Response of nesting Canada geese (Branta canadensis) to islands in stockdams in northcentral Montana
by John Joseph McCarthy

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:
The use of islands in stockdams by nesting Canada geese was studied from 1971-1972 in northcentral Montana. Physical characteristics of reservoirs and islands and the effects of fishing and rest rotation were evaluated in relationship to nesting and brood rearing. The greater use of reservoirs of 2 acres or more with islands by nesting geese was found to differ significantly from those without islands. Use of islands increased with off-shore distance and those islands of 0.05 of an acre or greater received more consistent use than smaller islands. Activities of fishermen were found to be incompatible with nesting and brood rearing. Recommendations were made for the evaluation of reservoirs being considered for island placement and construction of islands. Estimates of total duck production for the area were also presented and showed American widgeons, mallards and pintails produced 75% of the young over the two years.

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RESPONSE OF NESTING CANADA GEESE *(BRANTA CANADENSIS)* TO ISLANDS IN STOCKDAMS IN NORTHCENTRAL MONTANA

by

JOHN JOSEPH MCCARTHY

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ABSTRACT

The use of islands in stockdams by nesting Canada geese was studied from 1971-1972 in northcentral Montana. Physical characteristics of reservoirs and islands and the effects of fishing and rest rotation were evaluated in relationship to nesting and brood rearing. The greater use of reservoirs of 2 acres or more with islands by nesting geese was found to differ significantly from those without islands. Use of islands increased with off-shore distance and those islands of 0.05 of an acre or greater received more consistent use than smaller islands. Activities of fishermen were found to be incompatible with nesting and brood rearing. Recommendations were made for the evaluation of reservoirs being considered for island placement and construction of islands. Estimates of total duck production for the area were also presented and showed American widgeons, mallards and pintails produced 75% of the young over the two years.

INTRODUCTION

Construction of thousands of stock water and water detention dams by the U. S. Bureau of Land Management in eastern Montana has greatly increased the potential for waterfowl production in this usually arid region. Islands, developed either during reservoir construction or dam maintenance, have greatly enhanced this potential, especially for Canada Geese *(Branta canadensis)*.

This study was initiated to examine the response by geese to increased habitat and island construction in such an area. Secondary emphasis was placed on obtaining an index for total waterfowl production in such habitat in relation to other land uses.

Field work was carried out from June to mid-September 1971, and April to September 1972.

DESCRIPTION OF STUDY AREA

The study was conducted primarily on 52,600 acres located in south Phillips County approximately 50 miles south of Malta in northcentral Montana. The area was bordered on the south by the C. M. Russell Wildlife Range, on the west by the Bellridge Access Road, by U. S. 191 on the north, and C. K. Creek on the east (Figure 1). Five reservoirs outside the primary study area were also studied because of the presence of known age islands.

Gieseker (1926) described this portion of Phillips County as "... a rolling plain dissected by rather deeply intrenched streams and coulees. Rough, broken land, often approaching a bad land nature, is found along most of the streams and in the more feebly glaciated areas".

The climate is dry and annual precipitation ranges from 12-14 inches with 50% falling as rain from April 1 to August 1. Rainfall averages 2-3 inches for May and June (Gieseker, 1926). In 1971 precipitation data gathered from three stations near the study area averaged 11.1 inches with 6.8 inches falling from March 1 through August 1. In 1972, 14.7 inches of precipitation were recorded through August, with 13.4 inches falling from March through August 1. The average daily temperature for the period March through August was 55.1 and 53.9 for 1971 and 1972, respectively.

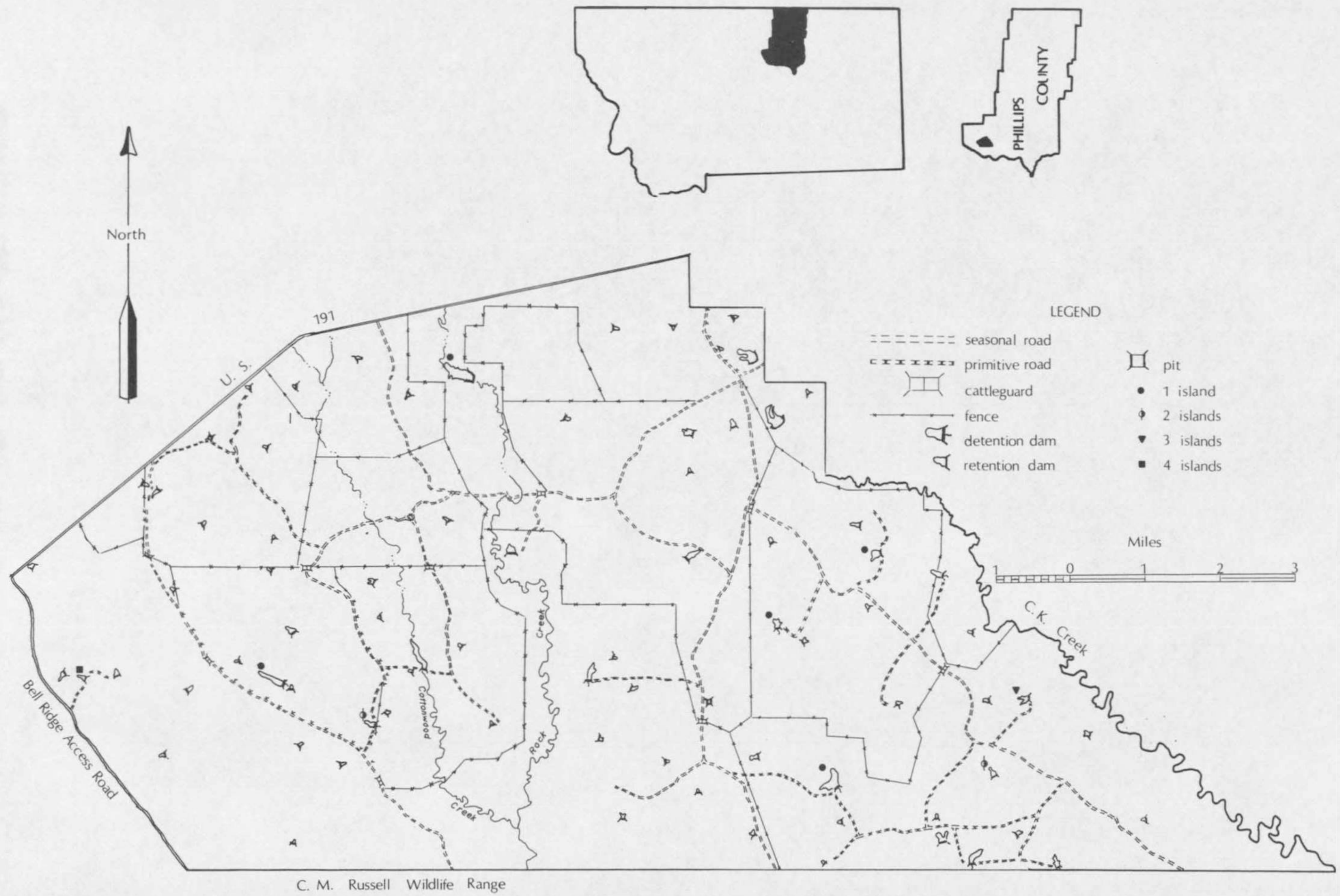
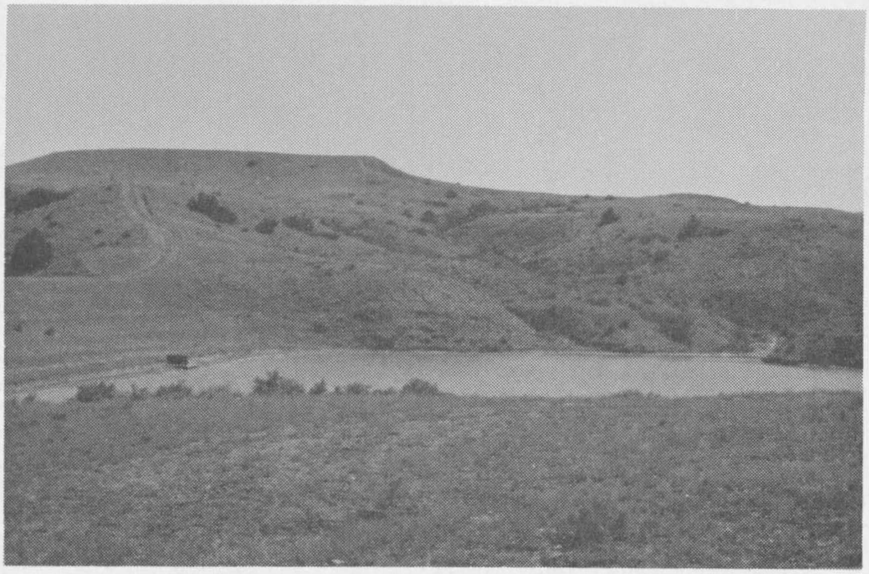


Figure 1. Map of study area showing distribution of reservoirs.

In 1971, seventy-nine reservoirs were present on the study area. A total of nine islands was located in seven reservoirs. In 1972, eighty reservoirs were present with sixteen islands found in nine reservoirs.

The five reservoirs outside the primary study area contained ten islands. Reservoirs were of three types; detention, retention and pit (Figure 2).

Vegetation was characterized by sagebrush grassland type. Big sage *(Artemisia tridentata)* was the dominant shrub with blue stem *(Agropyron smithii)*, desert saltgrass *(Distichlis stricta)* and blue grama *(Bouteloua gracilis)* being the most common grasses. Dominant forbs included yellow sweetclover *(Melilotus officinalis)*, fringed sagewort *(Artemisia frigida)* and broom snakeweed *(Gutierrezia sarothrae)*. Spike sedge *(Eleocharis macrostachya)* and *Carex* spp. were the most prominent shoreline aquatics with alkali bulrush *(Scirpus paludosus)* and American bulrush *(Scirpus americanus)* the main emergents. Milfoil *(Myriophyllum exalbescens)*, aquatic buttercup *(Ranunculus aquatilis)* and sago pondweed *(Potamogeton pectinatus)* were the primary submergents. Willow *(Salix* spp.*)* and plains cottonwood *(Populus deltoides)* were locally common as riparian species.



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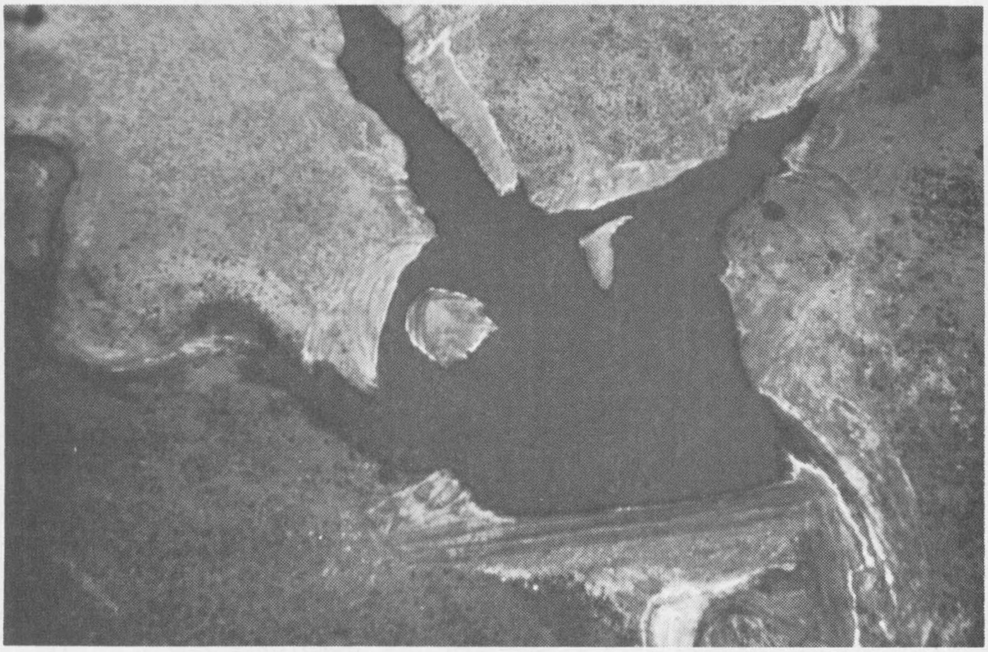

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Figure 2. Reservoir types. (A) Detention reservoir showing overflow-tube on dam. (B) Retention reservoir (no overflow-tube).

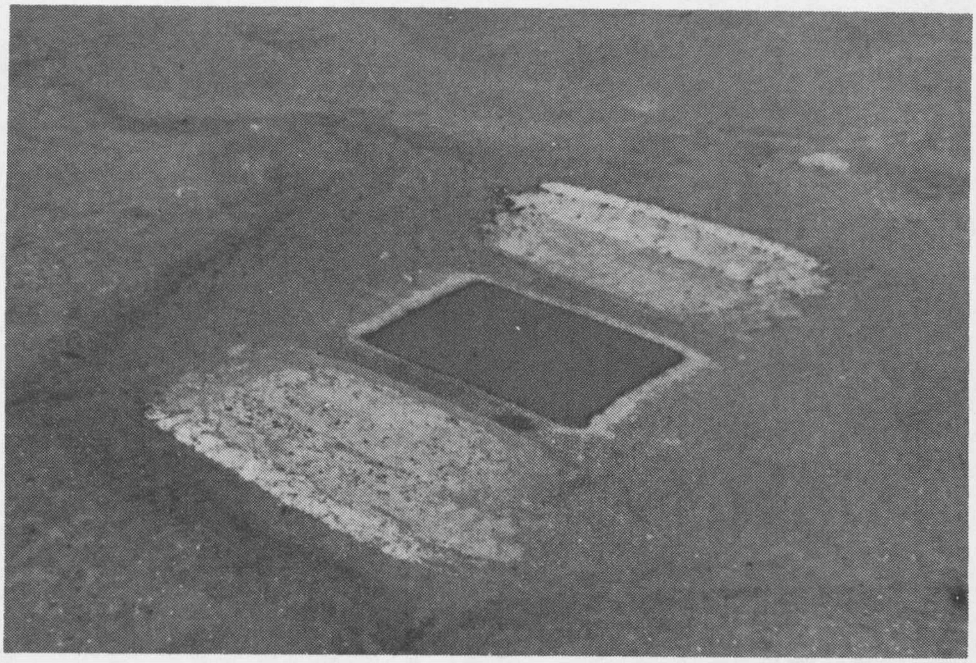

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Figure 2. (Continued). (C) Pit type reservoir.

METHODS

All reservoirs were classified using physical and vegetational characteristics. Physical data included: gross topography, size and type, presence of islands and the percentage of shoreline slope in each of four categories (steep = 45°+, medium = 30-45°, gentle = 10-30° and feather edge = less than 10°). Vegetational data included the aspect of the sagebrush-grassland community within which the reservoir occurred and percentage of shoreline vegetation falling into associations of these aspects. Categories describing both aspects and associations were: sagebrush-grassland, marsh, meadow, wooded and denuded.

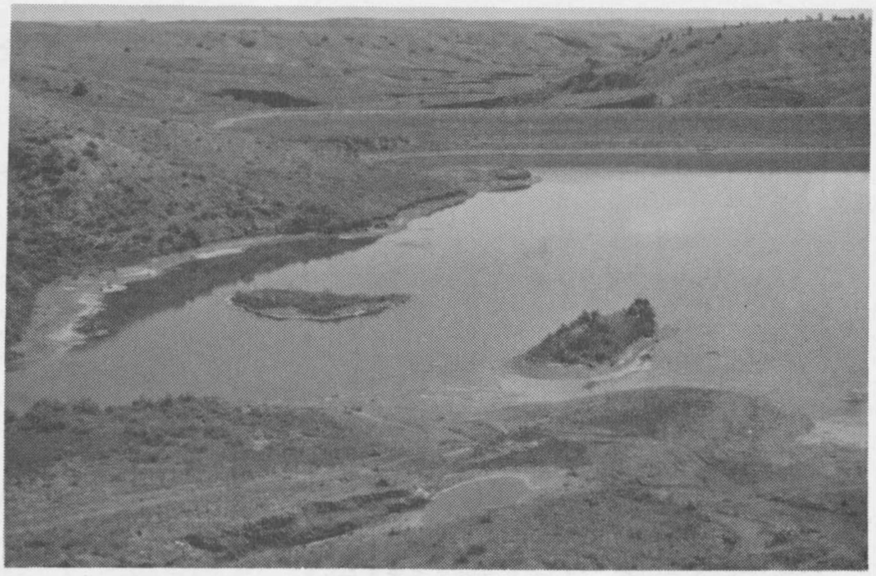
Canopy coverage adjacent to reservoirs which had islands and/or those used for goose nesting and/or brood rearing in 1971, was measured using a modification of the Daubenmeir method (1959). Three 100-foot lines were randomly located perpendicular to the shoreline of the reservoir in types representative of area vegetation. A frame (2 X 5 decimeters) was placed at 5 foot intervals along each line. The canopy coverage of taxa in each plot was visually estimated as occurring in one of six classes, these being; 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95% and 6 = 95-100%. The midpoint of each class was used in data tabulation. This same procedure was followed along lines extending the length and width of all islands. Percentage of vegetation in each of five height classes was also gathered for each plot. These classes were; 1 = 0-3 inches, 2 = 3-6 inches, 3 = 6-9 inches, 4 = 9-12 inches and 5 = 12+ inches. Point intercepts for the four legs of the frame were also recorded as bare ground, rock, litter, or living vegetation.

In both years, cover maps were drawn of shoreline and adjacent vegetation and island vegetation. In 1972, these maps were correlated with infra-red aerial photos taken of eight reservoirs used by geese for nesting and/or brood rearing. Vegetational data were collected from July through August 1971, and mid-May through June and again during August 1972. Vegetational data from transects were gathered on islands only in 1972.

The infra-red photos were used to obtain a measurement of the area, for six of the reservoirs, and the surface acres of all other reservoirs were obtained from aerial photos taken in 1969 by the U. S. Department of Agriculture. Reservoir and island ages were obtained through the Bureau of Land Management, Malta.

Islands were classified according to number per reservoir and origin (natural, cut-off, or push-up) (Figure 3). Because some islands became continuous with the shoreline with lower water levels they were further classified as being temporary or permanent.

Lengths and widths of islands were measured using a 50-foot tape in 1971 and a range finder in 1972. The range finder was also used to estimate the closest shoreline distance, if under 100 feet.



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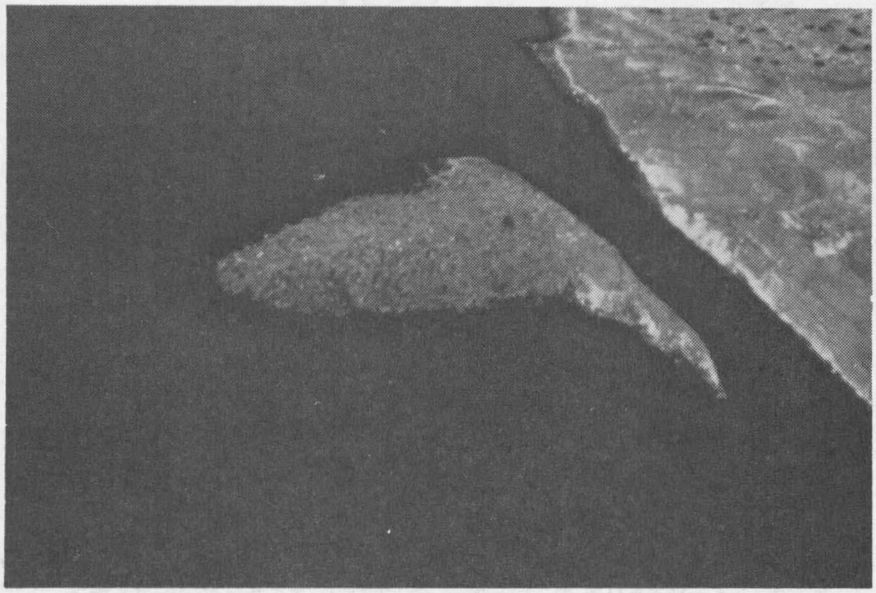

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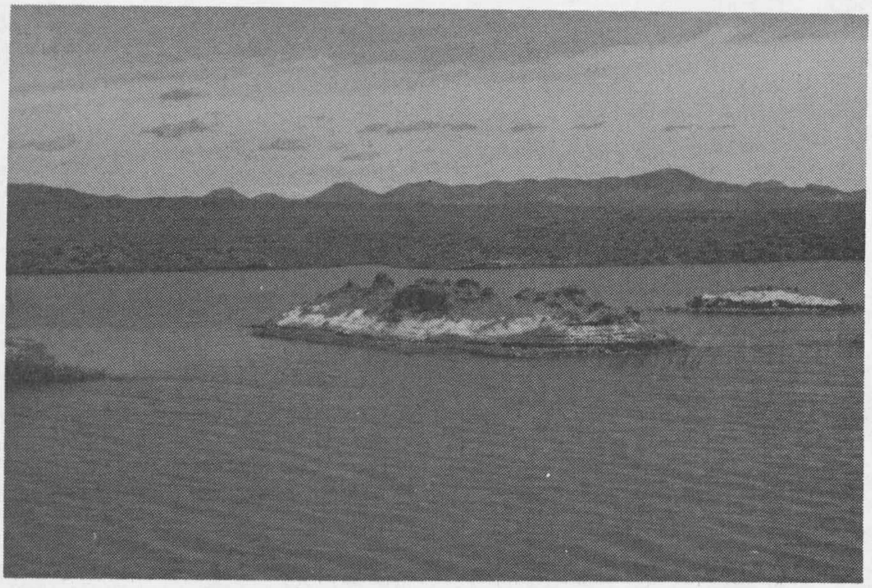
Figure 3. Island classes. (A) Natural island on left with cut-off in foreground. (B) Cut-off showing point of separation from the shoreline.



C

Figure 3. (Continued). (C) Push-up.

Circumference and area of eleven islands as well as shoreline distances greater than 100 feet were obtained from the infra-red photos. Maximum height of islands above high water was visually estimated.

Aerial surveys were made in May and June 1971, and from April through June 1972, to determine initial goose distribution and location of nesting geese and to assess brood movements.

All nests were visited at least once during incubation in 1972 at which time clutch sizes were determined and photos taken of the vegetation immediately surrounding the nest site. In addition, turbidity samples were taken from all reservoirs being utilized by geese. Later, nest sites were cover mapped and the nearest water and field of unobstructed view at 2½ feet above the nest recorded. Circumstances permitting, dates of nest initiation and hatch were estimated and the fate of all eggs recorded. Attempts were made to keep disturbances to geese to a mimimum.

Major taxa of plants used by feeding goslings were recorded on all feeding areas with visual estimates made of the percent usage of each species.

Ground surveys were used to estimate total waterfowl breeding populations in 1972 and production both years. Observations were generally made from the vehicle as reservoir locations seldom permitted an approach on foot using cover to minimize disturbance.

Binoculars (7 X 35) and a spotting scope (15-60 variable) aided observation. Breeding populations were estimated from three surveys using counts of pairs, lone drakes and/or combinations indicating pairs (Hammond, 1959). Production surveys were conducted approximately once every three weeks in 1971, and attempted on a weekly basis from mid-May through August 1972.

RESULTS

In 1972, the initial distribution of geese, which had taken place by late March, was altered by a storm on March 28. This storm covered the area with 6 to 8 inches of snow, and subsequently iced over the smaller reservoirs. An aerial survey conducted March 30, showed the geese to be utilizing the larger, open reservoirs, with the largest of these receiving heaviest use. An aerial survey on April 15, still showed a pronounced use of larger reservoirs, but a redistribution to smaller reservoirs had taken place, with a preference being shown for those with islands (Table 1).

Atwater (1959), in this same area, reported geese nesting on reservoirs of 2 or 3 acres. For this study two surface acres were used as the lower limit for reservoirs of suitable size for nesting. Table 2 summarizes nesting distribution for 1971-72. In 1971, while only 28% of the reservoirs with an area of two surface acres or greater had islands, they supported 83% of the nesting geese. In 1972, 43% of the reservoirs had islands and included 78% of the nesting geese. In all cases where reservoirs with islands were used for nesting, the island served as the nest site. This preference for islands as nest sites has been reported by others (Atwater, 1959; Vermeer, 1970).

From April 4 through 13, 1972, turbidity measurements determined with a Hach Chemical Kit (Model DR-EL) were made on sixteen reservoirs being used by geese. Results indicated geese used reservoirs with

TABLE 1. SPRING GOOSE DISTRIBUTION 1972

Surface Acres	3/30 Survey Pairs	3/30 Survey Other	4/15 Survey Pairs	4/15 Survey Other	Island Present
33.3	6		2	1	Yes
20.3	1		2	6	Yes
19.2	18		5		No
8.4			1		No
7.3			1		Yes
7.2	1		1		Yes
6.0			1		No
5.6	1		1		No
5.3			1		Yes
5.0	1		1		Yes
4.5			1		Yes
3.7			1	1	Yes

TABLE 2. UTILIZATION BY NESTING GEESE OF RESERVOIRS TWO SURFACE ACRES OR GREATER

Year	Total Reservoirs	Reservoirs with nests	Reservoirs with islands	Reservoirs with both
1971	21	6	6	5
1972	21	10	9	7

turbidities ranging from 5 to 500 J. T. U. but nests were limited to reservoirs with readings of 70 or less. Reservoirs used for nesting ranged in size from 3.7 to 33.3 surface acres and in depth from 5 to 25 feet. Steep and medium shoreline slope made up from 10 to 95% of the shoreline, and shoreline vegetation ranged from 80% marsh to 80% denuded. Reservoirs ranged from two and one-half (third nesting season) to ten plus years in age (Table 3).

No significance (95% confidence limits) was found between utilization by nesting geese of these reservoirs and their surface areas, depths, percentage of shoreline above or below 30° slope, shoreline vegetation or age.

During the two years, eleven of sixteen nests were located on reservoirs with 50% or less of the shoreline below 30° slope. While this would appear to be selection for this type reservoir, it was felt that the presence of an island in nine of these cases was the dominating factor in nest establishment. Islands were also present in three of the four instances where nests were established on those reservoirs with greater than 50% of the shoreline above 30° slope. Over the two years, nest establishment on reservoirs of two surface acres or more with islands present was found significantly higher ($P<0.05$ $t = 2.16$) than the establishment of nests on those reservoirs in this size class without islands.

TABLE 3. PHYSICAL AND VEGETATIONAL CHARACTERISTICS AND NESTING USE BY GEESE OF RESERVOIRS OF TWO SURFACE ACRES AND OVER.

Area	Depth	% Shoreline Slope				% Shoreline Vegetation						Age		Islands		Nests	
(Acres)	(Feet)	45°+	30-40°	10-30°	10-	Marsh	Meadow	Sage Grass	Prairie Grass	Wooded	Denuded	71	72	71	72	71	72
33.3	21	50	20	20	10	10	10	75		5		10+	10+	0	1	0	1
20.3	16	5	25	65	5			60	30		10	3	4	1	1	2	1
19.2	5	50		25	25			25	75			10+	10+	0	0	3*	2
9.4		75	10	10	5	5		60	25		10	7	8	0	0	0	0
8.4	25	5	90	5				100					3	0	0	0	1
7.8		40	40		20	25	40	30		5		10+	10+	0	0	0	0
7.3	11	30	30	30	10		30	65			5	4	5	2	2	1	1
7.2	14	20		10	70			100				4	5	1	1	1	0
6.0		15	50	30	5		10	10			80	10+	10+	0	0	0	0
5.6	7	10	0	80	10	80	20					10+	10+	0	0	0	1
5.3	17	10	40	50		10			85		5	4	5	0	4	0	1
5.2		15	85					100				4	5	0	0	0	0
5.0	16	10	75	15				100				3	4	3	3	0	1
4.7		20	60	20				100				4	5	0	0	0	0
4.6				100		80	20					10+	10+	0	0	0	0
4.5	12	20	20	50	10	10		70	10		10	3	4	1	1	1	1
3.8		65	25		10			80			20	7	8	0	0	0	0
3.7	6	10	30	50	10	10		10			80	4	5	1	1	1	1
3.2				100		40				60		10+	10+	0	0	0	0
2.9		50	50					100				5	6	0	0	0	0
2.8		5			95			100				10+	10+	0	0	0	0

*Personal communication with land owner.

Considering all the above factors, the presence of an island was believed to be foremost in the selection of a reservoir by nesting geese.

Though not found to be significant in this study, reservoir age may play an important role in nesting. One of six essential features of a good breeding ground, as listed by Williams and Sooter (1940), was "... an aquatic feeding and loafing area easily available from the nest site". Young reservoirs usually lack sufficient aquatic flora and fauna to the extent that an island may become secondary to nest establishment.

Only one first year reservoir with islands existed on the area. Older reservoirs with similar physical characteristics and surrounding vegetation, but without islands, in the immediate vicinity were used as feeding and loafing areas but no use was made of this first year reservoir.

The physical characteristics of all islands studied are presented in Table 4. Islands on the primary study area varied in size from 0.01 to 0.13 of an acre with maximum heights of 2 to 8 feet above spring high water level. Eighty-one percent of these islands had 51 percent or more of the shoreline sloping greater than 30°. Fifty-six percent of the islands were cut-offs, 31 percent push-ups, and 13 percent natural. Eight or 50 percent were within 20-feet of the shoreline. Fifty percent of the islands were also classified as

TABLE 4. PHYSICAL CHARACTERISTICS OF ISLANDS.

Island Number	Age 71	Age 72	Type	Size	Physical Dimensions: Circumference	Height	Length	Width	Shoreline Slope: Steep	Medium	Gentle	Feather	Off-Shore Distance	% Canopy Cover: 71	72[2]	72[3]	Stability Class	Nest 71	Nest 72
1		10+	N.	.03		2	68	18			100		40		85	98	T		1
2	3	4	P.U	.13[4]	332.6	8	14.29	60.1	90		10		143	73.3	64.6	72.5	P	2	1
3}	4	5	C.O	.02		5	52	11.5	95	5			25	38.2	21.8	61.7	T	1	1
4}	4	5	N.	.06		2	57	46.			60	40	40	56.9	21.0	51.7	P		
5	3	4	P.U.	.05[4]		4.5	54.5	24.1	100				150	25.9	51.8	45.0	T	1	
6}		1	C.O.	.05		2	55	27	85	5	10		12		24.8		P		
7}		1	C.O.	.01		2	40	22				100	12		17.3		P		
8}		1	P.U.	.02		6	50	20	95		5		16		0	0	P		
9}		1	P.U.	.03		6	70	20	95		5		30		0		-		1
10}	3	4	C.O.	.02[4]	133.3	4	60.8	24.9	85		15		17	44.4	40.0		T		
11}	3	4	C.O.	.08[4]	288	4	112.0	52	50	50			10	24.2	16.0		T		
12	3	4	C.O.	.02[4]	117.4	3.5	44.0	30.3	50	35	10	5	60	75.7	39.0	62.0	T		1
13	3	4	P.U.	.09[4]	256.8	7	101.0	49.8		80	20		59	66.8	77.4	89.1	T	1	1
14	4	5	C.O.	.07[4]	283.8	3	88.3	49.9	80	10	10		12	11.3	6.8	18.4	T	1	1
15}		1	C.O.	.03[4]	188.4	8	62.6	62.2	90	10			11		29.9		P		
16}		1	C.O.	.01[4]	159.9	8	57.7	46.3	95	5			9		36.4		P		
17[1]		4	C.O.	.05		3.5	73.0	37.5	20	10	70		12			75.8	T	1	1
18[1]		4	N.	.01		2	36	17.5	10	90			12			92.8	P		1
19[1]		2	C.O.	.12		2	135	45		20	80		25		59.1		T		1
20[1]		1	C.O.	.08		4.5	117	52	20	5	75		14		49.6		P		1
21[1]}		2	P.U.	.05		4.5	143	18	90	5	5		Marsh		27.0		T		
22[1]}		2	P.U.	.07		5.5	110	42	90	10			Marsh		15.5		T		

[1]Known age islands off main study area - used in computations only where so noted.

}Islands all on same reservoir.

[2]Spring survey. -

[3]Summer survey - corresponds in time with 1971 survey.

Type Key; N = Natural, P.U. = Push-up, C.O. = Cut-off.

[4]Taken from infra-red photos - others estimated.

Stability Key; T = Temporary, P = Permanent.

temporary. In 1971 canopy coverage of all islands ranged from 11.4% to 64.5% in late summer, and from 17.6% to 98% in August 1972 (Table 5).

Nesting on a yearly basis was not found to vary significantly (95% level of significance) with island type, age, shoreline slope, percent canopy cover, permanency or number of islands per reservoir.

Nesting was found to increase significantly on islands ($P<0.05$, $F = 4.74$, $df = 5$ and 22) with increased off-shore distance. Sherwood (1968) reported that geese selected islands well off-shore as preferred nest sites on narrow pools. During this study it was noted that on those reservoirs with multiple islands the one selected for nesting was usually the farthest from the shore. This tendency is apparently quite strong as is shown in a comparison between islands 6 through 9. Islands 6 and 7 were cut-offs with 23.5 and 14.5% canopy cover, respectively. Islands 8 and 9 were push-ups and consisted of large mounds of raw earth with no vegetation or litter. Island 9, the farthest from shore, was chosen as the nest site. The one exception to a seeming preference for distance from shore was the selection of island 3 over island 4 for nesting both years. High water emersed island 4 during the period of nest establishment, thereby preventing nesting.

Sherwood also reported that "seemingly good nesting islands were rarely used if adjacent islands were closer than about 150 feet and occupied by another goose", and that, "a pair might claim a cluster

TABLE 5. AVERAGE PERCENT CANOPY COVERAGE FOR ISLAND TYPES BY AGE[1]

Island	SPRING				SUMMER			
	Push-up		Cut-off and Natural		Push-up		Cut-off and Natural	
Age	No.	%Cover	No.	%Cover	No.	%Cover	No.	%Cover
1	2	0	5	31.6	1	0	5*	44.7
2	2	21.2	1	59.1	2*	34.3	1*	72.2
3	3*	32.2	3*	35.0	3	55.3	3	48.1
4	3	64.6	3	31.7	3	65.88	5	56.02
5			2	21.4			2	43.9
5+			1	85.0			1	98.0

[1]Includes islands off primary area.

*Estimated using 13.1% as average spring to summer difference.

of three or four small islands within 150 to 200 feet of one another". This territoriality on small islands could explain why in this study generally only one nesting pair occupied a reservoir regardless of the number of islands present. Under conditions found in this area a breakdown of such spacing would indicate an increase in nesting pairs and a shortage of preferred nesting habitat.

Incorporation of the larger islands as nesting sites was also found to be significant over use of smaller islands. An inverse relationship was found to exist between nest density per unit area and island size. This was also reported by Geis (1955) on islands in Flathead Lake, Montana. Table 6 shows this relationship as well as pointing out that islands above 0.05 of an acre received a more consistent use than smaller islands on a year to year basis.

A 48 day nesting season was estimated for 1972. The approximate date that each nest was initiated was determined by back dating, using a 28 day maximum incubation period and a laying period of 1.5 days per egg (Atwater 1959; Kossack 1947, 1950). The season extended from April 4 through May 22.

Of the six nest sites found in 1971, and the eleven in 1972, 18% were in meadow habitat, 6% in sagebrush and 76% on islands. Personal communication with a land owner also placed three other 1971 nests in meadow habitat, but the actual sites were not located.

TABLE 6. NESTING DENSITY AS RELATED TO SIZE OF ISLANDS.

Island Size	No. Of Islands	Total Acre	Av. Total Nest	Av. Nest Per Acre
.01 - .05	11[1]	0.29	3	10.34
.05+	5[1]	0.43	3.5	8.14

[1]Does not include reservoirs off area.

All three 1971 nests in meadow habitat, and two of three in 1972 were near a large (19.2 acre), shallow reservoir. This same reservoir received the heaviest prenesting utilization of any reservoir on the area in 1972. Proximity to two large grain fields was believed to influence this preference. The lone nest in meadow habitat not near this reservoir was by an adjacent reservoir approximately one-fourth mile away. All nest sites located utilized shrubs for initial cover.

The one nest in sage habitat was on the steep bank of a 9.6 acre reservoir, and utilized big sage as initial cover.

As with the other nests, those on islands were usually located near some type of vegetation or object that would afford the incubating female some degree of cover.

Other workers (Williams and Sooter 1940; Klopman 1957) have reported the importance of visibility from the nest as a factor in nest establishment. In 1972 no nest site on an island had less than a 300° field of view at 2½ feet above the nest. It was also noted that off shore distance may influence the location of the nest on an island (Table 7). Preferred sites on those islands within 25 feet of the shore were on the more distal portion of the island, i.e. furthest from shore. On islands greater than 100 feet from shore, preferred sites faced the shoreline. This behavior may result in decreased potential mammalian predation by better concealment on islands closer to shore and on islands farther from shore by allowing better observation of the most likely direction of disturbance. During the study no known case of predation upon goose nests occurred.

In 1972 nest success (those nests with at least one egg hatching) was 82% with nine of the eleven nests successful, and two being deserted. Sixty-three percent of all eggs hatched. Cold weather during April was felt to be the major factor contributing to the low hatch success for 1972.

In 1971, fifty goslings were on the area on May 18, forty-six of which attained flight. In 1972 of the thirty-two eggs that hatched, thirteen goslings were raised to flight. Disturbances, causing movement of broods, were primary in loss of young both years. Fishermen and/or cattle were the major sources of such disturbance.

Seven of the eleven reservoirs, that served as nest sites during the study, had recently been planted with fish. Fish had been introduced into six of the nine reservoirs with islands and traffic to one of these six crossed the dam of still another. Disturbance due to fishing was believed responsible for the movement of two broods in

TABLE 7. NEST LOCATION ON ISLAND COMPARED WITH OFF-SHORE DISTANCE.

Off-Shore Distance	Opposite Closest Shore	Facing Closest Shore
0 - 25	4	2
26 - 50	1	2
50 - 75	2	1
75 - 100	0	0
100 +	1	3

1971 and three broods in 1972, bringing about the loss of eight goslings in the two years. Fishing was also felt to be the cause of one case of nest desertion.

In 1972 disturbance by cattle may have resulted in the movement and loss of a brood of four and cattle and/or fishermen the movement and loss of a brood of five. The loss of one gosling in 1972 and the desertion of a nest of five eggs was attributed to weather, while unknown causes resulted in the loss of three other young.

Terrestrial feeding habits of broods and vegetational composition varied between reservoirs. Consistently used species, as listed in approximate order of importance included: spike sedge, desert saltgrass, foxtail barley *(Hordeum jubatum)*, green needlegrass *(Stipa viridula)*, Sandberg bluegrass *(Poa secunda)*, blue gramma, Junegrass *(Koeleria cristata)* and needle-and-thread grass *(Stipa comata)*. The preferred portions of the plants were young shoots and seed heads. Only incidental use of bluestem took place even though it had been seeded around some reservoirs.

DUCK PRODUCTION

A secondary objective of the study was to determine an index for duck production. Breeding pair surveys conducted in the spring of 1972 (Table 8) showed that 78% of the breeding population was composed of Baldpates *(Mareca americana)*, Mallards *(Anas platyrhynchos)* and Pintails *(A. acuta)*. These same three species accounted for 75% of the total duck production over the two years (Table 9).

Production estimates for Mallards and Pintails are believed to be low due to their behavioral trait of seeking cover in shoreline and terrestrial vegetation when reservoirs were approached.

Of the eighty reservoirs on the area in 1972, thirty-four were in areas under rest rotation grazing systems (Hormay 1961), while forty-six were in areas subjected to open grazing (Figure 4).

The use of larger reservoirs for brood rearing (Smith 1953; Berg 1956), was common to reservoirs on both types of grazing areas, as was the more frequent use of those reservoirs having under 60% of the shoreline above a 30° slope. This inverse relationship between percentage of steep shoreline and brood use was also pointed out by Gjersing (1971) who related it to a lack of feeding area for dabbling ducks.

Table 10 summarizes duck production on the reservoirs under the two grazing systems and suggests they prefer reservoirs in areas of

TABLE 8. ESTIMATED BREEDING PAIRS OF DUCKS - 1972.

Species	Pairs	% Total
American Widgeon *(Mareca americana)*	135	28
Mallard *(Anas platyrhynchos)*	130	27
Pintail *(Anas acuta)*	109	23
Green-Winged Teal *(Anas carolinensis)*	28	6
Lesser Scaup *(Aythya affinis)*	25	5
Gadwall *(Anas strepera)*	22	5
Blue-Winged Teal *(Anas discors)*	17	3
Shovler *(Spatula clypeata)*	15	3
Total	481	100

TABLE 9. OBSERVED NUMBER OF YOUNG DUCKS PRODUCED - CLASS II OR GREATER.

Species	1971	1972	% Total
American Widgeon	286	364	46
Mallard	113	115	16
Pintail	141	49	13
Blue-Winged Teal	105	173	12
Shovler	26	39	5
Gadwall	11	32	3
Lesser Scaup	16	24	3
Green-Winged Teal	0	9	1
Unknown	13	7	1
Total	674	744	100

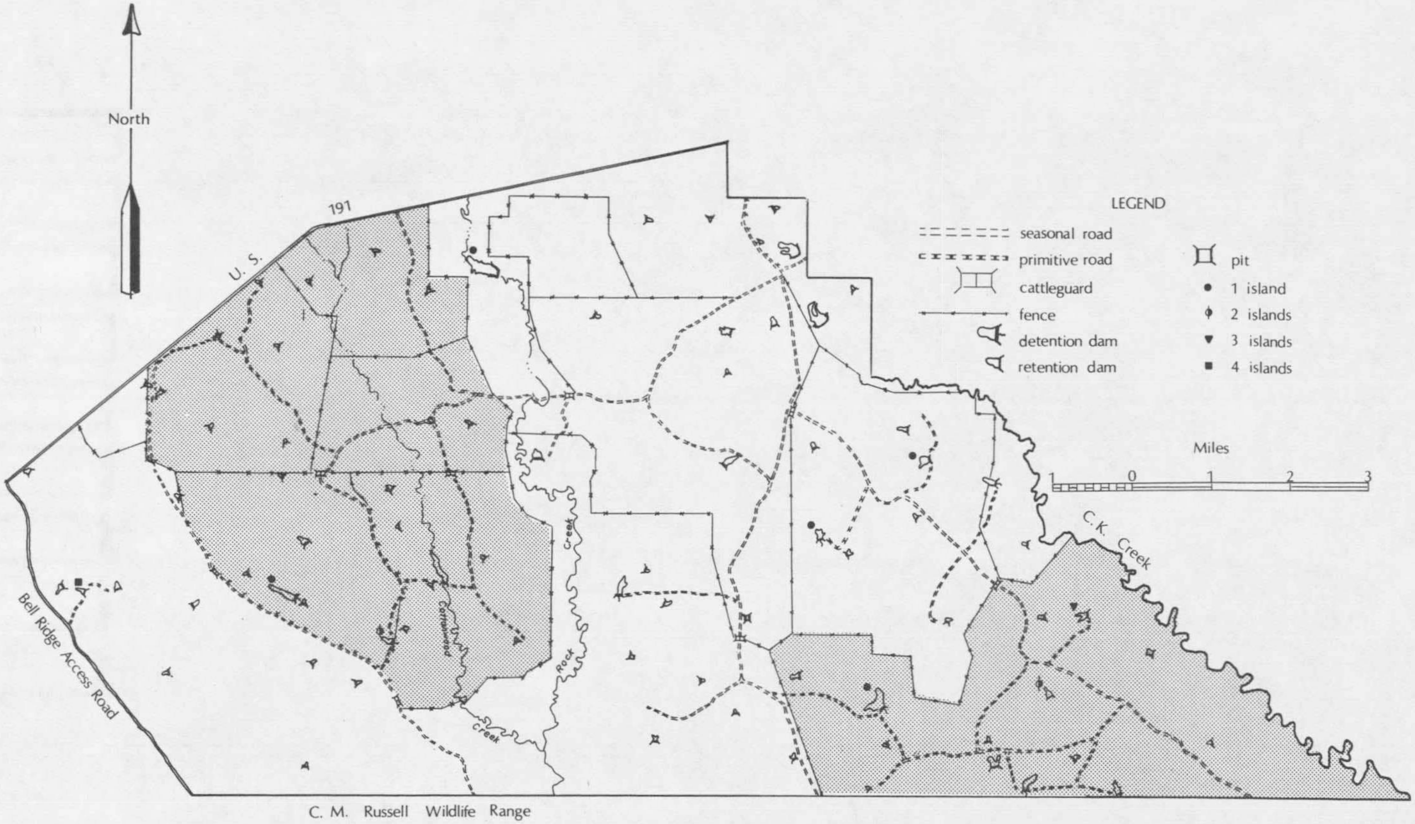


Figure 4. Darkened areas indicate rest-rotation pastures.

TABLE 10. COMPARISON OF RESERVOIRS IN REST-ROTATION PASTURES AND THOSE ON OPEN RANGE.

	Rest Rotation		Open Grazing	
	1971	1972	1971	1972
Reservoirs Available	33	34	46	46
Reservoirs with Broods	16	10	19	18
Young Produced	211	161	463	583

open grazing. The major factor behind this selection was thought to be a greater number of reservoirs larger than one acre with less than 60% of the shoreline above 30° slope on the open grazing areas. Only four of twelve reservoirs on rest rotation areas met these criteria as compared to fifteen of nineteen in open grazing areas. Heavier fishing pressure on stocked reservoirs under rest rotation was also believed to have reduced duck usage.

DISCUSSION AND RECOMMENDATIONS

The primary purpose for island construction on stockdams is to create habitat that will attract nesting waterfowl, particularly Canada geese. As economics dictates the number of islands that may be constructed, it is of utmost importance that the islands built be attractive to geese, thereby assuring their consistent use, and the reservoir used for island placement meet requirements allowing successful brood rearing. Therefore, before island construction is initiated several factors should be considered.

Reservoir size - Data on goose distribution in the spring indicated a preference for the larger reservoirs on the study area. Atwater (1959), suggested reservoirs of two surface acres or less may comprise marginal habitat for nesting geese. Considering the above it is recommended that those reservoirs with greater than two surface acres be given first consideration for island construction.

Shoreline slope - High percentages of shoreline above 30° slope greatly reduce the aquatic feeding area of young goslings, and may prevent access to terrestrial feeding sites. Thus reservoirs with 40% or more of the shoreline having a moderate degree of slope should be given high priority for island construction and any other waterfowl management considerations.

Terrestrial feeding sites - In this study the variety of plant species utilized by feeding geese indicate the desirability of a diverse floral composition around reservoirs. Native vegetation appeared adequate to fulfill this requirement. If seeding is to take place on disturbed areas following reservoir construction, it is recommended that preferred native species such as green-needle grass be used.

Physical characteristics of islands - Long, narrow push-ups of 0.05 acre or greater, at least 50 feet from and parallel to the shore, would represent the model island for this area. Construction during reservoir development would allow islands to be placed at greater off-shore distances and at less expense than would construction during periods of low water. Should present spacing characteristics change with an increased density of nesting geese, long, narrow islands would also allow for the establishment of two to four nests with a minimum of desertion due to crowding (Miller and Collins 1953; Naylor 1953; Hammond and Mann 1956). Several methods of erosion abatement may be employed to increase the life of an island. During construction the use of scrapers rather than bulldozers would result in a more compact, erosion-resistant island. The use of top soil from the borrow area to reduce the period required for vegetation establishment, riprapping, and the planting of emergents as wave barriers would also help in reduction of erosion.

Most islands are free from grazing pressure during the early growing season allowing the development of good vegetational cover a few years after construction as is illustrated in Figure 5. While the island pictured is a cut-off, with vegetation having been present prior to development, the trend shown is similar to that which occurs on new push-ups following seedling establishment.

If an island is created by cutting-off a segment of shoreline which projects into the reservoir, a long, narrow point is more desirable than a short, blunt point since it permits nest placement at a greater distance from shore.

Number of islands - The present density of nesting geese on the area does not indicate an urgent need for multiple islands on most reservoirs. To accommodate the territoriality exhibited by low densities of nesting geese (Sherwood 1968), larger reservoirs on which islands may be placed at distances greater than 200 feet apart should be given first consideration. This recommendation is based primarily on economics and does not imply the exclusion of developing a number of low-cost islands on a reservoir (e.g., cut-offs during dam construction). Other authors (Hammond and Mann 1956; Ewaschuk and Boag 1972) have shown that Canada geese exhibit greater tolerance to higher nesting densities indicating that future use may be made of such island clusters.

Other land uses - The activities of fishermen and successful goose production are apparently incompatible. Therefore, advanced planning is necessary to determine the most appropriate multiple use