Canada goose production and water level relationships on the Madison River, Montana
by Donald Arthur Childress

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

Abstract:
Canada goose production and nesting habitat were studied from 1970-1971 on a portion of the Madison River which is influenced by-water control. Resting data were recorded from 21 nests in 1970 and 39 nests in 1971. The nesting season began approximately March 23 in both years with peak hatch occurring during the first week of May. The average clutch size for the two years was 5.64.

An 80 percent nest success was found with deserted and destroyed nests each equalling 8.33 percent. Successful nests produced 5.31 goslings per nest. Color-marked broods in 1971 did not indicate that brood grouping had a distinct origin from different sections of the river. However, they did suggest that grouping of broods was related to gosling age. Average brood sizes at mid-May were 5.12 and 5.24 in 1970 and 1971 respectively. Fifty-two nests were located on islands. Islands used appeared to be related to preference as well as availability. Based on acreage available, islands less than 1/10 acre were the most preferred with progressively less preference shown for larger islands. Willow was the most often used cover type for nesting geese although type of cover did not appear to be important so long as concealment was provided. Geese selected nest sites on points or sides of islands where ice flow had reduced the density of vegetation and afforded greater visibility. Flooding of goose nests was not evident in this study. Water levels did not reach a stage to flood nests until after the major portion of nests had been completed. A comparison of hatching period and flooding on the Jefferson and Missouri Rivers, which have no water controls, showed a probable high loss of nests would have occurred in 1971.

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Date December 6, 1971

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December, 1971

ACKNOWLEDGMENT

To the following, among others, I wish to extend sincere appreciation for their contributions to this study: Dr. Robert Eng, Montana State University, for project planning, technical supervision and guidance in preparation of the manuscript; personnel of the Montana Power Company for cooperation; Dr. Don C. Quimby and Dr. Richard J. Graham, Montana State University, for critical reading of the manuscript; Dr. W. E. Booth, Montana State University, for verification of plant specimens; and Mr. and Mrs. Eugene Shows and family for hospitality and aid during the field work phase. During this study, I was supported by the Montana Power Company and the Montana Fish and Game Department.

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ABSTRACT

Canada goose production and nesting habitat were studied from 1970-1971 on a portion of the Madison River which is influenced by water control. Nesting data were recorded from 21 nests in 1970 and 39 nests in 1971. The nesting season began approximately March 23 in both years with peak hatch occurring during the first week of May. The average clutch size for the two years was 5.64. An 80 percent nest success was found with deserted and destroyed nests each equalling 8.33 percent. Successful nests produced 5.31 goslings per nest. Color-marked broods in 1971 did not indicate that brood grouping had a distinct origin from different sections of the river. However, they did suggest that grouping of broods was related to gosling age. Average brood sizes at mid-May were 5.12 and 5.24 in 1970 and 1971 respectively. Fifty-two nests were located on islands. Islands used appeared to be related to preference as well as availability. Based on acreage available, islands less than 1/10 acre were the most preferred with progressively less preference shown for larger islands. Willow was the most often used cover type for nesting geese although type of cover did not appear to be important so long as concealment was provided. Geese selected nest sites on points or sides of islands where ice flow had reduced the density of vegetation and afforded greater visibility. Flooding of goose nests was not evident in this study. Water levels did not reach a stage to flood nests until after the major portion of nests had been completed. A comparison of hatching period and flooding on the Jefferson and Missouri Rivers, which have no water controls, showed a probable high loss of nests would have occurred in 1971.

INTRODUCTION

The Great Basin Canada Goose, Branta canadensis moffitti, a common breeder along river and impoundment systems throughout its range, is noted to concentrate its nesting activities where rivers form numerous channels and islands (Craighead and Craighead, 1949). Flooding is an annual threat to nesting success for these geese and several studies have shown flooding to be a major source of nest loss (Craighead and Craighead, 1949; and Klopman, 1958). When subjected to annual water fluctuations in a river habitat, a major portion of the productivity can be lost in any given year.

The Madison River above Ennis Lake has an abundance of islands and harbors a breeding flock of Canada geese. Water levels are partially controlled on this stretch of river by a power dam. Annual banding operations by the Montana Fish and Game Department provide some insight on the numerical status of this flock. Thus the opportunity existed to study the relationship between water levels and goose production. Objectives of this study were to determine the breeding population and its success, to evaluate nesting habitat and to determine the water level-nesting success relationships.

The field study was conducted on a part-time basis from April to June, 1970, full-time from June to mid-September, 1970, and from April to mid-September, 1971.

DESCRIPTION OF STUDY AREA

The study area, located on an approximate 4.5 mile segment of the Madison River between Ennis and McAllister, Montana (Figure 1) includes an area of approximately 11,260 acres. Ennis Lake, in the north end of the area is 3,800 acres. The valley is bounded by the Jefferson Mountains on the west and the Madison Range on the east. The river at McAllister, drains an area of 2,186 square miles. Average discharge of the river is 1,675 cfs with a recorded maximum discharge of 7,750, having occurred in June, 1943, and a minimum of 210 in August, 1959. Two dams owned by the Montana Power Company influence the water flow along the Madison River; Madison Dam at McAllister, and Hebgen Dam 64 miles upstream from McAllister. From Ennis Lake to approximately 5 miles upstream the river is of a braided character with more than 400 islands (Figure 2).

The vegetation of the area is characterized by three types: meadow, river island and marsh. The meadow type supports bluegrass (Poa spp.), dandelion (Taraxicum spp.), thistle (Cirsium spp.), cinquefoil (Potentilla spp.), sedges (Carex spp.), and rushes (Juncus spp.). Many of the islands have an overstory of black cottonwood (Populus trichocarpa) and water birch (Betula occidentalis). The island understory is composed most commonly of red dogwood (Cornus stolonifera), woods rose (Rosa woodsi), western snowberry (Symphoricarpos occidentalis), goldenrod (Solidago spp.), cow-parsnip (Heracleum lanatum), nettle (Utrica spp.), raspberry (Rubus spp.), reedgrass

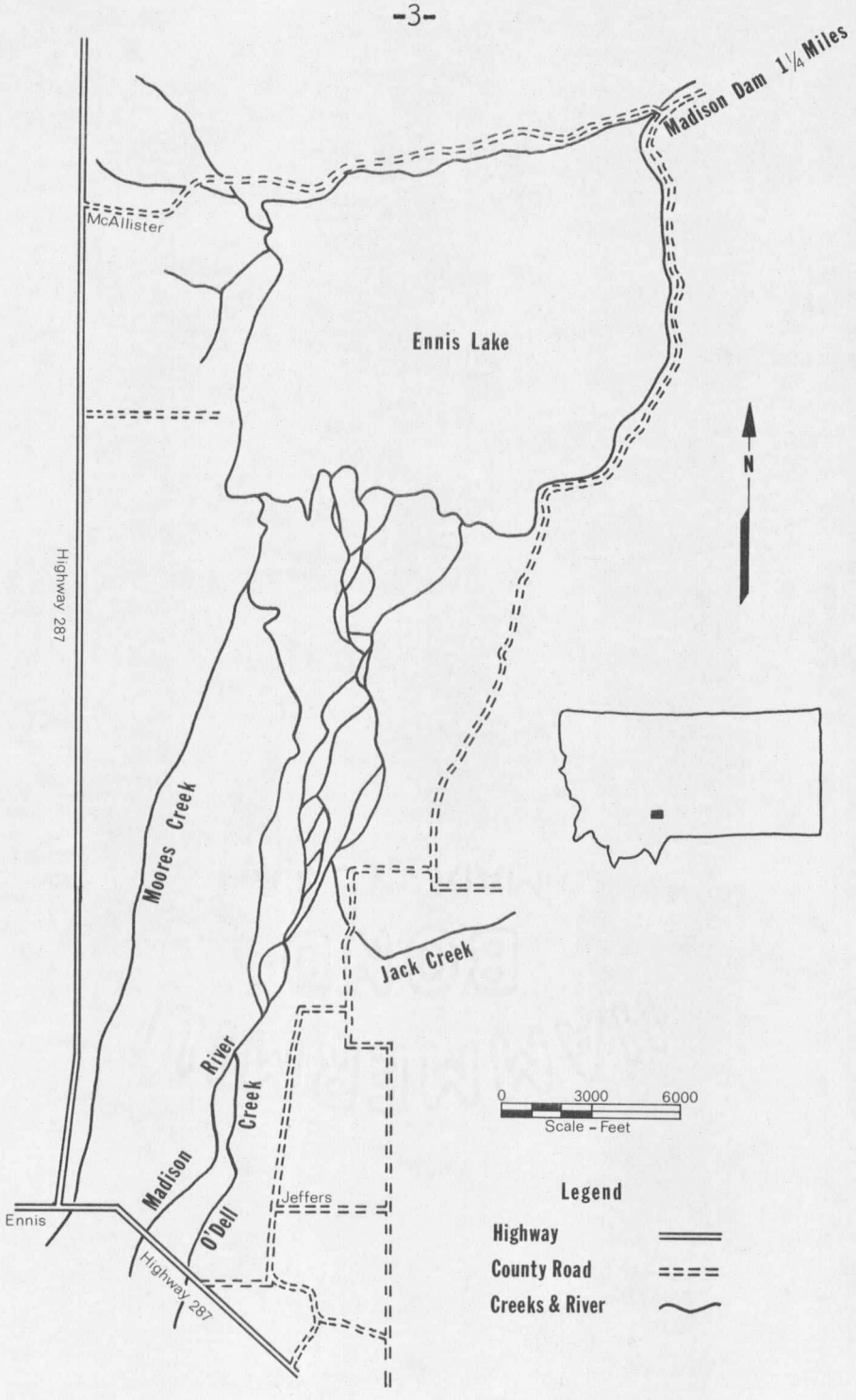

Figure 1. Map showing location of study area.

Figure 2. Aerial view of the channels area of the Madison River above Ennis Lake.

(Phragmites communis) and willow (Salix spp.). Moist areas on the islands support small-fruited bulrush (Scirpus microcarpus), American bulrush (Scirpus americana), beaked sedge (Carex rostrata) and wire rush (Juncus balticus). The marsh areas are extensive beds of cattail (Typha latifolia).

Weather data from the Ennis station show a mean annual temperature of 43 F. April is the first month to reach the average temperature of 40 F.

METHODS

During April and May of 1970 and 1971 an intensive search was made of the study area to locate as many goose nests as possible. Aerial flights made in late March and April aided in locating areas of activity and nesting pairs. At least three complete searches of the study area were made each year.

In 1970 all searches were made on foot. Searches on foot and by canoe were made in 1971. Nests were commonly located by observing males on waiting stations and searching surrounding habitat. Several nests were found in 1971 by returning to nest sites of the previous year. Location nests were marked by placing yellow flagging on willows at the opposite end of the island. Each nest was visited at 7-day intervals until the fate of the nest was determined. An effort was made to keep disturbance at a minimum. Distance to water, height above the water, location on the island, nesting material and the concealment cover were recorded at each nest site.

Brood observations were made tri-weekly at various times throughout the day from May until mid-June. Broods were observed with the aid of a 7 X 35 binocular and a 20-60 X spotting scope. Gosling ages were determined according to Yocum and Harris (1965).

In 1971 an attempt was made to determine the origin of broods appearing on the brood-rearing areas. The study area was divided into three sections (Figure 3) and a color dye assigned to each for marking

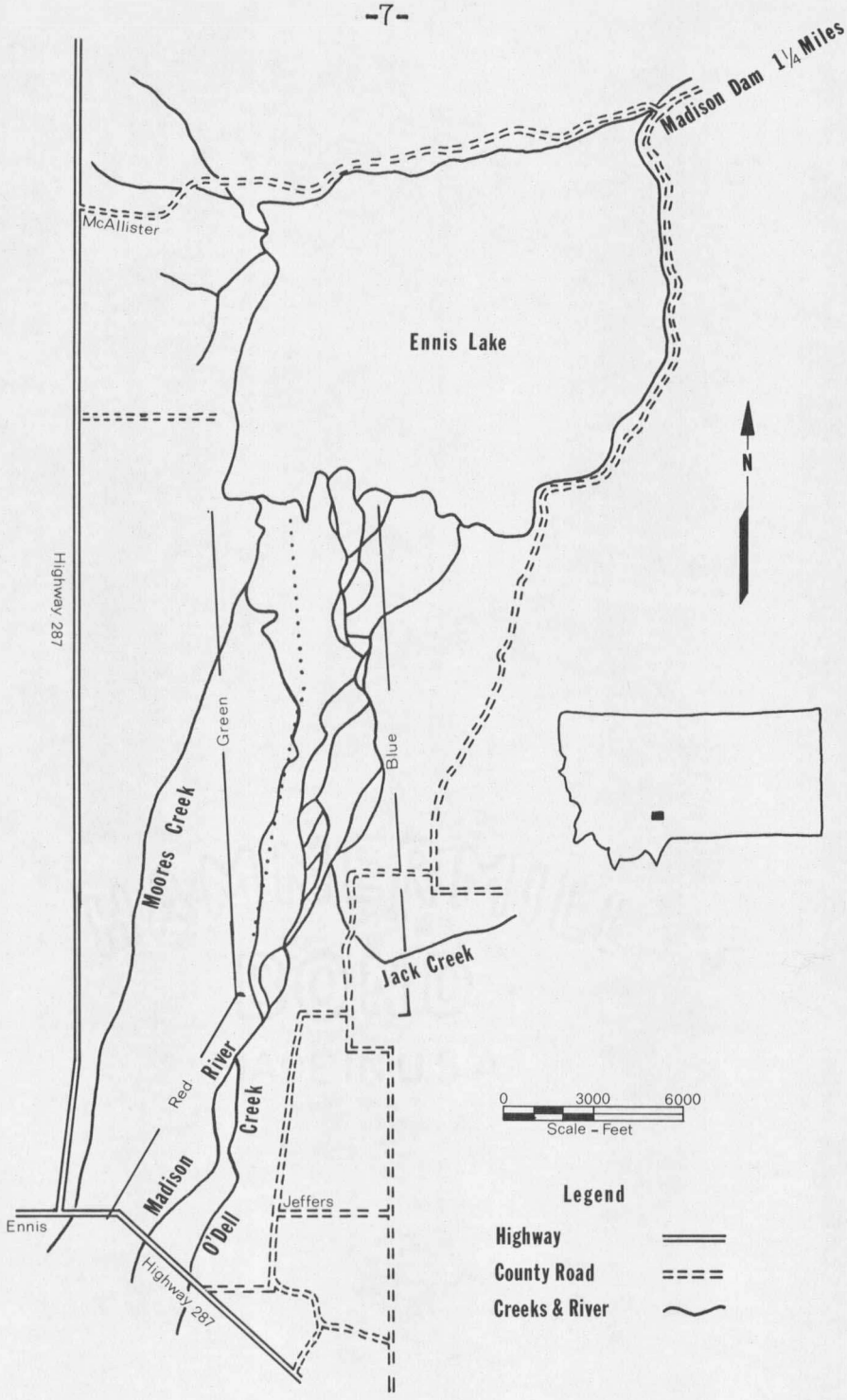

Figure 3. Study area showing the color of dye injected in eggs in each area.

of embryos in eggs (Evans, 1951). Eggs were injected in nests for which a complete history was known.

During June and July, length, width and circumference of islands used for nesting were measured. At nest sites, visibility measurements were taken at the four compass directions from a distance of 50 feet when feasible. From each of the four points, the estimated degree of obstruction was recorded.

Hydrological data for Hebgen and Madison Dams were obtained from the records of the Montana Power Company; data for the Jefferson and Missouri Rivers from the Water Resources Division, Geological Survey of the United States Department of the Interior.

RESULTS

Breeding Population

B. c. moffitti comprised the main breeding flock on the study area. Using the criteria of eye spot, cheek patch and white forehead set forth by Hanson (1965), specimens of B. c. maxima were observed on the study area during the spring of 1971. No nests were found that could be identified with B. c. maxima, although a goose believed to be of this race was observed with a brood.

Table 1 shows the numbers of geese inhabiting the study area during the spring of 1969, 1970 and 1971. Considering only the pairs and singles as a measure of the breeding population (Hanson and Browning, 1959), the data suggest a decrease from 1969 to 1970 and an increase from 1970 to 1971.

Table 1. Spring population counts on the study area.

Date	Pairs	Singles	Groups	Total
April 27, 1969 (aerial)	34	14	19	101
March 27, 1970 (aerial)	19	4	104	146
April 11, 1970 (ground)	24	6	124	176
April 22, 1970 (aerial)	14	7	22	57
April 29, 1971 (aerial)	30	18	56	134

Length of the Nesting Season

Canada geese were present on the study area at the beginning of field study each year. Aerial flights on January 4 and March 23, 1971

indicated a wintering flock of 100 to 200 geese on the study area.

The nesting season began approximately March 23 in 1970 and 1971. Dates for the initiation of egg-laying were calculated by back-dating the age of broods observed. A period of 36 days was used between hatching dates and the beginning of nesting. Kossack (1947) reported an incubation period of 26 days plus or minus one or two days and an egg-laying rate of 1.5 days per egg (Kossack, 1950). In 1971 an incubation period of 28 or 29 days was determined for one nest on the study area. Peak hatch occurred during the first week of May for both years of study.

Hanson and Browning (1959) referred to a mean daily temperature of 40 F for the initiation of nesting by Canada geese on the Hanford Reservation, Washington. In my study, mean daily temperature for a 7-day period prior to the nesting season were 41.3 F and 42.7 F for 1970 and 1971 respectively. A 5-inch snowfall occurred at the beginning of this period in 1970 and had completely melted five days later. Except for this snow cover, the nesting islands were free of ice well before the beginning of nesting. In 1971 the lower portion of the study area was covered with ice at the initiation of the nesting period (Figure 4). Only the upstream points of the islands were free of ice cover at the time of earliest nesting.

Other workers have pointed out that weather, particularly temperature during the early part of the season, has an effect on the breeding

Figure 4. Ice cover on the islands at the beginning of the nesting season in 1971.

phenology (Collias and Jahn, 1959; Brackage, 1965). The mean daily temperature appeared to have a greater influence on nest initiation than did ice and snow cover of short duration.

The nesting season lasted for 70 days in 1970 and 90 days in 1971. Continued incubation of a clutch of eggs which contained dead embryos, extended the season 9 days in 1971. These season lengths are in agreement with other studies done in areas of similar conditions (Geis, 1956; Flath, 1970; Hanson and Browning, 1959). Klopman (1958) at Dog Lake, Manitoba, found extension of the nesting season due mainly to renesting. Since none of the birds in this study were marked, renesting could not be identified.

Clutch Size

The average clutch size for 59 nests during the two years of study was 5.64. This clutch size compares favorably with those reported by other authors (Table 2). There was no appreciable difference between the average clutch of 5.76 and 5.55 for 1970 and 1971 respectively. Table 3 gives the frequency distribution of the number of eggs in each clutch. The larger average clutch size recorded in 1970 was primarily due to a higher percent of seven egg clutches in that year.

Martin (1963) indicated that younger geese nesting for the first time nest later in the season than older nesting geese. Hanson and Smith (1950) suggested that younger geese laid smaller clutches.

Table 2. Clutch sizes for Canada goose nests at other areas

Author and Nesting Area		Clutch Size	Number of Nests
Flath (Bitterroot Valley)	1970	5.88	16
Martin (Ogden Bay)	1956	5.2	34
	1957	5.6	66
	1958	5.7	102
Geis (Flathead Valley)	1953	5.55	169
	1954	5.15	189
Dey (Ogden Bay)	1959	5.2	62
	1960	5.3	62
Hanson and Browning (Hanford Reservation)	1959	5.3 - 5.5	732

Table 3. Frequency of distribution of clutch sizes

Clutch Size	1970		1971		Years Combined	
No. Eggs	No. Nests	%	No. Nests	%	No. Nests	%
3	2	9	0	0	2	3
4	0	0	5	13	5	8
5	5	24	11	29	16	27
6	8	38	18	47	26	44
7	6	29	4	10	10	17
Total Nests	21		38		59	
Average Clutch Size	5.76		5.55		5.64	

In 1971 nests in the first half of the season contained 5.52 eggs and those in the later half, 5.58.

Nest Fate

A total of 60 nests were found during the two years of the study. A nest was considered successful if at least one egg hatched. Nest success was 80 percent for the two years. Table 4 shows no significant difference in nest success between years.

Table 4. Fates of goose nests for 1970 and 1971.

	1970		1971		Total	
	No.	%	No.	%	No.	%
Number of Nests Found	21		39		60	
Successful Nests	17	80.95	31	79.48	48	80.00
Deserted Nests	1	4.76	4	10.25	5	8.33
Destroyed Nests	2	9.52	3	7.60	5	8.33
Unknown	1	4.76	1	2.56	2	3.33

The high percentage of nests hatched is comparable to the success of certain other river goose flocks. Grieb, Sheldon and Neff (1961) on the Green and Yampa Rivers of Wyoming found a nest success of 84 percent over a four year period. Naylor and Hunt (1954) reported a nest success of 79 percent on the Susan River in California.

Ten of the twelve unsuccessful nests were classified as deserted or destroyed. The two nests of unknown fate were partially destroyed but it is not known whether desertion took place before or after destruction. In 1970 two nests were destroyed, one by a skunk and the other by an unidentified predator. In 1971, the three nests destroyed were attributed to avian predation, and included the loss of the incubating geese. One nest, in the same vicinity, was deserted and may have had a similar fate although the goose carcass was not located. One nest, in which the eggs had been injected, was deserted although the goose was known to have incubated the eggs after the injection process.

Egg Success

A total of 332 eggs were laid in goose nests observed during the two years of study. Egg-hatching success for all nests was 77 percent. Deserted and destroyed eggs accounted for eight and nine percent of the egg loss respectively. Forty-five eggs from deserted and destroyed nests were examined for the two years. Embryonic death was evident in 43 of the eggs while the other 2 were infertile.

Successful nests had an egg success of 95 percent for the two years. Successful nests produced 5.31 goslings per nests. Of those eggs not hatched in successful nests, late embryonic death and infertility were evident.

Brood Production

Broods remained along the river channels until about mid-May. During this time, brood observations were difficult to obtain because of the vegetation height on the meadows used for feeding areas. After mid-May, broods began using the lake, at which time extensive brood counts could be made.

In 1970, two distinct groups of broods were evident on the brood-rearing area of the lake, suggesting distinct origin from segments of the nesting area. However, color-marked broods in 1971 from different sections of the river formed one large group after moving to the lake.

Movement to the lake and grouping of the broods appeared to be a function of gosling age. Movement to the lake after mid-May coincided with the majority of the broods reaching the age of three to four weeks. Late-hatching broods remained along the channels until reaching this approximate age before joining others on the lake. Although broods remained in major groups on the lake in both years, segregation of extreme age groups was noted.

Average brood sizes were calculated from all broods, including those which were obvious gang broods. Average broods sizes by May 20 were 5.12 and 5.24 in 1970 and 1971 respectively. Gosling mortality while on the brood-rearing area was calculated by comparing brood sizes for mid-May with those of mid-June. Gosling loss per brood on the brood-rearing area was .32 and .06 in 1970 and 1971 respectively.

Nest Site Selection

All 60 of the nest sites located during the two years were classified according to one of the vegetation types listed in the description of the area. Eighty-seven percent of the nests were found on the river island type, while eight and nine percent were found in the marsh and meadow types respectively. A preference for island nest sites had also been reported by Dimmick (1968), Grieb, et al. (1961) and Ballou (1954), all of whom found a greater than 70 percent use of islands.

The interrelationships involved in nest site selection make specific conclusions difficult. Based on vegetation types alone, marsh habitat may appear to be a preferred type for nest sites. Marsh area constitutes less than 15 acres of nesting cover on the area and supported 10 percent of the nests in 1971. In comparison, river islands were a minimum of 200 acres and held 64 percent of the nest sites in 1971.

If other criteria are considered, the seeming preference for marsh habitat may be more apparent than real. If marsh habitat was preferred, it would conceivably be utilized first in respect to other available nesting habitat and would be utilized to a maximum degree. Two of the nests located in marsh habitat were initiated during the latter half of the nesting season. Approximately one-third of the marsh habitat was located along the south-east side of the lake and had no observed nesting use. However, a disturbance

factor (adjacent to county road) may have been responsible in this case. Two nests were located on a cattail island classified as marsh habitat by vegetation but as an island structurally. This island was unique in that it was the only island to support more than one nest during a single season. Hammond and Mann (1956) suggested that preferred goose nesting sites are usually so located that vegetative cover seems of minor importance. If this is the case, these two nest sites would be more accuarately placed in the island type.

An average of 41 islands per mile of major channel are found on the study area. There is a general reduction in the number of islands upstream from the lake. The number of nests also decreases upstream, coincidental with the number of islands. This suggests a distribution of nests primarily related to availability of sites (islands) as indicated by Steele et al. (1957).

Table 5 presents the number of islands present by size classes and their use by nesting geese. On the basis of acreage available in each class, there is a suggested preference shown for the smallest islands with progressively less preference indicated for larger islands. As regards numbers of islands available in each class, a slight preference is suggested for islands from 1/10 to 1/2 acre in size. Undoubtedly other factors such as distribution play an important role in selection but it would appear that islands 1/2 acre or less would fall into a preferred group for goose nesting sites.

Table 5. Island distribution, size and use relationships.

Size of Island (acres)	No. of Islands	%	Area (acres)	No. of Nests	%	Nests/Acre
<1/10	149	33	4.975	13	25	2.613
1/10 - 2/10	163	36	22.400	23	44	1.027
3/10 - 5/10	62	14	23.600	10	19	0.435
6/10 - 1	40	9	30.000	2	4	0.067
>1	42	9	89.200	4	8	0.045
Total	456	101	170.175	52	100	0.306

Seven of the islands were used as nest sites during both years (Figure 5). The distances between neighboring nests were measured each year (Table 6). The number of nests present in 1971 was nearly double that found in 1970. Even so, the average distance between nests in 1971 decreased by only 5 percent.

Table 6. Distribution of mean nearest-neighbor distances between nests.

Range (yards)	1970		1971	
	Distance	No. Nests	Distance	No. Nests
0 - 99	70	2	80	4
100 - 199	166	7	135	7
200 - 299	240	3	227	5
300 - 399	337	2	343	10
400 - 499	457	1	437	4
500 - 1000	709	3	533	8
1000	1109	3	2051	1
Mean of All Nests	375		356	

Miller and Collins (1953), Steele et al. (1957) and Williams (1967) stress the importance of open water in close proximity to a good nest site. The range of distances to water in this study was one-half to 45 feet, with a mean distance of 3.54 and 8.58 in 1970 and 1971 respectively. The greater distance in 1971 was the result of four nests located more than 15 feet from water, two of which were located in marsh habitat and one each in island and marsh habitat. Fifty-six or 93 percent of the nests were within 15 feet of permanent water,

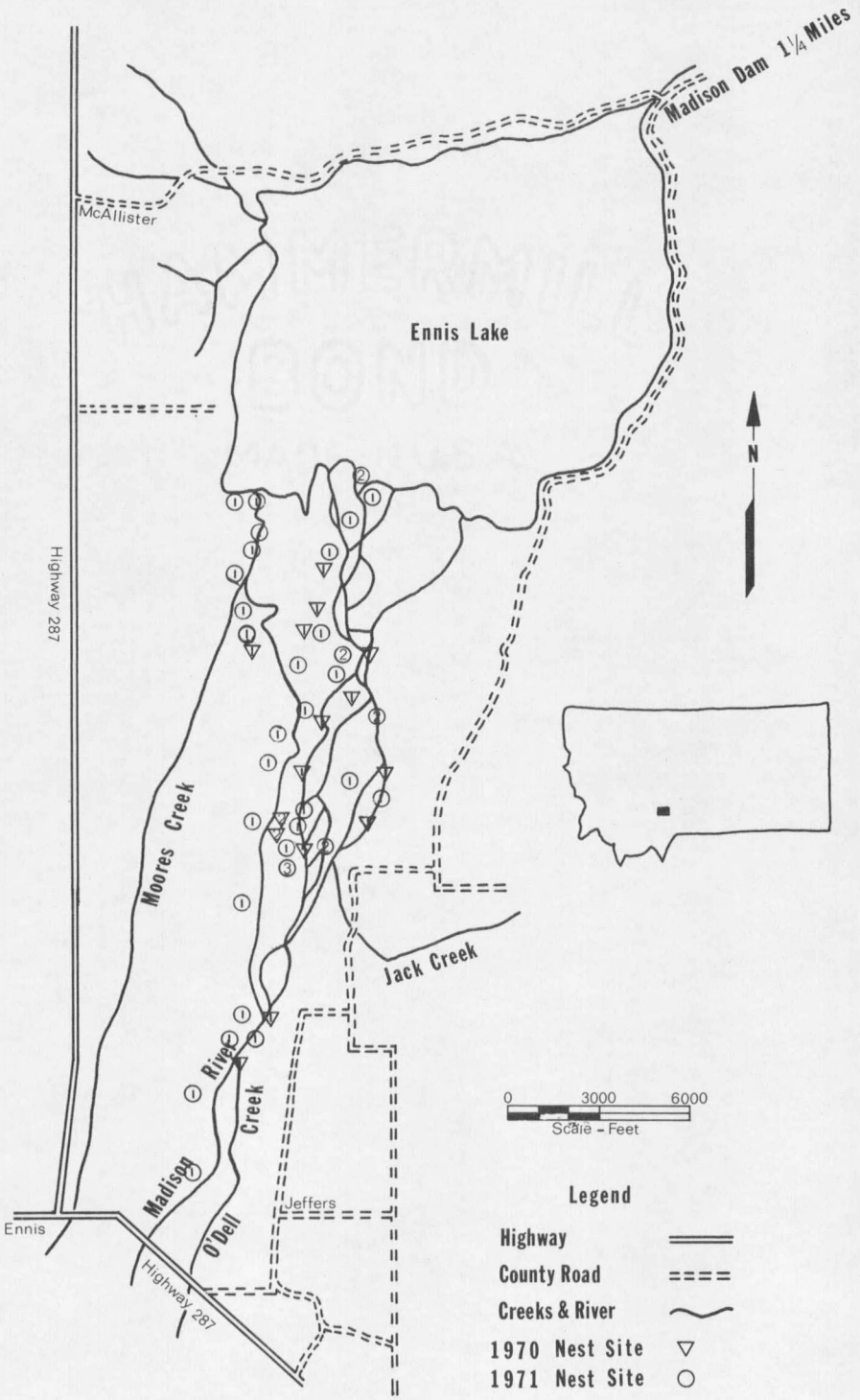

Figure 5. Distribution of nest sites on the study area.

while 53 percent were within 3 feet of water.

Height above the water was measured for nests at water levels recorded during the time of nest initiation. Mean heights were 2.17 and 1.85 feet in 1970 and 1971 respectively, with a range of one-half to 4 feet for the 2 years. The difference in height between the 2 years was primarily due to higher water levels in the river at the time of nest initiation in 1971.

Cover types utilized by nesting geese were classified according to the primary concealment at the nest site. In several cases more than one cover type was involved, but only the major one was recorded. Types of cover most often used were willow, driftwood and red dogwood (Table 7). Yocum (1952) and Dimmick (1968) observed a preference by geese for nest sites near logs or driftwood. Thirty-eight percent of the nests in this study were built near cover of this type. Types of cover did not appear to be important as long as concealment was provided. One island which was used both years and provided a choice of willow or dogwood, had a nest in willow the first year and in dogwood the second, even though the first year's nesting site remained relatively unchanged.

Of the 52 nests located on islands, 25 were on the upstream point and 20 were on the side of the island. Each winter heavy ice forms over the study area. In areas where islands lie favorably situated with reference to the configuration of the river channel, ice commonly scours part of the vegetation (Figure 6). This partial scouring of

Table 7. Cover types selected by nesting Canada geese

Cover Types	1970		1971		Combined	
	No.	%	No.	%	No.	%
Willow	12	57	16	41	28	47
Bulrush	0	0	2	5	2	3
Driftwood	4	19	9	23	13	22
Sedge	3	14	1	3	4	7
Dogwood	2	10	5	13	7	12
Goldenrod	0	0	2	5	2	3
Cattail	0	0	4	10	4	7
Total	21	100	39	100	60	101

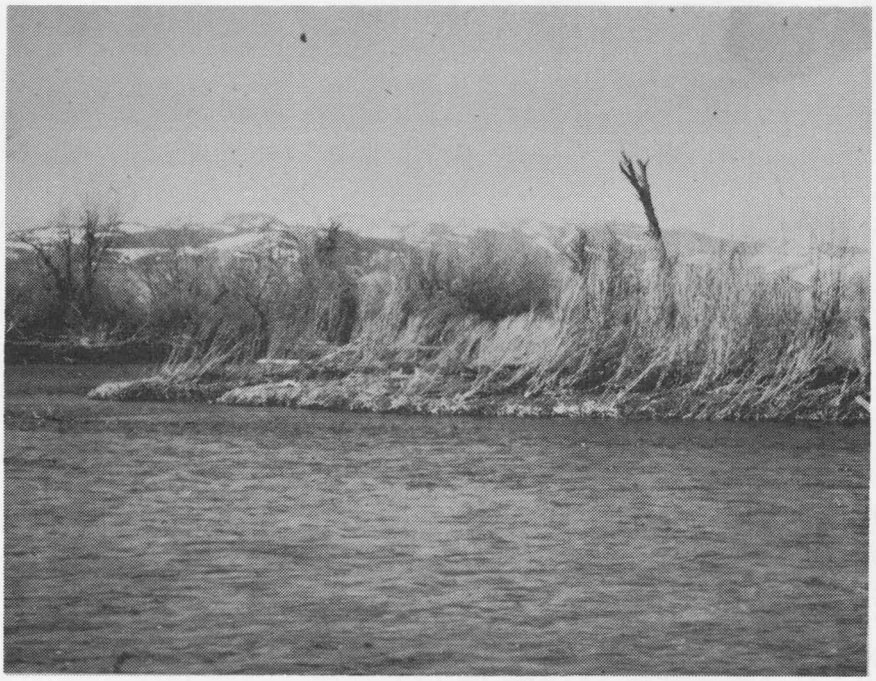

Figure 6. Island showing the effect of ice scouring on the vegetation.

the vegetation prevents development of dense willow stands, providing greater visibility and allows some vegetation to remain as concealment.

Miller and Collins (1953) stress the importance of the visibility requirement, while Grieb et al. (1960) considered this factor as the major influence in nest site selection. Good visibility was not evident at all nest sites in my study. Two nests were located in vegetation of sufficient density that the goose was forced to walk from the nest before taking flight. Twenty-eight nest sites were selected at random and visibility measurements recorded. Measurements were taken after annual growth had started so values are relative to those present when nesting began. Twenty-three of the 28 nests had at least one representative open side. Eighteen of the 23 nest sites with an open side were so located that water or ice flow may have had an effect on the vegetation at that point. Two of the five nests with no open side were located at the mouth of the river where reduced flow had little effect on reducing the density of vegetation. Table 8 presents the measurements of obstruction for the nests with an open side and those with a closed side. Seventy percent of the nests with an open side, had this side on the south, in direct line with the flow of the stream.

Water Levels

Flooding of goose nests was not evident in this study. During both years, the volume of water necessary to flood nests was not

Table 8. Degree of obstruction for Canada goose nests.

Height Level (feet)	Compass Direction			
	North	East	West	South
1	98	98	98	98
2	92	100	100	96
3	62	82	82	68
4	59	77	77	63
5	23	69	77	61
(5 nests with no open side)				
1	96	93	82	82
2	67	51	55	11
3	52	28	38	1
4	37	20	24	0
5	40	15	24	0
(23 nests with at least one open side)				

present until the last of May or early June. In 1971 when water levels reached a stage to inundate 53 percent of the nest sites, the volume of flow was approximately 3 1/2 times that measured at the start of goose nesting activity.

Flooding of goose nests on the Missouri and Jefferson Rivers is known to occur but the degree of this loss had not been documented. The sections of these two rivers being referred to are approximately 60 to 80 miles north of the Madison River study area and are not subjected to water flow control. Nesting occurs on the Missouri and Jefferson Rivers at approximately the same time as on the study area. Figure 7 and 8 present the percent increase in flow for the three rivers from early March to early June for 1970 and 1971 respectively. Based on these data, a high loss of nests to flooding on the Missouri and Jefferson Rivers would have been suspected for 1971.

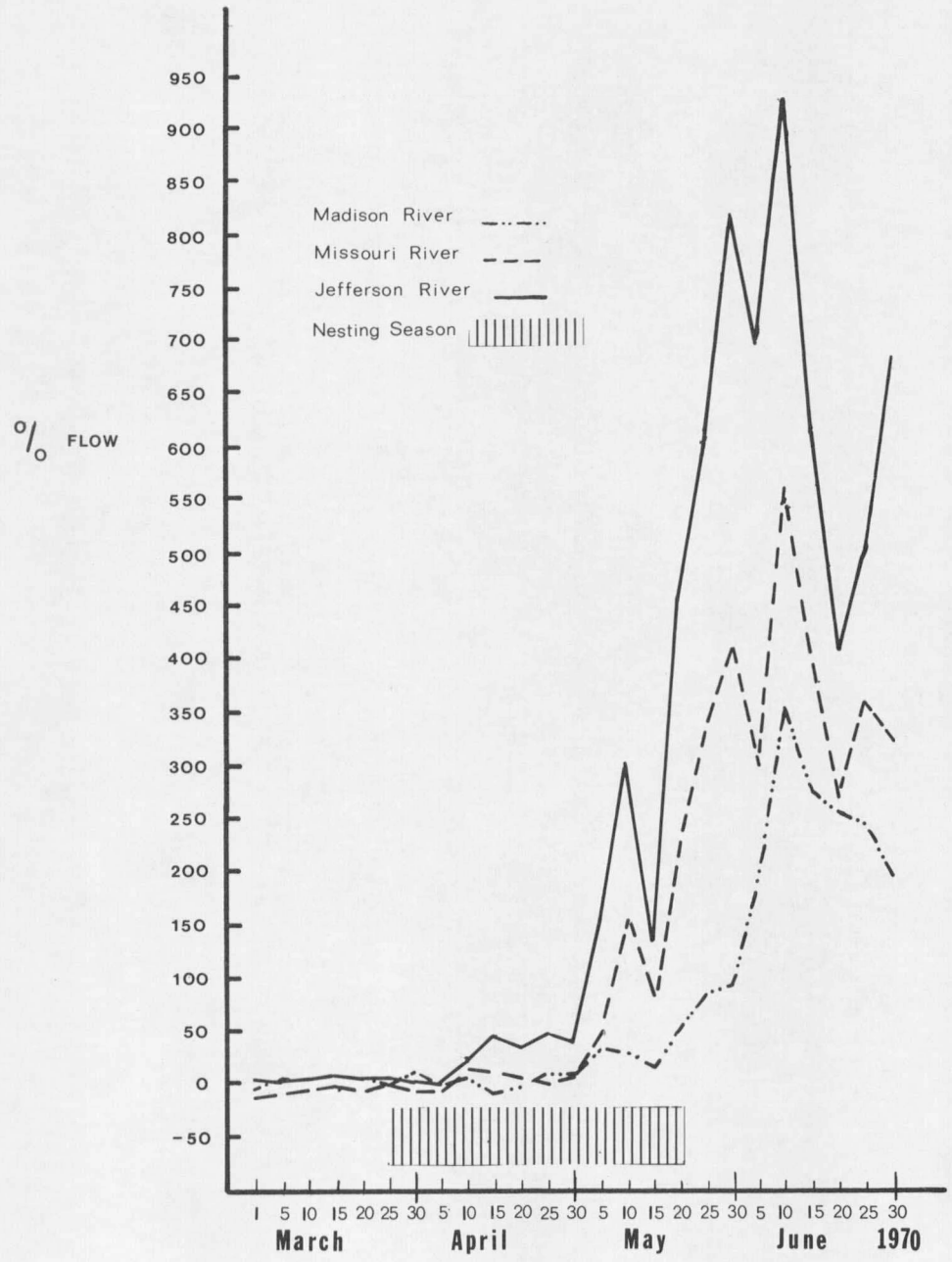

Figure 7. Changes in water flow for the Madison, Missouri and Jefferson Rivers for 1970.

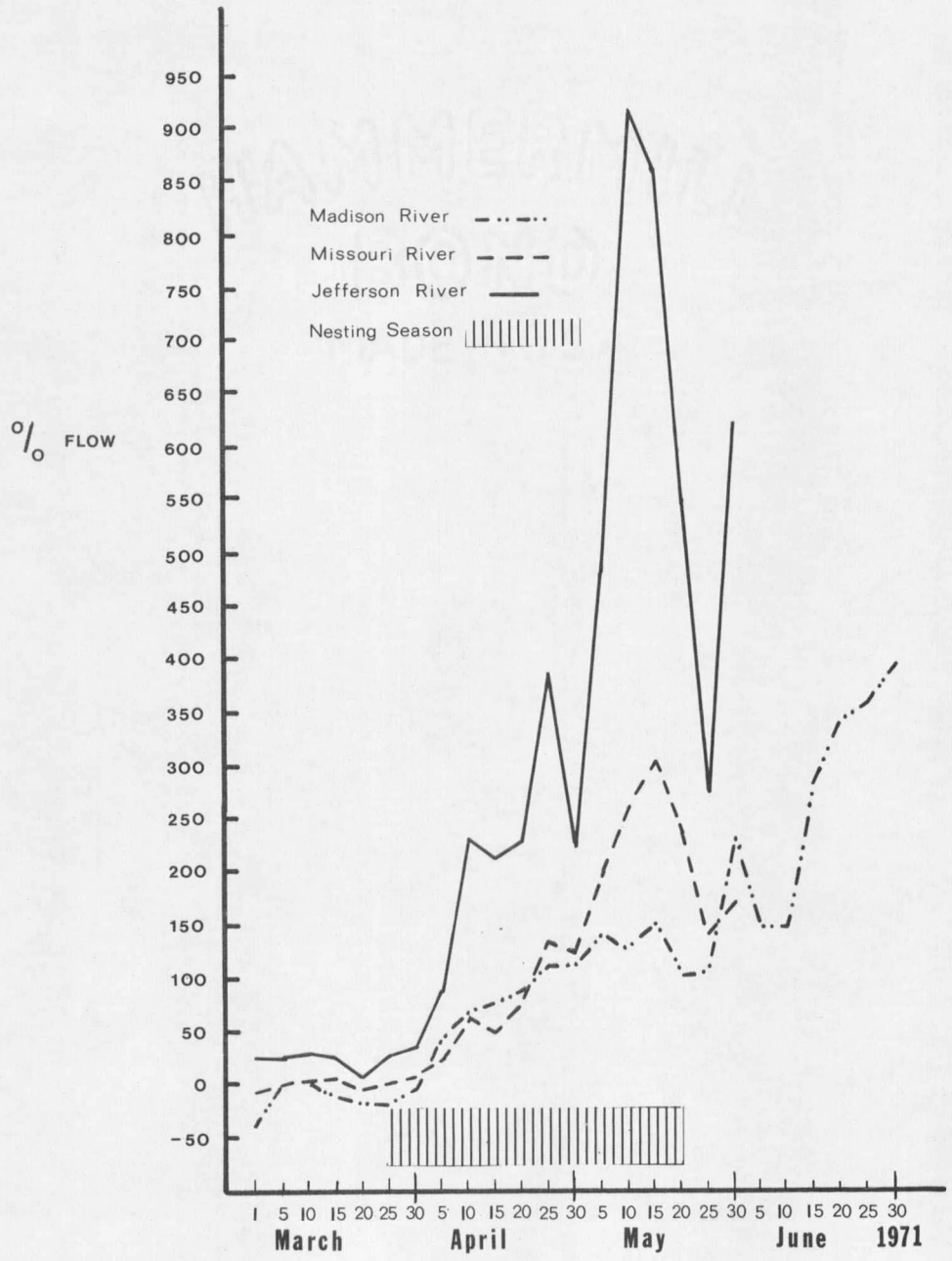

Figure 8. Changes in water flow for the Madison, Missouri and Jefferson Rivers in 1971.

DISCUSSION AND CONCLUSIONS

Results of this study suggest that the unique quality of ice gorging and water manipulation on the river have a positive influence on the goose nesting habitat in the area.

Large islands are continually being carved into smaller islands by the ice gorges and their movement. Islands thus created are frequently characterized by steep banks. The ice in its scouring action, also tends to reduce the dense vegetation on the islands, particularly on the upstream points. Water manipulation, which tends to reduce peak flows, seems to aid in the maintenance of many of the small islands created by ice gorges. Thus continued changes seem directed toward creating more of the habitat preferred by nesting geese.

Availability of, and the preference by geese for islands smaller than 1/2 acre are factors which have contributed to the goose flock reaching its present status.

The smallest size class (< 1/10 acre, Table 5) was the only class of 1/2 acre or less in which relative use was lower than availability. However, islands of less than 1/10 acre were frequently clustered in small groups (Figure 9), and the territorial behavior of nesting geese may make a large percentage of this class of islands unavailable for nesting. The distance between neighboring nests did not change appreciably for the two years. This and the fact that the desertion rate remained low for the period would suggest an unsaturated nesting habitat.

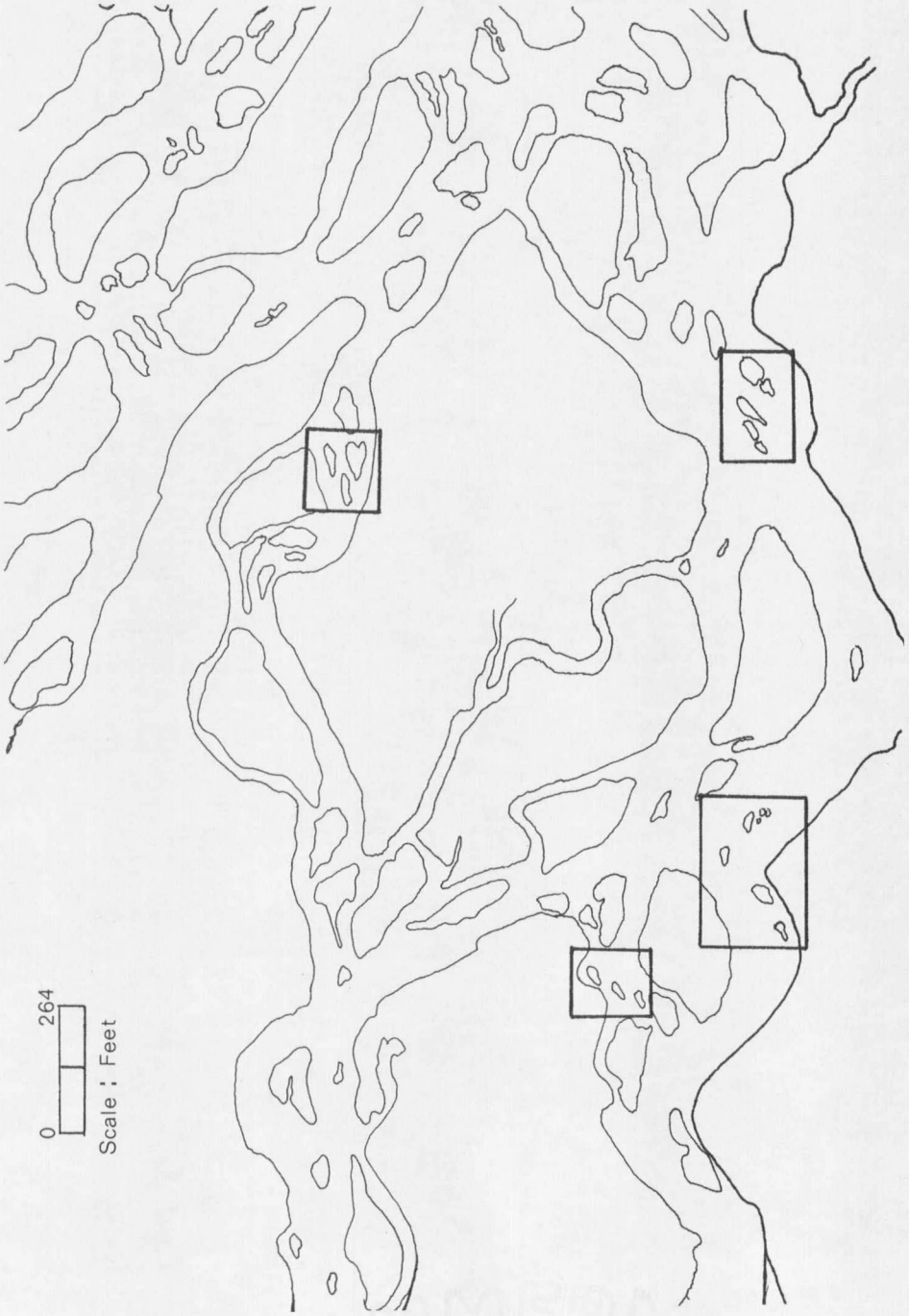

Figure 9. Section of the study area showing the clustering of small islands.

Flooding is a potential threat to successful goose nesting on river systems. River with controlled water releases may be as hazardous in terms of flooding as rivers without controls, although they do possess the means to minimize this threat. Hanson and Browning (1959) on the Hanford Reservation, Washington, reported a 12 percent loss to flooding in a single year due to early releases from Grand Coulee Dam. The influence of controlled water releases on nest losses is well typified by Jackson Lake Dam on the Snake River. Craighead and Craighead (1949) in 1947 found an estimated loss of 25 percent as the result of flooding from releases from this dam. During the period 1962 - 1964, Dimmick (1968) found losses on the same area had been reduced to less than 4 percent with better management of water releases.

No flooding losses were recorded in this study, which contributed to the 80 percent nest success achieved for the two years. The pattern of releases allows the major portion of the nesting to be completed before water flows reach a level to flood nests. During the two years of the study only renesting birds or late nesting birds would have been subjected to flooding conditions.

Reasonable stability of flow during the nesting season (late March to mid-May) is far more crucial to the nesting success of this goose population than the actual volume. If a need for greater water releases could be anticipated and instigated prior to nest initiation,

the geese would probably respond by seeking higher nest sites and losses to flooding would still be kept at a minimum.

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