



Waterfowl and hunter use of Freezout Lake game management area, Teton County, Montana
by Kenneth David Lorang

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Fish and Wildlife Management
Montana State University
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Abstract:

Waterfowl and hunter use of the state owned Freezout Lake Game Management Area were studied in 1977 and 1978.

The peak of spring migration for whistling swans, Canada geese and snow geese occurred in mid-March, when the area was entirely frozen. Ducks were present in greatest numbers in April, when ice-out occurred. One hundred and seven nests of Canada geese were located in 1978. Nest success averaged over 90% and gosling production was estimated at 459 birds. Islands were the preferred nest sites. Nest searches conducted in eight types of nesting habitat located 224 duck nests of 11 species. Islands were the most productive habitat, having both the greatest nest density and success.

Native grasslands contained the greatest diversity of nesting species and nests in this type were more successful than those located in other upland types. The distance of upland duck nests from water was inversely related to nest success and directly related to overland mortality of duck broods.

Nest success in upland habitats was poor, averaging 19.6%. Predation by striped skunks was the most significant cause of nest loss. Observations were made of 823 duck broods in 1977 and 1978. Peak hatching dates were calculated for each species and major brood areas determined. Data from vegetation analysis indicate a reduction in vigor in the major upland nesting habitats as a result of long term idling and a lack of habitat manipulation. Management recommendations were made for nesting habitat improvement. Fall migration chronology was monitored in 1978. Duck numbers peaked in late September just prior to opening of waterfowl season.

Mild weather throughout October followed by a rapid early November freeze-up resulted in a large overflight of whistling swans and snow geese. Interviews were obtained from 860 hunters and 1847 birds were checked during the fall water-fowl season. An estimated 5018 birds were harvested on the management area during the 1978 season. Mallards and pintails combined made up over 55% of the total harvest.

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GAME MANAGEMENT AREA, TETON COUNTY, MONTANA

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

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Fish and Wildlife Management

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April, 1979

ACKNOWLEDGEMENTS

To the following, among others, the author wishes to express his most sincere appreciation for their contributions to this study: Dr. Robert L. Eng, Montana State University, for project planning, technical supervision and aid preparation of the manuscript; Mr. Dale Witt, Montana Dept. of Fish and Game, for project planning; Dr. Richard Mackie and Dr. William Gould, for critically reviewing this manuscript; Mr. Merrill Hirsch, Montana Dept. of Fish and Game, for aid in obtaining necessary field equipment; Mr. Keith Aune, formerly of the Montana Dept. of Fish and Game, for personal interest in the study and aid in collection of field data; and to my wife, Cynthia, for her aid in typing, data reduction and her patient support for the duration of this study.

This study was funded by the Montana Dept. of Fish and Game through funds provided by Pittman-Robertson project number W - 120 - R.

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ABSTRACT

Waterfowl and hunter use of the state owned Freezout Lake Game Management Area were studied in 1977 and 1978. The peak of spring migration for whistling swans, Canada geese and snow geese occurred in mid-March, when the area was entirely frozen. Ducks were present in greatest numbers in April, when ice-out occurred. One hundred and seven nests of Canada geese were located in 1978. Nest success averaged over 90% and gosling production was estimated at 459 birds. Islands were the preferred nest sites. Nest searches conducted in eight types of nesting habitat located 224 duck nests of 11 species. Islands were the most productive habitat, having both the greatest nest density and success. Native grasslands contained the greatest diversity of nesting species and nests in this type were more successful than those located in other upland types. The distance of upland duck nests from water was inversely related to nest success and directly related to overland mortality of duck broods. Nest success in upland habitats was poor, averaging 19.6%. Predation by striped skunks was the most significant cause of nest loss. Observations were made of 823 duck broods in 1977 and 1978. Peak hatching dates were calculated for each species and major brood areas determined. Data from vegetation analysis indicate a reduction in vigor in the major upland nesting habitats as a result of long term idling and a lack of habitat manipulation. Management recommendations were made for nesting habitat improvement. Fall migration chronology was monitored in 1978. Duck numbers peaked in late September just prior to opening of waterfowl season. Mild weather throughout October followed by a rapid early November freeze-up resulted in a large overflight of whistling swans and snow geese. Interviews were obtained from 860 hunters and 1847 birds were checked during the fall waterfowl season. An estimated 5018 birds were harvested on the management area during the 1978 season. Mallards and pintails combined made up over 55% of the total harvest.

INTRODUCTION

A major concern in waterfowl management is the preservation of adequate habitat for breeding and migrating waterfowl. One result of this concern has been the purchase of waterfowl management areas by state and federal agencies.

Ellig (1955) studied waterfowl relationships at Freezout Lake during 1951 and 1952. In 1953 the area was acquired by the Montana Fish and Game Department, and since then has been developed and managed as a public hunting and waterfowl production marsh. This study of current waterfowl and hunter usage was initiated to assess the long term impact of the management program at Freezout Lake, knowledge of which could be useful in setting guidelines for future management decisions.

The specific objectives of this study were: 1) to determine the chronology and magnitude of spring migration; 2) to document the vegetative characteristics of the area and relate these to waterfowl activity; 3) to document the degree and success of nesting; 4) to estimate production by the occurrence of broods; 5) to monitor fall migration and hunter harvest; 6) to compare current waterfowl activity on the management area to that which occurred prior to development; 7) to make management recommendations to enhance future waterfowl use of the area.

DESCRIPTION OF THE STUDY AREA

Freezout Lake (formerly known as Greenfield's Lake) is located approximately 3 km northwest of Fairfield in north-central Montana. The lake is bordered on the east by the Fairfield Bench, a Bureau of Reclamation irrigation project, and to the west by rolling uplands. The lake lies in a natural sump in the lower portion of a glacial basin (Giesecker 1937). The major water supplies to the area are spring runoff and return water from adjacent irrigated land. Ellig (1955) presented a history and description of the area prior to development.

In 1953, following Ellig's (1955) study, the Montana Department of Fish and Game began to develop the area for waterfowl. This development included the construction of a drainage ditch from Freezout Lake to Priest Lake, and on to the Teton River. The placement of seven retention dikes with water control structures resulted in the formation of six pond units. Islands were constructed in each of these ponds. Currently the management area consists of Freezout Lake and six contiguous pond units (Figure 1) and Priest Lake which is separate from the rest of the management area, lying approximately 8 km to the north. A total of approximately 1900 ha of water is present on the area.

The management unit also includes approximately 2,560 ha

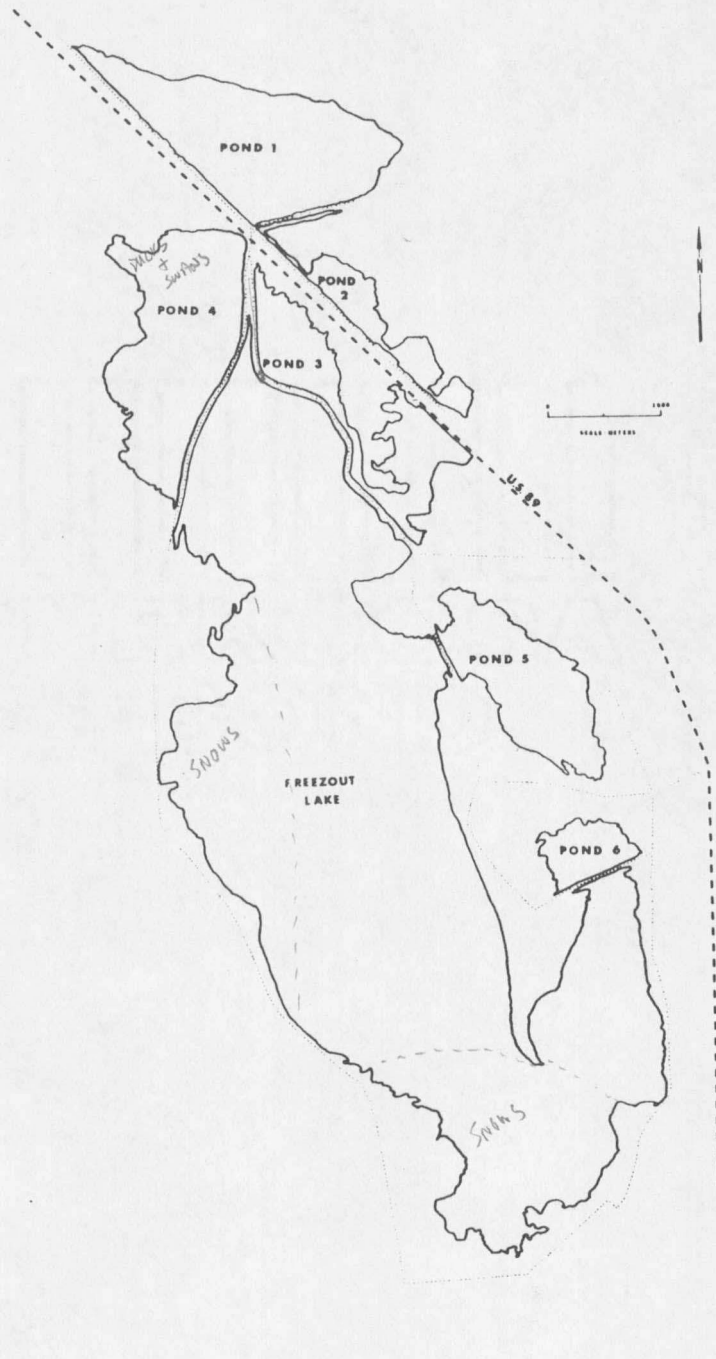


Figure 1. Map of the study area.

of upland habitat adjacent to the water. The majority of upland habitat is native grasslands. These grasslands have remained ungrazed for nearly 20 years (Dale Witt, pers.comm.). Greasewood (Sarcobatus vermiculatus) is dominant on alkaline areas near the interior of the project. Nesting cover plantings are present on disturbed soil along dike and drainage ditch banks and also in plots in certain upland areas. Two hundred and seventeen hectares are farmed for small grain intended to act as buffer crops to alleviate damage to private croplands by field feeding waterfowl. Shelter belts have been planted in several areas to enhance upland game bird habitat.

The climate at Freezout Lake is characterized by wide fluctuations in daily and seasonal temperatures, and relatively low annual precipitation (Gieseke 1937). The average annual precipitation is 31.7 cm (U.S. Dept. of Commerce 1977), with 105 frost free days per year (Caprio 1965).

METHODS

Field work for this study was conducted full time from June through August 1977, part time (four days/week) in March and April 1978, and full time May through November 1978.

Spring Migration

Migration chronology was monitored by ground observations made during March, April, and May 1978. Dates of first occurrence and the week of peak migration were recorded for major species observed on the area. Total numbers of waterfowl and relative abundance of each species were estimated weekly.

Vegetation Analysis

During the summer of 1977, a general survey of the area was made to determine the major types of habitat available to nesting ducks. The following types were identified and later searched for the presence of nests: native grassland, greasewood, dense nesting cover (upland areas seeded into grass-legume mixtures), retention dike banks, drainage ditch banks, agricultural land, islands and emergent vegetation.

Six study plots, 150 by 300 m, were established in each of the grassland, greasewood, and dense nesting cover types. Grassland and greasewood plots each included 150 m of shoreline. Six dikes, six ditches, and forty-five islands were chosen as representatives of these types of habitat. All

islands which were searched for duck nests were located in pond unit 4.

During the spring of 1978, a modification of the technique described by Robel et. al. (1970) was used to measure residual vegetation present on grassland, dike, ditch, and dense nesting cover areas. Height-density readings were taken along two 100 m transects in six areas in each of these types of habitat. Total visual obstruction was recorded to the nearest 0.5 dm at 10 m intervals along the transect. Readings were taken from a height of 1 m and a distance of 4 m in each cardinal compass direction at each station.

The line intercept method was used to measure shrub canopy coverage in the greasewood type (Canfield 1942). Three 100 m transects were established perpendicular to the shoreline in each of the six plots. Species composition and relative ground cover of other plants, excluding greasewood, were measured by the point intercept method (Copeland 1950) using three additional transects, 300 m long, established perpendicular to the shoreline in each plot. A ten-point reading was taken at 10 m intervals along each transect. The procedure was repeated to determine relative ground cover and composition on grassland areas. Planted areas were examined to determine kinds of plants present and their relative abundance.

Aerial photographs were taken of the study area in the summer of 1978. Color infra-red photos aided in delineating vegetational features. Maps were prepared showing the extent of major upland types of habitat, emergent vegetation, and vegetational types in riparian areas. Plant nomenclature follows Booth (1950), Booth and Wright (1959), and Booth (1972).

Nesting Study

Searches were conducted in late April and early May 1978 to determine the number and location of nesting Canada Geese on the study area. At the time of the search, the majority of nests were well into incubation. All islands and shorelines were searched for the presence of nests. Upon locating a nest, the attending goose was flushed, and the clutch size and general characteristics of the nest were noted. The locations of nests were marked and revisited in mid-May when nesting activity was believed terminated, to determine fate. A nest was considered successful if at least one egg hatched.

Some duck nests were located incidental to other activities in 1977, but systematic searches for nests were not made until 1978. From May 15 through July 15, 1978, an intensive search was conducted in major types of habitat on the study area, including the vegetational study plots. The size of

the area searched was limited to the amount that could be effectively covered in a three-week period. Each area, with the exception of the agricultural type, was searched three times. Late spring plowing eliminated the agricultural type as nesting cover after one search was completed.

Grassland, agricultural, and dense nesting cover areas were searched using a 53 m cable-chain drag device (Higgins et. al. 1977). Dike and ditch banks were searched either on foot or by using a flushing bar mounted on a small tractor. Greasewood areas and islands were searched on foot. Because of manpower limitations, emergent vegetation was searched only as time permitted.

Upon locating a nest, a field candler was employed to determine the incubation stage of the eggs (Weller 1956). The location of the nest was marked and the eggs were covered with the nest lining to lessen the chance of predation and embryonic death (Higgins and Kantrud 1973). Nests were revisited shortly after the projected hatching date to determine fate. Any nest in which at least one egg hatched, was considered successful. If a nest was unsuccessful due to predation, the nest site and surrounding area were examined in an attempt to determine the nest predator (Sooter 1946, Reardon 1951). The distance was paced from the nest site to the nearest permanent water.

Total area of each type of habitat searched was determined by planimeter readings from aerial photos. The nesting density and success between types of habitat was tested with the chi-square test for independence (Snedecor 1956).

Brood Observations

Weekly observations of broods were conducted during June, July, and August of 1977 and 1978. Observations were made during early morning hours by walking shorelines, driving a vehicle along project roads, and from a boat. Brood size was recorded and duckling age determined by the method described by Gallop and Marshall (1954). Hatching dates were back-calculated to find peak periods of hatch for each species. Major brood areas and associated aquatic and vegetational features were noted.

Fall Migration and Hunter Harvest

From mid-September until November an aerial census was made each week to monitor migration chronology on the study area. Estimates were made of total waterfowl numbers and relative abundance of each species and crosschecked with ground surveys following each flight.

Hunter check stations were operated at two major access points between sunrise and 1:00 P.M. on opening weekend of waterfowl season. Thereafter check stations were operated

each weekend and three days during the week at various points on the area. Information collected from hunting parties included: county of residence, number of hunters per vehicle, number of hours spent hunting, and the number, species and sex of waterfowl taken. Hunting pressure was estimated from vehicle counts taken twice daily throughout the season.

RESULTS

Spring Migration

The first recorded observations of waterfowl at Freezout Lake in 1978 were made 8 March by Fish and Game personnel, when whistling swans, Canada geese, and mallards were noted (Keith Aune, pers. comm.). At this time all pond units and the main lake were entirely frozen, but sheetwater from local runoff could be found in limited areas on top of the ice and in adjacent lowlands.

Table 1 lists the dates of first observations and the week of peak migration for all major species. In addition to the species listed, occasional observations were made of the wood duck (Aix sponsa), white-winged scoter (Melanitta fusca deglandi), and European wigeon (Anas penelope). By the end of March, all resident breeding species had arrived with the exception of blue-winged and cinnamon teal.

Break-up of the ice sheets began during the last week of March and by 1 April the main lake and pond units 2, 3, and 4 were ice free. Units 1, 5, and 6 remained frozen until 7 April.

Figures 2 and 3 depict chronology of spring waterfowl migration on the study area. The peak migration of whistling swans, Canada geese, and snow geese occurred prior to spring breakup. Swans remained on the area throughout the day

Table 1. First observation date and period of peak migration of waterfowl at Freezout Lake, 1978

Species	First Observation Date	Peak Migration
Canada Goose - <u>Branta canadensis</u>	3/8	3/12-18
Lesser Snow Goose - <u>Anser caerulescens</u>	3/14	3/19-25
Whistling Swan - <u>Cygnus columbianus</u>	3/8	3/12-18
Mallard - <u>Anas platyrhynchos</u>	3/8	4/2-8
Pintail - <u>Anas acuta</u>	3/9	3/26-4/1
Common Goldeneye - <u>Bucephala clangula</u>	3/10	3/16-4/1
American Wigeon - <u>Anas americana</u>	3/16	4/2-8
Canvasback - <u>Aythya valisineria</u>	3/16	4/2-8
R. B. Merganser - <u>Mergus serrator</u>	3/16	4/9-15
Redhead - <u>Aythya americana</u>	3/22	4/9-15
Bufflehead - <u>Bucephala albeola</u>	3/22	4/2-8
A.G-W. Teal - <u>Anas crecca carolinensis</u>	3/22	4/9-15
Northern Shoveler - <u>Anas clypeata</u>	3/23	4/30-5/6
Gadwall - <u>Anas strepera</u>	3/23	5/14-20
Ruddy Duck - <u>Oxyura jamaicensis</u>	3/27	4/16-22
Lesser Scaup - <u>Aythya affinis</u>	3/29	4/23-5/1
Ring-Necked Duck - <u>Aythya collaris</u>	4/1	4/9-15
Cinnamon Teal - <u>Anas cyanoptera</u>	4/6	5/7-13
B-W. Teal - <u>Anas discors</u>	4/22	5/7-13

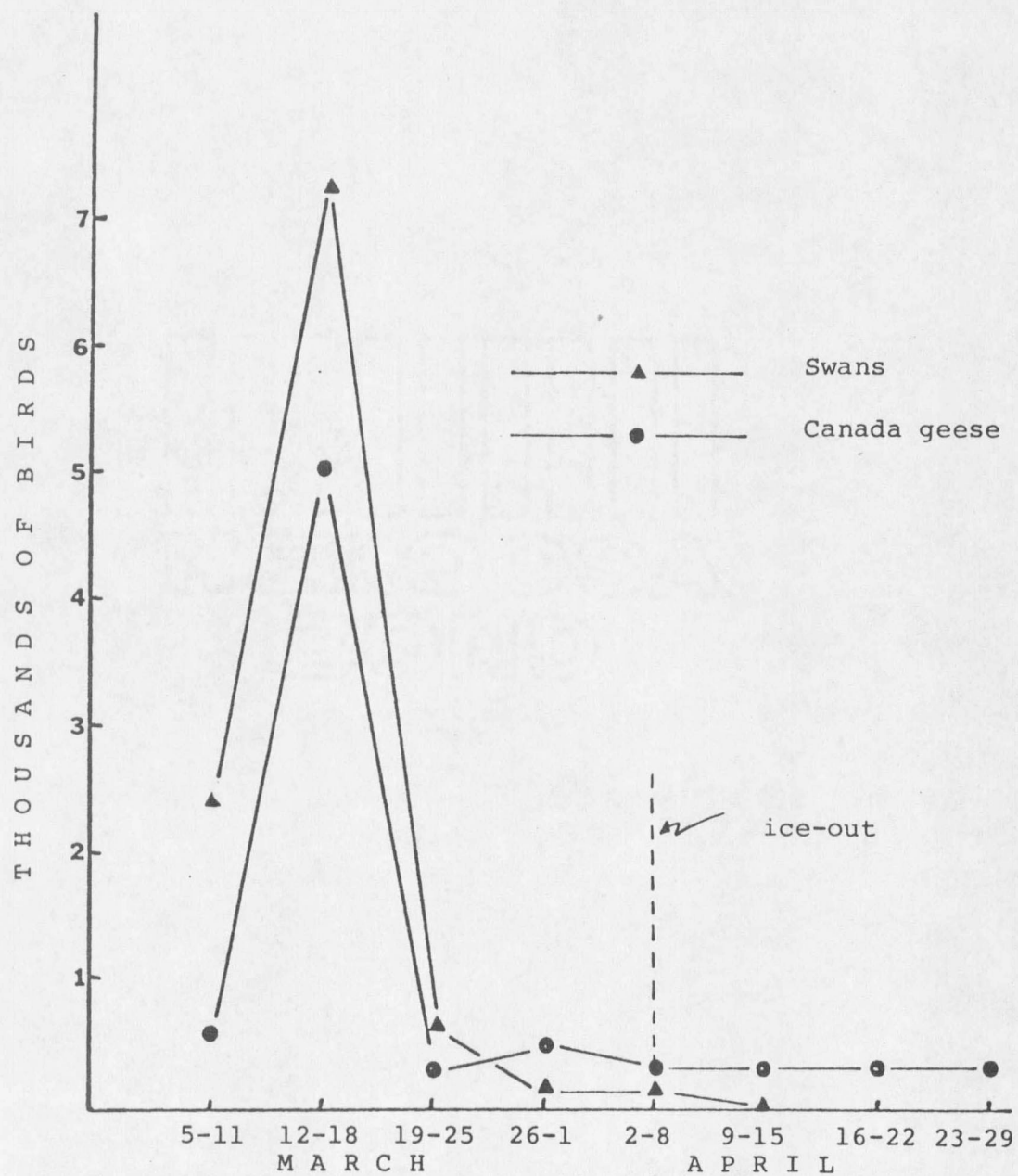


Figure 2. Chronology of spring migration of whistling swans and Canada geese, 1978.

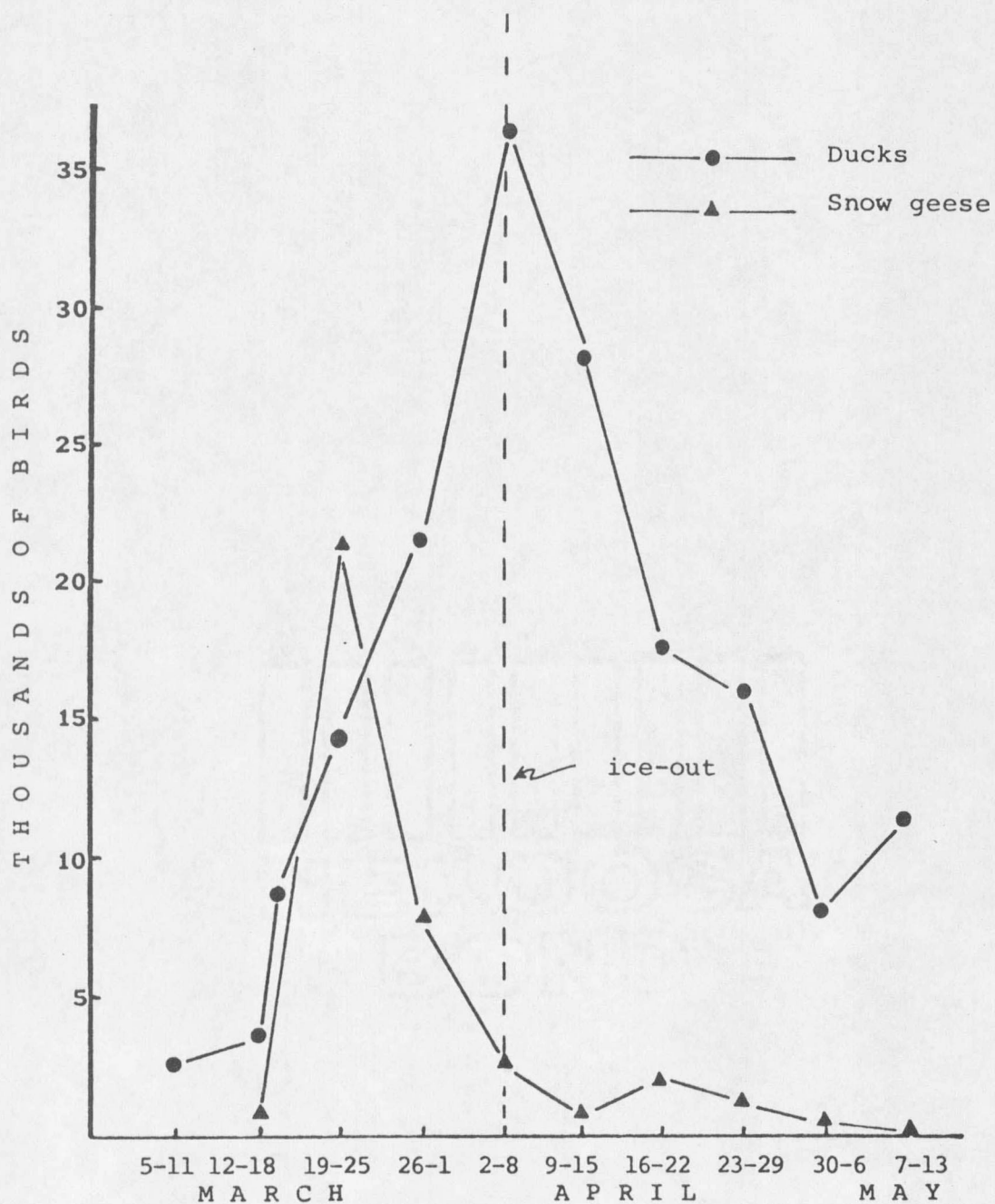


Figure 3. Chronology of spring migration of snow geese and ducks, 1978

feeding on upland vegetation, while Canada geese and snow geese made daily feeding flights to nearby stubble and winter wheat fields.

Duck numbers increased on the area until 8 April, when an estimated 35,000 were present. Peak migration of ducks corresponded with the final breakup of ice and a late winter storm, both of which may have encouraged staging of waterfowl on the area.

Duck numbers on the study area decreased rapidly throughout the remainder of April due primarily to the departure of many mallards, pintails, and American wigeon. Concurrent with this departure was an increased availability of temporary and seasonal bodies of water on private land in nearby areas. An unusually heavy spring runoff in 1978 resulted in above average numbers of these water types. A ground survey made in mid-April showed large numbers of dabbling ducks present on these areas. In years of heavy spring runoff, the study area may be relatively less important as a spring migration staging area due to the increased availability of alternate habitat.

By early May waterfowl numbers on the area had stabilized at an estimated 14,000 resident birds. Thereafter, numbers increased gradually throughout the summer as a result of an influx of molting birds and production.

Vegetation Analysis

Measurements of residual cover, as indicated by visual obstruction are presented in Table 2. Residual cover, measured to the nearest 0.5 dm, was greatest in the dense nesting cover, least in the grassland type, while dike and ditch banks were intermediate.

Table 2. Residual cover in four types of nesting habitats.

Type	Visual Obstruction (dm)	
	Mean	Range
Grassland	0.40	0.0 - 2.0
Dike Bank	0.83	0.0 - 7.0
Ditch Bank	1.98	0.5 - 8.0
Dense Nesting Cover	2.33	1.0 - 8.0

The technique used to measure residual cover in the above types of habitat did not lend itself to use in the greasewood type. Thus, canopy coverage, as indicated by the line intercept method, was chosen to measure residual cover in this type. Shrub canopy coverage in the greasewood type averaged 19.3% with a range for 18 intercepts of 9.6 - 27.3%. Soil erosion has resulted in depressions between individual greasewood plants giving the area a hummocky appearance. Spring runoff fills many of these depressions with water, making them unavailable as nest sites. As a result, the majority

of residual cover available in this type consists of shrubs located on higher ground.

Species present and their percentage of total plant cover, as measured by the point intercept method, are summarized for the greasewood type in Table 3. Average plant cover for 5,400 points was 21.2%. Foxtail barley (Hordeum jubatum) was the dominant species excluding greasewood. Bluestem (Agropyron smithii) and canby bluegrass (Poa canbyi) were locally abundant.

Table 3. Species present and their percentage of total plant cover in the greasewood type.

Species	%
<u>Hordeum jubatum</u>	46.8
<u>Agropyron smithii</u>	14.8
<u>Poa canbyi</u>	10.0
<u>Kochia scoparia</u>	7.3
<u>Distichlis stricta</u>	5.3
<u>Puccinella nuttalliana</u>	3.1
<u>Atriplex nuttalli</u>	2.8
<u>Lepidium densiflorum</u>	2.4
<u>Sonchus oleraceus</u>	1.7
<u>Lactuca serriola</u>	1.7
Other species	<1.0

Average plant cover for 5,400 points in the grassland type was 36.3%. Bluestem, blue grama (Bouteloua gracilis), and desert saltgrass (Distichlis stricta) were the dominant grasses (Table 4). Common salsify (Tragopogon dubius) and fringed sagewort (Artemisia frigida) were the dominant forbs. Downy chess brome (Bromus tectorum) and Japanese chess (Bromus japonicus) were locally abundant on areas adjacent to disturbed soils.

Dense nesting cover consisted of plots of grass-legume mixtures planted in upland areas. Tall wheat grass (Agropyron elongatum) and alfalfa (Medicago satira) was the most common mixture, but some areas also contained Russian wild-rye (Elymus junceus).

Dike banks were planted to the same grass-legume mixtures as dense nesting cover areas, however, a rip-rap project conducted in 1976 virtually removed vegetation on several dikes. Sweetclover (Melilotus officinale), summer cypress (Kochia scoparia), and lamb's quarter (Chenopodium album) were abundant on disturbed sites.

Vegetation on ditch banks varied considerably with ditch age. Dense stands of crested wheatgrass (Agropyron cristatum) were common on older areas. Newly constructed or recently cleaned ditches supported growths of tumble mustard (Sisymbrium altissimum), summer cypress, and lamb's quarter.

Table 4. Species present and their percentage of total plant cover in the grassland type.

Species	%
<u>Agropyron smithii</u>	21.3
<u>Artemisia frigida</u>	9.1
<u>Bouteloua gracilis</u>	8.6
<u>Bromus tectorum</u>	7.4
<u>Distichlis stricta</u>	7.1
<u>Tragopogon dubius</u>	7.0
<u>Bromus japonicus</u>	3.6
<u>Sonchus oleraceus</u>	3.4
<u>Hordeum jubatum</u>	3.3
<u>Iva axillaris</u>	2.4
<u>Kochia scoparia</u>	2.2
<u>Koeleria cristata</u>	2.2
<u>Poa canbyi</u>	2.1
<u>Stipa comata</u>	2.0
<u>Medicago sativa</u>	1.8
<u>Grindelia squarrosa</u>	1.5
<u>Puccinellia nuttalliana</u>	1.5
<u>Cirsium arvense</u>	1.5
<u>Agropyron cristatum</u>	1.5
<u>Salicornia rubra</u>	1.3
All others	41.0

The predominant plant cover on islands was tall wheatgrass. Some islands which received heavy use by California gulls (Larus californicus) and common terns (Sterna hirundo) contained little or no vegetation.

Emergent vegetation was abundant in the shallow water zones throughout the study area. Alkali bullrush (Scirpus paludosus) was the dominant plant, with soft stem bullrush (Scirpus validus) and cattail (Typha latifolia) locally abundant. Appendix figures 9 - 15 and Table 23 summarize the distribution of emergent and riparian vegetation for each pond unit.

Nesting Study

A total of 107 Canada goose nests was located in the spring of 1978. Table 5 shows numbers of nests and success by nest site. Islands were the preferred site, containing 79% of all nests. Approximately 50% of all available islands were utilized for nesting, 14% of those islands with nests contained more than one. Some selection seemed to occur for islands located in deeper water and at greater distances from the shoreline, but there was no obvious selection for islands with a particular vegetational composition.

Table 5. Canada goose nest success and location.

Nest Site	No. of Nests	% Success
Islands	85	93.0
Muskrat Lodge	13	84.6
Shorelines	7	87.5
Upland	<u>2</u>	<u>00.0</u>
Total	107	90.7

Lodges of muskrats (Ondatra zibethicus) and shorelines were also important nest sites. The nests located in upland areas were several hundred meters from the water.

Overall nest success was high, greater than 90%. Success was greatest for nests located on islands, and only slightly less for those located on lodges and shorelines. Egg success and average clutch sizes by nest sites are presented in Table 6.

Table 6. Egg success and average clutch size for Canada goose nests.

Nest Site	No. of Eggs	% Success	Average Clutch Size
Islands	456	85.5	5.4
Muskrat Lodge	55	74.5	4.2
Shorelines	35	87.2	4.9
Upland	<u>8</u>	<u>00.0</u>	<u>4.0</u>
Total	554	83.9	5.2

Destruction by predators was the major cause of egg loss, followed closely by flooding; 56% was attributed to these two factors. Embryonic death, infertility, and unknown causes were responsible for the remaining unsuccessful eggs.

Fluctuations in water depth affected the security levels of island, muskrat lodge, and shoreline nests. Table 7 depicts the distribution and success of nests in various ponds on the study area. An unequal distribution of available water accounted for the lower success in pond units 1 and 2. A rise in the water level of pond 1 concurrent with a reduction in the level of pond 2 resulted in nest failures due to flooding and/or an increased susceptibility to mammalian predators in the respective units.

A total of 224 duck nests were located during the spring and summer of 1978. These included 182 nests in upland habitats and 42 on islands or in emergent vegetation. Figure 4 shows the location and extent of areas searched for duck nests.

Nest density in upland habitats did not vary significantly ($p > .05$) between grassland, greasewood, dense nesting cover and dike types (Table 8). If all types of habitats have an equal chance of being selected by nesting waterfowl,

Table 7. Canada goose nest success by individual ponds

Area	No. of Nests	% Success
Pond 1	11	72.7
Pond 2	11	72.7
Pond 3	21	95.2
Pond 4	19	100.0
Pond 5	17	100.0
Pond 6	2	100.0
Priest Lake	16	93.8
Freezout Lake	10	80.0
Total	107	90.7

Table 8. Densities of duck nests by types of habitat

Type	ha Searched	No. of Nests	Nests /km ²
Grassland	198.9	94	47.2
Greasewood	60.5	26	42.9
Dense Nesting Cover	90.9	42	46.2
Dike Bank	23.8	9	37.8
Ditch Bank	9.0	7	77.7
Agricultural	74.9	4	5.3
Islands	0.9	37	4,111.1

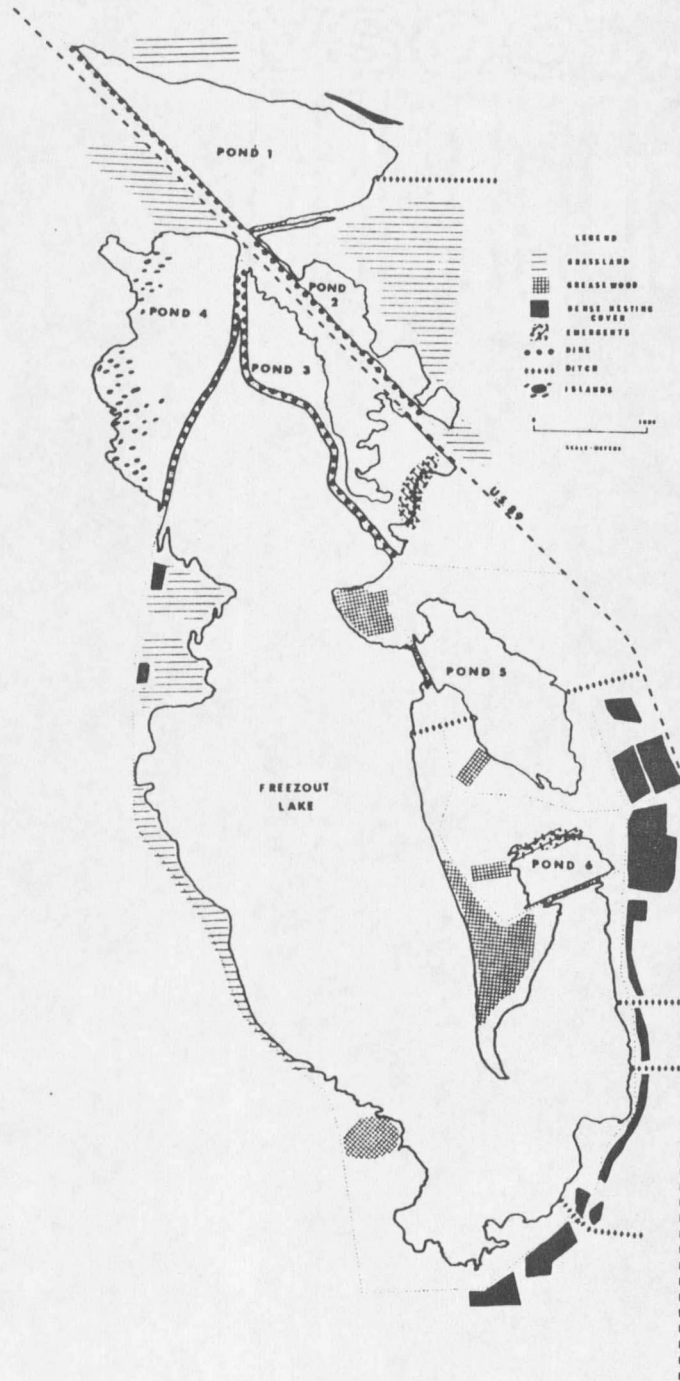


Figure 4. Location and extent of areas searched for duck nests.

these data would indicate no preference for any of the major upland nesting habitats. However, differences other than vegetational features may have affected nesting habitat selection, thereby masking an actual preference for a particular vegetational type. Such features as size and shape of the individual habitat unit, juxtaposition of other adjacent types of habitat, and the distance to nearby shorelines may have overshadowed vegetational features in the selection of a nest site.

A significantly higher density of nests was found on ditch banks than on other upland areas ($p < .01$). However, the small amount of land present in this habitat category, prevented this type from providing significant production of waterfowl on the study area.

Nest density was apparently lower on the agricultural type. However, since this type was searched only once during the nesting season, direct comparisons of nest densities cannot be made with other types of nesting habitats.

The density of nests on islands exceeded that of all upland areas. The 45 islands searched contained 37 nests. On an area basis, islands produced nearly 100 times as many nests as upland habitats. Time limitations prevented the searching of adequate areas of emergent vegetation to warrant discussion of nest density in this type.

Two indicators of the attractiveness of nesting habitat are the species composition of ducks nesting within a particular habitat (Table 9) and the distribution of nests of an individual species in various habitats (Table 10).

Pintails were the prevalent nesting species in greasewood, agricultural, and island types (Table 9). Blue-winged teal was the most prevalent species in grassland and dense nesting cover areas, while the gadwall was the dominant species nesting on dike and ditch banks. The greatest diversity of nesting species occurred on the grassland type.

All species of dabbling ducks, with the exception of the mallard, had the highest percentage of their nests located in the grassland type (Table 10). Mallard nests were found in greatest number in the dense nesting cover. Pintails showed the greatest variability in nest site selection, with nesting occurring to some degree in all types.

Habitat productiveness was measured by the number of successfully hatched clutches per unit area (Table 11). Grassland was the most productive upland habitat, followed by greasewood and dense nesting cover in that order. All nests under observation on dikes, ditches, or agricultural types were unsuccessful. Islands were the most productive habitat overall, with both the greatest nest density and success.

Table 9. Percent composition of ducks nesting in each type of habitat.

Species	Grassland(94) ^a	Greasewood(26)	Dense Nesting Cover(42)	Dike Bank(7)	Ditch Bank(7)	Agricultural(4)	Islands(35)	Emergents(7)
Pintail	24.4	42.3	9.6	22.2	14.3	75.0	45.7	14.3
B.W. Teal	28.7	15.4	21.4	11.1	14.3	---	---	---
Gadwall	13.8	23.1	19.0	33.4	42.8	25.0	11.4	---
N. Shoveler	12.8	3.8	16.7	---	14.3	---	---	---
L. Scaup	10.6	---	4.8	---	---	---	14.3	---
Mallard	1.1	7.7	19.8	---	7	---	14.3	---
Redhead	2.2	7.7	2.4	---	---	---	11.4	---
A. Wigeon	3.2	---	7.1	11.1	---	---	---	---
G.W. Teal	3.2	---	---	22.2	14.3	---	2.8	---
Canvasback	---	---	---	---	---	---	---	57.1
Ruddy Duck	---	---	---	---	---	---	---	---
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a = number of nests

Table 10. Percent duck nests of each species in various types of habitat.

Species	Grassland	Greasewood	Dense Nesting Cover	Dike Bank	Ditch Bank	Agricultural	Islands	Emergents	TOTAL
Pintail	37.7	18.0	6.6	3.3	1.6	4.9	26.3	1.6	100.0
B.W. Teal	64.3	9.5	21.4	2.4	2.4	---	---	---	100.0
Gadwall	35.1	16.2	21.7	8.1	5.4	2.7	10.8	---	100.0
N. Shoveler	54.6	4.5	31.8	---	9.1	---	---	---	100.0
L. Scaup	58.8	---	11.8	---	---	---	29.4	---	100.0
Mallard	6.2	12.5	50.0	---	---	---	31.3	---	100.0
Redhead	22.2	22.2	11.1	---	---	---	44.5	---	100.0
A. Wigeon	43.0	---	42.9	14.2	---	---	---	---	100.0
G.W. Teal	42.9	---	---	28.5	14.3	---	14.3	---	100.0
Canvasback	---	---	---	---	---	---	---	100.0	100.0
Ruddy Duck	---	---	---	---	---	---	---	100.0	100.0
All species	42.0	11.6	18.8	4.0	3.1	1.8	15.6	3.1	100.0

Table 11. Densities of successful duck nests by type of habitat.

Habitat Type	No. of Nests	No. Hatched	% Success	Successful Nests/km ²
Grassland	94	24	25.5	12.0
Greasewood	26	5	19.2	8.2
Dense Nesting Cover	42	6	14.0	6.4
Dike Bank	9	0	00.0	0.0
Ditch Bank	7	0	00.0	0.0
Agricultural	4	0	00.0	0.0
Islands	35	24	68.6	2,820.2

Nest success by species in each type of habitat is shown in Table 12. A total of 61 (27.2%) of 224 nests successfully hatched. Of the major nesting species (those for which over ten nests were found) mallards had the highest nest success, followed by pintails, gadwalls, blue-winged teal, and northern shovelers in that order. Nest success of 189 nests, excluding island nesting, was 19.6 percent.

Egg success closely paralleled nest success, with 478 (25.9%) of 1,846 eggs successfully hatching (Table 13). Clutch size of successful and unsuccessful nests averaged 9.6 and 7.2 eggs respectively.

Table 12. Number and percent success of duck nests by species in each type of habitat.

Species	Grassland No. (%)	Greasewood No. (%)	Dense Nesting Cover No. (%)	Dike Bank No. (%)	Ditch Bank No. (%)	Agricult- ural No. (%)	Islands No. (%)	Emergents No. (%)	Total No. (%)
Pintail	23 (13.0)	11 (27.3)	4 (25.0)	2 (0.0)	1 (0.0)	3 (0.0)	16 (87.5)	1 (0.0)	61 (34.4)
B.W. Teal	27 (18.5)	4 (0.0)	9 (11.1)	1 (0.0)	1 (0.0)	-----	-----	-----	42 (14.3)
Gadwall	13 (46.1)	6 (0.0)	8 (12.5)	3 (0.0)	2 (0.0)	1 (0.0)	4 (75.0)	-----	37 (28.0)
N. Shoveler	12 (16.6)	1 (0.0)	7 (0.0)	-----	2 (0.0)	-----	-----	-----	22 (9.1)
L. Scaup	10 (10.0)	-----	2 (0.0)	-----	-----	-----	5 (60.0)	-----	17 (23.5)
Mallard	1 (100.0)	2 (100.0)	8 (37.5)	-----	-----	-----	5 (40.0)	-----	16 (50.0)
Redhead	2 (50.0)	2 (0.0)	1 (0.0)	-----	-----	-----	4 (25.0)	-----	9 (22.2)
A. Wigeon	3 (66.6)	-----	3 (33.3)	1 (0.0)	-----	-----	-----	-----	7 (42.8)
G.W. Teal	3 (33.3)	-----	-----	2 (0.0)	1 (0.0)	-----	1 (100.0)	-----	7 (28.5)
Canvasback	-----	-----	-----	-----	-----	-----	-----	4 (0.0)	4 (0.0)
Ruddy Duck	-----	-----	-----	-----	-----	-----	-----	2 (50.0)	2 (50.0)

Predation was the major cause of nest loss, accounting for 80.2% of all unsuccessful nests (Table 14). Potential nest predators known to occur on the study area included: striped skunk (Mephitis mephitis), red fox (Vulpes vulpes), coyote (Canis latrans), raccoon (Procyon lotor), long-tailed weasel (Mustela fronata), badger (Taxidea taxus), mink (Mustela vison), California gull, and ring-billed gull (Larus delawarensis).

Table 13. Egg success and average clutch size by duck species.

Species	No. of Eggs	% Hatched	Average Clutch Size	
			Successful	Unsuccessful
Pintail	451	35.0	9.3	6.4
B.W. Teal	329	10.3	5.8	6.3
Gadwall	316	26.3	11.9	6.2
Northern Shoveler	217	8.8	9.5	9.9
Lesser Scaup	149	25.5	9.5	8.5
Mallard	153	56.9	11.8	7.4
Redhead	81	23.5	12.0	8.1
American Wigeon	57	38.6	7.3	8.8
G.W. Teal	40	37.5	8.5	4.6
Canvasback	42	0.0	0.0	10.5
Ruddy Duck	<u>11</u>	<u>36.4</u>	<u>4.0</u>	<u>7.0</u>
Total	1,846	25.9	9.6	7.2

Table 14. Causes of unsuccessful duck nests.

Species	No. Nests	-----% Attributed to-----								Total
		Skunks	Canids	Raccoon	Avian	Unknown Predator	Deserted	Flooded	Other	
Pintail	40	42.5	25.0	---	7.5	---	12.5	5.0	7.5	100.0
B.W. Teal	34	70.6	17.8	---	2.9	2.9	2.9	---	2.9	100.0
Gadwall	27	70.4	3.7	14.8	---	3.7	3.7	---	3.7	100.0
N. Shoveler	20	50.0	25.0	---	---	10.0	---	15.0	---	100.0
L. Scaup	13	38.6	23.0	---	---	---	23.0	15.4	---	100.0
Mallard	7	28.6	14.3	14.3	14.3	---	14.3	14.3	---	100.0
Redhead	8	50.0	25.0	---	---	---	25.0	---	---	100.0
A. Wigeon	4	75.0	---	25.0	---	---	---	---	---	100.0
G.W. Teal	5	60.0	---	---	---	---	---	---	40.0	100.0
Canvasback	4	---	---	---	---	---	---	100.0	---	100.0
Ruddy Duck	1	---	---	---	---	---	---	100.0	---	100.0
Total	163	53.4	17.2	3.7	3.1	2.5	7.9	7.9	4.3	100.0

The striped skunk was the most abundant and destructive of predators on the area. Skunk predation was the major cause of nest loss for all land nesting species of ducks. Predation by skunks accounted for over one-half of all nest loss, and 70% of all loss due to predators.

Canid predators, the red fox and coyote, were the second most important factor in unsuccessful nesting. All other predators combined were responsible for less than 10% of the total nest loss.

Flooding caused the destruction of 13 nests. Four nests in emergent vegetation were flooded due to wave action and/or rising water levels and nine nests were destroyed by surplus return water from flood irrigated grain fields. Included in the "other" category were two nests destroyed by a road grader, four nests destroyed by spring plowing, and a single nest destroyed during nest search operations.

The relationships between distance of upland duck nests from the shoreline and nest success are shown in Table 15. Successful nests were located, on the average, more than twice the distance from water than unsuccessful nests. The average distance from water of all upland duck nests was approximately 95 m. Redhead and lesser scaup nests averaged the shortest distance from the shoreline. Among dabbling ducks the northern shoveler and blue-winged teal

nested closest and the gadwall and American wigeon farthest from the water.

Since predation was responsible for over 80% of all nest loss, it seems likely that variable nesting success with regard to distances of nests from the shoreline was a result of differential predation pressure. Mallards, gadwalls, and American wigeon nested farthest from the shoreline, experienced less predation and had above average nest success (Tables 12 and 15). Conversely, those species nesting close to the shoreline, such as northern shovelers and blue-winged teal, suffered greater predation and thus, experienced lower nest success. Redheads and lesser scaup, although nesting closest to the shoreline, had higher nest success than northern shovelers and blue-winged teal. The higher nest success of these species can be explained by their use (in addition to upland sites) of relatively secure island nest sites, thereby increasing their overall success.

Broods

Variations in water levels and the resultant changes in emergent vegetation were the major factors affecting the distribution of duck broods on the study area. During 1977, water levels on the study area were below average and many zones which typically contained shallow water emergent

Table 15. Average distances of upland duck nests from water.

Species	Successful		Unsuccessful		Combined	
	No.	Dist.(m)	No.	Dist.(m)	No.	Dist.(m)
Pintail	8	160.6	38	68.8	46	84.8
B.W. Teal	7	141.8	34	82.5	41	92.6
Gadwall	9	254.3	22	89.4	31	137.3
Northern Shoveler	2	107.3	21	65.3	23	68.9
Lesser Scaup	1	186.0	11	49.4	12	60.8
Mallard	6	135.6	5	75.4	11	108.2
Redhead	1	31.0	4	58.8	5	53.2
American Wigeon	3	157.3	4	101.0	7	125.1
G.W. Teal	<u>1</u>	<u>286.0</u>	<u>5</u>	<u>72.6</u>	<u>6</u>	<u>108.2</u>
Total	38	172.9	144	74.2	182	94.8

vegetation were dry. This phenomenon was particularly evident on the main lake, where relatively little emergent vegetation was present. Brood usage under such conditions was concentrated in the pond units, where emergents were abundant, or in the few areas of the main lake where narrow bands of emergent vegetation existed.

In 1978, a high water year, the major concentrations of broods were in the main lake. The low water levels of the previous year had stimulated a resurgence of emergent

vegetation which provided attractive brood areas.

The presence of easily accessible escape cover, in the form of shallow water emergents, was the predominant factor in determining the distribution of duck broods. Areas void of emergent vegetation, but with similar water depths and vegetation received little use by duck broods.

The locations of major duck brood areas in 1977 and 1978 are shown in Figure 5. Three major types of brood areas were identified on the basis of water depth and vegetational features.

Type "A" was the dominant type in both years. This type was present in areas with water depths less than 45 cm, supporting dense mats of submerged aquatic plants consisting of a mixture of sage pondweed (Potamogeton pectinatus) and wigeon grass (Ruppia maritima). Escape cover consisted of emergent alkali bullrush.

Type "B" had water depths up to 60 cm and the dominant submerged and emergent species were water milfoil (Myriophyllum exalbescens) and cattail, respectively. Floating mats of coontail (Ceratophyllum denersum) were present in a few areas.

Type "C" refers to a single area with softstem bullrush as the dominant emergent. Water depths in this type reached

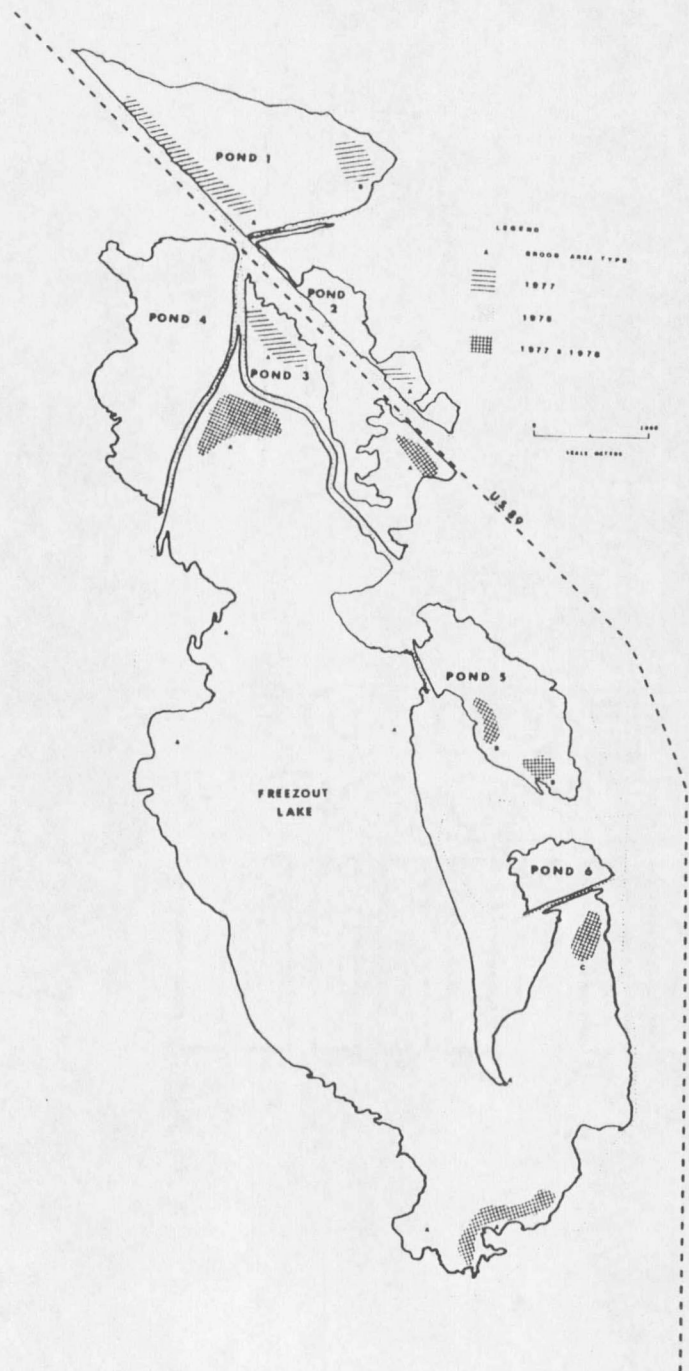


Figure 5. Locations of major duck brood areas.

90 cm, with sago pondweed as the dominant submergent. Alkali bullrush was also present in the shallower areas.

A total of 823 brood observations was made in the two years, with an increase of 36% from 1977 to 1978 (Table 16). The numbers of broods observed increased for all species except northern shovelers and canvasbacks. Average brood size was greater for all classes in 1978.

The increased production in 1978, was apparently a response of waterfowl to changes in available breeding habitat. Above average precipitation and below average temperatures occurred in the first five months of 1978 resulting in high water levels and increased shoreline length and irregularity (Table 17). These features, along with an abundance of temporary water bodies, may have accommodated greater numbers of territorial pairs, thus increasing the number of nesters and production of young on the area.

Hatching dates determined for all broods observed are shown in Table 18. Below average spring temperatures may have been responsible for the later hatching peaks in 1978, as compared to 1977. Eighty-five percent of all observed broods hatched during the months of June and July.

A comparison of average size of successful clutches to average size of Class I broods gives an indication of the

Table 16. Average size and age class of broods

Species	Class I		Class II		Class III		Total Breeds
	No.	Size	No.	Size	No.	Size	
Pintail	1977	11 6.4	18 4.7	29 4.9	58		
	1978	22 5.7	26 5.0	51 6.3	99		
B.W.Teal	1977	20 6.1	7 5.0	5 3.6	32		
	1978	14 7.4	11 6.7	20 5.3	45		
Gadwall	1977	39 5.7	71 4.9	25 6.8	135		
	1978	52 6.3	99 6.0	35 5.8	186		
Northern Shoveler	1977	17 5.5	18 4.8	8 4.4	43		
	1978	3 8.7	11 5.9	13 4.4	27		
L.Scaup	1977	9 7.7	16 6.9	5 7.4	30		
	1978	13 6.8	10 7.3	8 6.5	31		
Mallard	1977	6 7.7	3 4.0	10 4.3	19		
	1978	5 6.8	3 7.0	21 5.6	29		
Redhead	1977	-- --	-- --	-- --	--		
	1978	-- --	5 5.8	-- --	5		
A.Wigeon	1977	4 7.0	8 3.5	1 4.0	13		
	1978	3 6.6	8 5.9	9 5.1	20		
G.W.Teal	1977	1 6.0	-- --	1 4.0	2		
	1978	1 4.6	3 5.3	1 4.0	9		
Canvas-back	1977	2 5.0	7 5.9	6 4.6	15		
	1978	1 6.0	4 6.8	4 5.3	9		
Ruddy Duck	1977	2 4.0	2 4.0	-- --	4		
	1978	4 4.3	10 3.9	-- --	14		
Subtotal	1977	111 6.1	148 5.1	90 5.3	349		
	1978	119 6.4	189 5.9	166 5.6	474		
Total					823		

overland mortality occurring between the nest site and the water (Table 19). Generally speaking, those species which nested farthest from the water suffered highest mortality. These data suggest that in those nests located farther from the water, the higher nest success (Table 15) may be offset by a greater brood mortality.

Table 17. Average temperatures and precipitation at Fairfield, Montana 1977 and 1978.

Month	Temp. (F°)		Departure		Precip.		Departure	
	Average		Normal		Average		Normal	
	1977	1978	1977	1978	1977	1978	1977	1978
January	22.4	10.6	1.4	-10.4	0.57	0.57	0.14	0.14
February	39.1	19.1	-11.8	- 8.2	0.03	0.33	-0.36	0.06
March	33.9	35.5	2.8	4.4	0.20	0.54	-0.38	-0.04
April	48.5	30.6	5.7	- 8.2	0.02	1.73	-0.86	0.84
May	51.8	50.8	- 0.1	- 1.1	2.83	3.49	0.61	1.27

Mortality calculations from Class I to Class III were 13.1 and 12.5% in 1977 and 1978, respectively. These figures represent a minimum mortality as some combining of Class III broods was known to occur.

Table 18. Hatching dates of broods observed in 1977 and 1978.

Species	April		May		June		July			August		
	21-30	1-10	10-20	21-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20
Pintail												
1977	--	1	11	20	11	11	3	1	--	--	--	--
1978	1	19	26	5	30	15	3	--	--	--	--	--
B.W.Teal												
1977	--	--	--	--	3	4	13	7	2	2	--	--
1978	--	--	--	1	3	5	13	19	3	2	1	--
Gadwall												
1977	--	--	--	--	15	38	38	28	0	6	1	--
1978	--	--	--	1	3	30	69	32	32	17	2	--
N.Shoveler												
1977	--	--	--	3	11	9	10	9	1	1	--	--
1978	--	--	1	2	8	6	3	4	2	1	--	--
L.Scaup												
1977	--	--	--	--	--	--	7	18	3	1	1	--
1978	--	--	--	--	1	2	1	15	9	3	--	--
Mallard												
1977	--	--	2	3	5	5	4	--	--	--	--	--
1978	--	--	4	1	8	11	--	3	--	--	2	--
Redhead												
1977	--	--	--	--	--	--	--	--	--	--	--	--
1978	--	--	--	--	--	--	4	--	1	--	--	--
A.Wigeon												
1977	--	--	--	--	--	--	8	3	2	--	--	--
1978	--	--	--	--	--	2	8	9	1	--	--	--
G.W.Teal												
1977	--	--	--	--	1	1	--	--	--	--	--	--
1978	--	--	--	--	--	--	2	3	3	1	--	--
Canvasback												
1977	--	--	--	4	5	5	1	--	--	--	--	--
1978	--	--	--	--	3	4	2	--	--	--	--	--
Ruddy Duck												
1977	--	--	--	--	--	--	--	--	1	1	2	--
1978	--	--	--	--	--	--	--	--	1	1	6	6

Table 19. Overland mortality of duck broods.

Species	Nest Dist. from Water	Hatched Clutches Ave. Size	Class I Brood Size	Overland Mortality (%)
Pintail	160.6	9.3	5.6	39.0
B.W. Teal	141.8	5.8	5.2	10.3
Gadwall	254.3	11.9	6.3	46.9
N. Shoveler	107.5	9.5	8.7	8.8
L. Scaup	186.0	9.5	6.8	28.8
Mallard	135.6	11.8	6.5	42.8
Am. Wigeon	157.3	7.3	6.6	10.0
G.W. Teal	286.0	8.5	4.6	45.9
Average	172.9	9.2	6.1	33.7

Fall Migration and Hunter Harvest

The 1978 fall migration chronology for waterfowl at Freezout Lake is shown in Figures 6 and 7. Fall migration patterns for whistling swans, snow geese, and Canada geese were similar, with peak numbers for each species occurring just prior to freeze-up. Peak migration numbers of 3,000, 3,500, and 1,500 were noted for whistling swans, snow geese, and Canada geese respectively. Approximately twice this number of swan and ten times this number of snow geese

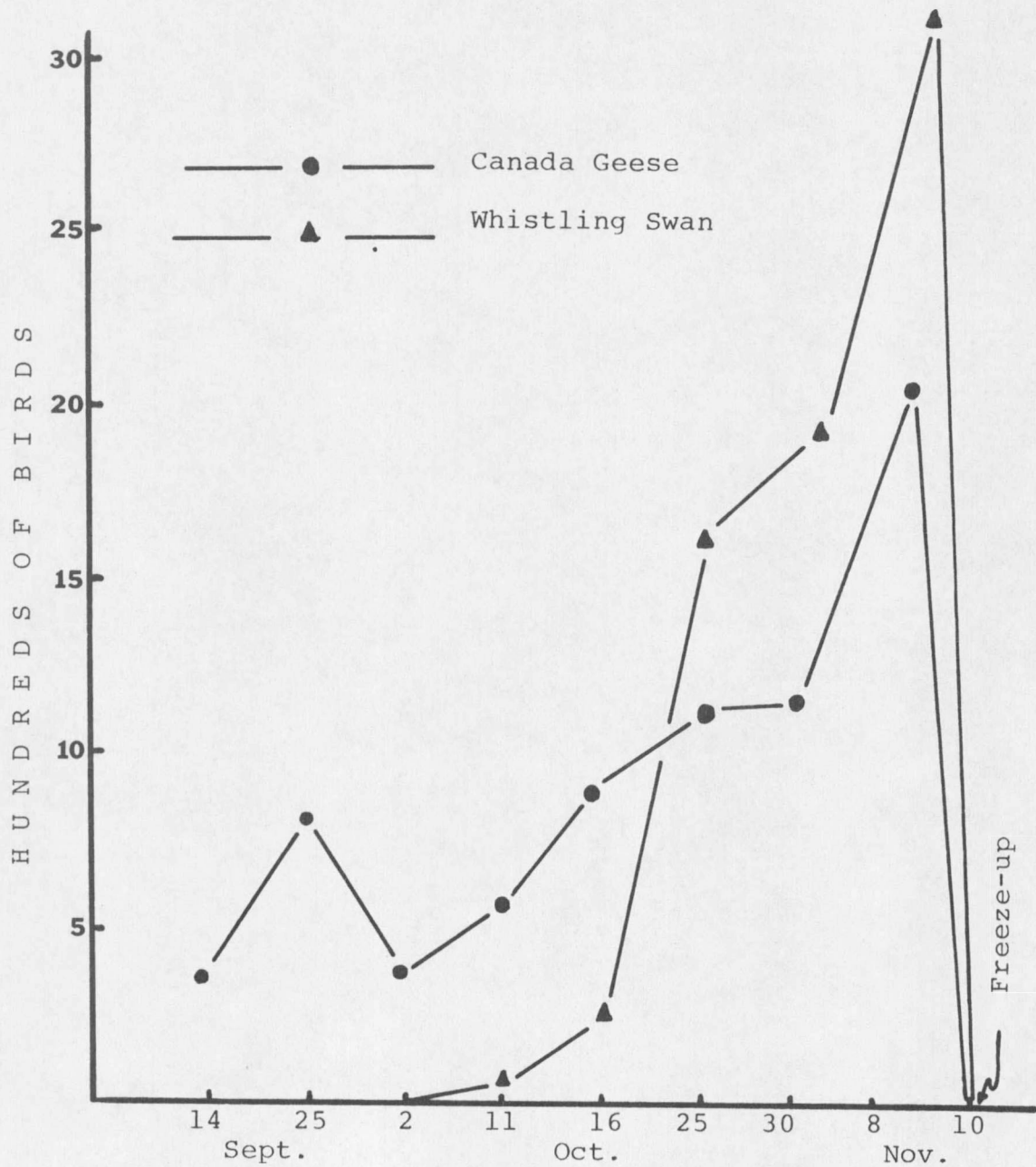


Figure 6 - Chronology of fall migration of whistling swans and Canada geese, 1978.

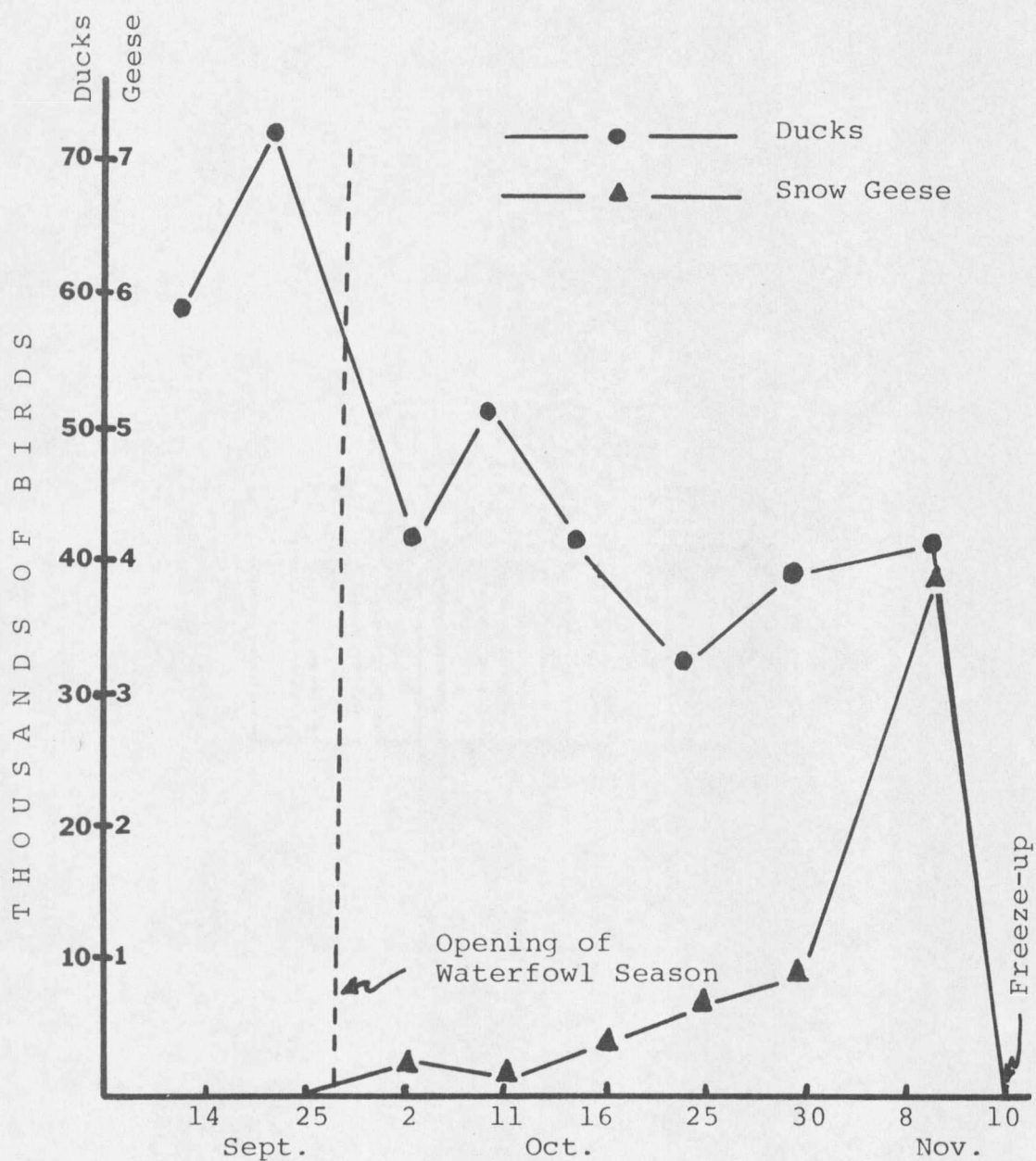


Figure 7 - Chronology of fall migration of snow geese and ducks, 1978.

normally occur on the study area during the fall migration (Dale Witt, pers. comm.). Unusually warm fall temperatures followed by a rapid freeze caused an overflight of large numbers of these species. During and shortly following freeze-up, large flocks of whistling swans and snow geese passed over the study area, but failed to stage there, presumably because of cold temperatures and a lack of open water.

The majority of the harvest of whistling swans and snow geese occurred in late October and early November when these species were present in their greatest numbers. Canada geese, however, were harvested most heavily during the first two weeks of the season when their numbers were lowest. Shortly following opening of waterfowl season, most Canada geese moved into, and remained in, the portion of the study area closed to hunting. As a result, late season hunting pressure on these geese was light.

Duck numbers on the study area peaked in late September, when an estimated 75,000 were present. Between 70 and 80% of all ducks present at that time were field feeding mallards and pintails. Green-winged teal, American wigeon, and gadwalls also participated in field feeding, but to a lesser extent.

The presence of unharvested grain fields, in areas closed to hunting, contributed to the maintenance of a base

population of about 25,000 field feeding ducks throughout the 1978 fall hunting season. However, this population provided few hunting opportunities since both feeding and resting spots for these ducks were adjacent to one another and closed to hunting. Limited hunting for these birds occurred in fields adjacent to, and along the boundaries of the closed area.

Duck numbers decreased substantially immediately following the opening weekend of waterfowl season. A slight increase in duck numbers during the week following opening weekend, resulted from a second influx of field feeding pintails. Thereafter, duck numbers again decreased with the departure primarily of pintails, teal, and gadwalls, until 25 October when an estimated 30,000 birds were present. A resurgence in duck numbers in late October and early November was due primarily to an increase in mallards, although peak numbers of lesser scaup, canvasbacks, and redheads also occurred at this time.

Waterfowl usage of the area ended dramatically with a rapid freeze of the entire study area. On 9 November temperatures began to drop, and by the morning of 11 November there were no ice-free areas present.

Hunter utilization and waterfowl harvest was determined by 860 personal interviews (Table 20). The opening weekend phenomenon was evident, with 18% of the season's pressure

Table 20. Hunter utilization and waterfowl harvest

Items	(2) ^a Opening Weekend	(10) Other Weekends	Weekdays (30)	All Days Combined
No. Vehicles	295	730	610	1,635
No. Hunters/Vehicle	2.01	1.94	1.86	1.92
Est. No. Hunters	593	1,416	1,134	3,143
No. Interviewed	295	196	269	760
Ave. Kill/Hunter	3.05	1.11	1.44	1.70
Est. Harvest	1,809	1,575	1,634	5,018

^a = number of days

and 36% of the harvest occurring in two days. Hunter success (number of ducks per hunter) was twice as great on opening weekend than at other times during the season. Success of weekday hunters exceeded that of weekend hunters during the remainder of the season.

Hunting pressure, as determined by vehicle counts, was distributed almost evenly at major access points on the opening weekend of the season. This self distribution by hunters was apparently an effort to reduce crowding and did not reflect the distribution of waterfowl.

Hunting pressure during the first three weeks of October was greatest at access points 1, 2, and 3 (Figure 8).

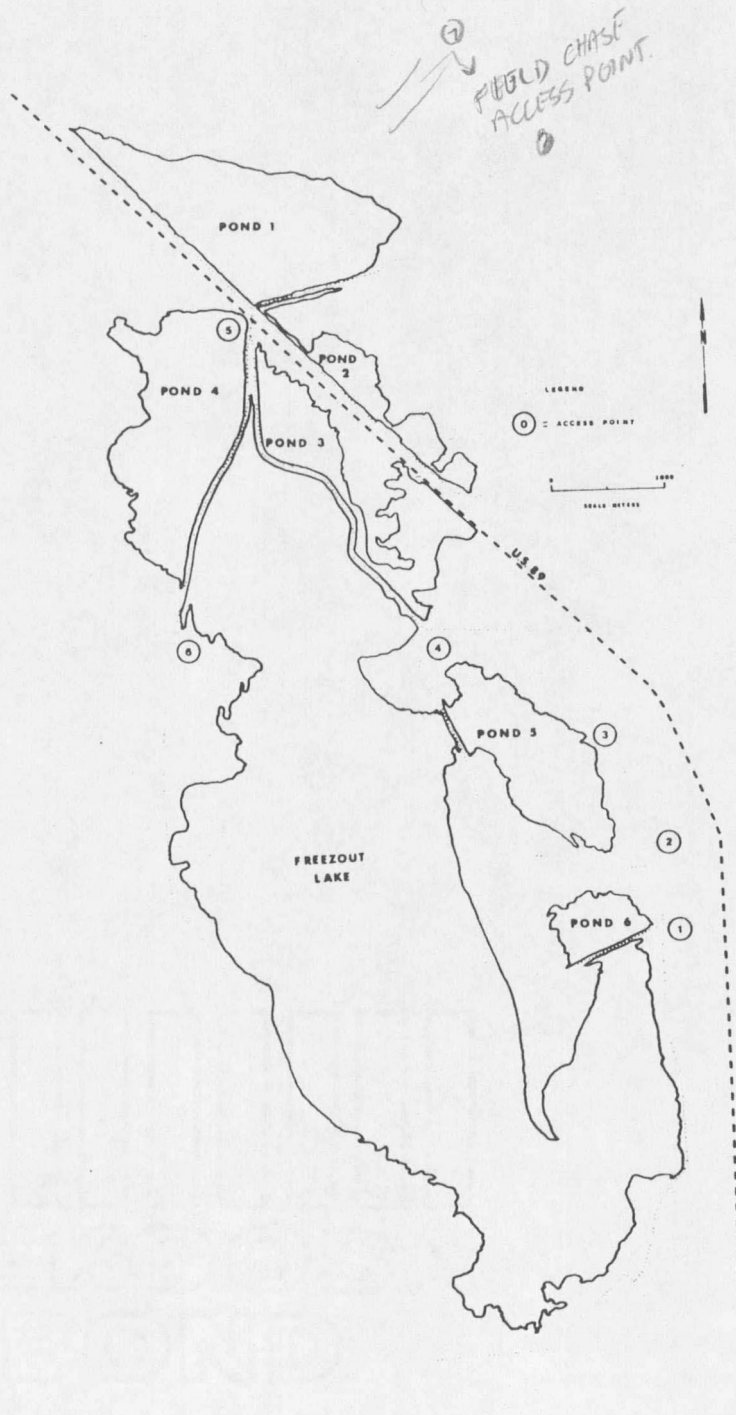


Figure 8. Locations of major hunter access points.

With the arrival of whistling swan and snow geese in late October, the majority of the pressure shifted to access points 4, 5, and 6. With the exception of late season hunting for whistling swans and snow geese, the overall distribution of hunters on the area seemed more related to such factors as ease of access, traditional use and/or the desire to avoid other hunters, than to the actual distribution of the waterfowl.

The species composition of waterfowl checked during the 1978 hunting season is given in Table 21. Over 55% of the total season's harvest consisted of mallards and pintails.

A comparison of species composition in the duck population to that of the bag is as follows: northern shovelers, gadwalls, American wigeon, common goldeneye, blue-winged teal, and ruddy ducks all made up a larger percentage of the harvest than of the actual population. Mallards, pintails, green-winged teal, and the remaining diving ducks made up a larger percentage of the population than of the bag.

Bag check data did not realistically reflect the numbers of snow, Ross', or Canada geese harvested. The majority of the hunting for these species involved field shooting, often at some distance from the study area. As a result, a majority of the harvest for these species went unreported.

Table 21. Species composition of waterfowl checked during the 1978 waterfowl season

Species	Opening	Weekend	Season Total	
	No.	%	No.	%
Pintail	183	15.0	292	15.8
B.W. Teal	83	6.8	103	5.6
Gadwall	108	8.9	168	9.1
Northern Shoveler	62	5.9	145	7.8
Lesser Scaup	16	1.3	42	2.3
Mallard	587	48.4	737	39.9
Redhead	8	.7	9	.5
American Wigeon	21	1.7	67	3.6
G.W. Teal	19	1.6	44	2.4
Canvasback	75	6.2	104	5.6
Ruddy duck	14	1.2	20	1.1
Common Goldeneye	11	.9	13	.7
Ring-necked Duck	--	--	2	.1
Bufflehead	3	.3	20	1.1
Snow Geese	--	--	13	.7
Ross' Geese	--	--	2	.1
Canada Geese	12	1.0	29	1.6
Whistling Swan	--	--	37	2.0
Total	1,213	100.0	1,847	100.0

Hunter questionnaires were attached to the 500 whistling swan permits issued by the Montana Fish and Game Department in 1978. Returns from 363 questionnaires indicated that approximately 125 whistling swans were shot on the study area in the fall of 1978. Success of those permit holders who actually hunted was 50%, and the average hunting time required to bag a swan was 4.6 days.

DISCUSSION AND CONCLUSIONS

Major changes in the nature and extent of waterfowl usage of Freezout Lake have occurred since its development as a waterfowl management area. A comparison of data obtained in this study to that of previous studies highlights the changes which have occurred and provides a basis for future management recommendations.

Spring Migration

The most obvious change in spring migration on the study area, since development was initiated in 1953 by the Montana Department of Fish and Game, has been an increase in overall waterfowl usage. Ellig (1955) estimated 18,200 birds present during the peak of spring migration. This represents approximately one-half the number of birds present during this study.

Several reasons may account for the increased use of the area by waterfowl. One factor influencing spring waterfowl numbers may be the changes which have occurred in available waterfowl habitat outside the study area. In the Rocky Mountains where waterfowl habitats are large but limited in distribution, migration corridors tend to be narrow (Bellrose 1969). Intensification of land use has resulted in a constant diminishing of waterfowl habitat throughout the

temperate zones of North America. Under conditions of shrinking habitat, large permanent water bodies, within a migration corridor, provide reliable, and therefore more heavily used, spring migration staging areas.

Another potential factor influencing spring waterfowl numbers may be the changes in the physical features of the study area associated with developments. The placement of control structures has resulted in more stable water levels throughout the study area. This stabilization, particularly in shallow water zones, may have led to an increase in submergent vegetation, thereby increasing the food supply for non-field feeding waterfowl.

In addition to an increased attractiveness to transient waterfowl, other changes affecting the resident population have occurred. Ellig (1955) reported total surface area of water and shoreline length to be 4,100 ac (1,600 ha) and 21.8 mi (35 km), respectively. At the present time surface area and shoreline are 1,900 ha and 77 km, respectively. Although surface hectarage of water has increased relatively little, shoreline length has more than doubled. This increase in shoreline length has resulted primarily from the construction of retention dikes which have divided the water area into smaller pond units. Hochbaum (1944) showed a nearly direct relationship between the numbers of territorial

pairs of ducks which a water body will accommodate and the length of available shoreline. Thus, a portion of the increase in the spring duck population on the study area may be explained by a greater accommodation of territorial pairs, associated with greater available shorelines.

Vegetation Analysis

Ellig (1955) discussed plant coverage and species composition existing on the study area. The major types of habitat, grassland and greasewood, were heavily grazed at that time. Shrub canopy coverage in the greasewood type and total plant coverage in both types have since decreased (Table 22).

Table 22. A comparison of vegetational data taken at Freezout Lake in 1952 and 1978.

Item	1952 (%)	1978 (%)
Shrub Canopy Coverage in Greasewood	19.3	14.1
Total Plant Cover in Greasewood	26.3	21.2
Total Plant Cover in Grassland	54.3	36.2

The removal of heavy grazing pressure, coupled with extended nonuse, may be responsible for the overall reduction

in plant cover in the greasewood type. Richard (1965, 1967) in describing undisturbed stands of greasewood, discussed the ability of this shrub to concentrate large amounts of salt in its leaves, which eventually resulted in a "salt shadow" when leaf drop occurred. This "salt shadow" inhibits the germination of other plants in areas adjacent to the shrub, thereby preventing competition for water under saline soil conditions. In the absence of any habitat manipulation, a trend develops towards fewer shrubs with larger stature.

The observed decline in total plant cover in the grassland type is a predictable one under conditions of long term idling. Dyksterhuis and Schmutz (1947) found that grasslands idled for long periods of time produced less upright green herbage and had more litter than those which had been disturbed by grazing. The importance of these changes in the grassland and greasewood habitat types will be discussed later as they relate to nesting.

Nesting Study

Hook (1973) described the development of a breeding population of Canada geese at Freezout Lake and the status of this population in 1971, 1972, and 1973. He suggested that production of young seemed to have stabilized at about

200 goslings per year, with nest predation and limited numbers of secure island nest sites dampening population growth.

Gosling production in the current study was calculated at 459 birds, or over twice that reported by Hook (1973). A comparison of nesting data from these two studies indicates that the increased production was due to greater nest densities, more available nest sites, and increased nest success. Hook (1973) reported that approximately 50% of all available islands were used for goose nesting, with typically a single nest per island. In the present study, utilization was again near 50%; but increased nesting pressure resulted in many islands containing more than one nest. Ewaschuk and Boag (1972) reported instances of densely nesting Canada geese. They found that with increased densities, desertion rates also increased, presumably because of intraspecific interactions. The increased nesting density in the present study, over that recorded by Hook (1973), has not been at the expense of nest success, as over 90% of all goose nests successfully hatched.

Another factor contributing to the increased production of Canada geese on the study area has been the use of previously unexploited nest sites. Thirteen nests of Canada geese were located on muskrat lodges in 1978, while Hook (1973)

reported no usage of such sites. Geese using muskrat lodges had smaller clutches and experienced lower nest and egg success (Tables 5 and 6). These data, plus the recent exploitation of these sites, suggests an expansion into these areas by an age class expressing first nesting attempts.

The status of the future breeding population of Canada geese will likely be a reflection of the available nesting habitat. If a continued increase in population levels is desired, efforts should be made not only to maintain the security levels of currently available nest sites, but also to increase the number of future sites through water level manipulation and island construction.

Overall success of upland duck nests was 19.6%, somewhat less than the 26.3% reported by Ellig (1955). Kalmbach (1939) suggested that areas managed for waterfowl nesting could achieve nest success on the order of 70%. Keith (1961) in a review of various nesting studies, suggested that hatching success of 39% would, with renesting, be more than adequate to maintain population levels. Using these criteria, the nest success of upland duck nests at Freezout Lake would be insufficient to maintain population levels, and is certainly below the potential of an area managed specifically for waterfowl. A comparison of the low success of upland nests to the relatively high success (68.6%) of island nests

indicates that a major factor limiting the productivity of upland nesting habitats is low security levels resulting in high predation losses.

Bellrose and Low (1978) pointed out that a major challenge in future waterfowl management will be to produce more ducks per unit area of existing waterfowl habitat. Increased production of waterfowl on the study area should be considered a major management objective. Habitat conditions most favorable in waterfowl reproduction and survival should be identified, following by the manipulation of available resources to achieve these conditions.

Greasewood dominates the vegetation throughout the interior of the study area with the majority of this type of habitat in close association with water on all sides. The majority of the duck nests found in the greasewood type by Ellig (1955) and during the present study were located under greasewood plants. If, as mentioned earlier, both the number of greasewood plants and the amount of adjacent plant cover are declining, then the attractiveness and security of this type to nesting ducks can also be expected to decline. Efforts should be made to enhance the attractiveness of this type of habitat, either by manipulation of native vegetation or its replacement by exotic planted nesting cover.

Grasslands are the dominant nesting habitat on the perimeter of the study area. The age of grassland communities, and thus their successional stage, influences their attractiveness and security levels as nesting habitat. Kirsch et. al. (1978) pointed out that periodic disturbances of nesting habitat are necessary to maintain the vigorous growth of early seral stages which is most attractive to nesting ducks. This disturbance is related to the balance between litter buildup and decomposition (Dyksterhuis and Schmultz 1947). Miller (1971) reported that lands idled for longer than four years had substantially poorer duck nest success than those idled less than four years.

The grasslands at Freezout Lake have been subject to long-term nonuse. A 33% decrease in total plant coverage in this habitat type has occurred since Ellig's (1955) study. Kirsch and Kruse (1972) demonstrated increased duck nest success and a greater diversity of upland nesting game birds on grasslands which had been disturbed by prescribed burns. Leo Kirsch (unpublished data) reports that North Dakota grasslands burned as often as three times in eight years still produced more wildlife, including non-game species, than untreated or lightly grazed areas.

Prescribed burning provides an inexpensive yet effective

method which could be used on grasslands to recycle nutrients and stimulate the vigorous growth typical of early successional stages. The intervals at which disturbances are required varies with the productivity of area (Kirsch et. al. 1978). The establishment of experimental burn plots and monitoring of waterfowl nesting responses over a period of time would provide the managing agency with information necessary to maintain grassland nesting habitat in its optimal condition.

The importance of residual cover for upland nesting ducks is well documented (Martz 1967, Kirsch 1969, Oetting and Cassel 1971), Jarvis and Harris 1972, and Deubbert and Kantrud 1974). Although observed nest densities in this study did not correlate well with measurements taken of residual cover (Tables 2 and 8), it is not felt that this indicates a lack of preference for residual cover by nesting ducks. Miller and Johnson (1978) point out that nest search methods which rely on flushing hens, such as the one used in this study, often result in an underestimation of nest densities. Using such methods, only those nests actively attended by an incubating female are located, while those destroyed prior to search operations go unnoticed. Nest success in this study was inversely related to residual cover, indicative of higher predation on areas with heavy

residual cover. Because of this relationship, it is likely that actual nest densities were substantially higher in areas with heavy residual cover than those estimated. If this is the case, those areas which support substantial amounts of residual cover, such as planted nesting cover areas should receive special attention to determine the reasons for low nest success.

One factor known to influence nest success is the size and shape of nesting cover areas. Kirsch (1969) found narrow strips and small clumps of idled nesting habitat to be especially vulnerable to predation. Deubbert and Lokomoen (1976) indicated that idle plantings between 16 and 65 ha provided both attractive and secure nesting cover. The majority of the planted nesting cover areas at Freezout Lake are long narrow strips or small clumps and the average size is below 10 ha. Increasing the size and/or changing the configuration of these nesting cover areas should result in a more secure and attractive nesting habitat.

On an area basis, islands were the most productive nesting habitat (Table 11). Degradation of some islands is currently occurring through the interaction of two factors. Heavy use of some islands by colonial nesting ring-billed and California gulls has denuded them of vegetation, which

enhances soil erosion by wave action, eventually resulting in destruction.

Odin (1957) described the use of islands by nesting gulls on a state bird refuge in Utah. Not only was the presence of gulls contributing to island erosion, but they also are significant predators on waterfowl eggs. Dietz (1967, working in the same area, demonstrated an increase in duck production after discouraging gull nesting. A regrowth of vegetation on islands previously used by nesting gulls, discouraged recolonization by gulls and attracted nesting ducks. Vermeer (1968) reported that fledging success was nil among ducks nesting on islands with California gulls.

The displacement of gull nesting from islands to mainland areas could be beneficial in several ways. It would allow for regrowth of vegetation, making the area more attractive to nesting ducks and reducing its susceptibility to erosion via wave action. Also the displacement of gulls to different nesting areas would lessen the chance of nest and duckling losses.

While nesting habitat manipulation provides the best means of increasing the long term productivity in many waterfowl breeding areas, other management tools are available which, when used in conjunction with habitat management, can maximize the productivity of an area.

Balzer et. al. (1966), after witnessing a 60% increase in Class I ducklings on a predator control unit, suggested that such control is justified if a major management objective is to maximize waterfowl production and serious predator losses are known to occur. Deubbert and Kantrud (1974) stated, "the rational reduction of predators can be justified to obtain high duck production on areas devoted to special management which contain excellent nesting cover and dense breeding populations." Idle grasslands on their study area produced four times as many ducklings in units where predators were reduced.

That serious predation losses occur at Freezout Lake is evident from Ellig (1955) and the present study. Ellig (1955) found that skunk removal alone, using a trapline, could result in nest success increases of 786%.

The feasibility of a predator control program in areas of prime nesting habitat should be investigated. In order to be effective a predator control program should operate concurrently with a nesting study to monitor waterfowl responses to reduced predation and to determine if compensatory losses are occurring.

Another factor which contributed to low nest success on the study area was human activity. Nine nests were destroyed when surplus irrigation water from grain fields was allowed

to drain into nesting cover. The placement of a collecting ditch at the lower ends of irrigated fields and a more careful monitoring of irrigation water could easily rectify this problem.

Broods

The brood areas present on the study area appear sufficient for the current levels of waterfowl production. A single feature common to all the brood areas is the presence of escape cover in the form of shallow water emergent vegetation. Should waterfowl production increase in the future, it may be desirable to create more brood areas. Kaldec (1962) described the use of drawdown as a technique to recycle nutrients and promote growth of emergent vegetation. Experimentation with drawdown on areas which currently contain little emergent vegetation, such as pond unit 4, could test the effectiveness of this technique in developing brood areas.

Species composition of broods observed has changed somewhat in the past 25 years. Ellig (1955) reported pintails as the most commonly observed species, followed by gadwalls. In the present study gadwall broods were far more abundant than those of other species. Gadwalls seek tall dense vegetation for nesting more than do other dabbling ducks (Bellrose 1976) and have been found to prefer dike and ditch banks

for nest sites (Gates 1962). Changes in the study area associated with development, such as dike construction and the planting of dense nesting cover, may have promoted the proportionate increase of gadwalls in the nesting population.

Fall Migration and Hunter Harvest

The development of Freezout Lake for public hunting has been a major accomplishment in the area's management. Hunting pressure has increased 425% in the past 27 years, with no significant reduction in hunting success. In 1978, the area provided over 3,000 hunter-days.

The majority of the waterfowl hunters interviewed resided in nearby Cascade County; however, use by hunters from throughout the state is common. The position of Freezout Lake as the single largest staging area for snow geese in Montana and the allowance of hunting for whistling swans add to the attractiveness of the area to waterfowl hunters from throughout the state.

With the possible exception of snow goose hunting, the study area seems to provide hunting opportunities equal to those reported by Ellig (1955). Date Witt (pers. comm.) reports that the staging of snow geese for longer periods in southern Canada has delayed their migration through the study area by several weeks over the past two decades. Considering

that hunting ends at approximately the same time each year due to freeze-up, this delayed migration of snow geese substantially shortens the period during which they are available to hunters on the area. In years in which freeze-up occurs nearly simultaneously in southern Canada and northern Montana, the majority of the fall flight of snow geese fails to stage on the study area, and hunter harvest is negligible.

As future demands for public shooting areas increase, management efforts directed at maximizing hunting opportunities for Montana sportsmen will be needed. In anticipation of these future demands, current hunting management programs should be evaluated in an effort to provide the maximum hunting opportunities consistent with the overall management of waterfowl on the area.

APPENDIX

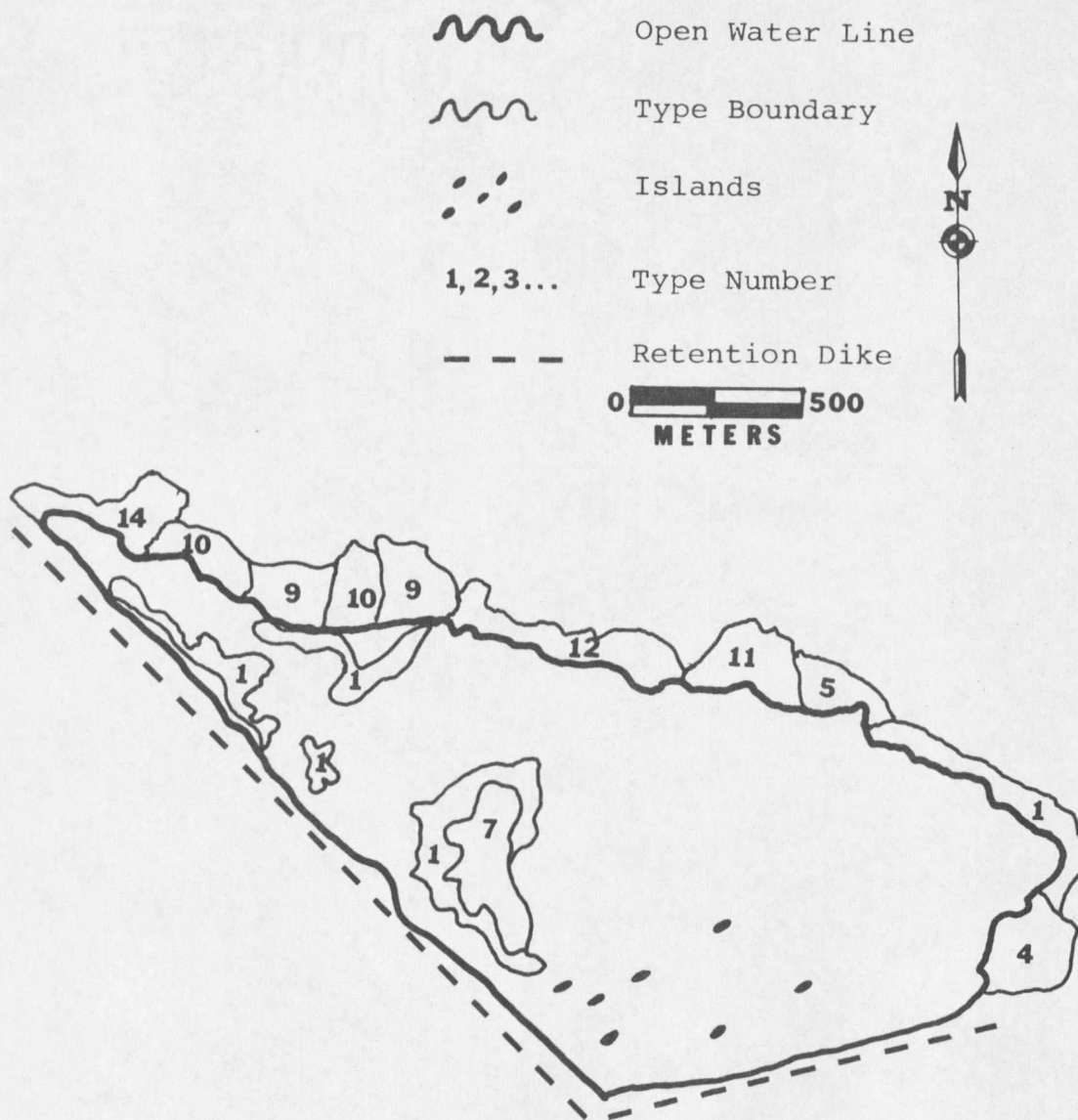


Figure 9. Distribution of vegetation types in the emergent and riparian zones of Pond 1 (see Table 23)

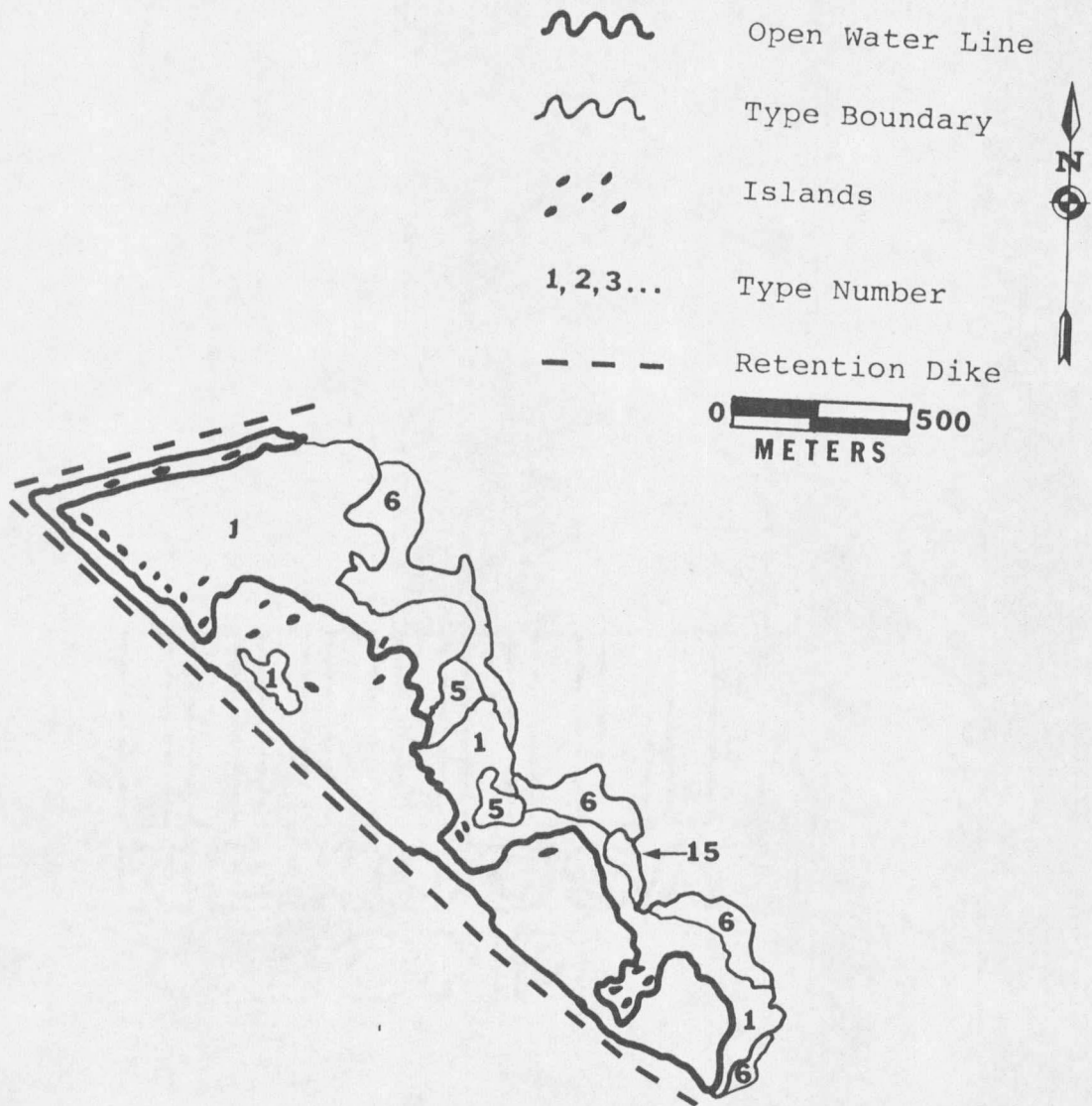


Figure 10. Distribution of vegetation types in the emergent and riparian zones of Pond 2

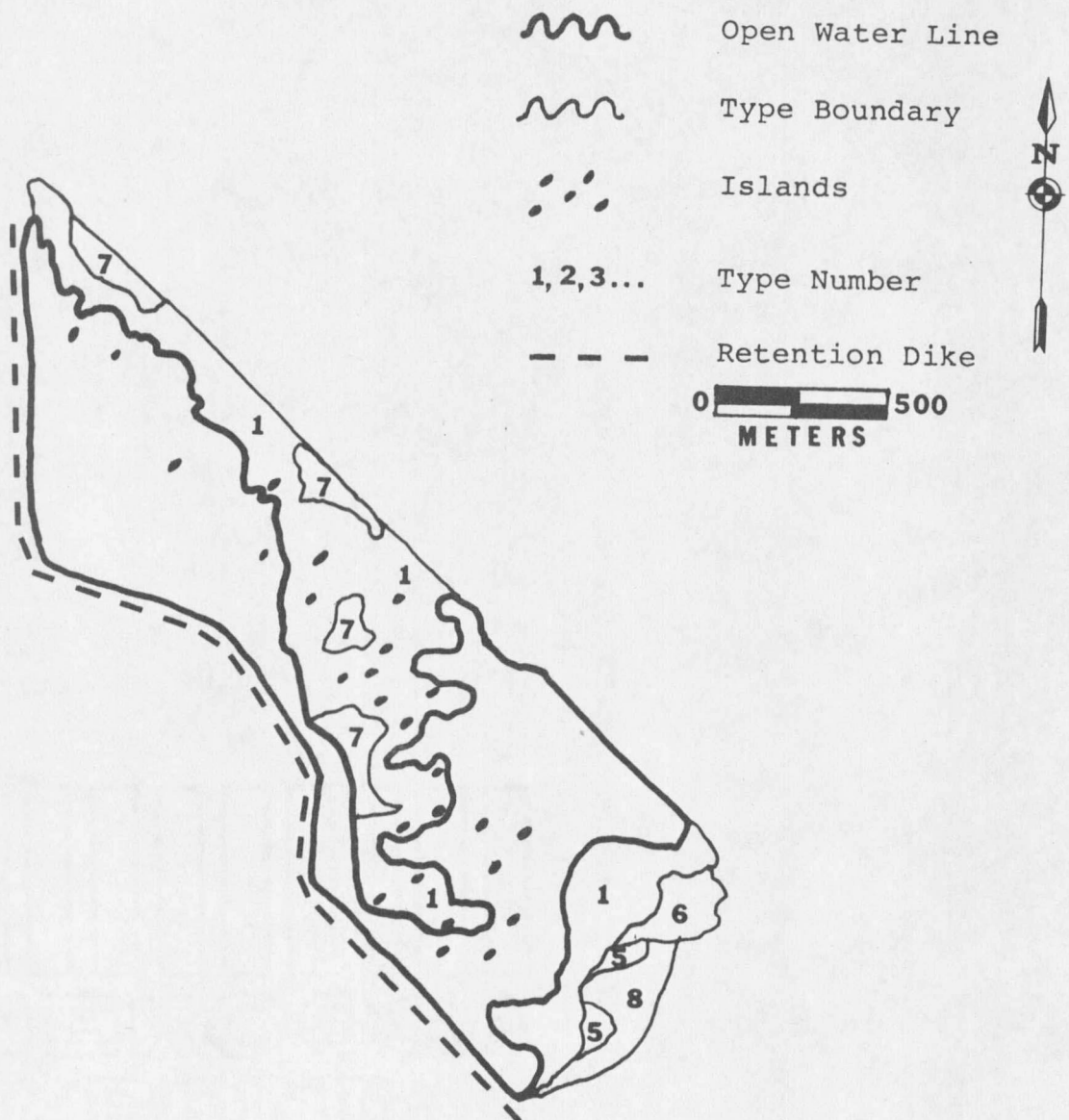


Figure 11. Distribution of vegetation types in the emergent and riparian zones of Pond 3

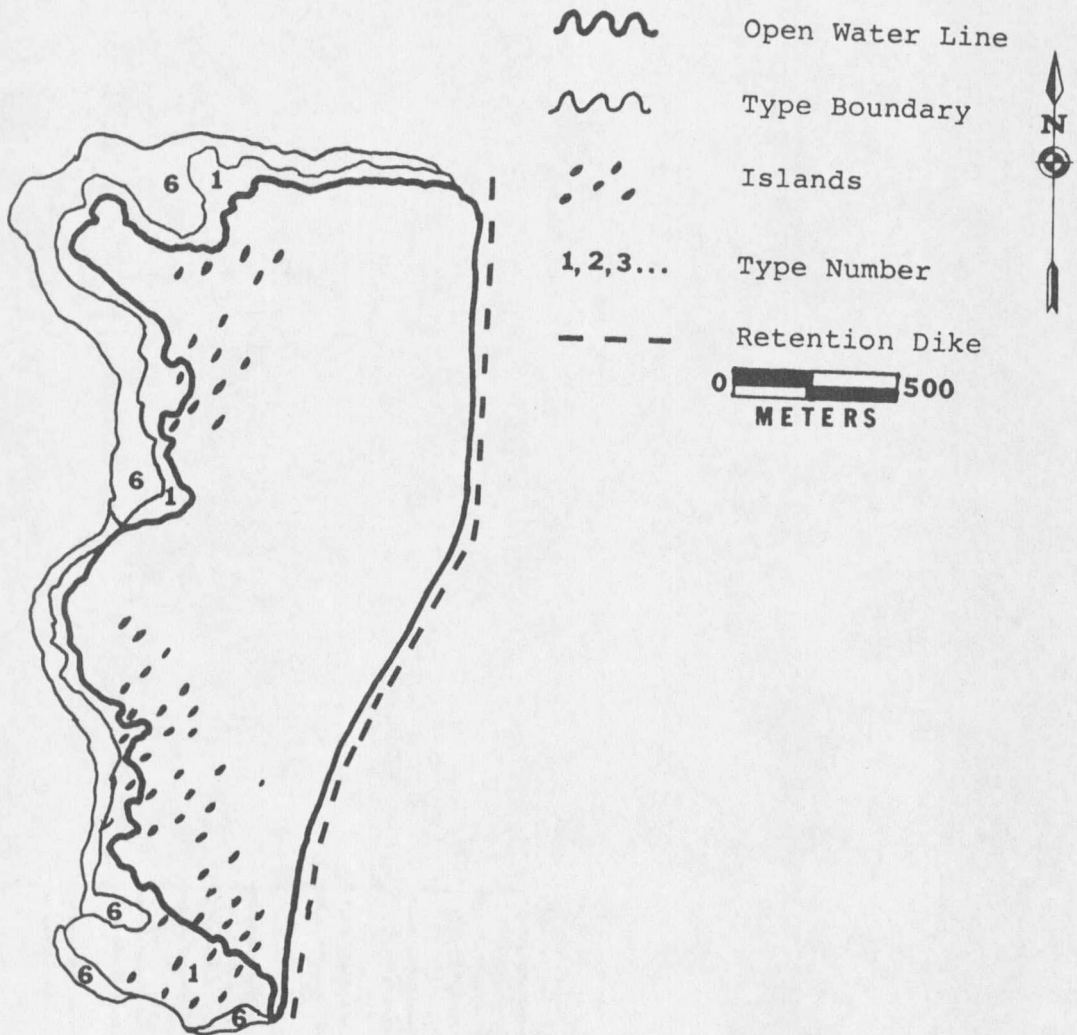


Figure 12. Distribtuion of vegetation types in the emergent and riparian zones of Pond 4.

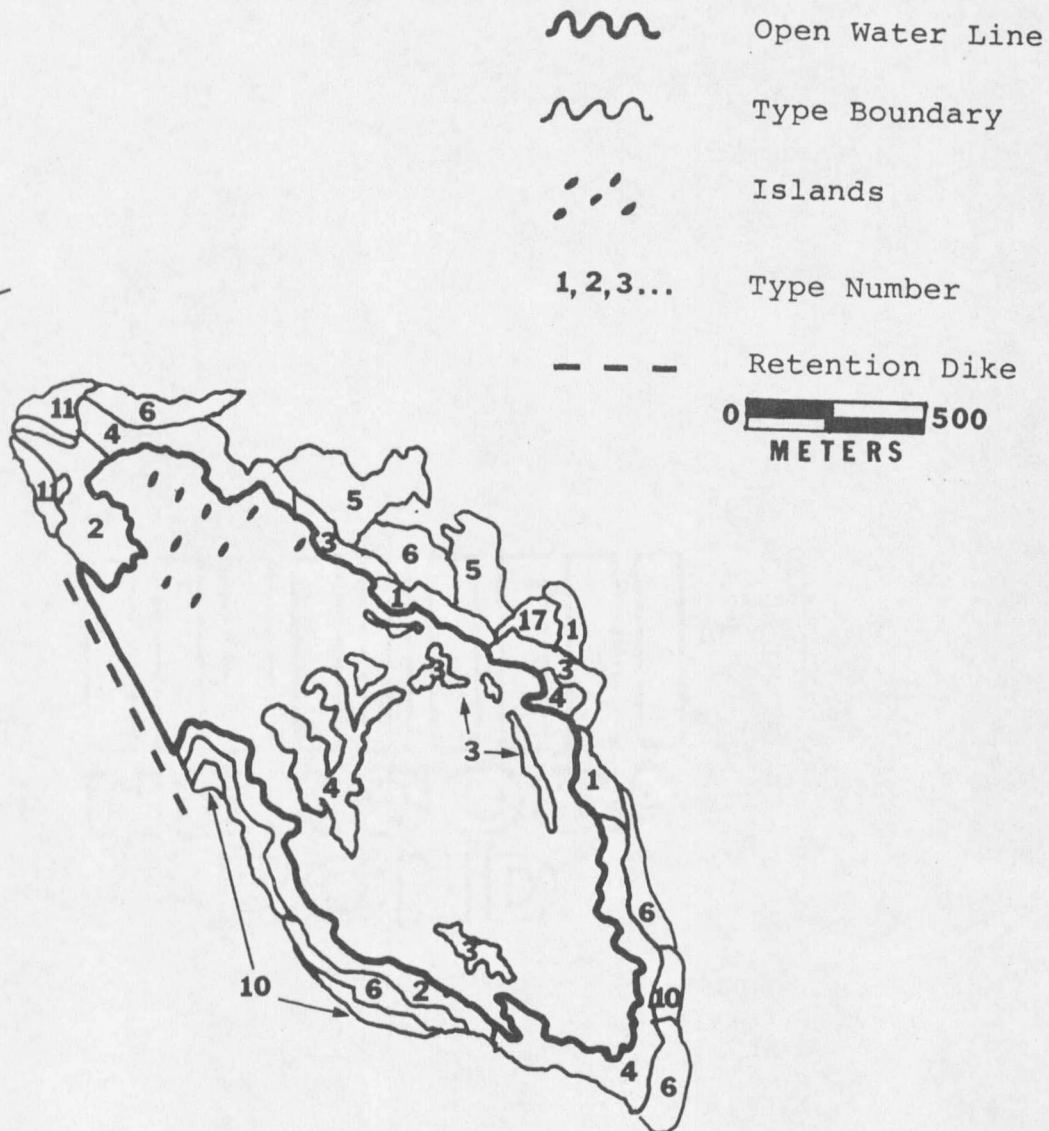


Figure 13. Distribution of vegetation types in the emergent and riparian zones of Pond 5

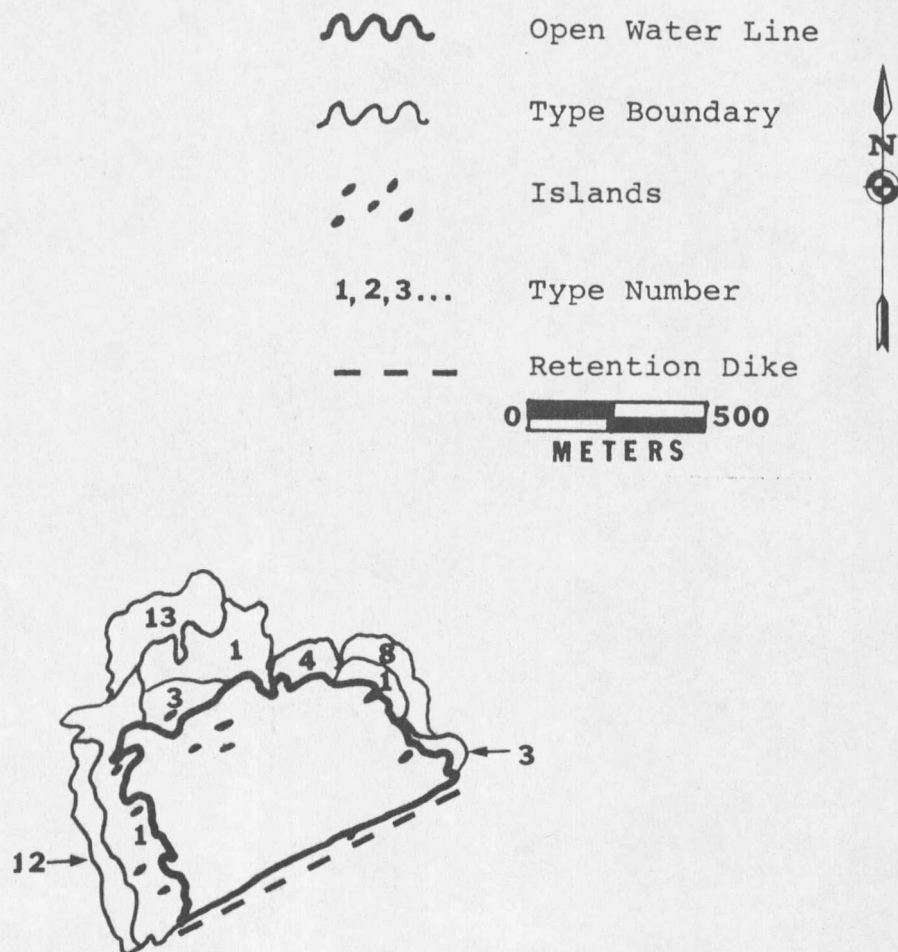


Figure 14. Distribution of vegetation types in the emergent and riparian zones of Pond 6

Table 23. Plant species present in vegetation types in riparian and emergent zones.

Type Designation No.	Dominant Species	Others Commonly Occurring
1.	<u>Scirpus paludosus</u>	---
2.	<u>Scirpus paludosus</u> <u>Scirpus validus</u> <u>Typha latifolia</u>	<u>Triglochin maritima</u> <u>Juncus balticus</u>
3.	<u>Typha latifolia</u>	<u>Lemna minor</u>
4.	<u>Scirpus validus</u>	---
5.	<u>Salicornia rubra</u>	<u>Kochia scoparia</u> <u>Distichlis stricta</u>
6.	<u>Puccinellia nuttalliana</u> <u>Hordeum jubatum</u>	<u>Sonchus oleraceus</u>
7.	<u>Puccinellia nuttalliana</u> <u>Salicornia rubra</u>	<u>Hordeum jubatum</u>
8.	<u>Puccinellia nuttalliana</u> <u>Poa cambyi</u>	<u>Agropyron smithii</u>
9.	<u>Puccinellia nuttalliana</u> <u>Triglochin maritima</u>	<u>Poa cambyi</u>
10.	<u>Sonchus oleraceus</u>	---
11.	<u>Sonchus oleraceus</u> <u>Poa cambyi</u>	<u>Lactuca serriola</u>
12.	<u>Sonchus oleraceus</u> <u>Hordeum jubatum</u>	<u>Puccinellia nuttalliana</u>
13.	<u>Sonchus oleraceus</u> <u>Rumex crispus</u>	<u>Chenopodium album</u>
14.	<u>Sonchus oleraceus</u> <u>Taraxicum officinale</u>	<u>Lactuca serriola</u>
15.	<u>Sonchus oleraceus</u> <u>Lactuca serriola</u>	---
16.	<u>Rumex crispus</u>	<u>Kochia scorparia</u>
17.	<u>Poa cambyi</u> <u>Kochia scoparia</u>	<u>Agropyron smithii</u>

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