION RESERVES

Certain areas of the forest are consistently used for teaching or demonstration exercises (Figure 3). Becasue these areas have characteristics that make them useful for teaching and demonstrating forest management concepts, they will be reserved for those purposes.

Figure 5 identifies five areas totaling 301 acres that will be reserved for instructional purposes. Management will not be done in these areas without first receiving approval from instructors that use the areas for teaching exercises.

FIGURE 4. Unique frorest type reserves within the Cloquet Forestry Center.

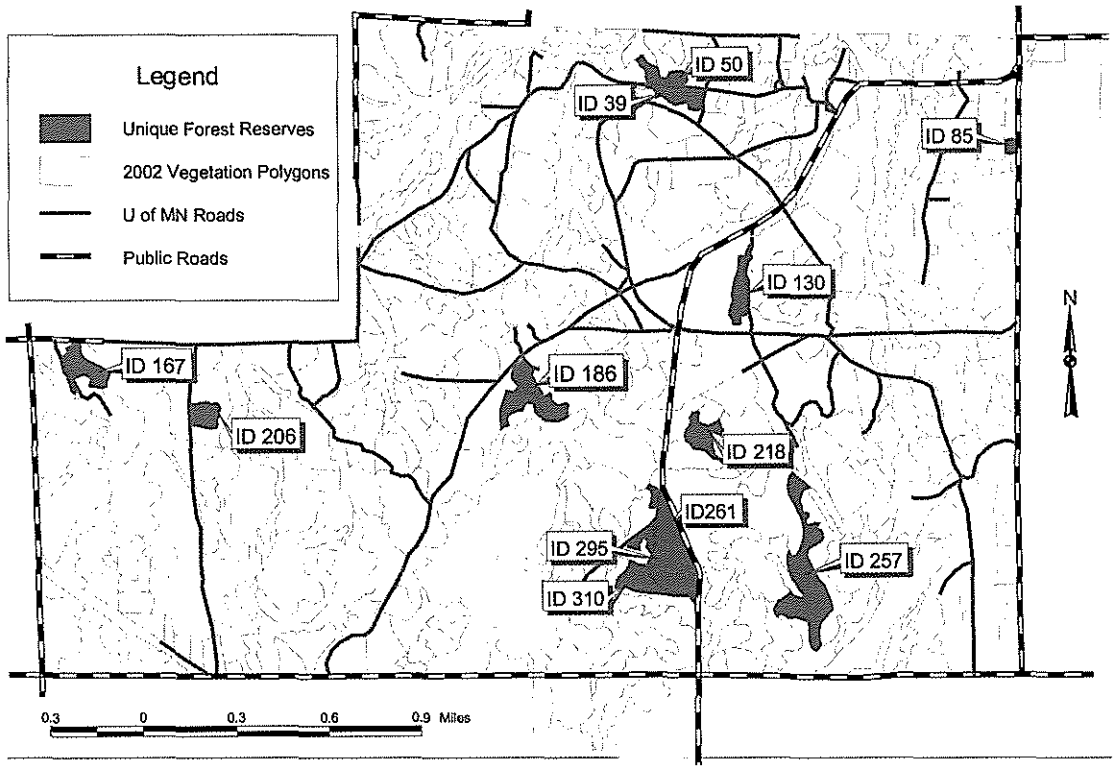
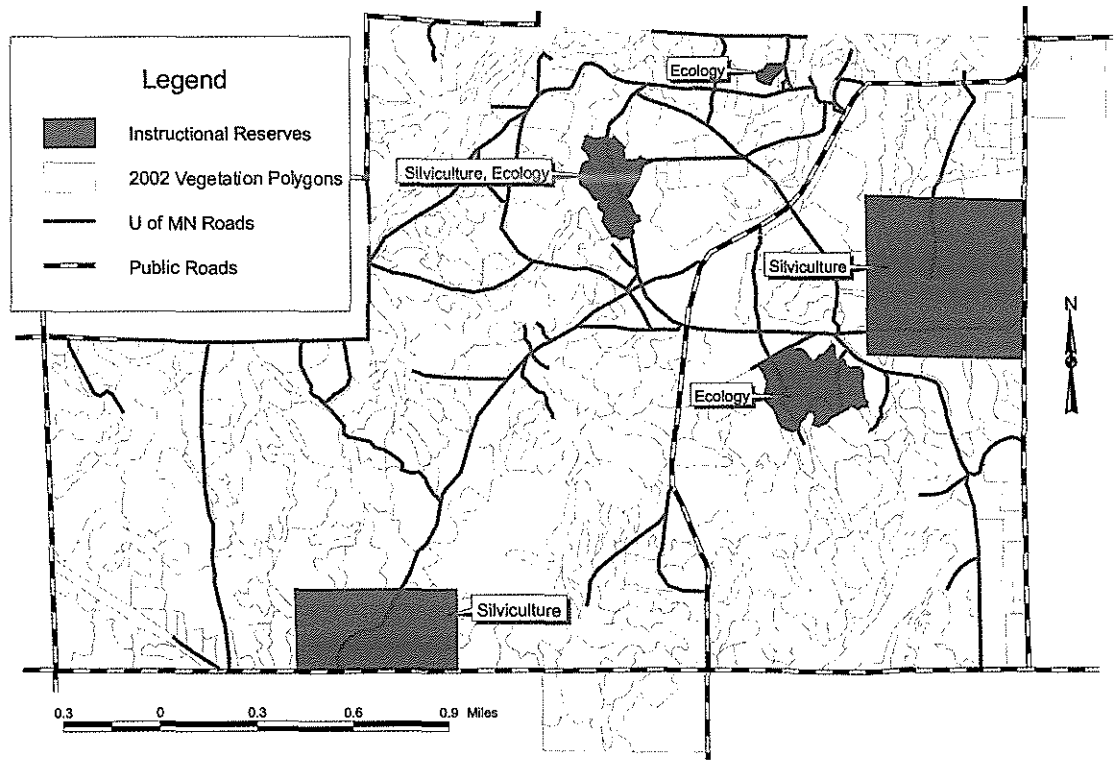


FIGURE 5. Instructional reserve locations within the Cloquet Forestry Center.



TIMBER HARVESTING

The objective of timber harvesting activities at the Cloquet Forestry Center is to help provide and maintain the variety of forest types, age classes, and management conditions required to meet the research, teaching, and outreach mission of the Center. Table 3 identifies the current vegetative composition of the Center's land base, categorized by dominate species cover type, noting the number of acres of each type and the associated percent occupancy of the forest.

During the period July 2001 through June 2011 a harvesting treatment will be applied to 18 separate areas totaling 344 acres, approximately 10 percent of the forest. Both clearcutting and partial cutting will be used, the decision based on species, age, stocking, and quality of the stand.

Clearcuts are prescribed for 11 areas ranging in size from 9 to 25 acres, totaling 218 acres. For management purposes, these stands are past desired rotation age, poorly stocked, or stocked with poor quality low value timber.

Thinning is prescribed for five areas ranging from 19 to 45 acres in size, totaling 128 acres. These are high value stands that have not yet reached a desired rotation age, but need silvicultural treatment to maximize growth (Figure 6).

Table 4 provides a summary of planned timber harvesting by forest type. Table 5 lists and describes each of the harvesting areas. Figure 6 illustrates one method that may be used for selective thinning in high value stands. Figure 7 identifies the location of each of the 18 areas to be

Table 3. Cloquet Forestry Center Vegetation Types, 2002.

Upland Vegetation Types		
Species	Acres	Percent Forest Cover
Red Pine	878	26.3
Aspen	563	16.8
Jack Pine	324	9.7
White Spruce	131	3.9
Balsam Fir	123	3.6
Birch	118	3.5
White Pine	23	0.7
Scotch Pine	5	0.2
Open	54	1.6
Experimental	40	1.2
Total	2,259	67.6

Lowland Vegetation Types		
Species	Acres	Percent Forest Cover
Black Spruce	229	6.9
Mixed Lowland Conifers	222	6.6
Tamarack	138	4.1
Black Ash	42	1.3
Cedar	30	0.9
Lowland Brush	293	8.8
Stagnate Spruce	66	2.0
Marsh	61	1.8
Total	1,081	32.4

Table 4. Harvest Summary by Forest Type for July 2001 – June 2011.

Forest Type	Clearcut Acres	Partial Cut Acres	Total Cut
Red Pine	2	85	87
Jack Pine	42	64	106
Aspen	91	-	91
Balsam Fir	22	-	22
Black Spruce	28	-	28
Birch	10	-	10
Total	195	149	344

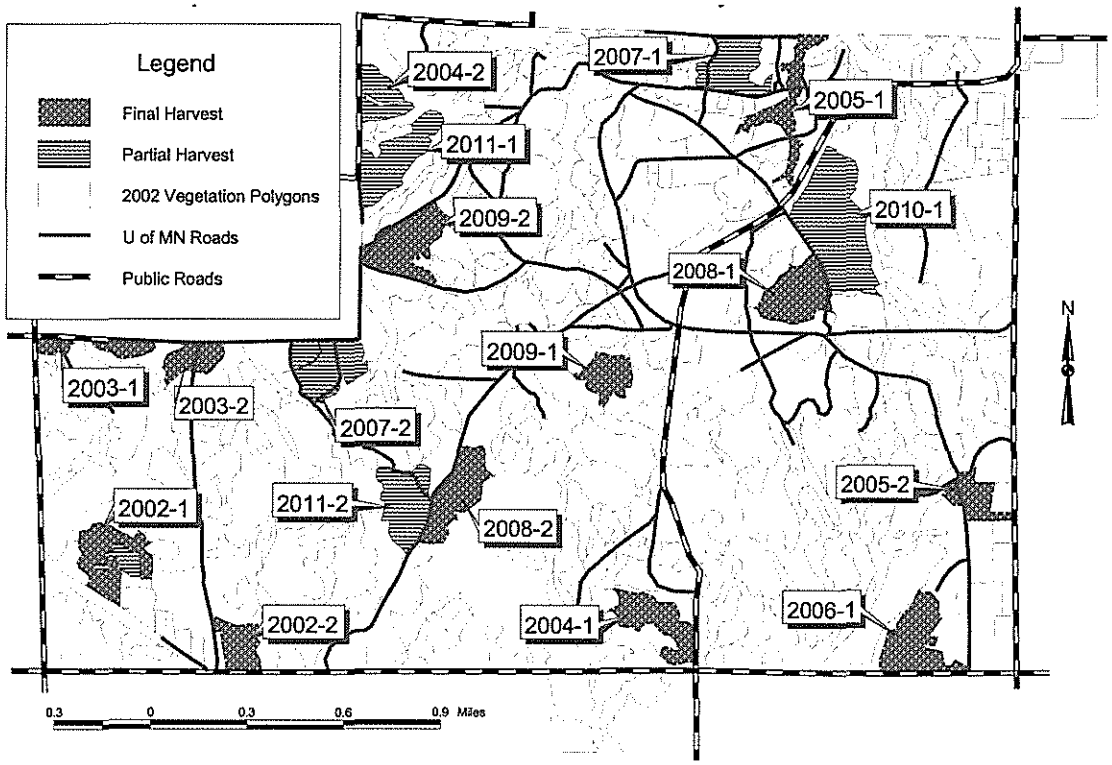
FIGURE 6. One method available for selective thinning of stands.

Table 5. July 2001 - June 2011 Harvesting Area Descriptions.

Area	Dominant Type	Age	Acres	Harvest Type*	Stand Description and Management
2002-1	Aspen	50-55	24	CC	Mature aspen stand that will be clearcut. Many portions of the stand are understocked with basal areas less than 50.
2002-2	Jack pine	98	11	CC	Jack pine and aspen are over-mature. Area sustained ice storm damage in 2001 causing severe damage in the jack pine.
2003-1	Jack pine	89	9	CC	Over-mature jack pine, stands sustaining heavy mortality.
2003-2	Balsam fir	90	10	CC	Over-mature balsam fir and white spruce. High mortality and poor stocking on much of the area.
2004-1	Balsam fir	88	19	CC	Heavy mortality in over-mature balsam fir. Much of the area is poorly stocked.
2004-2	Jack pine	90	11	PC	Remove over-mature jack pine. Leave red pine for shelterwood reproduction.
2005-1	Black spruce	93	16	CC	Remove cover type to establish fire break between forest and office area. Maintain as low stocked open area.
2005-2	Aspen	45	11	CC	Mature aspen with pockets of over-mature aspen which will result in poor stocking in the near future.
2006-1	Jack pine	91	22	PC	Remove all species except red pine and other advanced conifer regeneration. Manage to promote natural conifer regeneration.
2007-1	Red pine	37	19	PC	First thinning red pine plantation.
2007-2	Red pine	35	21	PC	First thinning red pine and jack pine plantations.
2008-1	Jack pine	114	24	CC	Over-mature jack pine, birch and aspen clearcut to promote birch regeneration.
2008-2	Aspen	55	25	CC	Multi-aged aspen stand clearcut to establish well stocked, even-aged aspen stand.
2009-1	Black spruce	96	12	CC	Mature black spruce. Cut to improve age class distribution of cover type.
2009-2	Aspen	54	20	CC	Clearcut mature aspen and over-mature jack pine, leave advanced conifer regeneration.
2010-1	Red pine	30-34	46	PC	First thinning red pine and jack pine plantations
2011-1	Jack pine	29	23	PC	First thinning jack pine
2011-2	Red pine	28	21	PC	First thinning red pine
TOTAL			344		

*CC=Clearcut, PC=Partial Cut

FIGURE 7. Proposed harvest areas for the period July 2001 – June 2011.



treated, the type of treatment it is to receive, and the proposed year of treatment.

Timber harvests will be conducted by contract loggers. Each harvesting area will incorporate a unique forest management objective or process to enhance the research, teaching, or outreach mission of the Center. Where special harvesting requirements needed to meet research or teaching needs are costly to the harvesting operation, the timber will be sold at a negotiated rate. Timber sales with unique but non-costly harvesting requirements will be sold to the highest bidder as a lump-sum or consumer scale sale.

All areas will receive an intensive pre-sale timber cruise to determine volumes, values, and harvesting requirements necessary for research, teaching, and proper forest management. Precise harvesting instructions will be included in each sale contract. Site level forest management guidelines will be applied as appropriate on every sale.

REFORESTATION

The forest management program's ongoing objective is to maintain a forest with a variety of vegetation types, stand age classes, and stand vigor conditions to accommodate future research and educational needs. Thus, successful reforestation of harvested areas is one of the highest management priorities in this plan.

To enhance research and education opportunities, various natural and artificial regeneration methods will be used to reforest harvested areas. Natural regeneration will be the primary means of regenerating hardwood stands. These are forest types consisting of aspen, birch and red maple. To date, natural regeneration of these hardwood species

has resulted in well stocked regeneration of cut over areas. New artificial methods for regenerating hardwood species will be used on a research or demonstration basis as they develop.

A variety of species, stock classes, stock types and planting densities will be employed to achieve the species and stand diversity goal set for this management program. One principle for artificial reforestation efforts is to have all planting stock grown from known and/or improved seed sources.

Artificial regeneration has historically been the primary means for regenerating conifer types. In support of increased interest in natural regeneration methods for upland conifers, some suitable upland conifer harvest sites in this plan will be regenerated using natural regeneration methods.

Table 6 lists the areas planned for harvest, the forest types of each of the areas before harvest, acres harvested, and the reforestation plan for the area.

Table 6. Reforestation of Final Harvest Areas.

Area ID	Acres	Post Harvest Regeneration Species	Reforestation Method	Target Density (trees/acre)
2002-1	24	Aspen	Natural	8,000+
2002-2	11	Jack Pine	Artificial	907 + Nat.
2003-1	9	Jack Pine	Artificial	907 + Nat.
2003-2	10	Balsam Fir	Artificial	680 + Nat.
2004-1	19	Balsam Fir	Artificial	680 + Nat.
2004-2	11	Jack Pine	Artificial	680 + Nat.
2005-1	16	Black Spruce	Natural	< 100
2005-2	11	Aspen	Natural	8,000+
2006-1	22	Jack Pine	Artificial	480 + Nat.
2008-1	24	Birch	Artificial	480 + Nat.
2008-2	25	Aspen	Natural	8,000+
2009-1	12	Black Spruce	Artificial	680 + Nat.
2009-2	20	JackPine/Aspen	(A) Natural (JP) Artificial	8,000+ 907 + Nat.

Table 7. Final Harvest and Reforested Acres by Forest Type for July 2001 – June 2011.

Forest Type	Total Acres (2001)	Final Harvest Acres	Reforested Acres	Acres Net Gain or Loss	Total Acres (2011)
Red Pine	878	2	0	-2	876
Jack Pine	324	61	57	-4	320
Aspen	563	91	76	-15	548
Balsam Fir	123	22	29	7	130
Paper Birch	118	10	24	14	132
Black Spruce	229	28	28	0	229
Total	2,235	214	214	0	2,235

The post-harvest vegetation types in Table 6 are the initial target establishments. Some areas will be left, following regeneration, to develop into mixed species stands with minimal release treatment. This may lead to some shifting of vegetation types. Table 7 shows total acres by forest type that will receive final harvest and be reforested during the ten year period. Table 7 also shows the net effect on the present forest types of the Center. In this ten year plan the forest will experience a slight increase in paper birch and balsam fir acres and a slight decrease in red pine, aspen and jack pine.

SURVIVAL AND COMPETITION ASSESSMENTS

Survival and competition assessments will be made one year and three years after planting. Although initial target stocking levels will be achieved by planting on some areas, it is recognized that initial stocking levels are seldom maintained because of losses due to mortality or increases due to natural regeneration. A wide range of stocking levels is necessary for future research opportunities. Additional plantings will be done if less than desirable stocking is established following the third year assessment (Figure 8).

Where assessments call for broadcast control of competing vegetation, ground spray units using approved chemical herbicides will be employed. Competition control not requiring broadcast spraying will be done by backpack spraying or hand release.

Current Cloquet Forest Center forest management staff are licensed pesticide applicators and all herbicide control work will be accomplished by them, assisted by contracted licensed applicators as needed. Chemical control areas will be posted declaring such treatment immediately following the treatment.

FIGURE 8. Stand regeneration may require hand planting to achieve desired tree densities following third year assessments.

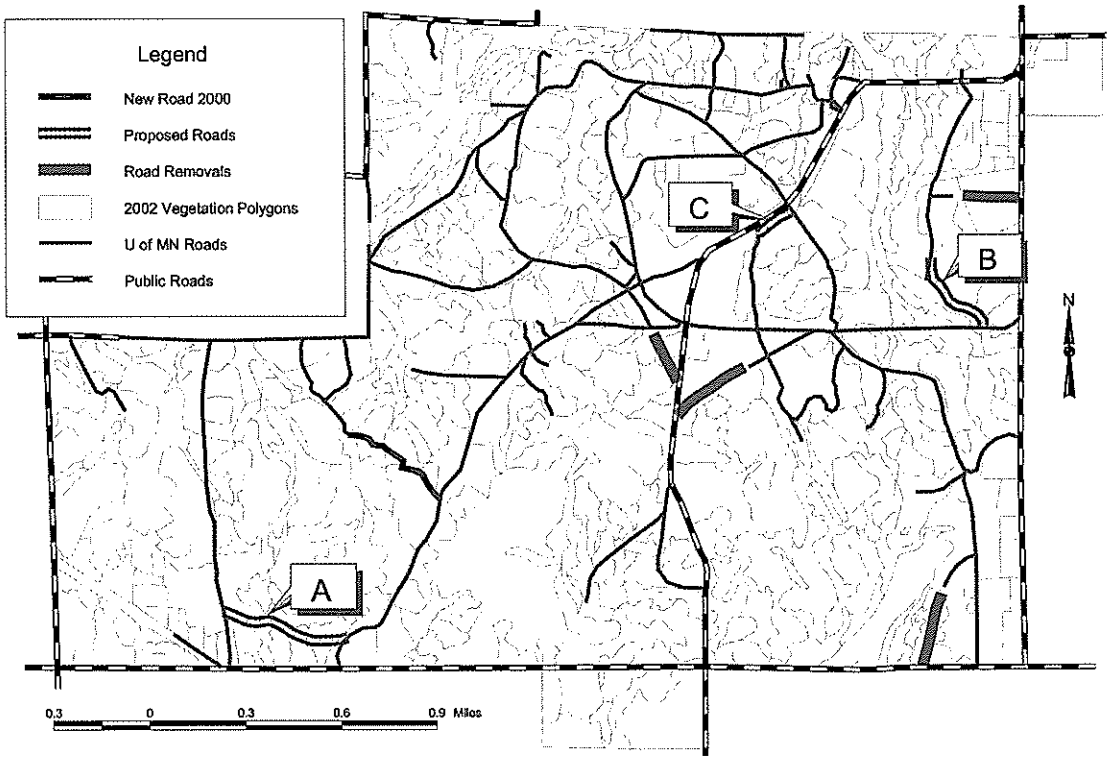
FOREST ROADS

Research, educational activities, and intensive forest management all require a safe and efficient road system. The Center has 27.6 miles of roads that traverse its interior and border its perimeter (Figure 9). Maintenance of about half these miles (17.4) is the responsibility of the Center.

Road priorities for the current planning period include:

- maintain the Center's existing road system at a safe level of operation;
- continue access control into the Cloquet Forestry Center;
- improve internal traffic routes within gated areas of the Center;
- minimize forest access points along public roads adjacent to the Center.

FIGURE 9. Roadwork plan for the period July 2001 – June 2011.



PRIORITY 1: MAINTENANCE AND SAFETY

Each year, the Center tends to experience increased use of its roads by researchers, students, and groups participating in educational activities. Maintaining the existing road system at a safe level of operation will be a high priority during the next ten years.

Approximately 40 cubic yards of surface material is required annually to spot fill washouts and repair damaged road surface areas. Approximately 16 hours of grading is required annually to maintain good road surfaces. It is anticipated that this level of maintenance will continue through the next ten year period.

Maximizing visibility of access control gates is essential for safety reasons. Every gate will have grass mowed and brush removed from around it annually. All gates will be repainted every five years with high visibility safety paint, accompanied by a re-application of safety reflector tape. No Parking signs will be posted at every gate to discourage people from parking vehicles in locations that block access to the forest.

Most of the interior road intersections that had short radius curves or blind corners have been improved. Most of the improvements were accomplished by logging contractors needing to get wood from interior timber sales out of the forest. The same holds true for areas where roads needed to be widened on the forest. At present most of the Center's interior roads are suitable for logging truck and tour bus accessibility (Figure 10).

PRIORITY 2: ACCESS CONTROL

Access control to forest roads began in 1981 and will continue through the duration of this plan. Access control is desired for the following reasons:

- increased forest road travel safety for researchers and center staff;
- increased protection of research equipment, research plots, and plot markers;

- decreased road maintenance and reconstruction costs;
- decreased dumping of garbage and debris in the forest interior.

Organizations that have access to forest roads for emergency purposes are Cloquet DNR Forestry, Cloquet DNR Law Enforcement, and the Cloquet Police and Fire Departments.

PRIORITY 3: NEW ROADS AND IMPROVING INTERNAL TRAFFIC ROUTES

Access control has benefited the Center and the forest road program. However, using gates to control access also hinders travel to various parts of the forest. This hindrance raises concerns about forest protection and management efficiency. Improving connections among roads within the gated forest would address these concerns. One new road segment was established in 2000 (Figure 9). This segment will continue to be improved.

Three additional road segments are proposed as construction resources become available. One is a 0.3 mile segment (Figure 9: location "A") located in Section 36. This segment was recommended in the last plan and is still needed. This segment would connect the lower section of the Bog Road to the lower section of the Sawyer Road. The second is a 0.2 mile segment, identified as location "B" in Figure 9. Construction of this segment would allow direct access from the Koch Road in the northeast quarter of Section 29 to the Railroad Grade road in the southeast quarter of Section 29. This would reduce travel distance from about 1.5 miles to 0.25 mile. A third segment (location "C" in Figure 9), about 0.1 mile long, is needed to connect the Tower Road with the Pine Grove Road. See Appendix B for road names and locations.

Construction standards for segments "A" and "B" are equal to main haul road standards. Haul road standards require a cleared width of 32 feet, a dozed wheel surface of 20 feet, minimum ditch depth of 2 feet, minimum gravel depth of 1 foot, a graveled wheel surface 16 feet wide, a minimum culvert length of 25 feet, and a minimum culvert diameter of 1 foot. Segment "C" crosses an open field and no additional work is required to make it useable.

Construction costs are estimated to be about $2,000 per 1/10 mile for each of the new road sections. If the timing is appropriate, they will be constructed to accommodate harvesting activities in nearby stands. If the need to improve access and efficiency is too important to wait for a harvesting operation, other funds will be used to construct the roads.

FIGURE 10. Most of the Center's interior roads are suitable for logging truck and tour bus accessibility.

PRIORITY 4: MINIMIZING FOREST ACCESS POINTS

As part of the measures taken to protect resources within the forest, the number of access points from the perimeter of the forest to its interior will be reduced. Selected unutilized access points (Figure 9) will be allowed to grow over and form natural barriers. Road segments originating from the abandoned entry points will be deleted from the forest road map.

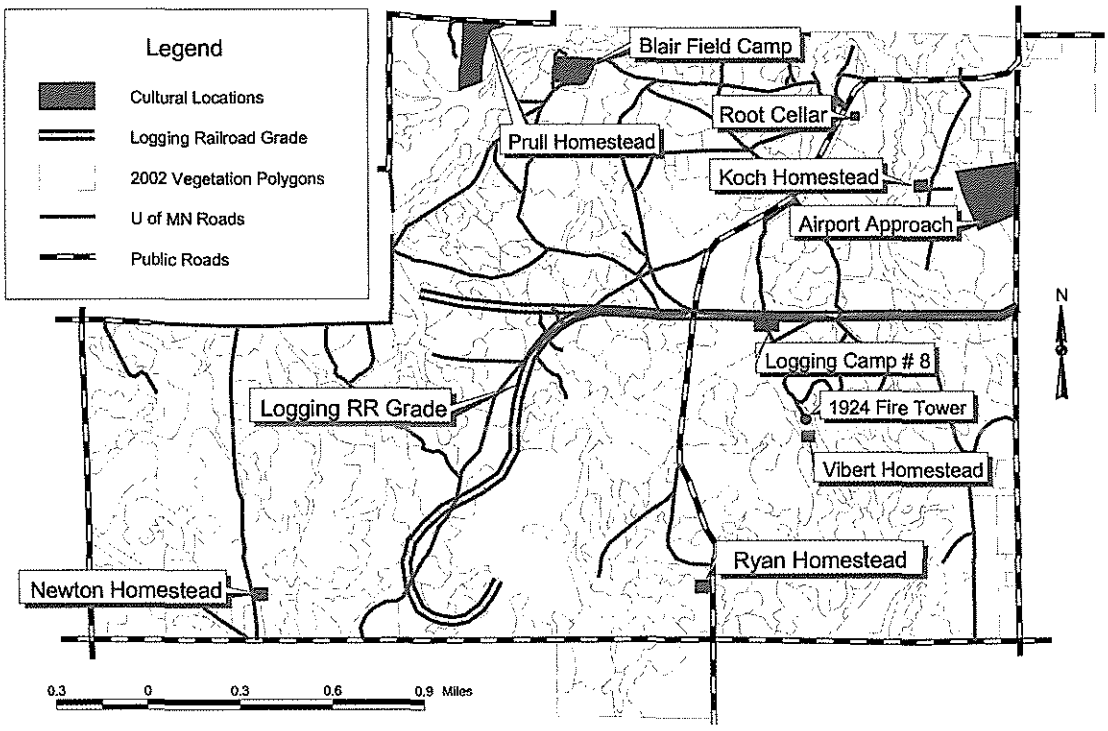
CULTURAL INTEREST LOCATIONS

As a result of the early 1854 establishment of the Fond du Lac Indian Reservation, much of the original 2,660 acres of land acquired to create the Cloquet Forestry Center was not available to pioneer settlement. This allowed the Center to be established before the land could be parceled for homesteading. Therefore, most of the land now making up the Center has always been forest land. Later acquisitions included some properties previously homesteaded or used for other purposes.

Cultural interest locations on the Cloquet forest are areas where past human activity created land uses that may impact field research results or may have current or future archaeological value. These locations are pioneer homestead building foundations, the original forestry field camp at Blair field, the early 1900s logging camp, old logging railroad grades, forested old farm fields, and abandoned gravel pits. For cultural and scientific purposes these sites are identified and documented in the forest data base.

Figure 11 identifies cultural interest locations on the Center. For viewing past land uses, 1939 and subsequent aerial photography is available at the Center or can be acquired through the Center's electronic Geographic Information System (GIS). Information related to the identified cultural locations is on file at the Center.

FIGURE 11. Cultural interest locations within the Cloquet Forestry Center.



RECREATION

One requirement for a quality research forest is to provide a land base where research can be conducted, and to the extent possible, protected from disturbances that might alter or invalidate the results. To fulfill that requirement, the Cloquet Forestry Center has identified a number of activi-

ties that are not compatible with its research emphasis, and are thus restricted or prohibited.

Many of those activities fall under the category of recreation. As residential development continues to increase around the Center and as the local population continues to grow, interest in recreating on the forest also expands. The Center allows certain types of recreation, primarily foot-based activities (e.g., hiking, cross country skiing) on the forest access roads. No separate trails are maintained or groomed for recreational purposes. The Center prohibits mechanized forms of recreation (e.g., bicycles, ATVs, snowmobiles, vehicles, etc.), with the exception of a snowmobile trail along the northern boundary of the property. Horseback riders are strongly encouraged to ride at other locations.

The forest has been a designated game refuge since 1924 and unauthorized hunting and trapping is prohibited. This policy protects individuals working in the woods, protects research plots and Center equipment, and allows study of wildlife populations unaffected by hunting pressures. By state law, hunting and trapping are permitted on the forest for research or nuisance purposes only when the activity is authorized by the University of Minnesota and the Minnesota Department of Natural Resources.

The Center has only minimal financial and human resources available to control, direct, and monitor recreational activities on the forest. Access control gates and information signs are the primary means of restricting recreation on the forest. Reasons for the restrictions on recreational activities are communicated at local civic meetings and during orientation sessions for various user groups at the Center. Additional signs will be placed around the perimeter of the forest indicating it is a University of Minnesota research forest and that hunting is not permitted.

The snowmobile trail was established by special permit to Carlton County in 1975. Local snowmobile clubs constructed and maintain the trail, but its use is permitted only as long as the terms of the permit are followed. All gated entrances to the forest are posted with signs stating that unauthorized motorized vehicles are prohibited from entering.

The self-guided walking tour that was established in 1986 will be refurbished and re-routed so it begins and ends near the administrative buildings at the Center. The new route will permit easier access to overnight and extended stay visitors and will continue to highlight forest management activities and issues. The updated walking tour and a new information guide should be completed by October, 2004. Maintenance and improvements to the tour route will be implemented as needed.

New and unforeseen recreational uses that pose a threat to research and education activities on the forest will be addressed as they are identified. Efforts will continue to inform the general public and surrounding landowners about recreational policies for the forest and their rationale.

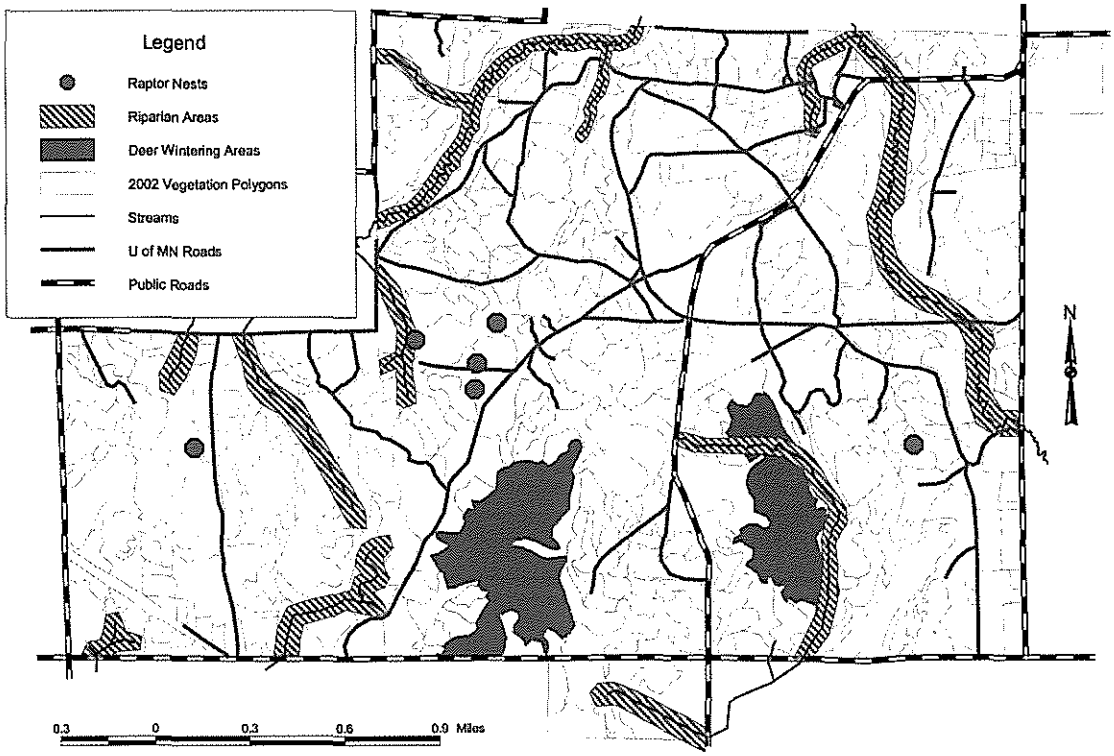
WILDLIFE CONSIDERATIONS

An integral part of the management plan for the Cloquet Forestry Center is improving and maintaining a variety of wildlife habitats. This objective is served to a large extent by the primary forest management objective of maintaining a forest with a variety of vegetation types, stand age classes, and stand vigor conditions. The resulting diverse vegetation types provide an array of wildlife habitats that make the Center attractive for a variety of wildlife research.

Various wildlife studies have been conducted at the Center. These studies have involved many species, including white tailed deer, red squirrels, snowshoe hare, woodcock, ruffed grouse, and trout (Alm 1988). Among the most notable wildlife studies was the long running ruffed grouse research project carried out at the Center by Gordon Gullion between 1958 and 1991. In 2001, under the direction of Dr. Rocky Gutiérrez, grouse research resumed at the Center.

The ruffed grouse project significantly influenced the management of the timber resource at the Center, particularly the aspen resource. Most aspen harvesting done in the 1970s and 1980s included specifications to improve ruffed grouse habitat as part of the harvesting plan. Some of that emphasis, particularly aspen stand age class distribution, continued through the 1990s.

FIGURE 12. Wildlife special interest locations within the Cloquet Forestry Center.



Although ruffed grouse has been the primary wildlife consideration in the timber management program, other species have been addressed and have benefited from management efforts. Snag management, raptor nest buffers, trout stream shading corridors, deer winter yard preserves, and other wildlife considerations have been included in the management of the forest resource. Figure 12 identifies locations such as raptor nest sites, deer wintering areas, and riparian corridors that will receive special considerations when forest management activities occur near them. When identified, wildlife research considerations will be incorporated into forest management activities.

FIGURE 13. The natural setting of the Center's timber stands is the site of significant wildlife research.

The addition of the Department of Fisheries, Wildlife and Conservation Biology (FWCB) to the College of Natural Resources in 1983 created new opportunities for wildlife research at the Center. FWCB faculty and researchers are encouraged to use the Center's forest for their research and teaching whenever possible (Figure 13). The summer field session for fisheries and wildlife students will begin at the Center in 2003. Efforts will be made to work with faculty to utilize information collected as part of teaching exercises to expand the fish and wildlife baseline data at the center. As the Center's fish and wildlife data base expands the Center will become increasingly more attractive for fish and wildlife research.

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APPENDIX A — CLOQUET FORESTRY CENTER RESEARCH PROJECTS (1992–2001)

FIELD RESEARCH ESTABLISHED 1992

Biocontrol of Sapstain in Conifers. Robert Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Effects of Municipal Solid Waste Compost Application on Early Growth in Forest Plantations. Thomas Nichols, PhD., Department of Forest Resources, University of Minnesota.

Wood Treatments to Prevent Decay in Living Trees. Robert Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Determining Optional Accord/Arsenal Mixes for Red Pine and White Spruce in the Lake States. Thomas Nichols, PhD., Department of Forest Resources, University of Minnesota.

Phytoxicity on White Spruce and Red Pine From Herbicide Release. Thomas Nichols, PhD., Department of Forest Resources, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1993

Treflan/Arsenal Herbicide, Long-Term, Slow Release Study. Tom Nichols, PhD., Department of Forest Resources, University of Minnesota.

Arsenal Formulation Study For Release. Tom Nichols, PhD., Department of Forest Resources, University of Minnesota.

Survival and Growth of Understory White Pine and Balsam Fir Seedlings Under Contrasting Light Environments. Peter Reich, PhD., Department of Forest Resources, University of Minnesota.

Extent Analysis of Armillaria in Old Growth Pine Stands. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Biocontrol of Sap Stain in Harvested Red Pine. Bob Blanchette, PhD., Department of Plant pathology, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1994

Biological Control of Blue Stain Fungi in Wood. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Controlling Decay Fungi in Wounded Aspen. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Examination of Phanerochaete gigantea *Colonization in Fresh Cut Wood.* Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Biology of Hyenenochete corrugate. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Control of Bark Beetles in Freshly Cut Logs. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Germination Requirements of Balsam Fir, White Pine, Northern White Cedar. Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Evaluation of the Role of Woody Understory in the Survival and Spread of Armillaria ostoyea *in Red Pine Sites.* Dave French, PhD., and Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1995

Comparison of Three White Spruce Genetic Sources. Bob Stine, PhD., Department of Forest Resources, University of Minnesota.

Demonstration - Black Spruce Full-sib Progeny Test. Bob Stine, PhD., Department of Forest Resources, University of Minnesota.

Bioprotection of Logs From Blue Stain Fungi, Applications of Basidiomycete Fungi to Pine For Biopulping Procedures, and Control of Bark Beetles. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Debarking and Pitch Reduction in 8 ft. Pine and Spruce Logs Inoculated With Phanerochaete gigantea. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Growth of Phanerochaeta gigantea *Under Different Environmental Conditions.* Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Insecticide Trials. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Prevention and Cessation of Blue Stain Fungi, Through Prior Inoculation With Phanerochaeta gigantea. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Debarking and Pitch Reduction in 32" Pine Logs. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota.

Comparative Snow Depths in Variable-aged Conifer Plantations in Northeast Minnesota. Jerrold L. Belont, Fond du Lac Indian Reservation.

Assessing Wetland Quality With Ecological Indicators. Susan Galatowitsh, PhD., Department of Horticultural Science.

Dynamics and Distribution of Course Woody Debris in Red Pine Forests of the Western Great Lakes. Dave Grigal, PhD., Department of Forest Resources, University of Minnesota.

Ecosystem Management of Minnesota Forests: An Integrated Stand-to-Stand Approach to Succession Biodiversity, Structure and Function in Harvested and Unharvested Northern Forests. Peter Reich, PhD., Department of Forest Resources, University of Minnesota.

Precommercial Thinning of Paper Birch: A look at Stand Dynamics For Three Difference Tree Densities. Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Silvicultural Practices For Paper Birch Plantations. Ron Severs, Cloquet Forestry Center, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1996

Biological Control of Sapstain in Pinus Resinosa. Bob Blanchette, PhD., and Chad Behrendt, Department of Plant Pathology.

Assessing Wetland Quality With Ecological Indicators. Susan Galatowitsh, PhD., Project Manager, Doug Mensing, Research Assistant, Department of Horticultural Science.

Competitive Interactions Between Various Overstories and Under-Planted White Pine Seedlings. Klaus Puettmann, PhD., and Matt Duvall, Department of Forest Resources, University of Minnesota.

NADA/NTN Air Quality Monitoring Project. Frederick A. Van De Venter, Fond du Lac Indian Reservation.

FIELD RESEARCH ESTABLISHED 1997

Acclimation of Dark Respiration to Light Level in Northern Temperate Tree Seedlings. Chris Lusk, PhD., Department of Forest Resources, University of Minnesota

Debarking and Colonization of Maple Logs Using Phanerochaete gigantea. Bob Blanchette, PhD., Department of Plant Pathology, University of Minnesota.

Establishment and Maintenance of Evenaged Black Ash Plantations. Ron Severs, Cloquet Forestry Center, University of Minnesota.

Frequency of Armillaria ostoyae *Infection of Small Woody Debris.* Bob Blanchette and Kathy Kromroy, Department of Plant Pathology, University of Minnesota.

Reproductive Potential of Lowland Hardwoods and Mixed Hardwood-Conifers on the Cloquet Forestry Center. John Zasada, PhD., U.S. Forest Service.

Response of White Pine Seedlings to Weeding Under Variable Density Shelterwood Treatments. Dr Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Response of White Pine Seedlings to Removal of Shade Tolerant Midstory. Klaus Puettmann, PhD., and Matt Duvall, Department of Forest Resources, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1998

White Pine Seed Zones in Minnesota; a Genetic, Physiological and Pathogenic Evaluation of Provenance Performance. Paul D. Anderson, USDA Forest Service.

Fungal Identifications Related to Bark Beetle Colonizations of White Spruce in the Lake States. Kirsten Haberkin, University of Wisconsin - Madison.

White Pine Under Planting: Balsam Fir Midstory. Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Evaluation of New Biopulping Fungus on Aspen. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota.

Biological Control Studies on Blue Stain Fungi and Bark Beetles. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota.

Silvicultural Considerations For Establishments and Maintenance of Evenaged Basswood Plantations. Ron Severs, Cloquet Forestry Center, University of Minnesota.

A Demonstration of Fire as a Management Tool in Controlling Understory Competition. Ron Severs, Cloquet Forestry Center, University of Minnesota.

FIELD RESEARCH ESTABLISHED 1999

Jack Pine Performance Trial. Rick Klevorn, Department of Natural Resources and Ron Severs, Cloquet Forestry Center, University of Minnesota.

Impacts of Harvesting on Regeneration, Productivity and Floristic Diversity of Quaking Aspen and Northern Hardwood Ecosystems. (Boone Tract) Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota and Jim Mattson, PhD., United States Forest Service.

Application of Forest Management Guidelines Related to Riparian Zone Management. Department of Natural Resources, University of Minnesota.

FIELD RESEARCH ESTABLISHED 2000

Biocontrol of Armillaria Root Rot in Stumps and Cut Logs. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota.

Fungal Diversity in Cut Red Pine. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota.

Timber Stand Improvement in Northern Stands - a Minimalist Approach. Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Bruning in Red Pine Thinning to Regenerate White Pine. Klaus Puettmann, PhD., Department of Forest Resources, University of Minnesota.

Gypsy Moth Survey in Minnesota. Greg Dinneen, Minnesota Department of Agriculture.

Effect of Cultural Practices and G>A>47 Injections on Flower Development in White Pine. Andy David, PhD., Department of Forest Resources, University of Minnesota.

CFI Plot - 2000 Remeasurement. Alan Ek, PhD., Department of Forest Resources, University of Minnesota.

By-Product Application to Forest Soils. Dan Gilmore, PhD., Department of Forest Resources, University of Minnesota.

FIELD RESEARCH ESTABLISHED 2001

Evaluation of Biocontrol Fungi in Red Pine Stumps. Bob Blanchette, PhD.,Department of Plant Pathology, University of Minnesota

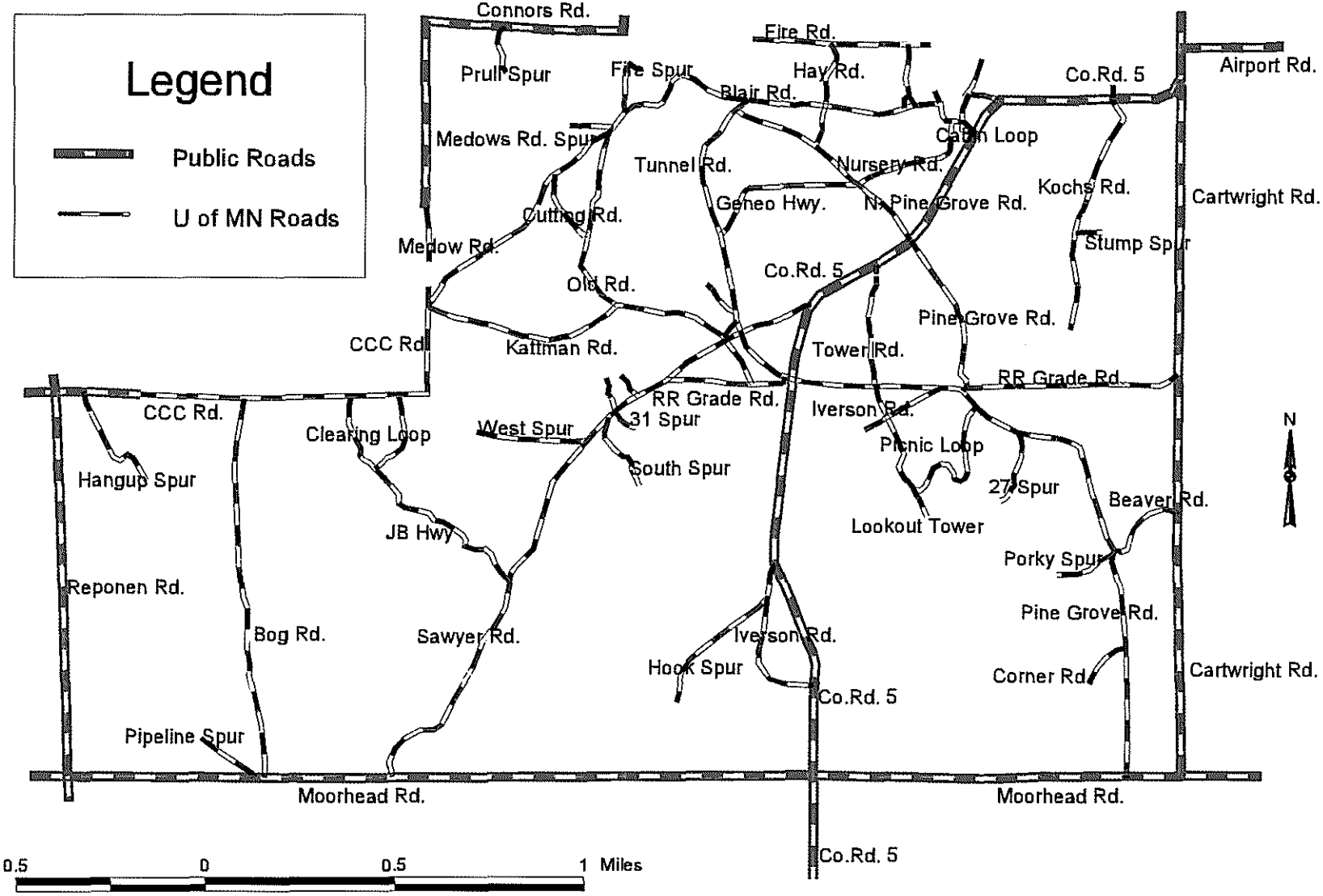
Intercept - Panel Trap Modified for Monitoring Forest Cerambycidae. Darek Czokajlo and Jim Warren, Department of Forest Resources, University of Minnesota

Large Scale Habitat Effects on Activity Levels of Ruffed Grouse Prior to the Breeding Season. R.J. Gutiérrez, PhD., and G.S. Zimmerman, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota.

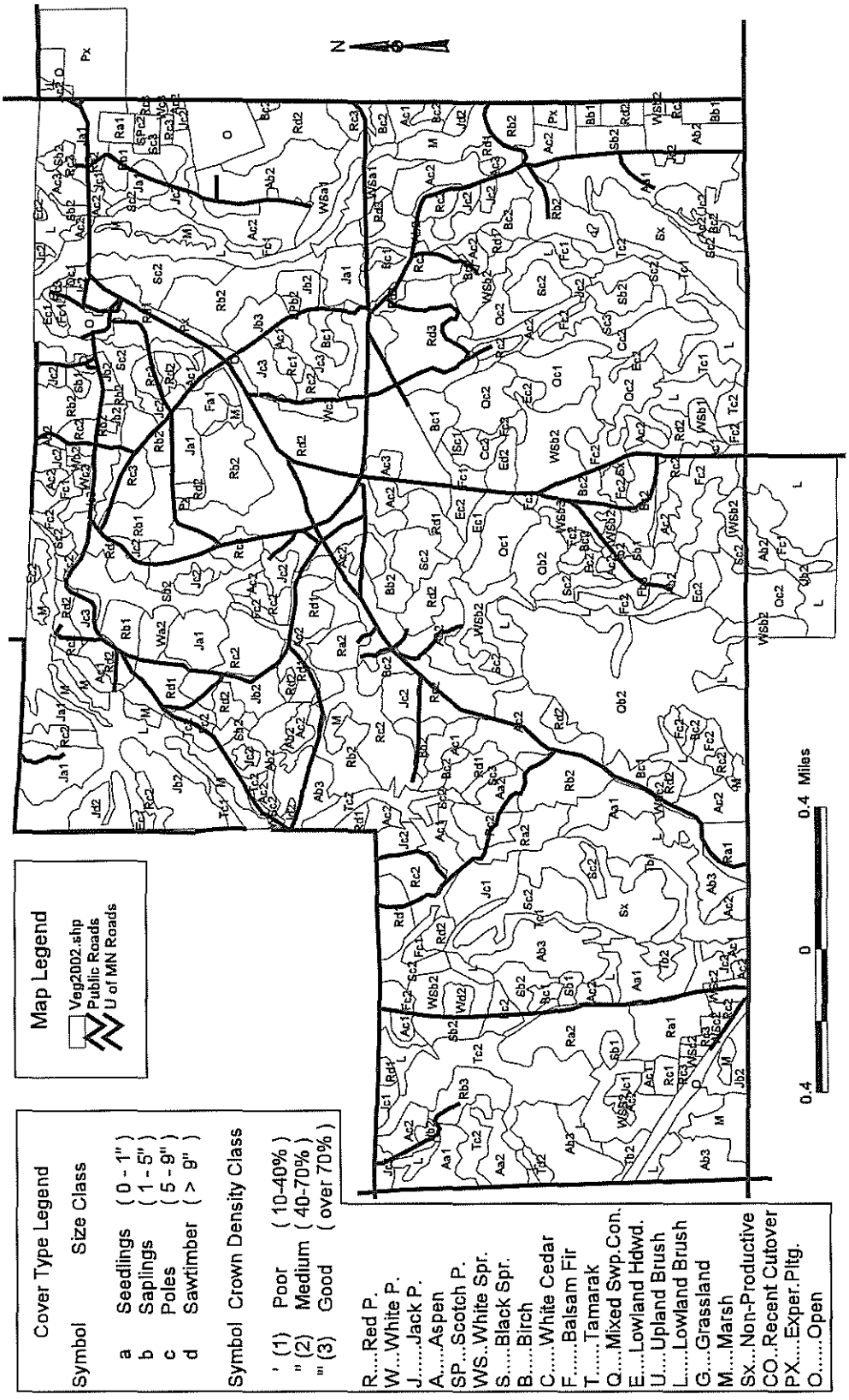
Drumming Activity of Ruffed Grouse in June and July on the Cloquet Forestry Center. R. J. Gutiérrez, PhD., and G.S. Zimmerman, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota.

Examining Changes in Water-Conducting Capacity With Increasing Sapwood Depth in Red Pine. Eileen Carey, PhD., Department of Forest Resources, University of Minnesota.

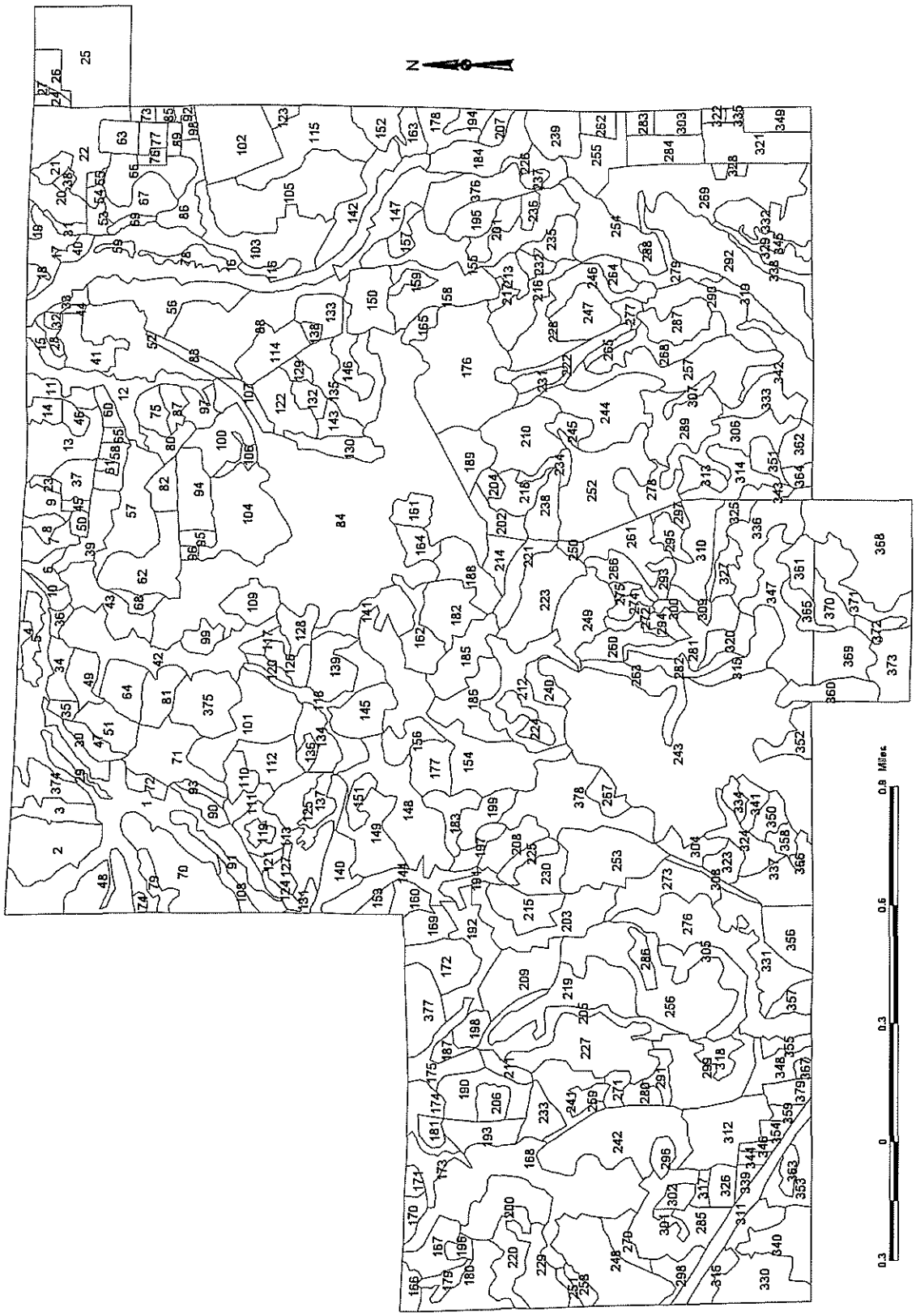
APPENDIX B — CLOQUET FORESTRY CENTER ROAD NAMES AND LOCATIONS



APPENDIX C — CLOQUET FORESTRY CENTER 2002 VEGETATION MAP



APPENDIX D — GIS POLYGON IDENTIFICATION NUMBERS FOR 2002 VEGETATION MAP



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