



**CARLOS AVERY
WILDLIFE MANAGEMENT AREA
MASTER PLAN, 1977–1986**

Minnesota Department of Natural Resources



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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 a 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 analysis, 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.

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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 management and development of the Carlos Avery Wildlife Management Area (WMA) through 1986. This plan was developed by defining area goals, examining existing conditions, identifying management considerations, and then developing appropriate management programs.

Description

The 21,713-acre Carlos Avery WMA is located in northeastern Anoka County and southwestern Chisago County, 31 miles north of the St. Paul-Minneapolis metropolitan area (Figure 1). The wildlife management area, bisected by Interstate Highway 35 into the south-

ern Carlos Avery and northern Sunrise units, is 18 miles long and varies from 1 to 4 miles in width.

The Carlos Avery WMA was established to preserve wildlife habitat and to provide public hunting for sportsmen in the Twin Cities. Since its establishment, the area has been managed principally for waterfowl with secondary emphasis on white-tailed deer, squirrels, and ruffed grouse. The primary goal of the management area has been preservation, development, and management of wetland habitat for the production of waterfowl. Public use is restricted to activities associated directly with fish and wildlife including hunting, fishing, trapping, observation, scientific investigation, and environmental education. Hunting and trapping are the dominant outdoor recreational uses.

Legal Purpose

Public lands have a limited potential for multiple

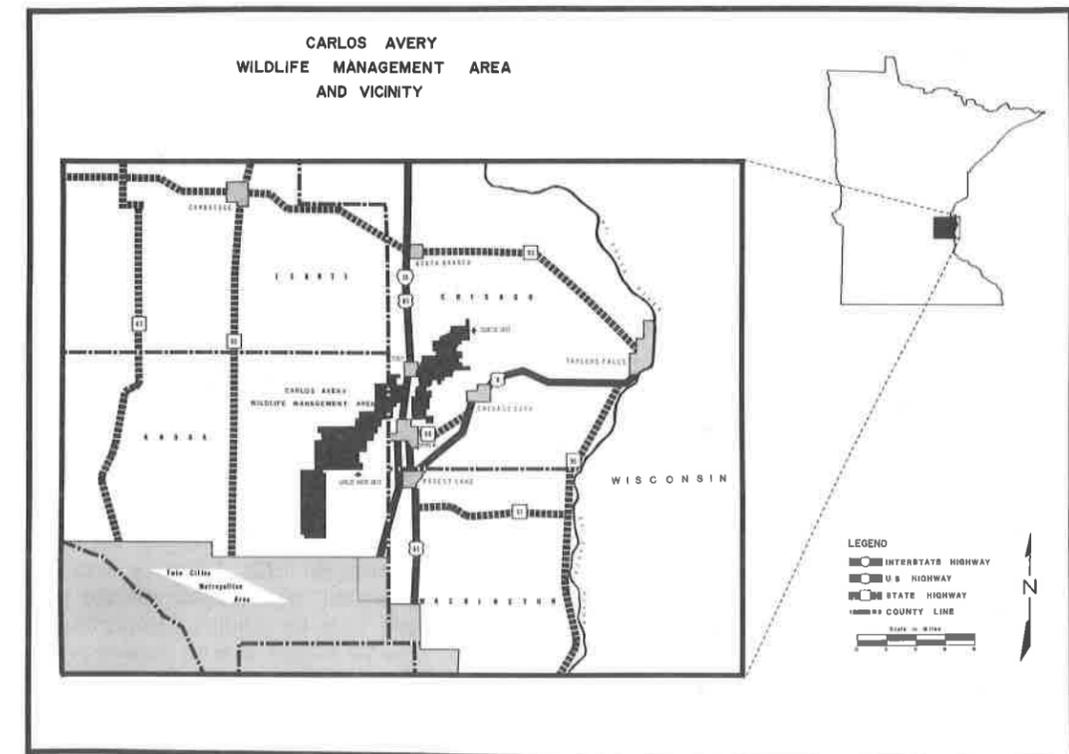


Figure 1

recreational use. Minnesota has never actively encouraged the multiple recreational 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 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 national wildlife refuge goals 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 habitat 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 oppor-

tunities for public hunting, trapping, fishing, and other compatible outdoor recreation (Minnesota Statutes, Section 86A.05, subd. 8, 1976).

Long-range Goals

A long-range goal of the Carlos Avery WMA is the development and management of wetlands to preserve the presettlement vegetational composition and related wildlife populations. Since the presettlement vegetation was characterized by wetland plant communities, perpetuation of wetlands is a sound ecological goal. Upland openings and forest areas will be managed to provide habitat diversity. Upland plant communities will enhance the value of the area to waterfowl, upland game, white-tailed deer, and other wildlife.

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

HISTORICAL AND ARCHAEOLOGICAL ASPECTS

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

Local History

The history of the management area and vicinity is reflected by the establishment, present boundaries, and vegetational composition of the Carlos Avery WMA. More than 8,000 acres of marsh in the Carlos Avery Unit was owned by the Crex Carpet Company. Marsh vegetation was managed by mowing, prescribed burning, and water level manipulation to grow wiregrass for the manufacture of rugs. Production was maximum from 1910 to 1925. In an attempt to use heavy agricultural machinery to harvest wiregrass, the Crex Carpet Company lowered water levels through a system of drainage ditches. Repeated cutting, coupled with lowered water levels, allowed broad-leaved forbs and grass to invade the wetlands and replace wiregrass (Rand 1953). Production declined while competition from synthetic materials for rugs and flooring became acute. Company operations ceased by 1930, and the land became tax delinquent.

Wildlife Management Area History

The Minnesota Conservation Commission (now the Department of Natural Resources) realized the potential of this abandoned marshland as wildlife habitat and for public hunting. Land acquisition began in 1933 after project approval from the Anoka and Chisago county commissioners. The initial purchase of 8,478 acres was tax delinquent Crex Carpet Company land. In 1935, an additional 120 acres were purchased and 800 acres leased. During the 1941 and 1942 biennium, 5,577 acres were acquired. In 1952, the area was expanded with the 7,100 acre Sunrise Unit in Chisago County. This addition was purchased by 1963.

Initially, the Carlos Avery WMA was surveyed, developed, and managed by an Emergency Conservation Work (ECW) camp. The Works Project Administration (WPA) constructed buildings and a game farm in 1935. A resident manager was hired in 1936 to provide coordinated development and planning for wildlife management projects. In 1938, 120 acres within Carlos Avery were designated as a nursery for the propagation of shrubs and trees for wildlife habitat improvement projects. The WPA continued to provide assistance for the construction of buildings, roads, dikes, and with wildlife habitat improvement until 1942.

During the 1930's, hand-reared birds were released and exotic species introduced on wildlife lands in Min-

nesota to increase both hunter success and existing wildlife populations. Accordingly, game farm operations and stocking on Carlos Avery began in 1937 with a quail propagation program. In 1938, a chukar partridge stocking program was initiated but was abandoned after several years due to unsuitable habitat. Quail propagation peaked in the mid 1950's and was also soon phased out because of unsuitable habitat. Ring-necked pheasant propagation began in 1946 and continues to the present. Approximately 50,000 day-old chicks are distributed each year from the game farm to school groups and sportsmen's clubs throughout the state. In addition, Canada geese were raised for distribution to state-owned management areas for the purpose of establishing resident goose flocks. In 1976, a prairie chicken propagation program was initiated to provide birds for release on the Lac qui Parle WMA in west-central Minnesota.

The nursery was operated by the Game and Fish Division (now the Division of Fish and Wildlife) until 1956 when the Forestry Division assumed responsibility. Nursery stock was raised for wildlife management purposes, soil and water conservation, and forest restoration on all state-owned lands. Stock was also provided to private landowners. Between 4 and 6 million trees and shrubs were produced each year from 1956 to 1973 when nursery operations were phased out. In 1976 all operations ceased, and the stock was moved to other

state-owned nurseries. The 90 acres of seedbeds are presently used as wildlife food plots and for the propagation of shrubs and aspen trees to be planted on the Carlos Avery WMA. However, the Division of Forestry maintains its Metro Region Headquarters and Carlos Avery District Headquarters at the nursery.

Archaeological Aspects

No prehistoric or historical archaeological sites are recorded within the Carlos Avery WMA (Johnson 1977). However, the area has not received an archaeological survey. Eight archaeological sites are recorded, and several were excavated along lakes in the management area vicinity. Early prehistoric sites may exist on the management area adjacent to the natural marshes.

Historical Sites

No historical sites in need of special consideration or preservation exists on the management area. The Anoka and Chisago county historical societies were contacted for information, and literature and documents available at the Minnesota Historical Society were also examined to identify significant sites. No areas on or adjacent to the Carlos Avery WMA have been declared eligible for designation as historical sites 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 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 Carlos Avery WMA vicinity is characterized by mild summers and long, cold winters. Average normal temperature for July is 69.9°F and for January 9.7°F (Table 1). Winter temperatures of -25°F are common. The average growing season is approximately 160 days, with the first killing frost on October 9 and the last killing frost April 30. Average normal annual precipitation is 28.48 inches, ranging

from 0.69 inches in February to 4.77 inches in June. Sixty-eight percent of the normal annual precipitation, approximately 19 inches, falls from 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 44.3 inches. Maximum accumulated snow depth averages 30 inches but ranges widely. Snow cover is 1 inch or greater for approximately 95 days per year. Prevailing winds are from the northwest during the winter, changing to the southwest during spring and summer.

Geology. Consolidated bedrock formations consist of 350 to 600 feet of Cambrian sandstones overlaying Precambrian basalt. The Franconia, Ironton, Galesville, and Mount Simon sandstone formations underlie the area (Lindholm *et al.* 1974). The bedrock surface is irregular, with relief up to 250 feet reflecting severe erosion during both glacial and preglacial periods.

Pleistocene glacial activity was responsible for the present soil and topographic features of the management area. Ice sheets covered the area several times during the

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

Month ¹	Average Normal Temperature (°F)	Average Normal Precipitation (inches)	Average Normal Snowfall (inches)
January	9.7	0.69	6.5
February	13.9	0.7	7.5
March	26.5	1.38	10.0
April	43.2	2.32	3.5
May	55.2	3.62	0.3
June	64.9	4.77	0.0
July	69.9	3.74	0.0
August	68.1	3.98	0.0
September	57.8	3.15	T ²
October	47.9	1.93	0.5
November	30.3	1.30	7.0
December	16.3	0.89	8.0
Total		28.48	44.3

1. Data from weather station at Cambridge, Minnesota.

2. Trace.

Source: Forecast Office, National Weather Service, U.S. Department of Commerce, Minneapolis, Minnesota.

Pleistocene, but present landforms and surficial deposits are the result of the most recent (Wisconsin) glaciation (Sims and Morey 1972). During the Wisconsin glaciation, the area was first covered with an ice sheet moving from the northeast out of the Lake Superior Basin. As this ice sheet receded, the Grantsburg sublobe of the Des Moines glacier moved over the area from the southwest depositing gray-brown sandstone and shale till carried from the Red River Valley. The Grantsburg sublobe blocked the Mississippi River and other drainage from the north, creating glacial Lake Grantsburg over a vast area in east-central Minnesota and west-central Wisconsin. As the sublobe withdrew, the lake drained, and meltwater flowed northeast to the St. Croix River, forming a series of coalescing outwash sand plains over 200 to 400 feet of glacial till. This area, referred to as the Anoka Sand Plain, covers the entire management area. Sand dunes, buried mounds of till, eskers, and erosion

are responsible for present topographic features. Depressions are the result of buried ice left by the retreating sublobe that later melted to form ice block depressions, or kettles.

There is no known mineral potential on or adjacent to the management area (David Meineke, Minnesota DNR, Division of Minerals, personal communication).

Soils. The Carlos Avery WMA has deep, moderately dark, sandy soils of glacial origin interspersed in very poorly drained, organic soils. Most of the management area is located in the Rifle-Isanti soil association (U.S. Department of Agriculture 1973). Isanti soils consist of black, loamy, fine sand or fine, sandy loam underlain by grayish, fine sand. These soils occur on uplands and as islands surrounded by poorly drained organic soil. Rifle soils are organic bog and marsh soils. The surface layer is black, mucky peat 10 inches to 10 feet deep with a water table at or near the surface and underlain by

Table 2. Soil characteristics of the Carlos Avery WMA.

Characteristics	Soil Map Designation Symbol	S.C.S. Soil Map Unit Number ¹
High		
Drainage	H-1	158, 8, 132, 169
Erosion potential	H-2	None ²
Fertility	H-3	None
Flooding potential	H-4	1001
Medium		
Drainage	M-1	161, 265
Erosion potential	M-2	None
Fertility	M-3	162
Flooding potential	M-4	None
Low		
Drainage	L-1	53, 541, 543
Erosion potential	L-2	None
Fertility	L-3	None
Flooding potential	L-4	None

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 area.

brown, mucky peat and sand.

Soils along portions of the area boundaries are in the Zimmerman-Isanti-Lino association. These soils are fine sands excessively to poorly drained, depending on topography. Subsoils are also fine sands. Fertility and water holding capacity are low.

The natural fertility of both soil associations is moderate to low, and the soils are moderately productive for agriculture. Drainage is poor over a large portion of Carlos Avery, with the water table at or near the surface on more than 80 percent of the area. Upland soils are subject to drought, and crop production is dependent on applications of fertilizer and lime.

The Carlos Avery WMA soils were grouped into 5 categories, based on physical and chemical characteristics and other factors that influence or limit use (Table 2). A map was prepared, using the soil characteristics as the

mapping unit (Figure 2).

Underground Hydrology. Groundwater on the area is available from aquifers in glacial drift and bedrock sandstone. Sand and gravel outwash zones are the primary sources of water in glacial drift (Lindholm *et al*, 1974). Water yielding capability and well depth vary widely in glacial drift because of the random occurrence of sand and gravel outwash. Wells in glacial drift could be completed at depths of 20 to 400 feet, while wells in bedrock sandstone aquifers could be 300 to 600 feet deep (Minnesota Conservation Department 1961). Four wells, ranging in depth from 28 feet to 108 feet, are located at the area headquarters. A 350 foot well in bedrock sandstone supplies water for the game farm. Due to the heterogeneous mineral composition of the glacial drift, groundwater is high in major ions, especially iron, calcium, and magnesium. Dissolved iron exceeds

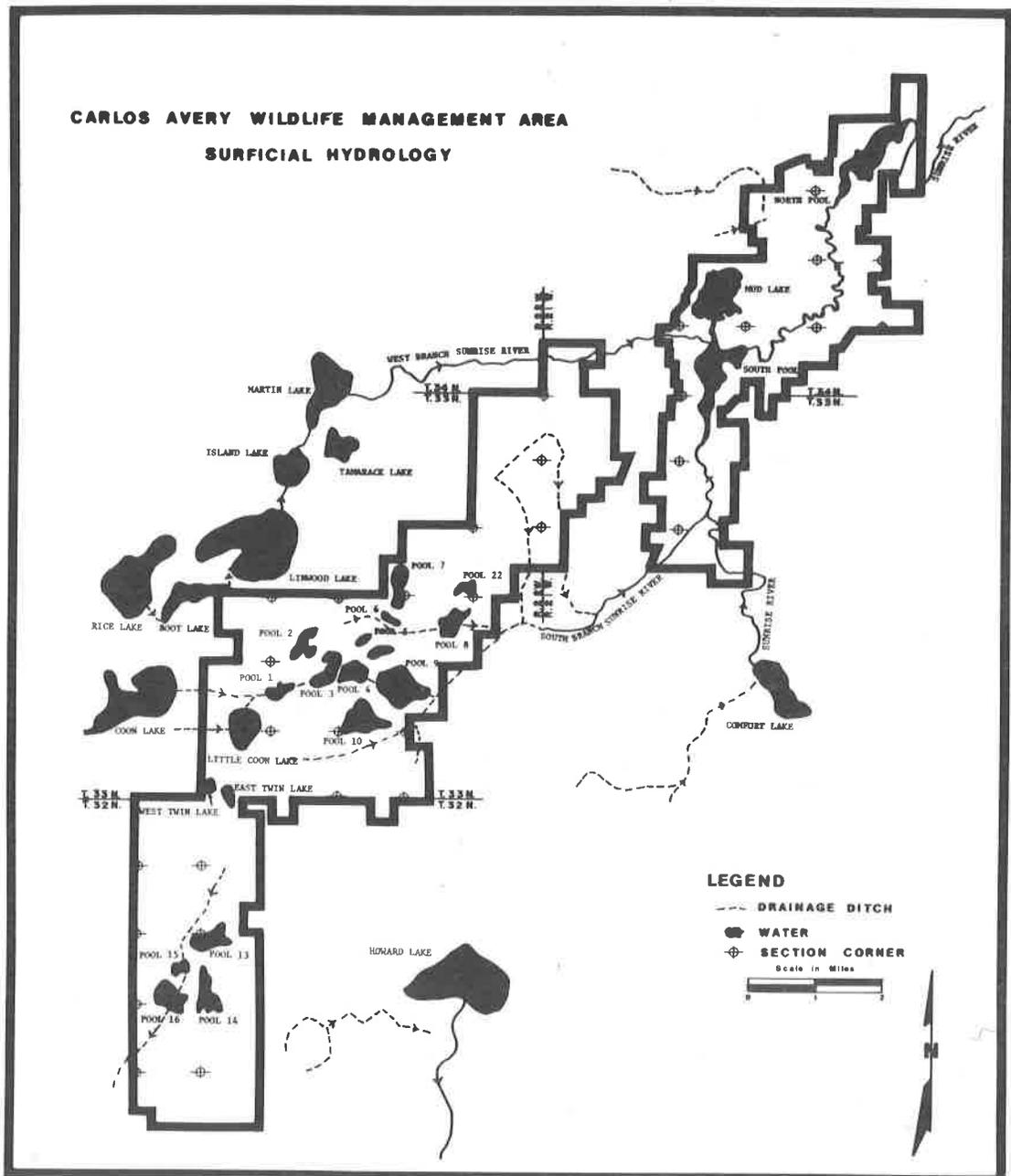


Figure 3

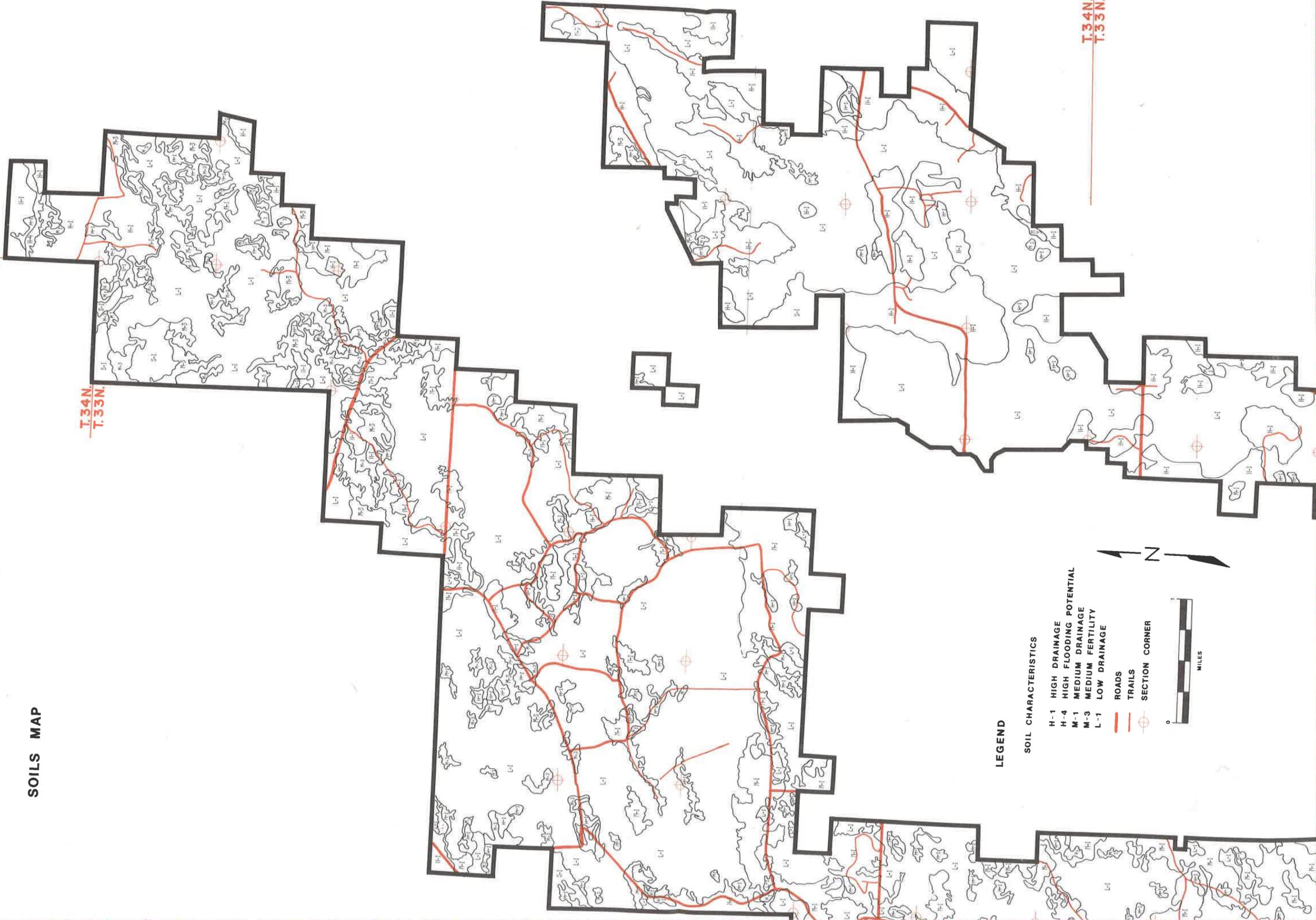
CARLOS AVERY WILDLIFE MANAGEMENT AREA

SOILS MAP

R.22W.

T.34N.
T.33N.

R.21W.
T.34N.
T.33N.

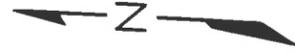


LEGEND

SOIL CHARACTERISTICS

- H-1 HIGH DRAINAGE
- H-4 HIGH FLOODING POTENTIAL
- M-1 MEDIUM DRAINAGE
- M-3 MEDIUM FERTILITY
- L-1 LOW DRAINAGE

- ROADS
- TRAILS
- SECTION CORNER



MILES

the 0.3 mg/l maximum domestic consumption limit in water from the 108-foot deep headquarters well (Minnesota Pollution Control Agency 1972).

Because of extensive wetlands, Carlos Avery is primarily a discharge area for underground water in the St. Croix and Metropolitan watersheds. Recharge sources are confined to upland forest and open areas. Groundwater is recharged primarily through snow melt and spring rains. Most summer precipitation is lost through evapotranspiration. Approximately 76 percent, or 22 inches, of the average annual precipitation in the Carlos Avery vicinity is lost through evapotranspiration; 24 percent, or 7 inches, remains as runoff for the underground and surficial systems.

Watersheds. Two major watershed drain the Carlos Avery WMA. The St. Croix Watershed drains an area of 930 square miles including the portion of the management area north of the game farm (Lindholm *et al*, 1974). The remainder of the management area drains south into the Metropolitan Watershed.

Three streams, the South Branch of the Sunrise River, West Branch of the Sunrise River, and the Sunrise River, flow through the area, leaving the North Pool on the Sunrise Unit as the Sunrise River (Figure 3). In addition, water flows into the impoundments on the Sunrise Unit from drainage ditches constructed outside

the area boundaries on the south, west, and north. Base flow of the Sunrise River at the control structure on the North Pool averages 9 cubic feet per second. Spring discharge rates are extremely variable, depending on winter snowfall and rapidity of spring snow melt; however, maximum spring discharge averages more than 200 cubic feet per second for April and May.

The management area has 4 natural lakes, Mud Lake, Little Coon Lake, East Twin Lake, and West Twin Lake. Water levels in Mud Lake on the Sunrise Unit are managed in conjunction with levels in the South Pool. Water levels are not managed on the other 3 lakes because of possible flooding of adjacent private land.

Since the establishment of the management area, 12.5 miles of dikes were constructed, creating 19 impoundments (Table 3). Although Carlos Avery was historically a wetland area, dikes were constructed to raise water levels to enhance cover and food sources for waterfowl. The dike system also retains water for waterfowl during periods of drought. More than 1,500 acres of open water are impounded on Carlos Avery. Of the nearly 5,000 acres of marsh associated with the impoundments, more than 3,000 acres are cattail and sedge floating in dense mats on 1 to 4 feet of water.

Coon Lake, west of the management area boundary, is a major source of water (Figure 3). Impoundment

Table 3. Waterfowl management units on the Carlos Avery WMA.

Unit	Total Acres	Open Water Acres	Marsh Acres	Upland Acres	Control Structure
Impoundments					
Pool 1	200	20	160	20	No
Pool 2	871	26	657	188	Yes
Pool 3	237	149	34	54	Yes
Pool 4	227	121	70	36	Yes
Pool 5	95	8	44	43	No
Pool 6 ¹					No
Pool 7 ²					No
Pool 8	308	150	100	58	Yes
Pool 9	372	100	183	89	Yes
Pool 10	671	145	441	35	Yes
Pool 11	315		280	35	No
Pool 13	643	24	429	190	Yes
Pool 14	467	45	320	102	No
Pool 15	95	12	55	28	Yes
Pool 16	259	163	12	84	Yes
Pool 17 ³					Yes
Pool 22	450	5	245	200	Yes
North Pool ⁴	959	123	836		Yes
South Pool ⁵	1,547	449	1,098		Yes
Total	7,716	1,540	4,964	1,212	
Lakes⁶					
Little Coon	108				
West Twin	14				
East Twin	16				
Total	138				

1. Water level managed with Pool 8.
2. Not managed, adjacent to private land.
3. Constructed summer 1976.
4. Management initiated spring 1976.
5. Management initiated spring 1976. Includes Mud Lake.
6. Not managed.

water is also derived from spring runoff and groundwater. A system of ditches, many constructed by the Crex Carpet Company, are used for water distribution. Water levels are maintained by drop inlet control structures installed in most dikes (Table 3).

Water was sampled from 14 locations within or adjacent to the management area in 1976. Total alkalinity and pH of water samples and location of sampling stations are presented in Appendix C.

Biotic Resources

Vegetation. Before the influence of modern man, the vegetation of the Carlos Avery WMA was a mosaic of oak savanna, tall grass prairie, marsh, and tamarack bog. Daubenmire (1936) classified the area as scrub oak subclimax due to the influences of fire and the droughty soils on the prevalent plant species. Kuchler (1964) included the area in the Oak Savanna type, characterized by bur oak scattered or in groves with an understory of tall grass prairie, and the Tall Grass Prairie type, dominated by big bluestem, little bluestem, switch grass, and Indian grass.

Presettlement vegetation was altered through cultivation, grazing, and drainage. By 1860, many of the upland areas were cleared and farmed. The marshes were burned regularly to stimulate hay production. Reed canary grass was often sown directly into the peat soils following fire to increase hay yields. By 1930, stricter state fire prevention laws ended the marsh burning practice. However, fires continued to be a problem during the 1930's because of unusually dry weather. The last major wildfire occurred in 1934, when most of the Carlos Avery Unit burned. In addition, the Crex Carpet Company had a substantial impact on the Carlos Avery vegetation, radically altering the species composition of the wetlands (Rand 1953).

Color infrared and black and white aerial photographs were used to map the vegetation of the Carlos Avery WMA. Eleven different upland and lowland vegetation types were recognized and mapped, according to the system used by the Division of Forestry, Minnesota DNR (Figure 4). Wetlands on Carlos Avery were classified, using criteria modified from Stewart and Kantrud (1969) and Cowardin and Johnson (1973). Five wetland types were described, based on water depth and seasonal water level fluctuations (Figure 5). In addition, seasonal and semi-permanent wetlands were assigned a cover type value representing degree of vegetation interspersion or closure. A brief description of the vegetation types, including dominant species and successional trends without disturbance, follows:

Oak. Oak is the most widely occurring upland vegetation type found on the management area. Bur oak and pin oak are found on xeric sites. On mesic sites, white oak and pin oak occur together (Curtis 1959). Trembling aspen and paper birch are subdominant in both oak types. Prominent understory shrubs are prickly ash, beaked hazel, raspberry, and New Jersey tea. Herbaceous plants include hog peanut, bracken fern, sedge, wild raspberry, and Kentucky bluegrass (Cottam 1949).

Successional trends will favor the replacement of shade-intolerant oaks by shade-tolerant oaks. White oak and northern red oak will replace bur oak and pin oak (Pierce 1954). However, topography and exposure are important factors influencing successional trends. The xeric oaks will remain dominant for a longer

period on dry, exposed areas. Aspen and paper birch will not reproduce under an overstory tree canopy and will eventually die out.

Northern Hardwoods. The northern hardwood vegetation type is a mixture of bur oak, pin oak, trembling aspen, and sugar maple. Lesser components are paper birch, basswood, and northern red oak. Oaks are the most abundant overstory species in this type, but trembling aspen and sugar maple approach oaks in frequency of occurrence. Succession is slow, since oaks may survive more than 250 years. The shade-intolerant oaks will gradually be replaced by white oak and northern red oak. On sites with better soil and moisture conditions, sugar maple and basswood may succeed the mesic oaks (Curtis 1959).

Tamarack-Paper Birch. This lowland forest type is limited to poorly drained peat soils. Overstory species composition is confined almost entirely to tamarack and paper birch (Pierce 1954). Black ash can also occur. The abundance of tamarack and paper birch depends on the nature of the peat soils. Almost pure stands of tamarack are found on loose, unconsolidated peat with a water table near the surface. On firm peat with a lower water table, paper birch and black ash are more abundant. The structure of the lowland forest bog varies from a savanna-like muskeg, with widely scattered clumps of trees, to a dense forest, interspersed with open glades formed by wind-thrown trees.

Understory species are similar, regardless of overstory composition. Labrador tea, leatherleaf, poison sumac, speckled alder, and red-osier dogwood are common shrubs. Mosses, especially *Sphagnum* sp. and *Polytrichum* sp., densely carpet the forest floor.

Successional development is extremely slow, since this type tends to be stable (Pierce 1954). Tamarack is susceptible to disease, insect attack, and wind-throw but reproduces readily in bogs. Paper birch reproduction will generally be more successful, as the peat soils become firmer and more consolidated.

Bottomland Hardwoods. The bottomland hardwood vegetation type is confined primarily to poorly drained mineral soils. This type is found adjacent to wetlands and tamarack-paper birch bogs. American elm, green ash, black ash, ironwood, sugar maple, and basswood are dominant overstory species. This type is stable, characterized by long-lived species, and will succeed itself (Fedkenheuer 1975).

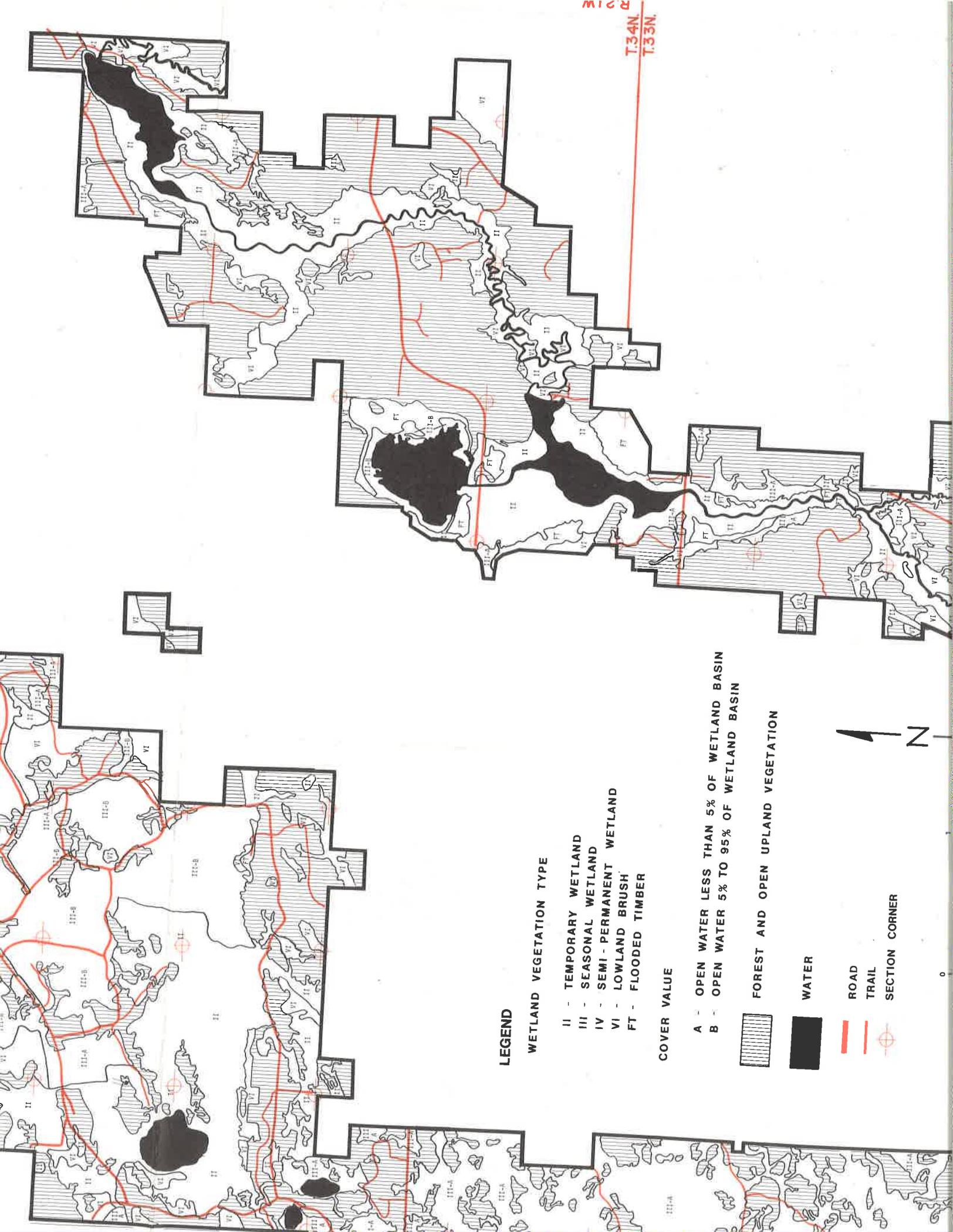
Understory vegetation is sparse because of the dense tree canopy. Beaked hazel, red-osier dogwood, poison sumac, and speckled alder are common shrub species. Ground cover is dominated by lady fern and maidenhair fern.

Aspen. Trembling aspen occurs over a wide range of soil moisture and nutrient levels. On xeric sites, northern red oak, bur oak, and paper birch can be associated with aspen, while on wetter sites, sugar maple, ironwood, and basswood occur (Pierce 1954). Prominent understory species include beaked hazel, juneberry, prickly ash, and smooth sumac.

Successional trends are related to topography and soil conditions. On sandy, well-drained soils, the short-lived aspen will give way to oaks. Where aspen is associated with tolerant hardwood on mesic sites, sugar maple and basswood will eventually dominate.

Oak Savanna. Oak savanna occurs primarily on the Sunrise Unit. Succession and the influence of modern man have combined to modify the species composition, as well as to reduce the distribution of this type on the management area. Widely scattered oaks, especially bur oak and pin oak, characterize the oak savanna. Ground cover consists of a mixture of prairie and forest species with grasses being most abundant. Introduced grasses, such as Kentucky bluegrass and brome grass, have become an important part of the oak savanna. Smooth sumac and red cedar are invading the savannas. With further succession, these sites will become oak forests.

Paper Birch. The paper birch type occurs in



T.34N
T.33N

LEGEND

WETLAND VEGETATION TYPE

- II - TEMPORARY WETLAND
- III - SEASONAL WETLAND
- IV - SEMI-PERMANENT WETLAND
- VI - LOWLAND BRUSH
- FT - FLOODED TIMBER

COVER VALUE

- A - OPEN WATER LESS THAN 5% OF WETLAND BASIN
- B - OPEN WATER 5% TO 95% OF WETLAND BASIN

FOREST AND OPEN UPLAND VEGETATION

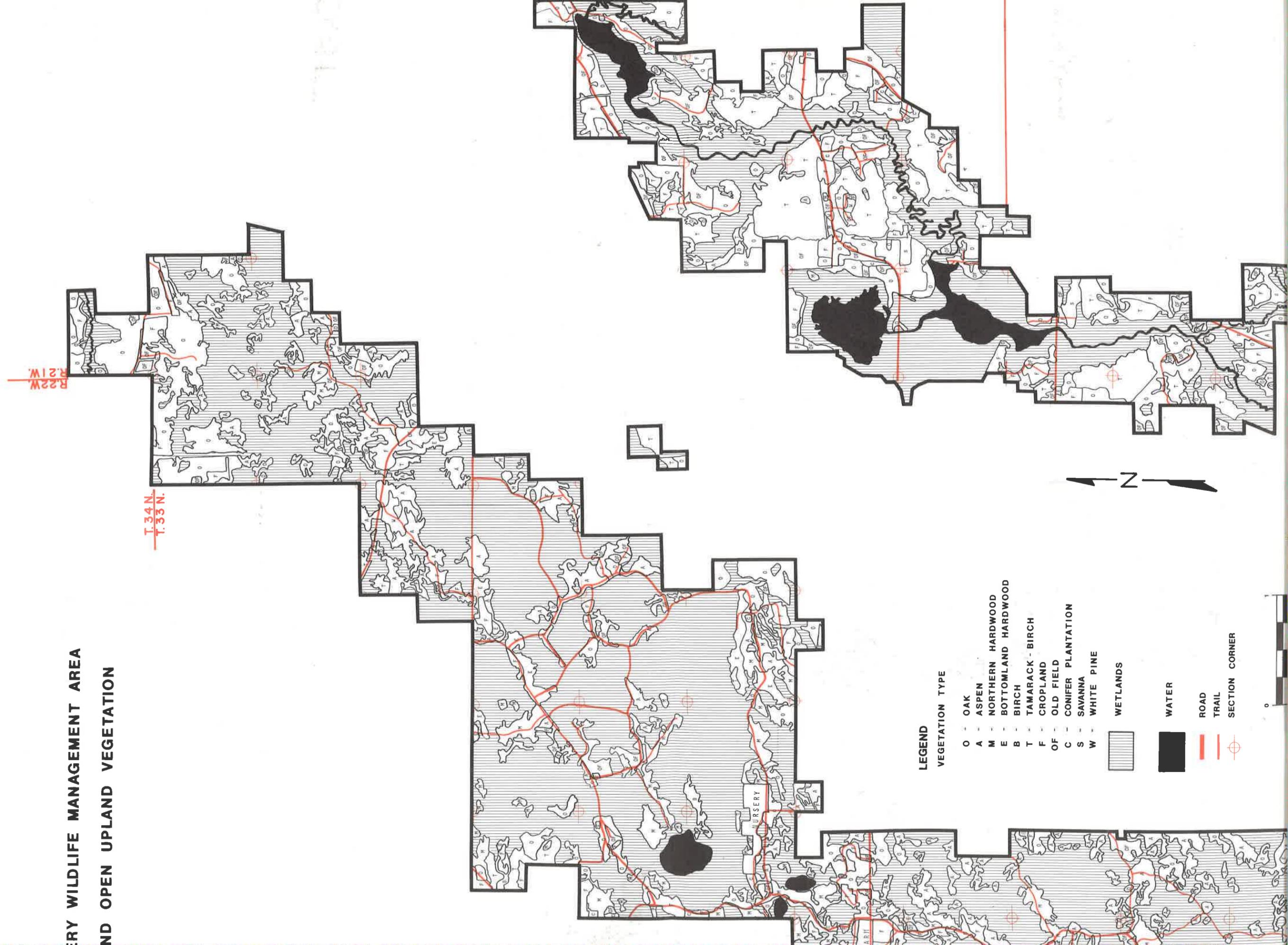
WATER

- ROAD
- TRAIL
- SECTION CORNER



0

**EVERY WILDLIFE MANAGEMENT AREA
AND OPEN UPLAND VEGETATION**



- LEGEND**
- VEGETATION TYPE**
- O - OAK
 - A - ASPEN
 - M - NORTHERN HARDWOOD
 - E - BOTTOMLAND HARDWOOD
 - B - BIRCH
 - T - TAMARACK - BIRCH
 - F - GROPLAND
 - OF - OLD FIELD
 - C - CONIFER PLANTATION
 - S - SAVANNA
 - W - WHITE PINE
- WETLANDS
 - WATER
 - ROAD
 - TRAIL
 - SECTION CORNER



small, homogeneous stands. Paper birch commonly occurs on upland site in a 20 to 50 foot wide band of trees adjacent to wetlands. Aspen or northern red oak are occasionally found within these stands. Paper birch is a short-lived tree that will eventually be replaced by oaks or sugar maple-basswood. Understory shrub and ground cover species composition resembles the aspen type.

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

Old Field. Inactive cropland or hayfields are classified as old fields. These areas are dominated by big bluestem, little bluestem, Indian grass, Kentucky bluegrass, and brome grass. Herbaceous plants characteristic of tall grass prairies also occur. Because of the droughty nature of the soils, red cedar has invaded many old fields. Bur oak and pin oak will eventually

replace red cedar, forming a dense oak forest (Curtis 1959).

Included in this type are areas adjacent to wetlands that have been cleared and planted as upland nesting cover. More than 93 acres were planted in 1976 with a combination of red clover, winter rye, brome grass, and Sudan grass to provide cover for nesting waterfowl and upland game birds. On low-lying areas, timothy is substituted for Sudan grass.

Cropland. Active cropland on the management area is included in this type. A total of 833.7 acres in 90 fields, ranging in size from 1 acre to 36 acres, comprises a system of food and nesting cover plots (Figure 6).

White Pine. Two isolated stands of mature white pine occur on Carlos Avery. The white pines are sparsely stocked and associated with trembling aspen and paper birch.

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-

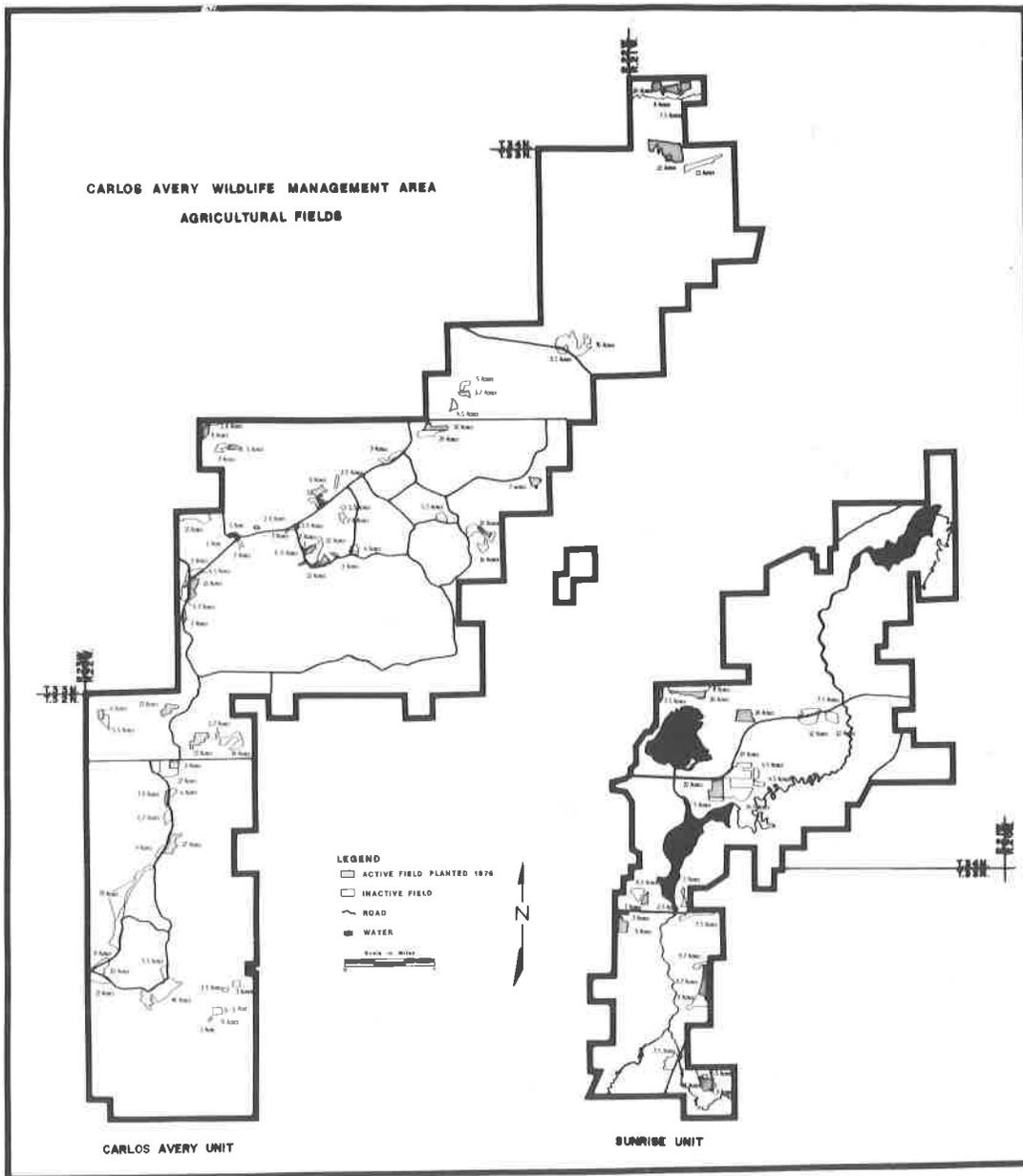


Figure 6

joint and narrow-leaf sedges, especially *Carix stricta*, account for more than 50 percent of the ground cover on some temporary wetlands (Rand 1953). Other common species include squirrel tail, blue flag, redtop, meadow rue, smartweeds, meadow aster, and swamp milkweed.

In the absence of fire and other disturbances, alder, willow, and red-osier dogwood will invade these wetlands, creating a dense shrub thicket. Tamarack and paper birch will eventually become established over a vigorous understory of shrubs (Pierce 1954).

Seasonal Wetland (Type III). This type occurs in depressions having variable water depths 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 are wild rice, giant reed grass, marsh marigold, rice cut-grass, water hemlock, and arrowheads (Cowardin and Johnson 1973). Emergents are more common on wetlands containing surface water for the majority of the growing season, while sedges are found on drier areas.

With the accumulation of organic matter in 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 dominate.

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 fluctuations, 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. Open water is often covered with a dense mat of floating cattails and sedges. Floating mats can become established when emergent vegetation rooted in peat detaches from the wetland basin, floats to the surface, and spreads over the water surface.

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 gradually fills, resulting in a change of species composition 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 snow melt or after heavy rains. Prominent shrubs include speckled alder, red-osier dogwood, and willow. Shrubs, ranging in height from 5 to 15 feet, form dense thickets. The understory is sedge, cattail, and reed canary grass.

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

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 season; 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 Carlos Avery WMA was compiled from several sources. Personnel from 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 244 birds may occur on the management area (Tables 4 and 5). Of these species, 121 are summer residents and probably nest on the area. Seventeen species occur only as winter visitors, and 106 non-resident species are spring and fall migrants.

The relative abundance of each species was estimated. Many species, especially migrants, were rated as 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 where they commonly migrate.

Table 4. Game birds occurring in the Carlos Avery WMA vicinity.

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

A = abundant, C = common, U = uncommon, R = rare.
1. Not presently hunted in Minnesota.

Table 5. Nongame birds occurring in the Carlos Avery WMA vicinity.

Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor	Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor
Nonresident					Resident				
Common loon		C	C		Brewer's blackbird		C	C	
Forster's tern		C	U		Common grackle		A	A	
Black tern		A	A		Brown-headed cowbird		A	A	
Rock dove	A				Scarlet tanager		U	U	
Yellow-billed cuckoo		C	C		Cardinal				
Black-billed cuckoo			C	C	Rose-breasted grosbeak		C	C	
Screach owl	U				Indigo bunting		C	C	
Great horned owl	C				Dickcissel		C	C	
Barred owl	C				American goldfinch		A	A	
Whip-poor-will		C	C		Rufous-sided towhee		U	U	
Common nighthawk		A	A		Savannah sparrow		C	C	
Chimney swift		A	A		Grasshopper sparrow		U	U	
Ruby-throated hummingbird		C	C		Vesper sparrow		C	C	
Belted kingfisher		C	C		Lark sparrow		U	U	
Common flicker		A	A		Chipping sparrow		C	C	
Pileated woodpecker	C				Clay-colored sparrow		U	U	
Pied-billed grebe		C	C		Field sparrow		C	C	
Great blue heron		C	C		Swamp sparrow		C	C	
Green heron		C	C		Song sparrow		C	C	
Great egret		C	C		Nonresident				
Black-crowned night heron		C	C		Red-necked grebe			U	
Least bittern		C	C		Horned grebe			C	
American bittern		C	C		Eared grebe			U	
Red-tailed hawk		C	C		Western grebe			R	
Broad-winged hawk		C	C		White-rumped sandpiper			U	
Marsh hawk		C	U		Baird's sandpiper			U	
American kestrel		C	C		Least sandpiper			C	
King rail		R	R		Dunlin			U	
Killdeer		C	C		Semipalmated sandpiper			C	
Spotted sandpiper		C	C		Western sandpiper			R	
Red-bellied woodpecker	U				Sanderling			C	
Red-headed woodpecker		C	C		Short-billed dowitcher			R	
Yellow-bellied sapsucker		U	U		Long-billed dowitcher			U	
Hairy woodpecker	C				Stilt sandpiper			U	
Downy woodpecker					Marbled godwit			R	
Eastern kingbird		C	C		Wilson's phalarope			U	
Western kingbird		U	U		Northern phalarope			U	
Great crested flycatcher		C	C		Herring gull			C	
Eastern phoebe		U	U		Ring-billed gull			A	
Willow flycatcher		U	U		Franklin's gull			C	
Least flycatcher		C	C		Bonaparte's gull			U	
Eastern wood pewee		U	U		Common tern			C	
Horned lark		A	A		Caspian tern			U	
Tree swallow		A	A		Snowy owl				U
Bank swallow		C	C		Hawk owl				R
Rough-winged swallow		C	C		Long-eared owl			U	
Barn swallow		A	A		Short-eared owl			U	
Cliff swallow		C	C		White pelican			R	
Purple martin		A	A		Turkey vulture			U	
Blue jay	A				Goshawk			U	
Black-capped chickadee	A				Sharp-shinned hawk			C	
Tufted titmouse	R				Cooper's hawk			C	
White-breasted nuthatch	A				Red-shouldered hawk			U	
House wren		C	C		Rough-legged hawk			C	
Long-billed marsh wren		C	C		Golden eagle			C	R
Short-billed marsh wren		C	C		Bald eagle			U	U
Gray catbird		C	C		Osprey			U	
Brown thrasher		C	C		Peregrine falcon			R	
American robin		A	A		Merlin			R	
Wood thrush		U	U		Semipalmated plover			U	
Eastern bluebird		C	C		American golden plover			R	
Blue-gray gnatcatcher		U	U		Black-bellied plover			R	
Cedar waxwing		A	A		Ruddy turnstone			U	
Loggerhead shrike		U	U		Upland plover			U	
Starling	A				Solitary sandpiper			R	
Yellow-throated vireo		U	U		Greater yellowlegs			R	
Red-eyed vireo		C	C		Lesser yellowlegs			U	
Golden-winged warbler		U	U		Willet			R	
Yellow warbler		C	C		Red knot			R	
Cerulean warbler		R	R		Pectoral sandpiper			C	
Common yellowthroat		C	C		Black backed 3-toed woodpecker				R
American redstart		C	C		Yellow-bellied flycatcher			U	
House sparrow	A				Alder flycatcher			U	
Bobolink		C	C		Olive-sided flycatcher			U	
Eastern meadowlark		C	C		Boreal chickadee				R
Western meadowlark		A	A		Red breasted nuthatch			C	
Yellow-headed blackbird		A	A		Brown creeper			C	
Red-winged blackbird		A	A		Winter wren			U	
Orchard oriole		U	U		Hermit thrush			C	
Northern oriole		C	C		Swainson's thrush			C	
Rusty blackbird		C	C						

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

Table 5 (continued)

Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor	Common Name	Year-round Resident	Migrant	Summer Resident	Winter Visitor
Gray-checked thrush		U			Palm warbler			A	
Veery		C			Ovenbird			A	
Golden-crowned kinglet		C			Northern waterthrush			U	
Ruby-crowned kinglet		C			Connecticut warbler			R	
Water pipit		U			Mourning warbler			C	
Bohemian waxwing				U	Wilson's warbler			C	
Northern shrike				C	Canada warbler			U	
Solitary vireo		U			Evening grosbeak				U
Philadelphia vireo		U			Purple finch		C		C
Warbling vireo		C			Pine grosbeak				U
Black-and-white warbler		C			Hoary redpoll				R
Tennessee warbler		A			Common redpoll				C
Orange-crowned warbler		C			Pine siskin		C		
Nashville warbler		A			Rod crossbill		U		
Northern parula		U			White-winged crossbill		R		
Magnolia warbler		C			Le Conte's sparrow		C		
Cape May warbler		U			Dark-eyed junco		A		A
Black-throated blue warbler		R			Tree sparrow		A		A
Yellow-rumped warbler		A			Harris' sparrow		C		
Black-throated green warbler		U			White-crowned sparrow		U		
Blackburnian warbler		C			White-throated sparrow		A		
Chestnut-sided warbler		C			Fox sparrow		C		
Bay-breasted warbler		U			Lincoln's sparrow		U		
Blackpoll warbler		C			Lapland longspur		C		
Pine warbler		U			Snow bunting		C		

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

Of the 34 species of game birds found on the Carlos Avery WMA, 30 have Minnesota DNR authorized seasons. Common resident waterfowl include the mallard, blue-winged teal, wood duck, ring-necked duck, and Canada goose (Table 6). The pintail, American wigeon, red-breasted merganser, hooded merganser, green-winged teal, redhead, and northern shoveler nest occasionally.

Weekly waterfowl counts were made during the 1975 hunting season (Table 7). The mallard and American coot were most abundant, with peak numbers of 20,000 and 30,000 birds. The area also attracts large numbers of migrating ring-necked ducks, wood duck, lesser scaup, and pintails. Other species of migrating waterfowl are less abundant during the hunting season.

Table 6. Waterfowl sighted on a 1972 brood survey and 1971 pre hunting season survey on the Carlos Avery WMA.

Species	1972 Brood Survey ¹			1971 Pre hunting Survey ² Number Sighted
	Broods	Juveniles	Total Adults Sighted	
Mallard	52	314	170	880
Blue-winged teal	37	310	120	1,058
Wood duck	24	144	162	145
Ring-necked duck	13	105	63	20
Coot	1	6	16	
Red-breasted merganser	1	10	1	
Green-winged teal			15	4
Pintail			1	
Ruddy duck			1	4
Lesser scaup			1	
Wigeon				7
Redhead				6
Black duck				7
Loon	4	6	7	10
Canada goose	6	33	8	
Unknown	9	53	9	97

1. Survey from June 12 through June 23 and July 5 through July 21, 1972.
 2. Survey on September 21, 1971.

Table 7. Estimated waterfowl numbers on the Carlos Avery WMA in 1975.

Species	Dates						
	9-29	10-6	10-13	10-20	10-28	11-3	11-18
Mallard	7,000	5,000	20,000	15,000	5,000	4,000	1,000
Blue-winged teal	4,000	3,000	1,000	500			
Green-winged teal			500				
Wood duck	3,000	1,000	2,000	500	500		
Pintail	1,500	1,500	3,000	3,000			
Wigeon	500	500	1,500	2,000			
Gadwall	250	200	1,500	500			
Black duck	200		100	1,000	50	1,500	
Ring-necked duck	1,000	1,000	3,000	5,000			
Lesser scaup			2,000	2,000	4,000 ¹	1,500 ¹	200
American coot	20,000	30,000	5,000	5,000	10,000	3,000	
Canvasback/ Redhead ²			200	200			
Canada goose	200	200	500	500		200	60

1. Numbers of ring-necked ducks and lesser scaup combined.
2. Totals combined.

Although blue-winged teal are common breeders, an early migration makes them less available to hunters.

The ruffed grouse and ring-necked pheasant are upland game birds occurring on Carlos Avery. Each year grouse numbers are indexed along 3 drumming count routes. Fluctuations in grouse numbers on the management area correspond to state-wide variations (Table 8), but grouse numbers on the Carlos Avery WMA are less than in central and southeastern Minnesota counties. Pheasants are not abundant, and no surveys are used to monitor bird numbers.

The management area attracts a wide variety of non-

game birds. Because of extensive marshes, many migrating and resident shorebirds occur. Wood warblers, flycatchers, vireos, woodpeckers, and thrushes occur in the forests. The presence of prey and the relative isolation of habitat from human disturbance make the area attractive to 21 migrant and resident raptor species, including the bald eagle, osprey, and an occasional peregrine falcon.

Table 8. Average number of ruffed grouse drums per stop for the Carlos Avery WMA, Central Minnesota, and Southeastern Minnesota, 1960-1976.

Year	Carlos Avery	Central Minnesota ¹	Southeast Minnesota
1960	0.4	1.3	0.7
1961	0.9	1.1	0.2
1962	1.3	1.6	0.5
1963	0.1	0.4	2.1
1964	0.3	0.3	1.3
1965	0.2	0.5	1.4
1966	—	0.7	1.9
1967	0.6	1.0	2.2
1968	0.5	1.0	1.3
1969	0.4	1.4	2.3
1970	1.1	1.6	2.1
1971	1.1	1.6	3.7
1972	1.4	2.0	3.1
1973	0.9	0.9	3.6
1974	0.9	0.7	3.0
1975	0.4	0.8	2.0
1976	0.3	0.9	2.2

1. Includes Chisago and portions of Anoka counties.



Blue-winged teal commonly nest on the Carlos Avery WMA.

Table 9. Mammals occurring in the Carlos Avery WMA vicinity.

Game	Nongame	
Eastern cottontail	Masked shrew	Red squirrel
Snowshoe hare	Water shrew	Thirteen-lined ground squirrel
Gray squirrel	Arctic shrew	Franklin's ground squirrel
Fox squirrel	Pygmy shrew	Southern flying squirrel
Beaver	Short-tailed shrew	Northern flying squirrel
Muskrat	Long-tailed shrew	Plains pocket gopher
Raccoon	Eastern mole	Plains pocket mouse
Mink	Star-nosed mole	White-footed mouse
River otter	Little brown myotis	Deer mouse
Bobcat	Keen's myotis	Red-backed vole
White-tailed deer	Silver-haired bat	Meadow vole
Black bear	Eastern pipistrelle	Southern bog lemming
Badger	Big brown bat	Norway rat
Striped skunk	Red bat	House mouse
Spotted skunk	Hoary bat	Meadow jumping mouse
Short-tailed weasel	Eastern chipmunk	Least weasel
Long-tailed weasel	Woodchuck	
Coyote		
Red fox		
Gray fox		

Mammals. Mammal occurrence on the area was determined from published records, comments from the University of Minnesota and Bemidji 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 management area (Table 9).

Twenty game mammals occur on the area, and 14 of these species have Minnesota DNR authorized seasons. The remaining mammals are hunted or trapped for pelts or recreation without season or bag limit restrictions. Mammals hunted on Carlos Avery are eastern cottontail, snowshoe hare, gray squirrel, fox squirrel, and raccoon. Trapping permits are issued during the appropriate season for mink, muskrat, raccoon, skunk, badger, and fox. Trapping of beaver and otter is prohibited.

The white-tailed deer is an important species on the

management area. An aerial census in 1971 revealed 150 deer, and 105 deer were counted in 1976. When corrected for deer unobserved because of tree coverage, these figures represent winter deer numbers of 16 to 19 deer per square mile on approximately 7,500 acres of upland deer habitat.

Fish. Much of the approximately 7,500 acres of water impounded on the area is unsuitable for fish. Water depths are too shallow to sustain fish over winter. Dense mats of floating vegetation further reduce suitable fish habitat. Only the North and South pools on the Sunrise Unit support fish. However, these pools are managed as waterfowl habitat and not for fish production. Fish species sampled by the Section of Fisheries in the Sunrise River and its tributaries (Minnesota Conservation Department 1967a, 1967b, 1968) are likely to occur in the North and South pools (Table 10).

Table 10. Fish occurring on the Carlos Avery WMA.

Game	Nongame
Northern pike	White sucker
Bluegill	Northern hog sucker
Green sunfish	Iowa darter
Pumpkinseed	Johnny darter
White crappie	Creek chub
Black crappie	Blacknose dace
	Central mudminnow
	Fathead minnow
	Slimy sculpin
	Common shiner
	Brook stickleback
	Northern redbhorse
	Bowfin
	Northern brook lamprey
	Carp
	Yellow perch
	Black bullhead
	Yellow bullhead

OPERATIONS

The operation of Carlos Avery WMA relies on capital improvements, equipment, staff, and funding. The relationship of the management area to other Minnesota 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 Carlos Avery WMA is one of Minnesota's 851 wildlife management areas and is administered through the Minnesota DNR Region VI office in St. Paul. Region VI consists of 7 counties and includes 16 other wildlife management areas with 3,188 total managed acres. Two area wildlife managers manage the 16 other wildlife areas. The regional wildlife manager supervises management of all wildlife areas in Region VI.

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 (Pittman-Robertson) and the Federal Aid in Sport Fish Restoration Acts (Dingell-Johnson). 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 Carlos Avery WMA are made at the resident manager's discretion. Major equipment is purchased and seasonal employees are hired with approval of the Region VI wildlife manager. Expenditures for salaries, minor equipment, taxes, and operational expenses amounted to \$75,930 in 1975 and \$112,661 in 1976 (Table 11). In 1976, \$30,468 was available for labor through a federal unemployment program.

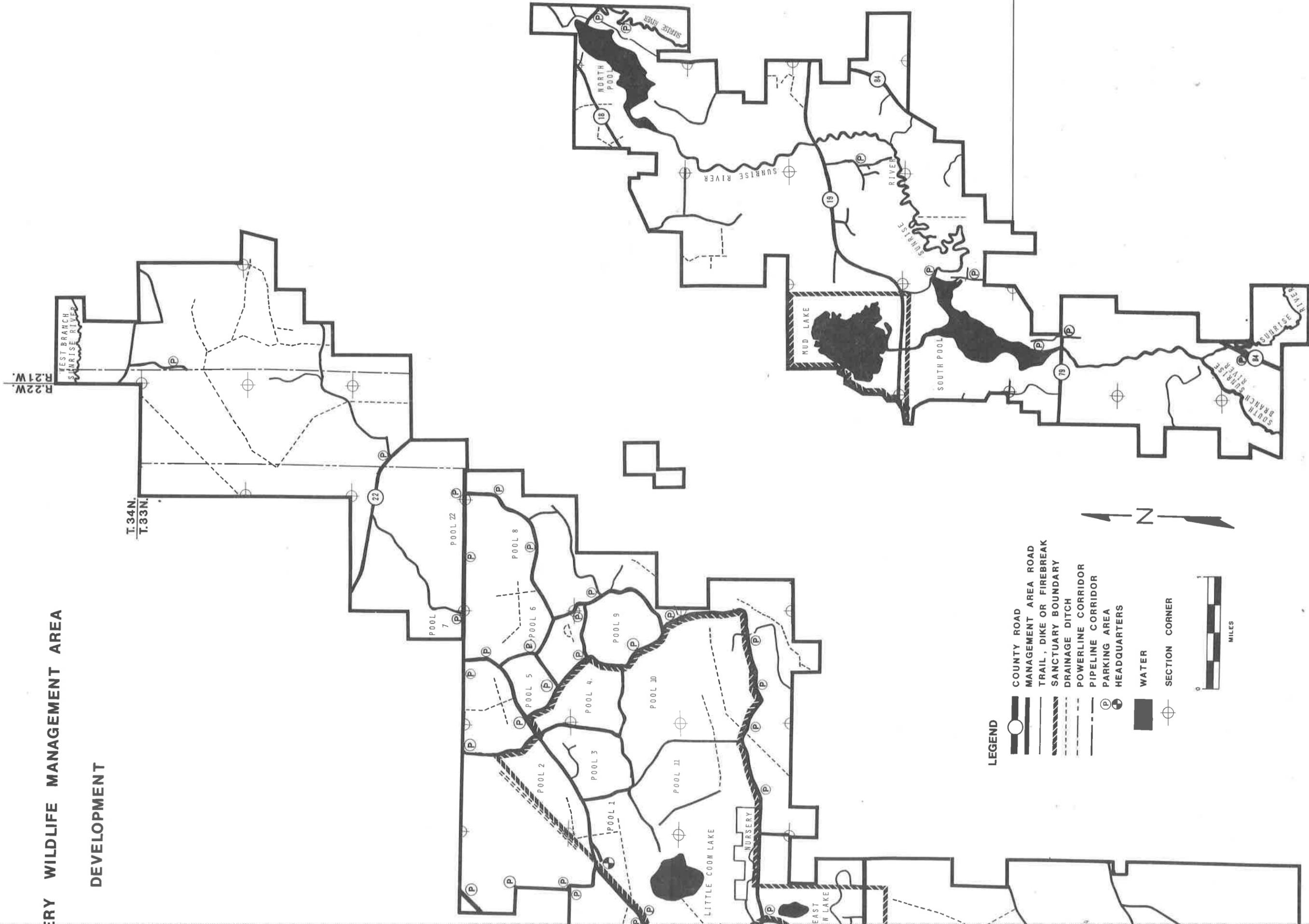
Table 11. Expenditures and income on the Carlos Avery WMA for fiscal years 1975 and 1976.

	Fy 1975	Fy 1976
Regional Expenditures		
Permanent salaries	\$39,141.00	\$ 41,640.00
Seasonal salaries	8,893.15	9,460.80
Temporary salaries	8,496.54	12,925.23
CETA ¹ salaries		30,468.16
Retail purchases	8,743.75	6,568.42
Land Bureau and Administrative Services		
Payments in lieu of taxes	\$10,656.25	\$ 10,656.25
Real estate taxes		942.22
Total Expenditures	\$75,930.69	\$112,661.08
Income		
Firewood permits	\$ 800.80	\$ 1,560.00
Agricultural leases	15.00	185.00
Total Income	\$ 815.80	\$ 1,745.00

1. Comprehensive Employment Training Act, a federally funded unemployment program.

ERY WILDLIFE MANAGEMENT AREA

DEVELOPMENT



LEGEND

- COUNTY ROAD
- MANAGEMENT AREA ROAD
- TRAIL, DIKE OR FIREBREAK
- SANCTUARY BOUNDARY
- DRAINAGE DITCH
- POWERLINE CORRIDOR
- PIPELINE CORRIDOR
- PARKING AREA
- HEADQUARTERS
- WATER
- SECTION CORNER



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 Carlos Avery is replaced when needed but after equipment priorities for other management areas within the region are considered. 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 made from the Game and Fish Fund to Anoka and Chisago 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 \$10,656.25 in 1974. These payments are made by the Minnesota DNR, Bureau of Lands in St. Paul.

In addition to in lieu of tax payments, Minnesota Statutes, Section 262.011 (1976) requires that the state pay real estate taxes on all state-owned residences occupied by state personnel. In 1976, \$942.22 was paid as real estate taxes on the manager's residence in Chisago County. The residences in Anoka County have not yet

been assessed by county officials. Taxes for the Carlos Avery WMA residences 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 Carlos Avery WMA headquarters is located 4 miles north of Anoka County Road 18 (Figure 7). Three wood frame residences, 3 garages, and 6 wood and metal frame buildings, storing equipment and housing offices, are located at the headquarters (Table 12).

Ten drop inlet water control structures regulate water levels in the impoundments. Concrete dams with radial gate spillways were constructed in 1965 on both the North and South pools.

Capital improvements used by sportsmen and other visitors are limited to parking areas, access trails, and an environmental education area (Figure 7). The environmental education area is adjacent to the game farm and consists of a one-fourth mile interpretative trail and agricultural demonstration site with a food plot, shelterbelt, and prairie site.

The Minnesota DNR, Section of Wildlife maintains 33 miles of improved road; 24 miles of road are main-

Table 12. The Carlos Avery WMA buildings and equipment.

Building	Dimensions (feet)	Construction Date	Condition
Residence	38 x 43	1939	Fair
Residence	24 x 27	Unknown	Fair
Residence	28 x 32	Unknown	Fair
Garage	12 x 22	1939	Fair
Garage	17 x 22	Unknown	Fair
Utility building	24 x 60	Unknown	Fair
Utility building	26 x 54	1956	Fair
Utility building	36 x 96	1948	Fair
Office	20 x 20	1973	Good
Barn	28 x 140	1939	Fair
Equipment	Make/Model		Model Year
Crawler tractor	Caterpillar (D6)		1965
Road grader	Galion		1972
Loader	Allis Chalmers		1971
Tractor	Ford (3000)		1972
Tractor	John Deere (2030)		1973
Tractor	Farm-All		1945
Dump truck	International		1966
Dump truck	Dodge		1970
Pickup, ½ ton	Dodge		1972
Pickup, ½ ton	Dodge		1974
Pickup, ½ ton	International		1967
Pickup, ½ ton	Ford		1968
Sedan	AMC		1972
2-bottom plow			1973
Cultivator			1973
4-bottom plow			1973
12-foot disc			1973
No till 4-row planter			1976
2-row planter			1972
4-section spike tooth harrow			1950
8-foot grain drill and grass seeder			1952
Brush disc			1962
Brush mower			1976
Cattail mower			1977



The dragline is used for dike and level ditch construction and maintenance, as well as for creating open water areas in cattail stands.

tained by the counties or townships (Figure 7). In addition, 21 miles of dikes and more than 23 miles of access trails and firebreaks were constructed by the Minnesota DNR, Section of Wildlife (Figure 7).

Additional capital improvements include 19 buildings located on the 120-acre game farm and 7 buildings which comprise the regional forestry headquarters at the 120-acre nursery (Appendix D).

Equipment

Heavy equipment stored at Carlos Avery is used primarily on the area but is occasionally loaned to other Minnesota DNR divisions in Region VI (Table 12). Farm equipment is used to prepare and plant wildlife food plots. Other heavy equipment is used to construct and maintain roads and firebreaks, manipulate wildlife habitat, and build dikes and water control structures.

Game Refuges

Two waterfowl sanctuaries were established and are posted in accordance with game and fish laws (Figure 7).

Except for limited trapping for raccoon and fox on a permit basis, trespass is prohibited at all times. The Carlos Avery and Sunrise sanctuaries are approximately 3,520 and 520 acres. The portion of the management area south of Anoka County Road 18 in the Metropolitan Goose Refuge and is closed to goose hunting.

Staff

Four full-time employees are assigned to the Carlos Avery WMA. Two resident managers share overall responsibility and are assisted by a full-time technician, a full-time laborer, and a 9-month employee. Summer laborers are hired when possible. 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, 4 employees are funded through the Comprehensive Employment Training Act (CETA) until August 1, 1977. Seven full-time and 3 seasonal employees operate the game farm but do not assist with management of the Carlos Avery WMA.

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

Land acquisition on the Carlos Avery WMA is com-

plete. Since 1933, 20,187 acres of private land, 80 acres of Trust Fund land, 873 acres of rural credit land, and 573 acres of tax forfeit land have been acquired (Table 13). Approximately one-third of the private land was tax delinquent.

A total of \$386,746 was spent for land acquisition. All land acquisition funds were derived from license revenues and excise taxes paid by sportsmen. Sixty-four percent was spent through federal-aid projects, and the rest was hunting and trapping license sales receipts (Table 14).

Table 13. Previous ownership of state-owned land in the Carlos Avery WMA.

Previous Ownership	Anoka County (acres)	Chisago County (acres)	Total (acres)
Private	13,796.31	6,390.58	20,186.89
Trust Fund		80	80
Tax-forfeit	167.17	406.2	573.37
Rural Credit ¹	440	433.33	873.33
Total	14,403.48	7,310.11	21,713.59

1. Land controlled by the discontinued Minnesota Rural Credit Administration.

Table 14. Source of funds and acreage purchased in the Carlos Avery WMA.

Source of Funds	Amount	Acreage
Section of Wildlife project	\$140,111.42	10,711.11
Federal aid project	246,634.73	11,002.42
Total	\$386,746.15	21,713.53

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 the public use on the Carlos Avery 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 wildlife and fish resources. Knowledge of present use levels is necessary to predict the future demand for outdoor recreation and to develop management programs.

Hunting

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

Waterfowl hunters accounted for 75 percent of all hunter-use days (Table 15). Ducks and mergansers made up most of the harvest, while goose hunting was incidental to duck hunting and occurred only outside the Metropolitan Goose Refuge.

Hunting pressure was unequally distributed during the 1975 season with opening day and weekends receiving the most waterfowl hunting pressure (Table 15). Weekdays received half the hunting pressure of weekends.

Waterfowl hunters were not equally distributed on the management area because of hunter preference and habitat differences. Compartment 1 on the Carlos Avery Unit and Compartment 4 on the Sunrise Unit accounted for 60 percent of the total waterfowl hunter-use days (Figure 8 and Table 15). Within these 2 compartments, hunters concentrated along the sanctuary boundaries, creating opening day densities of more than 150 hunters per square mile. Compartment 3 had few waterfowl hunters because of the lack of open water.

Pheasant and deer hunting occurred primarily in Compartments 1 and 2 of the Carlos Avery Unit (Table

15). Of the estimated 2,000 total hunter-use days during the firearms deer season, 25 percent occurred on the opening weekend and 37 percent on the 8 weekend days. First weekend deer hunter densities were 17 hunters per square mile in Compartment 1 and 28 hunters per square mile in Compartment 2. These estimated densities dropped to 6 and 11 hunters per square mile for the remaining weekends of the season. The 4-day Thanksgiving weekend accounted for approximately one half of the hunting pressure after the first weekend. Most bow hunting for deer also occurred on the weekends.

Small game hunting was for squirrels and rabbits. Small game hunters accounted for an estimated 2,000 hunter-use days during the 1975 season. Hunting pressure was greatest during the first week of the season and on weekends in Compartments 1, 2, and 3 (Table 15).

Trapping

All trappers must obtain a permit from the resident manager before harvesting animals on the management area. Trappers are also required to submit a report at the end of the season listing numbers and species of animals taken.

The number of permits issued depends on annual fluctuations in furbearer numbers observed by the resident manager. Applications are randomly selected to determine the permittees. In 1974, 28 trappers applied for 17 permits, and in 1975 there were 34 applicants for 28 permits.

Muskrats and mink constitute the majority of the catch. Red fox and raccoon are important because of their high pelt value. Estimated value of all pelts taken on Carlos Avery was \$6,999.50 in 1974 and \$9,205.00 in 1976.

Fishing

The impoundments on the area are managed for waterfowl and do not support substantial game fish populations. Fishing, primarily for northern pike, is confined to the North and South pools on the Sunrise Unit. Following hunting, sport fishing is the most popular activity on the area.

Other Activities

The Carlos Avery WMA receives a variety of outdoor recreation other than hunting, fishing, and trapping. Because manpower and funding constraints have precluded the accurate monitoring of nonhunting use,

Table 15. Estimated temporal and spatial distribution of hunters on the Carlos Avery WMA in 1975.

	Firearms Deer	Small Game	Ruffed Grouse	Pheasant	Waterfowl
Temporal Distribution					
Hunter-use Days	2,000	2,000	1,000	2,000	20,000
Opening Day	Sat. Nov. 1	Sat. Sept. 13	Sat. Sept. 13	Sat. Oct. 23	Wed. Oct. 1
% Use	13	45	45	40	13
Opening Weekend	Nov. 1,2	Sept. 13,14	Sept. 13,14	Oct. 23,24	Oct. 4,5
% Use	25	60	60	70	26
First Week	5 days	5 days	5 days	5 days	5 days
% Use	27	70	70	75	39
Remaining Weekdays	8 days	30 days	30 days	30 days	12 days
% Use	36	10	10	5	20
Remaining Weekends	18 days	76 days	76 days	15 days	33 days
% Use	37	20	20	20	41
Spatial Distribution					
% Use in Compartment 1 (6 square miles)	40	40	40	60	20
% Use in Compartment 2 (4 square miles)	45	20	20	40	25
% Use in Compartment 3 (7 square miles)	10	20	20	0	0
% Use in Compartment 4 (4 square miles)	4	10	10	0	35
% Use in Compartment 5 (6 square miles)	1	10	10	0	20

Table 16. Arrests made on the Carlos Avery WMA from 1973-1975.

Category	Number	Percent	Violation
Trespass	44	33.1	Trespass in refuge, after hours use.
Snowmobile and ATV	12	9.0	Snowmobiling on management area, motor vehicle (all-terrain vehicle) use of off roads.
Hunting	25	18.8	Exceed bag limits, out of season hunting, hunting without license, etc.
Fishing	4	3.0	Fishing without license, more than 1 line, etc.
Trapping	6	4.5	Trapping without permit, trapping out of season.
Firearms	42	31.6	Target shooting, transport of uncased guns, unplugged shotgun, etc.
Total	133	100.0	

the following discussion is qualitative.

Environmental education and sightseeing are the preeminent nonhunting activities. During 1976, 924 people visited the environmental education area. Large numbers and a variety of waterfowl during the spring and fall attract many nature enthusiasts. Automobiles are permitted on most dike roads, making waterfowl and shorebirds accessible to sightseers. Other outdoor recreation on the management area includes snowshoeing, cross-country skiing, and hiking. The operation of snowmobiles and all-terrain vehicles and horseback riding are prohibited.

Violations

Two conservation officers and both resident managers have primary responsibility for enforcing the Minn-

esota game and fish laws as well as the regulations relating to public use of the area (Appendix E). From 1973 through 1975, 133 arrests were made on the area (Table 16). Hunting, fishing, and trapping violations accounted for 26.3 percent of the arrests. Trespass, including travel within the refuge and after hours use, plus firearms violations accounted for 60.9 percent of the violations. The management area is closed to public use between the hours of 10:00 p.m. and 5:00 a.m. by commissioner's order. Illegal snowmobile use and mechanized travel off designated roads comprised 9.0 percent of the arrests. Illegal 4-wheel drive vehicle, motorbike, and horseback riding use are minor abuses. The most common firearms violations were target and trap shooting and transport of an uncased firearm in a motor vehicle.

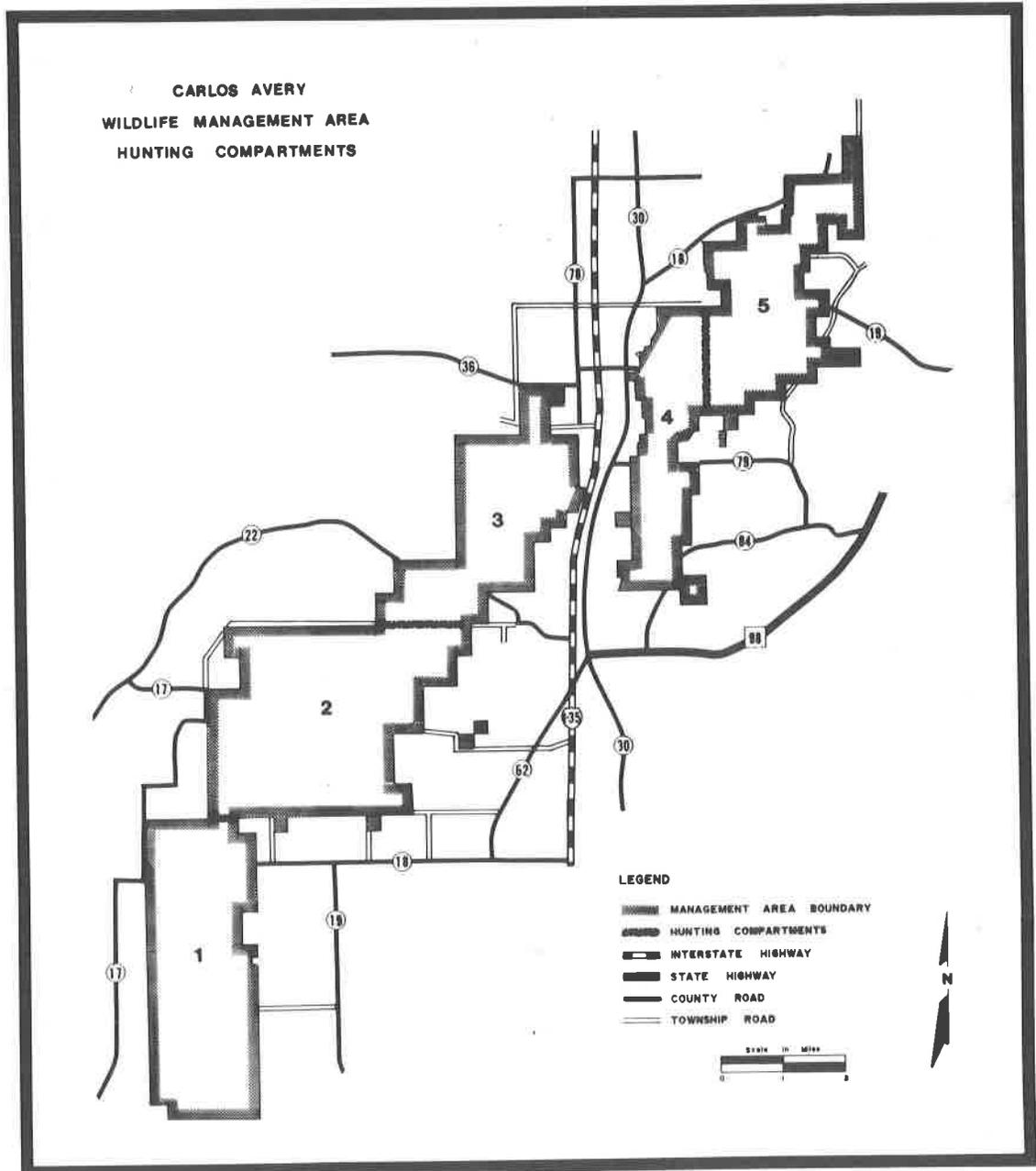


Figure 8

Timber Harvest

Firewood permits are issued to the public by the Division of Forestry to improve wildlife habitat. The location and size of areas to be cut are determined by the resident wildlife manager. All sales are approved by both divisions. In 1975 and 1976, 154 and 300 firewood permits were issued allowing the harvest of up to 25 cords per permit. Income from firewood permits was \$800 and \$1,500 in the 2 years.

Agricultural Leases

Agricultural land is leased to cooperating farmers to establish wildlife food plots and to maintain openings. In 1975 and 1976, 320 and 236.5 acres were farmed through cooperative agreements (Table 17). The resident manager negotiates the terms of the annual lease agreements. On areas planted to grain and row crops, the state's share is left standing as winter food for wildlife. On sites planted to red clover, rye, brome grass, or timothy for upland nesting cover, the lessee harvests the rye or brome grass for seed leaving the remaining legumes and grasses for ground dwelling wildlife. Income from leases was \$15.00 in 1975 and \$185.00 in 1976.



Agricultural leases are used to inexpensively maintain wildlife food plots near winter cover.

Table 17. Cooperative farming data for the Carlos Avery WMA in 1975 and 1976.

Crop	Acres farmed		State Returns					
			Cash		Unharvested (acres)		Harvested (acres)	
	1975	1976	1975	1976	1975	1976	1975	1976
Anoka County								
Corn	0	30 ¹	0	0	0	0	0	0
Hay/straw	12	0	0	0	4	0	0	0
Soybeans	34	16	0	0	12.6	8	0	0
Nesting cover	11	0	0	0	11	0	0	0
Chisago County								
Corn	153	75.5	0	0	50	15.9	0	9
Hay/straw	0	63.5	0	\$170	0	0	0	0
Soybeans	33	10	0	0	11	1	0	2.3
Nesting cover	42	18	0	0	42	18	0	0
Pasture	15	15	\$15	\$15	0	0	0	0
Clover	20	0	0	0	10	0	0	0
Total	320	228.0	\$15	\$185	140.6	42.9	0	11.3

1. The state purchased the seed and the lessee harvested the entire crop in exchange for applying lime to the field.

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. 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

Anoka County is within the 7-county Twin City Metropolitan Area and, with a population of 425 people per square mile, ranks third in population density among Minnesota's 87 counties. The county is an attractive residential area because of the demand for rural homes within commuting distance of the Twin Cities. Between 1940 and 1967, 100,000 rural acres, or more than one-third of Anoka County, were developed for residential, commercial, or industrial purposes (Table 18). By 1990, the Metropolitan Council (1975) estimates that an additional 1,000 square miles of land in the metropolitan area will be influenced by urbanization. Urban population growth in Anoka County from 1940 to 1960 was 612 percent, and the population is expected to increase another 30 percent by 1990 (Minnesota State Planning Agency 1975b). From 1971 to 1975, land values rose 222 percent to an average of \$1,035 per acre (University of Minnesota 1976). Land immediately adjacent to

the management area is even more costly because of its attractiveness for homesites.

Chisago County is primarily an agricultural county. Livestock and dairy production are the principal sources of farm income (Minnesota Department of Agriculture 1975). More than 53 percent of the county is either pasture or cultivated (Table 18); and oats, soybeans, and alfalfa are the major crops.

Chisago County ranks 41st in population among Minnesota's 87 counties. However, the population is expected to increase 37 percent by 1990 as growth in the Twin Cities Metropolitan Area affects Chisago County (Minnesota State Planning Agency 1975b).

Anoka and Chisago counties have a variety of public and private outdoor recreational facilities. Public areas include 2 state parks, 102 miles of trails, 20 state water access sites, and the Chengwatana State Forest (Table 19). Portions of the Rum, St. Croix, and Mississippi rivers are under consideration as State Wild and Scenic Rivers. In addition, the Metropolitan Parks Commission, through the Metropolitan Open Space Act, funds the purchase of parks in Anoka County. The 1980 county park acquisition goal is 7,500 acres with 3,500 acres already purchased. Anoka County will also purchase more than 1,000 acres of country forests.

The demand for facilities and land for outdoor recreation is greater in the 7-county metropolitan area than in any other region of the state (Minnesota DNR, 1974). Although the metropolitan area is well endowed with

Table 18. General land use in Anoka and Chisago counties.

	Anoka		Chisago	
	Acres	Percent	Acres	Percent
Forested	64,440	29.1	73,600	25.7
Cultivated	74,000	33.8	111,880	39.0
Pasture and open	74,200	33.7	70,840	24.7
Marsh	25,280	1.1	7,120	2.5
Water	12,920	.6	13,960	4.9
Residential	35,960	1.6	9,160	3.2

Source: Minnesota State Planning Agency, 1975a.

natural resources having recreational potential, Anoka County has been identified as deficient in recreational space and facilities. As a result, the Minnesota DNR has proposed a cooperative study with the Metropolitan Council to determine recreational needs (Minnesota DNR 1974).

Anoka County Park

Anoka County is developing a new county park adjacent to the management area north of County Road 22. The 350-acre proposed Linwood Lake Park would also adjoin the Island-Martin Lake County Park, creating

a 581-acre park complex. Future facilities for the park will include trails, bog walks, shelter, tables, cabins, and maintenance buildings.

Boot Lake

The Minnesota DNR, Division of Parks and Recreation has proposed the acquisition of a scientific and natural area adjoining the management area and the proposed Linwood Lake Park. The Boot Lake Scientific and Natural Area would encompass Boot Lake and 318 adjoining acres. Development of the area would be confined to access trails; and public use would be restricted to observation, hiking, skiing, and research.

Table 19. Public recreation areas in Anoka and Chisago counties.

Area	Name	Anoka	Chisago
State Park (acres)	St. Croix Wild River		6,000
	Interstate		273
Wildlife Management Area (acres)	Carlos Avery	14,403	7,310
	Bethel	640	
State Forest (acres)	Chengwatana		2,000
Wild and Scenic River ¹	Rum River		
	St. Croix River		
	Mississippi River		
State Water Access Site	Sites	10	10
	Acres	161	113
Other Water Facilities	Boat Accesses	11	15
	Swimming Beaches	8	8
	Marinas		8
	Marina Capacity (boats)		158
Trails (miles)	Snowmobile	34	1
	Hiking	44	6
	Bicycle	5	3
	Multi-use	5	4
Camping Areas	Tent Areas	1	2
	Vehicle Areas	2	6
	Total Sites	257	199
Picnic Areas	Areas	43	17

1. Proposed.

Source: Minnesota Department of Natural Resources 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 Carlos Avery 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.* 196), 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 population. Although seasons are structured to discourage changes in regional hunting pressure, deer hunting pressure on the Carlos Avery WMA has recently increased disproportionately to the state because of the proximity to the Twin Cities.

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 1963 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 wild-

life 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 Carlos Avery WMA will probably experience an increased demand for deer and small game hunting, and other wildlife related recreation that is greater than 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 Carlos Avery 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 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 Carlos Avery 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 Carlos Avery WMA has spectacular fall concentrations of waterfowl, a variety of plant communities and wildlife species, and is easily accessible to a large metropolitan area. Although used extensively for hunting, trapping, and fishing, the area can provide a variety of other unstructured wildlife oriented outdoor recreation. The management area can accommodate many visitor-days during the year that are related to waterfowl viewing, use of the area's interpretative trail for educational purposes, and other compatible activities.

Table 20. Hunter density guidelines proposed by the U.S. Fish and Wildlife Service and 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 Carlos Avery 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 complete and most waterfowl impoundments are constructed, the current management emphasis is on improvement of waterfowl habitat, followed by forest 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, ruffed grouse, and tree squirrels, but the responses of all indigenous wildlife species to forest management are important.

Considerations. The plant communities on the Carlos Avery WMA are dynamic. Through plant succession and the influence 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.

The restoration of grassy areas adjacent to waterfowl impoundments is an important aspect of waterfowl management. To encourage waterfowl nesting, upland areas adjacent to the pools should be cleared of trees and planted with grasses and legumes for nesting cover. Research has revealed the necessity of grassy uplands for ground-nesting waterfowl (Moyle 1964, John and Hunt 1964, Martz 1967, Cooch 1969, Shranck 1972).

Forest management should also be directed at improving habitat for white-tailed deer, upland game bird and other small game. These species benefit from the multiple age class forests established through tree harvests (Erickson *et al.*, 1961, Kohn and Mooty 1971, Waddell 1973, Wetzel *et al.* 1975).

Aspen harvest is beneficial to ruffed grouse and white-tailed deer. Cutting encourages aspen and associated trees and shrubs to resprout. Areas are clearcut to remove the overstory and to establish regenerating aspen suckers at densities of 12,000 to 15,000 stems per acre and reaching a height of 5 feet in the first growing season. With this level of regeneration, these areas should provide optimal ruffed grouse activity centers (Gullion 1976, Gullion and Svoboda 1972). Oak basswood, maple, and birch shoots also regenerate after cutting, improving the habitat for white-tailed deer.

Ruffed grouse are dependent on various age classes and stand densities throughout the year. Aspen should be cut in small blocks or strips located to obtain an interspersed of different overstory size and age classes. Areas adjacent to lowland and upland hardwood sites are cut first to increase forest diversity (Berner and Gysel 1969).

Commercial timber harvest on the Carlos Avery WMA is not presently profitable because of the lack of a nearby market.

The presettlement vegetation on the dry, sandy upland soils of the Carlos Avery vicinity was largely oak savanna (Daubenmaire 1936, Kuchler 1964). Frequent fires were responsible for the widely spaced oaks and ground layer of prairie vegetation that characterized this community. Fires killed above ground parts of oaks and shrubs but stimulated vigorous resprouting. With successive burns, huge underground burl-like root stocks, or grubs, formed and continued to sprout following further fires (Cottam 1949, Curtis 1959). Bur oak was the most prevalent tree, but both black oak and pin oak also produced grubs. Because wildfire has been excluded from Carlos Avery, the oak savanna rapidly succeeded to oak forests, suppressing many savanna species. Curtis (1959) described the oak savanna as the rarest plant community in Wisconsin, and the Minnesota DNR (1975) recognized this plant community as being in need of special consideration.

The oak savanna remaining on the management area is confined to the Sunrise Unit. Portions of the Carlos Avery Unit and Sunrise Unit, now dominated by mature oak forest, could be managed for oak savanna. The productiveness of these communities for white-tailed deer and other game species has been determined (Vogl 1964, 1965, 1967).

Present Programs. Most trees are cut by the management area personnel and by issuing firewood permits to

the public. A bulldozer and work crews equipped with chain saws fell trees. Many downed trees are removed by the public for firewood. Firewood permits are also issued for sites that were not previously cut by the area personnel. In this case, aspen, paper birch, ash, elm, and basswood are selectively cut, leaving oaks to produce a mast crop beneficial to wildlife. Occasionally, volunteer sportsmen organizations also cut trees. After timber harvest, the remaining slash is often burned.

Oak wilt and Dutch elm disease have killed many trees on the management area. These trees are not removed since funds are not available for disease control. To help prevent the spread of Dutch elm disease, diseased elms are not offered as firewood. However, dead white oak can be removed for firewood (French and Stienstra 1975).

Future Programs. To insure a well-balanced distribution of forest age classes and adequate waterfowl nesting cover, timber harvest will be systematic. The total acreage to be cleared around each pool and converted to nesting cover is presented in Table 21. Upland areas not cleared will be managed for white-tailed deer and small game. Trees will be cut as soon as possible with work on the Carlos Avery Unit completed before cutting on the Sunrise Unit begins.

In addition to the forested areas adjacent to waterfowl impoundments, timber harvest is also planned for other portions of the area. The portion of the Carlos Avery Unit south of the game farm, including Pools 14 through 17, will be managed by the area personnel (Figure 9). Work crews with chain saws and a bulldozer will fell trees. Limited firewood permits will be issued for this area. This portion of the management area is a mosaic of small upland islands surrounded by wetland vegetation. Access to upland islands is only possible during dry years even during the winter because the waterlogged soils are insulated from freezing by the snow and dead marsh vegetation. Paper birch, ash, elm, and willow will be removed from the island rims. Aspen will be cut to encourage a variety of overstory age classes on each island or group of islands.

Timber harvest in the Carlos Avery Unit Sanctuary will concentrate on the southern portion of the upland islands (Figure 9). Individuals with firewood permits and the area personnel will remove trees. Most mast producing oaks will not be cut, leaving approximately 20 percent canopy cover on upland islands. The southern portion of all upland islands in the sanctuary will be cut in 10 years. The remainder of the islands will be cut during the following 10 years. Following this second cut, the upland islands will be cut on a 30-year rotation.

Aspen will be planted, on an experimental basis, on some upland islands that are dominated by birch, oak, ash, or elm. Several varieties of aspen are grown at the nursery for use on Carlos Avery.

The extensive oak stands on the Sunrise Unit and the northern portion of the Carlos Avery Unit will be managed by prescribed burning and timber harvest. Small blocks of less than 10 acres will be cut on a rotational basis. Rotation schedules and more specific management proposals for these oak areas have not been determined. Experimentation with prescribed burning and cutting of oaks on the sandy soils of Carlos Avery is necessary to provide more information on the effects of different management activities on these communities.

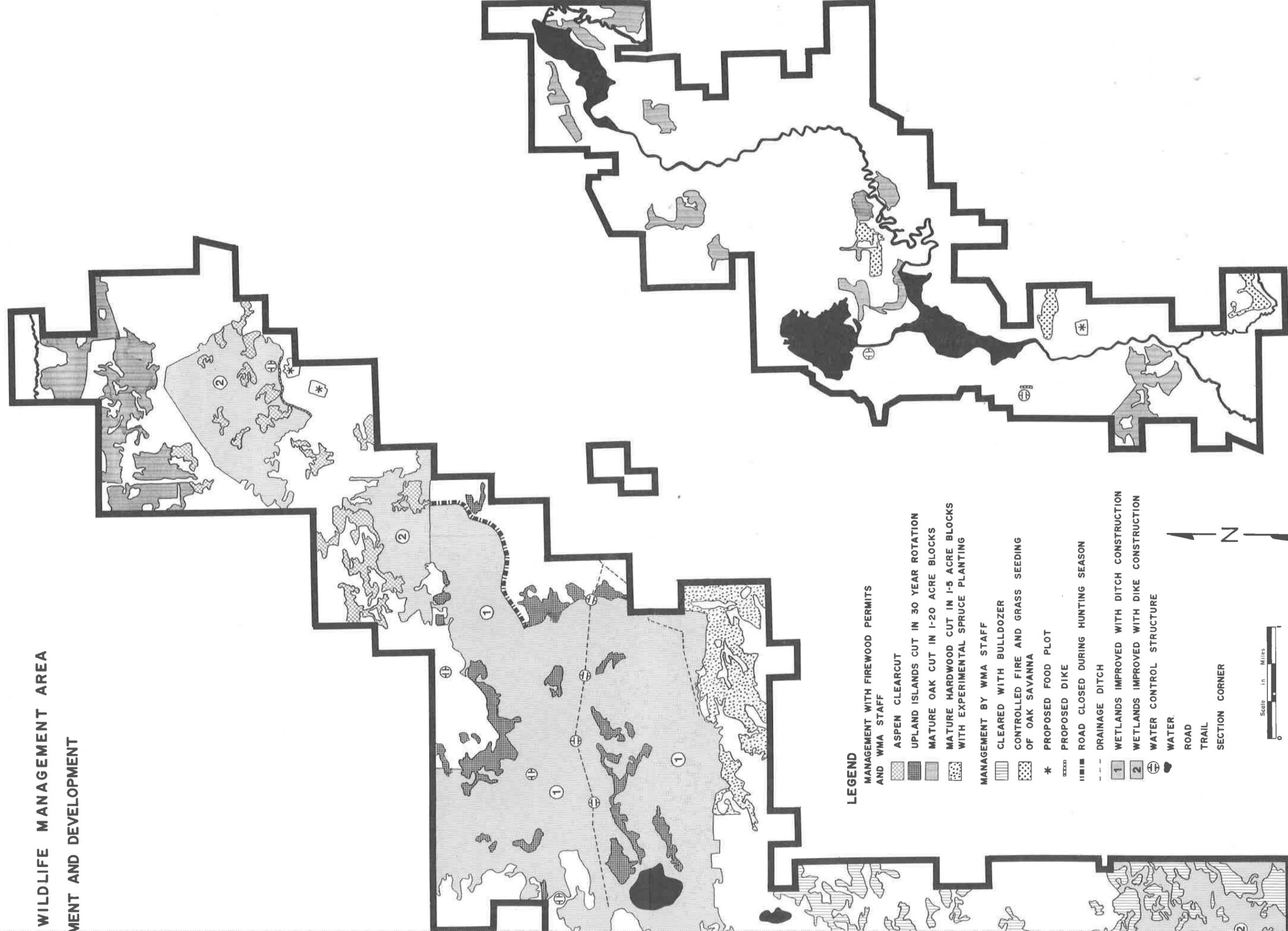
The oak savanna on the Sunrise Unit will be managed to preserve this community. Controlled burning or mowing is planned to prevent encroachment of woody vegetation. An objective of 7 to 10 white or bur oaks per acre will result in maximum mast yield and encourage understory grasses and herbaceous vegetation.

The pine plantation on the management area, planted during the 1930's and 1940's, will be thinned as necessary to promote better growth of the remaining pines. As the trees mature, the plantations will be harvested. No new plantations will be planted since their value to wildlife is low (Rutske 1969). However, spruce planted in stands of hardwoods will be evaluated as winter cover for wildlife. Spruce stocking rates will be less than those in the pine plantations. Areas of mature white pine and bottomland hardwoods on the Carlos Avery Unit will be preserved for nongame wild-

Table 21. Proposed management of the waterfowl impoundments on the Carlos Avery WMA.

Impoundment	Cattail Treatment (acres)	Nesting Cover Establishment (acres)	Wild Rice Seeding (acres)
Pool 1	100	10	0
Pool 2	657	5	8
Pool 3	0	0	95
Pool 4	8	0	30
Pool 5	35	5	5
Pool 6	8	0	0
Pool 8	12	20	30
Pool 9	100	0	0
Pool 10	130	0	90
Pool 11	200	0	0
Pool 13	400	0	0
Pool 15	55	0	0
Pool 16	163	0	5
Pool 22	245	0	0
Total	2,105	40	263

**WILDLIFE MANAGEMENT AREA
MANAGEMENT AND DEVELOPMENT**



LEGEND

- MANAGEMENT WITH FIREWOOD PERMITS AND WMA STAFF
 - ASPEN CLEARCUT
 - UPLAND ISLANDS CUT IN 30 YEAR ROTATION
 - MATURE OAK CUT IN 1-20 ACRE BLOCKS
 - MATURE HARDWOOD CUT IN 1-5 ACRE BLOCKS WITH EXPERIMENTAL SPRUCE PLANTING
- MANAGEMENT BY WMA STAFF
 - CLEARED WITH BULLDOZER
 - CONTROLLED FIRE AND GRASS SEEDING OF OAK SAVANNA
 - * PROPOSED FOOD PLOT
 - PROPOSED DIKE
 - ROAD CLOSED DURING HUNTING SEASON
 - DRAINAGE DITCH
 - WETLANDS IMPROVED WITH DITCH CONSTRUCTION
 - WETLANDS IMPROVED WITH DIKE CONSTRUCTION
 - WATER CONTROL STRUCTURE
 - WATER
 - ROAD
 - TRAIL
 - SECTION CORNER



SUNRISE UNIT

RY UNIT

life, environmental education purposes, and their diverse and unique character.

Implementation of the forest management plan will take 10 years to achieve desired rotation schedules over the entire management area. During this period, approximately 500 acres will be cut per year. After this time, the annual cutting schedule will be adjusted to permit a 30 percent timber harvest on the management every 10 years.

Wetland Management

Objectives. Wetlands will be restored and managed by water level regulation and vegetation manipulation for the benefit of waterfowl, marsh birds, and furbearers and for public hunting. Restoration should create waterfowl breeding sites in marshes lacking open water and increase plant species diversity. 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. Since wetlands on the area are managed to establish conditions similar to prairie type marshes, much of this research is applicable.

The soils of the major impoundments are peat. When flooded, peat may float because of ice action on aquatic vegetation (Linde 1969); this forms mats of floating vegetation unattractive to waterfowl (Ball 1973). The floating mats of cattail and sedge in the impounded marshes reduce open water and food sources for migratory and breeding waterfowl. Control of cattail through mowing may be most effective in late June or early July when total nonstructural carbohydrate reserves in the plant are lowest (Linde *et al.* 1976). Water level manipulation is also used to control floating cattail (Linde 1969).

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 to reducing floating mats of cattail.

The water level manipulation capabilities on the area are inadequate. Except for Pool 9, none of the Carlos Avery Unit sanctuary impoundments can be drained. The control structure on Pool 9 is insufficient to handle spring runoff, and adjacent nesting cover and nest sites in nearby pools are flooded. In addition, water level changes in the South Pool presently affect the water levels of Mud Lake. Both radial gates on the North and South pools are poorly designed, making water control difficult when water levels are high.

Water sources for the impoundments are also inadequate. The pools on the south end of the Carlos Avery Unit are located at the head of the Rice Creek Watershed. Flexible water level manipulation is not possible since sufficient water is not always available to reflood these southern pools. The water source for the remaining impoundments on the Carlos Avery Unit is more reliable but influenced by seasonal precipitation. Major early summer drawdowns are not used on the Carlos Avery Unit to promote the growth of smartweeds,

millet, rice cutgrass, dock, and pigweeds because the water source is not dependable or of sufficient magnitude to allow reflooding in the fall. The North and South pools have a more reliable water source except during extended drought.

The greater sandhill crane is not abundant on the management area but may occasionally nest in the impounded marshes. Although this species was an abundant resident and migrant in Minnesota wetlands (Roberts 1932), a drastic decline in numbers occurred in the late 1800's. A gradual recovery has occurred in Wisconsin (Hunt *et al.* 1976) and Minnesota (Johnson 1976) in recent years. The bird 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 by the Minnesota DNR (1975) because of its limited range in the state. If the sandhill crane expands its range in Minnesota as in Wisconsin (Gluesing 1974), this bird will 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 Carlos Avery WMA should benefit from the wetland management proposals. Four important factors necessary to sustain nesting sandhill cranes (Hunt *et al.* 1976) are present at the Carlos Avery 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 furnish breeding habitat since these birds will select nest sites in vegetation growing on peat soils (Gluesing 1974). However, periodic burning to prevent the encroachment of woody vegetation is necessary. Prescribed burning of wetlands, coupled with Minnesota's protection of the greater sandhill crane, should encourage greater abundance of cranes on the management area.

A resident Canada goose flock was established on the Carlos Avery Unit from flightless birds held at the game farm. Since 1973, juvenile birds produced by captive adults in the game farm goose pen have been marked with neckbands and released. Little is known about survival rates, nesting success, or resident flock size. Most geese nest in the vicinity of Pools 13, 14, 15, and 16.

Present Programs. Wetland management is influenced by weather trends. Taking advantage of the 1976 drought, 2 new impoundments, Pools 17 and 22, were constructed using heavy equipment that cannot ordinarily operate on waterlogged soils. Dikes built by the old Crex Carpet Company were repaired and control structures replaced. During dry years, a bulldozer and dragline are often used to remove cattails and sedges from the Carlos Avery Unit impoundments. This practice promotes the growth of more desirable aquatic vegetation.

Monitoring and manipulating water levels during the spring and winter are major activities. Each impoundment has a water level gauge, and water levels are recorded daily during the spring. In the fall, after ice has formed, water is released; this forms an air pocket between the ice and water surface which reduces winter loss

of muskrats. Muskrats are important as a furbearer and in controlling bullrush and cattail, as well as providing nest sites and loafing areas for geese and ducks. In the spring, water is released from the pools to prevent ice from uprooting aquatic vegetation. Following the spring runoff, water levels are adjusted to promote wild rice growth in several of the impoundments, including the North and South pools.

Prescribed burning is also used to manage wetlands. Fire is effective in deterring the encroachment of woody vegetation in semi-dry wetlands (Linde 1969). Encroachment of lowland brush is most serious in the extensive Type II wetlands. Late summer or early fall burns in dry years create a pothole effect by burning out solid vegetation and underlying peat. The following spring, these potholes will contain open water.

Level ditching is a management technique employed on the Carlos Avery WMA. Ditches are dredged with a dragline and are often located to serve as firebreaks. Muskrats make extensive use of ditches (Mathiak 1953). Breeding waterfowl use ditches as territorial and loafing sites. During drought years, ditches are important for wintering muskrats when most impoundments are dry.

Future Programs. Two pools will be restored on the Carlos Avery Unit by renovating dikes constructed by the Crex Carpet Company (Figure 8). Trees and brush will be removed from these old dikes and repairs will be made. Old structures will be replaced with drop inlet type water control structures to permit water level manipulation. Without adequate water control, these pools will rapidly become filled with cattail, eliminating more desirable aquatic plants.

Water control structures will be replaced or added to existing impoundments (Figure 9). An additional control structure will be placed on Pool 9 to accommodate the large volume of spring runoff and prevent flooding of adjacent upland nesting cover and nearby nest sites. A water control structure will be installed on Mud Lake to permit independent water level regulation between the South Pool and Mud Lake. The radial gate spillways on the North and South pool dams will be redesigned



Marshes like this provide excellent habitat for waterfowl, non-game birds, and aquatic furbearers.

to permit greater water level control and security against vandalism.

To permit water level control in the sanctuary pools, a drainage ditch from Little Coon Lake and crossing through the management area is proposed (Figure 9). The ditch will be constructed with a dragline and will cross Pools 1, 3, 4, and 9 to an existing ditch on the east boundary of the management area. The ditch will be 5 feet deep and 16 feet wide. Total length is 2.7 miles. Control structures will be necessary where the ditch crosses the dikes for Pools 1, 3, and 4.

A similar project is planned to widen and deepen an existing ditch in Pool 10 (Figure 9). This ditch will also connect to the existing drainage system on the east boundary of the management area. With construction of these 2 ditches within the Carlos Avery Unit sanctuary, water levels in each pool could then be regulated independently of other pools. Water could be stored on the management area to reflood dry impoundments. With flexible water level control, marshes now dominated by floating and nonfloating cattail may become more productive for waterfowl. In addition, the extensive sedge and grass meadows east of Little Coon Lake can then be drained. Controlled burning, coupled with pothole construction, could then turn this 2 square mile area into productive waterfowl nesting habitat.

Expansion of Carlos Avery is proposed with the acquisition of an 80-acre tract located in Section 5, 6, 32N, R. 22W (Figure 10). The acquisition of this tract is necessary to permit completion of the proposed level ditch through the sanctuary pools. An existing ditch on this private land would be deepened to allow drainage from the management area to the Sunrise River. This tract is dominated by marsh vegetation, making excellent wildlife habitat, and has little potential for commercial or residential development.

Water level manipulation, in conjunction with mowing, will be used to control cattail in the various impoundments. By regulating water levels and cutting cattail in early summer, the acreage of rooted cattail may be reduced. Floating cattail may also be killed with the Hockney Weed Mower in conjunction with water level manipulation. More than 2,000 acres of cattail will be removed from the impoundments on the Carlos Avery Unit (Table 21.)

Prescribed burning will continue to be an important management tool. The Carlos Avery Unit sanctuary is scheduled to be completely burned in 1977 or 1978. Following tree removal, wetland vegetation in each pool will be burned every 2 years using dikes as firebreaks. The area south of Pool 16 will also be burned using the proposed dike as a firebreak. This area is dominated by expansive cattail and sedges with little open water. Controlled burns will create pockets of open water attractive to resident and migratory waterfowl.

In dry years when water levels in the marshes are low, and when funds are available, heavy equipment will be used to manage habitat for waterfowl and furbearers. A yearly objective of 25 surface acres of water created by level ditching is proposed. In addition, when water levels and soil moisture conditions permit, potholes will be created in the cattail marshes and Type II wetlands. This procedure is expensive, ranging from \$600 to \$800 per acre-foot of water produced. Emphasis

will be on the area south of Pool 16 where open water for breeding and migratory waterfowl is deficient. Pot-holes will be constructed according to recommended guidelines (Linde 1969, Atlantic Waterfowl Council 1972, Bergquist 1973).

A survey and evaluation of goose nesting habitat on the Carlos Avery WMA will be completed. With this information, a decision can be made on the feasibility of providing nest structures, and recommendations for goose management can be formulated.

Non-forested Upland Management

Objectives. Non-forested uplands are old fields, cropland, forest openings, and areas managed as upland nesting cover for waterfowl. Cropland will be managed

as food plots. Old fields and upland nesting cover will be maintained to provide habitat essential to a variety of wildlife.

Considerations. With natural plant succession, woody vegetation will encroach and eventually dominate non-forested uplands on the Carlos Avery WMA. The result is loss of these habitats and a corresponding decrease in wildlife diversity. The importance of forest openings for deer (McCaffery and Creed 1969) as well as woodcock (Hale and Greg 1976) and ruffed grouse (Berner and Gysel 1969) was determined.

Present Programs. Old fields and upland nesting areas are managed through prescribed burning and mowing to prevent the encroachment of woody vegetation. Treatment type and frequency depend on the character-

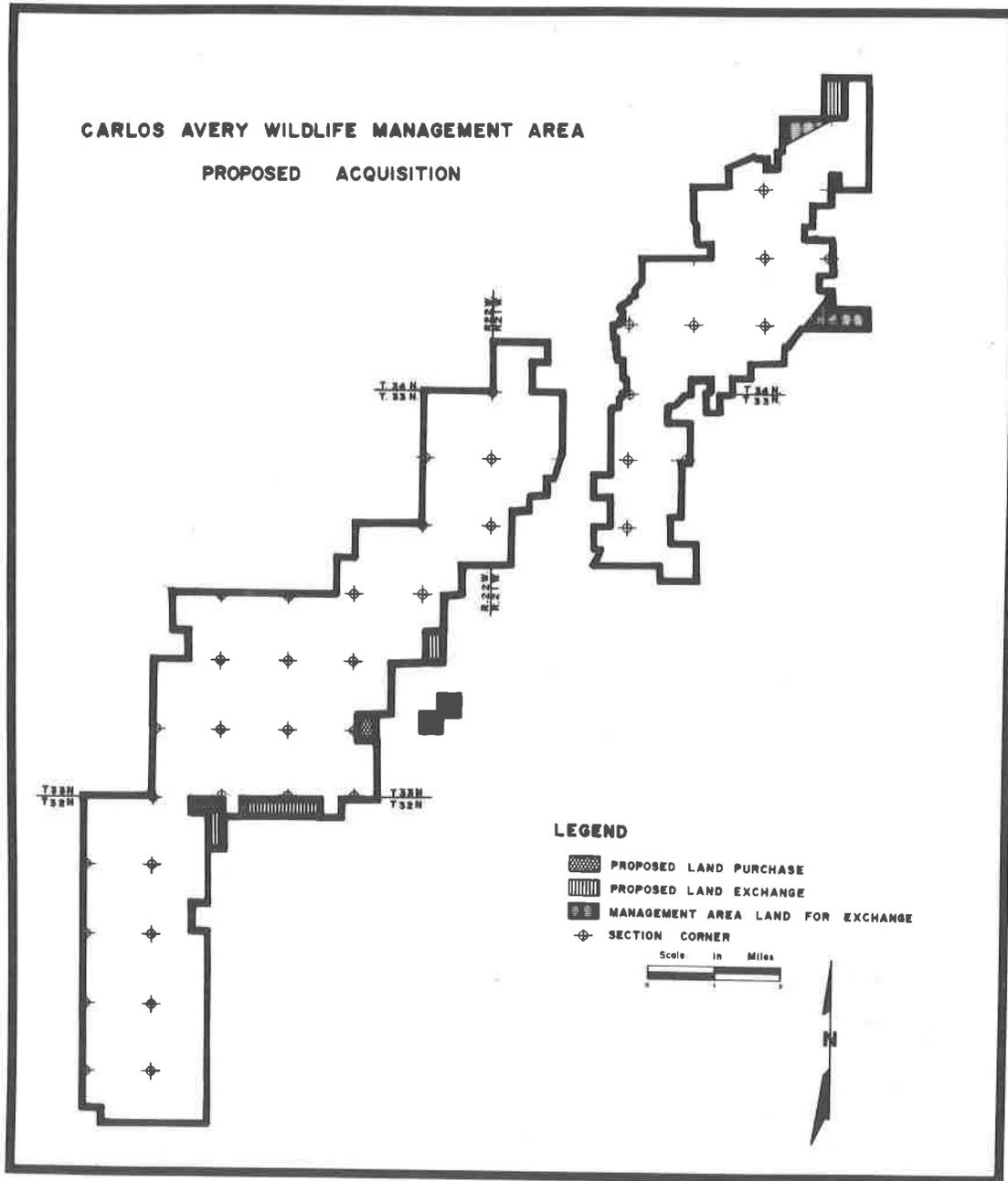


Figure 10

istics of each site as well as seasonal weather conditions suitable for controlled burning.

Grassy nesting areas are being established adjacent to the pools on the Carlos Avery Unit. Once cleared, prescribed burning is used to prepare the land for planting with a combination of sweetclover, red clover, winter rye, brome grass, and Sudan grass. Timothy is substituted for Sudan grass on low-lying areas. Periodic mowing is used to prevent encroachment of woody vegetation. When the brome grass is well established, usually 2 or 3 years following planting, these areas are maintained with prescribed burning. Since 1971, an intensified effort has been directed at establishing cover around all pools.

Management area personnel and cooperating farmers plant food plots that serve as winter food sources for white-tailed deer and other wildlife. Food plots are located to keep wintering deer away from county roads, thus minimizing accidents with motor vehicles. Winter carrying capacity for white-tailed deer is increased by providing these food sources. In addition, food plots are beneficial to pheasants.

Future Programs. The present management of non-forested uplands will continue. Prescribed burning and mowing will be used to maintain and improve some existing old fields. A minimum of 150 acres of winter food plots will be planted per year. New food plots to be established in old fields or following timber harvest of upland forest sites are indicated in Figure 9. A wintering deer population level of 750 animals is proposed for Carlos Avery. Food plot acreage will be reduced should 750 deer be more than the habitat can support without over-browsing or depredation on private land.

Priority will be given to the restoration of nesting habitat adjacent to the pools (Table 20). Approximately 40 acres remain to be converted to nesting cover on the Carlos Avery Unit. The Sunrise Unit will receive a similar effort when the Carlos Avery Unit is complete.

Native and exotic grass seed adapted to local soils and conditions will be raised on the Carlos Avery WMA, harvested, and planted as upland nesting cover and for old field maintenance. The seed varieties and mixtures appropriate for the existing soil and moisture conditions will be determined by experimentation.

Nongame Management

Objectives. An objective of wildlife management on the Carlos Avery 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 species will not be neglected.

Considerations. The Minnesota DNR has statutory responsibility for 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. Recently, 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 pro-

vide 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 on 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 can be achieved when the horizontal and vertical diversity of the vegetation are maximum. Second, 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 plan will be to promote seral plant communities and establish nesting sites adjacent to impoundments. Cutting has the effect of producing an ecotone, or edge, between 2 contrasting vegetation types (Resler 1972). The avian diversity and density increase in response to this edge, or horizontal diversity (Curtis and Ripley 1975). The flicker, rufous-sided towhee, and several species of sparrows use cuts (Conner *et al.* 1975). The catbird, common yellowthroat, and yellow warbler benefit from forest edge and brush areas along the perimeter of cuts. Downy and hairy woodpeckers use cutover areas 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). Forest openings also provide greater vegetative heterogeneity for birds.

Species attracted to cuts and edges usually have broad ranges of tolerance, high reproductive rates, and



The great blue heron is commonly seen in the shallow marshes of the Carlos Avery WMA.

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). The goshawk, ovenbird, barred owl, pileated woodpecker, red-headed woodpecker, and wood thrush are examples of species that require mature forests. The mature bottomland hardwood and white pine stands that will not be cut should be beneficial to these species.

Both plant species diversity and the relationship of aquatic vegetation to open water and shoreline are important to the abundance and composition of avian wildlife (Weller and Spatcher 1965). Pied-billed grebes and least bitterns nest in aquatic vegetation of medium density over open water. The Forster's tern and black tern nest in sparse vegetation, often on muskrat houses. Shoreward vegetation provides nest sites for American bitterns and redwing blackbirds. The Carlos Avery marshes are used by a variety of migrating shorebirds during the spring and fall. Management of the impoundments to simulate natural, short-term water level fluctuations common to marshes in Minnesota will maintain vertical and horizontal diversity important to nongame birds associated with marshes.

Other management aspects on the area can influence nongame wildlife. Establishment of upland nesting cover areas for waterfowl will provide breeding habitat for such songbirds as the dickcissel, bobolink, eastern meadowlark, vesper sparrow, and field sparrow. Although breeding songbirds and small mammals may not be affected by food plots, wintering songbirds may benefit from this food source (Burt 1976). Density and diversity of breeding songbirds and small mammals are influenced more by successional stages of habitat than availability of food plots.

Both the U.S. Fish and Wildlife Service (U.S. Department of the Interior 1974) and the Minnesota DNR (1975) list the peregrine falcon as endangered. The American peregrine falcon is a rare migrant on the management area and is rare throughout Minnesota. This bird is a cliff nesting species (Hickey and Anderson 1969, Berger and Mueller 1969), and the management area does not provide favorable nesting habitat.

The northern bald eagle and osprey are considered as "uncertain status" by the U.S. Fish and Wildlife Service (U.S. Department of the Interior 1974) and the Minnesota DNR (1975). Both species occur as migrants on the management area but do not nest. The bald eagle is also an occasional winter visitor. Habitat for breeding pairs of eagles and osprey is marginal. Open water supporting sizable fish populations is available only in the North and South pools.

No mammal species likely to occur on the area is considered endangered (U.S. Department of the Interior 1974, Minnesota DNR 1975). Both the river otter and beaver are of special interest because of their limited numbers on the management area. To preserve the beaver and river otter, trapping of these species is not permitted on the area.

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 nongame

wildlife to accurately assess the effect of game management on these populations. Specific proposals for nongame management cannot be presented.

Beginning in 1977, the Section of Wildlife initiated a nongame program. A nongame wildlife specialist was hired to evaluate current knowledge and propose research programs. The purpose of these research projects is to learn more about nongame wildlife, especially the responses of these species to specific management techniques. Knowledge gained from this research may be applicable to the Carlos Avery 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 Carlos Avery WMA is located 31 miles from a major metropolitan center of more than 2 million people. Anoka and portions of Chisago County are rapidly being developed for residential and commercial purposes. Considering projected increases for hunting, fishing, and other compatible outdoor recreation, the following use related problems are expected to continue or intensify unless the changes in management are made.

The temporal distribution of hunters is a traditional problem in wildlife management. Opening day and opening weekend hunting pressure is greatest not only on the Carlos Avery WMA but also on most wildlife management areas and other public lands. This statewide problem is considered when hunting regulations are established. However, regulations can only be partially successful in decreasing opening day and weekend hunting pressure.

Unequal hunter distribution on Carlos Avery is partially the result of both disparate hunting opportunities in the different compartments and hunter preference. Migratory waterfowl habitat has not been developed in Compartment 1, south of Pool 16, and in Compartment 3, north of County Road 22 (Figure 6). These areas are dominated by Type II, Type III, and Type VI marshes with little open water to attract hunters or waterfowl. Similarly, hunting opportunities for pheasants are found primarily in Compartments 1 and 2 where food and upland nesting cover exist. Management for deer and ruffed grouse has been concentrated on the Carlos Avery Unit, and, as a result, hunting pressure for these game species occurs primarily in Compartments 1, 2, and 3.

Carlos Avery receives heavy waterfowl hunting pressure, especially on opening day and on the first weekend. This hunting pressure may result in conflict between hunters. Concentrated waterfowl hunting occurs on the dike roads forming the east boundary of the Carlos Avery Unit sanctuary. Pass-shooting from the dike appeals to novice and young hunters who have not invested in decoys and other equipment. Persons with a stronger commitment to waterfowl hunting prefer to hunt with decoys (Smith and Roberts 1976) while concealed in marsh vegetation. Although more hunters may be accommodated by pass-shooting from dike roads, the potential for interference between hunters is greater in this situation.

The intensity and distribution of hunting use can be influenced by the location of access roads and parking areas. Sanctuary boundaries have also been adjusted in the past to affect hunter distribution. Opening day and first weekend waterfowl hunting pressure will continue to cause crowding problems. This situation could intensify should travel costs and energy constraints for sportsmen continue to escalate.

The capacity of the Carlos Avery WMA to accommodate waterfowl hunting may be exceeded during peak use periods on some portions of the management area. This may be true for Compartments 2 and 4 on opening day. Similarly, the number of weekend firearm deer hunters may also approach the capacity of the management area. The capacity of the area for deer hunting and permit trapping may be increased with improved temporal and spatial distribution of sportsmen. However, the total capacity for waterfowl hunting is restricted by the available waterfowl habitat. Marsh area may be increased with future management programs.

Other wildlife related outdoor activities, including cross-country skiing, environmental education, and sight-seeing, are minor uses compared to hunting, fishing, and trapping, and at their present levels, do not exceed the capacity of the area. These activities also occur almost exclusively on weekends.

Horseback riding occurs illegally on the management area. This activity is prohibited because of damage to dike roads. Snowmobiles, 4-wheel drive vehicles, and motorbikes are also prohibited because of damage to 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 managers have primary responsibility for enforcing the restriction on snowmobiles as well as restrictions on other motor vehicles. As a result of intensive enforcement, these illegal activities are minor uses.

Enforcement of game and fish laws on the Carlos Avery WMA is a major activity of the resident managers despite help from 2 local conservation officers. In addition to the game and fish laws, the commissioner's orders concerning public use on wildlife management areas (Appendix E) must be enforced. Snowmobiling, horseback riding, and after hours use are the most serious enforcement problems. Littering and dumping associated with after hours activities are so serious that sufficient funds are not available to remove trash. Portions of the Sunrise Unit are appreciably littered. Careless use of fire also occurs after the official 10:00 p.m. closing time. Because the managers reside on the area, enforcement has become a 24-hour responsibility in addition to regular wildlife management duties. Time and effort expended on enforcement by the resident managers could be utilized on wildlife management programs. Anoka and Chisago counties will continue to become more populated and urbanized, intensifying enforcement problems.

Vandalism is a major problem on the Carlos Avery WMA. Both the North and South pools were drained by vandals during late summer of 1976 impairing hunting opportunities on these pools. Water control structures are periodically opened by vandals, releasing water from the Carlos Avery Unit pools. Such indiscriminate actions

are detrimental to wildlife and aquatic vegetation. The resident managers must patrol the dikes in an attempt to prevent vandalism, and time spent in this manner detracts from other management activities.

Present Programs. User oriented projects are primarily directed at the hunter and trapper. Development has concentrated on the construction of parking areas. Roads have also been widened to permit parking and to disperse sportsmen.

The environmental education area is another user oriented project. This area is maintained by the game farm staff even though the trail and demonstration site are located outside the game farm.

To facilitate enforcement of commissioner's orders and game and fish laws, the management area boundary is being cleared of trees and shrubs. In 1976, work began on a 32-foot wide boundary line that is cleared of woody vegetation. Boundary signs are posted and maintained for the management area and both sanctuaries.

Future Programs Hunter distribution on the management area will be improved to help accommodate future hunting demand. The proposed waterfowl management projects south of Pool 16 and north of County Road 22 will provide additional waterfowl habitat and may help to relieve hunting pressure elsewhere on the management area. Motor vehicle access to these areas will be restricted. To further redistribute hunters, 1 dike road on the Carlos Avery Unit is scheduled to be closed to motor vehicles (Figure 9). The wetland management plan will be directed at improving the extensive Type II, Type III, and Type VI wetlands that are completely filled with cattail. As available habitat for migratory waterfowl increases through management, hunting pressure should become more uniform over the management area, but total pressure may also increase.

To encourage better hunter distribution and familiarize others with the area, a detailed map showing trails, firebreaks, roads, dikes, and access points will be provided at the headquarters. Major vegetation types will also be indicated on the map, making public use opportunities more apparent. An informational sign will be constructed at the headquarters to display maps, commissioner's orders governing visitor use (Appendix E), and other information concerning the management area. An informational brochure explaining the purpose, history, and recreational opportunities on the management area will be prepared for the benefit of hunting and non-hunting visitors.

These proposed management projects may not be successful in alleviating waterfowl hunter congestion should demand for hunting on the Carlos Avery WMA increase significantly by 1987. Steps taken to regulate waterfowl hunting pressure on Carlos Avery will depend on the level of future hunting demand. If needed, motor vehicles would first be prohibited on many of the trails and dike roads on the Carlos Avery Unit. Also, waterfowl hunting from dikes and management area roads could be prohibited and the sanctuary boundaries adjusted to affect hunter distribution. More stringent control measures to accommodate further increases in demand would include the establishment of waterfowl hunter quotas for each use compartment. Access could be controlled on a permit basis. The number of hunters allowed into each compartment would depend on the total acreage of marsh or other suitable land for hunting.

As a last resort in controlling waterfowl hunters throughout a compartment, hunters could be assigned specific sites within each compartment. This system is the least desirable because personal selection would be eliminated, and the regimentation of hunters decreases hunting quality. Regardless of which level hunter access control in Carlos Avery may take, additional funding and staff would be required.

In addition, it may be necessary to limit other compatible outdoor activities during the hunting and trapping seasons to minimize conflicts with sportsmen.

Efforts to clear a 32-foot wide boundary around the entire management area will continue. The sanctuary boundary on the Carlos Avery Unit will also be cleared. Work is accomplished primarily during the winter when access with heavy equipment is possible. Approximately 5 more years will be required to finish this project, depending on seasonal weather trends.

The acquisition of an 80-acre tract outside the management area boundaries in Sections 26 and 35, T. 33N, R. 22W would provide a buffer between the Carlos Avery Unit sanctuary and private land (Figure 9) and would reduce trespass and enforcement problems in the sanctuary.

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 used on Carlos Avery were developed through research in Minnesota and elsewhere in the Lake States Region. Generally, research is too expensive and time consuming to be a responsibility of the present staff and must be conducted in other ways.

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

Present Programs. Several research projects have been conducted by personnel from the University of Minnesota on the Carlos Avery WMA. From 1964 to 1966, 2 studies were conducted on the spatial distribution, food habits, and habitat selection of pocket gophers. From 1972 to 1976, a study on the dispersal rates of meadow mice was conducted on the management area. Plant succession on sites where overstory trees were killed by oak wilt was investigated on the Sunrise Unit from 1970 to 1975. In the spring of 1976, the Wood Products Laboratory at the University of Minnesota initiated a study on the strength, grade, and marketability of elm trees killed by Dutch elm disease. Since 1974, the Section of Wildlife and University of Minnesota have cooperated in banding Canada geese on Carlos Avery. A timber wolf behavior project at the game farm was initiated in 1976.

Future Programs. A survey will be developed to examine the level of public use on the area. All compatible outdoor recreation will be considered. Data are needed on number of users, temporal and spatial distribution of use, user behavior, and other statistics on management area visitors. In conjunction with this

survey, bag check surveys will be made to estimate game harvest. These surveys cannot be initiated without additional staff and funding.

Research projects in cooperation with the University of Minnesota will be encouraged. Research on the effects of water level manipulation on aquatic vegetation is needed. This study could be conducted with a modest investment of money and personnel. Techniques developed for controlling cattail and promoting desirable waterfowl foods would be applicable on other wildlife management areas in central Minnesota. This project should begin before completion of the 2 proposed impoundments to provide background information.

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

Local Development

Objectives. The preparation of a land-use plan by local governments in cooperation with the Minnesota DNR will direct and guide future private land development adjacent to the Carlos Avery WMA. The purpose of land-use planning is to protect the management area resources and to ensure quality recreational experiences.

Considerations. The private land immediately adjacent to the Carlos Avery WMA is being developed for residential purposes. Many homes and lots currently border the management area. The potential for conflict between private homeowners and hunters plus management area development and operations will increase with future residential development. Such management activities as prescribed burning may be curtailed as population density and homes increase. Hunting may also be restricted with future development. The primary goals of wildlife production and public hunting, trapping, and fishing may be jeopardized by unplanned residential growth adjacent to the management area.

Three land-use planning alternatives are available. The Mandatory Planning Act and Critical Areas Act both provide statutory requirements and procedures for land-use planning. The Critical Areas Act would be the most involved and time consuming process but would probably yield the most comprehensive plan for the specific needs of the management area. Planning required by the Mandatory Planning Act was initiated in 1976, and may provide adequate direction and control of adjacent development. The third alternative would be a special land-use plan to consider specifically the Carlos Avery WMA developed jointly by local governments and the Minnesota DNR. In this case, the final plan would be designed to accomplish the land-use planning objectives without formal involvement by other state agencies or lengthy preparation and review periods that are necessary for critical area designation and the Mandatory Planning Act.

The Mandatory Planning Act (Minnesota Statutes, Section 473.851, 1976) requires county and township governments within the Metropolitan Area to develop

comprehensive land-use plans. The plans must direct special consideration to residential and commercial development adjacent to any component of the Metropolitan Open Space System. Since the Carlos Avery WMA is part of this system, Anoka County and Linwood and Columbus townships must prepare plans to guide development next to the management area. The plans must be completed by 1979 and the Metropolitan Council will review and approve these plans. The plans must be consistent with the council's policies for protecting open space in the Metropolitan Area. However, the council, through the plans, only has limited authority to regulate development adjacent to the management area.

The designation of the Carlos Avery WMA as a critical area under the Critical Areas Act of 1973 (Minnesota Statutes, Section 116G.01, 1976) would result in planned and controlled adjacent residential development. This act provides state assistance to local units of government for the preparation of plans and regulations for the wise use of areas with historic, cultural, and natural values. The management area meets the criteria for critical area designation established by the Act and by the Minnesota Environmental Quality Board. In addition, development of model zoning ordinances and subdivision controls for land adjacent to the area would fulfill open space recommendations proposed by

the Metropolitan Council (1970).

Responsibility for the critical area designation initially resides with the Minnesota DNR (Minn. Reg. MEQC 51). Minnesota DNR recommendations would then be submitted to the Environmental Quality Board and the Metropolitan Council. These 2 groups would hold public hearings concerning the proposed designation and receive recommendations for a land-use plan to affect adjacent development. After the hearing process, the Governor may designate the Carlos Avery WMA as a critical area, acting on Environmental Quality Board and Metropolitan Council recommendations as well as public testimony. Following the Governor's action, the Environmental Quality Board would provide funds and assistance to local governments for the development of a land-use plan.

Future Programs. The Minnesota DNR will cooperate with local governments, the Metropolitan Council, and the Minnesota Environmental Quality Board to determine means of planning and controlling residential and commercial growth adjacent to the management area. The alternatives to be examined will include critical area designation, the development of satisfactory comprehensive plans under the Mandatory Planning Act, and the formulation of a special land development plan for private property next to the management area.

IMPLEMENTATION AND COST ESTIMATES

Specific programs to manage fish and wildlife and to 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

Land acquisition in the approved project boundaries is complete. Two 80-acre tracts outside the project boundaries are proposed for acquisition through purchase of land exchange, and 3 additional tracts are designated for acquisition through land exchange only (Figure 9). Four state-owned tracts within the project boundaries are available for land exchange. Acquisition of the two 80-acre tracts would permit the completion of the level ditch through the sanctuary pools and provide a buffer of state-owned land between private land and the sanctuary boundary on the Carlos Avery Unit. Acquisition of the 3 smaller tracts will allow improved management of existing state land by preventing such management activities as water level ma-

nipulation and prescribed burning from affecting private land.

Land will be acquired only when an owner agrees voluntarily to a land exchange or purchase. For this reason, a firm acquisition schedule is not presented for those tracts to be traded or purchased. If not acquired through land exchange, estimated acquisition cost of the proposed two 80-acre tracts is \$90,000. This price is expected to increase approximately 10 percent a year (University of Minnesota 1976).

Acquisition and land trades will be the responsibility of the resident manager in cooperation with the Minnesota DNR Bureau of Lands located in St. Paul. Funds for land exchanges or purchases are not considered part of the management area operating budget. Land acquisition funds will come from hunting and trapping license surcharge monies and the "Resource 2000" program. Appropriations from revenue generated by a tax on cigarettes is also a potential funding source.

Management Programs

The Section of Wildlife, through the Region VI office, will be responsible for implementing the proposals in this plan. The Division of Forestry, through the Carlos Avery District Office, will be involved in forest management, sale of firewood permits, and prescribed burning. However, additional funding or staff for the district forestry office will not be required for implementation of the forest management proposals.

Allocating funds for specific wildlife habitat projects on a management area is difficult, and the resident manager must have flexibility in deciding how wildlife funds will be spent. Many activities are dependent to a large degree on weather. Prescribed burning is most effective under precise conditions. The construction of dikes and potholes is also dependent on seasonal weather trends. Timber removal is related to the demand for firewood. For these reasons, 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 with those programs having the highest priority listed first (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. The present expenditures on Carlos Avery are about \$102,000 per year and represent present costs for facility maintenance and operation plus expenses for the 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 and support, including supplies, maintenance, and minor equipment, are listed.

To implement the management programs at each level, major equipment and capital improvements will be

necessary. Although spending levels are presented on an annual basis, costs for equipment and 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 and priorities within the region. 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 wildlife management is related to hunting and trapping license sales which, in turn, determines 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. Similarly, should license sales decline, revenue would also decline.

A \$3.00 Minnesota 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 \$400,000 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 waterfowl stamp and possible future general fund appropriations, management funds are not expected to significantly increase by 1987. Accordingly, most proposals are planned within the present budgetary constraints. Wildlife management finances in Region VI 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 management programs throughout the region and to implement all of the planned management on the Carlos Avery WMA, increased funding in Region VI will be needed.

Table 22. Annual spending alternatives for the Carlos Avery WMA.

Level I. Management at current spending level.

Forest management

1. Cut trees on sanctuary islands
2. Plant aspen on upland islands
3. Boundary clearing
4. Firewood permit arrangements

Wetland management

1. Dike and water control structure maintenance
2. Water control structure replacement
3. Water level management
4. Aquatic vegetation control
5. Wetland restoration

Non-forested upland management

1. Herbaceous seeding
2. Agricultural lease arrangements
3. Old field and nesting cover maintenance
4. Food plot planting

Public use management

1. Road and trail maintenance
2. Boundary posting
3. Parking area maintenance
4. Management of public hunts

Research and surveys

1. Cooperation with research
2. Wildlife census

<u>Annual spending</u>		<u>Immediate capital needs for implementation</u>	
1976 Baseline	\$102,000	Power seed drill	\$7,000
Added labor and support	- 0 -	Total	\$7,000
Annual total	\$102,000		

Level II. Additional management with increased spending

Forest management

1. Cut trees on upland islands south of Pool 16
2. Plant spruce for winter cover
3. Manage oak forests on Sunrise Unit

Wetland management

1. Wetland restoration on Sunrise Unit
2. Restore 2 impoundments on Carlos Avery Unit
3. Wetland restoration south of Pool 16
4. Water control structure replacement
5. Redesign concrete dams

Public use management

1. Informational brochure and maps
2. Headquarters sign

Table 22. (continued)

Annual spending		Immediate capital needs for implementation	
Research and surveys			
<ol style="list-style-type: none"> 1. Initiate user and wildlife harvest surveys 2. Goose nest habitat survey 			
Level I annual total	\$102,000	Level I total	\$ 7,000
Added labor and support	24,000	Crawler tractor	40,000
(2 full-time laborers)		Modification of dams	55,000
(support expenses)		Total	\$102,000
Annual total	\$126,000		
Level III Additional management with increased spending			
Forest management			
<ol style="list-style-type: none"> 1. Savanna management 2. Implement entire timber management plan 			
Wetland management			
<ol style="list-style-type: none"> 1. Level ditch on Carlos Avery Unit 2. Improved aquatic vegetation control 3. Pothole construction 			
Non-forested upland management			
<ol style="list-style-type: none"> 1. New food plots on Sunrise Unit 			
Public use management			
<ol style="list-style-type: none"> 1. Improve environmental education program 			
Annual spending		Immediate capital needs for implementation	
Level II annual total	\$126,000	Level II total	\$102,000
Added labor and support	34,000	Farm Tractor	22,500
(2 full-time laborers)		2 Butler storage sheds	10,000
(1 3-month laborer)		4 Control structures for	
(support expenses)		level ditch	10,000
Annual total	\$160,000	Total	\$144,500

Table 23. Equipment replacement schedule for the Carlos Avery WMA.

Period	Item/Model	Cost
1977-1981	Crawler tractor/Caterpillar	\$50,000
	Wheel tractor/Ford	10,000
	Dump truck/International	9,000
	Dump truck/Dodge	9,000
	Pickup/Dodge	5,000
	Pickup/Ford	5,000
	Pickup/Dodge	5,000
	Pickup/International	5,000
	Sedan/AMC	4,000
	8-foot grain drill	2,500
Brush mower	800	
1982-1986	Loader/Allis Chalmers	\$38,000
	Wheel tractor/John Deere	10,000
	Wheel tractor/Farm-all	8,000
	Road grader/Galion	27,000

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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 Areas	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 Forest 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 these 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 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 Carlos Avery WMA soils.

Number	Series	Type
8	Sartell	fine sand
53	Marsh	unclassified
132	Hayden	sandy loam
158	Zimmerman	loamy fine sand
161	Isanti	fine sandy loam
162	Lino	loamy fine sand
169	Braham	loamy fine sand
265	Soderville	fine sand
541	Rifle	mucky peat
543	Markey	muck
1001	Alluvial	undifferentiated, occasionally flooded

Appendix C, Table 1. Location description of water sampling sites in the Carlos Avery WMA and contributing waters for 1976.

Station	Location	Station	Location
1	Drain into Little Coon Lake, culvert on refuge road south and west of headquarters, Anoka County, T33N, R22W, Sec.32.	6	County road 79 bridge, South Pool, Chisago County, T33N, R21W, Sec. 4.
1a	Drainage ditch from Coon Lake into refuge, culvert on refuge road west of headquarters, Anoka County, T33N, R22W, Sec. 29.	7	County road 78 bridge on the West Branch of the Sunrise River west of Stacy, Chisago County T34N, R21W, Sec. 31.
2	Control structure at the stone bridge on Pool 8, Anoka County, T33N, R22W, Sec. 23.	8	Highway 30 bridge on the West Branch of the Sunrise River, Stacy, Chisago County, T34N, R21W, Sec. 32.
2a	Control structure on refuge road on the east side of Pool 9, Anoka County, T33N, R22W, Sec. 24.	10	Highway 19 culvert between Mud Lake and the South Pool, Chisago County T34N, R21W, Sec.33
2b	Control structure on refuge road on the north side of Pool 8, drains into Pool 8, Anoka County, T33N, R22W, Sec. 14.	11	South Pool dam, Chisago County, T34N, R21W, Sec. 34.
3	Bridge on South Branch of the Sunrise River immediately west of I-35 and Wyoming, Chisago County, T33N, R21W, Sec. 19.	12	Highway 19 bridge on the North Pool, Chisago County, T34N, R21W, Sec. 26.
4	Highway 30 bridge on the South Branch of the Sunrise River in Wyoming, Chisago County, T33N, R21W, Sec. 17.	13	Control structure on south end refuge road between Pool 14 and Pool 16, Anoka County, T32N, R22W, Sec. 18.
5	County Road 84 bridge on the East Branch of the Sunrise River, Chisago County, T33N, R21W, Sec. 16.	14	Control structure on the south end of Pool 16, Anoka County, T32N, R22W, Sec. 19.
5a	Highway 98 bridge on the East Branch of the Sunrise River west of Wyoming, Chisago County, T33N, R21W, Sec. 22.		

Appendix C. Table 2. Total alkalinity expressed as ppm CaCO₃ for selected sampling stations in the Carlos Avery WMA and contributing waters for February and March 1976.

Station	2/12	2/13	2/17	2/18	2/19	2/23	2/26	3/2	3/4	3/5	3/17
1	—	—	—	—	—	155	140	95	—	—	150
1a	—	—	—	—	—	130	128	95	—	—	115
2	475	—	438	—	325	—	313	—	290	—	255
2a	—	—	—	—	—	—	208	—	—	—	150
2b	—	—	—	—	—	—	238	—	—	—	—
3	218	—	193	—	—	—	198	—	—	—	—
4	210	—	188	—	—	—	190	—	—	—	—
5	—	—	173	—	—	—	—	—	—	155	163
6	—	170	163	—	—	—	—	—	—	—	168
7	—	—	148	—	—	—	—	—	—	—	—
8	—	—	148	—	—	—	—	—	—	135	133
9	—	—	—	—	—	—	—	—	—	—	—
10	—	—	145	—	—	—	—	—	—	—	153
11	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	163	—	—	—	—	—	—	160
13	—	—	—	—	—	—	—	—	220	—	188
14	—	—	—	—	—	—	—	—	215	—	213

Appendix C. Table 3. Dissolved oxygen concentrations (ppm) for selected water sampling stations in the Carlos Avery WMA and contributing waters for February and March 1976.

Station	2/12	2/13	2/17	2/18	2/19	2/23	2/24	2/26	3/4	3/5	3/17
1	—	—	—	—	—	0.2	0.7	3.3	3.5	—	—
1a	—	—	—	—	—	6.2	6.8	6.5	6.7	—	—
2	0.0	—	0.0	—	0.0	—	0.0	—	0.0	0.0	—
2a	—	—	—	—	—	—	0.0	—	0.0	0.0	—
2b	—	—	—	—	—	—	0.0	—	—	—	—
3	1.4	—	2.7	—	—	—	0.1	—	—	—	—
4	2.5	—	4.0	—	—	—	0.3	—	—	—	—
5	—	—	9.8	—	—	9.0	—	—	—	8.8	—
6	—	7.2	8.5	—	—	—	—	—	—	8.0	—
7	—	—	7.5	—	—	7.1	—	—	—	7.0	—
8	—	—	8.8	—	—	8.0	—	—	—	7.4	—
9	—	—	—	—	—	—	—	—	—	—	—
10	—	—	8.5	—	—	—	—	—	—	—	0.0
11	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	8.9	—	—	—	—	—	—	7.5
13	—	—	—	—	—	—	—	0.0	0.0	—	—
14	—	—	—	—	—	—	—	0.0	0.0	—	—

Appendix D. Buildings and equipment used for the operation of the game farm and forestry headquarters on the Carlos Avery WMA.

Game Farm			Forestry Headquarters	
Buildings	Dimensions		Buildings	Dimensions
Residence	20 x 58		Residence	24 x 48
Residence	20 x 46		Residence	16 x 20
Residence	22 x 26		Residence	16 x 20
Research center	20 x 62		Garage and office	28 x 100
Central heating plant & garage	22 x 42		Garage	20 x 60
2-Brooder houses	10 x 12		Utility building	26 x 90
2-Brooder units	22 x 500		Utility building	36 x 90
Utility building	30 x 150			
Utility building	36 x 90			
Storage building	24 x 80			
Garage	16 x 24			
Animal pen	10 x 64			
Machine shed	30 x 80			
Grain storage shed	14 ft. diameter			
Pump house	10 x 20			
Fire shed	10 x 12			
Equipment	Item/Model	Year		
	3-ton flatbed truck/International	1967		
	3-ton flatbed truck/Dodge	1970		
	3/4-ton pickup truck/Ford	1968		
	3/4-ton pickup truck/International	1972		
	Station wagon/Chevrolet	1968		
	Wheel tractor/Ford (4000)	1968		
	Wheel tractor/Allis Chalmers (c)	1950		
	Wheel tractor/Ford (601)	1953		
	Compartment incubator/Robbins			
	Hatcher/Robbins			
	5-Brooder units			

Appendix E. 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 *during the waterfowl season*.
 - (d) In the Orwell Wildlife Management Area (Ottetail 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. 210 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.