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CONTROLLED POOL ELEVATION AND ITS EFFECTS ON CANADA GOOSE PRODUCTIVITY AND NEST LOCATION[1]

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Abstract. A 5-year study was conducted that assessed Canada Goose (*Branta canadensis moffitti*) productivity and nest location in relationship to a controlled pool elevation. Data on clutch size were obtained for 108 nests of the 128 nests located, and no significant variation among years was detected. Nest success for the study period ranged from 66 to 86% while the number of nests varied from 22 to 29. No flooding of nests occurred because of the higher water levels, and nest productivity did not change significantly. Aspect of visibility was also found to be important with 77% of the geese having a view of the water.

Key words: *Canada Goose; controlled; nesting; pool; productivity.*

INTRODUCTION

Thompson Falls Dam, a run-of-river hydroelectric facility located in Sanders County, Montana, was built in 1913 and became operational in 1916. In 1979 the Montana Power Company (MPC) identified this site for expanded generation to increase the capacity from 40 to 90 MW. To do this, the installation of radial gates was needed to allow better regulation of the reservoir's pool level, i.e., to keep the reservoir's pool elevation near or at the high water mark.

Historically, the reservoir inundated about 200 ha and the pool level was controlled by removing the flash boards in March or April that would result in a 4.3-m drawdown. The radial gates were installed in 1982 and became operational in 1983. Consequently in 1982, MPC initiated a 5-year study to assess Canada Geese (*Branta canadensis moffitti*) productivity and nest-site selection within or near the reservoir and below the dam.

The purpose of this study was to document any adverse or beneficial effects that may occur from the change in operation of the hydroelectric facility. Hence, this paper reports the findings from the past 5 years of research on Canada Goose breeding success at Thompson Falls, Montana.

STUDY AREA

Thompson Falls reservoir is an impoundment of the Clark Fork River, approximately 160 km northwest of Missoula, Montana (47°35′ latitude by 115°20′ longitude). Annual reservoir discharge is approximately 566 m^3/sec with the high water mark at 730.6 m. The study area includes about 16 km of the Clark Fork River from 4.0 km below the powerhouse to just above the Thompson River. Three major islands occur within the study area; one is below the dam, Virginia, and two are within the reservoir, Steamboat and Equisetum.

METHODS

ASSESSMENT OF BREEDING BIOLOGY AND PRODUCTIVITY

In 1982 and 1983, searches were made of the shoreline and the islands within the study area to collect nesting data. During these 2 years, nests were found only on islands, consequently, only islands were searched from 1984 through 1986. The nest searches were conducted from late March through late May.

One or more eggs in each nest were examined to determine the stage of embryonic development during initial surveys, using a variation of the flotation technique described by Westerskov (1950). Nest initiation was determined by backdating the estimated hatching date of eggs by 5 weeks, assuming 1 week for laying the clutch and 4 weeks for incubation. These estimations were based on the egg-laying rate of 1.5 days per egg (Krohn and Bizeau 1980) and an incubation period of 25 to 28 days (Bellrose 1980).

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TABLE 1. Clutch size of Canada Geese nests, 1982 to 1986.

Year	No. of nests	$\bar{x}$	SD
1982	15	4.9	± 1.2
1983	24	5.4	± 1.5
1984	26	5.0	± 1.2
1985	23	5.4	± 1.8
1986	20	5.9	± 1.7
Total	108		

TABLE 2. Egg and nest success of Canada Geese, 1982 to 1986.

Year	No. of eggs	Percent successful	No. of nests	Percent successful
1982	73[1]	72.6	28	78.6
1983	129	82.9	24	79.2
1984	131	66.4	29	65.6
1985	124	74.2	25	72.0
1986	117	91.5	22	86.4
Mean	125[2]	77.5	26	76.4

[1] Figures based on 15 nests.
[2] Does not include 1982 data.

Nesting success was described as successful, unsuccessful, or fate unknown. Nests containing shells and membranes from hatched eggs were classified as successful. If membranes were absent, but desertion or destruction were not evident, the nest was classified as fate unknown. However, if evidence of desertion or destruction existed, then the nest was classified as unsuccessful. In determining nest success only one egg membrane within the nest had to be found, whereby I assumed that the entire clutch hatched. Finally, desertion and destruction of individual eggs were accounted for in determining egg-hatching success.

NEST LOCATION

Vegetative cover, aspect of visibility, nesting material, height of nest above water, and distance to water were measured to describe nest location. In late June 1982, vegetation plots were analyzed to characterize flora of the three major islands within the study area. This was done by sampling 0.25-ha circular plots. The plots were sampled to evaluate the ground cover provided by understory plants; the percent shrub cover and average height; and, if the island contained trees, their diameter at breast height (dbh). Two plots were sampled on Virginia, seven on Steamboat, and four on Equisetum Islands. The sample plots were placed systematically to represent the diverse vegetation. In addition, prominent vegetation species within 0.9 m of each nest site were recorded each year along with materials used in nest construction.

Aspect of visibility was measured each year at individual nest sites using a hand-held compass. Finally, the height of the nest above the high water mark and distance of the nest to water were measured using a rope and tape. These measurements were taken when Thompson Falls Reservoir was at full pool.

Analysis of variance, χ^2 and Mann-Whitney U statistics were conducted on egg and nest data to test for significant variations among years.

RESULTS

NEST INITIATION, CLUTCH SIZE AND NEST SUCCESS

Initial egg laying during the 5-year study ranged from 8 March to 22 March with the latest hatching date occurring on 24 May. Data on clutch size were obtained for 108 nests of the 128 nests located, and Table 1 depicts the average clutch size per year. Statistical analysis showed clutch size distribution did not vary among years when compared to the average for all years ($\chi^2 \leq 10.3$, $P \geq 0.25$; $F = 2.3$, $P = 0.14$), however, clutch size appears to be increasing. In addition, Table 2 lists egg and nest success, and neither varied significantly during the 5-year period ($\chi^2 = 5.9$, $P = 0.23$; $\chi^2 = 0.8$, $P = 0.93$, respectively).

NEST-LOCATION VARIABLES

Of the 128 nests located, 107 were on the three major islands, 14 on rock outcrops, four on artificial structures, and three on an island created by backwater from the radial gates. A wide variation was found in aspects of visibility (Table 3), but most nests had an aspect of visibility facing water. However, it was not significant ($P = 0.12$).

Nest materials overwhelmingly consisted of only duff and litter. However, some variation in additional nesting materials occurred between islands: mock orange (*Philadelphus lewisii*) and serviceberry (*Amelanchier alnifolia*) (Virginia Island); bark, cones, twigs, and needles (Steamboat Island); and horsetail (*Equisetum* spp.) and grass (Equisetum Island).

Thirteen vegetation plots were analyzed on the three major nesting islands in 1982. The most

TABLE 3. Predominant aspect of visibility from nest sites surveyed.

Island	No. of nests	Primary direction of view N	NW	W	SW	S	SE	E	NE	View in all directions
Virginia	13	1	2	0	3	2	2	2	0	1
Steamboat	64	1	3	4	8	7	9	13	5	14
Equisetum	25	3	2	4	0	2	2	0	0	11
Total	102	5	7	8	11	9	13	15	5	27
% of total		5	7	8	11	9	13	15	5	26

Reevaluated: Primary direction looking at the water, land, or all directions

Island	Total no. of nests	Looking towards water	Looking towards land	View in all directions
Virginia	13	11	1	1
Steamboat	64	29	21	14
Equisetum	25	12	1	12
Total	102	52	23	27
% of total		51	23	26

heavily timbered was Steamboat Island with ponderosa pine (*Pinus ponderosa*) ranging from 7.5 to 57.5 cm dbh, Douglas-fir (*Pseudotsuga menziesii*) 12.5 to 50 cm dbh, and juniper (*Juniperus communis*) less than 12.5 cm dbh. Virginia Island supported one tree, a ponderosa pine, with a 15 cm dbh. There were no trees on Equisetum Island.

Nest-site location on the three islands shows geese avoiding the downstream end of Virginia and Steamboat islands which have the lowest elevations. In contrast, Equisetum Island is mostly flat but has a slightly higher elevation on the downstream side of the island, yet there is no avoidance of this area by nesting geese. This disparity is easily explained because I observed geese selecting nest sites on the highest end of each island. For instance: 77% of the nests occurred above 9.0 m on Virginia Island, 71% were above 6.0 m on Steamboat Island, and 69% were at or above 1.0 m on Equisetum Island. In addition, four nests in 1983, three in 1984, three in 1985, and four in 1986 were located on small rock outcrop islands. Also, each nest was on the highest and most sheltered spot available.

Nest density and the average distance of nests to water and the average height of nests above water for the three major islands are presented in Table 4. Reservoir pool elevations from 1 March through 31 May are evaluated in Table 5.

DISCUSSION

BREEDING BIOLOGY AND PRODUCTIVITY

The nesting period is defined as the interval between laying the first egg and hatching the last egg of all nests examined. The dates of nest initiation are comparable to other Montana findings (Geis 1956, Childress 1971, Hook 1973). However, the 8 March 1983 date is 1 week to 3 days earlier than other studies reported in the Flathead Valley (Geis 1956, Mackey et al. 1985). The latest completion date for nesting during the 5-year period is normal for the area.

In 1982 and 1984, the average clutch size is lower than other areas in the Rocky Mountains: Ennis, Montana, 5.6 per nest (Childress 1971); Flathead Lake, Montana, 5.3 per nest (Geis 1956); and the average for *B. c. moffitti* population in the Rocky Mountain region, 5.5 per nest (Krohn

TABLE 4. Nest density and mean height (m) above water and distance to water (m) of Canada Geese nests on the three major islands.

Island	Island area (ha)	Total no. of nests	Mean nest per hectare	$\bar{x} \pm$ SD Height above water	Distance to water
Virginia	0.6	13	4.3	12.8 ± 5.3	9.6 ± 7.8
Steamboat	1.4	65	9.7	8.6 ± 5.0	10.1 ± 8.0
Equisetum	1.3	29	4.5	1.1 ± 0.5	6.3 ± 3.3

TABLE 5. Thompson Falls reservoir's pool elevation (m) from 1 March through 31 May, 1982 to 1986.

	Year				
Reservoir pool elevation	1982	1983	1984	1985	1986
Mean	728.31	730.29	730.49	730.25	730.62
Maximum	730.46	730.67	730.64	730.67	730.67
Minimum	726.37	729.18	729.85	728.81	730.34
SD ±	1.68	0.30	0.16	0.40	0.05

and Bizeau 1980). In contrast, the 1983, 1985, and 1986 clutch sizes are similar or slightly higher than the above findings.

The nest success at Thompson Falls is similar to or somewhat higher than the 73% reported by Krohn and Bizeau (1980). However, the 65.5% nest success reported in 1984 is low because of human destruction of several nests. The egg success for 1983 and 1986, 82.9% and 91.5% respectively, are close to the 88.7% reported by Hanson and Eberhardt (1971). However, the 72.6% (1982), 66.4% (1984), and 74.2% (1985) egg successes are low for the region.

Nest densities on the three major islands showed a lack of nest desertions which indicated nesting geese are not crowded. Nonetheless, nesting density of the Thompson Falls geese may be considered low when compared to other densities on relatively small areas. Geis (1956) reported nest densities as high as 14.8 nests per hectare on an area on Flathead Valley, Montana. Vermeer (1970) reported densities of 19.8 nests per hectare in Alberta. However, Johnson (1947) suggested a desirable nest density for Canada Geese should not exceed 4.9 nests per hectare at Seney National Wildlife Refuge, thus the 4.3 to 9.7 per hectare density may be optimal for geese in this area of Montana. Finally, there were significantly more nests found on Steamboat Island than on the other two islands ($P < 0.01$).

NEST LOCATION

Islands were the only nest sites used by geese at Thompson Falls from 1982 to 1986. Klopman (1958) suggested that islands provide a stronger stimulus to nest than other locations regardless of visibility characteristics. Also, nests on islands are usually less subject to predation and human disturbance than are nests on the shoreline.

An island created by backwater from the radial gates holding the pond elevation constantly near high pool was used by geese in 1984, 1985, and 1986. In these 3 years, two nests were successful and one nest was destroyed. Additionally, rock outcrops within the reservoir were not used for nesting in 1982, but once the water level was controlled at a higher level, geese nested consistently on them. Over the 5 years, I observed the number of nests on Virginia and Steamboat Islands decline slightly while Equisetum nest density remained about the same. It appears that this nest decline is not actually a loss, but rather a redistribution of nests to newly created habitat (e.g., rock outcrops). Nonetheless, no nests were flooded by the raised water levels, and the number of nests for the 5 years did not significantly change ($P = 0.48$).

The geese at Thompson Falls selected nest material from the vegetation immediately surrounding the nest. I did not observe any relationship between nest-site locality and available vegetation. Sherwood (1968) reported geese in his study area selected islands for nest sites regardless of available nest-building material. Hammond and Mann (1956) found geese nesting on bare islands and on islands with dense vegetation as long as there was a bare spot available for nest construction. Observations at Thompson Falls support Hammond and Mann's findings. However, the highest concentration of nests in this study was found on Steamboat Island where there was a high percentage of shrub cover. I speculate that shrub cover in certain areas may provide visual obstructions between nests, allowing greater nest density. This theory has also been suggested by Giroux (1981).

Many investigators researching Canada Geese have stressed the importance of visibility from the nest site. Dimmick (1968) found that nesting geese at Jackson Hole, Wyoming, showed a definite tendency to select nest locations that provided good or excellent visibility. Craighead and Craighead (1949) reported that goose nests on the Snake River in Idaho provided sufficient visibility that researchers could not approach the nests undetected.

Observations and measurements at the nest sites showed that visibility from the nest was important and the geese had at least one direction of view. The data showed that 77% of the geese had a view of water. Also, the majority of the geese seen nesting were noted to have rock outcroppings, trees, or tall shrubs at their backs.

In conclusion, studying the effects of a controlled pool elevation has shown that Canada Geese productivity, the number of eggs and nests produced, remained consistent for the 5 years. Clutch size did not change significantly between years, however, it does appear to be increasing. Canada Geese at Thompson Falls nested only on islands with the majority of nests having an aspect of visibility facing water. Finally, islands created by higher water levels were used by nesting geese within 1 year of controlling the pool elevation.

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