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EVALUATION OF GIANT CANADA GOOSE RESTORATION IN WESTERN SOUTH DAKOTA

BY

DENNIS L. LENGKEEK

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Wildlife Biology,
South Dakota State University

1973

EVALUATION OF GIANT CANADA GOOSE RESTORATION

IN WESTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

_____ _____

Thesis Advisors Date

Head, Wildlife and Fisheries Science Department Date

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EVALUATION OF GIANT CANADA GOOSE RESTORATION IN WESTERN SOUTH DAKOTA

Abstract

Dennis L. Lengkeek

A study of giant Canada goose (Branta canadensis maxima) restoration in western South Dakota was conducted during 1970 and 1971. Nesting, production and mortality, homing, and pioneering were evaluated both years. Nesting began April 4 in 1970 and extended for 73 days, but the peak of nesting occurred from April 29 to May 5. In 1971, nesting began April 1 and continued for 69 days, with the peak occurring April 8 - 14. The peak of hatching occurred June 6 - 12 in 1970 and May 8 - 14 during 1971.

Small stockponds were utilized for nesting both years. Islands were preferred nesting sites. Peninsulas and shore sites contained over half of the nests and artificial structures were also used. Of the 82 nest observed, 85 percent were in ungrazed areas.

Nests on land were found an average of 27 feet from water and 68 percent were within 15 feet. The mean elevation above water was 3.4 feet for all nests; 3.7 feet for land nests and 1.6 feet for nests in artificial structures. Almost all nest sites were found in relatively bare areas and afforded maximum visibility for the nesting geese. Thirty-four plant species were observed at nest sites, but no species was preferred.

Thirty-two clutches had 158 eggs during 1970, and 50 clutches had 273 eggs during 1971; mean clutch size was 4.9 eggs in 1970 and 5.5 in 1971. Clutches ranged from 2 to 9 eggs during the 2-year period. Clutches of 1 to 4 eggs had 45.5 percent hatchability, and larger clutches of 5 to 9 eggs had hatchability of 73.1 percent.

Of the 82 nests, 78.1 percent successfully hatched and 15.9 percent were destroyed; 12.2 percent by mammalian predators and 3.7 percent by flooding. Desertion occurred in 3.6 percent of the nests, and eggs in 2.4 percent were incubated but failed to hatch. Infertility accounted for 14.2 percent of the egg loss. Embryonic death occurred in 5.6 percent of the eggs, and 11.8 percent were destroyed.

During the 2 years, 295 goslings were produced from 64 nests. Of these, 263 (89.2 percent) were raised to flight stage. Ninety-one percent of the gosling mortality occurred during the initial 2 weeks following hatching when broods were moving between water areas. Broods in the Belvidere area moved an average of 2.7 miles before congregating on a rearing-molting area.

The sex ratio of 136 adults homing to the study area was 1.1 females per male and 29 yearlings that homed had a sex ratio of 2.2. Pioneering was limited both years. Seventy percent of the geese were recaptured within 5 miles of the dam on which they were reared or released in previous years. The mean distance moved from the original release site to the site of recapture was 1.0 miles. Of 64 geese

released in 1970, 6 pairs that returned in 1971 were observed to have pioneered an average of only 3.4 miles from the release site.

High nest success, low mortality of goslings, and homing to the area of release have all contributed to the success of the restoration project. The population is now self-sustaining and will continue to grow if factors affecting production remain favorable and mortality factors do not increase appreciably.

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INTRODUCTION

The Canada goose (Branta canadensis)[1] is one of our most intensively managed waterfowl species, and much of the management has been directed towards restoration of breeding populations. In the northern Great Plains, efforts at restoration have centered on the giant Canada goose (B. c. maxima).

The giant Canada goose was once native to much of the northern Great Plains. It commonly nested throughout South Dakota (Delacour 1954). During the late 1800's and early 1900's, this subspecies began declining as a result of egg gathering and hunting by early settlers. Its decline was so drastic that most authorities considered the giant Canada goose to be extinct by the 1950's (Delacour 1954, Greenway 1958).

The giant Canada goose was rediscovered in January, 1962, by H. C. Hanson of the Illinois Natural History Survey (Hanson 1965). His discovery resulted from examination of a wintering flock of Canada geese at Rochester, Minnesota. Subsequent examination of other wild and captive flocks throughout the north-central states showed that this subspecies was still present in substantial numbers.

Various programs to restore the Canada goose were established prior to the rediscovery of the giant Canada goose. Captive flocks, for restoration purposes, were maintained on many National Wildlife Refuges

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[1]Scientific names of geese follow the A.O.U. Check-list, 5th Edition (1957).

and on state waterfowl-management areas as early as the middle 1930's (Nelson 1963). Experimental release programs for reestablishment of breeding populations were initiated on several National Wildlife Refuges in the north-central region during 1936. These refuges, combined with state areas, were producing 4,000 to 4,500 geese annually by 1962 (Nelson 1963).

South Dakota initiated a giant Canada goose restoration program in 1962 (Gram 1964, Drewien and Schoonover 1969, Kuck 1971). Western portions of the state, in which the giant Canada goose had once nested, seemed ideally suited for such a program. The program was established through a cooperative agreement between the South Dakota Department of Game, Fish and Parks and the U. S. Bureau of Sport Fisheries and Wildlife. A three-phase plan to implement the project consisted of (1) maintenance of a captive flock for the production of young, (2) a landowner-cooperator program where the landowner raised geese to the flight stage, and (3) release of free-flying birds in areas of suitable habitat.

The current study was initiated in 1970 to determine the success of birds released during the restoration project in western South Dakota. Its primary objectives were (1) to determine production, (2) to evaluate homing and pioneering, and (3) to determine the future potential for restoring giant Canada geese in western South Dakota.

DESCRIPTION OF STUDY AREA

The study area was located in southwestern South Dakota, encompassing approximately 2,500 square miles of Jackson, Haakon and Pennington counties (Fig. 1). The area included that portion of Jackson County west of South Dakota highway 63; all of Haakon County south of U. S. highway 34 and west of the county road from Midland to State Highway 34; and that part of Pennington County bounded on the west by the Cheyenne River and on the south by Interstate Highway 90 from Wasta to Wall and alternate U. S. Highway 16 from Wall to Cedar Pass.

Numerous man-made stockdams are found throughout the area, most of which vary in size from 1 to 20 acres. Three major rivers, the White, the Bad, and the Cheyenne, traverse the area.

Soils in the area belong to the Chestnut great soil group. Major soil associations include the Kadoka-Epping and Badlands Associations in the southern and southwestern portions of the study area and the Opal-Samsil Associations in the northern portions (Westin et al. 1967). Parent materials include the White River Beds, consisting of unconsolidated silts and clays in the Badlands and Kadoka-Epping Associations. Pierre shales, composed of deep and moderately deep clays, underlie the remainder of the study area (Westin and Buntley 1962). Topography is undulating to rolling, with elevations ranging from 1,800 to 3,600 feet (Westin et al. 1951).

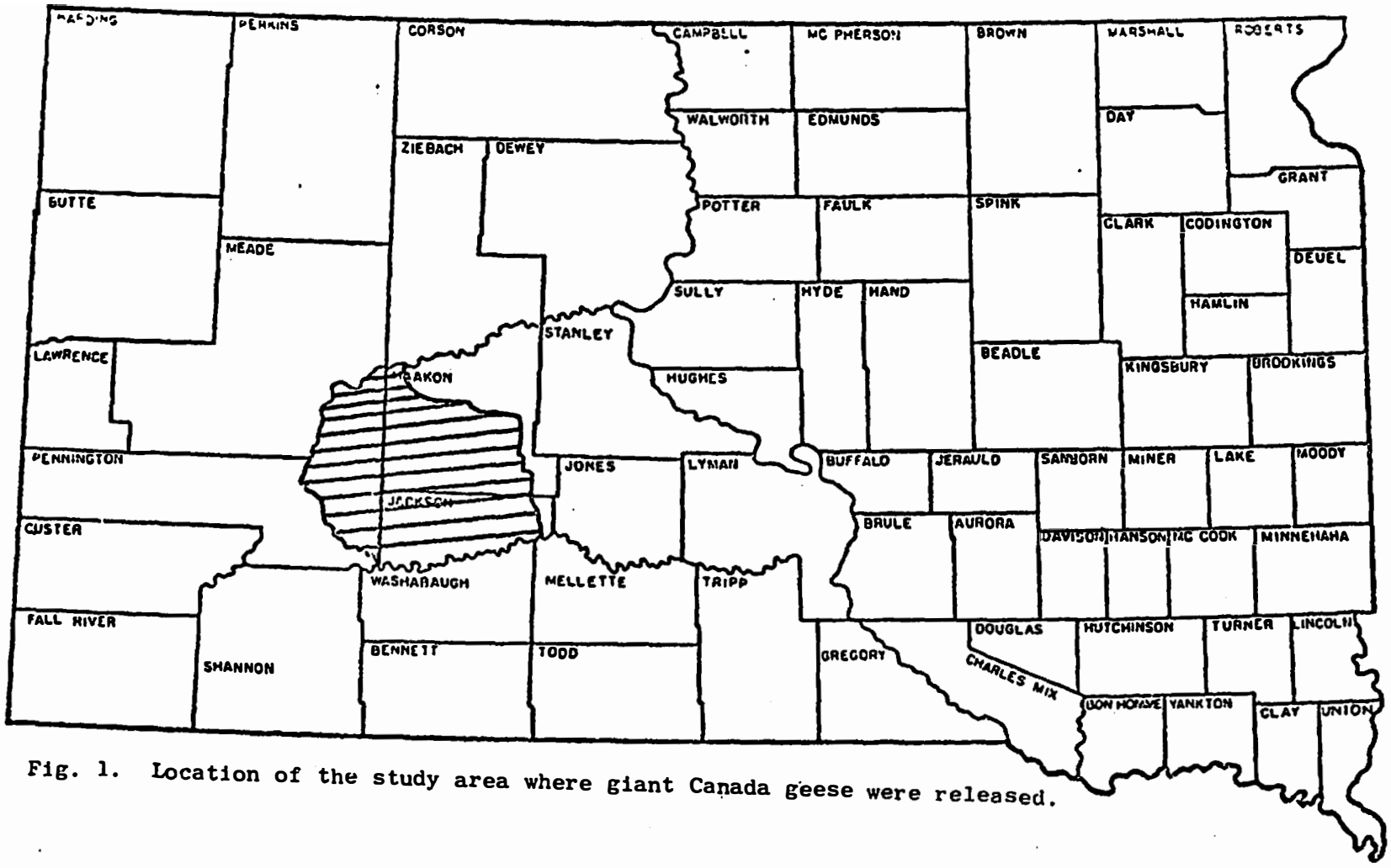

Fig. 1. Location of the study area where giant Canada geese were released.

Vegetation on the study area consisted of mixed prairie, with short grasses dominating overgrazed areas. Kuchler (1964) has classified the northern portion of the area as a wheatgrass-grama-buffalo grass climax community and the southern portion as a wheatgrass-needlegrass climax community. Dominant grassland species include western wheatgrass (Agropyron smithii)[1], blue grama (Bouteloua gracilis), needle-and-thread (Stipa comata), green needlegrass (Stipa viridula), and buffalo grass (Buchloe dactyloides). Cheatgrass (Bromus tectorum) has become an important invader throughout the area.

Cropland varies from less than 15 percent of the land area in the Badlands basins to 60 percent in areas north of Wall and Philip (Westin and Buntley 1962). Grazing is the most important land use. Over 80 percent of the total area is rangeland. Hayland, both tame and wild, makes up approximately 6 to 9 percent of the area, and small grains are grown on 1 to 4 percent of the area (Westin et al. 1967).

The climate of the area is semiarid and continental. The average annual temperature is 46.6 F and temperatures range annually from extremes of -20 F or lower to 100 F or higher. The average dates for first and last killing frosts are September 22 and May 19; accordingly, growing seasons average approximately 126 days.

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[1]Scientific names of plants are according to Fernald (1950).

Annual precipitation averages 15 inches. Most of this occurs during spring and early summer in the form of thundershowers. Average seasonal snowfall is 24 inches per year, and snow provides ground cover for an average of 36 days per year.

Average annual wind velocity is 11 mph. The prevailing direction is northwest in winter and southeast in summer. Weather data were obtained from National Weather Service records for the Cottonwood Range Experiment Station, which was centrally located in the study area (U. S. Weather Bureau 1968).

METHODS AND MATERIALS

Releases

The first phase of the giant Canada goose restoration program consisted of establishing a captive flock of geese for the production of young. This flock, consisting of select, pinioned pairs, was maintained at Sand Lake National Wildlife Refuge at Columbia, South Dakota. Goslings were transported to LaCreek National Wildlife Refuge at Tuthill, South Dakota. This refuge was close to the restoration project area, facilitating subsequent transport of birds to release sites.

The second phase of the program involved the establishment of captive flocks of pinioned giant Canada geese. George Hauk (Cottonwood), Lavon Shearer (Wall), and the Belvidere Rod and Gun Club raised captive flocks used for production of free-flying offspring. These cooperators were selected on the basis of available habitat and facilities for care and production of the birds.

The third phase of the program, the release of free-flying birds, was initiated in the spring of 1967. The first release was made in Mellette County, south of the study area. In 1968, the first release of free-flying geese, consisting of 22 birds, was made on a stockpond in the study area proper. Release sites were preselected on the basis of available habitat, both at the release site and the surrounding area, and on available food. Relative isolation from disturbance and ample water area for protection were also necessary, because the birds were

unable to fly until they had molted and regrown their clipped primaries. To reduce excessive hunting mortality, a 5-county area that included the study area was closed to goose hunting in 1967. The closed area has since been expanded to include all or portions of 14 counties.

Annual releases of birds were made on the study area each spring following the 1968 release. Releases consisted of 200 birds in 1969, 64 in 1970, and 204 in 1971 (Fig. 2). The total release of free-flyers through the study period was 490 birds. An additional 106 birds were released on the area in 1972.

Nest Searching

Ground searches were considered the most effective means of locating nests. As many stockponds as possible were checked at least once each year during the nesting period, but emphasis was placed on searching those stockponds on which releases had been made. The greatest density of nesting pairs was expected in close proximity to release sites because of the limited pioneering tendencies of Canada geese (Hochbaum 1955). Concentrated nest searching was started only after the nesting period was well under way. Binoculars and a spotting scope were used extensively during nest searching. If adequate observations of potential nesting areas could not be made visually, thorough searches were made on foot. Ground searches were also made if only one bird or a pair was observed on a stockpond. Since nesting cover was sparse, nests could easily be found by walking around the stockpond.

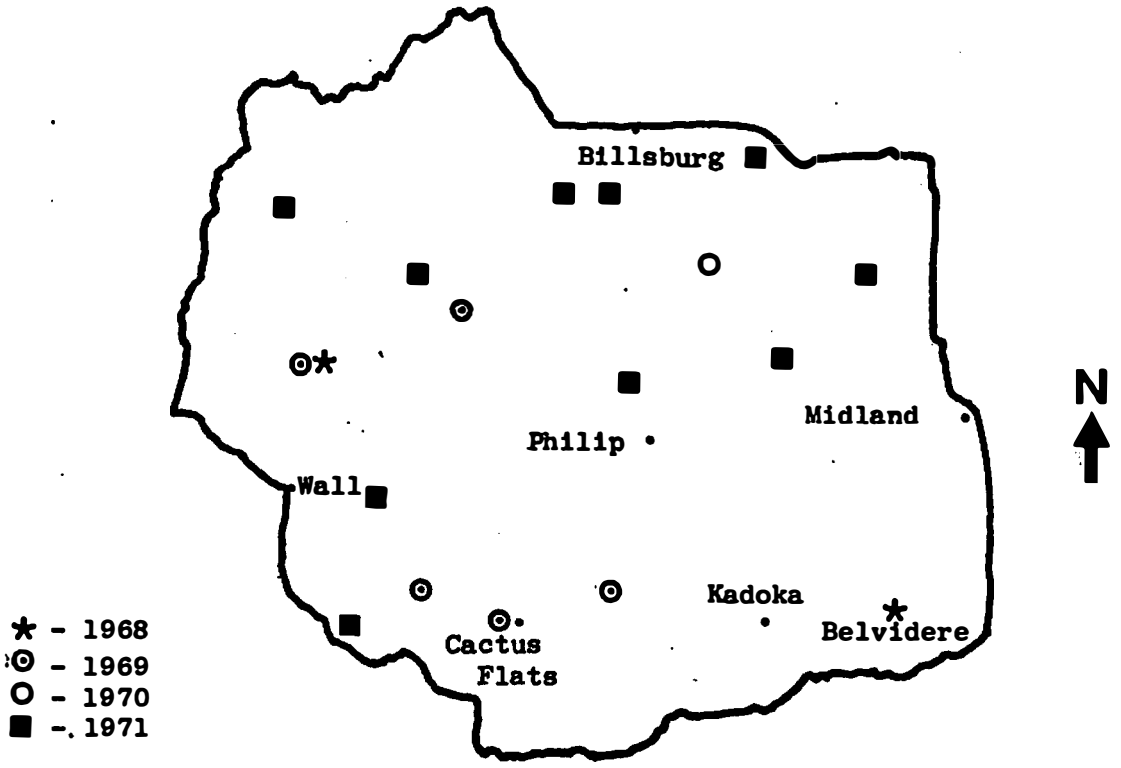


Fig. 2. Sites where giant Canada geese were released from 1968 to 1971.

Local conservation officers and area ranchers were cooperative in reporting nests or pairs. A newspaper article published in 1971, requesting assistance in locating goose nests, also aided in securing nesting data. Forest Service personnel recorded geese observed on National Grasslands. Soil Conservation Service personnel also provided information on breeding pairs of geese.

Aerial surveys were made in addition to ground searches both years. Personnel of the S. D. Dept. of Game, Fish and Parks surveyed all of the area by air in late April, 1970, after nesting had begun. A survey was also flown in early May of 1971, by the personnel of the U. S. Bureau of Sport Fisheries and Wildlife, over areas of known goose concentration and areas surrounding past release sites. The aerial antelope survey, conducted in mid-May of both years by the Department of Game, Fish and Parks, resulted in additional sightings of pairs or family groups.

Nest Observation

Care was taken to cause as little disturbance as possible when observing nests, since disturbance prior to incubation often causes nest abandonment. After incubation had begun, nests were checked at least once weekly. Frequently it was possible to check the nest without flushing the hen, since the hen often stood over the nest while exhibiting aggressive displays. Hens that did not leave continued

incubation almost immediately, and hens that flushed usually returned soon after I left the nest site.

Nest-initiation dates were determined by back-dating. An egg-laying interval of 1.5 days per egg was used to calculate the date incubation began (Kossack 1950, Brakhage 1965). When it was necessary to backdate from the hatching date, 28 days were used as the incubation period (Collias and Jahn 1959, Schoonover et al. 1970).

Eggs were broken after abandonment, full-term incubation, or flooding to determine their status. Eggs were classified as infertile if the yolk was wholly or partially suspended in the albumen (Kossack 1950).

Nesting Structures

Nesting structures were placed throughout the study area to reduce nest loss from flooding and predation. Previous investigators (Yocom 1952, Brakhage 1965) stressed the importance of such a technique in managing Canada geese.

Floating nest platforms, developed at Sand Lake National Wildlife Refuge (Schoonover et al. 1970), were modified to include the rounded end of a reject, fiberglass fertilizer or pesticide tank (Fig. 3). A similar fiberglass "tub" was reversed and fastened to the bottom of the platform to provide extra buoyancy. Prior to the nesting period, floating platforms were placed on stockponds known to be used by geese.

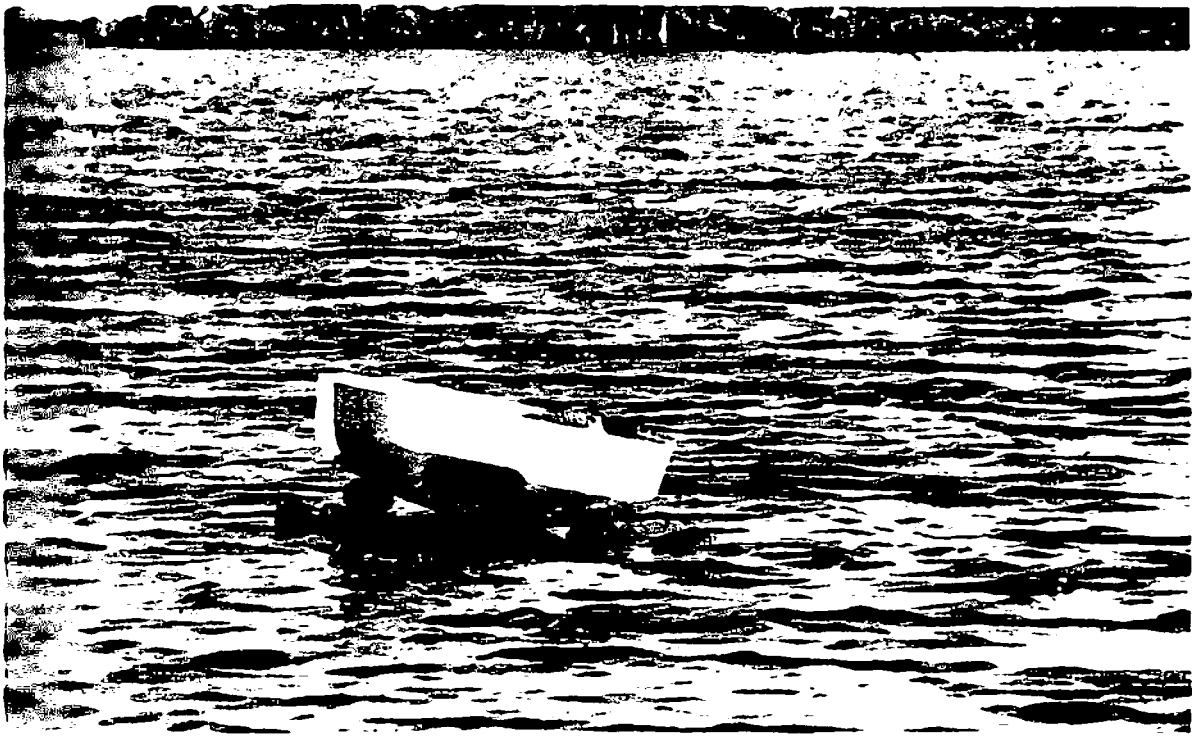


Fig. 4. Floating nest structures were placed on lakes and stockponds in the study area.

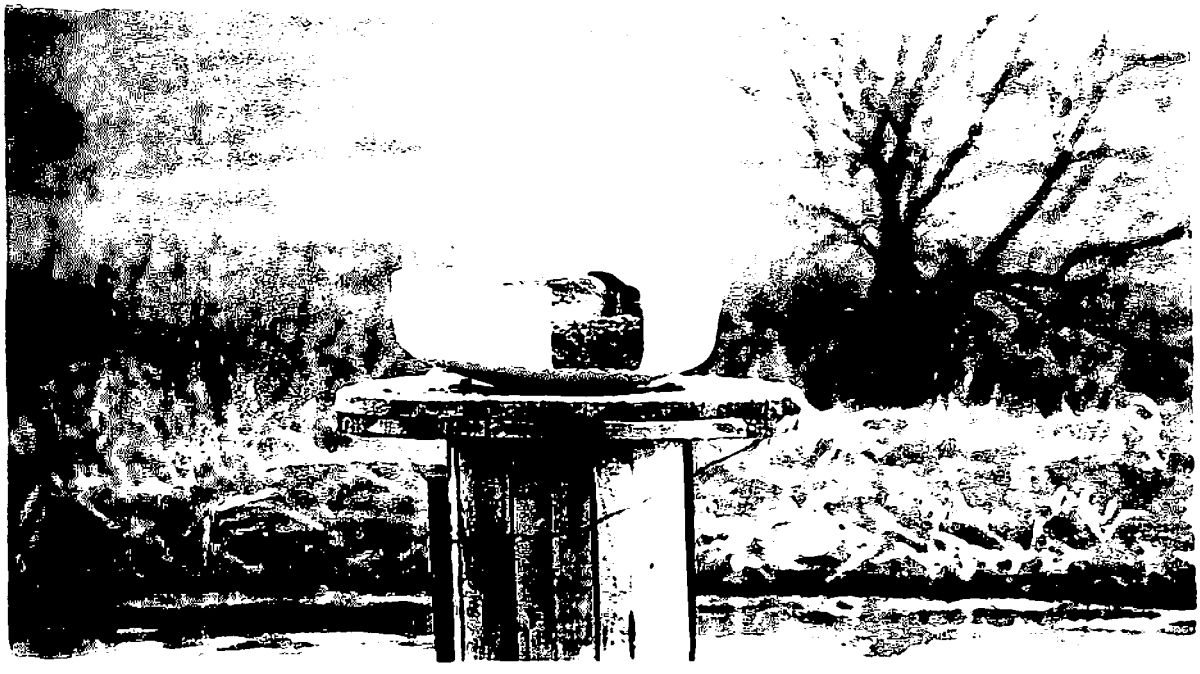


Fig. 5. Stationary nest structures were utilized by geese for nesting.

Cable spools, with fiberglass tubs attached, were also used as nesting structures (Fig. 4). These were placed in approximately 3 feet of water to provide artificial islands on Belvidere Lake. Steel posts were used to secure them to the bottom.

The Forest Service installed 25 elevated fiberglass nesting structures (Dill 1966) on water areas in the National Grasslands. Firm anchoring was necessary to prevent damage by ice.

Banding

All birds released on the study area were banded prior to release. A Fish and Wildlife Service numbered band and a color-coded band were placed on the leg of each bird (Fig. 5). Released birds were band-coded according to their sex. On males, a numbered band was placed on the left leg and the colored band on the right. On females, band positions were reversed. Birds were banded with different colors each year. Birds released in 1969 were banded with white, vinyl-clad aluminum bands (Clad-Rex Vinyl Division, Delta-Chicago Inc., Franklin Park, Illinois). Dark-red, vinyl-clad aluminum bands were used in 1970. All birds released in 1971 were banded with blue, anodized-aluminum bands (National Band and Tag Co., Newport, Kentucky). Coding of bands according to sex and year of release provided the basis for analysis of homing and pioneering within the study area, as well as future identification.

5. Coded bands were used to identify individual birds and year classes.

6. Stockponds were used for nest sites.

A concerted effort was made during both summers to band as many goslings as possible. Adults and goslings were most effectively trapped while concentrated in family groups on molting areas. Drive traps were used when the number of geese present warranted their use. Isolated broods were banded by driving the adults and goslings to shore, whereupon they were captured by dip nets.

The most desirable age to band goslings was approximately 6 weeks of age, since at 8 to 9 weeks of age they became capable of flight (Hanson 1965). Goslings were also band-coded according to sex and year of production.

RESULTS AND DISCUSSION

lesting Phenology

The first known nest was initiated on April 4 in 1970 and on April . in 1971. The latest known nest was initiated on May 14 in 1970 and lay 10 in 1971. Peak clutch initiation during 1970, based on 25 known ıests, occurred during the period April 29 to May 5, with a secondary ɔeak between April 8 and 14 (Fig. 7). Peak clutch initiation during .971, based on 29 known nests, occurred April 8-14, and was followed by ı smaller peak April 22-28. The nest-initiation curve in 1971 was con-ːidered typical of an average nesting year and was similar to that re-ɔorted by Collias and Jahn (1959) in Wisconsin, and Dimmick (1968) in lyoming. The length of the nesting season was 73 days during 1970 and ;9 days during 1971. These compare with a 4-year average of 73 days .n studies of the giant Canada goose in Missouri (Brakhage 1965).

Hatching extended from May 11 to June 15 in 1970, and from May 7 ːo June 8 in 1971. The peak of hatch in 1970, based on 21 successful ıests, occurred June 6-12 (Fig. 8). During 1971, the peak of hatch, ıased on 25 observed nests, occurred during May 8-14.

Weather differed considerably between the nesting seasons of 1970 ınd 1971, with meteorological conditions during April apparently having ːhe greatest effect on nesting. Temperatures during April of 1970 were .ower than the long-term mean of 46.2 F (U. S. Weather Bureau 1968). lesting was delayed during 1970 because of low temperatures, particularly

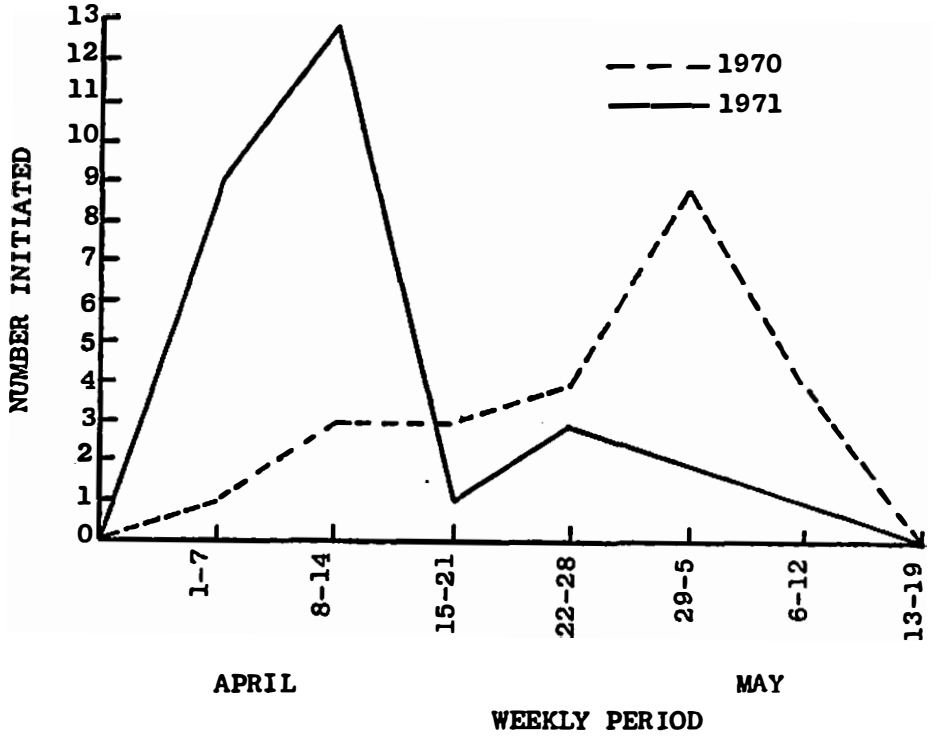


Fig. 7. Chronology of nest initiation, 1970-1971.

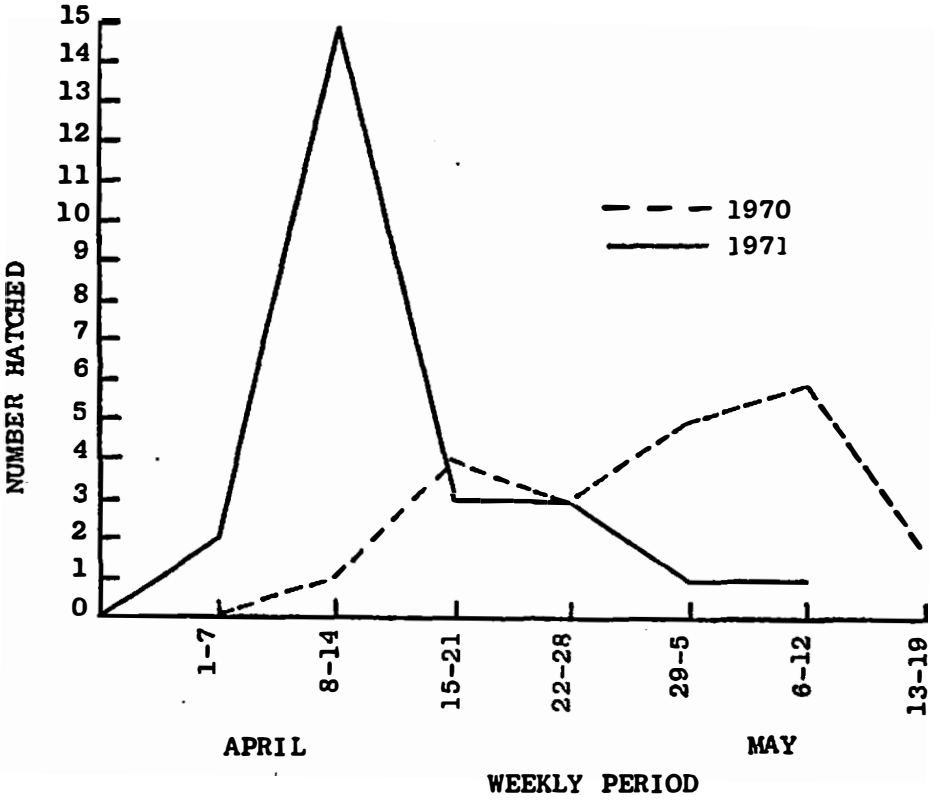


Fig. 8. Chronology of hatching, 1970-1971.

he unseasonably low temperatures, coupled with snow, from April 12 o 18 (Fig. 9). Several investigators (Naylor and Hunt 1954, Collias nd Jahn 1959, Hanson and Browning 1959, Hanson and Eberhardt 1971) ave noted that lowered temperatures cause a delay in nesting. April emperatures in 1971 were near normal and had little adverse effect n nesting.

Precipitation also varied between April of 1970 and 1971. While he long-term mean precipitation for the month of April was 1.8 inches, nd the long-term mean snowfall was 3.1 inches, 3.7 inches of rain and 1.0 inches of snow fell during 1970. This snow and rain hampered arly nesting. Many nests, in early stages of egg laying or incubation, ere abandoned from April 12-18, when the 21.0 inches of snow fell. ther investigators (Naylor and Hunt 1954, Geis 1956, Hanson and Eberardt 1971) also found that excessive precipitation had an adverse ffect on nesting.

Precipitation and snowfall during April of 1971 were also above verage; 4.0 inches of rain and 6.0 inches of snow fell. This preipitation, however, had no apparent adverse effect on nesting. The ainfall occurred over a period of 8 days that had average temperatures bove the monthly mean. The snow fell on 2 days near the end of the onth and melted rapidly when temperatures returned to normal.

Renesting was evident both years, but constituted a proportionatey greater part of the nesting effort in 1970 as a result of early nest

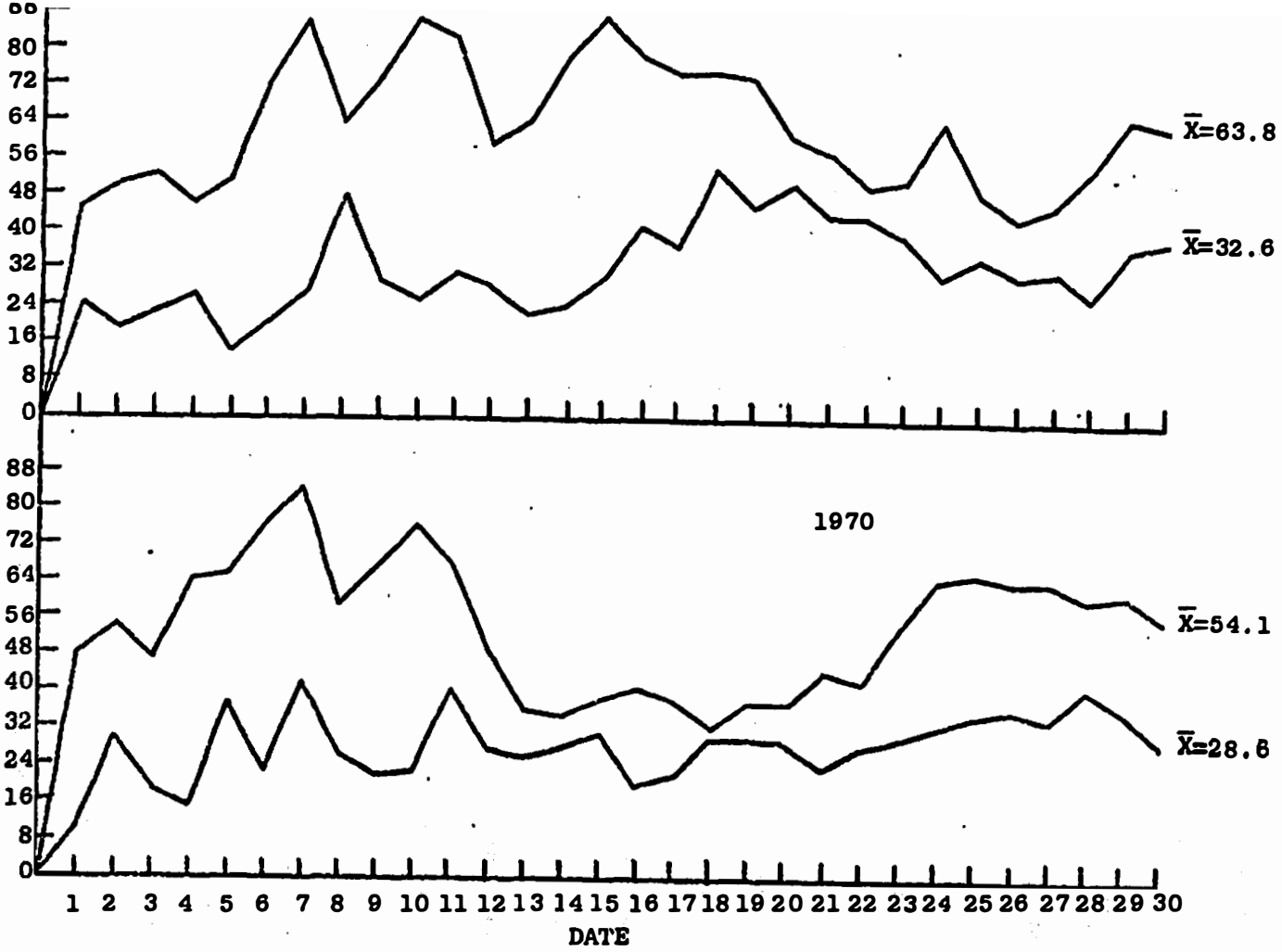


Fig. 9. Maximum and minimum daily temperatures recorded at the Cottonwood Range Experiment Station, Cottonwood, South Dakota, during April, 1970-1971 (U.S. Dept. of Commerce 1970, 1971).

abandonment. Renesting can normally be evaluated by examining curves of nest initiation. Dimmick (1968) stated that secondary peaks in the curve of nest initiation may represent renesting attempts. It must be realized, however, that secondary peaks may also represent first nesting attempts by subadults. By comparing bands, it was found that at least 3 pairs renested in 1970. The initial nesting peak (Fig. 7) of 1970 occurred during the beginning of the 6-day blizzard. The weather effectively stopped nest initiation and incubation during the period, and a secondary peak resulted. The primary peak occurred approximately 2 weeks after the last day of the heavy snowfall. Atwater (1959) reported that the renesting interval was 2.0-2.5 weeks, and Brakhage (1965) reported the interval to be 13 days. A portion of the late, primary peak likely resulted from renesting, and part of the peak was undoubtedly due to late nesting attempts. The nest initiation curve in 1970 extended from early April to mid May and had no large concentration of nests in the initial peak. This type of curve is typical of renesting populations according to Klopman (1958).

Renesting was less apparent during 1971 (Fig. 7). The primary peak of nest initiation occurred early in the season, and accounted for over 75 percent of all nests examined. A secondary peak, of much smaller magnitude, occurred 2 weeks later and the total nesting season was shortened. Populations with little renesting have this type of nesting curve (Klopman 1958). However, at least two renests were

known to occur in 1971. Renesting has been shown to contribute significantly to the total nesting effort by many investigators (Kossack 1950, Geis 1956, Klopman 1958, Atwater 1959, Brakhage 1965).

Nest Location

Available water areas were either dugouts or impoundments resulting from the damming of drainage-ways, such as shallow ravines (Fig. 6). Dams were the preferred nesting areas during the 2-year period. No nests were observed on dugouts. The average size of all stockponds used for nesting was 11.2 acres. Single pairs established nests on 42 stockponds that averaged 9.4 acres. More than one pair were found nesting on 5 stockponds that averaged 26.4 acres in size. Densities as high as 6 stockponds per square mile were observed on the study area; consequently, there was vitually no limitation on availability of nesting habitat.

Three nests were found in natural wetlands. Very few marshes were present on the study area and those present consisted of Type IV wetlands (Martin et al. 1953).

Ten nests were found on lakes; all except one were located on Belvidere Lake. Nesting birds concentrated on Belvidere Lake both years; probably because it was the site of a previous restoration attempt at which releases had been made.

Islands were preferred as nesting sites and were utilized whenever available. Twenty-nine (35.4 percent) of the nests found were on

islands (Table 1), even though few islands were available for nesting. The average dimension of islands used for nesting was 10.2 x 36.4 feet. Large islands occasionally accommodated more than 1 nesting pair. The importance of islands for nesting has been emphasized by other investigators. Miller and Collins (1953) and Naylor (1953), in California, reported that 30 to 40 percent of the nests were situated on islands. Craighead and Craighead (1949) found 95 percent of the nests on islands, and Dimmick (1968) found 71.6 percent on islands. Klopman (1958), Hanson and Browning (1959), and Vermeer (1970) reported almost exclusive use of islands by nesting geese. Islands offer protection from disturbance, especially mammalian predators, and provide accessible food, water, and loafing sites (Hammon and Mann 1956).

Peninsulas were utilized by 14.6 percent of the nesting pairs (Table 1). Because they allowed only one avenue of approach for potential mammalian nest predators, peninsula nests were easily defended. Geis (1956) and Atwater (1959) observed that peninsulas were used for nest sites in the absence of islands.

Nearly 38 percent of all nests were found on banks or shores (Table 1). Although they showed the highest use, they were normally utilized only if islands or peninsulas were not available.

Floating nest platforms were the artificial structures used most often for nesting (Table 1). Forty-five floating platforms were placed on dams during the spring of 1971. Use the first year was light,

Table 1. Nest sites utilized by Canada geese in western South Dakota, 1970-1971.

Nest Site	1970		1971		Total	
	Number	Percent	Number	Percent	Number	Percent
Island	12	37.5	17	34.0	29	35.4
Peninsula	4	12.5	8	16.0	12	14.6
Bank or shore	13	40.6	18	36.0	31	37.8
Artificial structure						
Stationary	2	6.3	1	2.0	3	3.7
Floating	1	3.1	6	12.0	7	8.5
Total	32	100.0	50	100.0	82	100.0

with only 5 (11 percent) being used by nesting birds. One nest was found each year on platforms built before 1970. Light use of platforms was anticipated because many of the structures were not installed early enough in the 1971 breeding season and since the structures were also new to the birds. Craighead and Stockstad (1961) and Reinecker (1971) observed that use of structures increased with time. They felt that nesting in artificial structures involved a learning process. Will and Crawford (1970) reported that floating structures were used for nesting in Colorado.

The two stationary structures at Belvidere Lake had 50 percent utilization during 1970 and 1971, with one being used each year. The only nest known to be on stationary structures constructed by the Forest Service was found during 1970 (Table 1). Use of these structures was limited, because few geese were found throughout much of the area in which the structures were placed, and because many of the structures were improperly located in relation to shoreline and loafing areas. Stationary structures, if placed properly, are readily used (Yocom 1952, Brakhage 1965, Reinecker 1971), and can greatly increase the number of potential nesting sites, especially in concentrated nesting populations.

Seventy of 82 nests (85.4 percent) were established in ungrazed areas during the initial nesting period. Of these 70 nests, 29 were found in summer pastures, and the remainder in ungrazed areas.

Apparently there was a tendency to nest away from all forms of disturbance. Dow (1943) stated that most nests were found in areas not extensively used by livestock. Dimmick (1968), however, reported that geese nested in harmony with grazing livestock.

Three pairs of geese used the same nest in both 1970 and 1971. Hanson and Browning (1959) and Hanson and Eberhardt (1971) found that pairs used the same nest site from year to year on the Columbia River in Washington. Geis (1956) observed that 45 percent of the nests were on or near sites occupied in previous years, and Vermeer (1970) found that at least one-third of the nests at Dowling Lake, Alberta, were built on old nests.

Nests averaged 27 feet from the nearest water, and 68 percent of the nests on land were within 15 feet of water. The distance of nests from water varied from 6 inches to 648 feet. These findings were similar to those of Dimmick (1968) in Jackson Hole, Wyoming. He found that the mean distance was 45.7 feet, but the range was from 0 to 525 feet. Most writers agree that the majority of nests are found near open water (Williams and Marshall 1937, Kossack 1950, Miller and Collins 1953, Atwater 1959).

The mean distance above water for all nests was 3.4 feet, and ranged from 6 inches to 25 feet. For nests on land, the mean height was 3.7 feet, and for artificial structures it was 1.6 feet. These heights are comparable to those observed in other studies. Craighead

and Craighead (1949) found a mean height of 2.9 feet above water and Dimmick (1968) found a mean height of 3.3 feet.

Almost all nests on the area were situated on sites that offered good visibility. Twenty-nine nests in summer pastures were established on overgrazed areas where limited cover allowed maximum visibility. Several investigators have indicated that visibility is one of the prime factors in nest-site selection (Dow 1943, Kossack 1950, Miller and Collins 1953, Hanson and Browning 1959, Hanson and Eberhardt 1971). Williams and Nelson (1943) pointed out that nest sites must have a browsing area for the nesting birds, must be free of disturbance, must furnish a firm foundation for the nest, and must have good visibility. These characteristics were found at nest sites in this study with few exceptions.

Plant Species Utilized for Nesting

Vegetation utilized for nest sites included 34 plant species (Table 2). Few nest sites consisted of monotypic vegetation; consequently, most had more than one species present. The 14 species found most commonly ranged from western wheatgrass (22.2 percent frequency of occurence) to lady's thumb (Polygonum persicaria) (4.2 percent frequency of occurrence). Each of the remaining 20 species was found at less than 4 percent of the total nests.

Table 2. Plant species utilized by land-nesting Canada geese in western South Dakota, 1970-1971.

Cover Type	1970 (29 nests)		1971 (43 nests)		Total	
	Number of Nest Sites	Percent of Nest Sites	Number of Nest Sites	Percent of Nest Sites	Number of Nest Sites	Percent of Nest Sites
Western wheatgrass (Agropyron smithii)	7	24.1	9	20.9	16	22.2
Foxtail barley (Hordeum jubatum)	7	24.1	9	20.9	16	22.2
Cheatgrass (Bromus tectorum)	6	20.7	9	20.9	15	20.8
Yellow sweetclover (Melilotus officinalis)	6	20.9	9	20.9	15	20.8
Prairie cordgrass (Spartina pectinata)	3	10.3	7	16.3	10	13.9
Green needlegrass (Stipa viridula)	5	17.2	5	11.6	10	13.9
Willow (Salix spp.)	5	17.2	4	9.3	9	12.5
Hardstem bulrush (Scirpus acutus)	1	3.4	7	16.3	8	11.1
Red sorrel (Rumex acetosella)	2	6.9	5	11.6	7	9.7
Common cattail (Typha latifolia)	2	6.9	4	9.3	6	8.3
Kentucky bluegrass (Poa pratensis)	2	6.9	2	4.7	4	5.6
Fringed sagewort (Artemisia frigida)	1	3.4	3	7.0	4	5.6
Common sunflower (Helianthus annuus)	2	6.9	2	4.7	4	5.6
Lady's thumb (Polygonum persicaria)	1	3.4	2	4.7	3	4.2
Others (20 species)	10	34.5	20	46.5	30	41.7

Nesting

Clutch Size.—Thirty-two completed clutches contained a total of 158 eggs during 1970, and 50 clutches contained a total of 273 eggs during 1971 (Table 3). The mean clutch size was 4.9 ± 0.2 (SE) eggs per clutch in 1970 and 5.5 ± 0.2 in 1971. The mean clutch size for 1971 was similar to those reported by Naylor (1953), Brakhage (1965), and Hanson and Eberhardt (1971).

Clutches ranged from 3 to 9 eggs in 1970 and 2 to 7 eggs in 1971. A high percentage (93.8) of clutches were in the range of 3 to 6 eggs per clutch in 1970 (Fig. 10). Clutch sizes were larger in 1971, with 94.0 percent of the clutches ranging from 4 to 7 eggs per clutch. Hanson and Eberhardt (1971) found that 90 percent of the clutches contained 4 to 7 eggs. Brakhage (1965) noted that clutch size increased with age and experience at nesting. Hanson and Eberhardt (1971) observed that average clutch sizes decreased as social interaction, usually in the form of competition, increased.

The 21 successful (1 or more eggs hatched) nests during 1970 contained a total of 109 eggs, for a mean of 5.2 ± 0.2 eggs per clutch (Table 3). During 1971, 43 successful nests contained 242 eggs, for a mean of 5.6 ± 0.2 eggs per clutch.

Hatchability of eggs was higher in larger clutches. Clutches of 4 eggs or less had 45.5 percent hatchability, whereas clutches of 5 eggs or greater had hatchability of 73.1 percent. Hanson and Browning

Table 3. Clutch size of Canada goose nests in western South Dakota, 1970-1971.

	All Nests		Successful Nests	
	1970	1971	1970	1971
Total eggs	158	273	109	242
Number of nests	32	50	21	43
Mean clutch size	4.9	5.5	5.2	5.6
Range	3-9	2-7	3-7	3-7
Standard error	± 0.2	± 0.2	± 0.2	± 0.2

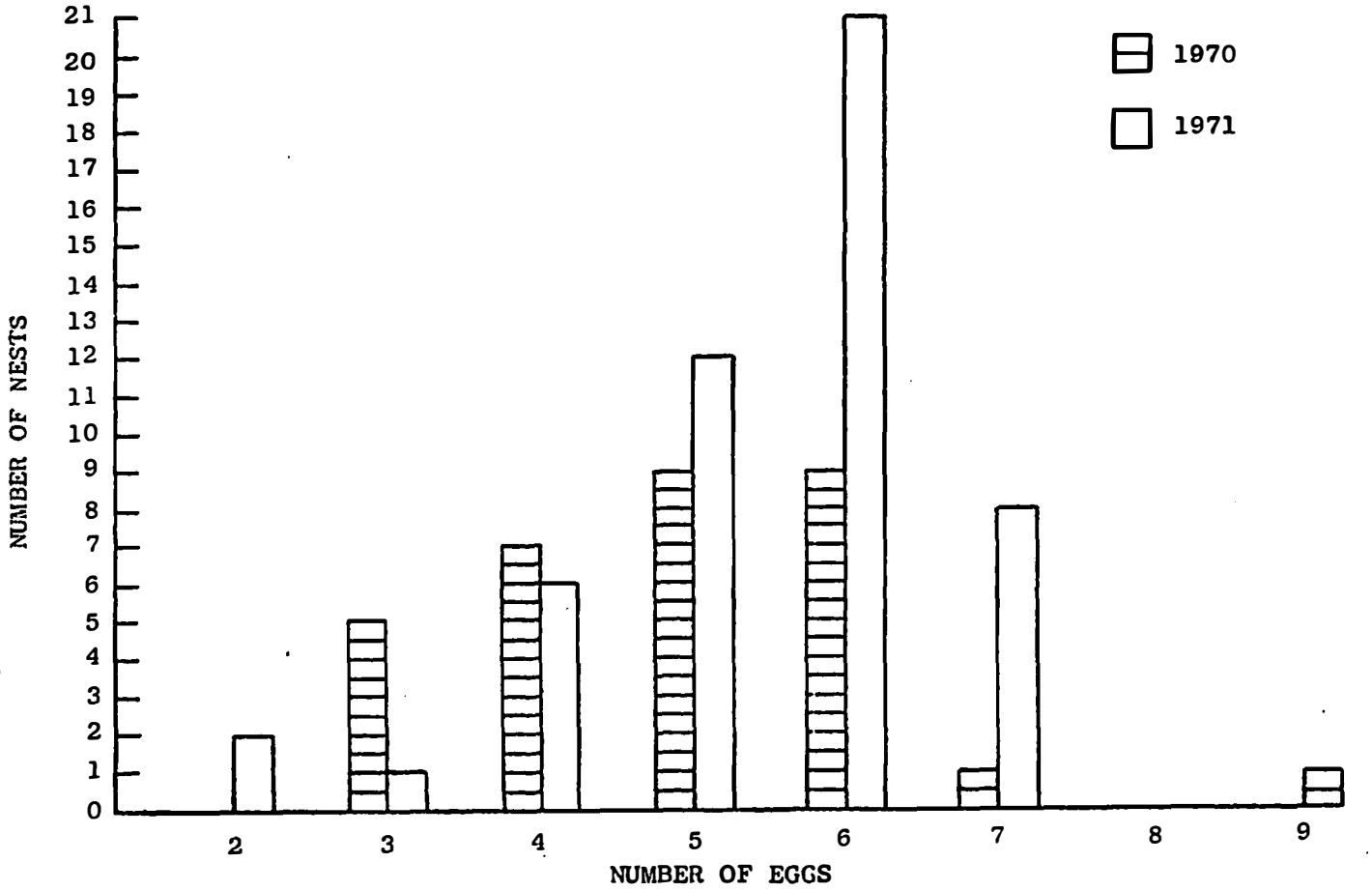
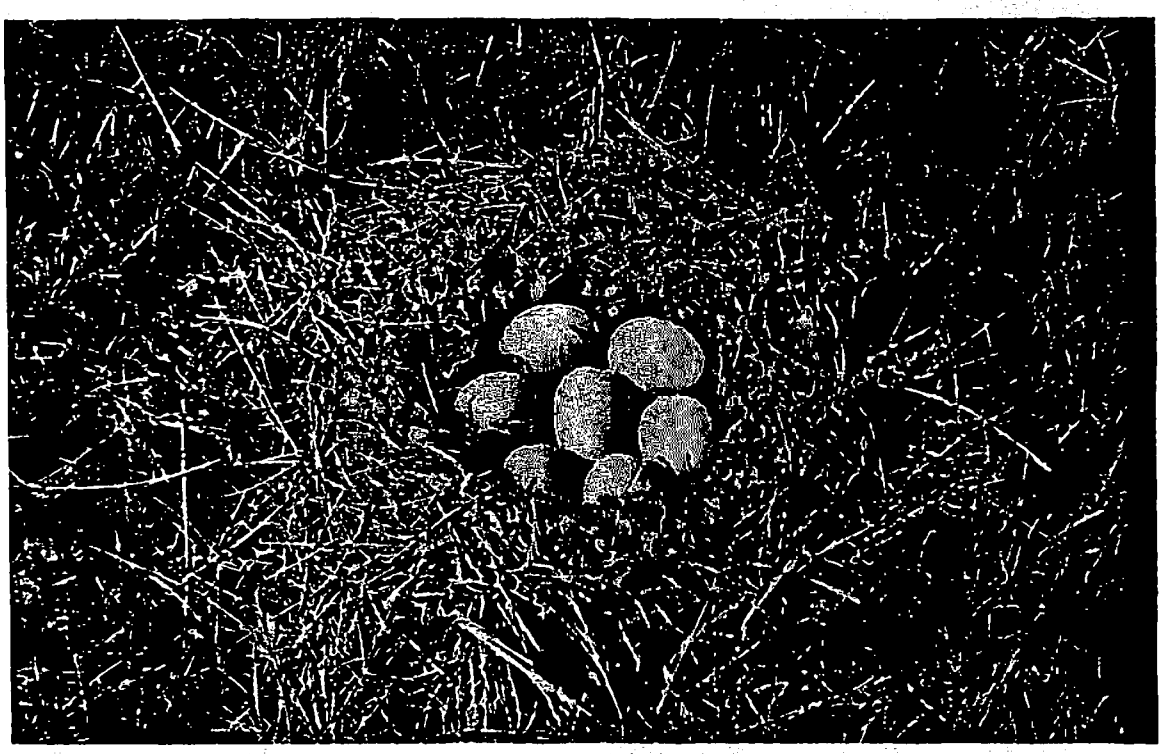


Fig. 10. Frequency distribution of clutch size in Canada goose nests, 1970-1971.

(1959) found that smaller clutches were less successful than clutches nearest the mean in size. Their results, however, indicated that larger clutches were also less successful than the clutch sizes nearest the mean. This was not true in this study, as clutches of 7 to 9 eggs exhibited 72.2 percent hatchability.

Success of Nests.—Eighty-two nests were observed during the 2-year period (Fig. 11). Of these, eggs in 64 (78.1 percent) successfully hatched (Table 4), including 65.7 percent in 1970 and 86.0 percent in 1971. Overall nesting success was comparable to the 79 percent figure reported by Miller and Collins (1953) and 80 percent success reported by Steel et al. (1957). Nests on islands were most successful, with 82.8 percent hatching at least 1 egg. Nests on artificial structures had 80.0 percent success, compared with 74.4 percent success of bank and shore nests. Flooding and mammalian predation were major causes of nest destruction (Table 4). Following the period of heavy snowfall in April, 1970, melt water quickly filled dams to maximum capacity, and many established nests were flooded. Several flooded nests (Fig. 12) were found later in the summer, after water levels had subsided. Although the number lost could not be determined, it was believed to be substantial. One nest in a stationary nest structure under observation for nearly 2 weeks was also flooded by a rise in water level.



ig. 11. A Canada goose nest on the study area.

ig. 12. Appearance of a nest after flooding.

Table 4. Fates of Canada goose nests in western South Dakota, 1970-1971.

Nest Fate	1970		1971		Total	
	Number	Percent	Number	Percent	Number	Percent
Hatched	21	65.7	43	86.0	64	78.1
Destroyed						
Mammalian predation	8	25.0	2	4.0	10	12.2
Flooding	1	3.1	2	4.0	3	3.7
Deserted						
Competition	1	3.1	1	2.0	2	2.4
Hailstorm	1	3.1	0	0.0	1	1.2
Incubated but not hatched	0	0.0	2	4.0	2	2.4
Total	32	100.0	50	100.0	82	100.0

Water levels on dams were at their maximum during the spring of 1971; only one nest was flooded as the result of a heavy thundershower. Another nest was flooded on a floating nest structure which became submerged during a wind storm. Flooding has been listed as a limiting factor by other investigators, including Dow (1943), Craighead and Craighead (1949), and Klopman (1958).

Nest predation by mammals was the most important cause of nest failure. The nests (12.1 percent) were destroyed by mammalian predators (Table 4). Nest predation was most prevalent during 1970, when 8 nests were lost. Many of these nests had been initiated while water levels were at their peak. These high water levels created many temporary islands that were readily utilized as nest sites. After water levels subsided, nests were no longer protected by water and two were lost to nest predators.

Nest predation was minimal in 1971, with only 2 nests (4 percent) preyed upon. Nest predation can be substantial, as noted by Geis (1956) and Sherwood (1968). Hanson and Eberhardt (1971) observed that 12 percent of the nests were destroyed by predators on the Columbia River in Washington

Raccoons (Procyon lotor), badgers (Taxidea taxus), and skunks (Mephitis mephitis) were known to have destroyed 5, 3, and 2 nests, respectively. The presence of tracks and hair at the nest sites and

the characteristic appearance of nests preyed upon, as described by Rearden (1951), were used to identify nest predators.

Coyotes (Canis latrans) have been listed as a nest predator by several writers (Dow 1943, Sooter 1946, Sherwood 1968, Vermeer 1970). Although coyotes were present throughout most of the study area, no nests were known to have been destroyed by them. One nest, located 150 yards from a dam along a fenceline, was 300 yards from an active coyote den with 4 pups. The eggs in this nest, however, were hatched successfully.

Three nests were deserted during the 2 years (Table 4). One nest was deserted each year because of intraspecific intolerance. One 2-year old hen, nesting for the first time, apparently could not compete with several other pairs on the dam. Geis (1956) and Brakhage (1965) both observed that younger birds were more likely to desert their nests than older birds. Another nest was abandoned because the gander, with a deformed wing, was unable to aid the hen in defending the nest site against the intrusions of another pair. A hailstorm in early spring caused the desertion of the third nest. Miller and Collins (1953) and Naylor (1953) indicated that competition caused abandonment in dense California nesting populations. Human disturbance was the cause of frequent nest desertion observed by Dow (1943) and Steel et al. (1957). No nests were known to be deserted because of human disturbance in the present study. After incubation began, nesting geese were quite tolerant of human activity.

Two nests were incubated full-term during 1971, but the eggs failed to hatch. One was initiated very late in the season and was incubated well into June. The other was laid by a hen whose mate claimed 2 hens. At least three other polygamous matings were observed on the area. Brakhage (1965) also noted polygamy in giant Canada geese in Missouri.

Success of Eggs.—Eighty-two nests observed during 1970-71 contained 431 eggs (Table 5). Hatching success was accordingly 68.4 percent, lower than that reported by most other investigators (Naylor and Hunt 1954, Klopman 1958, Hanson and Browning 1959). Similar success (56 to 68 percent), however, was noted by Sherwood (1968) at Seney National Wildlife Refuge.

Unsuccessful eggs made up 31.6 percent of the eggs laid, including infertile eggs, eggs destroyed, and eggs fertile but not hatched. The greatest egg loss was due to infertility. Infertility was higher during 1971, with 16.8 percent of the eggs infertile, as compared to 9.5 percent during 1970. Overall infertility, 14.2 percent, was considerably higher than that found by other investigators, e.g., 1.9 percent (Miller and Collins 1953), to 7.5 percent (Collias and Jahn 1959). The reason for the high infertility of eggs in the present study was not clear.

Forty-two (10 percent) of the eggs destroyed were lost to nest predators. The high rate of nest predation in 1970 (25 percent) accounted for most of the predation loss over the 2-year period.

Table 5. Fates of Canada goose eggs in western South Dakota, 1970-1971.

Fate of Eggs	1970		1971		Total	
	Number	Percent	Number	Percent	Number	Percent
Hatched	92	58.2	203	74.4	295	68.4
Destroyed						
Mammalian predators	36	22.8	6	2.2	42	9.7
Broken by hen	1	0.6	8	2.9	9	2.1
Fertile, unhatched						
Early embryonic death[a]	5	3.2	6	2.2	11	2.6
Late embryonic death	9	5.7	4	1.5	13	3.0
Infertile	15	9.5	46	16.8	61	14.1
Total	158	100.0	273	100.0	431	100.0

[a]Early embryonic death was considered to be before the eighth day of incubation.

Breakage by hens, although minimal (2.1 percent), was a factor in egg loss. Most of the breakage occurred when the hens were disturbed on the nest by the investigator.

Twenty-four eggs were fertile, but failed to hatch because of embryonic death (5.6 percent). Eggs were classified as early embryonic death when death occurred during the first week of incubation and as late embryonic death thereafter. Loss of eggs was found to be almost equally divided between the two periods. Embryonic death of 5.6 percent in this study was similar to that reported by Dow (1943), Steel et al. (1957), and Hanson and Browning (1959). Flooding and nest desertion due to a hailstorm both contributed to embryonic death. Hanson and Browning (1959) attributed embryonic death to individual embryonic weaknesses and to chilling of eggs during prolonged exposure to air or water.

Young

Gosling Production.—Production during the 2-year study totaled 295 goslings from 64 successful nests (Table 6). Ninety-two of these were produced during 1970 in 21 nests, for an average of 4.4 ± 0.2. Thirteen additional goslings appeared on the area following the 1970 nesting season, but were not included in the calculations because their nest sites had not been observed. The 1971 production of goslings was 203 from 43 successful nests, for an average brood size of 4.7 ± 0.2. Average brood size for the two years combined was 4.6 ± 0.2 goslings.

Table 6. Brood size of Canada geese at hatching in western South Dakota, 1970-1971.

	1970	1971	Total
Number of broods	21	43	64
Goslings produced	92	203	295
Mean brood size	4.4	4.7	4.6
Range	2-6	1-7	1-7
Standard error	± 0.2	± 0.2	± 0.2

Table 7. Mortality of Canada geese goslings in western South Dakota, 1970-1971.

	1970	1971	Total
Goslings produced	92	203	295
Goslings reared to flight stage	78	185	263
Goslings lost prior to flight stage	14	18	32
Percent mortality	15.2	8.9	10.8

This was similar to brood size averages recorded by Craighead and Craighead (1949), Steel et al. (1957), and Dimmick (1968).

Gosling Mortality.—Fourteen goslings were lost prior to flight during 1970 for a mortality rate of 15.2 percent (Table 7). The 8.9 percent mortality during 1971 was much lower. Overall mortality prior to flight was 10.8 percent. Mortality rates reported by other investigators vary considerably. Brakhage (1965) noted mortality as high as 36 percent in Missouri, while Dimmick (1968) concluded that mortality was negligible in Wyoming. Ninety-one percent of the goslings that died in my study were lost during the initial 2 weeks following hatching, as they were quite vulnerable to predation and stress during that period of their life. Brakhage (1965) found that 90 percent of the gosling loss occurred during the initial 2 weeks of life.

Brood Behavior.—Behavior was an important factor in brood mortality. After leaving the nest, most broods spent the first week in the vicinity of the nest site, or made what appeared to be random movements. Since waterways available for movement were limited, broods moved overland from one water area to another. Distances traveled varied between broods. One family group, beginning the first day after hatching, traveled 6.5 miles in 19 days from one dam to another. One gosling was lost during that period.

Five broods in the Belvidere area were observed as closely as possible without disturbing them during 1971. The average distance

traveled by these broods was 2.7 miles. Very little disturbance was necessary to stimulate movement. Several instances were noted where the family group immediately moved to another dam after cattle were turned into the summer pasture surrounding the dam. Not all broods moved from dams on which they had hatched, but remained on the same dam until they were able to fly.

Other investigators have reported similar movements, both on land and on water (Naylor and Hunt 1954, Hanson and Eberhardt 1971). Geis (1956) reported that it was not unusual for broods to move overland nearly 1 mile, and many deserted goslings or goslings killed by dogs, cats and other predators were found.

Concentration involved the combination of family groups on a rearing dam. Molting of adults began during this period. Some yearling birds, single adults, and unsuccessful pairs in the area also joined these family groups on dams where birds became concentrated. Most of these birds, however, were not tolerated by broods until after the molt was completed and the young were able to fly. Sherwood (1967) reported similar intolerance during and following the molting period.

Movements generally ceased from 1 to 4 weeks after hatching. Observation of broods in the Belvidere area showed that an average of 30 days elapsed between time of hatch and the time that broods grouped together. Some family groups were observed to have concentrated as

soon as 1 week after hatching. Hanson and Eberhardt (1971) noted that broods became concentrated after spending an initial brooding period near the nest site. This was followed by extensive mixing of broods the third or fourth week after hatching.

After molting had begun, all of the birds were flightless. Adequate escape cover, usually emergent vegetation, was necessary to provide cover for both molting birds and juveniles. Often, cover was sparse so that predators could be seen, and grazing by geese helped to keep cover short. All of the molting areas had good supplies of aquatic foods and pasture grasses which were heavily utilized. Observations of feeding habits of both adults and juveniles indicated distinct preferences for western wheatgrass and Kentucky bluegrass when these species were present. Geis (1956) observed that geese moved considerable distances to reach areas of good aquatic vegetation and pasture grass at Flathead Lake in Montana. This may have been true on my study area also, since all of the dams utilized for molting had abundant aquatic vegetation and were adjacent to good stands of preferred grasses. Some family groups traveled several miles, by-passing several dams in the process, to get to these dams.

Homing

Fifty-four adults released prior to 1970 were reobserved in 1970 and 82 were seen in 1971 (Table 8). In 1970, 28 were females and 26 were males, a sex ratio of 1.1 females per male. The sex ratio in 1971

Table 8. Sex ratios of Canada geese that homed in western South Dakota, 1970-1971, based on observations of banded birds.

	Adults			Yearlings		
	Females	Males	Sex Ratio	Females	Males	Sex Ratio
1970	28	26	1.1	--	--	---
1971	42	40	1.1	20	9	2.2
Total	70	66	1.1	20	9	2.2

was also 1.1 females per male when 42 females and 40 males were observed. The majority of birds observed were breeding pairs, among which an even sex ratio would be expected. These birds probably represented only a portion of the number of birds that actually returned since many birds raised on the study area were not banded.

Homing of 29 yearling birds was analyzed during 1971, based on banding in 1970. Twenty were females and 9 were males; a sex ratio of 2.2 females per male (Table 8). Surrendi (1970) found that homing by yearling females was significantly higher than for yearling males. He concluded that females were apparently attracted to release sites regardless of whether they were paired or unpaired, but that males homed to the area and remained only if pair associations had been formed.

Twenty banded adult birds were recaptured or recovered on the study area from 1970 to 1972 (Table 9). These consisted of released birds, as well as wild-reared birds that had been captured and banded; 19 were adults and one was a yearling. Based on adult birds, the sex ratio was 1.6 females per male. One of the birds was captured 2 consecutive years on the same dam where it had been released. Fourteen additional birds were recaptured once on or near the dam where they had been released.

Pioneering

Data on geese recaptured from 1970 to 1972 (Table 9) were also analyzed. Fourteen (70 percent) of 20 birds were recaptured within

Table 9. Homing by Canada geese in western South Dakota, 1970-72, based on banded birds that were recaptured.

Band Number	Sex	Banding Site	Date	Recapture Site	Date
558-41079	--	Belvidere Lake	1966	Klima Dam	1971
558-41478	Female	Belvidere Lake	1967	Klima Dam	1971
558-41477	Female	Belvidere Lake	1967	De Vries Dam	1970
558-41479	Female	Belvidere Lake	1967	Belvidere	1970
558-41335[b]	Female	Belvidere Lake	1968	Belvidere	1971
558-41214	Female	Stout Dam	1969	Stout Dam	1971
558-41220	Male	Stout Dam	1969	Stout Dam	1971
558-41212	Female	Stout Dam	1969	Willert Dam	1971
558-41222	Male	Stout Dam	1969	Willert Dam	1971
558-41220	Male	Stout Dam	1969	Stout Dam	1972
558-41114[b]	Male	Hauk Dam	1969	Hauk Dam	1971
558-41118[b]	Female	Shearer Dam	1969	Wasta	1970
558-41128	Female	Hauk Dam	1969	Hauk Dam	1970
558-41252	Female	Cactus Flats	1969	Cactus Flats	1970
558-41299	Male	Cactus Flats	1969	Belvidere	1970
558-41618[a]	Male	De Vries Dam	1970	Klima Dam	1971
558-41657	Female	Belvidere	1970	Klima Dam	1971
558-41602	Female	McIlravy Dam	1970	McIlravy Dam	1971
558-41573	Male	McIlravy Dam	1970	Pearson Dam	1971
558-41899[b]	Male	Hewitt Dam	1971	Waggoner Lake	1972

[a]Yearling bird
[b]Recovered dead

5 miles of the dam where they were reared or released in previous years. The mean distance of recaptures from the original banding site was 1.0 miles. Seven birds were recaptured on the same dam on which they had been banded. These data indicate that pioneering was limited on the study area. Canada geese are noted to exhibit limited pioneering tendencies (Hochbaum 1955, Greenway 1958). Strong family and group bonds effectively limit expansion of flocks, whether released or reared in the area.

Records from 64 geese released on the McIlravy Dam during 1970 were analyzed during 1971. A small number of birds returned to the locality of the release site during the spring of 1971. This may have been the result of rather heavy hunting mortality in neighboring states during the fall of 1970 (T. L. Kuck, Waterfowl Biologist, South Dakota Department of Game, Fish and Parks, Aberdeen, personal communication). Six pairs returned to the area and established territories. Distances pioneered from release sites varied from 0.8 to 5.8 miles and averaged 3.4 miles (Table 10). The pair observed 5.8 miles from the McIlravy Dam established a territory during the nesting season, but did not nest. A pair, also from the 1970 release, was found nesting 34 miles from the release site.

During the 2-year period, nest distribution showed a definite clustering effect around release sites. Apparently the parent stock

Table 10. Distances between sites where Canada geese were released in 1970 and locations of nesting territories established in 1971.

Nesting Dam	Distance in Miles
K. McIlravy Dam	2.8
Pearson Dam	4.5
Buchert Dam	2.7
B. McIlravy Dam	0.8
Roberts Dam[a]	5.8
McDanial Dam	3.6
Mean Distance	

[a]Established territory but did not nest

expanded slowly (Fig. 13), and although pioneering was continued by their progeny, it proceeded at a slow rate.

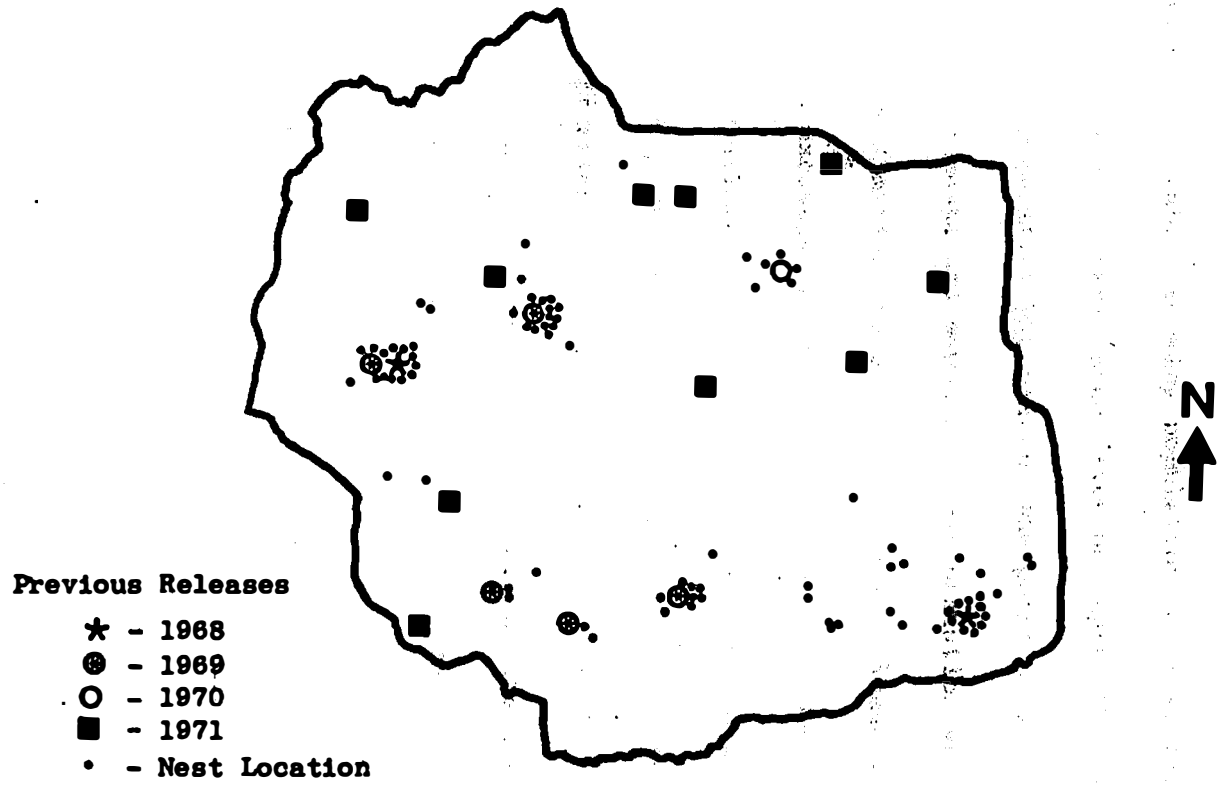


Fig. 13. Location of nests in 1970-71 in relation to release sites for geese; geese nested near the site where they were released.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The giant Canada goose has become well established in western South Dakota. A viable, growing population has resulted from the restoration program. Yearly production now appears to exceed mortality; thus, the population has reached the point of self-sustenance.

Flooding of nests and mammalian nest predation were the most obvious factors limiting reproductive success. These were especially important when excessive precipitation occurred. During this study, geese preferred islands for nesting when they were available. Islands normally provide a nest site free of predators, and are not subject to flooding if island height exceeds spillway height.

Construction of islands on dams throughout the area could be valuable to management. Many islands could be easily constructed by cutting off long peninsulas and utilizing the borrow dirt for building additional islands. Artifical nest structures should be maintained as part of the management program, since they provide satisfactory substitutes. These should be placed on dams which do not have good nest sites. The high percentage of success shown by birds nesting on islands and nest structures suggests that flooding and predation loss can best be offset by their use.

Egg infertility was another limiting factor apparent during both years of the study, but the reason for it was unknown. If egg

infertility continues to remain high, it will be one of the most important factors limiting nesting success.

Released birds and those reared on the area readily returned to the area to nest each spring. Homing was instrumental in building the population to its current level.

Pioneering was limited due to strong family or group ties that restricted outward movement of the population. If additional releases are made, they can most effectively be utilized to further distribute the population.

There is still potential for population growth of Canada geese in western South Dakota. Large portions of the area are devoid of geese, although suitable habitat is present. As the population continues to grow, these areas will eventually be utilized.

Additional research is necessary to fully evaluate the success of the giant Canada goose restoration project. Importance of hunting mortality, that occurs in both South Dakota and other states where the geese migrate or winter, will need study. This mortality might be especially important until the population becomes established. Another area for future research is landowner attitudes toward the establishment of a resident goose flock in western South Dakota.

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