5-1970

Evolution of Molting Areas of Great Basin Canada Geese

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EVALUATION OF MOLTING AREAS OF GREAT BASIN CANADA GEESE

by

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

of

MASTER OF SCIENCE

in

Wildlife Biology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1970

ACKNOWLEDGMENTS

Financial assistance for this study was provided by the Bureau of Sport Fisheries and Wildlife. The Migratory Bird Populations Station supplied band recoveries. To them I express appreciation.

I especially thank Dr. Jessop B. Low, leader, Utah Cooperative Wildlife Research Unit, for supervising the research. Professor Arthur H. Holmgren and Berniece A. Andersen of the Intermountain Herbarium and other professors in the Departments of Botany, Natural Resources, Soils and Meteorology, and Zoology provided valuable assistance in various aspects of the project.

Special thanks go to Dr. James E. Bell and other personnel of the Deseret Livestock Company for allowing the study to be conducted on their lands.

I sincerely appreciate the help and cooperation throughout the study from John E. Nagel, principal waterfowl biologist, and other employees of the Utah Division of Fish and Game.

To my parents I am deeply grateful for moral support and financial assistance in furthering my education. I dedicate this thesis to them.

Paul D. Arneson

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ABSTRACT

Evaluation of Molting Areas of
Great Basin Canada Geese

by

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Utah State University, 1970

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Department: Wildlife Resources

Environmental factors at Neponset and Woodruff Narrows reservoirs were evaluated to determine their effects on molting Canada geese. More geese utilized Woodruff Narrows. Geese apparently favored the larger expanse of open water and adequate food supply.

Most of the molting geese were from the Bear River drainage. Some geese came from scattered areas in Utah, Idaho, Wyoming, and Montana. After molting, the geese flew to migration staging areas in southeastern Idaho before migrating to wintering areas in southern California and Arizona.

Females outnumbered males by 6 percent. The mean annual mortality rate for adult geese was 42 percent. Recovery rates between the sexes were not significantly different ($P \leq 0.01$). Juvenile geese were 1.4 times more vulnerable than adults to hunting mortality. Hunting pressure on the geese at the reservoirs was not great enough to be detrimental to the flock.

Of 89 nests, 53 percent were successful. Mean clutch size was 4.85 eggs per nest with a range of 1-7. Mammalian and avian predators destroyed 25 percent of the eggs. Forty-seven broods were observed with an average brood size of 4.77 young.

Other waterfowl populations did not affect the goose population.

(80 pages)

INTRODUCTION

Each June, Canada geese *(Branta canadensis)* seek specific bodies of water on which to molt their primary feathers. In the Great Basin region, certain areas have become traditional molting areas. What makes these lakes and reservoirs attractive to molting geese has not been studied in detail. With such information waterfowl managers could possibly manipulate other areas to improve molting conditions for geese.

A study was initiated in 1968 to determine the requirements of molting geese and other information concerning the flocks at Neponset Reservoir, Rich County, Utah, and Woodruff Narrows Reservoir, Uinta County, Wyoming. Objectives of the study were to:

1. Evaluate the reservoirs as molting areas and determine the environmental factors affecting their usage.

2. Determine migration patterns of the geese utilizing the reservoirs.

3. Determine the age and sex composition of the geese.

4. Determine uses of the reservoirs other than molting.

5. Determine the effects of other waterfowl species on the goose populations.

LITERATURE REVIEW

Recorded observations of Canada geese began as early as the 1800's. Kortright (1942) mentioned the courtship behavior of geese as described by Audubon in 1840. A life history of the geese was written by Bent (1925). Books of general and specific interest have been written by Linduska (1964), Hanson (1965), Williams (1967), and Hine and Schoenfeld (1968).

The latest American Ornithologists' Union Check-list of North American Birds (1957) recognized 10 subspecies of *Branta canadensis*. Other authors recognized 11 (Hanson, 1965; Hine and Schoenfeld, 1968). The subspecies *B. c. moffitti* is composed of two populations: the Highline and the Great Basin. The Highline population, which breeds in southwestern Saskatchewan, southern Alberta, and eastern Montana (Grieb, 1968), consists of about 19,000 birds. They winter from central New Mexico to southeastern Wyoming.

The Great Basin population, ranging from British Columbia and Saskatchewan to southern California and Arizona, numbers about 100,000 (Hansen, 1968). Many isolated flocks make up the aggregation of Great Basin Canada geese. Most of these flocks have been studied to some extent. Munro (1958) studied geese in British Columbia, Hanson and Browning (1959) in Washington, Geis (1956) in Montana, Steel et al. (1957) in Idaho, and Dow (1943), Miller and Collins (1953), Naylor (1953), and Naylor and Hunt (1954) in California. Wyoming geese were studied by Craighead and Craighead (1949), Dimmick (1968), and Appel (1969). Utah geese along the Great Salt Lake were studied by Williams and Marshall (1937 and 1938), Martin (1963), and Dey (1964). These studies dealt with breeding biology, demography, and behavior. Few have dealt solely with molting geese although many mentioned certain aspects of molting.

Reported dates of molt initiation were not the same for all flocks of geese. Biotic events were delayed four days for each degree of latitude or 400 feet altitude (Hopkins, 1938). Therefore, breeding and molting of geese were later at higher altitudes and northern latitudes. Along the Bear River marshes non-breeding geese left the breeding area in late May (Martin, 1963) and molted in Idaho, Montana, Wyoming, and on the Bear River Refuge. Dey (1964) stated that they molted at some unknown location. According to Hanson and Jones (1968), non-breeding geese molted 7-10 days before hatching of the young, and breeding geese molted 7-10 days after their young hatched.

Some geese traveled great distances to molt. Montana geese may travel as far as 1,150 miles into the Northwest Territories to molt (Kuyt, 1962). Hanson (1965) suggested giant Canada geese *(B. c. maxima)* travel over 1,400 miles from Rochester, Minnesota, to Aberdeen Lake, Northwest Territories, to molt.

Favorable environmental factors for molting geese have not all been determined. Williams and Sooter (1940) indicated geese need to spend a brief period in marsh cover. Emergent vegetation used as escape cover was considered necessary by Naylor and Hunt (1954) for molting geese, but they also described the need for secluded areas and large bodies of open water. Similarly, Dimmick (1968) observed that geese sought open water when alarmed. This type of molting environment closely paralleled that for diving ducks, whereas dabbler ducks utilized emergent vegetation in marshes (Hochbaum, 1944).

According to Hanson and Jones (1968), the length of the flightless period varied directly with the size of the bird but lasted from 24-42 days. The mean was about five weeks.

STUDY AREAS

Neponset and Woodruff Narrows reservoirs were located approximately 35 miles south of Bear Lake, Utah. Both areas were about 6,400 feet above sea level with similar climates. Since the inception of a Climatological Station in Woodruff, annual precipitation averaged 9-10 inches, most coming as late-spring and early-fall rains. Temperatures were quite low with a growing season of 20.7 days, 56 frost-free days, a mean annual temperature of 38.6 F, and a mean summer temperature of 59.0 F (Stoddart, 1940). Neponset was completed in 1910 and Woodruff Narrows in 1962.

Neponset Reservoir

Neponset Reservoir was located 10 miles southeast of Woodruff, Utah (Figure 1). An 11-mile canal entered the 930 acre reservoir from the Bear River. Runoff water had little effect on reservoir water levels. Neponset was situated in gentle slopes and rolling hills of big sagebrush *(Artemisia tridentata tridentata)* and western wheatgrass *(Agropyron smithii)*. Four islands and several peninsulas were evident when the reservoir was filled. Private ownership of most of the land surrounding the reservoir isolated the waters from outside activity. The remaining land was controlled by the Bureau of Land Management. Soils surrounding the reservoirs were sierozems with parent material of gray shale. The soil was a plastic clay loam and distinct enough to be called Neponset clay. The water stored in Neponset was used for irrigation of hay meadows and stock watering by Deseret Livestock Company.

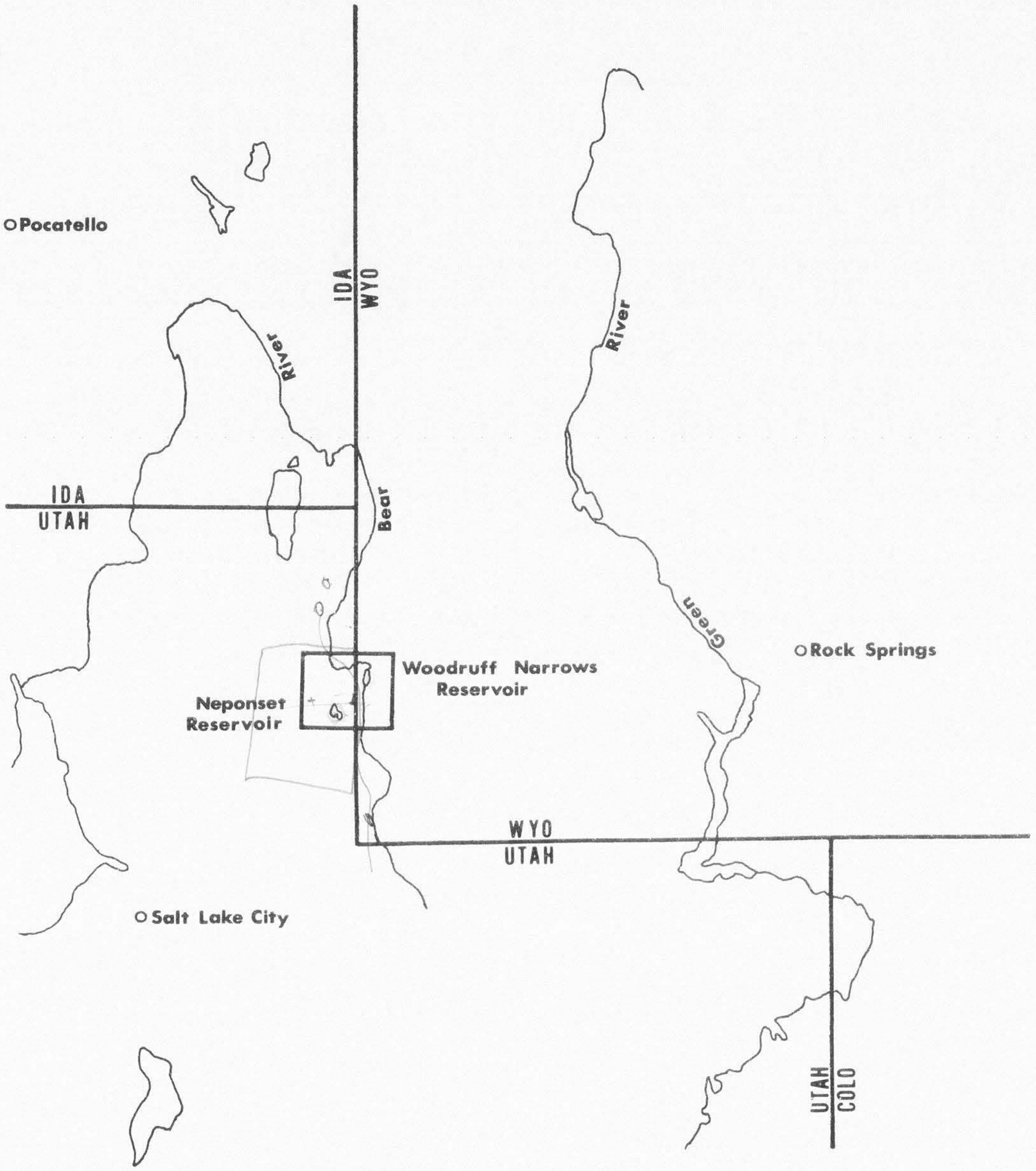

Figure 1. Location of Neponset and Woodruff Narrows reservoirs.

Woodruff Narrows Reservoir

Woodruff Narrows Reservoir was located about 10 miles northeast of Neponset and 15 miles north of Evanston, Wyoming. The 1,620 acre basin was formed by mountains on the east and north, high sagebrush hills on the west, and level hay meadows to the south. The most common vegetation was big sagebrush and greasewood *(Sarcobatus vermiculatus)*, along with the grasses and sedges of wild hay fields. Except for small alluvial fans, no peninsulas or islands were present. The soil was a silt loam, with sand on parts of the shoreline. Public access to the reservoir was provided by the Wyoming Game and Fish Commission. The reservoir was used extensively by fishermen, and the water was used to irrigate hay meadows east and north of Woodruff.

METHODS AND MATERIALS

Measurement of Environmental Factors

Biotic factors

Terrestrial vegetation. Twenty-four transects were arbitrarily selected on each side of both reservoirs to sample terrestrial vegetation. Each transect began at the high water line and extended perpendicularly inland. A variation of the wheelpoint method of vegetation measurement was used in sampling (Tidmarsh and Havenga, 1955). The wheel placed a point every 2.5 feet (Figure 2). Vegetation "hit" by the points was recorded to species. Each transect consisted of 100 points, giving a total of 2,400 points for each reservoir. Transects were sufficiently long to include goose feeding areas. Transect slopes were measured with an Abney level.

Mudflat vegetation was measured similarly. From the high water mark, a line was stretched perpendicular to the water's edge. These transects were not of equal length.

Aquatic vegetation. Five transects were used for equatic vegetation sampling on Neponset. These north-south transects were equally spaced on the reservoir and ran from shore to shore. Lengths varied from 0.5-1.5 miles. An ocular estimate of percent cover for each species in a 5-foot square quadrat was recorded every 60 feet. Only plants within 18 inches of the surface (accessible to geese) were recorded. Water depth and distance from shore were recorded at each sampling site. Due to the absence of visible aquatic vegetation, no quantitative sampling was done at Woodruff Narrows.

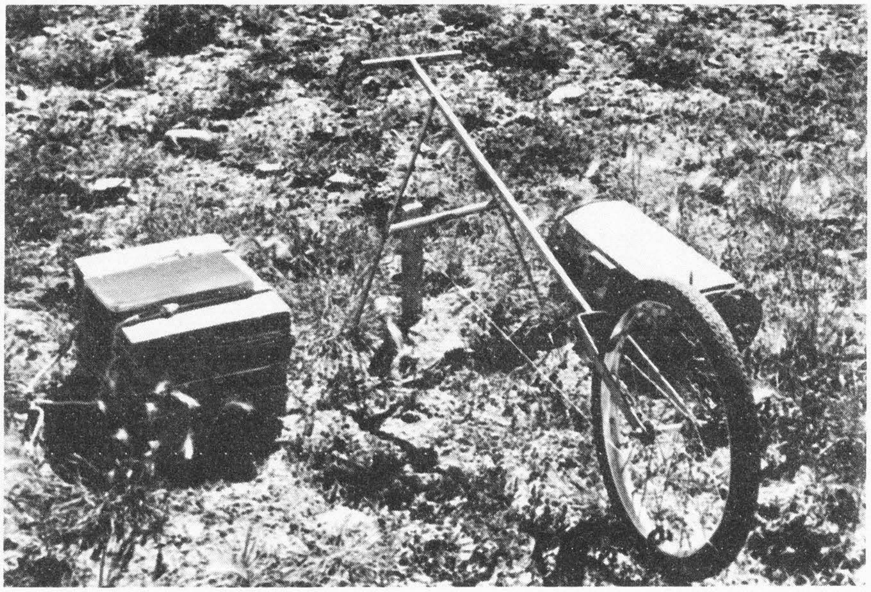

Figure 2. Equipment used to sample terrestrial and mudflat vegetation.

Aquatic invertebrates. Aquatic invertebrates were collected at 20 sampling sites on each reservoir. These sites were located where the mudflat vegetation transect reached the water's edge on the first 20 transects. Each week 10 sites were sampled at each reservoir, alternating between odd and even numbered sites. Invertebrates were collected with a funnel and collecting sack (McKnight, 1969) pulled twice through one m^3 of water (Figure 3). Invertebrates were identified to family and the average volume of invertebrates at each sampling site recorded.

Benthic organisms were sampled once at five locations on each reservoir during July. The Neponset sampling sites were approximately equidistant around the periphery, and at Woodruff Narrows they were equidistant along the west shore. Bottom samples containing 500 cc of mud were sifted through wire screens and the remainder stored for subsequent counting of invertebrates.

Physical factors

Soil. Soil samples were collected at two locations along the water's edge on both reservoirs in July. They were stored in plastic bags and eventually analyzed for pH, organic matter, and available phosphorus, potassium, and nitrate-nitrogen by the Soils Department, Utah State University. Sampling sites were located in characteristic soil types on opposite sides of each reservoir.

Water chemistry. Water samples were collected each week at about 9:00 A.M. at two areas on each reservoir. A field analysis was performed with a portable water engineer's laboratory made by the Hach Chemical Company. A colorimeter was used to measure pH and turbidity.

Figure 3. Equipment used to sample aquatic invertebrates.

Titrametric tests were used to determine hardness, alkalinity, and chloride concentrations.

Water-level fluctuations. Calibrated stakes on Neponset were used to determine water level fluctuations. Data from the Water Resources Division, United States Geological Survey, were used for water level fluctuations at Woodruff Narrows.

Weather. Data from the Climatological Station in Woodruff, Utah, were used to determine mean temperatures and precipitation.

Isolation, grazing, and predators. Direct observations on the study areas were used to determine the effects of isolation, grazing, and predators on the molting goose populations.

Determination of Non-environmental Factors

Band recoveries

Band recovery cards from the Migratory Bird Populations Station, Laurel, Maryland, were used to analyze goose migration patterns, staging areas, sex and age composition, mortality, and hunting vulnerability by age and sex.

Banding

Geese were banded at Neponset during the summers of 1953 and 1963-1969 by the Utah Division of Fish and Game. Molting geese and broods were drive-trapped with airboats and then sexed and aged. Since 1966 most of the adult geese have been marked. Blue plexiglass collars (Ballou and Martin, 1964) were placed on 200 geese in 1966, white on 174 in 1967, and red on 33 in 1969. In 1968, lime-green patagial tags were placed on 25 molting geese as part of another study (Appel, 1969). Geese on Woodruff Narrows were not banded during this study.

Censusing

Each week during 1968 and 1969, all geese and broods on both reservoirs were censused with the aid of a spotting scope. Marked geese were recorded. Goose feeding areas and other places of activity were determined by full-day observations from a blind on a selected vantage point. After the molting period, trips were made to nearby goose concentration areas to locate marked geese.

Ducks were censused during the goose molt and peak duck molt. Duck broods were censused during the peak brood rearing period.

Nesting surveys

During the spring of 1969, a search was made for nests on Neponset, at and up river from Woodruff Narrows, along the Bear River below Woodruff Narrows, and along Saleratus Creek. The survey began after the initiation of nesting and was repeated every five days. Recorded at each nest site were: date, cover type, nest material, distance to water, visibility, height above ground, flushing distance, amount of down, and number of eggs.

RESULTS AND DISCUSSION

Environmental Factors

Terrestrial vegetation

Thirty-three species of terrestrial plants were recorded at Neponset and 77 species at Woodruff Narrows (Appendix, Table 14). The 15 most abundant upland species and their basal cover percentages are presented in Table 1. Seven of these species were common to both reservoirs. Basal ground cover was 28.08 percent at Neponset and 42.92 percent at Woodruff Narrows. The mean slope for all transects at Neponset was 3.9 percent, with a range of 0.5-7.0. At Woodruff Narrows the mean slope was 8.8 percent, ranging from near 0-60.

Plant species previously found to be important goose foods (Williams and Sooter, 1940; Martin et al., 1951) and found on the study areas were: clasping peppergrass *(Lepidium perfoliatum)*, cheatgrass *(Bromus tectorum)*, foxtail *(Hordeum jubatum)*, samphire *(Salicornia rubra)*, desert saltgrass *(Distichlis stricta)*, and sago pondweed *(Potamogeton pectinatus)*.

Species composition and basal cover of mudflat vegetation at Neponset and Woodruff Narrows reservoirs are shown in Table 2. Basal cover was 28.34 percent at Neponset and 17.52 percent at Woodruff Narrows.

Vegetation stratifications existed around most of Neponset (Figure 4). The mudflat region was normally underwater in early spring and mid-summer. This affected the species composition of that region. Desert saltgrass, foxtail, samphire, dock *(Rumex mexicanus)*, aster

Table 1. Basal cover of the 15 most abundant plant species, and composition of exposed ground at Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

Species	Neponset basal cover (percent)	Woodruff Narrows basal cover (percent)
Agropyron repens	--	0.92
A. smithii	5.04	1.75
Artemisia tridentata nova	4.58	1.00
A. t. tridentata	0.92	4.29
Artiplex nuttallii	1.63	--
Bassia hyssopifolia	1.96	--
Bromus tectorum	--	1.71
Chrysothamnus visidiflorus	0.79	0.96
Deschampsia caespitosa	--	2.88
Eurotia lanata	0.50	--
Gutierrezia sarothrae	0.46	--
Hordeum brachyantherum	--	1.13
H. jubatum	4.58	1.67
Kochia tricophylla	0.54	--
Melilotus officinalis	--	0.79
Phleum pratense	--	1.00
Phlox hoodii	1.38	--
Poa pratensis	--	6.96
P. sandbergii	0.71	1.54
Salicornia rubra	0.38	--
Sitanion hystrix	2.08	2.83
Suaeda oxidentalis	0.58	--
Taraxacum officinalis	--	0.88
Total vegetative cover	28.08	42.92
Soil	70.08	53.46
Litter	1.79	1.92
Rock	0.04	1.71

Table 2. Species composition, basal cover, and composition of exposed ground of mudflat vegetation at Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

Species	Neponset basal cover (percent)	Woodruff Narrows basal cover (percent)
Agropyron repens	--	0.23
Bassia hyssopifolia	--	0.12
Carex lanuginosa	--	0.58
C. nebraskensis	--	0.93
C. praegracilis	--	1.05
Chenopodium rubrum	3.04	0.93
Eleocharis acicularis	14.17	0.23
E. macrostachya	2.43	4.67
Helenium montanum	0.10	--
Hordeum brachyantherum	--	0.23
H. jubatum	2.02	1.75
Juncus balticus	--	1.40
Mentha arvensis	--	1.17
Plagiobothrys cognatus	--	0.47
Monolepis nuttalliana	--	0.12
Poa pratensis	--	0.93
Polygonum amphibium	--	0.82
Potentilla anserina	--	0.58
Rorrippa obtusa	3.34	0.35
Rumex mexicanus	0.10	0.12
Salicornia rubra	0.20	--
Spergularia marina	0.61	--
Taraxacum officinale	--	0.35
Veronica peregrina	2.33	0.47
Total vegetative cover	28.34	17.52
Soil	70.75	77.34
Litter	0.91	4.09
Rock	--	1.05

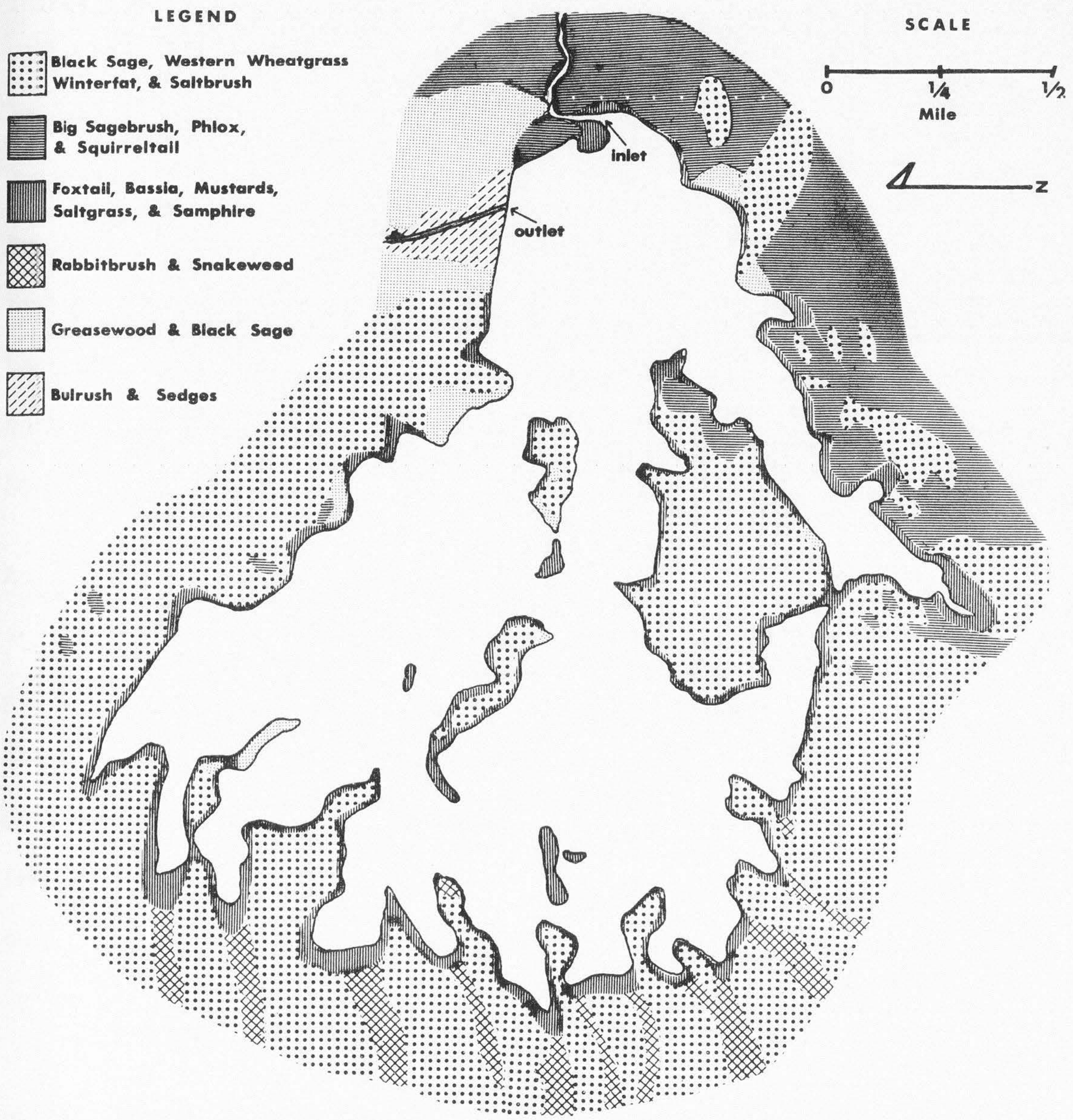

Figure 4. Cover map of terrestrial vegetation at Neponset Reservoir, Utah.

(Aster foliaceus), and sneezeweed *(Helenium montanum)* were nearest the shoreline. Above this was a layer of poverty weed *(Iva axillaris)* and several chenopod and mustard species. Beyond these were the upland, desert species including sagebrushes and western wheatgrass.

Woodruff Narrows did not have vegetation stratifications (Figure 5). Human land-use patterns have created several vegetative types. Wild hay fields bordered the reservoir on the south and southwest sides. A varied species composition was present along the west. The east and north sides remained in a pristine upland condition similar to that at Neponset.

Aquatic vegetation

Almost 44 percent of Neponset had aquatic vegetation that was accessible to geese (Table 3). Water milfoil *(Myriophylum exalbescens)* and Richardson's pondweed *(Potamogeton richardsonii)* made up 36.40 percent of the aquatic vegetation. These species also had the largest frequency of occurrence. Richardson's pondweed was found in 72.34 percent of the quadrats and water milfoil in 69.30 percent. Vegetation inaccessible to geese was found in only 10.03 percent of the quadrats.

At Neponset there was stratification of aquatic vegetation in relation to depth of water (Figure 6). Waterweed *(Elodea canadensis)* was the only plant found in the deepest water (over 9 feet). Water milfoil and Richardson's pondweed were most abundant in intermediate depths (3-9 feet). The remaining six species occurred in water less than 3 feet deep.

Aquatic vegetation was not quantitatively sampled in 1968, but a species change was apparent between the two summers. White water

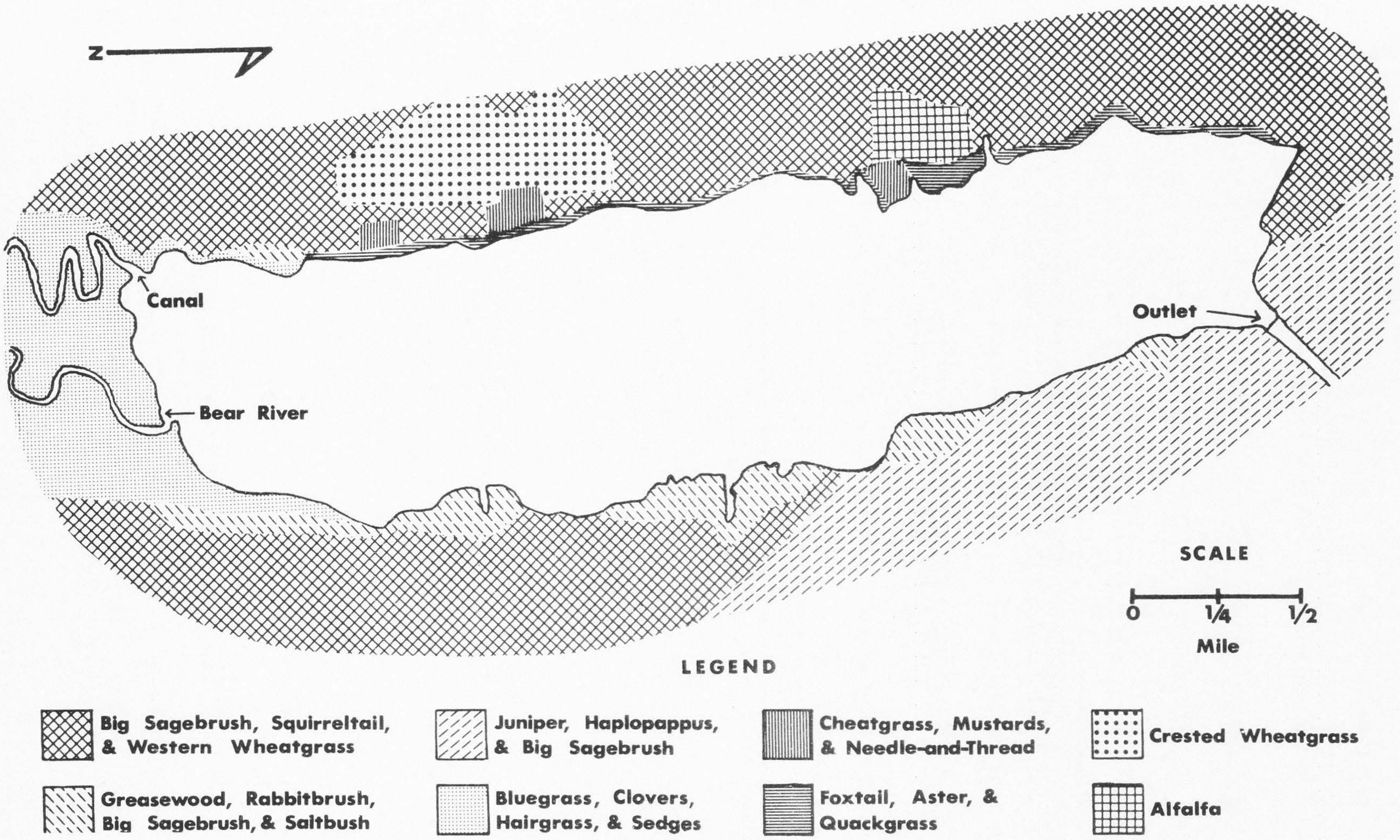

Figure 5. Cover map of terrestrial vegetation at Woodruff Narrows Reservoir, Wyoming.

Table 3. Frequency and percent cover of aquatic vegetation available to Canada geese on Neponset Reservoir, Utah, 1969

Species	Frequency of occurrence (percent)	Cover (percent)
Potamogeton richardsonii	72.34	14.55
Myriophyllum exalbescens	69.30	21.85
Potamogeton pectinatus	34.95	3.98
Elodea canadensis	30.40	2.76
Potamogeton pusillus	6.38	0.49
Ranunculus circinatus	5.78	0.18
Alisma graminea	4.56	0.06
Potamogeton filiformis	1.82	0.06
Eleocharis acicularis	0.30	0.01
No vegetation	10.03	--
Total	--	43.94

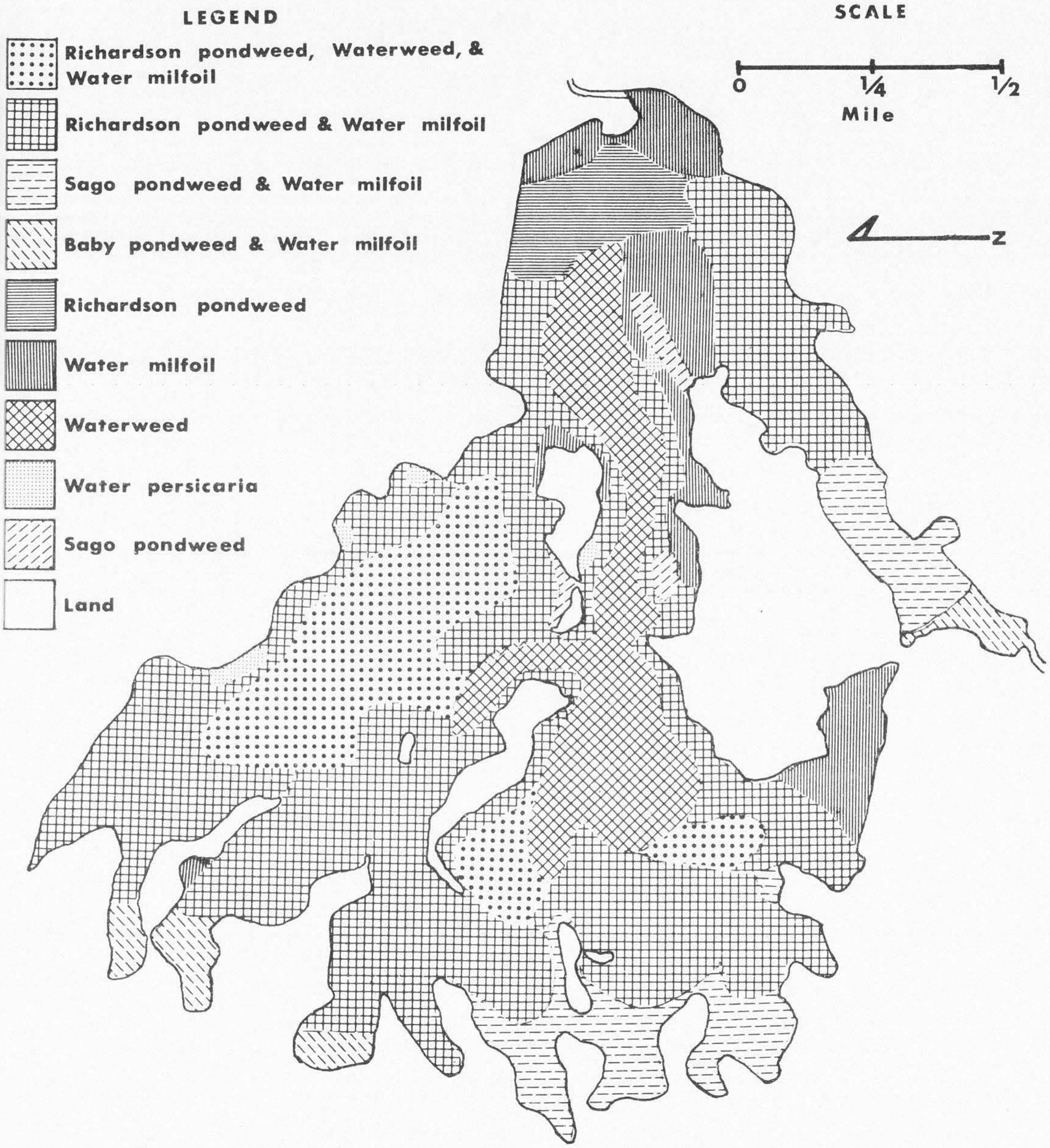

Figure 6. Cover map of aquatic vegetation at Neponset Reservoir, Utah.

crowfoot *(Ranunculus circinatus)* was much more abundant in 1968 and sago pondweed less abundant than in 1969. The degree of change was not known.

The only plant reaching the water's surface at Woodruff Narrows was water persicaria *(Polygonum amphibium)*. It was present in small patches near the inlet to the reservoir. These patches were remnants of vegetation growing in canals and oxbows before the completion of the reservoir.

Three genera of algae--*Rivularia*, *Spirogyra*, and *Chara*--were prominent on Neponset, but their importance as food for geese was unknown. *Rivularia* coated much of the aquatic vegetation making it gelatinous. On Woodruff Narrows *Spirogyra* was present, but less abundant than on Neponset.

Aquatic invertebrates

There was a marked difference in the numbers of aquatic invertebrates at the two reservoirs. Amphipods (Talitridae) averaged 1.35 cc per cubic meter of water for all transects at Neponset (Table 4), with a range of 0.25-4.00. The largest numbers occurred along the southeast section of the reservoir. Next in abundance were damselflies (Coenagrionidae), with concentrations of 0.95 cc per cubic meter. Damselfly naiads crossed the mudflats in large numbers to metamorphose. This species apparently was an important food, because young geese spent a great deal of time feeding along the mudflats. Peak emergence occurred in mid-June, coinciding with hatching of goslings. Five families (Talitridae, Coenagrionidae, Corixidae, Dytscidae, and Limniphilidae) were found on all transects, although volumes varied considerably.

Table 4. Frequency of occurrence and mean volume of aquatic invertebrates per cubic meter of water on Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

	Neponset		Woodruff Narrows	
Family	Frequency of occurrence (percent)	Mean volume cc	Frequency of occurrence (percent)	Mean volume cc
Talitridae	100	1.35	30	tr
Coenagrionidae	100	0.95	30	tr
Corixidae	100	0.51	75	0.20
Notonectidae	95	0.12	5	tr
Dytiscidae	100	0.07	10	tr
Baetidae	85	0.02	95	0.04
Limniphilidae	100	tr	10	tr
Chironomidae	85	tr	100	0.03
Hydrophilidae	15	tr	--	--
Libeelulidae	15	tr	--	--
Culicidae	10	tr	--	--
Ceratopogonidae	10	tr	10	tr
Tabanidae	10	tr	--	--
Elmidae	10	tr	--	--
Curculionidae	10	tr	5	tr
Phryganeidae	10	tr	--	--
Ephemeridae	5	tr	--	--

In comparison to Neponset, Woodruff Narrows was unproductive. There were only 0.20 cc water boatmen (Corixidae) per cubic meter of water. The next most voluminous family was Baetidae (mayflies), with 0.04 cc per cubic meter. Only one family, Chironomidae (midges), was found on all transects at Woodruff Narrows, but measurable volumes occurred on only three. Transects along flooded hay meadows were the richest in aquatic animal life.

There was a marked difference in benthic organisms between the two reservoirs. At Neponset samples averaged 254.8 chironomid larvae per 500 cc of mud, with a range of 208-348. The mean at Woodruff Narrows was 66.7 chironomid larvae, with a range of 28-142.

Snails found at Neponset were from the families Physidae, Planorbidae, and Lymnaeidae. In 1968, the larger *Physa* and *Stagnicola* were commonly seen floating on the surface of the water, easily accessible to geese.

Soils

Results of the soil samples taken at the two reservoirs are shown in Table 5. Alkaline soils, common to arid regions, were found at both reservoirs. Causes for the difference in pH within both reservoirs were not determined.

Values of slightly over 1 percent organic matter were similar at both reservoirs. These values were similar to soils of the region.

Of the three soil nutrient determinations, the greatest difference between reservoirs was in available potassium. A possible explanation is that the rich aquatic plant life at Neponset took potassium from the soil, whereas the lack of plant life at Woodruff Narrows allowed it to remain in the soil. This same reasoning could be applied to available phosphorus since values of available phosphorus at Woodruff Narrows exceeded those at Neponset.

Nitrate-nitrogen is soluble in water; therefore, little should be found in the soil at the water's edge, as the values of 1.2-1.6 ppm indicated. No noted difference was present between the reservoirs with this nutrient.

Table 5. Results of soil samples taken at Woodruff Narrows Reservoir, Wyoming, and Neponset Reservoir, Utah, 1969

Site	pH	Organic matter %	Available K[a] ppm	Available P ppm	NO_3-N[a] ppm
Woodruff Narrows--dam area	7.6	1.12	259	9.0	1.4
Woodruff Narrows--old hayfield	8.3	1.48	321	9.1	1.6
Neponset--dam area	7.8	1.64	170	7.2	1.3
Neponset--west side	8.1	1.16	43	2.1	1.2

[a]Available K and NO_3-N were tested on wet samples.

Water chemistry

Marked differences in certain aspects of water chemistry occurred between Neponset and Woodruff Narrows reservoirs (Table 6). Water sources for the two reservoirs were essentially the same, and water samples were taken at the same time of day at both reservoirs. Therefore, differences were probably intrinsic. Insufficient parameters were examined to fully explain differences in water nutrients, but certain hypotheses accounting for differences are presented.

Table 6. Results of water tests on samples collected at sites on Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

Sample site	Chloride ppm	Alka-linity ppm $CaCO_3$	Hardness Ca ppm $CaCO_3$	Hardness Total ppm $CaCO_3$	pH	Turbidity JTU[a]
Woodruff Narrows--dam	1.3	149.0	96.3	135.0	8.6	19
Woodruff Narrows--inlet	1.2	155.3	96.3	144.3	8.6	24
Neponset--dam	1.6	125.2	71.3	117.2	9.2	15
Neponset--NW bay	2.4	112.8	49.7	109.3	9.8	5
Neponset--SW bay	2.6	115.7	59.3	113.0	9.6	6

[a]Jackson Turbidity Units.

Age of the reservoir was one of the greatest sources of dissimilarity. There had been insufficient time at Woodruff Narrows for soluble nutrients to be leached away. Sedimentation had not occurred long enough to form an impermeable silt layer on the bottom; therefore, hardness values as a partial measure of fertility were much higher at Woodruff Narrows.

Chloride concentrations in the two-bay areas of Neponset were higher, perhaps because little water circulation in this area had allowed them to accumulate. The outlet was within one-quarter mile of the inlet, so water was short-circuited. It was assumed that the chloride ions were tied up with sodium ions making the water in these two bays more saline.

Photosynthesis in aquatic plants took place in the morning when water samples were collected. This process removed CO_2 from the water (Reid, 1961) and raised the pH values. It also resulted in the precipitation of calcium carbonate as marl on *Potamogeton* and *Elodea* at Neponset. With the abundant aquatic vegetation at Neponset, pH values were raised to near 10.0, which might have been detrimental to some forms of aquatic life. The pH was not as high at Woodruff Narrows where aquatic vegetation was sparse.

The turbidity at Woodruff Narrows was consistently higher than at Neponset. Organic and inorganic turbidity were considered together. Turbidity was caused largely by detritus and silt. At Neponset differences in turbidity between bays were found. The bay with the inlet and dam was almost three times as turbid as the other two bays.

Water level fluctuations

Water began flowing into Neponset on May 10, 1969. A week later the outlet was opened to flood the hay fields below the reservoir. The water level receded 2 feet during the molt. The inflow became low during July, August, and September as irrigation water was drained from the canal above Neponset. On September 17, the reservoir was 7 feet below the spring high. With irrigation water no longer needed, the water level rose 4.5 feet before the reservoir froze in November.

Water levels in Woodruff Narrows peaked in mid-May because of spring runoff. Irrigation then began and a steady decline followed until late June, when a slight increase occurred as irrigation ceased. The water level dropped several feet in July and continued decreasing until September, when it remained stable. From the high point in mid-May to the September low, the water level dropped 15 feet.

Weather

The mean annual temperature for both reservoirs was 38.6 F and mean annual precipitation was 9.22 inches (Climatological Data, 1968 and 1969). In 1968 and 1969, the mean annual temperatures were 38.3 F and 38.5 F, respectively. Total precipitation was 9.93 inches in 1968 and 8.27 inches in 1969. Total precipitation for June, the goose molting month, was 2.27 inches in 1968 and 2.39 inches in 1969, whereas the normal was 0.90 inches.

Winds occurred almost daily at both reservoirs. They were predominantely from the southwest and normally started in mid-morning and continued until late evening. Velocities exceeding 20 mph were common, but winds were often gusty and changed directions from day to day.

Isolation

There was an average of one vehicle per day at Neponset. These visits were by ranch workers driving past the reservoir or manipulating the outlet control. Occasional airplanes flying overhead were the only other source of disturbance.

Woodruff Narrows was visited regularly. Fishermen drove the length of the reservoir daily to fish near the dam. The geese were disturbed several times a day, and they fled to the safety of open water each time a vehicle approached. Fishing boats occasionally were present on the lake, usually on the north end away from the geese. Water skiers used the reservoir on one occasion.

Grazing

During the first part of the goose molt, approximately 250 head of cattle grazed the western shores of Neponset. The cattle moved inland for several days when insects were bad but returned during cooler weather. More cattle were added the last week in June, bringing the total to about 600 head. Where cattle came enmasse to the reservoir to drink, the mudflat region became so pock-marked that geese did not utilize these areas. However, there were not enough of these areas to adversely affect the geese, and there was little competition between cattle and geese for the grasses surrounding the reservoir. Fewer than 30 head of cattle and sheep grazed around Woodruff Narrows, with no apparent effect on the geese.

Predators

Mammalian and avian predators were common on both areas. Striped skunks *(Mephitis mephitis)* were the most destructive mammalian predator. Although they primarily destroyed duck nests, some goose nest predation was attributed to them. Coyotes *(Canis latrans)* and badgers *(Taxidea taxus)* were common on the area, but signs of their predation on geese were not observed.

Island nesting by the geese at Neponset did not preclude predation. Skunks and coyotes were observed to cross 20 foot channels by Hammond and Mann (1956). The local conservation officer saw a badger cross from an island to the shore of Neponset in the spring of 1968. Bobcat *(Lynx rufus)* sign was seen at Woodruff Narrows, but predation by them was not detected.

Only one avian predator, the golden eagle *(Aquila chrysaetos)*, was known to have preyed on the geese. At Neponset an incubating goose was killed while on her nest in 1969. Another possible predator was the California gull *(Larus californicus)*. A colony of about 1,000 nested on Neponset. They were observed taking ducklings and eared grebe *(Podiceps auritus)* eggs, but goose broods and nests were normally watched closely enough by their parents to prevent gull predation. Williams and Marshall (1937 and 1938) observed California gulls taking both goose eggs and goslings. Other avian predators that affected nesting waterfowl on other areas (Geis, 1956; Hanson and Browning, 1959; Williams, 1967; Dimmick, 1968) were present, but did not appear to harm the geese. These included magpies *(Pica pica)*, crows *(Corvus brachyrhynchos)*, and marsh hawks *(Circus cyaneus)*.

Migration Patterns

Adult non-breeding geese molting at Neponset numbered 292 in 1968 and 122 in 1969. No figure was available for 1968 at Woodruff Narrows, but 242 molted in 1969. Total numbers of geese at Woodruff Narrows were about the same each year, so it was assumed that the number of molters in 1968 was comparable to 1969.

To determine the origin of molting geese, 1,923 geese were banded in 1953 and from 1963-1968. Because of hunting regulation changes, data for 1953 have been omitted from most of the analyses. In addition, since 1966, 421 of these geese were marked with either collars or patagial tags.

Movements of geese were determined on the basis of band recoveries, collar sightings, and census records (Figure 7). Geese arrived on the

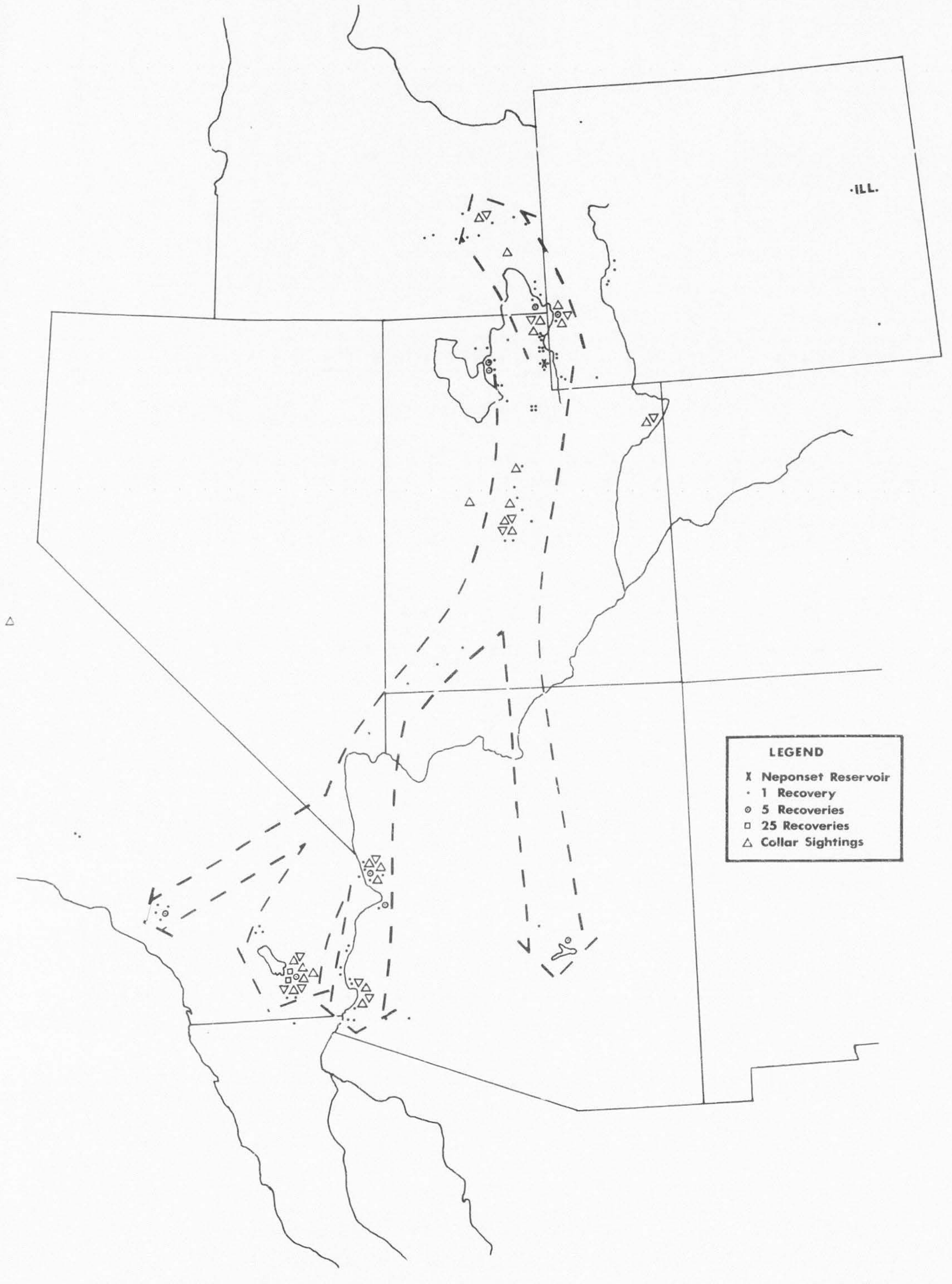

Figure 7. Migration patterns of Canada geese as determined from first-year recoveries and collar sightings of geese banded and marked with collars as molters at Neponset Reservoir, Utah.

study area the first week in April when spring runoff opened parts of the reservoirs. Cattle feedlots were used for feeding by the early migrants until food became available elsewhere.

Geese increased in numbers throughout May (Figure 8). This increase consisted of both non-breeders and unsuccessful breeders. The molting period lasted about six weeks, but individual geese were not flightless that long. As the molting geese regained their flight in July, there was considerable interchange between the two reservoirs. Total population size remained relatively stable until the first week in August.

In late August and early September, many of the geese flew north to migration staging areas in southeastern Idaho. Williams and Sooter (1940) reported geese flying long distances after the molt to find feeding and resting areas. This northward flight was derived from first-year band recoveries during the first weeks of the goose season, 71 percent of the bands being recovered in October. Collar sightings were too infrequent to determine movements to these areas.

The geese began to return to the study areas in late September, with a peak of 1,200-1,400 geese in late October. About 700 more geese were present then, than during the molt. These geese were probably from the populations nesting along the Bear River. By late November, the reservoirs froze, and the geese left for their wintering areas.

Migration routes were constructed from first-year band recoveries (see Figure 7). The percent recoveries by state for first-year and total recoveries are presented in Table 7. The Salton Sea area in the Imperial Valley, California, was the major wintering area where the most hunting mortality occurred. The lower Colorado River and the area

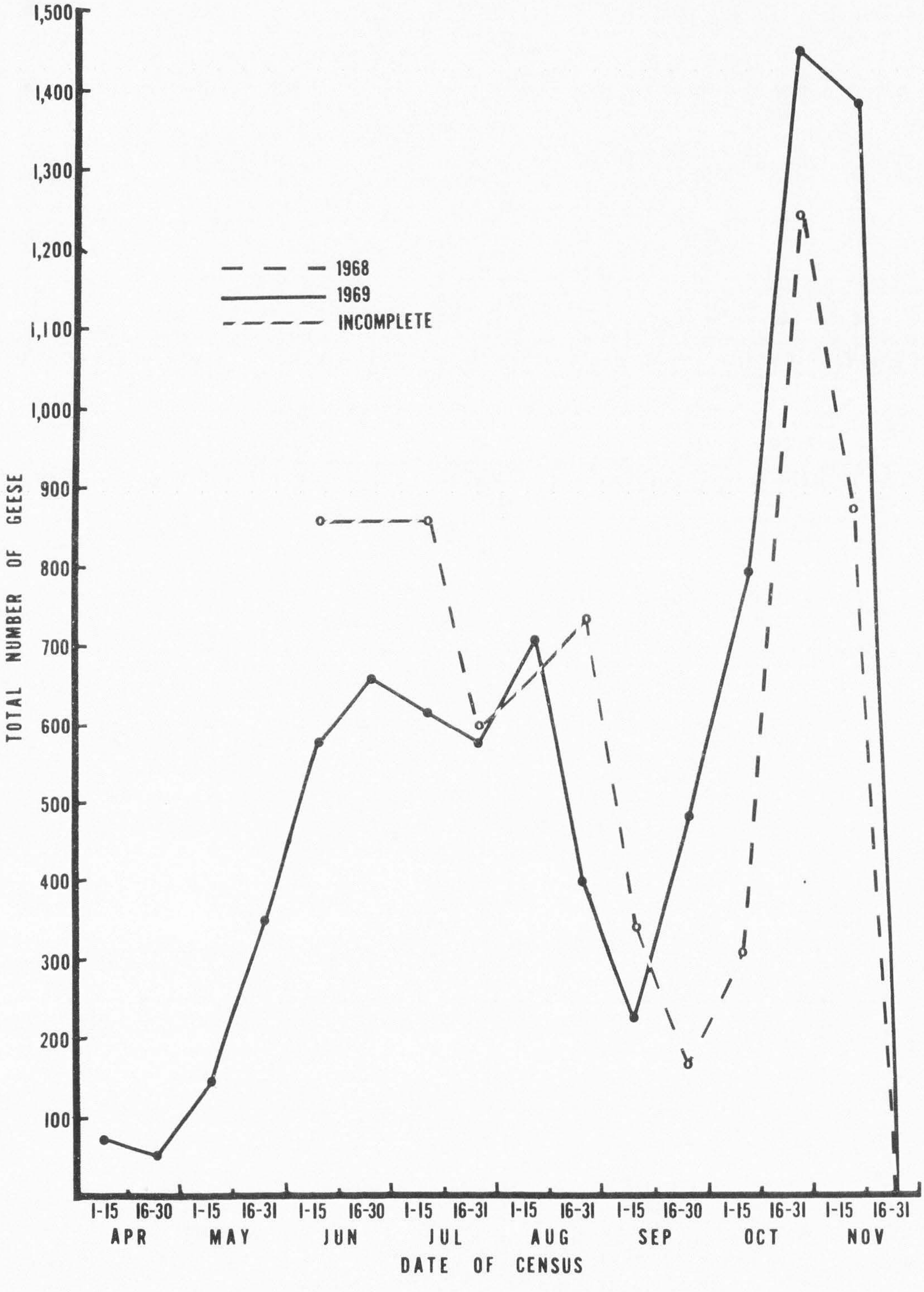

Figure 8. Total numbers of Canada geese on and near Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1968-1969.

around Roosevelt Lake, Arizona, were minor wintering areas. Geese using the latter area broke off from the main flight and flew directly to central Arizona (Fleming, 1959). The chronology of band recoveries depicted the geese's movements from their migration staging areas in Idaho to their wintering grounds.

Table 7. Location of first-year and total recoveries from geese banded as molters on Neponset Reservoir, Utah, 1953 and 1963-1968

State or region	First-year recoveries		Total recoveries	
	Number	Percent	Number	Percent
California	76	40.0	211	34.4
Utah	45	23.7	177	28.8
Arizona	27	14.2	80	13.0
Idaho	21	11.1	74	12.1
Wyoming	18	9.5	57	9.3
Nevada	1	0.5	5	0.8
Mexico	1	0.5	3	0.5
Montana	--	--	2	0.3
Alberta	--	--	2	0.3
Illinois	1	0.5	1	0.2
Oregon	1	--	1	0.2
Nebraska	--	--	1	0.2
Total	190	100.0	614	100.1

An exceptional flight was recorded when an adult female banded on Neponset in June was trapped and released in February at the Union County Refuge, Illinois. This pioneering flight is common in ducks but uncommon in geese. Because of strong family ties, immature geese normally accompany their elders in migration (Hochbaum, 1955).

Observations of collars indicated that most geese utilizing the study areas were not traveling long distances to molt. Assuming a 42 percent mortality rate each year, as was found in this study, and a collar loss of 10 percent per year (Ballou and Martin, 1964), 26 blue collars, 54 white collars, and 15 green patagial tags (loss unknown) would be left in the population the summer of 1969. During the nesting survey at both reservoirs and along Saleratus Creek and the Bear River east of Woodruff, three blue, six white, and four green marked geese were seen. During the molt on the two reservoirs, six blue, eleven white, and three green marked geese were seen. Not all the marked geese present were observed. Normally, geese with blue collars had to be within 200 yards before their collars were noticed. Most observations were made from at least 0.25 mile. Marked geese were also seen by Appel (1968) along the Bear River near Cokeville, Wyoming. Ten geese (five of which were collared) banded at Neponset were also retrapped along the Bear River near Randolph, Utah. The marked geese observed along the Bear River represented a substantial part of those present in the population. It was assumed that most of the geese using Neponset and Woodruff Narrows for molting were from that region.

To verify this assumption, census data from state and federal waterfowl management areas within 125 miles of the study areas were analyzed to determine if geese leaving or arriving at these management areas correlated with goose arrivals or departures from the study areas. Only patterns at Brown's Park Waterfowl Management Area correlated closely, but geese using that area molt in central Wyoming (Nagel, 1970).

Geese did not come in large numbers from areas outside the local Bear River drainage to molt on the study areas. Few geese banded outside the area that were retrapped at Neponset were from any one area. They came in small numbers from various areas in Utah, Idaho, Montana, and Wyoming (Table 8).

Only one collar sighting directly substantiated this. A red collar was sighted along the Green River east of Vernal, Utah, one month after the goose was collared. This might have represented a yearling returning to its breeding area 120 miles from the molting area.

Table 8. Sex and age structure and origin of band of molting Canada geese based on numbers of geese retrapped at Neponset Reservoir, Utah, 1963-1969

	Origin of band							
	Neponset Reservoir		Other areas in Utah[a]		Outside of Utah[b]		Total	Percent
Sex	A	B	A	B	A	B		
Males	4	107	10	--	--	2	123	42.8
Females	6	133	14	2	--	--	155	54.0
Unknown	--	--	--	--	5	4	9	3.1
Total	10	240	24	2	5	6	287	99.9

A = yearlings and known two-year-olds (non-breeders).
B = unknown two-year-olds and older.
[a]Nineteen banded on Bear River, Rich County, four on Farmington Bay WMA, two on Bear River NWR, and one on Public Shooting Grounds WMA.
[b]Seven banded in Wyoming, two in Idaho, and two in Montana.

Age and Sex Composition

Age structure

Congregations of molting waterfowl consisted of non-breeding birds and unsuccessful breeders. The age at which geese bred was not definitely known. Many authors have felt that geese do not breed until their third year (Elder, 1946; Balham, 1954; Wood, 1964 and 1965). Craighead and Stockstad (1964) in Montana and Martin (1963) in Utah found 27-36 percent of the two-year-olds nesting. In this analysis, two-year-olds were assumed incapable of breeding.

During banding, geese were aged as immature or adults. Known-age adults were identifiable only from geese previously banded as immatures and retrapped during the molt. Yearlings or young of the previous year and two-year-olds were recorded as non-breeders (see Table 8). Many of the geese listed under column B also could have been two-year-olds (called adults when banded as one-year-olds). Consequently, it is not known what portion of the retrapped geese were incapable of reproduction. The majority of geese coming from other areas in Utah were non-breeders. There was an unexplained lack of non-breeders in retraps from geese banded at Neponset. Many of the geese making up the molting flock were unsuccessful breeders from the vicinity.

Hunting vulnerability associated with age

Juvenile game birds are more vulnerable to hunting than adults. Craighead and Stockstad (1964) estimated first-year mortality as high as 70 percent in geese, and Hansen (1962) found it twice that of adults. In dusky Canada geese *(B. c. occidentalis)*, Chapman et al. (1969) found young 2.19 times more vulnerable and Miller et al. (1968) stated that immature white-fronted geese *(Anser albifrons)* were 2.3 times as vulnerable as adults. In this study juveniles were 1.4 times more vulnerable. This relative recovery rate was determined by dividing the direct recovery rate of immatures by that of adults (Table 9).

Table 9. First-year and total recovery rates by sex and age for geese banded at Neponset Reservoir, Utah, 1953 and 1963-1968

Category	Adult			Immature		
	Male	Female	Total	Male	Female	Total
Number banded	819	940	1,759	94	67	161
Percent of total banded	42.7	49.0	91.7	4.9	3.5	8.4
Number first-year recoveries	82	86	168	15	7	22
Total recoveries	269	306	575	25	13	38
Percent of total recoveries	43.9	49.9	93.8	4.1	2.1	6.2
First-year recovery rate	10.0	9.1	9.6	16.0	10.4	13.7
Total recovery rate	32.8	32.6	32.7	26.6	19.4	23.6

Sex ratios

The percentages of males and females banded and recovered at Neponset are listed in Table 9. Females outnumbered males by about 6 percent, assuming no trapping bias. Funk and Grieb (1965) found no difference in sex ratios, regardless of the trapping method. Similarly, Craighead and Stockstad (1964) found no important difference between the numbers of each sex; but Imber (1968) found females predominant.

Hunting vulnerability associated with sex

Recovery rates for males (see Table 9) were higher than females, especially in immatures. This might indicate greater hunting mortality among males. Relative recovery rate between sexes showed no differential mortality (not significantly different at $P \leq 0.01$) between males and females. Chapman et al. (1969) also found this to be true, but Imber (1968) in New Zealand found that males were 1.15 and 1.08 times more vulnerable than females.

Mortality

Hunting

During the goose hunting season, trips were made to the areas. Hunting pressure on the geese was determined by observation. Few hunters were seen at either reservoir and their success on geese was moderate. Geese sought refuge in the open water and spent the day out of range of gunfire.

Geese feeding in harvested barley fields near Woodruff were more vulnerable to hunting. Hunting pressure was heavier at the grainfields than at the reservoirs in 1968, but in 1969, the fields were plowed before the start of the season. The light hunting pressure in the area was not considered to be detrimental to the flock in total numbers killed. More geese were killed in other sections of their flyway.

Natural

Mean annual goose mortality was 42 percent for adults (Table 10).

This rate compares favorably with other studies. Martin (1963) found adult mortality to be 47, 35, 49, and 43 percent, Dey (1964) 53.7, 42.0, and 34.0 percent, and Dimmick (1968) 40.1, 34.0, and 51.3 percent. When band recovery data for geese banded in 1953 were included with the 1963-1968 data, mean annual mortality was 48 percent. Less stringent seasons in earlier years might have caused the increased mortality. Sample sizes of immature geese were too small to determine first-year mortality.

Table 10. Dynamic life table of adult geese banded at Neponset Reservoir, Utah, 1963-1968. Figures are based upon bands recovered up to 1969 from birds shot and found dead

Year banded	Number banded	Hunting seasons survived					
		1	2	3	4	5	6
1963	307	44	34	5	13	4	5
1964	311	42	19	17	4	8	
1965	182	10	15	10	8		
1966	174	13	16	9			
1967	200	21	20				
1968	224	23					
Total	1,398	153	104	41	25	12	5
Banded birds available		1,398	1,174	974	800	618	307
Recoveries per 1,000 banded		109.4	88.6	42.1	31.3	19.4	16.3
Alive going into period		307.1	197.7	109.1	67.0	35.7	16.3
Mortality rate[a]		.356	.448	.386	.467	.543	100.0

[a]Average annual mortality rate for 1963-1968 was .419.

Mean longevity for geese was approximately six years. From the 1953 cohort, there were single geese living to 9, 10, 11, and 16 years of age. Maximum for a wild goose is 27 years (MacBride, 1970).

Goose Nesting

A secondary consideration was to determine goose production in the study areas. Research was begun too late in 1968 to conduct a nesting survey. However, the local conservation officer and Bureau of Land Management personnel searched for nests on three of the islands in Neponset and found 22 goose nests. A maximum of 19 broods and 91 goslings (a brood size of 4.77 young per brood) were observed in 1968 on Neponset. Undoubtedly, some nests were missed in their survey, since not all areas were searched.

Censusing of broods on Woodruff Narrows was done too late in 1968 to easily distinguish young from adults. Five broods and 21 young were observed (a brood size of 4.20 young per brood).

In 1969, an intensive survey was made for nests on the reservoirs and on areas in the vicinity (Table 11). By back-dating, using a laying time of 1.5 days per egg (Balham, 1954; Klopman, 1958) and 28 days for incubation (Hanson and Browning, 1959; Williams, 1967), the start of nesting was estimated to be the second week in April. This was 1-4 weeks later than other areas in Utah. Martin (1963) claimed laying began in the second week of March at Ogden Bay Refuge, Dey (1964) reported that incubation at Ogden Bay began on March 28 and April 3 for the two years of his study, and Williams and Marshall (1937) found the first nest at Bear River Refuge on April 3. By applying Hopkins (1938)

Table 11. Summary of nesting data for Canada geese on and near Nepsonet Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

	Neponset	Bear River[a]	Saleratus Creek	Total
No. nests found	24	20(11)[b]	16(18)[b]	60(89)[c]
No. successful nests	18	10(10)	8(1)	36(47)
% successful nests	75	50	50	60(53)
Unsuccessful nests:				
Avian predators	1	1	0	2
Mammalian predators	2	7(1)	5(17)	14(32)
Nests deserted	3	2	3	8
Mean clutch size	5.29	4.75	4.31	4.85
Range of clutch sizes	2-7	2-7	1-7	1-7
Total eggs laid	127	95	69	291
% eggs hatched	63	53	59	59
% eggs lost to predators	17	34	29	25
% eggs lost to desertion	9	11	9	10
% eggs--dead embryo	6	2	1	3
% eggs--infertile	5	1	1	3
No. of broods	16	29	2	47
Total young	78	134	12	224
Brood size	4.88	4.62	6.0	4.77
Initiation of nesting	April 8	April 11	April 9	

[a]Nest survey along Bear River was above and below Woodruff Narrows Reservoir.
[b]Additional nests with incomplete histories.
[c]Total nests found with complete and incomplete histories.

bioclimatic theory, a 20 day delay in nesting would be expected for the 2,000 foot difference in altitude between marshes along Great Salt Lake and the study areas.

Nests were completed by June 2, resulting in a nesting period of 56 days. This was much lower than many studies. Other lengths for nesting periods of Great Basin Canada geese are 53 and 61 days (Klopman, 1958), 73 days (Brakhage, 1965), and 80 days (Martin, 1963).

All goose nests on Neponset were on the four islands. Attempted nesting on the shore was unsuccessful due to predation. A strong preference for island nesting also was found in other studies. Klopman (1958) reported all but a few nests were restricted to islands, Geis (1956) found 90 percent, Craighead and Craighead (1949) 95 percent, and Craighead and Stockstad (1961) 96 percent of goose nests on islands. The value of islands as nesting sites was explained by Hammond and Mann (1956).

Acreage of the islands totaled 30.8, giving a mean nesting density of 0.78 nests per acre with a range of 0.53-1.82. This density was quite low when compared with other studies, but was probably maximal. Craighead and Stockstad (1961) reported 5 nests per acre, Hammond and Mann (1956) 16 nests per acre, and Munro (1958) 9.4-30.7 nests per acre. Hansen and Nelson (1964) reported densities of 0.23-60 nests per acre. Using tubs as artificial nest sites, Brakhage (1966) found optimum spacing to be one nest per acre.

Two of the nests on Neponset were deserted because of intra-specific competition. These nests were 3 and 13 yards from the closest nest. Munro (1958) reported nest desertions occurred when nests were 10-15, 18, and 35 feet apart. But Dow (1943) claimed nests within

10-12 feet of one another existed with little fighting, and Williams and Sooter (1940) found 11 nests on one haystack.

Nest site selection at Neponset varied from barren ground scrapes to areas in dense willows with limited visibility. Most authors agree that geese prefer nest sites with good visibility, but Martin (1963) thought that good visibility did not seem important. Craighead and Stockstad (1961) and Hammond and Mann (1956) did not feel vegetation was a major factor in site selection. Dow (1943) found that some nests were merely depressions scratched in the ground. However, Geis (1956) found larger clutch sizes in nests hidden in dense cover.

On one island at Neponset old nest sites were marked in the fall of 1968. Of the nine nests on that island the next spring, five were on old nest sites, one a yard away, and only three not on previous nest sites. Several other authors found reuse of nest sites or at least nesting in the same territory held the previous year (Balham, 1954; Hanson and Browning, 1959; Craighead and Stockstad, 1961; Martin, 1963; and Dey, 1964).

Many of the geese nesting along the Bear River also used islands for nesting. These islands generally were small and with one nest. River banks, under brush and trees, and abandoned bird nests were also used as nest sites. As reported by Williams and Marshall (1937), Williams and Sooter (1940), Dow (1943), Dey (1964), and Weigand et al. (1968), all nests were near permanent water.

Nest sites along Saleratus Creek were almost entirely on haystacks. Only two of 34 nests were on the ground. Twenty-two of the nests were destroyed in a manner described as skunk predation by Rearden (1951). When haystacks were improperly stacked, skunks residing beneath the stacks had easy access to the nests and destroyed them. As temporary water along the hay fields dried, broods had long distances to travel to reach water. Broods have been recorded traveling up to 10 miles to brood rearing areas (Geis, 1956). They eventually swam down creeks and canals to the Bear River.

There was an unexplained difference in clutch size among the three areas. Mean clutch size was largest where nesting success was highest and smallest where nesting success was lowest, which may partially explain the difference. All values of clutch size were similar to those of previous studies (Naylor and Hunt, 1954; Steel et al., 1957; Martin, 1963; Dey, 1964). There was a 0.08 gosling difference between the mean clutch size of 4.85 and the mean brood size of 4.77. This represented a low gosling mortality, as also was found by Steel et al., (1957) and Dey (1964). This also might have been due to brood mixing, which was evident on the areas. Brood size varied from 2-14, and the maximum clutch size was 7. Broods as large as 26 were reported by Williams and Marshall (1938). Neponset and Woodruff Narrows might have been crowded enough as brood rearing areas to cause brood mixing (Geis, 1956).

Goslings apparently became vegetarians at an early age. Observations indicated vegetation was eaten when the geese were 3-6 days old. Sugden (1969) found gadwall *(Anas strepera)* ducklings took four weeks to become vegetarians. This period was somewhat shorter for American widgeon *(Mareca americana)*.

Infertility percentage, dead embryo percentage, and hatching success (see Table 11) did not markedly differ from values found in other studies. All studies were somewhat different, depending on conditions at the area. Values found during this study fell within the range of values of previous works.

Use by Other Waterfowl

The degree of use of the reservoirs by other waterfowl was studied to determine if it might adversely affect geese. Because of the rich food supply at Neponset, it attracted more nesting and molting ducks than Woodruff Narrows (Tables 12 and 13). Competition for food between ducks and geese was not considered detrimental to the geese. Geese, as grazers, fed largely on the mudflat or upland vegetation, while ducks remained in the water. American widgeon and coots *(Fulica americana)* did graze on the mudflats, but their total numbers (235) were not significant.

General

The two reservoirs were quite different in their physical and biotic characteristics. Neponset was isolated from outside disturbances to geese and offered many islands and sandbars for loafing sites. Aquatic vegetation was varied and well-distributed throughout the reservoir. Terrestrial vegetation along the shoreline was abundant and preferred by the geese in early spring. The most utilized vegetation was found in the late spring when the water level receded and a thick vegetative carpet emerged on the exposed mudflat areas. Needle spikerush *(Eleocharis acicularis)* was the predominant species. Dimmick (1968) also found this species heavily utilized by geese grazing on mudflats. Kortright (1942) stated that geese will also feed on crustaceans and small molluscs. Neponset had a variety of these invertebrates. Aquatic insects,

Table 12. Numbers of duck broods, young, and nests for Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1969

Species	No. nests found		No. broods maximum		Total young		Average young per brood	
	Nep	WN[a]	Nep	WN	Nep	WN	Nep	WN
American Widgeon	0	--	30	2	159	12	5.3	6.0
Gadwall	5	--	25	3	146	24	5.8	8.0
Lesser Scaup	10	--	12	0	106	0	8.8	0.0
Teal (BW/Cinn.)	5	--	8	1	43	5	5.4	5.0
Pintail	17	--	6	2	36	16	6.0	8.0
Mallard	4	--	4	2	24	12	6.0	6.0
Shoveler	1	--	1	0	8	0	8.0	0.0
Common Merganser	0	--	0	2	0	14	0.0	7.0
Unknown	14	--	--	--	--	--	--	--
Total	56	--	86	12	522	83	6.1	6.8

[a]A nesting survey was not done.

Table 13. Numbers of adult ducks and other waterfowl on Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, during goose molt and peak duck molt, 1969

Species	Neponset	Woodruff Narrows
July 3		
American Widgeon	150	23
Lesser Scaup	115	0
Gadwall	89	49
Redhead	30	0
Mallard	24	16
Pintail	15	10
Cinnamon Teal	12	2
Ruddy Duck	9	0
Green-winged Teal	4	7
Blue-winged Teal	4	2
Shoveler	2	2
Canvasback	2	0
Bufflehead	0	7
Common Merganser	0	4
Total ducks	456	122
Eared Grebe	359	0
Coot	85	2
Western Grebe	4	30
Trumpeter Swan	2	0
D. C. Cormorant	0	6
Total	906	160
August 8		
Dabbler Ducks	1,112	306
Diver Ducks	752	13
Coots	1,828	0
Total	3,692	319

amphipods, and small snails were found in all parts of the reservoir and readily available to geese. Because of the well distributed food supply, goose activity was not confined to any one part of the reservoir.

Woodruff Narrows was not isolated and had no loafing sites for geese. The geese were disturbed daily by activity around the reservoir. Aquatic vegetation was nonexistent. Succulent terrestrial vegetation was found only on the southern third of the reservoir. It was in this area that adult and young geese spent the majority of their time. It was not until goslings were five weeks old that geese used the northern end of the reservoir. The mudflat region was sparsely covered with vegetation, offering little food for geese. Small quantities of aquatic invertebrates were present, occurring mostly on the flooded hay meadows at the south end of the reservoir, but observations did not reveal that they were an important food source to geese.

Neponset and Woodruff Narrows were important to molting and breeding geese, although Neponset appeared to be more favorable. However, since the inception of Woodruff Narrows in 1962, the number of geese molting at Neponset has dropped from an estimated 905 in 1964 to 122 in 1969. There has been a corresponding increase at Woodruff Narrows. The larger size and denser cover of terrestrial vegetation at Woodruff Narrows may have effected this distributional change of molting geese. The larger size was perhaps the most important advantage. Geese used the large expanse of open water to escape danger during the molt. Dimmick (1968) found that disturbed geese escaped to open water on Yellowstone Lake. Therefore, isolation is unnecessary. The denser cover of terrestrial vegetation was caused by wild hay meadows at the southern end of the reservoir. *Poa, Juncus, Festuca, Hordeum,* and other plants associated with these meadows were apparently sufficient for the nutritional needs of the geese without aquatic and mudflat vegetation. Food and energy requirements of molting geese might be less than assumed, since there was this lack of food. Because the water level receded more than twice that of Neponset, the geese had farther to travel across exposed mudflats to get food at Woodruff Narrows. This might have increased the chance for predation but did not affect goose use of the area.

Aging of Woodruff Narrows might further improve it for waterfowl use. Knight (1965) found that increases in aquatic and emergent vegetation with time increased an area's use by waterfowl. Turbid water may have retarded plant growth, but soil and water nutrients at Woodruff Narrows favored greater plant and animal production. Aquatic vegetation and invertebrates might become more abundant with time, giving the adults and young geese more food. With the outlet and inlet on opposite ends, the life of the reservoir may be extended.

Neponset, with its short-circuited water source, might have passed its peak of importance to molting geese. Coatings of marl and *Rivularia* on aquatic vegetation could make it unpalatable for geese. The alkaline water and low soil nutrients on the west side of the reservoir could adversely affect plant and animal growth. Due to its abundance of proteinaceous food, it should remain an important brood rearing area.

The value of reservoirs in waterfowl management depends largely on their location (White and Malaher, 1964). Many reservoirs in the western United States are flooding important nesting areas, and their compensatory values to waterfowl are questionable. Both reservoirs studied were ideally located. Water filling Neponset flooded sparse sagebrush foothills but provided a valuable goose and duck breeding and staging area. Woodruff Narrows flooded some nesting sites, but the value to brood rearing, molting, and staging outweighed this loss.

RECOMMENDATIONS

1. Establishment of new reservoirs should be located in suitable areas, including large expanses of open water, an adequate food supply for geese, and availability of islands.

2. Predator-proof nesting structures (Appel, 1969) should be optimally spaced (Brakhage, 1965 and 1966) on the reservoirs to increase goose production.

3. A study of nutritional needs and feeding habits of goslings from hatching to fledging stages should be undertaken. This information would be useful in evaluating brood rearing areas.

4. Fat deposition before the molt and feeding habits and metabolism during the molt of adult geese should be studied to determine the necessity of large food supplies to molting geese.

SUMMARY

Two molting areas for Canada geese--Neponset and Woodruff Narrows reservoirs--were studied in 1968 and 1969. Environmental factors affecting their usage were sampled quantitatively and qualitatively.

Basal ground cover for terrestrial vegetation was 28 percent at Neponset and 43 percent at Woodruff Narrows. Slopes of vegetative transects were 3.9 percent and 8.8 percent, respectively. Basal ground cover for mudflat vegetation was 28 percent at Neponset and 18 percent at Woodruff Narrows.

Aquatic vegetation on Neponset covered 44 percent of the reservoir, with *Myriophylum exalbescens* and *Potamogeton richardsonii* accounting for 36 percent of the plant cover. *Polygonum amphibium* was the only aquatic plant at Woodruff Narrows.

Aquatic invertebrates were more abundant at Neponset. Talitridae, Coenagrionidae, and Corixidae were the most voluminous families.

Soils at Woodruff Narrows were richer in available potassium and phosphorus. Both reservoirs contained soils similar in nitrate-nitrogen, organic matter, and pH.

Waters at Neponset contained more chloride ions and had a higher pH, but alkalinity, hardness, and turbidity were lower. Summer water levels dropped vertically 7 feet at Neponset and 15 feet at Woodruff Narrows.

Isolation of the reservoirs did not appear to be an important factor in the selection of molting areas by geese.

Most of the molting geese were from the Bear River drainage. Some geese came from scattered areas in Utah, Idaho, Wyoming, and Montana.

After molting, the geese flew to migration staging areas in southeastern Idaho before migrating to wintering areas in southern California and Arizona.

Females outnumbered males by 6 percent. The mean annual mortality rate for adult geese was 42 percent. Recovery rates between the sexes were not significantly different ($P \leq 0.01$). Juvenile geese were 1.4 times more vulnerable than adults to hunting mortality. Hunting pressure at the reservoirs was not detrimental to the flock. Thirty-four percent of the geese were shot in California and 29 percent in Utah. The rest were shot in various areas.

Of 89 nests, 53 percent were successful. Mean clutch size was 4.85 eggs per nest with a range of 1-7. Mammalian and avian predators destroyed 25 percent of the eggs. Forty-seven broods were observed with a mean brood size of 4.77 young.

Nest initiation was during the second week of April, and the nesting period lasted 56 days. The mean nesting density on the islands of Neponset was 0.78 nest per acre. Nesting densities on these islands were maximal.

Neponset had larger populations of nesting and molting waterfowl besides geese than Woodruff Narrows. These populations were not large enough to adversely affect goose populations.

The large expanse of open water and adequate food supply were possibly the factors causing more geese to select Woodruff Narrows than Neponset.

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APPENDIX

Table 14. Plant species found on Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1968-1969

Scientific name	Common name
Family Cupressaceae	
Juniperus osteosperma (Torr.) Little[a]	Utah Juniper
Family Najadaceae	
Potamogeton pectinatus L.[b]	Sago Pondweed
P. filiformis Pers.[b]	Pondweed
P. pusillus L.[b]	Baby Pondweed
P. gramineus L.	Variable Leaf Pondweed
P. richardsonii (Benn.) Rydb.[b]	Richardson's Pondweed
Family Juncaginaceae	
Triglochin maritima L.[a]	Seaside Arrowgrass
Family Alismataceae	
Alisma graminea Gmel.[b]	Narrow-leaf Water Plantain
Family Hydrocharitaceae	
Elodea canadensis Michx.[b]	Waterweed
Family Gramineae	
Bromus tectorum L.[a]	Cheatgrass
B. inermis Leyss.	Smooth Brome
Festuca elatior L.[a]	Meadow Fescue
Puccinellia nuttalliana (Schult.) Hitchc.[ac]	Alkali Grass
Poa nevadensis Vasey[ac]	Nevada Bluegrass
P. sandbergii Vasey[ac]	Sandberg Bluegrass
P. pratensis L.[ad]	Kentucky Bluegrass
P. fendleriana (Steud.) Vasey	Mutton Grass
Distichlis stricta (Torr.) Rydb.[ac]	Desert Saltgrass
Dactylis glomerata L.[a]	Orchard Grass
Agropyraon cristatum (L.) Beauv.	Crested Wheatgrass
A. smithii Rydb.[ac]	Western Wheatgrass
A. repens (L.) Beauv.[ad]	Quack Grass
A. spicatum (Pursh) Scribn. & Smith[a]	Bluebunch Wheatgrass
A. inerme (Scribn. & Smith) Rydb.	Beardless Wheatgrass
A. dasystachyum (Hook.) Scribn.[a]	Thickspike Wheatgrass
Elymus cinereus Scribn. & Merr.[a]	Giant Wild-rye
Sitanion hystrix (Nutt.) J. G. Smith[ac]	Squirreltail
Hordeum jubatum L.[acde]	Foxtail
H. brachyantherum Nevski.[ad]	Meadow Barley
Deschampsia caespitosa (L.) Beauv.[a]	Tufted Hairgrass
Phleum pratense L.[a]	Timothy
Oryzopsis hymenoides (Roem. & Schult.) Ricker[a]	Indian Ricegrass

Table 14. Continued

Scientific name	Common name
Family Gramineae (Continued)	
Stipa comata Trin. & Rupr.[a]	Needle-and-Thread
Phalaris arundinacea L.	Reed Canary Grass
Family Cyperaceae	
Eleocharis acicularis (L.) R. & S.[bde]	Needle Spike Rush
E. calva Torr.	Spike Rush
E. macrostachya Britt.[ade]	Pale Spike Rush
Carex douglasii Boott.	Douglas Sedge
C. praegracilis W. Boott.[ad]	Sedge
C. vernacula Bailey	Sedge
C. lanuginosa Michx.[ad]	Woolly Sedge
C. capitata L.[a]	Sedge
Family Juncaceae	
Juncus balticus Willd.[ad]	Wire Rush
Family Liliaceae	
Zigadenus paniculatus S. Wats.	Foothill Death Camas
Allium acuminatum Hook.	Wild Onion
Calochortus nuttallii Torr.	Sego Lily
Fritillaria atropurpurea Nutt.	Leopard Lily
Family Salicaceae	
Salix exigua Nutt.[a]	Sandbar Willow
Family Santalaceae	
Comandra umbellata (L.) Nutt.[a]	Bastard Toadflax
Family Polygonaceae	
Eriogonum umbellatum Torr.[ac]	Eriogonum
E. ovalifolium Nutt.[c]	Cushion Eriogonum
E. chrysocephalum Gray[a]	Eriogonum
E. caespitosum Nutt.	Matted Eriogonum
Rumex mexicanus Meisn.[cde]	Mexican Dock
Polygonum watsoni Small[ac]	Watson Knotweed
P. amphibium L.[d]	Water Persicaria
P. lapathifolium L.	Curlytop Ladysthumb
P. persicaria L.	Spotted Ladysthumb
Family Chenopodiaceae	
Monolepis nuttalliana (Shult.) Greene[d]	Nuttall Monolepis
Chenopodium chenopoioides (L.) Aellen[de]	Red Goosefoot
C. humile Hook.	Goosefoot
Atriplex rosea L.[a]	Red Orache
A. argentea Nutt.	Silverscale

Table 14. Continued

Scientific name	Common name
Family Chenopodiaceae (continued)	
A. patula L.[a]	Spearscale
A. nuttallii S. Wats.[ac]	Nuttall Saltbrush
A. confertifolia (Torr. & Frem.) S. Wats.[a]	Shadscale
A. truncata (Torr.) Gray	Wedgescale Saltbrush
Kochia scoparia (L.) Schrad.[c]	Belvedere Summer Cypress
Salicornia rubra A. Nels.[ce]	Samphire
Sarcobatus vermiculatus (Hook.) Torr[ac]	Greasewood
Suaeda intermedia S. Wats.	Alkali Seepweed
S. oxidentalis S. Wats.[ac]	Seepweed
Bassia hyssopifolia (Pall.) Kuntze[cd]	Fivehook Bassia
Salsola kali L.[a]	Russian Thistle
Eurotia lanata (Pursh) Moq.[ac]	Winterfat
Family Caryophyllaceae	
Arenaria kingii (S. Wats.) Jones	Sandwort
Spergularia marina (L.) Griseb[e]	Sand Spurry
Family Ranunculaceae	
Delphinium nelsonii Greene	Low Larkspur
Ranunculus circinatus Sibth.[b]	White-water Crowfoot
R. cymbalaria Pursh	Buttercup
R. testiculatus Crantz[c]	Bur Buttercup
Family Cruciferae	
Thelypodium sagittatum (Nutt.) Endl.	Thelypodium
Cardaria draba (L.) Desv.	White-top
Lepidium perfoliatum L.	Clasping Peppergrass
L. densiflorum Schrad.	Peppergrass
L. dictyotum Gray	Peppergrass
L. montanum Nutt.[a]	Peppergrass
Thlaspi arvense L.[a]	Penny-cress
Descurainia sophia (L.) Webb	Tansy-mustard
D. incisa (Engelm.) Britt.[a]	Tansy-mustard
Sisymbrium altissimum L.	Tumbling-mustard
S. linifolium Nutt.	(Mustard)
Rorippa obtusa (Nutt.) Britt.[de]	Spreading Cress
Physaria australis (Payson) Rollins	Double Bladder-pod
Lesqerella multiceps Maguire[c]	Bladderpod
Arabis holboelii Hornem	Rockcress
Erysimum repandum L.	Wall Flower
E. wheeleri Rothr.	Wall Flower
E. capitatum (Dougl.) Greene	Coastal Wall Flower
Malcolmia africana (L.) R. Br.	Malcolmia
Conringia orientalis (L.) Dum.	Hare's Ear
Chorispora tenella DC.[a]	Chorispora

Table 14. Continued

Scientific name	Common name
Family Crassulaceae	
Sedum stenopetalum Pursh	Stonecrop
Family Rosaceae	
Rosa woodsii Lindl.[a]	Wild Rose
Potentilla gracilis Dougl.[a]	Cinquefoil
P. anserina L.[ad]	Silver Weed
Family Leguminosae	
Thermopsis montana Nutt.	Thermopsis
Trifolium pratense L.[a]	Red Clover
T. repens L.[a]	White Clover
T. gymnocarpon Nutt.[ac]	Hollyleaf Clover
Medicago sativa L.[a]	Alfalfa
M. lupulina L.[a]	Black Medic
Melilotus officinalis (L.) Lam.[a]	Yellow Sweetclover
Astragalus agrestis Dougl.	Loco Weed
A. utahensis T. & G.[a]	Lady Slipper
A. purshii Dougl.	Loco Weed
A. simplicifolius (Nutt.) Gray	Tufted Milkvetch
A. miser Dougl.	Loco Weed
A. diversifolius Gray	Loco Weed
A. drummondii Hook	Drummond Milkvetch
Family Linaceae	
Linum lewisii Pursh	Blue Flax
Family Callitrichaceae	
Callitriche palustris L.	Water Starwort
Family Malvaceae	
Sphaeralcea coccinea (Pursh) Rydb.	Globe Mallow
Family Violaceae	
Viola praemorsa Dougl.	Yellow Violet
Family Cactaceae	
Opuntia rhodantha Schum.[a]	Prickly Pear Cactus
O. polyacantha Haw.	Prickly Pear Cactus
Family Onagraceae	
Oenothera flava (A. Nels.) Garrett[c]	Evening Primrose
O. heteranthera Nutt.	Evening Primrose
Gaura parviflora Dougl.	Gaura
Family Haloragidaceae	
Myriophyllum exalbescens Fern.[b]	Water Milfoil

Table 14. Continued

Scientific name	Common name
Family Umbelliferae	
Cicuta douglasii (DC.) C. & R.	Water Hemlock
Cymopterus fenleri Gray	Chimaga
Lomatium grayi C. & R.	Desert Parsley
Family Primulaceae	
Glaux maritima L.[a]	Saltwort
Family Apocynaceae	
Apocynum medium Greene	Dogbane
Family Polemoniaceae	
Phlox longifolia Nutt.	Phlox
P. diffusa Benth.[c]	Phlox
P. hoodii Rich[ac]	Hood's Phlox
Family Boraginaceae	
Cynoglossum officinale L.	Hound's Tongue
Lappula redowskii (Horsem.) Greene[a]	Stickseed
Cryptantha flavoculata (A. Nels.) Payson	Cryptantha
C. minima Rydb.[a]	Cryptantha
Plagiobothrys cognatus (Greene) Johnston[ad]	Plagiobothrys
Mertensia oblongifolia (Nutt.) G. Don	Oblongleaf Bluebells
Family Labiatae	
Mentha arvensis L.[d]	Mint
Family Scrophulariaceae	
Penstemon humilis Nutt.	Low Penstemon
P. brevifolius (Gray) A. Nels.[c]	Penstemon
P. leonardi Rydb.[a]	Leonard Penstemon
Veronica peregrina L.[de]	Speedwell
Castilleja chromosa A. Nels.[a]	Indian Paint Brush
C. flava S. Wats.	Yellow Indian Paint Brush
Cardylanthus ramosus Nutt.[ac]	Cordytanthus
Family Plantaginaceae	
Plantago tweedyi Gray[a]	Plantain
Family Lobeliaceae	
Downingia laeta Greene	Downingia

Table 14. Continued

Scientific name	Common name
Family Compositae	
Gutierrezia sarothrae (Pursh) Britt. & Rusby[ac]	Snakeweed
Haplopappus acaulis Nutt.[a]	Haplopappus
Chrysothamnus viscidiflorus (Hook.) Nutt.[ac]	Rabbitbrush
C. nauseosus (Pall.) Britt[a]	Rabbitbrush
Aster chilensis Nees.	Aster
A. foliaceus Lindl.	Aster
Erigeron pumilis Nutt.	Fleabane
E. engelmanni A. Nels.[a]	Fleabane
Antennaria dimorpha (Nutt.) T. & G.[ac]	Everlasting
Gnaphalium palustre Nutt.	Cudweed
Iva axillaris Pursh[ac]	Poverty Weed
Chaenactis douglasii H. & A.	Chaenactis
Helenium montanum Nutt.[e]	Sneezeweed
Achillea lanulaosa Nutt.[a]	Yarrow
Artemisia tridentata Nutt. ssp. tridentata[ac]	Big Sagebrush
A. t. ssp. nova (A. Nels.) H. & C.[ac]	Black Sage
Senecio integerrimus Nutt.	Senecio
Tetradymia canescens DC.[a]	Spineless Horsebrush
Cirsium arvense (L.) Scop.	Canada Thistle
C. vulgare (Savi) Tenore	Bullthistle
Tragopogon dubius Scop.	Salsify
Taraxacum officinale Web.[ad]	Dandelion

[a]Plants found on upland vegetation survey, Woodruff Narrows Reservoir.
[b]Plants found on aquatic vegetation survey, Neponset Reservoir.
[c]Plants found on upland vegetation survey, Neponset Reservoir.
[d]Plants found on mudflat vegetation survey, Woodruff Narrows Reservoir.
[e]Plants found on mudflat vegetation survey, Neponset Reservoir.
Source: Scientific and common names are from: A. H. Holmgren, and J. L. Reveal. 1966. Checklist of the vascular plants of the intermountain region. U.S. Forest Service Research Paper INT-32. 160 p., and A. H. Holmgren. 1948. Handbook of the vascular plants of the Northern Wasatch. The National Press, Palo Alto, California. 202 p. Identification was confirmed by Arthur H. Holmgren, Director, Intermountain Herbarium.

Table 15. Birds observed at Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1968-1969[a]

Common name	Scientific name
Common Loon	*Gavia immer* (Brunnich)
Eared Grebe	*Podiceps caspicus* (Hablizl.)
Western Grebe	*Aechmophorus occidentalis* (Lawrence)
Pied-billed Grebe	*Podilymbus podiceps* (L.)
White Pelican	*Pelecanus erythrorhynchos* Gmelin
Double-crested Cormorant	*Phalacrocorax auritus* (Lesson)
Great Blue Heron	*Ardea herodias* L.
Snowy Egret	*Leucophoyx thula* (Molina)
Black-crowned Night Heron	*Nycticorax nycticorax* (L.)
American Bittern	*Botaurus lentiginosus* (Rackett)
White-faced Ibis	*Plegadis chihi* (Vieillot)
Trumpeter Swan	*Olor buccinator* Richardson
Whistling Swan	*O. columbianus* (Ord)
Canada Goose	*Branta canadensis moffitti* Aldrich
Mallard	*Anas platyrhnchos* L.
Gadwall	*A. Strepera* L.
Pintail	*A. acuta* L.
Green-winged Teal	*A. carolinensis* Gmelin
Blue-winged Teal	*A. discors* L.
Cinnamon Teal	*A. cyanoptera* Vieillot
American Widgeon (Baldpate)	*Mareca americana* (Gmelin)
Shoveler	*Spatula clypeata* (L.)
Redhead	*Aythya americana* (Eyton)
Ring-necked Duck	*A. collaris* (Donovan)
Canvasback	*A. valisineria* (Wilson)
Lesser Scaup	*A. affinis* (Eyton)
Common Goldeneye	*Bucephala clangula* (L.)
Bufflehead	*B. albeola* (L.)
Ruddy Duck	*Oxyura jamaicensis* (Gmelin)
Common Merganser	*Mergus merganser* L.
Red-breasted Merganser	*M. serrator* L.
Red-tailed Hawk	*Buteo jamaicensis* (Gmelin)
Golden Eagle	*Aquila chrysaetos* (L.)
Bald Eagle	*Haliaeetus leucocephalus* (L.)
Marsh Hawk	*Circus cyaneus* (L.)
Prairie Falcon	*Falco mexicanus* Schlegel
Sparrow Hawk	*F. sparverius* L.
Sage Grouse	*Centrocercus urophasianus* (Bonaparte)
Sandhill Crane	*Grus canadensis* (L.)
Sora	*Porzana carolina* (L.)
American Coot	*Fulica americana* Gmelin
Snowy Plover	*Charadrius alexandrinus* L.
Killdeer	*C. vociferus* L.
Mountain Plover	*Eupoda montana* (Townsend)
Black-bellied Plover	*Squatarola squatarola* (L.)

Table 15. Continued

Common name	Scientific name
Long-billed Curlew	*Numenius americanus* Bechstein
Spotted Sandpiper	*Actitis macularia* (L.)
Willet	*Catoptrophorus semipalmatus* (Gmelin)
Greater Yellowlegs	*Totanus melanoleucus* (Gmelin)
Lesser Yellowlegs	*T. flavipes* (Gmelin)
Baird's Sandpiper	*Erolia bairdii* (Coues)
Least Sandpiper	*E. minutilla* (Vieillot)
Long-billed Dowitcher	*Limnodromus scolopaceus* (Say)
Western Sandpiper	*Ereunetes mauri* Cabanis
Marbled Godwit	*Limosa fedoa* (L.)
American Avocet	*Recurvirostra americana* Gmelin
Wilson's Phalarope	*Steganopus tricolor* Vieillot
Northern Phalarope	*Lobipes lobatus* (L.)
California Gull	*Larus californicus* Lawrence
Franklin's Gull	*L. pipixcan* Wagler
Forster's Tern	*Sterna forsteri* Nuttall
Caspian Tern	*Hydroprogne caspia* (Pallas)
Black Tern	*Chlidonias niger* (L.)
Rock Dove	*Columba livia* Gmelin
Mourning Dove	*Zenaidura macroura* (L.)
Great Horned Owl	*Bubo virginianus* (Gmelin)
Short-eared Owl	*Asio flammeus* (Pontoppidan)
Common Nighthawk	*Chordeiles acutipennis* (Forster)
Broad-tailed Hummingbird	*Selasphorus platycercus* (Swainson)
Belted Kingfisher	*Megaceryle alcyon* (L.)
Red-shafted Flicker	*Colaptes cafer* (Gmelin)
Eastern Kingbird	*Tyrannus tyrannus* (L.)
Say's Phoebe	*Sayornis saya* (Bonaparte)
Horned Lark	*Eremophila alpestris* (L.)
Violet-green Swallow	*Tachycineta thalassina* (Swainson)
Tree Shallow	*Iridoprocne bicolor* (Vieillot)
Rough-winged Swallow	*Stelgidopteryx ruficollis* (Vieillot)
Barn Swallow	*Hirundo rustica* L.
Cliff Swallow	*Petrochelidon pyrrhonota* (Vieillot)
Black-billed Magpie	*Pica pica* (L.)
Common Crow	*Corvus brachyrhynchos* Brehm
Long-billed Marsh Wren	*Telmatodytes palustris* (Wilson)
Rock Wren	*Salpinctes obsoletus* (Say)
Sage Thrasher	*Oreoscoptes montanus* (Townsend)
Robin	*Turdus migratorius* L.
Mountain Bluebird	*Sialia currucoides* (Bechstein)
Loggerhead Shrike	*Lanius excubitor* L.
Audubon's Warbler	*Dendroica auduboni* (Townsend)
Western Meadowlark	*Sturnella neglecta* Audubon
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus* (Bonaparte)

Table 15. Continued

Common name	Scientific name
Red-winged Blackbird	*Agelaius phoeniceus* (L.)
Brewer's Blackbird	*Euphagus cyanocephalus* (Wagler)
Brown-headed Cowbird	*Molothrus ater* (Boddaert)
Western Tanager	*Piranga ludoviciana* (Wilson)
American Goldfinch	*Spinus tristis* (L.)
Lark Bunting	*Calamospiza melanocorys* Stejneger
Savannah Sparrow	*Passerculus sandwichensis* (Gmelin)
Vesper Sparrow	*Pooecetes gramineus* (Gmelin)
Sage Sparrow	*Amphispiza belli* (Cassin)
Oregon Junco	*Junco oreganus* (Townsend)
Brewer's Sparrow	*Spizella breweri* Cassin
White-crowned Sparrow	*Zonotrichia leucophrys* (Forster)

[a]Names are those given in: American Ornithologists' Union. 1957. Checklist of North American Birds, 5th ed. American Ornithologists' Union, Baltimore, Maryland. 591 p.

Table 16. Mammals found at Neponset Reservoir, Utah, and Woodruff Narrows Reservoir, Wyoming, 1968-1969[a]

Common name	Scientific name
White-tailed Jack Rabbit	*Lepus townsendii townsendii* Bachman
Nuttall Cottontail	*Sylvilagus nuttallii grangeri* (Allen)
White-tailed Prairie Dog	*Cynomys leucurus* Merriam
Uinta Ground Squirrel	*Spermophilus armatus* Kennicott
Least Chipmunk	*Eutamias minimus consobrinus* (Allen)
Beaver	*Castor canadensis duchesnei* Durrant and Crane
Deer Mouse	*Peromyscus maniculatus osgoodi* Mearns
Muskrat	*Ondatra zibethica osoyoosensis* (Lord)
Coyote	*Canis latrans lestes* Merriam
Badger	*Taxidea taxus taxus* (Schreber)
Striped Skunk	*Mephitis mephitis hudsonica* Richardson
Bobcat	*Lynx rufus pallescens* Merriam
Mule Deer	*Odocoileus hemionus hemiones* (Rafinesque)

[a]Names are those given in: S. D. Durrant. 1952. *Mammals of Utah.* University of Kansas, Lawrence, Kansas. 549 p.

VITA

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Publication: 1967. The effects of weather on spring migration of waterfowl near St. Paul, Minnesota. Loon 39(3):77-81.