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# CANADA GOOSE BROOD BEHAVIOR AND SURVIVAL ESTIMATES AT CREX MEADOWS, WISCONSIN

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Many studies have reported on the biology of Canada Goose (*Branta canadensis*) broods in a variety of geographical locations and habitat types. Different methods based on observations of both marked and unmarked broods, however, have yielded a wide range of results concerning brood loss, brood mixing and gosling survival. This paper reports on a study of Canada Goose broods in a managed, reestablished flock. The objectives were to describe certain aspects of the behavior and survival in individually identified broods, to examine some potential biases inherent in goose brood studies and to compare the results with data collected in other studies.

## STUDY AREA AND METHODS

The study was done at the 12,185-ha Crex Meadows Wildlife Management Area in northwestern Wisconsin near Grantsburg, Burnett Co. The Wisconsin Department of Natural Resources began management of marsh-prairie habitats on Crex Meadows in 1947 and an effort to reestablish nesting Giant Canada Geese (*B. c. maxima*) began in 1952 (Hunt and Jahn 1966). Production of goslings increased from virtually nothing in 1957 to approximately 480 in 1973 (Zicus 1974:83). These Canada Geese are migratory and usually arrive in early March and begin nesting in mid-March or early April. Nesting now occurs throughout the study area, but most brood rearing takes place in 5 marshes. Accordingly, other marshes are used very little by Canada Geese during the summer.

Wetlands vary in size from less than a hectare to several hundred hectares in size. Many wetlands are shallow sedge (mostly *Carex stricta*) and grass (mostly *Calamagrostis canadensis*) meadows. There are also numerous impounded marshes with varying amounts of open water, emergent vegetation and floating mats of sedge (*Carex* spp.) and cattail (*Typha angustifolia*). Uplands are forests of jack pine (*Pinus banksiana*) and northern pin oak (*Quercus ellipsoidalis*) and brush-prairie savanna (Vogl 1964). The area has had a long fire history, and habitats are managed intensively through controlled burning of wetlands and uplands and the manipulating of water levels in many once drained marshes. Approximately 121 ha of cropland are also planted annually in the center of the management area to provide supplemental food for wildlife.

Sixty-three marked families from known nest locations and 74 marked pairs with goslings from undiscovered nests were observed. Several marking techniques were used, but most of the data involved 131 families in which one or both of the adults had vinylite neckbands (Sherwood 1966a). Limited data were also obtained from 6 clutches of eggs injected with vegetable dyes (Evans 1951). Geese were captured by cannon netting in autumn (Dill and Thornsberry 1950), summer drive trapping (Cooch 1955) and mist netting nesting females (Zicus 1975). Nests were located in 1972–1974 by intensively searching the study area on foot and from a canoe. Clutch-size, fate of the clutch, egg fertility and number of goslings hatched were determined for each nest.

Observations were made daily from dike roads and accessible points in the marshes. Time of day, number of broods seen together, number of goslings in each family, gosling age, as

well as location and activity were recorded for all marked families observed. The ages of goslings hatched from undiscovered nests were estimated by comparing gosling size, plumage and behavior with goslings in known-age broods. Goslings, usually brooded on the nest until the morning after hatching (Cooper 1978:53), were considered 1 day old at departure. All references to broods are to individually identified broods unless otherwise stated.

Gosling survival was estimated at 7-day intervals each year by counting goslings with neckbanded adults. Survival during the first 7 days after hatching was determined using the last complete gosling count during the first week after hatching for marked families whose numbers at hatching were known. Estimates for each week of age up to 8 weeks were made using the last gosling counts from families observed in consecutive weeks. Weekly survival estimates determined in this way should not have been biased by gosling adoption if the marked pairs under observation adopted goslings and lost goslings to adoption at the same rate as those pairs not being observed during the 7-day interval.

The survival of goslings through 8 weeks of age was estimated by 2 methods. The first method combined weekly survival estimates, while the second involved a modeling process using a number of reproductive parameters estimated during the study. These estimates included the proportion of the pairs raising broods through 8 weeks (successful pairs) and the proportion of the pairs hatching goslings but not raising a brood (unsuccessful pairs), and the average brood size at hatching for both successful and unsuccessful pairs. This allowed the number of goslings hatched by any given number of pairs to be determined. Next the number of goslings hatched by both successful and unsuccessful pairs was multiplied by the apparent gosling survival for each type of pair. The apparent survival of goslings in broods of unsuccessful pairs was zero, while the apparent survival in broods with successful pairs was determined by comparing the numbers of 8-week-old goslings with different marked pairs to the number of goslings hatched by these pairs. In this way, the total number of goslings alive after 8 weeks could be compared with the total number hatched by any given number of pairs.

## RESULTS

Canada Geese were never observed rearing broods singly on marshes that were not being used by other families. Many Canada Goose pairs left their nesting marshes soon after hatching a brood (Table 1). Between 60 and 67% of all marked families moved, although, in many cases, the nesting marshes appeared to be similar to those used for brood rearing. Furthermore, 25–53% of the pairs observed nesting successfully on a major brood rearing marsh also moved their young to a different brood rearing marsh.

The time between departure from the nest and the first observation of a brood on the marshes used for brood rearing was short and suggested immediate and direct movement to the brood rearing marshes (Table 2). One family was observed 4.8 km from the nest within 24 h of leaving the nest; in 2 consecutive years, another pair moved their broods 8.4 km in a maximum of 2 days. Almost 53% of the families originating from nests in major brood rearing marshes were observed on a different marsh within 4 days after departure from the nest. Similarly, 40% of the broods leaving nests in marshes that were not used for brood rearing were observed on another marsh within 4 days.

TABLE 1
EARLY MOVEMENT OF MARKED CANADA GOOSE FAMILIES, 1972–1974

| Marked families | 1972 | 1973 | 1974 | All years |
|---|---|---|---|---|
| All successful nests | 9 | 20 | 22 | 51 |
| Broods leaving marsh | 6 | 12 | 14 | 32 |
| Percent | 67 | 60 | 64 | 63 |
| Successful nests in major brood rearing marshes | 4 | 15 | 17 | 36 |
| Broods leaving marsh | 1 | 7 | 9 | 17 |
| Percent | 25 | 47 | 53 | 47 |

Distances between the nest locations and the centers of the marshes that were first used for brood rearing ranged from 0.7–8.4 km (Table 3). The major brood rearing marshes were centrally located and Canada Goose families leaving nests in these marshes did not have to move as far to reach other major brood rearing marshes as families from nests in peripheral marshes. Nonetheless, 41% of the families from nests in major brood marshes moved more than 3.0 km to reach their initial brood marshes. The longest distances moved were those from nesting marshes that were not used for brood rearing with 27% of these families moving more than 7.5 km.

Canada Geese usually remained on their first brood rearing marsh for the entire brood rearing period. For the 3 years, an average of 86% (N = 70) of the marked pairs were observed each year on only 1 brood rearing marsh. In contrast, 10 pairs (14%) were seen during the early portion of the brood rearing period on 1 marsh and later on a second marsh. The

TABLE 2
NUMBER OF DAYS BETWEEN NEST DEPARTURE AND FIRST OBSERVATION OF CANADA GOOSE BROODS ON MARSHES OTHER THAN THE NESTING MARSHES, ALL YEARS COMBINED

| Days since leaving nest | Hatched in major brood rearing marshes | | Not hatched in major brood rearing marshes | | All broods | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 1–4 | 9 | 53 | 6 | 40 | 15 | 47 |
| 5–8 | 1 | 6 | 4 | 27 | 5 | 16 |
| 9–12 | 2 | 12 | 1 | 7 | 3 | 9 |
| 13–16 | 1 | 6 | 1 | 7 | 2 | 6 |
| 17–20 | 1 | 6 | 0 | 0 | 1 | 3 |
| 21+ | 3 | 18 | 3 | 20 | 6 | 19 |

TABLE 3

DISTANCES BETWEEN NEST LOCATIONS AND CENTER OF INITIAL BROOD REARING MARSHES USED BY CANADA GOOSE BROODS LEAVING NESTING MARSHES, ALL YEARS COMBINED

| Distance (km) | Hatched in major brood rearing marshes | | Not hatched in major brood rearing marshes | | All broods | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 0.0–1.5 | 4 | 24 | 2 | 13 | 6 | 19 |
| 1.6–3.0 | 6 | 35 | 8 | 53 | 14 | 44 |
| 3.1–4.5 | 5 | 29 | 1 | 7 | 6 | 19 |
| 4.6–6.0 | 2 | 12 | 0 | 0 | 2 | 6 |
| 6.1–7.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.6–9.0 | 0 | 0 | 4 | 27 | 4 | 12 |

movement to a second marsh usually occurred within a few days of the time the adults molted their flight feathers. Movement distances between the center of the initial and second brood rearing marsh ranged from 1.4–4.8 km and averaged 2.3 km.

The brood rearing period was divided into pre-molt and post-molt segments to examine yearly fidelity to specific brood rearing marshes. Individual pairs were faithful to specific marshes from year to year. Before molting, 11 pairs successfully raising broods in 2 consecutive years and 2 pairs raising broods in 3 consecutive years used the same marshes each year. Likewise, after molting and before gaining flight, 13 pairs raising broods in 2 consecutive years and 2 pairs raising broods in 3 consecutive years used the same marshes. In addition, 2 pairs moving to a second marsh for the post-molt segment during the same season made a similar move when rearing young in a second year. Another pair used the same marsh through the brood period in 1972 and 1973, but used a different marsh through the brood period in 1974.

Of 3 marked females with previous brood rearing experience that paired with different ganders and 5 marked males with previous experience rearing broods and paired with different females, all 3 females used the same marshes they last used, while 2 of the 5 ganders reared broods on marshes other than the one they last used. In 1 case, both members of the new pair had previously raised broods on different marshes. The goslings hatched by this pair were raised on the marsh last used by the female and not the male.

As broods began to concentrate in the brood rearing areas, both marked and unmarked broods fed together along dikes and on floating mats of vegetation. At times, goslings became separated from their parents and

TABLE 4
MINIMUM ESTIMATES OF GOSLING ADOPTION FOR CANADA GOOSE PAIRS BY WEEKLY BROOD-AGE INTERVALS, ALL YEARS COMBINED

| Brood-age interval | Pairs observed | Pairs showing increased brood size | |
|---|---|---|---|
| | | N | % |
| Hatch–week 1 | 46 | 11 | 24 |
| Week 1–week 2 | 42 | 11 | 26 |
| Week 2–week 3 | 47 | 7 | 15 |
| Week 3–week 4 | 49 | 8 | 16 |
| Week 4–week 5 | 40 | 4 | 10 |
| Week 5–week 6 | 27 | 2 | 7 |
| Week 6–week 7 | 26 | 2 | 8 |
| Week 7–week 8 | 23 | 1 | 4 |

broodmates, and many were adopted into other families; of 87 pairs observed during the 3 years, a minimum of 40 (46%) adopted goslings at some time. All pairs adopting goslings could not be determined, because all broods were not observed frequently enough to detect gosling adoption that compensated for goslings lost to other pairs or through mortality. However, based on observations of only those broods increasing in size, a minimum of 36–50% of the marked pairs adopted young into their broods between hatch and 8 weeks of age. Adopted goslings were usually about the same age as their new broodmates.

Adoption was most common during the first 2 weeks after hatching (Table 4). The number of goslings associated with some pairs would change daily as the broods fed on mats of vegetation or moved from favored feeding sites along the dikes. Sometimes, goslings joining another brood would rejoin their own family within several minutes. Other instances of adoption appeared to be more permanent, and limited gosling adoption continued through 8 weeks of age.

An average of 24.2% of the successful nesting pairs did not raise broods to flight (range 17.9–33.3%). Pairs raising broods and those that did not had different reproductive characteristics (Table 5). Egg fertility, egg success and the average brood size at hatching were significantly lower for pairs that did not raise a brood ($\chi^2 = 8.21$, df = 1, $P < 0.01$; $\chi^2 = 6.74$, df = 1, $P < 0.01$; and $t = 2.24$, df = 60, $P < 0.05$). Pairs that did not raise young also tended to have lower average clutch-sizes ($t = 1.19$, df = 60, $P = 0.24$ [NS]), but not different hatching success ($\chi^2 = 0.02$, df = 1, NS). In addition, a greater proportion of the pairs that failed to raise young also tended to have at least one 2-year-old pair member than did those pairs that successfully raised young.

TABLE 5

BROOD REARING SUCCESS AND REPRODUCTIVE CHARACTERISTICS OF SUCCESSFUL NESTING CANADA GEESE, 1972–1974

| Characteristic | Raised brood (N = 47) | Did not raise brood (N = 15) |
|---|---|---|
| Average clutch | 5.8 | 5.3 |
| Fertility (%) | 92.7 | 81.1 |
| Hatching success (%)[a] | 97.4 | 95.0 |
| Egg success (%)[b] | 86.2 | 73.6 |
| Average brood size at hatching[c] | 5.0 | 3.9 |

[a] Equals percent of fertile eggs that hatch (Cooper 1978:61).
[b] Equals percent of all eggs that hatch (Cooper 1978:61).
[c] Equals average clutch times egg success.

Most gosling mortality occurred during the first 12 days after hatch (Table 6). In 1 interval, a survival estimate greater than 100% was obtained when the observed pairs adopted more goslings than they lost to adoption in the interval. Based on the combination of weekly estimates, gosling survival through 8 weeks averaged 61.2% (range 47.7–71.5%) during the study. By comparison, the apparent survival to 8 weeks in broods with successful pairs averaged 80.5% (range 76.7–82.9%), but estimated gosling survival was lowered to an average of 62.5% (range 60.7–70.5%) when the reproductive performance of the flock was modeled to include goslings produced by pairs unsuccessful in rearing a brood. Both estimates based on a combination of weekly survival rates and those based on modeling reproductive performances gave similar results in each year.

TABLE 6

CANADA GOOSE GOSLING SURVIVAL ESTIMATES BY WEEKLY AGE INTERVALS, 1972–1974

| Brood-age | Average age (days) | No. of broods | Survival (%) |
|---|---|---|---|
| Hatch–week 1 | 5 | 30 | 86.5 |
| Week 1–week 2 | 12 | 32 | 76.9 |
| Week 2–week 3 | 20 | 28 | 98.5 |
| Week 3–week 4 | 26 | 33 | 100.0 |
| Week 4–week 5 | 33 | 31 | 100.8 |
| Week 5–week 6 | 40 | 21 | 96.7 |
| Week 6–week 7 | 46 | 15 | 97.3 |
| Week 7–week 8 | 56+ | 15 | 98.5 |

## DISCUSSION

The movement of Canada Goose broods from nest locations to brood rearing areas immediately after hatching at Crex Meadows was similar to that reported for Canada Geese in other areas. Canada Goose brood movements to selected rearing marshes depend, in part, on the distribution of rearing habitat in relation to nesting areas. Geis (1956:416) reported that geese nesting on islands where no food was available in Flathead Lake, Montana, moved broods to rearing areas 6–10 miles (10–16 km) away immediately after hatching; those geese nesting along the Flathead River moved broods downstream from the nest-sites to brood rearing areas. MacInnes and Lieff (1968:99–101) observed that broods near the McConnell River in the Northwest Territories moved 10–15 km from nest locations to feeding areas. In contrast, Dimmick (1968:53) reported goose broods at Jackson Hole, Wyoming, left the immediate vicinity of the nest, but remained in the nesting area for several weeks. Most individual pairs and females at Crex Meadows made the same movements to a brood rearing area each year, and once there, they rarely changed location until the young were grown and the adults had regained flight. Similarly, Geis (1956:416) reported that broods rarely moved to other rearing grounds once they were established on a rearing area, and Martin (1964:23) observed many pairs at Ogden Bay, Utah, using the same rearing areas in consecutive years.

The patterns of rearing marsh selection observed at Crex Meadows have probably developed with the growth of the flock and reflect the distribution of marshes with food and molting security and the preference of individual nesting females. Cooper (1978:23) reported individual female Canada Geese nesting in approximately the same locations each year, and Martin (1964:16) and Brakhage (1965:768) observed older geese establishing nests first. These factors may force novice nesters to establish territories in the available unoccupied habitat which may or may not be near the brood rearing marshes. Sherwood (1966b:70) reported novice nesting 2-year olds nested and/or raised their broods in the same general area that they had been hatched or reared in, but did not discuss any specific influence on site selection by the male or the female of the pair. Martin (1964:23), however, was unable to observe any definite pattern in rearing area selection by adults with their young in Utah. The movements of broods to rearing areas and from rearing marshes used for nesting to different ones that were observed at Crex Meadows could persist if geese established nests wherever possible in the marshes, but females preferred the marshes for brood rearing that they had previsouly used. I speculate that females may initially use the marshes that they themselves were raised in, thus explaining how these movement patterns might evolve. Numerous authors

have concluded that the female Canada Goose rather than the male chooses the nest-site (Collias and Jahn 1959:485, Brakhage 1965:757, and others), and that rearing marsh selection may be similar and may depend on the initial and subsequent experiences of the female.

Crex Meadows goslings were commonly adopted from one brood to another. Gosling adoption was most prevalent during the first 2 weeks of age, but occurred until at least 8 weeks of age. In contrast, Martin (1964:25) observed no change in brood size after 3 weeks of age, and Sherwood (1966b:124–127) found that brood size changes were most prevalent during the first 2 or 3 weeks, but that they still occurred into the fourth week after hatch. Sherwood (1966b:129) also reported that goslings could not recognize their broodmates or parents until 5 or 6 weeks of age. Unlike observations in Missouri (Brakhage 1965:767), abnormally large broods or broods escorted by more than 1 pair formed infrequently and were never observed with marked pairs at Crex Meadows.

The loss of entire broods at Crex Meadows was similar to that reported at the Seney National Wildlife Refuge (NWR), but different from that reported near the McConnell River. At least 6 of 20 marked pairs observed at the Seney NWR in 1965 lost their entire broods (Sherwood 1966b:132); brood loss may have been even greater if some pairs lost their broods before Sherwood first observed them. However, only 3 of 96 marked pairs lost entire broods near the McConnell River (MacInnes et al. 1974:696). Pairs losing broods at Crex Meadows had smaller clutches with lower fertility and hatched fewer young; these characteristics have been associated with younger birds (Brakhage 1965:760, Cooper 1978:53, 74). Sherwood (1966b:130–131) also observed 4 of 6 marked pairs with 2-year-old females lose their broods. While not defining the phrase, he concluded that the ability to hold a brood was related primarily to the "age of the pair." Since he presented only data on the ages of the females in the marked pairs, I believe he was referring primarily to female age when discussing "age of the pair." Other aspects of pair age, such as the age of the gander or the length of time individual geese had been mated, could also be important if older geese and those mated for the longest time developed the strongest brood rearing abilities. Sherwood (1966b) further concluded that the ability to hold a brood was secondarily related to the size of the brood at hatching. The actual size of the brood might be important if goslings, unable to recognize their parents or broodmates, were attracted to larger broods as Sherwood speculated. Broods were concentrated at both Crex Meadows and the Seney NWR, where brood loss was higher, whereas they were more dispersed at the McConnell River where loss was lower. The greater loss of broods at Crex Meadows and the Seney NWR probably resulted from prolonged contacts between different pairs

with those pairs made up of the youngest geese, or perhaps those paired for the shortest time the most likely to lose golsings.

Studies relying solely on marked geese to estimate gosling survival are few in number and make comparisons with Crex Meadows difficult. MacInnes et al. (1974:697–699) reported that the survival of goslings with neckbanded adults, from 6 days before hatching to approximately 7 days of age, ranged from 64.7–87.3% near the McConnell River. Survival from 7–35 days of age was 91.9–99.3%. When the McConnell River estimates are combined with the approximate 3% loss of entire broods MacInnes et al. (1974:697) reported, survival to 35 days old ranged from 60.0–83.7% with a 5-year mean of 72.6%. In comparison, survival to 33 days old at Crex Meadows ranged from 57.2–81.0% with a 3-year mean of 64.7%.

Gosling survival has been determined in other studies by comparing total goslings hatched with the goslings alive at some time later or by observing changes in average brood size over a period of time. Estimates using total gosling counts are as reliable as the investigator is accurate in determining the number of goslings hatched that use a specific rearing area and in subsequently counting all survivors from this group of goslings. In many situations, accurate counts of all goslings hatched in an area are almost impossible. Estimates obtained using total gosling counts have ranged from 80–84% in Montana (Geis 1956:417), 64–80% in Missouri (Brakhage 1965:768) and 16–78% in Michigan (Sherwood 1966b:47). In comparison, survival estimates based on average brood size comparisons are biased if any pairs lose their entire brood. Estimates using this method have sometimes revealed average brood sizes greater than the average hatch per successful nest (Williams and Marshall 1938:17–18, Steel et al. 1957:4, Martin 1964:50). These authors estimated gosling survival until late in the brood period at 93–97%.

The behavior of Canada Goose broods at Crex Meadows created a serious potential bias for estimating gosling survival and flock production. More than half of the marked pairs observed with broods were from nests that were not found. This resulted from my inability to find all the nests on Crex Meadows and the tendency for geese to move broods considerable distances to brood rearing marshes. As a result, gosling survival could not be assessed by comparing total goslings hatched with total goslings alive at some time later. Likewise some successful nesting pairs lost all of their goslings to mortality and/or to adoption into other broods. If gosling survival was calculated by a comparison of average brood size at hatching to the average brood size at fledging, production would have been overestimated by an average of 27%. These potential biases seem likely to exist to varying degrees in any goose brood study. The degree to which esti-

mates will be biased depends on the behavior of pairs and their young. Consequently, gosling survival and production estimates without the benefit of marked geese should be viewed cautiously.

## SUMMARY

A study of marked Canada Geese examined the use of brood rearing areas and brood and gosling survival between 1972 and 1974 in managed marshes in northwestern Wisconsin. Between 60 and 67% of the pairs hatching goslings moved them to 1 of 5 major rearing marshes where there were other broods. However, 25–53% of the pairs nesting on a major brood rearing marsh also moved to a different brood rearing marsh to raise their young. Movements of all pairs with broods ranged from 0.7–8.4 km, and were made immediately after hatch with 47% of the families reaching their first rearing marsh in less than 4 days. Once on a rearing marsh, families rarely moved to another. Almost all pairs raised young on the same marshes in subsequent years. Observations of males and females with previous brood rearing experience that had formed new pairs between years suggested females may influence the selection of a brood marsh. At least 36–50% of the pairs adopted goslings into their broods at sometime between hatch and 8 weeks. Adoption was most prevalent before goslings were 2 weeks old. From 18–33% of all pairs failed to raise their young to flight. These pairs also had lower egg fertility and brood sizes at hatching than pairs raising young. Overall gosling survival determined by the observation of young in marked broods ranged from 60.7–70.5%. Serious biases due primarily to the behavior of the broods affected survival estimates determined in other ways with production being overestimated by an average of 27% if the loss of entire broods was not considered.

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## LITERATURE CITED

BRAKHAGE, G. K. 1965. Biology and behavior of tub-nesting Canada Geese. J. Wildl. Manage. 29:751–771.

COLLIAS, N. E. AND L. R. JAHN. 1959. Social behavior and breeding success in Canada Geese (*Branata canadensis*) confined under semi-natural conditions. Auk 76:478–509.

COOCH, G. 1955. Modifications in mass goose trapping technique. J. Wildl. Manage. 19:315–316.

COOPER, J. A. 1978. The history and breeding biology of Canada Geese of Marshey Point, Manitoba. Wildl. Monogr. 61.

DILL, H. H. AND W. H. THORNSBERRY. 1950. A cannon projected net trap for capturing waterfowl. J. Wildl. Manage. 14:132–137.

DIMMICK, R. W. 1968. Canada Geese of Jackson Hole, their ecology and management. Wyoming Game Fish Comm. Bull. No. 11.

EVANS, C. D. 1951. A method of color marking young waterfowl. J. Wildl. Manage. 15:101–103.

GEIS, M. B. 1956. Productivity of Canada Geese in the Flathead Valley, Montana. J. Wildl. Manage. 20:409–420.

HUNT, R. A. AND L. R. JAHN. 1966. Canada Goose breeding populations in Wisconsin. Wisconsin Conserv. Dept. Tech. Bull. 38.

MACINNES, C. D. AND B. C. LIEFF. 1968. Individual behavior and composition of a local population of Canada Geese. Pp. 93–101 *in* Canada Goose management (R. L. Hine and C. Shoenfeld, eds.). Dembar Educational Res. Serv. Inc.

———, R. A. DAVIS, R. N. JONES, B. C. LIEFF AND A. J. PAKULAK. 1974. Reproductive efficiency of McConnell River small Canada Geese. J. Wildl. Manage. 38:686–707.

MARTIN, F. W. 1964. Behavior and survival of Canada Geese in Utah. Utah State Dept. Fish Game Infor. Bull. 64–67.

SHERWOOD, G. A. 1966a. Flexible plastic collars compared to nasal discs for marking geese. J. Wildl. Manage. 30:853–855.

———. 1966b. Canada Geese of the Seney National Wildlife Refuge. Ph.D. thesis, Utah State Univ., Logan, Utah.

STEEL, P. E., P. D. DALKE AND E. G. BIZEAU. 1957. Canada Goose production at Gray's Lake, Idaho, 1949–51. J. Wildl. Manage. 21:38–41.

VOGL, R. J. 1964. Vegetational history of Crex Meadows, a prairie savanna in northwestern Wisconsin. Am. Midl. Nat. 72:157–175.

WILLIAMS, C. S. AND W. H. MARSHALL. 1938. Survival of Canada Goose goslings, Bear River Refuge, Utah, 1937. J. Wildl. Manage. 2:17–19.

ZICUS, M. C. 1974. A study of the giant Canada Geese nesting at Crex Meadows, Wisconsin. M.S. thesis, Univ. Minnesota, St. Paul, Minnesota.

———. 1975. Capturing nesting Canada Geese with mist nets. Bird-Banding 46:168.

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