MILLE LACS WILDLIFE MANAGEMENT AREA MASTER PLAN, 1977–1986

Minnesota Department of Natural Resources

MILLE LACS WILDLIFE MANAGEMENT AREA
MASTER PLAN, 1977-1986

Minnesota Department of Natural Resources
Division of Fish and Wildlife
St. Paul, Minnesota
August, 1977

PREFACE

Concurrent with our population growth, our natural resources have been increasingly exploited through demands for raw materials and outdoor recreational opportunities. Recognizing Minnesota's existing and potential recreation and natural resource use problems, the 1969 legislature requested a "Study of the Total Environment" called Project 80. The study, to guide the legislature in reviewing appropriation requests for the acquisition, development, and maintenance of state-owned lands used for outdoor recreation, was conducted by the State Planning Agency and the Department of Natural Resources.

Project 80 recommendations led to the Outdoor Recreation Act of 1975. The Act established an outdoor recreation system to preserve and properly use Minnesota's natural, cultural, and historical resources. The system is composed of 11 different classes of state-owned lands administered by the Department of Natural Resources, the Minnesota Historical Society, and the Department of Transportation (Appendix A). Each class within the system has an unique purpose and use. In this way, the system provides a variety of recreational opportunities with minimal use conflicts.

The Department of Natural Resources is preparing comprehensive management plans for 9 wildlife management areas having resident managers. The plans include present and projected regional perspectives, resource inventories, and demand and use analyses, as well as acquisition and development schedules, cost estimates, and resource management programs. Existing written and unwritten plans are synthesized into comprehensive documents. These are 10-year management plans, and they will be revised as new management practices develop, new resource philosophies evolve, and new problems are encountered.

Under a cooperative agreement with the State Planning Agency, the Department of Natural Resources completed plans for the Whitewater, Carlos Avery, Mille Lacs, Talcot Lake, and Lac qui Parle Wildlife Management Areas during the 1976-77 biennium. Plans for the Roseau River, Red Lake, Hubbel Pond, and Thief Lake Wildlife Management Areas will be completed during the 1978-79 biennium.

TABLE OF CONTENTS

PREFACE . . . . . *i*

TABLE OF CONTENTS . . . . . *ii*

INTRODUCTION 1
- Description
- Legal Purpose
- Long-range Goals

HISTORICAL AND ARCHAEOLOGICAL ASPECTS 2
- Local History
- Wildlife Management History
- Archaeological Aspects
- Historical Sites

RESOURCE INVENTORY 3
- Abiotic Resources
  - Climate
  - Geology
  - Soils
  - Underground Hydrology
  - Watersheds
- Biotic Resources
  - Vegetation
  - Birds
  - Mammals
  - Fish

OPERATIONS 15
- Administrative and Fiscal
- Capital Improvements
- Equipment
- Staff

LAND OWNERSHIP 18
- Acquisition Status
- Acquisition Priorities

PUBLIC USE 20
- Hunting
- Trapping
- Fishing
- Other Activities
- Timber Harvest
- Agricultural Leases

LOCAL PERSPECTIVE 22
- General
- Adjacent Development

RECREATION DEMAND AND CAPACITY 25
- Demand
- Capacity

MANAGEMENT PROGRAMS 27
Forest Management
Objectives
Considerations
Present Programs
Future Programs
Wetland Management
Objectives
Considerations
Present Programs
Future Programs
Nongame Management
Objectives
Considerations
Public Use Management
Objectives
Considerations
Present Programs
Future Programs
Research and Surveys
Objectives
Considerations
Present Programs
Future Programs

IMPLEMENTATION AND COST ESTIMATES 35
Land Ownership
Management Programs
Management Area Funding

LITERATURE CITED 38

PHOTO CREDITS 40

APPENDIX A 41

APPENDIX B 42

APPENDIX C 42

APPENDIX D 43

INTRODUCTION

Minnesota has an abundance of natural resources. To many people, Minnesota's wildlife management areas and their associated wildlife and plant communities are among the state's most precious resources. In accord with the Outdoor Recreation Act of 1975, this master plan outlines the management of the Mille Lacs Wildlife Management Area (WMA) through 1986. This plan was developed by defining area goals, examing existing conditions, identifying management considerations, and then developing appropriate management programs.

Description

The Mille Lacs Wildlife Management Area is a 39,156 acre unit in Mille Lacs and Kanabec counties. The management area is 87 miles north of the Twin Cities and 2 miles southeast of Onamia (Figure 1). Major access points are from U.S. Highway 169 to Mille Lacs County Road 20 on the west and Minnesota Highway 47 to Kanabec County Road 26 on the south.

The Mille Lacs WMA was originally established to preserve and manage habitats for white-tailed deer and ruffed grouse and, to a lesser extent, for waterfowl and furbearing mammals. The primary goal of the management area has been the preservation and enhancement of forest habitat for the production of wildlife. Public use is restricted to those activities associated directly with fish and wildlife including hunting, fishing, trapping, observation, scientific investigations, and environmental education. Public hunting is the dominant outdoor recreational use.

Legal Purpose

Public lands have a limited potential for multiple recreational use. Minnesota has never actively encouraged the multiple use of wildlife lands. The Commissioner of Natural Resources recognized that those public uses directly associated with public enjoyment through observation, interpretation, and understanding of fish

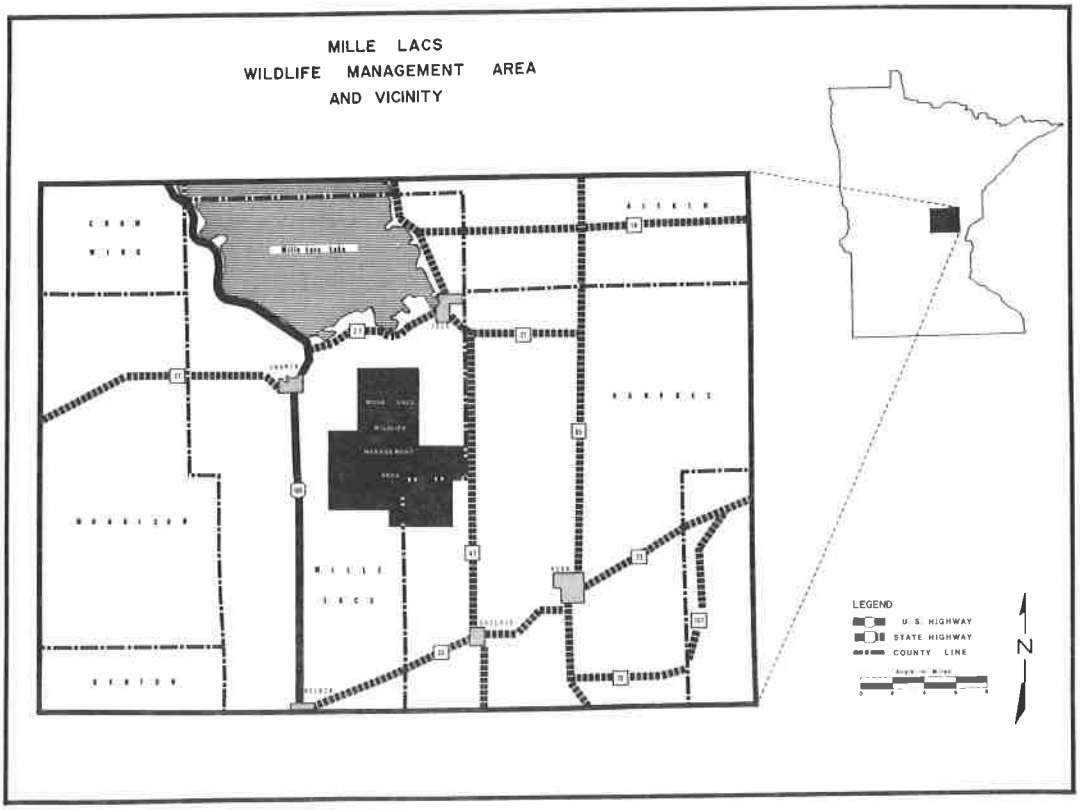

Figure 1

and wildlife populations and habitats were recreational uses compatible with Minnesota's wildlife management areas. Similarly, the U.S. Fish and Wildlife Service has recently realized that the goals of our national wildlife refuges are endangered by conflicts between the demand for recreation and the ability of the resource to accommodate the demand (Pulliam 1974). The greatest contribution from our country's wildlife lands is the fostering of public uses directly associated with fish and wildlife and their habitats.

Minnesota's wildlife management areas are administered by the Commissioner of Natural Resources to perpetuate and, if necessary, reestablish quality wildlife habitats for the maximum production of a variety of wildlife species. These areas are land and water habitats having a high potential for wildlife and providing opportunities for public hunting, trapping, fishing, and other compatible outdoor recreational uses (Minnesota Statutes, Section 86A.05, subd. 8, 1976).

Long-range Goals

The long-range goal of the Mille Lacs WMA is the management of forest habitats suitable for white-tailed deer, ruffed grouse, and other forest wildlife. Since the management area was forested at settlement, perpetuation of forests for wildlife is a sound ecological goal. Existing wetlands, bogs, and openings will be maintained and managed to enhance habitat and wildlife diversity. By managing native plant and animal communities, the Mille Lacs WMA will contribute to the preservation of Minnesota's wildlife.

Public use of the area compatible with the preservation and management of wildlife habitats is another long-range goal. Hunting and trapping will be the primary outdoor recreational uses. Other public use will be accommodated only if compatible and associated with fish and wildlife.

HISTORICAL AND ARCHAEOLOGICAL ASPECTS

Historical knowledge of an area is invaluable to natural resource management. Many of the land use problems and attitudes toward the management area's resources arose with settlement of the region. Cognizance of the historical use of the management area's natural resources, the strong points and shortcomings of these practices, and the policies regarding natural resource use is necessary for the development of a comprehensive plan.

Local History

Mille Lacs and Kanabec counties contained vast areas of enormous white and red pines that supported a vigorous timber industry during the late 1800's. The Rum River carried logs each spring to mills located in Milaca and Princeton. The first cutting, mainly by Weyerhauser, of the most mature and finest trees, including those on the management area, was completed by 1890. After the turn of the century, a second major cutting by Jim McGrath and his employees removed most of the remaining pines and oaks.

After this second cutting of timber was completed, the land was sold to settlers for as little as 6 dollars per acre. Farming was difficult because large numbers of stones and stumps had to be removed by hand. Potatoes were the most popular crop during the early 1900's, and Mille Lacs and Kanabec counties became Minnesota's potato center. Most of the management area was never farmed because the soils were too stony or poorly drained. At the time the management area was established, large blocks of land were tax forfeited because of their unsuitability for agriculture, and only 18 families owned land within the project boundaries.

Wildlife Management Area History

The Mille Lacs WMA was established in 1949 following approval by the Mille Lacs and Kanabec County Commissioners acting on Division of Game and Fish (now Division of Fish and Wildlife) recommendations. In 1950, the project was approved for federal funding by the U.S. Bureau of Sport Fisheries and Wildlife (now the U.S. Fish and Wildlife Service) under the Federal Aid in Wildlife Restoration Act. Land acquisition began in 1950. In 1952, there were 1,920 acres along Mille Lacs County Road 19 included in the project to improve access.

Archaeological Aspects

No prehistoric or historic archaeological sites are recorded within Mille Lacs WMA (Johnson 1977). However, the area has not received an archaeological survey. Eighteen archaeological sites are recorded, and several have been excavated along the Rum River near Lake Onamia and Mille Lacs Lake. Since the Knife River was a major drainage system during prehistoric times, early prehistoric sites may exist along the Knife River within the management area.

Historical Sites

No historical sites in need of special consideration or preservation exist on the management area. The Mille Lacs County Historical Society was consulted and

literature and documents available at the Minnesota Historical Society were examined to identify significant sites. An abandoned railroad grade extends 4 miles into the management area from the north. This spur line originated in Wahkon and was operated by the "Soo Line" to remove timber from the interior of the management unit and adjacent areas. No areas on or adjacent to Mille Lacs have been declared eligible for designation as a historical site on the National Register of Historic Places.

RESOURCE INVENTORY

The resources were divided into 2 classes: abiotic and biotic. While each category influences the other, the abiotic conditions in an area generally determine the diversity, distribution, and density of the biotic resource. For this reason, the abiotic resource inventory is presented first, followed by the biotic resource inventory. Examination of the existing resources and conditions, with an understanding of the food habits, cover requirements, population dynamics, and behavior of game and nongame wildlife, is needed to develop programs resulting in the sustained production and use of these populations.

Abiotic Resources

Climate. The climate of the Mille Lacs WMA vicinity is characterized by short, mild summers and long, cold winters. Average normal temperature for July is 71.2° F and for January 11.2° F (Table 1). Winter temperatures of -35° F are common. The average growing season is approximately 125 days with the first killing frost September 15 and the last killing frost May 15. However, low-lying areas are susceptible to frost throughout the summer. Average normal precipitation is 28.16 inches ranging from 0.86 inches in February to 4.90 inches in June. About 18 inches, or 65 percent of the normal annual precipitation, falls during May through September. A 10 to 30 day drought may occur during the growing season, especially August and September, but duration and frequency of the drought are not predictable. Average normal snowfall is 52.3 inches, and maximum accumulated snow depth averages 40 inches. Snow cover is 1 inch or greater for approximately 110 days per year. Prevailing winds are from the northwest during the winter, changing to the southwest and south during spring and summer.

Geology. The management area has intrusive Precambrian bedrock formations. This diverse base complex is the southern extent of the Canadian Shield. Predominant composition is diorite, grandiorite, and quartz monzonite (Ericson *et al.* 1974). There are numerous

Table 1. Average normal temperature, precipitation, and snowfall for the Mille Lacs WMA vicinity, 1941-1970.

Month [1]	Average Normal Temperature (°F)	Average Normal Precipitation (inches)	Average Normal Snowfall (inches)
January	11.2	0.88	9.0
February	14.6	0.86	9.5
March	26.1	1.35	12.0
April	42.8	2.22	4.0
May	55.7	3.71	0.5
June	65.3	4.90	0.0
July	71.2	3.29	0.0
August	68.8	3.92	0.0
September	58.8	2.59	T [2]
October	47.5	1.94	0.8
November	30.0	1.64	7.5
December	17.1	0.87	9.0
Total		28.16	52.3

1. Data from weather station at Mora, Minnesota.
2. Trace.
Source: Forecast Office, National Weather Service. U.S. Department of Commerce. Minneapolis, Minnesota.

bedrock outcroppings on the area and throughout Mille Lacs and Kanabec counties. The bedrock surfaces slope gently to the south in Mille Lacs County and southeastward in Kanabec County. Minor irregularities in the bedrock surface are due to stream and glacial erosion.

Pleistocene glacial activity was responsible for the present soil and topographic features of the management area (Sims and Morey 1972). Ice sheets covered the area several times during the Pleistocene, but present landforms and surficial deposits are the result of the most recent (Wisconsin) glaciation. Fifty to 100 feet of the undifferentiated glacial drift of red sandstone and shale derived from the Lake Superior Basin underlie the soils. The area is bounded on the north by moraines forming the southern and western shore of Mille Lacs Lake and giving the northern one-third of the area a hilly topography. Drumlins and eskers formed by the Superior-Rainey ice sheet give the southern two-thirds of the unit a gently rolling topography. Erosion and deposition have modified the landscape in the 10,000 years since the last glaciation. Except for possible sand and gravel borrow pits for road construction materials, there is no known mineral potential on or adjacent to the unit (David Meineke, Minnesota DNR, Division of Minerals).

Soils. The Mille Lacs WMA has forest (podzol) soils that developed in a climate of mild summers and cold winters. The soils formed from red sandstone, limestone, and parent material of glacial origin. Weathering and organic matter accumulation have produced a typical podzol profile development. The soil surface is characterized by a layer of leaf mold underlain by a dark humus layer of well decomposed organic matter and mineral products (Bodman *et al.* 1927). Beneath these layers is typically a well leached, strongly acidic zone low in organic matter underlain by an acidic, weakly cemented layer of clayey materials.

The Mille Lacs WMA soils are marginally productive for agriculture. The upper soil layers are well weathered and leached resulting in low nitrogen levels and a strongly acid condition (McMiller *et al.* 1939). The many boulders and rocks in surface layers have restricted cultivation in areas adjacent to the unit. Occurring beneath most mineral soils at a depth of 2 to 6 feet, is a fragipan composed of dense, compacted till that restricts root penetration and reduces water holding capacity.

The Mille Lacs WMA soils were grouped into 5 categories based on physical and chemical characteristics and other factors that would influence or limit land use (Table 2). A soils map was prepared using the characteristics as the mapping unit (Figure 2).

Underground Hydrology. The groundwater availability is related to the glacial history of the management area. Sand and gravel outwash zones, buried in glacial till, are the primary sources of underground water (Ericson *et al.* 1974). Groundwater moves southeasterly through glacial till with negligible quantities reaching bedrock aquifers. Bedrock formations are generally impermeable except at fractures or joints and are unreliable sources of groundwater.

Because of extensive marshes, bottomlands, and peat bogs, the Mille Lacs WMA is primarily a discharge area for underground water in the Rum River and Snake River Watersheds. Recharge sources on the unit are confined to moraines, rolling till plains, and high areas of outwash. Groundwater is recharged primarily in the spring through snow melt and rains. Most summer precipitation is lost through evapotranspiration. Approximately 70 percent, or 20 inches, of the average normal precipitation in the Snake River Watershed is lost through evapotranspiration, while 30 percent, or 8 inches, enters the underground and surficial systems.

Static water levels are 10 to 35 feet below the surface, and most wells on the unit could be completed in 20 to 100 feet, depending on topography. However, depths of 40 to 200 feet may be necessary along the northern boundary. A well, 65 feet deep, supplies water for the area headquarters. Due to the heterogeneous mineral composition of the glacial drift, groundwater is high in major ions, especially iron, calcium, and magnesium. Measurements of chemical constituuents in groundwater sampled from the Rum River and Snake River watersheds are presented in Table 3. In some areas, dissolved solids, iron, nitrates, and magnesium concentrations in groundwater can exceed domestic consumption limits

Table 2. Soil characteristics of the Mille Lacs WMA.

Characteristics	Soil Map Designation Symbol	S.C.S. Soil Map Unit Number [1]
High		
Drainage	H – 1	12
Erosion potential	H – 2	None [2]
Fertility	H – 3	None
Flooding potential	H – 4	1001
Medium		
Drainage	M – 1	266
Erosion potential	M – 2	None
Fertility	M – 3	277, 152
Flooding potential	M – 4	None
Low		
Drainage	L – 1	13, 995
Erosion potential	L – 2	None
Fertility	L – 3	None
Flooding potential	L – 4	Mpme

1. U.S. Soil Conservation Service standard numerical designation for soil series in Minnesota. Names of soil series corresponding to these numbers are listed in Appendix B.
2. Soils with this characteristic do not occur on the unit.

Table 3. Hardness and dissolved solids in milligrams per liter of ground water sampled in glacial drift in the Rum River and Snake River watersheds.

	Rum River Watershed			Snake River Watershed			
	Maximum	Minimum	Median	Maximum	Minimum	Median	Consumption Limits
Silica	39	13	23	23	23	23	
Iron	42	0.03	0.42	7.60	0.02	0.19	0.30
Manganese	1.60	0.02	0.13	0.98	0.0	0.09	0.05
Calcium	88	14	52	88	14	58	
Magnesium	38	0.1	15	46	5.1	24	
Sodium	18.0	2.8	7.2	40	3.1	7.7	
Potassium	3.4	0.1	1.9	4.9	0.8	1.0	
Bicarbonate	416	28	244	383	46	268	
Sulfate	46	0.9	8.8	82	1.0	3.9	250
Chloride	39	0.7	0.3	88	1.0	3.9	250
Fluoride	0.3	0.0	0.2	0.4	0.1	0.2	1.5
Nitrate	42.1	0.0	0.4	75	0.0	4.4	45
Boron	0.11	0.0	0.05	28	0.01	0.03	
Dissolved solids	420	123	248	550	109	300	500
Hardness as $CaCO_3$	330	48	198	410	56	240	
pH	8.2	7.4	7.9	8.2	7.5	7.9	

1. Recommended domestic consumption limits (Minnesota Pollution Control Agency 1972).
Source: Lindholm *et al.* 1974, Ericson *et al.* 1974.

established by the Minnesota Pollution Control Agency (1972).

Watersheds. Two watersheds drain the Mille Lacs WMA. The snake River Watershed drains an area of 1,022 square miles, including 70 percent of the management area (Lindholm 1974). The remaining 30 percent is drained by the 1,500 square mile Rum River Watershed (Ericson *et al.* 1974). Three rivers, the Groundhouse, Knife, and Little Ann, originate in the area. All are within the Snake River Watershed. Flow in the headwaters of these rivers is derived primarily from runoff during the spring and from groundwater discharging directly into stream channels during the summer. Base flow for the rivers in the management area is less than 0.5 cubic feet per second in the summer and fall and often intermittent during drought years. Spring discharge rates are extremely variable depending on the winter snowfall and rapidity of snow melt.

Since 1962, 13 dikes have been constructed, retaining water in 6 impoundments (Table 4). Dikes con-

Table 4. Impoundments and ponds constructed on the Mille Lacs WMA.

	Total Area (acres)	Open Water (acres)	Number of dikes	Date Constructed
Impoundments				
DeWitt	146	43	1	1962
Ernst	299	50	1	1963
Korsness/Cranberry	1,326	86	3	1965-1968
Mikkelson	520	33	3	1968-1969
Section	197	13	2	1969
Headquarters	365	29	3	1971
Total	2,853	254	13	
Ponds				
Olson		1		1966
Albrecht		14		1970
Grants		2		1970
Kollar		5		1974
Korsness No. 1		7		1975
Korsness No. 2		1		1975
Korsness No. 3		1		1975
Berry		10		1971
Total		41		

structed on the Little Ann and Knife rivers form the DeWitt and Ernst pools. Other dikes were constructed across low areas, intermittent drainages, and the headwaters of the Groundhouse River. Since impounding, mats of sedges and lowland shrubs growing on floating peat have overgrown many open water areas. Because floating mats of vegetation occur adjacent to non-floating lowland and bog vegetation, actual sizes of the impoundments are difficult to determine. The open water area and total size of each impoundment were estimated.

Impoundment water is derived from spring runoff and from groundwater discharging directly into low-lying areas and bogs on the Mille Lacs WMA. Water levels are maintained by at least 1 drop inlet type water control structure in each impoundment.

Water samples taken from the Korsness, Ernst, and DeWitt pools in May and July, 1976 were analyzed at the Section of Ecological Services laboratory located on the Carlos Avery WMA. Measurements of water quality parameters for these 3 impoundments are presented in Table 5.

To provide habitat for waterfowl production, 8 ponds have been constructed since 1966. These ponds, located in lowlands, were constructed with a bulldozer or dragline, hold open water during most of the summer, and impound 41 acres of open water less than 4 feet deep. In addition, beaver dams impound approximately 22 acres of open water. These acreages fluctuate from year to year depending on precipitation levels and beaver activity.

Biotic Resources

Vegetation. The presettlement vegetation of the Mille Lacs WMA and vicinity consisted of white pine, red pine, and northern hardwoods. Red pine and white pine occurred in almost pure stands. Periodic wildfires maintained the species composition and structure of these pine forests (Hansen *et al.* 1974). Braun (1950) classified the presettlement forests as Hemlock-White Pine-Northern Hardwoods. Kuchler (1964) included the area in the Great Pine Forest with white pine, red pine, and jack pine as dominant trees and trembling aspen, red oak, and bur oak as lesser components. The Maple-Basswood Forest, dominated by sugar maple and basswood, and the Conifer Bog Forest, consisting of tamarack and black spruce, were 2 other presettlement forest types occurring in the Mille Lacs vicinity according to Kuchler.

The presettlement vegetation was altered through logging and settlement. Intensive logging of the pines began in 1863. By 1890, logging peaked and most of the mature pine had been removed. Settlers began clearing the land of remaining trees for farming. Fire was employed, often indiscriminately, to clear large areas of land. Several major forest fires burned portions of Mille Lacs and Kanabec counties during the early 1900's. The last major fire was in 1930. Since then, indiscriminate burning has stopped, and the management area has been free of major wildfires for 46 years. The present vegetational composition of the Mille Lacs WMA is a result of the removal of most mature pines, followed by clearing, frequent burning until 1930, and recent fire exclusion.

Infrared black and white aerial photographs were used to map the vegetation of the Mille Lacs WMA. Ten different upland vegetation types were recognized and mapped according to the system used by the Division of Forestry, Minnesota DNR (Figure 3). Wetlands on Mille Lacs were classified using criteria modified from Stewart and Kantrud (1969) and Cowardin and Johnson (1973). Eight wetland types were described based on water depth and seasonal water level fluctuations (Figure 4). In addition, seasonal and semi-permanent wetlands were assigned a cover type value representing the degree of vegetation interspersion or closure. A brief description of the vegetation types, including dominant species and successional trends without disturbance, follows.

Aspen. Aspen is the most abundant upland vegetation type found on the management unit. Trembling aspen is an adaptable species occurring over a wide range of soil moisture and nutrient levels. On drier sites, red oak and bur oak can be associated with aspen. On wetter sites, red maple, ironwood, and basswood occur.

Prominent understory shrubs in the aspen type include beaked hazel, juneberry, Canadian honeysuckle, and mountain maple.

Successional trends are related to the purity of the aspen stand. Trembling aspen, being intolerant to shade, will not reproduce under a canopy of mature trees. Homogeneous aspen stands will develop into aspen shrublands as mature aspen succumb to disease or wind damage (Fedkenheuer 1975). As the forest canopy opens with the death of mature trees, hazelnut and other aggressive shrubs will respond to the increased light. Sparse aspen reproduction by root suckering from mature trees will perpetuate the aspen shrubland.

On xeric sites in less homogeneous stands, the short-lived aspen will give way to the longer-lived northern red and bur oaks. These species can live 250 years, compared to 40 to 80 years for aspen. Where aspen is associated with tolerant hardwoods on mesic sites, sugar maple and basswood will eventually dominate (Curtis 1959).

Northern Hardwood. On the Mille Lacs WMA, the northern hardwood type is a mixture of trembling aspen, paper birch, red maple, and northern red oak. Trembling aspen is the most abundant overstory species, but paper birch, red maple, and northern red oak approach aspen in frequency of occurrence.

Beaked hazel is the most abundant understory shrub in

Aspen vigorously regenerates by root suckering in this recently clearcut area.

the northern hardwood type. Large-leaved aster, wild sarsaparilla, false lily of the valley, and bracken fern are a few of the more common herbaceous plants.

The short-lived aspen and paper birch will begin to die at 40 to 80 years. The longer-lived oaks and red maple will gradually be replaced by sugar maple, basswood, and lesser numbers of yellow birch, green ash, and American elm (Fedkenheuer 1975).

Tamarack-Black Spruce. This lowland forest type is limited to poorly drained peat soils. Overstory species composition is almost entirely black spruce and tamarack; however, paper birch or black ash occur sparsely in some bogs. The abundance of tamarack and black spruce depends on the nature of the peat soils (Curtis 1959). Almost pure stands of tamarack are found in areas where the bog mat is still loose and advancing over water. On firm peat in completely filled basins, black spruce becomes the dominant overstory species occurring in virtually pure stands. The structure of lowland forest bogs varies from savanna-like muskegs with widely scattered clumps of trees to a dense forest interspersed with open glades filled with ericaceous understory species.

Understory species composition is similar, regardless of the composition of the overstory. Common ericaceous species found in tamarack-black spruce bogs include labrador tea, wild cranberry, leatherleaf, and bog rosemary. Mosses, especially *Sphagnum* sp. and *Polytrichum* sp., carpet the forest floor in a dense, thick mat. The feather mosses, *Hypnum* sp. and *Thridium* sp., replace mosses under denser overstory canopies.

Successional development in the tamarack-black spruce type is extremely slow. Both tamarack and black spruce are susceptible to disease and insect attack but reproduce readily in bog conditions (Duncan 1954). With the accumulation and consolidation of the peaty soils, black spruce will replace tamarack (Curtis 1959). In the absence of fire or water level changes, white cedar will eventually invade and dominate as an overstory species excluding all other trees except balsam fir.

Bottomland Hardwood. The bottomland hardwood type is confined to poorly drained and periodically flooded mineral soils. This type is found along the margins of the Knife, Little Ann, and Groundhouse rivers as well as adjacent to many of the wetlands and tamarack-black spruce bogs. American elm, green ash, black ash, ironwood, yellow birch, and basswood are dominant overstory species.

Understory vegetation is sparse because of the dense overstory tree canopy. Beaked hazel, willow, elderberry, chokecherry, and speckled alder are found. Ground cover is dominated by lady fern and maiden-hair fern.

The bottomland hardwood type is stable, characterized by long-lived species, and will succeed itself.

Oak. This localized type is confined to sandy well-drained soils usually on hills and south facing slopes where conditions are unfavorable for other hardwoods (Fedkenheuer 1975). Northern red oak and bur oak are the major components. Hill's oak and paper birch also occur. Oaks can be expected to live 250 years, and with the reproduction of shade-tolerant oaks under a canopy of mature trees, this type will maintain itself.

Understory vegetation is similar to the aspen type with beaked hazel the most abundant understory shrub. Currant and prickly ash are also associated with oaks. Ground cover includes such xeric species as hog peanut, enchanter's nightshade, wild bedstraw, and plantain.

Paper Birch. The paper birch type occurs in small, homogeneous stands. Aspen or northern red oak is occasionally found within these stands. Paper birch is a short-lived tree that will eventually be replaced by oaks on xeric sites and sugar maple-basswood on mesic sites. Understory shrub and ground cover species composition resembles the aspen type.

Tamarack — black spruce bogs occupy extensive areas on the Mille Lacs unit.

Pine Plantation. Plantations are areas planted with jack pine, red pine, or Scotch pine. Planting began with the establishment of the management area and has continued irregularly to the present. Pine trees have been planted for erosion control, windbreaks, and for wildlife management purposes. Due to the density of trees in most pine plantations, understory species, including shrubs and herbaceous ground cover, are almost absent.

Old Field. Inactive cropland or hayfields are classified as old fields. These areas will eventually be invaded by shrubs such as pin cherry, willow, raspberry, and juneberry. Depending on site quality, either trembling aspen or oaks will dominate the overstory.

Cropland. Active cropland, hayfields, and pastures are grouped into this type. A total of 498 acres in 34 fields comprise a system of food plots and upland nesting cover areas ranging in size from 4 acres to 160 acres.

Logged 1976. This type includes sites that were clearcut during the winter of 1975-76 and the spring and summer of 1976. Size of cuts was variable, but maximum block size was approximately 10 acres. These logged areas were considered as a separate type because natural regeneration began with the 1976 growing season. Areas logged previous to the winter of 1975-76, where regeneration is more advanced, were included in a vegetation type according to the regenerating species.

Emphemeral Wetland (Type I). This wetland type is a seasonally flooded depression containing water for a brief period during the spring or after heavy rains. Characteristic vegetation includes Kentucky bluegrass, sedges, quack grass, smartweeds, burreeds, wild lettuce, and spikerush. Shrub cover is very sparse or absent but without disturbance will eventually become dominant.

Temporary Wetland (Type II). Surface water remains in these wetlands for only a few weeks after spring snow melt. Soils are raw sedge peat or muck and remain waterlogged within a few inches of the surface during the entire growing season. Blue-joint and narrow-leaf sedges, especially *Carix stricta,* can account for more than 50 percent of the ground cover on some temporary wetlands. Other common species include squirrel tail, water parsnip, redtop, meadow rue, marsh fern, meadow aster, blue flag, and swamp milkweed (Cowardin and Johnson 1973).

In the absence of fire and other disturbances, alder, willow, and red-osier dogwood will invade these wetlands,

creating a dense shrub thicket. Tamarack will eventually become established over a vigorous understory of shrubs.

Seasonal Wetland (Type III). This type occurs in depressions having variable water depths of up to 30 inches. Water remains in at least a portion of the wetland during spring and early summer. Emergent aquatic vegetation is characteristic of seasonal wetlands. Both water depth and water chemistry influence species composition; however, cattail, bulrushes, spikerushes, and sedges are usually present. Also occurring on some areas are wild rice, giant reedgrass, marsh marigold, water hemlock, rice cut-grass, and arrowheads. Emergents are more common in wetlands containing surface water for the majority of the growing season, while sedges are found in drier areas.

With the accumulation of peat in these wetland basins, surface water levels will begin to decrease. As the peat soils accumulate, sedges will replace emergents, and gradually a hydric shrub stage of willow, alder, and red-osier dogwood will become dominant.

Semi-permanent Wetland (Type IV). This type is a deep marsh with water depths up to 5 feet and containing surface water through the entire growing season. Species composition is influenced by water depth, seasonal water level fluctuation, and water chemistry. Emergents found in seasonal wetlands are also common to semi-permanent wetlands, as are such submergent aquatics as bladderwort, coontail, yellow waterlily, and sago pondweed (Cowardin and Johnson 1973).

Successional trends of semi-permanent wetlands follow a pattern similar to seasonal wetlands. Through the accumulation of dead organic matter and peat, the marsh basin will gradually fill, and the species composition will change from emergent aquatics to sedges and finally shrub-tamarack (Curtis 1959).

Lowland Brush (Type VI). This type occurs on mineral or organic soils that are waterlogged during the entire growing season, often with up to 1 foot of surface water following spring melt or after heavy rains. Prominent shrubs include speckled alder, red-osier dogwood, and willow. Ericaceous shrubs, including labrador tea, leatherleaf, bog rosemary, and blueberry, also occur. Shrubs up to 15 feet tall form dense thickets. The understory is sedge, cattail, and reed canary grass.

Because of the dense shrub cover, succession is slow. Tamarack, paper birch, black ash, or black spruce will invade these areas.

Northern Cattail Bog (Type IX-1). The northern cattail bog consists of cattail and sedges occurring in a dense floating mat over water up to 5 feet deep. Floating mats of vegetation resulted from construction of impoundments on low-lying areas with peat soils. Portions of the peat soils have floated to the surface after flooding. Vegetation quickly became established on floating peat and gradually spread, covering open water. The thickness of the cattail mat varies with age. Encroachment of willow and dogwood can occur on thicker portions of the floating mat.

Northern Shrub Bog (Type IX-2). This type is a mixture of floating shrubs, sedges, and cattails that also became established after the construction of impoundments on peat soils. Shrubs, especially willow, red-osier dogwood, bog birch, and bog rosemary, are dominant, often forming dense thickets.

Flooded Timber. These areas consist of timber killed by high water following the construction of impoundments. On most sites, dead trees are standing in 1 to 4 feet of water during the entire year, but on some sites, trees were killed by seasonally high water levels in the impoundments.

Birds. A list of birds likely to occur on the Mille Lacs WMA was compiled from several sources. The Minnesota Ornithologists' Union provided a preliminary species list. This list was compared to species lists and accounts available in the literature. Finally, the resident manager and local amateur ornithologists provided comments.

A total of 226 bird species may occur on the management area (Tables 5 and 6). Of these species, 116 are either year-round residents or summer residents and probably nest on the area. Twenty-three species occur only as winter visitors, and 87 nonresident species are spring and fall migrants.

The relative abundance of each species was estimated. Many species, especially migrants, are uncommon or rare because the management area contains marginal habitat for these species or is situated on the edge of their range. Most of these species are more common in other portions of Minnesota where habitat is more suitable or they commonly migrate.

Of the 30 species of game birds found on the Mille Lacs WMA, 26 have Minnesota DNR authorized seasons. Resident waterfowl include the mallard, blue-winged teal, wood duck, ring-necked duck, and hooded mer-

Table 5. Game birds occurring in the Mille Lacs WMA vicinity.

Common Name	Year-round Resident	Migrant	Summer Resident	Common Name	Year-round Resident	Migrant	Summer Resident
Nonresident				Resident			
Canada goose		C		Mallard		A	A
Snow goose		C		Blue-winged teal		C	C
Black duck		U		Wood duck		C	C
Gadwall		U		Ring-necked duck		C	C
Pintail		U		Hooded merganser		C	R
Green-winged teal		U		Hungarian partridge	R		
Northern shoveler		U		Ruffed grouse	C		
Redhead		U		Ring-necked pheasant	U		
Canvasback		U		Virginia rail		U	U
Greater scaup		R		Sora		C	C
Lesser scaup		A		American coot		C	C
Common goldeneye		C		American woodcock		C	C
Bufflehead		C		Common snipe		C	C
Ruddy duck		U		Sandhill crane[1]		R	R
Common merganser		C		Mourning dove[1]		C	C
Red-breasted merganser		C		Common crow	A	A	A
Whistling swan[1]		C					

A = abundant, C = common, U = uncommon, R = rare.

1 Not presently hunted in Minnesota

ganser. The American coot, sora, Virginia rail, and common snipe are also resident game birds.

Four species of upland game birds occur on the management area. The ring-necked pheasant and gray partridge are the least abundant because of unsuitable habitat. These birds are associated with more intensely farmed regions and probably occur only near privately owned agricultural land. Woodcock are more abundant and breed on the management area.

The ruffed grouse is the most popular upland game bird. Each year, ruffed grouse drumming is recorded along 2 drumming count routes to provide an index to population numbers. Fluctuations in grouse numbers on the management unit correspond to state-wide variations (Table 7). Grouse numbers on Mille Lacs are well above averages for northern and central Minnesota.

Table 6. Nongame birds occurring in the Mille Lacs WMA vicinity.

Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor
Nonresident				
Red-necked grebe		U		
Horned grebe		C		
Eared grebe		C		
Pied-billed grebe		C		
Double-crested cormorant		C		
Great egret		U		
Black-crowned night heron		U		
Least bittern				
Turkey vulture		U		
Rough-legged hawk		C		C
Golden eagle		U		U
Bald eagle		C		U
Osprey		U		
Merlin		R		
Semipalmated plover		U		
Killdeer		C		
American golden plover		U		
Black-bellied plover		U		
Ruddy turnstone		R		
Solitary sandpiper		U		
Spotted sandpiper		C		
Greater yellowlegs		C		
Lesser yellowlegs		C		
Pectoral sandpiper		U		
White-rumped sandpiper		U		
Baird's sandpiper		U		
Least sandpiper		U		
Dunlin		U		
Semipalmated sandpiper		U		
Sanderling		U		
Short-billed dowitcher		U		
Long-billed dowitcher		U		
Stilt sandpiper		U		
Hudsonian godwit		R		
Northern phalarope		R		
Herring gull		C		
Ring-billed gull		C		
Bonaparte's gull		C		
Common tern		C		
Caspian tern		U		
Snowy owl				U
Great gray owl				R
Gray jay				R
Black-billed magpie				R
Common raven				R
Boreal chickadee				R
Winter wren		U		
Wood thrush		R		
Hermit thrush		C		
Swainson's thrush		C		
Golden-crowned kinglet		C		U
Ruby-crowned kinglet		C		U
Water pipit		U		
Bohemian waxwing				U
Northern shrike				C
Solitary vireo		U		
Philadelphia vireo		R		
Black and white warbler		C		
Tennessee warbler		A		
Orange-crowned warbler		C		
Nashville warbler		A		
Magnolia warbler		C		
Cape May warbler		C		
Black-throated blue warbler		R		
Yellow-rumped warbler		A		
Black-throated green warbler		U		
Cerulean warbler		U		
Bay-breasted warbler		U		
Blackpoll warbler		C		
Pine warbler		U		
Northern waterthrush		U		
Connecticut warbler		R		
Mourning warbler		U		
Wilson's warbler		C		
Canada warbler				
Purple finch				C
Pine grosbeak				C
Hoary redpoll				R
Common redpoll				A
Pine siskin		C		C
Red crossbill				C
White-winged crossbill				U
Sharp-tailed sparrow		R		
Dark-eyed junco		A		A
Tree sparrow		A		A
Harris' sparrow		U		
White-crowned sparrow		U		
Fox sparrow		U		
Lincoln's sparrow		U		
Lapland longspur		U		
Snow bunting				A
Resident				
Common loon		C	R	
Great blue heron		C	C	
American bittern		C	C	
Sharp-shinned hawk		C	U	
Cooper's hawk		C	C	
Red-tailed hawk		C	C	
Red-shouldered hawk		U	U	
Broad-winged hawk		C	C	
Marsh hawk		C	C	
American kestrel		C	C	
Upland sandpiper		U	U	
Wilson's phalarope		R	U	
Black tern		C	C	
Rock dove	A			
Black-billed cuckoo		U	U	
Saw-whet owl	U			
Screech owl	U			
Great horned owl	C			
Barred owl	C			
Long-eared owl		U	U	
Whip-poor-will			U	U
Common nighthawk			A	A
Chimney swift			A	A
Ruby-throated hummingbird			C	C
Belted kingfisher			C	C
Common flicker			A	A
Pileated woodpecker	C			
Red-headed woodpecker			C	C
Yellow-bellied sapsucker			C	C
Hairy woodpecker	C			
Downy woodpecker	C			
Black-backed 3-toed woodpecker	U			
Eastern kingbird			C	C
Western kingbird			R	R
Great crested flycatcher			C	C
Eastern phoebe			C	C
Yellow-bellied flycatcher			U	U
Alder flycatcher			C	C

Table 6. (Continued)

Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor
Resident				
Least flycatcher		C	C	
Olive-sided flycatcher		U	U	
Horned lark		C	C	
Tree swallow		A	A	
Bank swallow		C	C	
Rough-winged swallow		C	C	
Barn swallow		C	C	
Cliff swallow		U	U	
Purple martin		A	A	
Blue jay	A			
Black-capped chickadee	C			
White-breasted nuthatch	C			
Red-breasted nuthatch		U	U	
Brown creeper		C	C	
House wren		C	C	
Long-billed marsh wren		U	U	
Short-billed marsh wren		C	C	
Gray catbird		C	C	
Brown thrasher		C	C	
American robin		A	A	
Veery		C	C	
Eastern bluebird		C	C	
Cedar waxwing		C	C	
Loggerhead shrike		C	C	
Starling	A			
Yellow-throated vireo		U	U	
Red-eyed vireo		C	C	
Warbling vireo		C	C	
Golden-winged warbler		U	U	
Northern parula		U	U	
Yellow warbler		C	C	
Blackburnian warbler		C	C	
Chestnut-sided warbler		C	C	
Ovenbird		C	C	
Common yellowthroat		C	C	
American redstart		C	C	
House sparrow	A			
Bobolink		C	C	
Eastern meadowlark		C	C	
Western meadowlark		A	A	
Yellow-headed blackbird		C	C	
Red-winged blackbird		A	A	
Rusty blackbird		C	C	
Brewer's blackbird		C	C	
Common grackle		A	A	
Brown-headed cowbird		A	A	
Scarlet tanager		C	C	
Cardinal		R	R	
Rose-breasted grosbeak		C	C	
Indigo bunting		C	C	
American goldfinch		C	C	
Rufous-sided towhee		C	C	
Savannah sparrow		C	C	
Grasshopper sparrow		R	R	
Le Conte's sparrow		U	U	
Vesper sparrow		C	C	
Lark sparrow		R	R	
Chipping sparrow		C	C	
Clay-colored sparrow		C	C	
Field sparrow		U	U	
White-throated sparrow		A	C	
Swamp sparrow		C	C	
Song sparrow		C	C	

A = abundant, C = common, U = uncommon, R = rare

The management area attracts a wide variety of non-game birds. Because of extensive wetlands, a large number of migrating and resident shorebirds occur. Wood warblers, flycatchers, vireos, woodpeckers, and thrushes occur in the forests. The abandoned fields are suitable habitat for such prairie or old field birds as the bobolink, eastern meadowlark, song sparrow, and savannah sparrow. The presence of prey and the relative isolation of habitat from disturbance makes the Mille Lacs WMA attractive to 19 migratory and resident raptor species, including the bald eagle and osprey.

Mammals. The occurrence of mammals on the Mille Lacs WMA was determined from published records, comments from University of Minnesota and Bemidji

Table 7. Average number of ruffed grouse drums per stop for the Mille Lacs WMA, Northern Minnesota, and Central Minnesota 1961-1975.

Year	Mille Lacs	Northern Minnesota [1]	Central Minnesota
1961	2.9	2.0	1.1
1962	1.6	2.3	1.6
1963	1.1	0.6	0.4
1964	1.4	0.7	0.3
1965	1.5	1.3	0.5
1966	–	1.3	0.7
1967	1.9	2.0	1.0
1968	2.6	2.6	1.0
1969	4.0	2.8	1.4
1971	–	3.1	1.6
1972	4.1	3.3	1.6
1973	4.8	3.4	2.0
1974	3.3	1.3	0.9
1975	2.5	1.1	0.7
	1.6	1.4	0.8

1. Includes Mille Lacs and Kanabec counties.

The ruffed grouse is a common game bird on the unit.

White-tailed deer are the most intensely hunted mammals on the unit.

State University mammalogists, annual game surveys, and observations by Section of Wildlife field personnel. Fifty-three species of mammals are likely to occur on the unit. The area is situated near the southern extent of the Great Lakes Pine Forest and northern limit of the Northern Hardwood Forest (Kuchler 1974). Mammal species associated with these 2 major vegetation associations exist on the fringe of their range and are not found in large numbers on the area (Table 8). Examples of such peripheral species include the wood chuck, southern flying squirrel, fox squirrel, and raccoon. Trapping permits are issued during the appropriate season for mink, muskrat, raccoon, red and gray foxes, beaver, and for the trapping of mammals not controlled

Table 8. Mammals occurring in the Mille Lacs WMA vicinity.

Game	Nongame	
Eastern cottontail	Masked shrew	Eastern chipmunk
Snowshoe hare	Water shrew	Least chipmunk
Gray squirrel	Arctic shrew	Woodchuck
Fox squirrel	Pigmy shrew	Red squirrel
Beaver	Short-tailed shrew	Thirteen-lined ground squirrel
Muskrat	Eastern mole	Franklin ground squirrel
Coyote	Star-nosed mole	Southern flying squirrel
Red fox	Little brown myotis	Northern flying squirrel
Gray fox	Keen's myotis	Meadow jumping mouse
Raccoon	Silver-haired bat	Woodland jumping mouse
Short-tailed weasel	Big brown bat	Porcupine
Long-tailed weasel	Red bat	Least weasel
Mink	Hoary bat	Timber wolf
Badger		
Striped skunk		
River otter		
Bobcat		
White-tailed deer		
Black bear		

by state regulations.

The white-tailed deer is the most important and popular game mammal on the area. Spring pellet group surveys indicated densities of approximately 23 and 32 deer per square mile for the winters of 1974-75 and 1975-76. These figures are greater than the estimated winter densities of 14 deer per square mile in 1975 and 7 deer per square mile in 1976 for the Mille Lacs-Kanabec County vicinity.

Fish. Three rivers, the Groundhouse, Little Ann, and Knife, with headwaters originating on the management area were sampled for species composition as part of a biological survey of the entire Snake River Watershed (Huber 1966). Table 9 lists species likely to occur on the area. Because of low base flow and the often intermittent nature of these headwaters, most species would occur on the management area only during spring peak flow periods. Species common to lakes and streams of the Snake River Watershed probably also occur in the impoundments.

Table 9. Fish occurring in the impoundments on the Mille Lacs WMA.

Game	Nongame
Northern pike	Channel catfish
Bluegill	Black bullhead
Black crappie	Brown bullhead
Pumpkinseed	Yellow bullhead
Green sunfish	Carp
	Yellow perch
	Bowfin
	Sheepshead
	Chestnut lamprey
	Northern redhorse
	Silver redhorse
	White sucker

OPERATIONS

The operation of the Mille Lacs WMA relies on capital improvements, equipment, staff, and funding. The relationship of the management area to other wildlife areas is important to understanding administrative and funding procedures and problems. A knowledge of the present operation is necessary to formulate a comprehensive plan that will utilize existing development and equipment and can be implemented under anticipated budgetary and administrative constraints.

Administrative and Fiscal

The Mille Lacs WMA is one of Minnesota's 851 wildlife management areas and is administered through the Minnesota DNR Region III office in Brainerd. Region III consists of 14 counties and includes 86 other wildlife management areas with 40,043 total managed acres. Five area wildlife managers manage the 86 other wildlife areas. The regional wildlife manager at Brainerd supervises management of all wildlife areas in Region III.

Wildlife and fish administration and management in Minnesota is financed primarily through appropriations from the Game and Fish Fund. Receipts from hunting, trapping, and fishing license sales, cash receipts from wildlife management areas, and federal-aid matching funds are paid into the Game and Fish Fund. These monies are dedicated for state-wide fish and wildlife management and are disbursed to the Minnesota DNR Sections of Wildlife and Fisheries.

Federal matching funds are derived from the Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act) and the Federal Aid in Sport Fish Restoration Act (Dingell-Johnson Act). These acts imposed an excise tax on sporting arms, ammunition, archery equipment, and fishing equipment. Funds from these taxes may be used to match state funds on a 3:1 ratio for federally approved wildlife and fish management.

The Section of Wildlife administers and finances wildlife management through a program budget system. Funding is for specific programs and not individual management areas in the region. Day to day purchases on the Mille Lacs WMA are made at the resident manager's discretion. Major equipment is purchased and seasonal employees are hired with approval of the Region III wildlife manager. Expenditures for salaries, taxes, equipment, and operational expenses amounted to $78,322 in 1975 and $105,069 in 1976 (Table 10). In 1976, $19,940 was available for labor through a federal unemployment program.

Heavy equipment, major equipment repairs, and capital improvements are itemized and paid from the regional wildlife management budget. These expenses for the area vary yearly depending on equipment and management needs. Equipment used on Mille Lacs is replaced when needed but after equipment priorities for other management areas within the region are con-

Table 10. Expenditures and income on the Mille Lacs WMA for fiscal years 1975 and 1976.

	FY 1975	FY 1976
Regional Expenditures		
Permanent salaries	$37,616.00	$39,596.00
Seasonal salaries	7,416.92	15,674.72
CETA salaries		19,940.04
Contract services	3,696.36	2,959.87
Retail purchases	7,723.85	6,936.03
Equipment purchases	18,410.80	15,321.48
Land Bureau and Administrative Services Expenditures		
Payment in lieu of taxes	$3,458.62	$3,458.62
Real estate taxes		1,183.16
Total Expenditures	$78,322.55	$105,069.92
Income		
Timber sales	$13,047.22	$9,057.82
Agricultural leases	354.00	354.00
Total Income	$13,401.22	$9,411.82

Table 11. The buildings and equipment maintained on the Mille Lacs WMA.

Building	Dimensions (feet)	Construction Date	Condition
Manager's residence	26 x 44	1968	Good
Utility building	30 x 66	1959	Fair
Steel pole building	30 x 67	1969	Good
Storage shed	12 x 16	1949	Fair
Steel storage building	30 x 67	1977	Good

Equipment	Make/Model	Model Year	%WMA USE
Dragline	Lorain (L-15)	1956	80
Crawler tractor	Caterpillar	1963	90
Crawler tractor	John Deere (45D)	1969	80
Articulated loader	Case	Unknown [1]	90
Tractor	International (2606)	1963	90
Tractor	Ford (4000)	1972	90
Tractor	John Deere (1020 RU)	1968	100
Dump truck	GMC	1974	90
Dump truck	Dodge	1960	90
Dump truck	International	1974	90
Swartzbed	Chevrolet	1970	50
Pickup, ½ ton	Chevrolet	1971	100
Pickup, ½ ton	Dodge	1974	90
Trackster	Cushman	1972	90
Road grader	Allis Chalmers (M-65)	1975	90
Snowmobile	Bolens	1970	10
Brush disc			100
Tandem disc			100
3-Section drag			100
16 ton tilt top trailer			90
Tractor rotary mower			90
Tractor sickle mower			90

1. Purchase from army surplus.

sidered. Similarly, major capital improvements, such as buildings, dikes, and control structures, are funded on a region-wide priority basis.

Since 1945, payments in lieu of taxes from privately owned land acquired within the management area have been paid from the Game and Fish Fund to Mille Lacs and Kanabec counties. Payments are not made for tax forfeited or Trust Fund land that is acquired (Minnesota Statutes, Section 97.49, subd. 3, 1976). Payments are presently $0.50 per acre and amounted to $3,458.62 in 1975 and are paid by the Minnesota DNR, Bureau of Lands in St. Paul.

In addition to in lieu of tax payments, Minnesota Statutes, Section 272.011 (1976) requires the state to pay real estate taxes on all state-owned residences occupied by state personnel. In 1976, $1,183.16 was paid as real estate taxes on the manager's residence. Taxes for the Mille Lacs WMA residence are paid by the Minnesota DNR, Administrative Services, Section of Field Services located at Grand Rapids. Twenty-seven percent of the Field Services budget is Game and Fish Fund revenues.

Capital Improvements

The Mille Lacs WMA headquarters is located at the intersection of Mille Lacs County Roads 19 and 20 (Figure 5). Headquarters structures include a manager's residence, utility building with office, and steel pole building (Table 11).

Parking areas and access trails are the only capital improvements used by hunters and other visitors. Fifty eight parking areas, accommodating approximately 580 vehicles, are maintained along the perimeter of the area (Figure 5). The Division of Fish and Wildlife maintains 48 miles of improved road and 106 miles of access trails and firebreaks (Figure 5). There are no hunting stations, interpretative trails, or improved water access sites.

Six drop inlet water control structures are maintained. The Ernst and DeWitt pools each have 1 structure; 2 structures were installed on the Cranberry and Headquarters pools.

Equipment

Heavy equipment stored at Mille Lacs is used on the area and on other wildlife lands within Region III (Table 11). Farm equipment is used to prepare and plant wildlife food plots. Other heavy equipment is used to maintain roads and firebreaks, manipulate wildlife habitat, and build dikes and install water control structures.

Staff

Five full-time and part-time employees are assigned to the Mille Lacs WMA. A resident manager has overall responsibility and is assisted by 2 full-time technicians, a 9-month employee, and a 7-month employee. Additional personnel were employed in the past through various federal and state programs for the unemployed. The number of employees and length of employment has changed with the various programs. Presently, 2 employees are funded through the Comprehensive Employment Training Act (CETA) until May 1, 1977.

LAND OWNERSHIP

The management area goals can be realized when all lands within the project boundary are acquired. The management direction and acquisition status are related to land ownership patterns, the project acquisition history, and the sources of acquisition funds. Priorities must be set for unacquired land to identify those tracts where special acquisition effort is necessary to improve the management capabilities of the project.

Acquisition Status

Since 1949, 27,725 acres of tax forfeit land, 2,785 acres of Trust Fund land, and 7,117 acres of private land have been acquired (Table 12). Seventeen tracts, totaling 2,528 acres, remain to be acquired within the wildlife management area (Table 13). Seven tracts, including 1,617 acres, are Trust Fund land. The remaining 911 acres in 10 tracts are privately owned.

Approximately 120 acres administered by the Division of Fish and Wildlife in 2 tracts are located outside the Mille Lacs WMA boundaries in Section 25, T. 40N., R. 26W. These tracts, located in the Rum River State Forest, were purchased in 1963 along with land located in the management area. Also, 640 acres of land administered as part of the Rum River State Forest are located within the management area boundaries (Section 16, T. 40N., R. 25W.). This section of land is not continguous with the remainder of the forest.

Land acquisition expenditures since 1949 have totaled $138,640 (Table 14). All land acquisition funds were derived from license revenues and excise taxes paid by sportsmen. Federal-aid project funds were used to purchase all but 240 acres. These acres were acquired with Division of Fish and Wildlife hunting and trapping

Acquisition Priorities

Acquisition priorities were established for each tract (Minnesota DNR, 1975a). Eleven tracts, totaling 1,937 acres, are designated as "critical" for immediate purchase (Table 13). The remaining parcels have "desirable" or "eventual" priorities.

Table 12. Previous ownership of state-owned land in the Mille Lacs WMA.

Previous Ownership	Mille Lacs County (acres)	Kanabec County (acres)	Total (acres)
Private	6,306.81	810.44	7,117.25
Trust Fund	2,785.55		2,785.55
Tax-forfeit	21,811.12	4,844.17	26,725.29
Total	30,903.48	5,654.61	36,628.09

Table 13. Acreage and acquisition priority of land to be acquired in the Mille Lacs WMA.

Owner	Section	Township (North)	Range (West)	Description	Acreage	Priority [1]
W.G. Benson	33	42	25	E½ NE¼	80	D
V.E. Shubert	33	42	25	W½ NW¼	80	D
A.D. Perhats	12	41	26	SW¼	160	C
G. Benson	22	41	26	N½ NW¼	80	D
~~L.J. Shubert~~	4	41	25	N½ NW¼	60.27	D
Trust Fund	4	41	25	SW¼ E½, NW¼ SE¼, NE¼ SW¼	160	C
Trust Fund	16	41	25	All of fractional section	560	C
A.H. Olsen	18	41	25	E½ NW¼	86.76	D
W. Olsen	18	41	25	SW¼	160	D
P.S. Arthur	25	41	25	NE¼ NE¼ NE¼	5	E
(R. Flemming contract vendees)	26	41	25	NW¼ SE¼, SW¼ NW¼	80	C
Trust Fund	34	41	25	NW¼ SW¼, SW¼ NW¼	80	C
Trust Fund	36	41	25	SE¼ SE¼	39.5	D
~~I.A. Peterson~~	36	41	25	SW¼ S½	~~80~~	C
Trust Fund	2	40	26	W½	16.98	C
Trust Fund	15	40	26	NW¼ NW¼	40	C
C. Alstine	17	40	26	NW¼ NW¼	80	C
G. Polinder	17	40	26	NE¼ NW¼, S½ NW¼	40	C
~~J.P. Kollar~~	16	40	25	All of Section	640	C
Trust Fund						
Total					2,528.51	

1 C = critical, D = desirable, E = eventua..

Table 14. Source of funds and acreage purchased in the Mille Lacs WMA.

Source of Funds	Amount	Acreage
Section of Wildlife project	$ 161.00	240
Federal aid project	138,479.62	36,388.09
Total	$138,640.62	36,628.09

PUBLIC USE

Wildlife management areas in Minnesota are available for a broad spectrum of public uses. Outdoor recreation has always accounted for the largest share of public use on the Mille Lacs WMA, but the area is also utilized for timber harvest, cooperative farming, and environmental education. The area's capacity to accommodate public use must be considered to manage the fish and wildlife resources. Knowledge of present levels is necessary to predict the the future demand for outdoor recreation and to develop management programs.

Hunting.

Hunting has been the dominant outdoor recreation on the Mille Lacs WMA. Actual numbers of hunters using the area are difficult to determine. Hunters are not required to register at the headquarters. Further, the area can be entered at any point along the boundary. Hunter numbers on the management area have been estimated from occasional roadside and parking lot car counts. Periodic bag checks are also used to estimate game harvest. Car counts and bag checks were conducted irregularly during past hunting seasons when funding and manpower were available. In some years, hunter use was not estimated. Because hunter-use data are incomplete, the resident manager estimated temporal and spatial use on the management area during the 1975 season.

The Mille Lacs WMA is popular for white-tailed deer, ruffed grouse, and, to a lesser extent, waterfowl hunting. Most hunting pressure was on the opening day of the seasons and on weekends (Table 15). Out of an estimated total of 7,500 hunter-use days, approximately 1,275 occurred on opening day and 2,700 on the first weekend of the 1975 firearms deer season (Table 15). Hunting pressure for waterfowl and ruffed grouse was moderate on opening day.

Motor vehicle access into most of the management area is not permitted during the hunting season. All visitors must park in the parking areas or along boundary roads. Because of restricted access, an estimated 80 percent of the deer hunters and 95 percent of the ruffed grouse and waterfowl hunters used the periphery (Compartment 1) of the management area (Figure 6). The interior compartment, or areas more than 1 mile from roads, received less hunting pressure. Hunter densities were estimated to be 29 hunters per square mile in the 35 square mile Compartment 1 and 10 hunters per square mile in the 26 square mile Compartment 2 on the opening day of the 1975 firearms deer season. This differential hunter use was characteristic of the hunting

Table 15. Estimated temporal and spatial distribution of hunters on the Mille Lacs WMA in 1975.

	Firearms Deer	Ruffed Grouse	Waterfowl
Temporal Distribution			
Hunter-use Days	7,500	4,500	1,500
Opening day	Sat. Nov. 1	Sat. Sept. 13	Wed. Oct. 1
% Use	18	8	10
Opening Weekend	Nov. 1, 2	Sept. 13, 14	Oct. 4,5
% Use	36	13	17
First Week	5 days	5 days	5 days
% Use	4	8	16
Remaining Weekdays	19 days	76 days	33 days
% Use	5	21	22
Remaining Weekends	6 days	30 days	12 days
% Use	55	58	45
Spatial Distribution			
% Use in Compartment 1 (35 square miles	80	95	95
% Use in Compartment 2 (26 square miles)	20	5	5

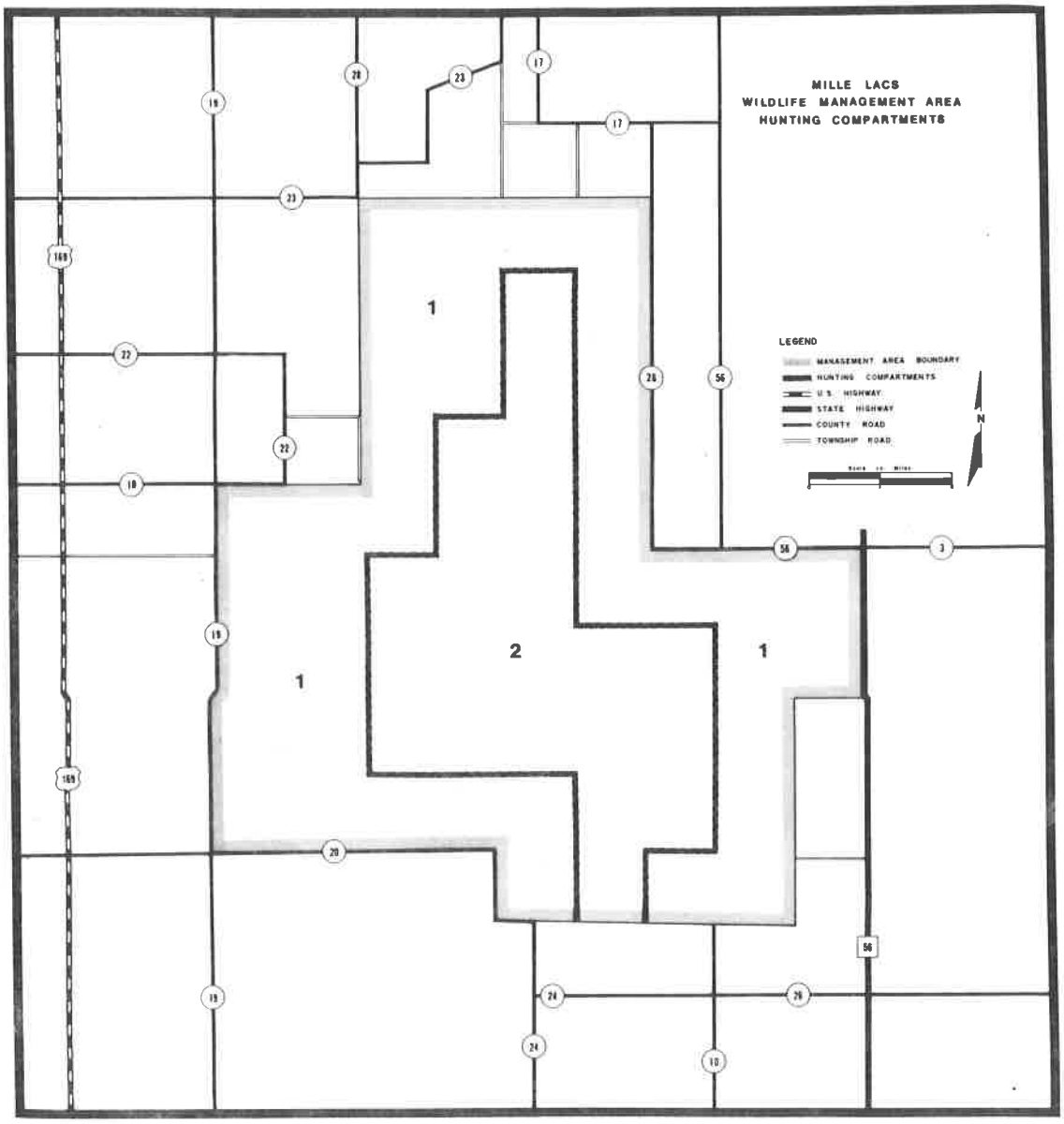

Figure 6

seasons for all game species.

Trapping

All trappers must obtain a permit before harvesting animals on the management area. Trappers are also requested to submit a report at the end of the season listing number and species of animals taken. Beaver permits are limited, and more trappers apply than the number of permits available. In 1974 and 1975, 10 beaver permits were issued. Muskrat, mink, and other furbearers may be trapped on an unlimited permit basis, and 19 trappers in 1974 and 18 in 1975 applied for permits.

Fishing

The impoundments on the Mille Lacs WMA are managed for waterfowl and do not support substantial game fish populations. Water levels are shallow resulting in frequent winter-kill of fish. During the spring, local residents occasionally catch northern pike in the DeWitt Pool.. No creel census has even been conducted on the management area pools.

Other Activities

The Mille Lacs WMA is used for a variety of outdoor recreation other than hunting and trapping. Because manpower and funding constraints have precluded the accurate monitoring of nonhunting use, the following discussion is qualitative.

Camping is allowed only on a permit basis. Hunters are permitted to camp in the parking areas along the boundary of the unit. During the summer, Scout and 4-H groups are allowed to camp within the management area, and approximately 5 to 10 groups use the area for camping each year. No facilities or improved sites are provided for camping.

Other activities include sightseeing, walking through the area, and environmental education. Horseback riding is allowed on a permit basis. In addition, the logging and hunter access trails and firebreaks are used for cross-country skiing. Snowmobile and motorbike use occurs illegally (Appendix E), but these activities are minor uses.

Timber Harvest

Habitat for white-tailed deer and ruffed grouse has been managed with commercial timber harvest. The resident wildlife manager determines the rotation and cutting schedule plus the size and location of cuts. The Division of Forestry approves and supervises the sales.

Since 1971, more than 2,200 acres of timber have been sold (Table 16). Most timber is harvested for pulpwood, but larger hardwoods are cut for sawtimber. The quantity of timber sold depends on current market prices and the demand for wood. Since 1974, a favorable market has increased sales on the area. Timber is sold to local operators in Onamia, Princeton, and Milaca with most pulpwood and sawtimber initially processed in Onamia. Firewood permits to remove slash and unharvested trees after clearcutting are sold by the Division of Forestry. In most years, 20 to 25 firewood permits are sold. Income from timber leases was $13,047 in 1975 and $9,057 in the first 6 months of 1976 (Table 16).

Agricultural Leases

Agricultural land is leased to cooperating farmers to establish wildlife food plots and to maintain openings. A total of 498 acres of agricultural land was leased to 11 local farmers in both 1975 and 1976 (Table 17). Land is leased annually for haying, grazing, and planting. The resident manager sets prices and determines cutting schedules for hayfields to minimize effects on ground dwelling wildlife. Land is currently leased at $2.00 per acre for tame hay, $1.00 per acre for wild hay, and $0.50 per head for 3 months for cattle leases. In corn fields, 25 per cent of the acreage is left unharvested as food plots. Fields planted to oats, timothy, and clover can be harvested once for seed by the lessee. Total income from leases in 1975 and 1976 was $354 each year.

Table 16. Timber harvest statistics for the Mille Lacs WMA from 1971 to July 1, 1976.

Year	Number of Sales	Quantity		Value	Acres
		Cords [1]	MBF [2]		
1976	23	3,883	431.4	$ 9,057.82	334
1975	35	4,009	800.1	13,047.22	500
1974	35	3,708	887.3	12,582.33	506
1973	7	303	287.6	3,308.68	114
1972	17	501	588.7	4,928.21	262
1971	18	2,280	786.6	9,415.11	497
Total	135	14,684	3,751.7	$52,339.37	2,213

1. Volume of pulpwood. One cord equals 128 cubic feet.
2. Sawtimber quality logs measured in thousand board feet.

Table 17. Cropland farmed cooperatively on the Mille Lacs WMA in 1976.

Lease Number	Field Number	Twp.	Range	Sec.	Acres	Type [1]	Fee
1	1	42	25	32	120	Pasture	$30.00
	2	42	25	32	4	Wild hay	4.00
2	1	42	26	36	10	Corn	
3	1,2	42	25	33	7	Tame hay	14.00
4	1	40	26	24	6	Oats, clover, timothy	
	2	40	26	24	6	Tame hay	12.00
5	1 – 3	41	26	27	30	Tame hay	60.00
	4	41	26	27	20	Wild hay	20.00
6	1, 2	41	26	22	10	Tame hay	20.00
7	1, 2 – 6	40	26	8	24	Tame hay	48.00
	3	40	26	8	4	Wild hay	4.00
8	1, 2	40	26	14	16	Tame hay	32.00
	3, 4	40	26	14	20	Corn	
9	1	41	25	36	160	Pasture	30.00
	2, 3	41	25	25	10	Tame hay	20.00
	4	41	25	25	15	Oats, clover, timothy	
10	1	41	25	7	10	Tame hay	20.00
11	1	40	26	17	6	Oats, clover, timothy	
	2, 3	40	26	17	20	Tame hay	40.00
Total					498		$354.00

1. One-fourth of planted corn is left unharvested as a wildlife food plot. Cooperating farmers harvest fields planted to oats, clover, and timothy for seed.

LOCAL PERSPECTIVE

Fish and wildlife management can be influenced by factors in the management area vicinity. Land use, demographic characteristics, and economic conditions must be examined before formulating a comprehensive plan. Commercial and residential development or the potential for development adjacent to the management area may affect future management decisions. In addition, the availability of public lands for outdoor recreation in the vicinity will influence the demand for recreation on the area.

General

The management area is located in a sparsely populated region. Mille Lacs and Kanabec counties rank 51st and 75th in population density among Minnesota's 87 counties. The combined 2-county population density is 26 people per square mile (Minnesota State Planning Agency 1975b).

Forestry and agriculture are the principal land uses in Mille Lacs and Kanabec counties (Table 18). More than 48 percent of Kanabec and 38 percent of Mille Lacs counties are forested. Forest resources are confined to the northern half of each county where pulpwood is the major forest product. Approximately 15 percent of both counties is cultivated. Corn, oats, and alfalfa are raised for dairy cattle and other livestock. Climate and soil conditions are unfavorable for more intensive farming and the production of such cash crops as soybeans and wheat.

Mille Lacs and Kanabec counties will continue to have agricultural based economies, and industrial, residential, and other associated development will not be a significant factor influencing the management area in the future. Although the number of farms in the 2-county area has fallen since 1964, total acres in farms has remained stable (Minnesota Department of Agriculture 1975). Farmland prices for central Minnesota, including Mille Lacs and Kanabec counties, have reflected a nationwide trend, increasing 286 percent since 1964 to an average of $298 per acre (University of Minnesota 1976).

Outdoor recreation is an important source of income for Mille Lacs County. The county ranks 11th out of Minnesota's 87 counties for tourist generated expenditures as a percent of total sales (Minnesota Department of Economic Development 1975). Fishing on Mille Lacs Lake is the county's major recreation attraction, appealing to resident as well as large numbers of nonresident fishermen. During the winter of 1975-76, there were more than 4,000 fish houses on the lake.

Both Mille Lacs and Kanabec counties have a variety of public and private recreational facilities in addition to the management area (Table 19). Public areas include 2 state parks, state water access sites, state trails, and the 16,951 acre Rum River State Forest which adjoins the management area on the south. Portions of the Rum and Snake rivers are under consideration as State Wild and Scenic Rivers. In addition, within both counties there are 16 public and private camping areas with more than 1,000 campsites.

Adjacent Development

Development adjacent to the management area is limited. The Minnesota Department of Transportation has long-range plans for the expansion of U.S. Highway

Table 18. General land use of Mille Lacs and Kanabec counties.

	Mille Lacs		Kanabec	
	Acres	Percent	Acres	Percent
Forested	166,160	38.4	166,160	48.9
Cultivated	66,200	15.3	52,040	15.3
Pasture and open	100,560	23.2	104,120	30.6
Marsh	24,280	5.6	9,160	2.7
Water	65,720	15.2	4,120	1.2
Residential	10,040	14.7	4,240	1.2

Source: Minnesota State Planning Agency 1975b.

169 to 4 lanes. The city of Wahkon, 2 miles north of Mille Lacs, is constructing a new sanitary sewer collection and treatment system that will discharge waste water into the headwater drainage of the Knife River adjacent to the management area. However, effluent standards will meet Minnesota Pollution Control Agency regulations. Mining potential in the vicinity is low; although, there is a granite quarry 2 miles east of the management area on Mille Lacs County Road 19. Future residential development will be primarily confined to the population centers of Princeton, Milaca, and Mora. Summer homes and resorts with associated businesses will increase around Mille Lacs Lake.

Table 19. Public recreation areas in Mille Lacs and Kanabec counties.

Area	Name	Mille Lacs	Kanabec
State Park (acres)	Father Hennepin	316	
	Mille Lacs Kathio	9,951	
Wildlife Management Area (acres)	Mille Lacs	30,903	5,654
	Kunkel	1,899	
	Ann Lake		1,614
	Belacs	130	
	Bean Dam		200
	Hay-Snake		800
	Lake 5		280
	Rice Creek		598
	Tozier Creek		316
	Whited		173
	White Fish	54	
	Onamia	68	
State Forest (acres)	Rum River	13,175	3,357
	Snake River		7,757
	Other Forestry Land	7,042	3,293
Wild and Scenic River[1] (acres)	Rum River		
	Snake River		
State Water Access Site	Sites	4	12
	Acres	12	19
Other Water Facilities	Boat Accesses	26	18
	Swimming Beaches	18	3
	Marinas	25	6
	Marina Capacity (boats)	314	64
Trails (miles)	Snowmobile	52	20
	Hiking	17	3
	Horse	10	0
	Bicycle	0	5
	Multi-use	16	5
Camping Areas	Tent Areas	3	1
	Vehicle Areas	7	5
	Total Sites	685	324
Picnic Areas	Areas	22	6

1. Proposed.
Source: Minnesota DNR 1974.

RECREATION DEMAND AND CAPACITY

Anticipating the demand for hunting, trapping, fishing, and other wildlife oriented recreation is essential for the development of a management plan. By relating future demand to the recreation capacity of the area, programs can be designed to both utilize and protect the area's resources.

Demand

Projecting the wildlife and fish oriented use of the Mille Lacs WMA is difficult. These projections can be made for hunting, trapping, and fishing by examining state-wide population trends, game abundance and harvest, availability of private land for these activities, and license sales. The future demands for other types of compatible recreation can be estimated from participation surveys when the survey limitations are recognized (Minnesota DNR 1974). Although Minnesota sportsmen and wildlife enthusiasts are mobile, most recreation pressure will occur on lands closest to densely populated regions.

Annual aerial censuses and "pellet group" counts provide indexes to Minnesota white-tailed deer populations. Deer numbers have declined as a result of habitat deterioration through plant community succession in northern forested areas (Erickson *et al.* 1971, Mooty 1971, Byelich *et al.* 1972). At the same time, deer harvest has declined and hunter success has dropped from a high of 66 percent in 1940 to 21 percent in 1974. To help reverse these trends, the Minnesota DNR restricted the deer season in 1976.

Except for 1969-1971, big game license sales increased since 1940 at a rate greater than the overall population growth. With a restricted and delayed season in 1976, 233,091 licenses were sold. Restrictive deer seasons are likely to continue in the near future, and license sales will probably remain between 300,000 to 350,000 through 1985 increasing proportionately to the state's population. Deer hunting pressure on the Mille Lacs WMA has reflected state-wide increases in hunter numbers.

Changing farm practices since 1940 have greatly reduced habitat for farmland wildlife. A shift from small grains to row crops, coupled with fall plowing, drainage, and removal of fences and shelterbelts, has contributed to the loss (Nelson and Chesness 1964, Harmon and Nelson 1973). This trend is most apparent in south-central, southwest, and west-central Minnesota. A 1972 sample of 4 townships in south-central Minnesota revealed that fall plowed land accounted for up to 79 percent of a total township area (Brown *et al.* 1975). Land retirement programs, such as Soil Bank and Set-Aside, have been discontinued, further reducing land available for wildlife (Berner 1972).

Similarly, to expand tillable acreage, wetlands are being drained at the rate of 4 percent a year. In the 19 western county prairie pothole region, where federal waterfowl production areas are concentrated, 26,004 wetlands were drained from 1964 to 1974 (U.S. Department of the Interior 1975). Drainage resulted in a 57.6 percent decrease in Type III wetlands, the most productive areas for waterfowl and wetland furbearers. In 1974, 117,026 acres of wetlands, or 47.6 percent of all wetlands in these 19 counties, were protected by state or federal programs. Because of intensive agricultural practices, farmland wildlife and waterfowl are not as much a by-product of agriculture as they once were.

Reflecting the general decline in farmland wildlife, small game license sales have declined from a 1973 high of 341,687 to 221,154 in 1969. However, sales of small game licenses have stabilized at about 280,000 since 1970 and are expected to remain near this level. Waterfowl hunters presently account for over half of total small game license sales.

Sales of federal migratory waterfowl stamps are related to bag limits and season lengths, as well as the cost of the stamp. Sales have fluctuated between 122-180,000 since 1966. The number of waterfowl hunters should remain a relatively constant proportion of the state's population if waterfowl populations remain relatively stable (Minnesota DNR 1974). Future restriction of regulations, increases in the price of the federal migratory bird stamp, and the Minnesota waterfowl stamp may temporarily depress the number of waterfowl hunters in Minnesota.

The demand for trapping opportunities will, no doubt, be related to the availability of places to trap, fur prices, and public sentiment towards trapping. The number of trapping licenses sold in Minnesota has fluctuated widely from a high of 53,899 in 1946 to a low of 5,903 in 1971. More than 11,000 trapping licenses were sold in 1975. The demand for trapping opportunities will probably remain near the current level in the near future.

The Minnesota DNR presently administers 851 wildlife management areas, many of which are located in Minnesota's farm belt and contain wetlands. Because intensive agricultural practices are depressing the production of wildlife on private land, wildlife management

areas are increasingly important for both wildlife and sportsmen. Additionally, forest habitat improvement for white-tailed deer is concentrated on wildlife management areas or other public lands and will attract an increasing number of hunters. Wildlife management areas are important for a growing number of urban hunters who have difficulty obtaining access to private land (Klessig 1970). As Minnesota's population increases, so will the number of hunters, especially the urban hunters who rely on wildlife management areas.

Admittedly, the preceding discussions are only qualitative. These projections suggest that total hunting demand in Minnesota will not increase dramatically in the near future, but increasingly intensive use of private lands will accelerate the importance of management areas to Minnesota's wildlife and sportsmen. Likewise, the same trend is developing for other wildlife related recreation. The Mille Lacs WMA will probably experience an increased demand for deer and small game hunting, and other wildlife related recreation equal to the state average. Most importantly, wildlife management areas are becoming key elements in perpetuating Minnesota's fish and wildlife heritage.

Capacity

In order to develop comprehensive plans insuring quality public recreational use while protecting a wildlife management area's resources, the capacity of the area for hunting, trapping, fishing, and other compatible uses must be examined. Concentrations of sensitive wildlife populations may require the exclusion of hunting, trapping, fishing, or trespass at specific times from sanctuaries and refuges established within a wildlife management area.

The capacity of the Mille Lacs WMA to accommodate hunters, trappers, and fishermen is related to many factors, such as fish and wildlife abundance; hunting, trapping, and fishing regulations; topography; vegetation; and access. Excessive user densities result in interference or conflicts between sportsmen. The U.S. Fish and Wildlife Service and U.S. Bureau of Outdoor Recreation have developed hunter density guidelines for quality hunting which may be a useful guide for wildlife management areas (Table 20).

Furthermore, quality experiences depend not only on user densities, fish and wildlife habitats, and fish and game abundance, but also on the sportsmanship and sense of responsibility of hunters and fishermen. Thus, the same set of user density standards cannot be applied uniformly to all wildlife management areas. The capacity of the Mille Lacs WMA to accommodate hunters should be examined in terms of hunting experiences which are rewarding to hunters and acceptable to the nonhunting public.

The Division of Fish and Wildlife encourages the use of wildlife management areas for activities related to fish and wildlife or their habitats. A management area's attractiveness for and capacity to support compatible outdoor recreation, such as wildlife observation and photography or walking through the area, depend on many factors such as access, the variety and sensitivity of the area's wildlife populations, plant communities, and topography. The Mille Lacs WMA does not have spectacular concentrations of waterfowl, easily observed wildlife, nor scenic topography. Nevertheless, the area can accommodate many visitor-days during the year that are related to environmental education, the understanding of wildlife management techniques, and other compatible activities.

Table 20. Hunter density guidelines proposed by the U.S. Fish and Wildlife Service and the U.S. Bureau of Outdoor Recreation.

Game Species	Standard	Length of Stay (hours)
Geese	1 blind per 200 yards per 2 hunters	4
Ducks	1 blind per 10 acres of marsh per 2 hunters or 1 blind per 200 yards	4
Upland game birds	13 hunters per square mile	2
Small game	13 hunters per square mile	4
Pheasants	64 hunters per square mile	3
Deer	13 hunters per square mile	8

Source: U.S. Department of the Interior 1967, 1972.

MANAGEMENT PROGRAMS

Plans for the Mille Lacs WMA should insure the sustained production and use of a variety of wildlife and the protection of unique scientific, historic, and aesthetic resources. To develop plans, the problems and needs, as well as the opportunities for better management, were first identified. These considerations were determined by relating the resources, public use, land acquisition programs, operation, and local perspective of the area to each other in light of the projected future demand for wildlife oriented recreation. Management programs were then developed from research knowledge and experience. Since acquisition is nearly complete and major waterfowl impoundments are constructed, the current emphasis is on forest habitat management followed by wetland management, projects aimed at improving public use, and nongame management.

Forest Management

Objectives. Management should provide stable, naturally diverse forests characterized by an interspersion of forest types, age classes, and openings. Forest management will be most beneficial to game species, such as white-tailed deer and ruffed grouse, but the responses of all indigenous wildlife species to forest management are important.

Considerations. The plant communities on the Mille Lacs WMA are dynamic. Through plant succession and the influences of modern man, the structure and composition of the plant communities are continuously changing. The populations of white-tailed deer, ruffed grouse, and other wildlife respond to changes in the forest. To achieve the management objectives, active forest manipulation will always be required.

Forests on the Mille Lacs WMA are extensive and must be managed primarily through commercial logging. Research in Minnesota has demonstrated the value of logging as a wildlife management technique while making commercial timber harvest profitable (Gunvalson *et al.* 1952, Erickson *et al.* 1961, Kohn and Mooty 1972, Waddell 1973, Wetzel *et al.* 1975). Logging removes mature trees and promotes vigorous sprouting of aspen, oak, and maple, as well as understory shrubs and herbaceous plants. The result is increased yield of available woody browse and other food for wildlife (Stoeckler and Macon 1956, Erickson *et al.* 1961, Perala 1971) and increased habitat diversity through establishment of a multiple age class forest.

Aspen harvest and regeneration are important to the management of the Mille Lacs WMA forests. Clearcuts resulting in 12,000 to 15,000 aspen suckers per acre that grow to 5 feet in height during the first growing season are desirable. With this level of regeneration, stem density will exceed 10,000 stems per acre by the fourth growing season and will provide optimal ruffed grouse activity centers (Gullion 1970, Gullion and Svoboda 1971).

Several factors influence aspen regeneration. Shade cast by any residual trees inhibits aspen regeneration (Farmer 1963), and these trees must be removed. Aspen approaching 60 to 80 years old does not resprout as vigorously following timber harvest as 40-year old aspen (Graham *et al.* 1963). Deer find suckers of over-mature trees more palatable than younger trees at Mille Lacs and can severely retard aspen regeneration (Gordon Gullion, University of Minnesota, personal communication). In addition, aspen regeneration may not be possible by clearcutting over-mature stands since northern hardwood reproduction exceeds aspen regeneration on these areas.

Slash removal, following logging, encourages greater ruffed grouse utilization (Gullion 1976) and improves hunter access. Prescribed burning has been used to remove slash from the Mille Lacs WMA (Sando 1972) and is beneficial to nutrient cycling. Firebreaks must be constructed around the cutting blocks, and the slash must be allowed to dry for at least 1 year before burning. In addition, optimal conditions may preclude controlled burning for several years following timber harvest. Slash can be removed by mechanical means, but removal is expensive and tree stumps prevent the effective use of heavy equipment.

The total acreage harvested and location of clearcuts will depend on market prices and how far from improved roads private loggers will haul logs. In addition, more than the planned annual cut should be authorized in years when conditions are favorable for private logging in anticipation of less favorable years. For these reasons, the timber management plan must be flexible.

Research has revealed that 1-acre clearcuts may be beneficial to grouse (Gullion 1976). However, blocks of less than 10 acres are not commercially economical.

Forest openings are also important for deer (McCaffery and Creed 1969) and woodcock (Hale and Gregg 1976). Logging trails and landing sites fill with herbaceous plants and are valuable wildlife openings (Dolgaard *et al.* 1976).

Present Programs. Aspen and northern hardwood types

are clearcut in 10-acre blocks with 2 blocks having common corners. Blocks are clustered by section to make logging commercially attractive. The interval between successive harvests on the same block is 40 years. Trees left after clearcutting are usually less than 6 inches in diameter at breast height (DBH) and are removed by management area personnel with chain saws. These programs provide the desired aspen regeneration and cover type interspersion.

Bottomland hardwoods are selectively cut to remove no more than 70 percent of the overstory tree coverage. Selective cutting of bottomland areas discourages the establishment of shrubs that would prevent overstory regeneration.

Trees are cut either for pulpwood or saw timber. With a 40-year rotation, trees are 45 to 60 feet tall and 14 to 16 inches DBH. Trees less than 6 inches DBH are not merchantable. A hydraulic feller-buncher is used to shear and stack trees. Crews with chain saws remove tops and limbs. The larger trees are also felled with chain saws. Rubber-tired skidders move trees to a central landing where tree length logs are loaded on pole-trailers with a mobile heelboom loader. Trees smaller than saw log size may be processed into chips at the logging site with a Mobark Chip Harvester.

Logging slash is not removed by the commercial logger. Slash is removed primarily by issuing firewood permits to the public, but currently more slash is available than can be removed. Slash is removed by mechanical means in areas adjacent to roads and trails.

Ruffed grouse research is concentrated on the Cranberry Unit and North Unit experimental areas. Forests are manipulated to evaluate size and orientation of cutting blocks for optimal grouse production. Prescribed burning is also being evaluated as a management tool, and a commercial logging plan was developed for both areas (Figure 7). Grouse management outside the experimental units is confined to commercial logging in 10-acre blocks.

Access trails and firebreaks are maintained as needed for wildlife openings with a bulldozer and brush disc. Approximately 10 to 15 miles of trails are maintained per year, depending on the weather. New trails are constructed each year to provide access for hunters and loggers and to serve as forest openings. These primitive trails are often seeded with white Dutch clover.

Future Programs. To insure a well balanced distribution of forest age classes through commercial logging, an annual cutting plan is proposed. The Division of Forestry completed a forest resource inventory of the management area within Mille Lacs County. Based on the existing amount of harvestable timber, an annual harvest schedule was developed using a 40-year rotation. A total of 496 acres in the Mille Lacs County portion of the management area and an estimated 100 acres in Kanabec County will be cut annually (Table 21). Since the forest inventory for Kanabec County is not complete, annual harvest was estimated from the vegetation survey reported in the Resource Inventory section of this plan.

The 1,387 acre Cranberry and 1,439 acre North Experimental Units will receive logging priority. The remaining annual cut will be distributed over the management area to achieve a 596-acre total annual harvest. Logging priority will also be given to stands approaching over-maturity followed by mature aspen and northern hardwood stands (Figure 8).

Table 21. Forest resources and annual harvest recommendations for the Mille Lacs WMA.

	Acres
Mille Lacs County	
Size Class	
Seedlings	951
Saplings	1,858
Pole timber	8,870
Saw timber	6,104
Non-forested bog	18,550
Annual Cut	
Aspen–Birch	250
Northern hardwood	150
Oak	16
Bottomland hardwood	80
Kanabec County	
Size Class	
Survey not completed	
Annual Cut[1]	
Aspen-Birch	50
Northern hardwood	25
Bottomland hardwood	25
Total Annual Cut	596

1. Estimate for the portion of the management area in Kanabec County based on vegetation survey reported in the Resource Inventory section of this plan.

Because of the expense of clearcutting small areas 1-acre blocks have not been cut since 1972. To improve ruffed grouse habitat, thirty-seven 1-acre blocks have been marked in the Cranberry Experimental Unit and should be cut and maintained on a rotational basis. These blocks will be cut by management area personnel should funds become available.

Three to 5 percent of the forest land will be maintained as openings beneficial to deer and other wildlife. Openings will be maintained as access trails, firebreaks, and log landings. Agricultural land on the management area will be maintained through leases with cooperating farmers (Figure 8). These areas are also important in providing habitat diversity.

The total acreage that can be commercially logged on the Mille Lacs WMA depends to a large degree on market conditions for pulpwood and saw timber. Between 1972 and 1975, logging on private land in the vicinity has accelerated as landowners cleared land for agricultural purposes. To attract loggers to the management area, pulpwood may be sold at less than the Division of Forestry recommended price. Also, management personnel may construct logging trails for private loggers. If market values should decline, private loggers will not be interested in cutting the 596 acres annual harvest each year. As an alternative, cutting blocks could be cleared on a contract basis. This procedure is expensive, ranging from $24 to $105 per acre. The slash disposal problem is compounded because harvested trees are not removed from the site. Funds from special appropriations such as the 1977 legislative deer habitat improvement program could also be used on the management

area.

Currently, commercial loggers are required to cut all standing woody vegetation as a condition of the timber lease agreement. Non-merchantable trees, tree tops, and limbs are left on the site, and only the trunks are removed. The slash eventually decays if prescribed burning is not used to clear cutting blocks. To speed slash decay and the return of nutrients to the soil, the loggers will be required to cut all slash to within 18 inches of the ground. This requirement will be introduced into the timber lease agreement on an experimental basis to determine if this type of slash treatment is economically feasible.

Wetland Management

Objectives. Wetlands will be restored and maintained by natural processes for the benefit of waterfowl, marsh birds, furbearers, and public hunting. Wetlands that have become monotypic and dominated by sedges, cattails, or hydric shrubs will be managed to encourage a wider diversity of aquatic plants interspersed with open water.

Considerations. Waterfowl research in Minnesota has traditionally studied the highly productive prairie pothole region of the west-central portion of the state. Research on waterfowl in forested areas similar to the Mille Lacs WMA is not extensive, making a management plan difficult to propose.

Beaver ponds are abundant on the management area. Beaver ponds contribute significantly as waterfowl breeding habitat in some areas (Beard 1953, Knudsen 1962, Renouf 1972). Mallards, wood ducks, and blue-winged teal breed on small woodland ponds in Minnesota (Cline 1965, Ball 1973). Periodic drawdowns occurring every 5 to 10 years, when beaver temporarily abandon ponds, may be beneficial for breeding waterfowl (Beard 1957, Renouf 1972).

Marshes are dynamic systems requiring periodic water level manipulations to maintain plant and animal productivity and diversity (Weller and Fredrickson 1974). This fact applies to impounded marshes where water level regulation is important in maintaining open water and aquatic vegetation and reducing floating mats of cattail.

The soils of the major impoundments are peat. When flooded, peat may form floating mats of aquatic vegetation unattractive to waterfowl (Ball 1973). The floating mats of cattail and sedge in the impounded marshes reduces open water and food sources for migratory and breeding waterfowl.

Water sources for the impoundments are inadequate. Since the management area is located at the head of 3 watersheds, there is no reliable water source to allow flexible water level manipulation.

The greater sandhill crane occasionally nests in the impounded marshes but is not abundant on the manage-

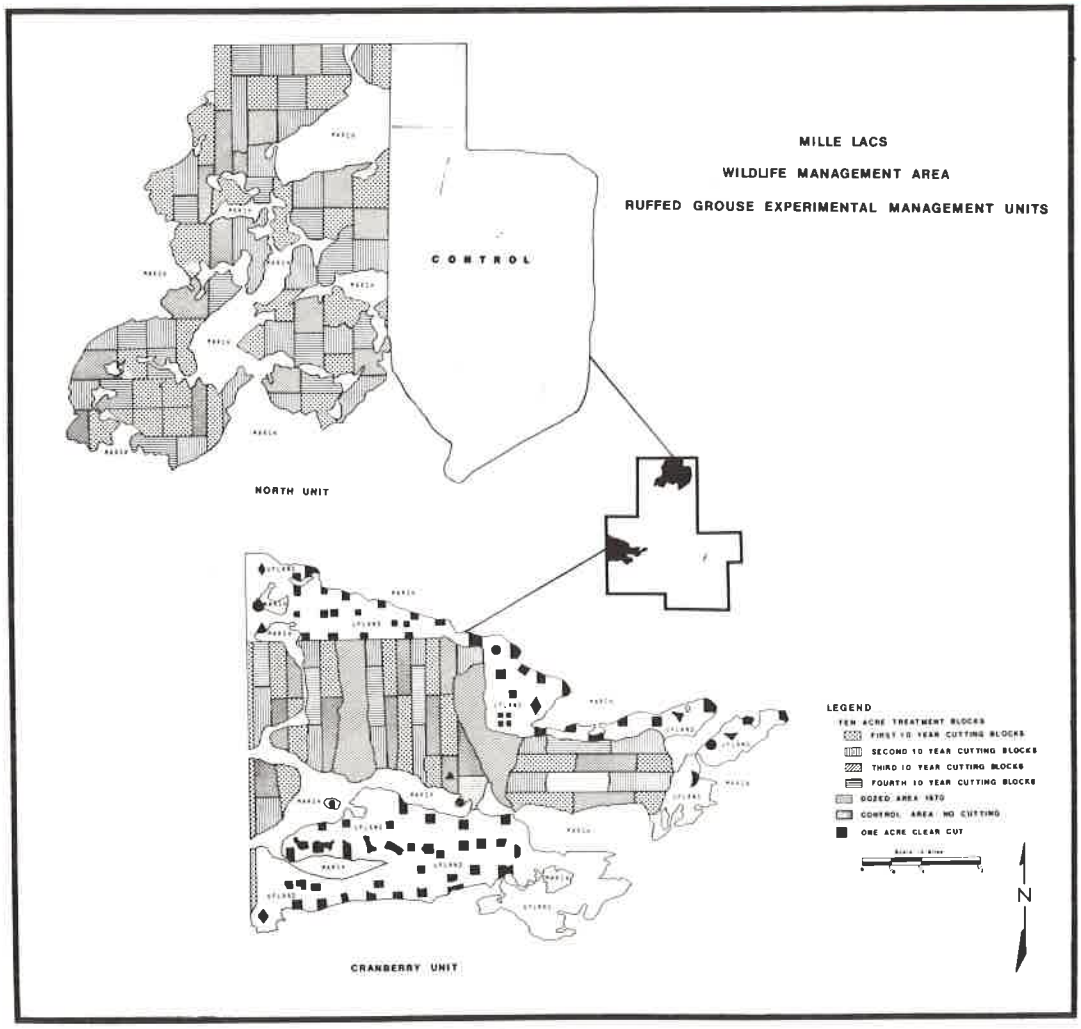

Figure 7

ment area. Although once an abundant resident and migrant in Minnesota wetlands (Roberts 1932), a drastic decline in crane numbers occurred in the late 1800's. A gradual recovery has occurred in Wisconsin (Hunt *et al.* 1976) and in Minnesota (Johnson 1976)in recent years. The birds was removed from the U.S. Fish and Wildlife Service "Endangered List" in 1973 (U.S. Department of the Interior 1974). However, the greater sandhill crane is listed as threatened in Minnesota (Minnesota DNR 1975b) because of its limited range in the state. If the sandhill crane expands its range in Minnesota, as in Wisconsin (Gluesing 1974), this bird may become a more common resident on the management area. Management information on the greater sandhill crane is not extensive; nevertheless, recommendations can be made.

Greater sandhill cranes at the Mille Lacs WMA should benefit from the wetland management proposals. Four factors necessary to sustain nesting sandhill cranes (Hunt *et al.* 1976, Johnson 1976) are present at the Mille Lacs WMA; namely (1) large Type II and Type III wetlands, (2) nesting sites, (3) minimal public disturbance during the breeding season, and (4) upland feeding sites. The extensive Type II and Type III impounded marshes are adequate breeding habitat since these birds will select nest sites in vegetation growing on peat soils (Gluesing 1974). However, periodic burning to prevent encroachment of woody vegetation is necessary. Wetland prescribed burning, coupled with Minnesota's protection of the greater sandhill crane, should encourage greater abundance of cranes on the management area.

Present Programs. Following the construction of the 13 major dikes, waterfowl management was de-emphasized in favor of forest management. Maintenance and improvement of the dikes is an important activity. Waterfowl ponds larger than 1 acre were constructed when marsh conditions permited. During the 1976 drought, 20 smaller potholes were created using heavy equipment that cannot ordinarily operate on the waterlogged soils. Wild rice was seeded in the DeWitt and Mikkelson impoundments and is maintained by regulating water levels.

Future Programs. The first step in a comprehensive wetland management plan will be a detailed inventory of both active and inactive beaver ponds. Beaver ponds will be inventoried with aerial reconnaissance followed by on-site inspections. A topographic survey of the major drainages and marshes will also be completed to determine water flow patterns on the management area. With this information, a detailed wetland-beaver management plan can be developed.

Waterfowl use of beaver ponds can be enhanced at minimal expense. The installation of "beaver pipes", or fenced culverts that are difficult for beavers to plug, can be used to maintain average water depth at approximately 2 feet (Atlantic Waterfowl Council 1972) and pond size at 5 acres or greater (Renouf 1972). Also, by maintaining water flow through a dam, beaver activity downstream will be encouraged. Fenced culverts will also retard the deterioration of abandoned beaver dams. Finally, spring runoff can be diverted with construction of small dikes, into flowages that can be dammed by beavers.

Management activities will also be directed at improving the composition of the aquatic plant communities in the impounded marshes. Some floating cattail has been removed with a dragline, but this is a short-term measure. A long-term solution to this problem will result from extended observations of the effects of drawdowns and experimental treatment of the vegetation and soils in the impoundments. Impounded wetlands that will be managed through water level manipulation, prescribed burning, wild rice seeding, and pothole development are indicated in Figure 8.

Most of the extensive Type II and Type VI wetlands lack open water and are unsuitable for waterfowl production. Potholes that simulate conditions in beaver ponds will be constructed in these wetlands with bulldozers during dry years. Costs average from $600 to $800 per acre-foot of open-water area produced. Potholes will be constructed with irregular shorelines and will be preferably 5 acres but not less than 1 acre in size. (Atlantic Waterfowl Council 1972). Water depths will be approximately 2 feet. Woody vegetation in the marshes will be removed with controlled burning.

A dragline is used to construct potholes for waterfowl.

Nongame Management

Objectives. An objective of wildlife management on the Mille Lacs WMA is an effectively balanced program for all indigenous wildlife species. Although nongame management will be accomplished in conjunction with other management activities, planning for nongame will not be neglected.

Considerations. The Minnesota DNR has statutory responsibility for the protection, propagation, and wise use of Minnesota's wildlife resources. Management of game species is presently emphasized because of existing knowledge and their popularity for hunting. In recent years public interest and concern for nongame wildlife, especially endangered species, has increased. However, functional information concerning the effects of land management on nongame wildlife is lacking (Curtis and Ripley 1975).

Birds constitute a large portion of the management area's nongame wildlife. Management should provide for the habitat requirements of summer residents, winter visitors, and migrants. Populations of many migratory species show dramatic fluctuations in density from year to year even when vegetation is not physically modified (Balda 1975). Winter or spring climatic aspects or conditions in wintering areas will influence migrant and breeding bird densities. These factors complicate management and the evaluation of different programs.

A management plan for nongame birds should consider 3 factors (Zeedyk and Evans 1975). First, structural characteristics of the vegetation influence avifauna composition. Maximum birdlife diversity occurs when the horizontal and vertical diversity of the vegetation are maximum. Second, bird species are adapted to nearly every habitat so management benefiting some species can be detrimental to others. Lastly, bird species differ in their ability to adapt to habitat variability since some species have specific requirements, while others are more general.

Avian species diversity often increases with forest maturity (Odum 1971) resulting from the greater vertical diversity or layers in mature forests. The primary focus of the forest management will be to promote seral plant communities. Clearcutting has the effect of producing an edge, or ecotone, between 2 contrasting vegetation types (Resler 1972). The avian diversity and density increases in response to this edge, or horizontal, diversity (Curtis and Ripley 1975). The flicker, rufous-sided towhee, and several species of sparrows use clearcuts (Conner *et al.* 1975). The catbird, common yellowthroat, and yellow warbler benefit from forest edge and brush areas along the perimeter of clearcuts. Downy and hairy woodpeckers use clearcuts for feeding (Conner and Crawford 1974). As resprouting vegetation matures, species closely associated with early successional stages, such as the chestnut-sided warbler, indigo bunting, and catbird, will benefit (Curtis and Ripley 1975). Access trails and forest openings also provide greater vegetative heterogeneity for birds.

Species attracted to clearcuts and edges usually have broad ranges of tolerance, high reproductive rates, and good powers of dispersal. Other species with more narrow ranges of tolerance may be eliminated from certain portions of the management area should management be directed solely at species diversity and density (Balda 1975). Goshawks, ovenbirds, barred owls, pileated woodpeckers, red-headed woodpeckers, and wood thrushes are examples of species that require mature forests. The selective cutting of bottomland areas to leave a portion of the forest canopy should be beneficial to these species. Contiguous areas of mature forest are also important to some owls and woodpeckers. The bottomland hardwood vegetation maintained on the area may be able to meet these needs. Aspen, birch, and northern hardwood vegetation types will probably not succeed to climax communities before being logged.

Other management aspects on the area can influence nongame wildlife. Wetland management will provide habitat for the migrant shorebirds and marsh birds. By maintaining agricultural fields, the bobolink, meadowlark, several species of sparrows, dark-eyed junco, and snow bunting will benefit.

Both the bald eagle and osprey occur on the Mille Lacs WMA but do not nest. Both species are classified as "uncertain status" by the U.S. Fish and Wildlife Service (U.S. Department of the Interior 1974) and the Minnesota DNR (1975b). Habitat for breeding pairs of eagles and osprey is marginal. Large trees important for eagle nest sites (Juenemann 1973) are lacking. Large amounts of open water supporting sizable fish populations are also necessary for these raptors. The present impoundments are not sufficiently deep or large enough to support fish through the winter, and the intermittent streams on the management area are also unattractive to eagles and osprey. The construction of large impoundments supporting sizable fish populations to sustain breeding eagles and ospreys is not feasible.

A lone, radio-marked wolf was located several times during the spring of 1976 on the management area (William Berg, Minnesota DNR, personal communication). This wolf, originally trapped in northern Minnesota, wandered widely and has not returned to the management area since the spring of 1976. Although the U.S. Fish and Wildlife Service classified the eastern timber wolf as endangered (U.S. Department of the Interior 1974), the Minnesota DNR is seeking a complete declassification of the timber wolf by the federal government. This step is necessary before a comprehensive

The American bittern uses impounded marshes on the unit for nesting.

state-directed wolf management plan can be implemented. While the timber wolf historically occurred in the Mille Lacs area, the management area is south of the peripheral wolf zone in Minnesota (Minnesota DNR 1975c). Wolves occurring on the area will probably be transients rather than a permanent part of the management area's fauna. Roads, farms, and human activity in the Mille Lacs vicinity preclude the permanent establishment of wolves on the area (Weise *et al.* 1975).

The previous discussion on nongame management is subjective and concerns primarily bird species. While more is known about birds than mammals, too little is known about the relationships of habitat requirements, population density, and behavior of most nongame wildlife to accurately assess the effect of game management on these populations. Specific proposals for nongame management cannot be presented in this plan. As more information becomes available on the requirements of nongame wildlife, management activities can be adjusted.

Beginning in 1977, the Section of Wildlife initiated a nongame program. A nongame wildlife specialist was hired to evaluate current knowledge and to propose research programs. The purpose of these research projects is to develop specific management techniques for nongame wildlife. Knowledge gained from this research may be applicable to the Mille Lacs WMA.

Public Use Management

Objectives. Optimum public use of the area is a management goal. User oriented programs will attempt to maintain public use within the constraints of the area to protect the management area resources and to ensure quality outdoor recreation.

Considerations. The temporal distribution of hunters has been a traditional problem in wildlife management. The greatest hunting pressure occurs on the opening day and opening weekend on the Mille Lacs WMA as well as on most other wildlife management areas and public lands. This statewide problem is considered when hunting regulations are established. However, regulations can only be partially successful in equalizing weekend, weekday, and opening day hunting pressure.

Old logging roads make prime grouse hunting trails.

Differential hunting pressure occurred in the peripheral and interior compartments during the 1975 firearms deer season. The peripheral compartment received an estimated average of 31 hunters per square mile on opening day and during the first weekend. During the remaining weekends of the 1975 firearms deer season, estimated hunter densities in the peripheral compartment were only slightly higher than guideline levels. In contrast, the interior compartment received one-third of the hunter density during the entire season.

Ruffed grouse hunter density in both compartments was also less than guideline levels during the entire season. Although only an estimated 4 duck hunters per square mile hunted on the waterfowl season opening day, hunting pressure is confined to a limited number of hunting areas. Waterfowl hunting pressure declines after opening day.

Except for hunting pressure on the opening weekend of the firearms deer season and the opening day of the waterfowl season, the Mille Lacs WMA furnishes quality hunting recreation. The capacity for firearm deer hunting can be increased with improved temporal and spatial hunter distribution. The waterfowl hunting capacity is restricted by the available habitat for waterfowl.

An adequate map indicating roads and trails on the management area is not available for visitors. As a result, most hunters use 6 primary access points that are easily located from boundary roads. Other access points receive less use by hunters unfamiliar with the area.

Other compatible wildlife uses of the Mille Lacs WMA are not extensive for several reasons. Forest dwelling wildlife is difficult to observe, and there are no spectacular concentrations of migrating waterfowl to attract users. The management area does not have striking scenery or unique geological features. Also, the abundance of mosquitoes and other biting insects can make travel during the summer unpleasant. Activities such as hiking, cross-country skiing, environmental education, and sightseeing are minor uses compared to hunting and trapping and, at their present demand levels, do not exceed the capacity of biotic and abiotic resources.

Snowmobiles and motorbikes are used illegally on the management area. Both uses are minor, but they are incompatible due to destruction of wildlife habitats (Wanek 1973, Newman and Merriam 1972). In addition, snowmobiling may be detrimental to wintering white-tailed deer and other wildlife (Jarvinen and Schmid 1971, Kopischke 1974, Dorrance *et al.* 1975). The resident manager has the primary responsibility for enforcing the restriction on snowmobiles as well as the motor vehicle access policy restricting motorbikes and other vehicles.

Present Programs. User oriented projects are primarily directed at hunters and trappers. Development has concentrated on the construction of parking areas and trails to aid access. The importance of providing trails for hunter access and the effect on hunting pressure distribution has been documented (James *et al.* 1974, James *et al.* 1969).

Future Programs. Hunter distribution on the management area will be improved to accommodate future

Construction and maintenance of logging roads is essential to forest management and research programs. The roads provide access for loggers and foot trails for the public.

hunting demand. The restriction of motor vehicles has been successful in promoting quality recreation, as well as reducing hunting and trespass violations, and will continue.

To encourage hunter use of the interior compartment and to familiarize others with the area, a detailed map showing trails, firebreaks, roads, dikes, and access points will be available at the headquarters. Major vegetation types will be indicated on the map to make hunting opportunities in the interior compartment more apparent. Although the Mille Lacs WMA does not receive extensive use outside the hunting and trapping seasons, an informational brochure explaining the purpose, history, and recreational opportunities of the management area will be prepared in conjunction with the map to benefit both the hunting and non-hunting visitor.

An informational sign will be constructed at the headquarters to display maps, commissioner's order governing visitor use (Appendix D), and other information concerning the management area. Access points on the boundary roads will be marked with appropriate signs.

An environmental education area is planned for the Mille Lacs WMA. This area will consist of a self-guided trail and demonstration site that would minimize demands on the existing staff. Initial expense will be incurred in the preparation of informational material and construction of the trail. The area will be designed to conform with the motor vehicle access policy.

Research and Surveys

Objectives. Surveys will be used to monitor public use as well as wildlife harvest. Research is necessary to evaluate present management projects and to develop new techniques.

Considerations. Management techniques for ruffed grouse used on the Mille Lacs WMA were developed through research on the area. Those techniques used for other game species were developed elsewhere in Minnesota or the Lake States Region. Generally, research is too expensive and time consuming to be a responsibility of the staff, and must be conducted in other ways.

Information on wildlife harvest is necessary to improve the management activities on the area. Wildlife population levels and the success of management can be determined, in part, by examining game harvest statistics. Funding and manpower have not been available in the past to allow accurate monitoring of wildlife abundance.

Present Programs. Game animals have been captured and marked by the Section of Wildlife to study the effects of management projects. In 1962 and 1963, white-tailed deer were trapped and fitted with color coded collars to determine seasonal movements. A woodcock banding program was undertaken from 1968 to 1971.

The University of Minnesota and the Section of Wildlife have cooperated on several research projects. Since 1966, both groups have cooperated on a long-term ruffed grouse habitat study. The project was inactive from 1973 to 1975 for lack of funds. An investigation of the nutrient quality of ruffed grouse food was initiated in 1968 and completed in 1973. In addition, the effects of snowmobiles on winter deer movements were investigated during the winters of 1972-73 and 1973-74. From 1972 to 1974, white-tailed deer habitat selection and food habits were studied using radio-telemetry.

In 1976, ruffed grouse research was resumed, and a field station was established at the management area headquarters. A graduate student from the University of Minnesota began evaluating the effects of clearcutting for ruffed grouse management on nongame birds in the spring of 1977.

Future Programs. The Minnesota DNR, University of Minnesota, and North Central Forest Experiment Station are planning a long-term "aspen ecosystem" study. Sources of funding are being sought to initiate this multidisciplinary research project. The proposed study will provide a variety of information should funding become available. Ruffed grouse research will continue to be conducted through a long-term study with University of Minnesota personnel, and the nongame bird study will continue until 1979 or 1980.

A survey will be developed to examine the public use of the area. All compatible outdoor recreation will be considered. Data are needed on numbers of users, temporal and spatial distribution of use, user behavior, and other statistics on the management area visitors. In conjunction with this survey, bag check surveys will be undertaken to estimate harvest. These surveys cannot be initiated without additional management area staff and funding.

To identify potential prehistoric and historic archaeological sites, a stratified sample of field test excavations will be encouraged. The test excavations, weighted toward the northern half of the management area, should sample approximately 20 percent of the land area. The necessity for future field research or more intensive investigations will depend on the initial survey results. This archaeological reconnaissance will be conducted by trained archaeologists with a funding source other than the Game and Fish Fund.

IMPLEMENTATION AND COST ESTIMATES

Specific programs to manage fish and wildlife and provide quality fish and wildlife related recreation were outlined. Implementation of these programs depends on land ownership, land and management costs, funding sources, and the level of funding available.

Land Ownership

Acquisition priorities were established for each tract in 1975 (Table 13). The priorities were based on the necessity of acquiring the remaining private land to permit the completion of scheduled habitat improvement projects on the area. The acquisition schedule is still applicable, and the estimated acquisition cost for the 2,528 acres of private and Trust Fund land is $300,000. This cost is expected to increase 10 percent per year (University of Minnesota 1976). Land will be acquired when private owners sell voluntarily, thus precluding a firm acquisition schedule.

Acquisition will not be the sole responsibility of the resident manager. The area wildlife manager at Cambridge will initiate land acquisition and coordinate efforts with the Minnesota DNR Bureau of Lands in St. Paul.

Management Programs

The Section of Wildlife, through the Region III office, will implement the proposals in this plan. The wildlife management proposals involve changes in funding and staffing for the management area. The Division of Forestry, through the Onamia District Office, will be involved in forest management, timber sales, and prescribed burning. However, additional funding and staff for the Division of Forestry will not be required for implementation of the forest management proposals.

Allocating funds for specific wildlife habitat projects is difficult, and the resident manager must have the flexibility to decide how wildlife management funds will be spent. Many activities are dependent to a large degree on the weather. Prescribed burning is only effective under exact conditions. The construction of dikes and potholes is dependent on seasonal weather trends. In addition, the volume of commercial timber harvested is related to market conditions for pulpwood and saw timber. For these reasons, the costs of the specific management programs are not itemized.

Three alternative spending and management levels for the yearly operation of the area are listed on a priority basis (Table 22). All costs are estimated in 1976 dollars.

Included in the first spending level are those programs having the highest priority that can be implemented at the current spending level without management cutbacks. Present expenditures of about $85,100 per year represent present costs for facility maintenance and operation plus expenses for present habitat maintenance and development. Salaries for personnel employed through the Comprehensive Employment Training Act (CETA) are included in the present expenditure level. Without these federal funds, present management activities would be curtailed.

The 2 additional spending levels will enable more intensive management (Table 22). Additional spending will result in increased benefits for game species, greater emphasis on nongame wildlife, and intensified efforts to improve public use by hunters and other visitors. Within the 2 highest spending levels, the additional expenses for labor, supplies, maintenance, and minor equipment are listed.

To implement the management programs at each level, major equipment and capital improvement purchases will be necessary. Although spending levels are presented on an annual basis, costs for capital improvements listed in Table 22 will only occur once during the 10-year implementation period.

Equipment replacement needs are difficult to predict because of the uncertain demands on equipment. Also, major equipment replacement is dependent on funding, needs, and priorities within Region III. Because of these factors, the anticipated equipment replacement is scheduled in 5-year intervals (Table 23).

Management Area Funding

Although special appropriations are sometimes received, the acquisition, development, and operation of the management area is generally dependent on dedicated funds. Revenue available to the Division of Fish and Wildlife for state-wide fish and wildlife management is related to hunting, fishing, and trapping license sales which, in turn, determine the level of federal-aid matching funds the state is eligible to receive. For the most part, the Division of Fish and Wildlife operates within a budget that can only be increased through greater license sales or higher license fees. Similarily, should license sales decline, revenue would also decline.

A $3.00 Minnesota migratory waterfowl stamp was initiated in 1977. Purchase of this stamp by waterfowl hunters and other people interested in conservation will

provide increased funds for wetland development. In addition, the 1977 legislature appropriated $500,000 for state-wide wildlife habitat improvement during the 1978-79 biennium as part of the general fund "Resource 2000" program.

Except for the recent increase in revenue provided by the migratory waterfowl stamp and possible future general fund appropriations, management funds will probably not increase significantly by 1987. Accordingly most proposals are planned within the present budgetary constraints. Wildlife management finances in Region III are somewhat flexible, and funds can be shifted from item to item. However, the restructuring of spending priorities could be detrimental to some regional wildlife management functions. To maintain the present wildlife programs throughout the region and to implement all of the planned management on the Mille Lacs WMA, increased funding in Region III will be needed.

Table 22. Annual spending alternatives for the Mille Lacs WMA.

Level I. Management at current spending levels

Management at current spending level
- Forest management
  1. Log priority areas
  2. Timber and agricultural lease arrangements
  3. Vegetation control
  4. Firebreak maintenance
  5. Herbaceous seeding
- Wetland management
  1. Dike and water control structure maintenance
  2. Impoundment water level control
  3. Beaver control
  4. Wild rice management
- Public use management
  1. Road and trail maintenance
  2. Management of public hunts
  3. Parking area maintenance
  4. Boundary posting and maintenance
- Research and surveys
  1. Cooperation with research
  2. Wildlife census

Annual spending	
1976 Baseline	$85,000
Added labor and support	— 0 —
Annual Total	$85,000

Immediate capital needs for implementation	
Metal utility building 40' x 100'	$30,000
Total	$30,000

Level II. Additional management with increased spending.

Additional management with increased spending
- Forest management
  1. Log alternate mature forests
- Wetland management
  1. Controlled burning in wetlands
  2. Wetland restoration
  3. Aquatic vegetation control
- Public use management
  1. Environmental education area
  2. Informational brochure and maps
  3. Headquarters informational sign
- Research and surveys
  1. Beaver pond survey
  2. Public use and wildlife harvest surveys

Table 22. (Continued)

Annual spending		Immediate capital needs for implementation	
Level I annual total	$85,000	Level I total	$30,000
Added labor and support (assistant resident manager) (2 6-month laborers) (support expenses)	27,000	Level II needs	– 0 –
Annual total	$112,000	Total	$30,000

Level III. Additional management with increased spending

Additional management with increased spending

Forest management
1. Log 1-acre clearcuts
2. Experimental slash disposal
3. Controlled burning of upland forests

Wetland management
1. Beaver management
2. Pothole construction

Research and surveys
1. Aspen ecosystem research
2. Topographic survey

Annual spending		Immediate capital needs for implementation	
Level II annual total	$112,000	Level II total	$30,000
Added labor and support (natural resources technicial) (4 6-month laborers) (support expenses)	32,000	Level III needs	– 0 –
Annual total	$144,000	Total	$30,000

Table 23. Equipment replacement schedule for the Mille Lacs WMA.

Period	Item/Model	
1977-1981	Crawler tractor/Caterpillar	$45,000
	Tractor/International	10,000
	Dump truck/Dodge	9,000
	Pickup/Chevrolet	5,000
1982-1986	Crawler tractor/John Deere	$22,500
	Swartzbed/Chevrolet	8,500
	Pickup/Dodge	5,000
	Dump truck/GMC	9,000
	Loader/Case	35,000

Literature Cited

Atlantic Waterfowl Council. 1972. Techniques handbook of waterfowl habitat development and management. 2nd Ed. Bethany Beach, Delaware. 217pp.

Balda, R.P. 1975. Vegetation structure and breeding bird diversity. Pages 59-80 *in* Proceedings: A symposium on management of forest and range habitats for nongame birds. U.S. For. Serv. Gen. Tech. Rep. WO–1. 343pp.

Ball, I.J. 1973. Ecology of duck broods in a forested region of north central Minnesota. Ph.d. Thesis. Univ. of Minnesota, St. Paul. 67pp.

Berner, A. 1972. Summarization and analysis of set-aside acre management survey. Minnesota Game Res. Proj. Q. Prog. Rep. 32 (3): 159-169.

Bodman, G.B., C.H. Hammer, S. Hill, T.H. Matcher, H.T. Petraborg, J.W. Moon, A.H. Hasty, and J.A. Zentmire. 1927. Soil survey of Mille Lacs County, Minnesota. U.S. Dept. Agric. Washington, D.C. 46pp.

Beard, E.B. 1953. The importance of beaver in waterfowl management at the Seney National Wildlife Refuge. J. Wildl. Manage. 17:398-436.

Braun, E.L. 1950. Deciduous forests of eastern North America. The Blakeston Co., Philadelphia.

Brown, D.A., J.A. Harrington, T. Isley, D. Soehrn, J.M. Smiley, and E. Stern. 1975. Wildlife habitat change and seasonal cultivation. Minnesota State Planning Agency, St. Paul. 7 pp.

Byelich, J.D., J.L. Cook, and R.I. Blouch. 1972. Management for deer. Pages 120-125 *in* Aspen symposium proceedings. U.S. For. Serv. Gen. Tech. Rep. NC–1. 154pp.

Cline, D. 1965. Woodland pond habitat selection in ducks. M.S. Thesis. Univ. of Minnesota, Minneapolis. 142pp.

Conner, R.N., and H.S. Crawford. 1974. Woodpecker foraging in Appalachian clearcuts. J. For. 72: 564-566.

———H.S. Crawford, and H.S. Mooty. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. Virginia Polytechnic Institute, Blacksburg. 12pp. Typescript.

Cowardin, L.M., and D.H. Johnson. 1973. A preliminary classification of wetland plant communities in north-central Minnesota. U.S. Fish Wildl. Serv. Spec. Sci. Rep. 168. 33pp.

Curtis, J.T. 1959. The vegetation of Wisconsin. University of Wisconsin Press, Madison. 657pp.

Curtis, R.L., and T.H. Ripley. 1975. Water management practices and their effect on nongame habitat values in a deciduous forest community. Pages 128-141 *in* Proceedings: a symposium on management of forest and range habitats for nongame birds. U.S. For. Serv. Gen. Tech. Rep. WO–1. 343pp.

Dolgaard, S.J., G.W. Gullion, and J.C. Haas. 1976. Mechanized timber harvesting to improve ruffed grouse habitat. Minnesota Agric. Exp. Stn. Tech. Bull. 308. 11pp.

Dorrance, M.J., P.J. Savage, and D.E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J.Wildl. Manage. 39:563-570.

Duncan, D.P' 1954. A study of some of the factors affecting the natural regeneration of tamarack (*Larix laricina)* in Minnesota. Ecol. 35:498-521.

Erickson, A.B., V.E. Gunvalson, M.H. Stenlund, D.W. Burcalow, and L.H. Blankenship. 1961. The white-tailed deer of Minnesota. Minnesota Conserv. Dept. Tech. Bull. 5. 64pp.

Ericson, D.W., G.F. Lindholm, and J.O. Helgesen. 1957. Water resources of the Rum River Watershed, east-central Minnesota. U.S. Geol. Surv. Hydrologic Investigations Atlas, HA–509. Washington, D.C.

Farmer, R.E., Jr. 1963. Effect of light intensity on growth of *Populus tremuloides* cuttings under two temperature regimes. Ecol. 44:409–411.

Fedkenheuer, A.W. 1975. Past and present forest communities of St. Croix State Park, Minnesota and their use in determining ecomanagement direction. Ph.D. Thesis. Univ. of Minnesota, St. Paul. 338pp.

Gluesing, E.A. 1974. Distribution and status of the greater sandhill crane in Wisconsin. M.S. Thesis. Univ. of Wisconsin, Stevens Point. 81pp.

Graham, S.A., R.P. Harrison, Jr., and C.E. Westell, Jr. 1963. Aspens: phoenix trees of the Great Lakes Region. University of Michigan Press, Ann Arbor. 272pp.

Gullion, G.W. 1970. Factors influencing ruffed grouse populations. Trans. N. Am. Wildl. Nat. Resour. Conf. 35:93–105.

———. 1976. Ruffed grouse habitat manipulation-Mille Lacs Wildlife Management Area. Minnesota Dept. Nat. Resour. Job Completion Rep. 30pp. Typescript.

———, and F. J. Svoboda. 1972. The basic habitat resource for ruffed grouse. Pages 113-119 *in* Aspen symposium proceedings. U.S. For. Serv. Gen. Tech. Rep. NC–1. 154pp

Gunvalson, V.E., A.B. Erickson, and D.W. Burcalow. 1952. Hunting season statistics as an index to range conditions and deer population fluctuations in Minnesota. J. Wildl. Manage. 16:121-131.

Hale, J.B., and L.E. Gregg 1976. Woodcock use of clearcut aspen areas in Wisconsin. Wildl. Soc. Bull. 4:11–115.

Hansen, H.L., V. Kurmis, and D.D. Ness. 1974. The ecology of upland forest communities and implications for management in Itasca State Park, Minnesota. Minnesota Agric. Exp. Stn. Tech. Bull. 298. 43pp.

Harmon, K.W., and M.M. Nelson. 1973. Wildlife and soil considerations in land retirement programs. Wild. Soc. Bull. 1:28-38.

Huber, E.H. 1966. A biological survey of the Snake River Watershed Pine, Kanabec, Mille Lacs, Isanti and Chisago Counties. Minnesota Conserv. Dept. Spc. publ. 32. 70pp.

Hunt, R.A., E.A. Gluesing, and L.E. Nauman. 1976. The sandhill crane in Wisconsin: A preliminary report. Wisconsin Dept. Nat. Resour. Res. Rep. 86. 17pp.

James, G.A., F.M. Johnson, and F.B. Barick. 1964. Relations between hunter access and deer kill in North Carolina. Trans. N.Am. Wildl. Nat. Resour. Conf. 29:454–463.

———, H.K. Cordell, F.B. Barick, and R.L. Downing. 1969. Small game hunting on western North Carolina wildlife management areas. PartII. Importance and use of forest roads and trails. Wildl. N. Carolina. 33(11):10–12.

Jarvinen, J.A., and W.D. Schmid. 1971. Snowmobile use and winter mortality of small mammals. Pages 131–141 *in* Proceedings: 1971 snowmobile and off-road vehicle research symposium. Coll. Agric. Nat. Resour., Michigan State Univ., Lansing. 196pp.

Johnson, E. 1977. Archaeological sites in nine wildlife management areas. State archaeologist. Univ. of Minnesota, Minneapolis. 9pp.

Johnson, J.M. 1976. Territory, nesting and habitat utilization of greater sandhill cranes in Morrison County, Minnesota. M.S. Thesis. St. Cloud State Univ., St. Cloud. 46pp.

Juenemann, B.G. 1973. Habitat analysis of selected bald eagle nest sites on the Chippewa National Forest. M.S. Thesis. Univ. of Minnesota, St. Paul. 151pp.

Klessig, L.L. 1970. Hunting in Wisconsin: initiation, desertion, activity patterns and attitudes as influenced by social class and residence. M.S. Thesis. Univ. of Wisconsin, Madison. 152pp.

Kohn, B.E., and J.J. Mooty. 1971. Summer habitat of white-tailed deer in north-central Minnesota. J. Wildl. Manage. 33:476-487.

Knudson, G.J. 1972. Relationship of beaver to forests, trout and wildlife in Wisconsin. Wisconsin Conserv. Dept. Tech. Bull. 25. 52pp.

Kopischke, E.D. 1972. Effects of snowmobile activity on the distribution of white-tailed deer in south-central Minnesota, 1971-72. Minnesota Game Res. Proj. Q. Prog. Rep. 32. (3):139-145.

Kuchler, A.W. 1964. Potential vegetation of the conterminous United States. Manual to accompany the map. Am. Geogr. Soc. Spec. Publ. 36. 116pp.

Lindholm, G.F., J.O. Helgesen, W.L. Broussard, and D.W. Ericson. 1974. Water resources of the Snake River Watershed east-central Minnesota. U.S. Geol. Surv. Hydrologic Investigations Atlas, HA–488. Washington, D.C.

McCaffery, K.R., and W.A. Creed. 1969. Significance of forest openings to deer in northern Wisconsin. Wisconsin Dept. Nat. Resour. Tech. Bull. 44. 104pp.

McMiller, P.R., I. Nygard, S. Hill, A.E. Shearin, and C.S. Simmons. 1939. Soil survey Kanabec County, Minnesota. U.S. Dept. Agric. Washington D.C. 43pp.

Minnesota Department of Agriculture. 1975. Minnesota agricultural statistics 1975. St. Paul. 100pp.

Minnesota Department of Economic Development. 1975. Economic distribution of tourist expenditures in Minnesota by regions and counties. St. Paul. 14pp.

Minnesota Department of Natural Resources. 1974. Minnesota state comprehensive outdoor recreation plan. Bur. Environ. Planning and Protection. St. Paul. 213pp.

———. 1975a. Wildlife management area long-range acquisition plan. Div. Fish and Wildl. St. Paul. 36pp.

———. 1975b. The uncommon ones: animals and plants which merit special consideration and management. Div. Fish and Wildl. St. Paul. 32pp.

———. 1975c. Eastern timber wolf recovery plan. Div. Fish and Wildl. St. Paul. 47pp.

Minnesota Pollution Control Agency. 1972. Rules, regulations and classifications and water standards. Minnesota Reg. WPC–14. St. Paul.

Minnesota State Planning Agency. 1975a. Minnesota pocket data book 1975. St. Paul. 286pp.

———. 1975b. Minnesota population projection 1970–2000. St. Paul. 55pp.

Mooty, J.J. 1971. The changing habitat scene. Pages 27-33 *in* M.M. Nelson, ed. The white-tailed deer in Minnesota symposium proceedings. Minnesota Dept. Nat. Resour. 86pp.

Nelson, M., and R.A. Chesness. 1964. The effect of long-term land use trends and the feed grain program on pheasants in Minnesota. Paper presented at 26th Midwest Fish Wildl. Conf., Des Moines. 20pp. Typescript.

Newman, P.W., and H.G. Merriam. 1972. Ecological effects of snowmobiles. Can. Field Nat. 86:207-212.

Odum, E.P. 1971. Fundamentals of ecology. 2nd ed. W.B. Saunders, Co., Philadelphia. 574pp.

Perala, D.A. 1971. Regeneration: biotic and silvicultural factors. Pages 97–101 *in* Aspen: symposium proceedings. U.S. For. Serv. Gen. Tech. Rep. NC–1. 154pp.

Pulliam, J.W., Jr. 1974. Public use policy of the National Wildlife Refuge System. Paper presented at The Great Dismal Swamp: A symposium. 11pp. Typescript.

Renouf, R.N. 1972. Waterfowl utilization of beaver ponds in New Brunswick. J. Wildl. Manage. 36:740–744.

Resler, R.A. 1972. Clearcutting: beneficial aspects for wildlife resources. J. Soil Water Conserv. 27:250-254.

Roberts, T.S. 1932. The birds of Minnesota. Univ. of Minnesota Press, Minneapolis.

Sando, R.W. 1972. Prescribed burning of aspen-hardwood stands for wildlife habitat improvement. Paper presented at 34th Midwest Fish Wildl. Conf., Des Moines. 12pp. Typescript.

Sims, P.K., and G.B. Morey, ed. 1972. Geology of Minnesota. Minnesota Geol. Surv. St. Paul. 356pp.

Stewart, R.E., and H.A. Kantrud. 1969. Proposed classification of potholes in the glaciated prairie region. Pages 57-69 in Saskatoon wetlands seminar. Canada Wild. Serv. Rep. Ser. 6. 261 pp.

Stoeckler, J.H., and J.W. Macon. 1956. Regeneration of aspen cutover areas in northern Wisconsin. J. For. 54:13-16.

University of Minnesota. 1976. The Minnesota rural real estate market in 1975. Dept. Agric. Applied Econ., Econ. Rep. ER–76–1, St. Paul. 41pp.

U.S. Department of the Interior. 1967. Outdoor recreation space standards. Bur. Outdoor Recreation, Washington, D.C. 67pp.

———. 1972. Program, planning and budgeting and evaluation handbook. Fish Wild. Serv. Washington, D.C.

———. 1974. United States list of endangered fauna. Fish Wildl. Serv. Washington, D.C. 22pp.

———. 1975. 1974 western Minnesota wetlands inventory. Fish Wildl. Serv. Fergus Falls. 3pp. Typescript.

Waddell, B.H., Jr. 1973. Fall ecology of white-tailed deer in northern Minnesota. M.S. Thesis. Univ. of Minnesota, St. Paul. 47pp.

Wanek, W.J. 1973. The ecological impact of snowmobiling in northern Minnesota. Pages 57-76 in Proceedings: 1973 snowmobile and off-road vehicle research symposium. Coll. Agric. Nat. Resour. Michigan State Univ. 202pp.

Weise, T.F., W.L. Robinson, R.A. Hook, and L.D. Mech. 1975. An experimental translocation of the eastern timber wolf. Fish Wildl. Serv. Ft. Snelling. 28pp.

Weller, M.W., and L.H. Fredrickson. 1974. Avian ecology of a managed glacial marsh. The Living Bird 12:269–291.

Wetzel, J.F., J.R. Wambaugh, and J.M. Peek. 1975. Appraisal of white-tailed deer winter habitats in north-eastern Minnesota. J. Wildl. Manage. 39:59–67.

Zeedyk, W.D., and K.E. Evans. 1975. Silvicultural options and habitat values in deciduous forests. Pages 115-127 *in* Proceedings: a symposium on management of forest and range habitats for nongame birds. U.S. For. Serv. Gen. Tech. Rep. WO–1. 343pp.

PHOTO CREDITS

Cover

Both — Leonard Lee Rue III

Page 7 — David Urich - DNR

Page 10 — David Urich - DNR

Page 13 — U.S. Department of the Interior, Fish and Wildlife Service

Page 14 — Ted Hammond - DNR

Page 31 — David Urich - DNR

Page 32 — Mike Zicus - DNR

Page 33 — Chuck Wechsler - DNR

Page 34 — David Urich - DNR

Appendix A. The Minnesota Outdoor Recreation System.

Classification	Purpose	Administration
Natural State Park	A natural state park shall be established to protect and perpetuate extensive areas of the state possessing those resources which illustrate and exemplify Minnesota's natural phenomena and to provide for the use, enjoyment, and understanding of such resources without impairment for the enjoyment and recreation of future generations.	Commissioner of Natural Resources
Recreational State Park	A recreational state park shall be established to provide a broad selection of outdoor recreation opportunities in a natural setting which may be used by large numbers of people.	Commissioner of Natural Resources
State Trail	A state trail shall be established to provide a recreational travel route which connects units of the outdoor recreation system or the national trail system, provides access to or passage through other areas which have significant scenic, historic, scientific, or recreational qualities or reestablishes or permits travel along an historically prominent travel route or which provides commuter transportation.	Commissioners of Transportation and Natural Resources
State Scientific and Natural Area	A scientific and natural area shall be established to protect and perpetuate in an undisturbed natural state those natural features which possess exceptional scientific or educational value.	Commissioner of Natural Resources
State Wilderness Area	A state wilderness area shall be established to preserve, in a natural wild and undeveloped condition, areas which offer outstanding opportunities for solitude and primitive types of outdoor recreation.	Commissioner of Natural Resources
State Forests and State Forest Sub-Areas	A state forest, as established by Minnesota Statutes, Section 89.021, shall be administered to accomplish the purposes set forth in that section, and a state forest sub-area shall be established to permit development and management of specialized outdoor recreation at locations and in a manner consistent with the primary purpose of the forest.	Commissioner of Natural Resources
State Wildlife Management Area	A state wildlife management area shall be established to protect those lands and waters which have a high potential for wildlife production and to develop and manage those lands and waters for the production of wildlife, for public hunting, fishing, and trapping, and for other compatible outdoor recreational uses.	Commissioner of Natural Resources
State Water Access Site	A state water access site shall be established to provide public access to rivers and lakes which are suitable for outdoor water recreation and and where the access is necessary to permit public use.	Commissioner of Natural Resources
State Wild, Scenic, and Recreational Rivers	State wild, scenic, and recreational rivers shall be established to protect and maintain the natural characteristics of all or a portion of a river or stream or its tributaries, or lake through which the river or stream flows which together with adjacent lands possesses outstanding scenic, scientific, historical, or recreational value, as provided by Sections 104.31 to 104.40.	Commissioner of Natural Resources
State Historic Sites	A state historic site shall be established to preserve, restore, and interpret buildings and other structures, locales, sites, antiquities, and related lands which aptly illustrate significant events, personalities, and features of the history and archaeology of the state or nation.	Commissioner of Natural Resources, Minnesota Historical Society, Board of Regents of the University of Minnesota, Governmental subdivisions of the State and County Historical Societies.
State Rest Area	A state rest area shall be established to promote a safe, pleasurable, and informative travel experience along Minnesota highways by providing areas and facilities at reasonable intervals for information, emergencies, or the rest and comfort of travelers.	Commissioner of Transportation

Appendix B. U.S. Soil Conservation Service soil numbers, series, and types for the Mille Lacs WMA soils.

Number	Series	Type
12	Emmert	loamy sand
13	Adolph	silty clay loam
152	Milaca	fine sandy loam very fine sandy loam
266	Freer	silt loam
277	Onamia	fine sandy loam very fine sandy loam
995	Histisols	undifferentiated peat
1001	Alluvial	undifferentiated, occasionally flooded

Appendix C. Water chemistry measurements from 3 impoundments on the Mille Lacs WMA, 1976.

Parameters [2]	Sites sampled 5-21-76 [1]			Sites sampled 7-24-76		
	A	B	C	A	B	C
Total phosphate	0.084	0.0250	0.115	0.035	0.287	0.145
Soluable phosphate	0.014	0.113	0.049	0.001	0.094	0.058
Nitrogen						
Ammonia	0.055	0.057	0.065	0.420	0.310	0.260
Nitrite	0.0005	0.0005	0.0005	0.0005	0.0008	0.0013
Nitrate	0.01	0.053	0.01	0.01	0.01	0.01
Total Kjeldahl	2.36	4.26	2.86	–	–	–
Sulfate	1	1	1	1	1	1
Iron	0.23	0.23	0.26	0.7	1.5	1.6
Copper	0.0019	0.0012	0.0019	0.010	0.010	0.01
Zinc	0.0024	0.0028	0.0025	0.3	0.4	0.04
Mercury[3]	0.2	0.2	0.2	0.2	0.2	0.2
Chloride	4.1	7.6	3.7	8.1	12.0	16.5
PH	6.65	7.70	7.50	–		–
Total alkalinity	42.5	50.0	45.0	–	–	–

1. Sampling sites
   A. Ernst pool
   B. DeWitt pool
   C. Korsness pool
2. Measurements in parts per million.
3. Measurements in parts per billion.

Appendix D. Regulations relating to the Public Use of Wildlife Management Areas, Commissioner's Order No. 1961.

No use shall be made of any state-owned wildlife management area except in accordance with the following regulations:

Section 1. *Entry and use.*

(a) Those parts of wildlife management areas posted "STATE GAME REFUGE – NO TRESPASSING" or "WILDLIFE SANCTUARY – NO TRESPASSING" shall not be entered except as authorized by an agent of the Commissioner.

(b) No part of any wildlife management area may be entered or used during the hours 10:00 P.M. to 5:00 A.M. if so posted at the major access points.

Sec. 2. *Hunting and trapping.*

(a) Protected wild animals may be taken on wildlife management areas by hunting or trapping during the established seasons therefore in the zones in which they are located unless the wildlife management area is specifically closed by Commissioner's Order. Upon request by an agent of the Commissioner, all persons shall report animals taken on wildlife management areas and submit them for inspection.

(b) Unprotected wild animals may be taken on wildlife

management areas from September 1 through the last day in February unless the wildlife management area is specifically closed by Commissioner's Order. Nuisance animals may be controlled under permit issued by a wildlife manager.

Sec. 3. *Commercial fishing.*

The taking of minnows and other live baits for commercial purposes may be allowed only under permit from the wildlife manager and only on wildlife management areas over 2000 acres in size.

Sec. 4. *Watercraft.*

Use of motorized watercraft is permitted only on the following wildlife management areas except where posted otherwise by agents of the Commissioner:

(a) In the Gores Wildlife Management Area (Mississippi River Pool 3, Dakota and Goodhue Counties) motorized watercraft may be used without limitation on size.

(b) In the Lac Qui Parle Wildlife Management Area (Big Stone, Chippewa, Lac Qui Parle, and Swift Counties) motorized watercraft may be used without limitation on size.

(c) In the Mud-Goose Wildlife Management Area (Cass County) motorized watercraft powered by motors of 10 horsepower or less may be used except during the waterfowl season.

(d) In the Orwell Wildlife Management Area (Ottertail County) motorized watercraft powered by motors of 10 horsepower or less may be used.

(e) In the Roseau River Wildlife Management Area (Roseau County) motorized watercraft may be used in the main channel of the Roseau River. Motorized watercraft powered by motors of 10 horsepower or less may be used elsewhere on this management area during the waterfowl season only.

(f) In the Talcot Lake Wildlife Management Area (Cottonwood and Murray Counties) motorized watercraft may be used on Talcot Lake except during the waterfowl season. Such watercraft are not permitted on the river and marshes.

(g) In the Thief Lake Wildlife Management Area (Marshall County) motorized watercraft powered by motors of 10 horsepower or less may be used.

(h) In the Walnut Lake Wildlife Management Area (Faribault County) motorized watercraft powered by motors of 10 horsepower or less may be used in that portion of the area known as South Walnut Lake.

Sec. 5. *Vehicles*

(a) Regulations in this Section do not pertain to Federal, State or County highways or Township roads.

(b) No person shall operate an all-terrain vehicle, hang glider, air boat, or hover craft in a wildlife management area. No person shall operate a snowmobile in any wildlife management area without the written permission of the wildlife manager in charge thereof in that part of the state lying south and west of a line described as follows: U.S. Highway No. 2 from East Grand Forks easterly to Bemidji; thence southerly along U.S. Highway No. 71 to Wadena; thence easterly along U.S. Highway No. 10 to Staples and U.S. Highway No. 21 to Carlton; thence east in a straight line to the easterly boundary of the state.

(c) Motor vehicles may be operated on the following wildlife management areas, but not in excess of 20 mph. They may be operated only on established roads, and no vehicle may be driven beyond a sign prohibiting vehicular use or beyond any man-made vehicle barrier.

1. Carlos Avery Wildlife Management Area (Anoka and Chisago Counties)
2. Hubbel Pond Wildlife Management Area (Becker County)
3. Mille Lacs Wildlife Management Area (Kanabec and Mille Lacs Counties)
4. Red Lake Wildlife Management Area (Beltrami County)
5. Roseau River Wildlife Management Area (Roseau County)
6. Thief Lake Wildlife Management Area (Marshall County)

(d) Vehicles are prohibited on all other wildlife management areas except they may be operated, not in excess of 20 mph, on those routes designated by signs as being for travel purposes.

(e) No vehicle shall be parked where it obstructs travel.

Sec. 6. *Aircraft.*

Unauthorized use of aircraft below 1000 feet AGL above ground level) over a wildlife management area is prohibited except in emergencies.

Sec. 7. *Firearms and target shooting.*

Target, trap, skeet, or promiscuous shooting is prohibited.

Sec. 8. *Disorderly conduct.*

Obnoxious behavior or other disorderly conduct is prohibited.

Sec. 9. Disposal of waste and abandonment of property.

Disposal or abandonment of garbage, trash, spoil, sludge, rocks, vehicles, or other debris or personal property on any wildlife management area is prohibited. Boats, decoys, and other equipment must not be left unattended overnight except traps on those wildlife areas open to trapping.

Sec. 10. *Destruction or removal of property.*

Signs, posts, fences, buildings, trees, shrubs, vines, plants, or other property may not be destroyed or removed except that marsh vegetation may be used to build blinds on the area, and edible and decorative portions of plants (except wild rice) may be picked for personal use. Wild rice may not be harvested unless the area is specifically opened by commissioner's order.

Sec. 11. *Private property or structures.*

No person shall construct or maintain any building, dock, fence, billboard, sign, or other structure on any wildlife management area, except that duck blinds may be erected but shall not become private property or be used to preempt hunting rights. It is unlawful to construct, occupy or use any elevated scaffold or other elevated device for the purpose of hunting, watching for or killing big game, except that portable tree stands may be used for this purpose provided they are removed each day at the close of hunting hours and do no permanent damage to trees in which they are placed.

Sec. 12. *Private operations.*

Soliciting business, agricultural cropping, beekeeping or conducting other commercial enterprises on any wildlife management area is prohibited except by lease agreement.

Sec. 13. *Introduction of plants or animals.*

Plant and animal life taken elsewhere shall not be released placed, or transplanted on any wildlife management area except as approved by the wildlife manager.

Sec. 14. *Animal trespass.*

Livestock, horses, and other domestic animals, except dogs being used for hunting purposes, shall not be permitted on wildlife management areas except under cooperative agreement or permit prepared by the wildlife manager.

Sec. 15. *Camping.*

No person shall camp on any wildlife management area except by permit or in designated areas during the hunting season.

Sec. 16. *Other compatible uses.*

Wildlife management areas may be used for hiking, wildlife observation, sport fishing, and other wildlife-related uses provided such uses are not inconsistent with sections 1 through 15 of this order.

Sec. 17. These regulations do not apply to persons engaged in official Department of Natural Resources operations or research projects approved by the Department of Natural Resources.

Sec. 18. Commissioner's Order No. 1948 is hereby superseded.

R. 26 W.
R. 25 W.

T. 42 N.
T. 41 N.

T. 41 N.
T. 40 N.

WILDLI

LEGEND

SOIL CHARACT

H-1 HIG
H-4 HIG
M-1 MED
M-3 MED
L-1 LOW

ROAD
TRAIL
SECTION

0 1/2
MILES

R 26 W
R 25 W

T 42 N
T 41 N

T 41 N
T 40 N

WILDLIFE

FOREST AN

LEGEND

VEGETATION

A -- ASPE
M -- NORT
E -- BOTT
Tx -- TAMA
OF -- OLD
F -- CROP
O -- OAK
B -- BIRC
PP -- PINE
LG -- LOGG

SIZE CLASS

I - less
II - 2 to
III - 6 to
IV - 10 to

V

ROA

TRA

SEC

R 26 W
R 25 W

T 42 N
T 41 N

T 41 N
T 40 N

WILDLIFE

WETL

LEGEND

WETLAND VE

I EPH
II TEM
III SEA
IV SEM
VI LOW
IX-1 NO
IX-2 NO
FT FL

COVER VALU

A OP
B OP

FO

RO

TR

SE

R.26 W.
R.25 W.

T.42 N.
T.41 N.

GRANTS DIKE

ERNST DIKE

KORSNESS THREE DIKE

KORSNESS TWO DIKE

KORSNESS ONE DIKE

KORSNESS DIKE

CRANBERRY TWO DIKE

CRANBERRY THREE DIKE

CRANBERRY ONE DIKE

T.41 N.
T.40 N.

SECTION THREE EAST DIKE

MIKKELSON DIKE

JONES TWO DIKE

SECTION THREE WEST DIKE

ALBRECHT POND

JONES ONE DIKE

HEADQUARTERS ONE DIKE

HEADQUARTERS TWO DIKE

HEADQUARTERS THREE DIKE

KOLLAR PONDS

BERRYS DIKE

R.26 W.
R.25 W.

T.42 N.
T.41 N.

T.42 N.
T.41 N.

T.41 N
T.40 N

WILDLIFE

PROPOS

LEGEND

PRIORITY LOG

C

C

M

G

ALTERN

MANAGE

AGRICU

UNACQ

PROPOS

ROAD

TRAIL

SECT

0

MIL