NESTING AND MOVEMENTS OF CANADA GEESE ON THE SNAKE RIVER IN WASHINGTON

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Too frequently the need for fundamental ecological research has been realized only after such information could no longer be obtained. This paper is the result of a study designed to evaluate the status and behavior of the western Canada Goose, *Branta canadensis moffitti*, in southeast Washington prior to the completion of a series of dams on the Snake River.

The earliest work done here was by Yocom (1951). Buss and Wing (1966) reported pre-impoundment observations of wintering Mallards and nesting Canada Geese for the 1954–1965 period. The present study was initiated in February 1966 and continued through May 1968. Specific objectives were to continue nesting data collection, to study the extent of undetected nesting, and to study the movements and behavior of juvenile, adult, and migrant geese.

DESCRIPTION OF THE AREA

The study area included five islands and a 28-mile stretch of the Snake River in Whitman and Garfield Counties, Washington. A sixth island, Davis Bar, was destroyed by construction of Lower Granite Dam (fig. 1). The river flows through a steep-sided basalt canyon approximately 1700–2000 ft below the surrounding Palouse plateau. Many side canyons, typified by low basalt cliffs, talus slides, and steep slopes, enter the main canyon. The river is fast-flowing, interrupted by occasional rapids, and about 200–800 ft wide. Summers are dry with 70 per cent of the annual 20 inches of precipitation falling between October and late March. Ambient temperatures in the canyon are typically several degrees warmer than on the surrounding plateau. Winter snows seldom accumulate on the river banks.

The islands vary in size from 9 to 26 acres and occur as deposits of rock and sand at bends or wide stretches of the river. Erosion and deposition are constantly altering the islands' peripheries. The higher downstream ends of the islands are rarely flooded and are covered with a sandy soil which tends to support a relatively large number of plants generally in advanced seral stages. The upstream ends are rocky. Daubenmire (1942) described the vegetation as the *Agropyron spicatum-Poa secunda* climatic climax association. Buss and Wing (1966) described the islands and vegetation of the area in detail.

METHODS

The area was divided into two overlapping study units (fig. 1). Unit A included 14 miles of river and five islands from Almota to Penawawa Goose Island. Nesting studies were conducted on these islands because they were known to be breeding sites. Unit B, which extended 16 miles downstream from Penawawa to Wild Goose Island, was studied because there were high concentrations of geese there during fall and winter.

Nest hunting began in the last week of February, and subsequent visits were made at 7-day intervals. Each island was searched methodically by four biologists walking abreast at close intervals. Numbers, location, and behavior of geese seen during each trip were recorded, together with the characteristics and history of each nest. A numbered stake was driven in the ground 10 ft from each nest to facilitate locating and studying its re-use. On Notebook Island, potential nest sites of wood shavings and straw were placed at 135 random locations in a 70 × 300-yard rectangular grid.

Geese were captured by drive-trapping and cannon-netting, and banded and marked with vinyl-nylon neckties as described by Craighead and Stockstad (1956). Others were marked with flexible plastic collars (Sherwood 1966a). Broods were color-marked with dyes injected into eggs, using a modification of Evans' (1951) technique. Units A and B were surveyed by boat to count and observe geese.

RESULTS AND DISCUSSION

Nesting season counts in Unit A. Counts of geese in Unit A were made in 1965 (Buss and Wing 1966), 1967, and 1968 from the last week in February through mid-May (table 1). The mean counts were 157, 97, and 83 in 1965,

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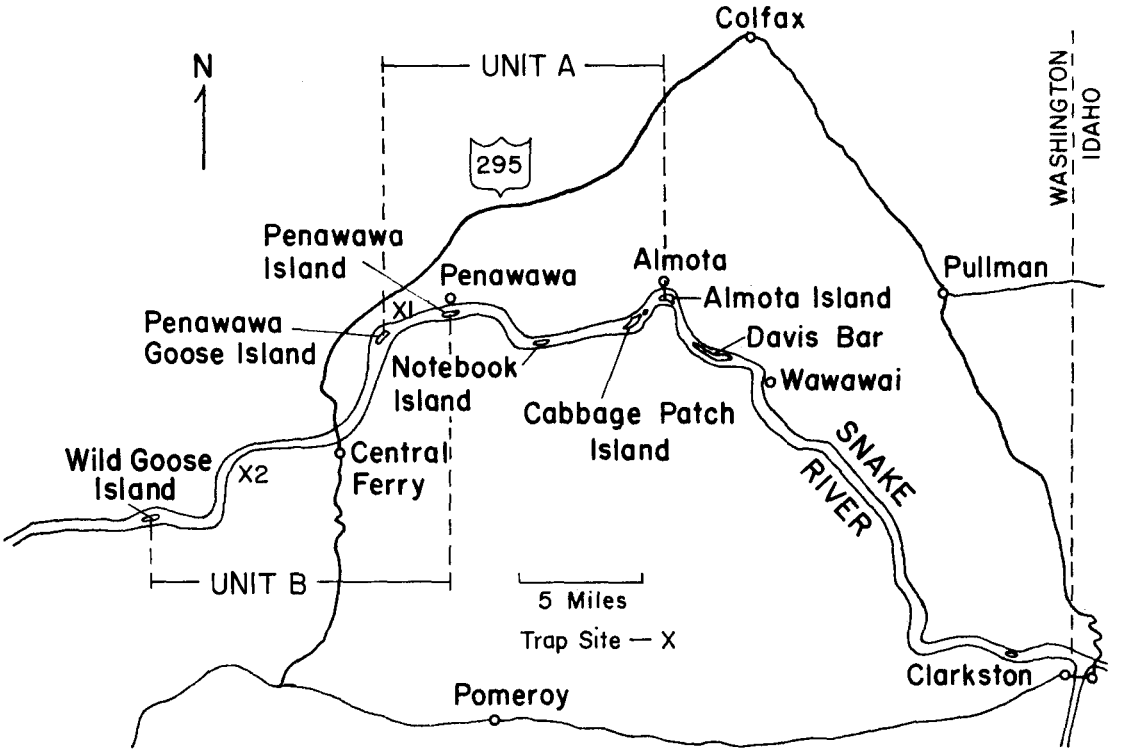

FIGURE 1. Snake River study area in southeast Washington.

1967, and 1968, respectively. Correspondingly, the number of island nests observed was 30, 27, and 20. Thus, at least 38, 55, and 48 per cent of the geese observed in Unit A in 1965, 1967, and 1968 were breeders. Brood observations indicated that much larger percentages of geese seen were breeding (see section on Non-island nesting). Barraclough (1954) observed that 40–50 per cent of the geese counted on the nesting grounds were breeders.

Chronology. The egg-laying peak for the 77 nests of 1966–1968 occurred during the last week of March and the first week of April. The hatching peak occurred during the last week of April and the first week of May. These peaks are almost identical to those for Flathead Lake, Montana (Geis 1956), and the Columbia River (Hanson and Browning 1959).

Nest sites. The basis for nest site selection by the Canada Goose has been the object of speculation by many observers. Williams and Marshall (1937), Dow (1943), Kossack (1950), Miller and Collins (1953), Naylor (1953), Steel et al. (1957), Hanson and Browning (1959), and Buss and Wing (1966) agree that good visibility of the surrounding terrain is an important factor. For this area, Buss and Wing (1966) indicated that locations free

TABLE 1. Numbers of geese (yearlings or older) seen in Unit A on river surveys.

1965	No. geese	%	1967	No. geese	%	1968	No. geese	%
Feb. 6	104	9.4	Feb. 26	115	10.8	Feb. 29	120	18.0
Feb. 27	185	16.8	Mar. 12	126	11.8	Mar. 7	90	13.5
Mar. 20	183	16.7	Mar. 17	92	8.6	Mar. 16	58	8.7
Apr. 3	197	17.9	Mar. 26	102	9.6	Mar. 21	87	13.2
Apr. 17	127	11.5	Mar. 31	99	9.3	Mar. 31	89	13.4
May 2	115	10.4	Apr. 9	109	10.2	Apr. 13	56	8.4
May 15	191	17.3	Apr. 23	72	6.7	Apr. 28	59	8.8
			Apr. 30	73	6.8	May 16	107	16.0
			May 7	94	8.8			
			May 14	71	6.7			
			May 21	114	10.7			
Total	1102			1067			666	
Mean	157			97			83	

from human and animal disturbances are preferred. They also suggested that height above water level is important in nest site selection. Higher nesting locations are more likely to escape flooding which commonly occurs during or just prior to the hatching peak. Vegetation type is reported to have little effect on selection of a nesting site (Hanson and Browning 1959; Buss and Wing 1966).

Notebook Island is located midway between the other four nesting islands in Unit A (fig. 1). It has all the above mentioned desirable attributes for nest site selection in addition to close proximity to suitable feeding and brood rearing areas. This island is nearly the same size as Penawawa and Penawawa Goose Islands, but its nesting density is 9.6 acres per nest compared with 2.9 and 1.5 acres per nest, respectively, for Penawawa Island and Penawawa Goose Island for the period 1954–1965 (Buss and Wing 1966). One feature that distinguishes Notebook Island from the other two islands is its cobblestone substrate with relatively sparse vegetation. Penawawa and Penawawa Goose Islands have predominantly sandy substrates and correspondingly more vegetation. Klopman (1958) suggested that island nesting geese did not use the gravel midribs of islands because of the absence of nesting materials. In early February 1968 nesting material was distributed on Notebook Island (see Methods). Only one nest was constructed of the artificial material. The total number of nests on the island dropped from three nests in each of the previous two years, to two nests in 1968. Apparently, the addition of considerable amounts of nest building material to the island did not encourage nesting there.

Of 77 nests observed on all the islands from 1966 through 1968, 63 (81.8 per cent) were located on sandy substrate. In 1968 four eggs were known to have been broken in nests, all from two of the four nests located on cobblestone substrate. There were no broken eggs in any of the 16 nests located on a sandy substrate. Apparently geese have difficulty adequately lining nests located on rocky ground. Of the four nests made on cobblestone, only the one built on the artificial material had a well-formed and adequately insulated nest bowl. The other three nests were shallow depressions in which the nesting material tended to fill the spaces between rocks, but offered little protection from the surfaces of the stones. In one nest built over cobblestone, from which a goose was flushed, one egg was found laying directly on bare rock. That egg was noticeably cooler than the other eggs in the clutch. Two of the eggs in this nest were broken and did not hatch.

TABLE 2. Nest and egg data for successful island-nesting Canada Geese.

	1966	1967	1968	Overall mean
Nests				
Total	30	27	20	25.7
Hatched	24	9	11	14.7
Abandoned or destroyed	6	18	9	11.0
% hatched	80.0	33.3	55.0	57.1
Eggs				
Total	164	144	108	138.7
Hatched	124	48	57	76.3
% hatched	75.6	33.3	52.7	55.0

The implications from these observations toward nesting success are twofold. First, nesting on cobblestone may result in more broken eggs and thus decrease the probability of success. Second, chilling of incubating eggs could cause death of developing embryos and further decrease hatching success. If these observations reflect general trends, they provide the basis upon which nesting geese may have "selected" sandy substrate over cobblestone for nest sites. Perhaps the cobblestone substrate of Notebook Island provides only marginal nesting habitat and is responsible for lower nesting density there.

Island nest data. Table 2 shows the nesting data for island breeding geese for 1966–68. For this period the nest success averaged 57 per cent, and egg success averaged 55 per cent. For 1954–65 Buss and Wing (1966) found a 72 per cent nest success and a 69 per cent egg hatching success on the Snake River. Generalizing from nesting reports by Miller and Collins (1953), Naylor (1953), Steel et al. (1957), and Hanson and Browning (1959), a nesting success of 70 per cent and an egg success of 75–85 per cent is normal. The nest and egg success for 1966–68, therefore, is below average.

In 1967 and 1968 good weather and relatively low water levels were conducive to use of the islands by fishermen and picnickers. In 1967, when on all the islands only 33 per cent of both the nests and eggs were successful, six of 18 nests deserted or destroyed were on Almota Island. During that nesting season, major construction work on Lower Granite Dam and nearby rail and vehicle roads resulted in a great deal of noise by stripping of large amounts of gravel from Almota Island. In 1968, seven of the nine nests deserted or destroyed were on Penawawa and Penawawa

TABLE 3. Broods seen in Unit A on river surveys, 1967.

Date	No. marked broods	No. unmarked broods	Total
April 30	1	3	4
May 7	3	6	9
May 14	2	3	5
May 21	3	1	4
Total	9	13	22

Goose Islands. Within 300 yards of each of these sites the orchards and farms on shore were being demolished in preparation of the reservoir for Little Goose Dam. Circumstantial evidence thus points to human disturbance as the major cause of nest desertion, and also suggests that destroyed nests were the indirect result of human activity.

The average clutch size for 1966–68 was 5.8 and the average hatch per breeding pair was 5.2. During the study, an average of 76.3 goslings (table 2) were hatched annually from island nests in the 14-mile study area.

Nest site re-use. Twelve nest sites were re-used one or more times between 1960 and 1967. More than 26 nests have been located on these sites, and four sites have been used four or more years in succession. According to Buss and Wing (1966), the base of a large sage bush on Penawawa Island and the inside corner of an old log foundation on Almota Island were used at least nine successive years. Ten of the 12 re-used sites have been on the two islands where the most nests and highest success have occurred. From 1960 to 1967, 20 of the 26 nests on old sites (77 per cent) were successful. Buss and Wing (1966) concluded that their re-use indicated a preference over other sites; their success has surpassed the 1954–65 overall success of 72 per cent.

The re-use of nest sites by geese has varied widely from study to study. Barraclough (1954) found that 45 per cent of 173 nests were on or within 25 ft of the previous year's site, whereas Naylor (1953) found only 2 per cent of 360 nests built on old sites. Grieb et al. (1961) reported that frequently nests found in the same location were tended by the same pair of neck-banded birds in successive years.

One marked pair was known to renest in 1968 with a renesting interval of 12 days. This interval is similar to the 11-day interval reported by Balham (1954).

Non-island nesting. Observations of eight broods color-marked in Unit A showed that they remained within one mile of their island nests for several days post hatching, and then moved slowly upstream or downstream. Since

TABLE 4. Comparison between the number of goslings observed and the number of eggs known to have hatched from island nests.

Date	No. goslings observed	No. eggs hatched
7 May 1967	47	24
9 May 1968	42	29
16 May 1968	69	33

the nearest islands to Unit A are 20 miles downstream and 31 miles upstream, nesting geese from other islands probably did not bring their broods into the area during the first few weeks after hatching. Increased numbers of adult geese were observed in Unit A during and after the hatching peaks in mid-May of 1965, 1967, and 1968 (counts were not made in 1966). In 1968, pair counts in Unit A averaged eight pairs per trip. They ranged from six to 14 pairs and averaged 11.5 on the first six trips. The counts made on April 28 and May 16 were 19 and 18 pairs, respectively. Perhaps geese nesting on the cliffs or shoreline adjacent to the river were counted only after bringing their newly-hatched goslings to the river.

Yocom (1951) found several nests on steep cliffs in Unit B. In 1957, a nest was observed in the cliffs 200 ft from the river at the upstream end of Unit A. Later, five goslings were seen leaving the nest and entering the river. In 1961, a goose was seen leading three goslings from the cliffs to the river 15 miles upstream of Unit A. In 1967, two nests were found upstream of Unit A near the first ledge above the river. One nest held six hatched eggs and the other was inaccessable. In 1967, four geese were flushed from cliffs in Unit A where a year-old nest and a recently dug nest pit were found. Hansen and Oliver (1951), Hanson and Browning (1959), and Yocom (1962) have discussed similar sites found on the Snake and Columbia Rivers in central Washington.

Counts of color-marked broods also suggest the presence of cliff or river-bank nests. In 1967 all nine broods hatched from five islands were marked. Table 3 presents data obtained on four trips during which marked and unmarked broods were sighted in Unit A. Fifty-nine per cent of the broods observed were not hatched on islands.

Table 4 presents a comparison of the number of goslings observed on three trips in 1967 and 1968 with the number of eggs known to have hatched from island nests by the same date. Overall, at least 46 per cent of the goslings observed were not hatched on the islands. These data suggest that approximately

50 per cent or more of the total gosling production is from cliff or river-bank nesting geese.

Mortality and production. Only two observations on gosling mortality were obtained. In 1967, about 17 days after hatching, a lone brood of one marked gosling and its parents from Notebook Island were observed. Since broods of two, six, and six had hatched there, either one or five goslings had been lost from this brood or had joined other broods. All seven goslings in another brood had been marked. Only six of the dyed goslings were seen in what appeared to be the same brood 18 days later and one mile away.

Brood mixing and intermingling made conclusions about mortality from brood size reductions impractical. Broods of 12, 18, and 20 were sometimes tended closely by only two older geese in a rearing area at Penawawa. In 1967 when both marked and unmarked goslings were present, brood grouping and exchange were even more obvious. Frequently, two or more broods seen on the river seemed to be traveling together. Brood grouping in *Branta canadensis moffitti* has been observed by Naylor and Hunt (1954), Geis (1956), and Hanson and Browning (1959).

Islands in Unit A produced an average of 76 goslings per year in the 1966–68 period. If that production was equaled by cliff and river-bank nesting geese, perhaps 150 goslings were produced annually in this 14-mile stretch of the Snake River. In 1967, when broods were marked, 48 goslings hatched from island nests, but average productivity cannot be estimated due to the lack of data necessary to produce a mortality estimate.

Post-hatching movements. Six to eight days after hatching, one marked brood from Notebook Island was seen ¼ mile upstream from the island. Two marked broods from Notebook Island were observed five miles downstream near Penawawa Island, 17 and 31 days post-hatching. A pasture adjacent to the river one mile upstream from Penawawa Goose Island was used as a rearing area for approximately 10 broods in 1966 and 4 in 1967. Two marked broods from Penawawa Goose Island remained on the island at least two days after hatching. One of these two broods was at the rearing area one mile upstream 17 days after hatching, and three other marked broods from the island were there 7 days after hatching. None of the goslings marked upstream from the rearing area were observed there.

Naylor and Hunt (1954) noted brood movements down the Susan River in California. On the Flathead River in Montana, Barraclough (1954) observed that "broods generally tended to move downstream from nesting areas and congregated where low grassy pastures were adjacent to the river." Other broods may be encountered as the families move slowly down the river in the late spring and summer months, as Craighead and Craighead (1949) observed on the upper Snake River in Wyoming.

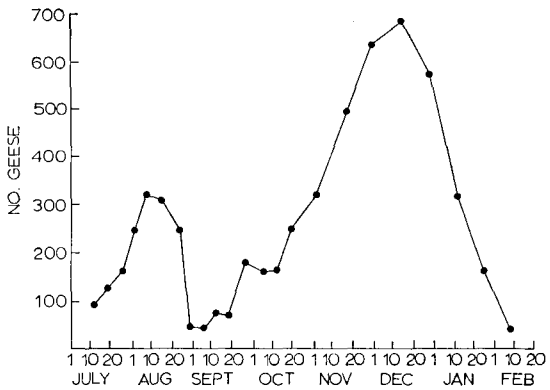

FIGURE 2. Number of geese observed in Unit B of study area, 16 July–30 November 1966 and 11 July 1967–8 February 1968.

Banding and marking. A total of 91 geese were captured. They were cannon-netted at sites no. 1 and no. 2, and drive-trapped at site no. 1 (fig. 1). Of the 36 geese captured and banded in 1966, 30 were also color-marked. In 1967 and 1968 55 geese were banded and color-marked.

Local movements. Boat trips were made through Unit B to observe the behavior of marked and unmarked geese. Figure 2 shows the number of geese observed in Unit B 16 July–30 November 1966 and 11 July 1967–8 February 1968.

A rapid increase in the number of geese seen in July and early August is apparent. Martin (1963) noted a large influx of geese at Ogden Bay, Utah, during the first week of August in 1956, 1957, and 1958. His observations of marked geese showed that they were returning, non-breeding birds that had left before molting. Jenkins (1944) and Balham (1954) have observed that the young of the previous year may rejoin their parents some time after the adults have hatched their new broods. Observations during trapping attempts in June and July 1966–67 indicated that young-of-the-year were just becoming capable of short flights in early July. Two large flocks of 36 and 39 geese and goslings were observed moving downstream from Wawawai and Notebook Island on 29 June and 14 July 1966 respectively. The fact that this July–August increase appeared shortly after the young

gained greater mobility suggests that goose families moved into the area from elsewhere on the river.

During the last three weeks in August and in early September, counts dropped rapidly. In 1966, on six trips, 16 July–25 August, there were 88 observations of the 30 young-of-the-year that had been captured and marked at site no. 1 (fig. 1). During the eight trips made after 25 August 1966, only 13 observations were obtained. In 1967, on seven trips, 11 July–23 August, there were 29 observations of 10 immature geese that had been captured and marked. During the 16 subsequent weekly trips, until 8 February 1968, none of the locally-reared, marked immatures were observed. These observations of marked geese and total goose numbers indicate that most locally-reared geese, as well as new arrivals, left the study area in late August.

Band recoveries and observations of marked geese. Band recoveries were obtained from 11 geese banded as flightless young at trapsite no. 1 in early summer 1966. Two of these geese were shot the following December and a third was shot in December 1968. All three were within 12 miles of the trapsite when killed. A fourth goose was retrapped at the original capture site in February 1968. A band recovery of one 1967 summer-marked immature was reported from Sprague Lake, about 50 mi. N and 10 mi. W of the study area on 14 October 1967. Four geese trapped and marked at trapsite no. 1 on 21 September 1967, were observed about 50 miles directly north of the study area on the Turnbull National Wildlife Refuge near Cheney, Washington (Jon M. Malcom, pers. comm.). The geese were last seen in the study area 26 September and first noted on the refuge on 6 October. They were seen together at Turnbull until 14 November, but may have been there longer. One of the four was seen again at the refuge on 29 December. On 21 February 1968 one of these marked birds was found dead on Penawawa Goose Island. Sightings revealed that two of the other three marked geese had also returned to the study area by the same date.

In the 1969–70 hunting season one immature and a three-year-old goose, two yearlings, and one two-year-old goose were shot within 20 mi. NW and 30 mi. N of Unit B, respectively. Another yearling was taken on the Columbia River 100 mi. SW of the study area. These limited data on marked and banded birds indicate that at least part of the local population winters in eastcentral Washington, within 50–100 miles of the study area.

Hansen and Oliver (1951) found that *B. c. moffitti* in southcentral Washington are permanent residents and do not migrate any great distance. Hanson (1961) stated that most of the young geese hatched in the vicinity of the Hanford Reservation (southcentral Washington) spend their first winter there.

One goose banded in the summer of 1966 was shot as a yearling in the fall of 1967 near Camrose, Alberta. Similar wandering movements have been reported frequently in the literature (Hansen and Nelson 1964; Sherwood 1966b).

Migrants in Unit B. Wintering geese began to arrive on the study area in mid-September (fig. 2). Maximum counts of 550 and 675 were reached between late November and late December in 1966 and 1967, and declined until counting was terminated.

Since 1964, the river directly upstream from Central Ferry (fig. 1) has been open to hunting, but the river below the bridge has been closed. On nine trips made during and after the 1967–68 hunting season, 95 per cent of the 3,469 goose observations were made in the area closed to hunting.

Most of the wintering geese were *B. c. moffitti.* Counts during November 1966 and November and December 1967 indicated that about 25 per cent of the geese were *B. c. minima.* On 7 January 1968, 20 of the small race were captured in a cannon net at trapsite no. 2 along with eight *B. c. moffitti.* One of the *B. c. minima* had been banded on 21 April 1967, near Vanderhoof, B. C. *B. c. minima* migrate up the Columbia River and then turn south again east of the Cascade Mountains (Hansen and Nelson 1964). Apparently some of them continue on up the Snake River into eastern Washington. Small flocks are observed frequently near Lewiston, Idaho, in the fall, and these may be on their way further south through the canyon formed by the Snake River between Idaho and Washington.

SUMMARY

Data on nesting were collected in 1966, 1967, and 1968. No significant differences from the 1954–1965 data reported by Buss and Wing (1966) were noted. Sand or soil was preferred to rock for nest substrate. Twelve nest sites were re-used one to four times between 1960 and 1967. One successful re-nesting attempt occurred with a 12-day renesting interval. Observations indicated that 50 per cent or more of the gosling production on the Snake River came from cliff or river-bank nests. Broods remained within one mile of their island nests for several days and then moved

slowly upstream or downstream. Many broods were reared in grassy pastures adjacent to the river. A rapid increase of geese in July and August, appearing shortly after the young gained greater mobility, indicated that geese had hatched in cliff and river-bank nests or had moved into the study area from elsewhere. Observations of marked geese and counts indicated that most locally-reared geese as well as new arrivals left the study area in late August. Data on marked and banded birds indicated that at least a part of the local population wintered in eastcentral Washington within 50–100 miles of the study area. Migrant geese began arriving on the Snake River in mid-September, and maximum numbers were observed in late November and December. About 25 per cent of the geese observed here in the winter were *B. c. minima.*

ACKNOWLEDGMENTS

We are grateful to H. L. Eastlick and T. S. Russell for their helpful suggestions. We also appreciate the help from Washington State University students who assisted with the collection of data. This study was supported by the State of Washington Water Research Center and the U. S. Department of the Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964.

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Accepted for publication 9 November 1970.