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Nesting and Brood Rearing Ecology of the Vancouver Canada Goose on Admiralty Island Southeast of Alaska

Charles S. Lebeda

NESTING AND BROOD REARING ECOLOGY OF THE
VANCOUVER CANADA GOOSE ON ADMIRALTY ISLAND
IN SOUTHEAST ALASKA

BY

CHARLES S. LEBEDA

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

John T. Ratti
Thesis Advisor

Charles G. Scalet, Head
Department of Wildlife
and Fisheries Sciences

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ABSTRACT

Nesting and brood rearing biology of Vancouver Canada geese (*Branta canadensis fulva*) was studied in 1978 (preliminary) and from April-August 1979 in Seymour Canal, Admiralty Island, Alaska. Geese used trees for perching during the incubation period (24 April-7 June) and use was significant ($P < .0001$) for early morning hours. This behavior is considered unique among all Canada goose subspecies. An average of 86.3 search hours were conducted for each of 19 active nests located in 1979. Seven additional nests from previous years were also located. Twenty-two nests were located in forest habitat. All forest nests were in association with vegetation similar to vegetation described for U.S. Forest Service classification of F4 and F5 (poorly drained) soil types. Mean clutch size was 4.4 ± 1.3 eggs. Mean egg length and width were 86.1 mm ± 3.14 and 56.4 mm ± 2.76, respectively. Success of all nests hatching at least one egg was 55.6%. Egg hatching success of successful nests was 95.7%. Total hatching success of all eggs was 62.0%. Forest habitat was used extensively for brood rearing. Broods generally avoided large bodies of water. Single family broods were found most often in forest habitat while creches were more common in meadows and intertidal zones. Breeding adults and goslings were comparatively less vocal in the forest. Goslings less than 2 weeks of age used forest habitat extensively and shifted to forest edge and intertidal zones with age. Forest habitats, rather than open water, were used as escape cover by breeding adults and broods. Nesting and brood rearing habitat was similar, thus, nest site selection may be closely tied to requirements for brood rearing habitat. Molting, non-breeding or unsuccessful breeding geese also used forest habitat freely and avoided observers by fleeing into the forest. Use of habitat compared to tide stage was significant ($P < .0001$) and may be a function of availability. Habitat use compared to daily time periods appeared to reflect feeding activity peaks in early morning and late afternoon. Adult geese primarily used the intertidal zone during pre-incubation; the grassy intertidal zone was used more during incubation and post-incubation. Skunk cabbage (*Lysichiton americanum*) comprised 23.8% aggregate of foods utilized and appeared to be the most important food during brood rearing. Goslings and molting geese also utilized sea lettuce (*Ulva* spp.) and blueberry (*Vaccinium* spp.) berries. Plant matter comprised the bulk of food items.

INTRODUCTION

Many of the 10 subspecies of Canada geese (*Branta canadensis*) (A.O.U. 1957) have been extensively studied. However, there is a lack of information concerning the ecology and status of the Vancouver Canada goose (*B. c. fulva*) (Bartonek et al. 1971:354). Banding studies have indicated Vancouver Canada geese are primarily non-migratory (Ratti and Timm 1979) and are found almost exclusively in Southeast Alaska. Southeast Alaska is heavily forested; the U.S. Forest Service owns and manages most of the lands inhabited by Vancouver Canada geese. Bartonek et al. (1971:354) stated that because "so little is known about their ecology and status effects of logging and other special uses of these lands, whether harmful or beneficial, cannot be evaluated." Since the Vancouver Canada goose is dependent upon southeastern Alaska for year-round subsistance the need for basic biological information is evident.

The main objectives of this study were to describe and analyze the nesting and brood rearing habitats of the Vancouver Canada goose in an essentially non-logged forest. Other objectives were determination of clutch size, nesting success, production, and food habits.

LITERATURE REVIEW

The white-cheeked goose (*B. c. occidentalis*) was reported breeding from Prince William Sound and Mitkof Island south to northwestern California along the Pacific coast and wintering from Washington to southern California (A.O.U. 1910). Bailey (1927:190) noted George Willet to believe the white-cheeked "species to be a local one, and feels he has observed a family throughout the summer, fall and winter. However, be that as it may, a large goose, designated as *occidentalis*, is present the year around." Peters (1931) lumped all the large, dark geese breeding along the Pacific coast from Cook Inlet, Alaska, south through Vancouver Island as dusky Canada geese (*B. c. occidentalis*). Aldrich (1946:96) in discussing speciation of white-cheeked geese reported the "extremely dark *B. canadensis occidentalis* occupies the relatively narrow area of southeastern Alaska and British Columbia south to Vancouver Island during the breeding season," the breeding habitat now described for the Vancouver subspecies, *B. c. fulva* (Hansen 1962). Delacour (1954:155) proposed 1 species of the Canada goose with 12 subspecies. He stated "it appears that the exclusively coastal forms, *fulva, occidentalis, leucopareia, asiatica* and *minima* in the west, *hutchinsi* in the east, rarely interbreed and mingle with the more interior forms." In 1957 the American Ornithologists' Union recognized the Vancouver Canada goose as a separate subspecies, *B. c. fulva.*

Hansen (1962:303) described the breeding range of the dusky Canada goose as extending "along the coast from the vicinity of Bering Glacier on the southeast to Cook Inlet on the west," while the breeding range of the Vancouver Canada goose "appears to terminate at Cross Sound near Glacier Bay on the northwest about 300 miles southeast of the breeding terminus for occidentalis" and "terminates on the south in the vicinity of Dixon or possibly into British Columbia." Hansen (1962:301) reported "recovery of banded birds demonstrates very clearly that occidentalis and fulva are different populations." Weights and measurements of Vancouver and dusky Canada geese have been reported by Ratti et al. (1977) and Chapman (1970), respectively. Johnson et al. (1979) used selected morphological characteristics to separate each of the 6 subspecies of Canada geese in Alaska through statistical analysis. All research to date supports the A.O.U. (1957) assignment of fulva as a separate subspecies.

Delacour (1954) and Gabrielson and Lincoln (1959) agreed that Vancouver Canada geese are primarily non-migratory, but reported small numbers of geese migrating as far south as northwestern California. Hansen (1962:301) reported "164 recoveries from 3,593 fulva banded in and near Glacier Bay between 1956 and 1960." Hansen (1962:307) found "only 17% of the recoveries have been made on the coast of Washington and in the Willamette Valley" (Oregon). "About 62% came from within 100 miles of Glacier Bay and another 20% only 50 miles farther. The few fulva that migrate to Oregon from southeast Alaska go directly to the Gray's Harbor-Willapa Bay area. No recoveries of this subspecies have been made between Alaska and the Washington coast." Hansen (1962:307) stated "no bands from fulva were returned from farther south than Benton County, Oregon." Ratti and Timm (1979:210) discussed "how geographic differences in harvest pressure misrepresent migratory behavior of B. c. fulva." They reported (Ratti and Timm 1979:208) "a total of 4,665 Canada geese was banded in Southeast Alaska (93% banded at Glacier Bay, 129 km west of Juneau) and hunting season recoveries have totaled 413. Alaska accounted for 84% of the recoveries, British Columbia 3%, Washington 1%, and Oregon 12%." Their findings "suggest that Southeast Alaska is even more important to Vancouver geese than previously thought, with approximately 98% of the population being relatively sedentary" (Ratti and Timm 1979:211).

Delacour (1954:170) noted that Vancouver Canada geese "make their nests just inside the woods or brush on the shore of both fresh and salt water lakes as well as out on open muskeg. A favourite nesting place is on an island in a lake." Birds were also reported to build nests (Delacour 1954:170) "on the tops of stumps in the woods, 30 feet above the ground; but they usually build on the ground near water like other Canadas." Hansen (1962:304) reported "on both the islands and mainland of the Alexander archipelago south of Cross Sound and Lynn Canal, B. c. fulva nests in a more or less solitary fashion." Ratti (1973:31) located 9 nests; "5 nests were found on small islands in saltwater bays and coves. One nest was found on a freshwater island (rock), 1 on the bank of a freshwater beaver pond, and 1 on a cut tree stump located in an intertidal zone. The most unusual nest was located on a horizontal limb of a spruce tree, approximately 50 feet off the ground." Ratti (1973:31) estimated "egg laying began the last few days of April with many eggs hatching around June 1."

Three active goose nests were found by Harrington (1977) on Heceta Island: "Nest no. 1 was located on a mound formed by an old log, extending onto a sedge-grass shoreline. ---Nest no. 2 was located on May 5 in the top of a 4-foot diameter rotten stump 6 feet high. ---Nest no. 3 was located adjacent to Crooked Lake on a root wad where a tree had been uprooted." Harrington estimated that no more than 50% of the nests in the area were located, indicating the difficulty in locating nests. As of February 1979 only 23 nests of Vancouver Canada geese had been reported in the literature (Van Horn et al. 1979).

In contrast to most subspecies of Canada geese, broods of Vancouver Canada geese were not observed on open water (Ratti 1973). Ratti (1973:32) found "broods are quite secretive, spending much of their time near the forest edge. Broods readily escaped potential danger in the forest underbrush." Delacour (1954:170) reported "young hatched near beaches are taken up the mountains by parents to feed on berries, returning to saltwater when mostly full grown and flying well." This theory is proposed by many local residents; a possible origin of Delacour's reports. Gabrielson and Lincoln (1959) found that geese begin in August to gather into flocks.

Ratti (1973:31) surveyed 1,745.6 independent km of beach and shoreline and "birds were most commonly found in protected coves and bays near tidal flats. These areas frequently had grassy meadows, large acreages of tidal flats during low tide, and freshwater streams emptying into the bay. Areas producing few goose observations were exposed shorelines, usually having a narrow low-high tide margin, with rocky intertidal zone."

Hansen (1962) reported that there is a light hunter harvest of Vancouver Canada geese. Ratti et al. (1978) also reported relatively light harvests, showing that harvest and recovery rates were low compared to *B. c. occidentalis* (Chapman et al. 1969) and estimated a mean annual survival rate of 83.6%. Hansen (1962:320) suggested "that it looks as though there are more idle adult birds in this southeast population than there really should be." This may be the result of lower mortality rates of Vancouver Canada geese.

Other Subspecies of Canada Geese (Branta canadensis)

Breeding ecology in other subspecies of Canada geese has been extensively researched. Canada geese generally nest in open habitats (Miller and Collins 1953, MacInnes 1962, Hanson and Eberhardt 1971, Mickelson 1975, and Cooper 1978). Geese have been reported nesting on top of muskrat houses (Kaminski and Prince 1977), on man-made structures (Brakhage 1965, Cooper 1978), on haystacks (Dow 1943), and on cliffs (Culbertson et al. 1971). Craighead and Craighead (1949:51) reported one goose nest "in a large Douglas fir tree within an old red-tailed hawk nest approximately 80 feet above the water." The general tendency is for Canada geese to select nest sites providing high visibility (Klopman 1958), closeness to water (Craighead and Craighead 1949, Miller and Collins 1953), and near large areas of open water (Kaminski and Prince 1977), although use of forest or brush has been reported (Geis 1956, Klopman 1958).

Nesting sites are selected with adequate brood rearing areas in close proximity (Williams and Sooter 1940). Hanson and Eberhardt (1971: 52) described major brood rearing areas as "with gently sloping shorelines, freedom from boat traffic or with escape cover, and abundant pasturage."

Migration has been studied by Sterling and Dzubin (1967) and Raveling (1976). Problems inherent in population dynamics and harvest have been studied extensively by Boyd (1962), Hanson (1965), Martinson and McCann (1966), Chapman et al. (1969), Grieb (1970), and Brownie et al. (1978).

Canada geese are reknown for the strong family bonds. Behavioral interactions between family members and sexual displays have been studied by Collias and Jahn (1959), Klopman (1962), Raveling (1969, 1970), and Radesater (1974).

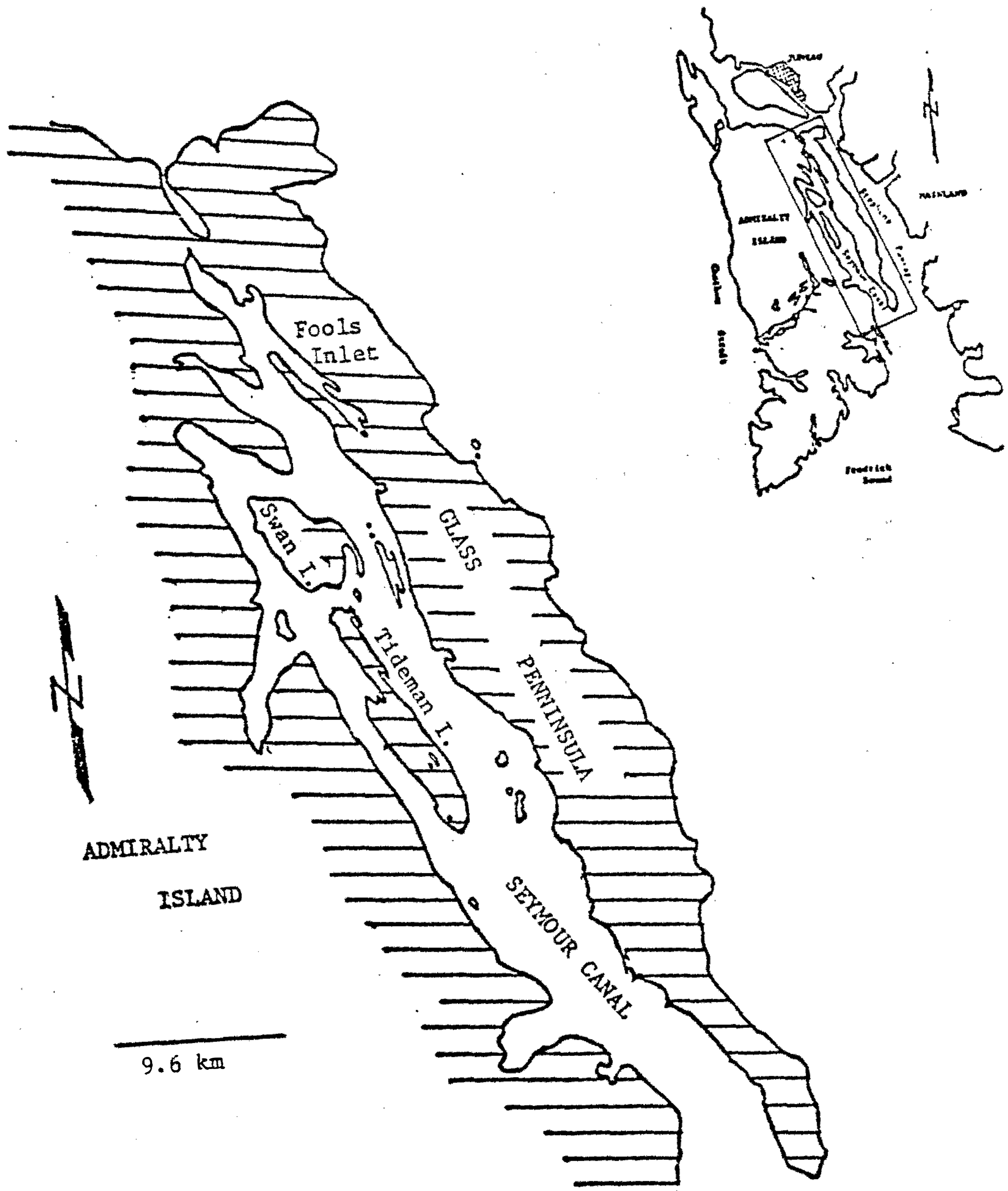
STUDY AREA

My study area was approximately 368 km^2 north of latitude 57^o 45' N in Seymour Canal, Admiralty Island in Southeast Alaska (Fig. 1). The study area is part of the Tongass National Forest.

Temperature, wind velocity, and wind direction for the study area, located 40 km south of Juneau, were felt to be comparable to weather conditions for Juneau. Mean monthly temperatures for April, May, June, July, and August 1979 were 5.06, 8.72, 11.22, 13.72, and 14.52 C, respectively. Precipitation for the same months was 24.9, 62.2, 69.6, 138.2, and 14.2 mm, respectively (National Weather Service Office, Juneau, Alaska). Precipitation is generally abundant due to strong disturbances acting on moist Pacific airstreams, aided by orographic uplift, and temperatures are modified by oceanic influences (Hare and Hay 1974). Maximum summer temperatures range from 13-16 C; minimum winter temperatures range from -6 to 2 C (Viereck and Little 1972). Average annual precipitation for Juneau is 1,387 mm, with a mean daily temperature of 4.5 C. Winds are predominately east-southeast.

A coastal temperate rain forest composed of Sitka spruce (*Picea sitchensis*), Alaska cedar (*Chamaecyparis nootkatensis*), western hemlock (*Tsuga heterophylla*), mountain hemlock (*Tsuga mertensiana*), and lodgepole pine (*Pinus contorta contorta*) dominated much of the study area (Viereck and Little 1972). Major understory vegetation is composed of blueberry (*Vaccinium* spp.), rusty menziesia (*Menziesia ferruginea*), devil's club (*Oplopanax horridux*), and a variety of mosses (*Sphagnum* spp.). Mountains rise from sea level to an elevation of approximately

Figure 1. Map of the Vancouver Canada goose study area, Seymour Canal, Admiralty Island, Alaska, 1979.



1,230 m. The subalpine is covered by Sitka alder *(Alnus sinuata)* and borders alpine meadows (Hultén 1968). River drainages empty into tidal estuaries creating extensive tidal flats. Major habitat types are forest, meadow, muskeg, freshwater lakes, and intertidal zones. A comprehensive review of the history and geography of Admiralty Island is presented by Rosenthal et al. (1973).

Forests on the study area are mostly primeval with only 1 extensive area of logging activity. Admiralty Island was selected for the study area because of its relatively undisturbed status and suitable populations of Vancouver Canada geese. Several areas on Admiralty Island were surveyed in 1973 (Ratti 1973) and in 1978 for possible study sites; Hood Bay, Mitchell Bay, the Admiralty Lakes region, Pybus Bay, Little Pybus Bay, and Gambier Bay. Seymour Canal was best suited because of the numbers of geese and logistical accessibility.

METHODS AND MATERIALS

Nesting

Nest searching began with stationary observations in areas of goose use. Attempts were made to locate nests or nesting territories through observations of single or paired birds (Craighead and Craighead 1949). Aerial surveys in 1978 and 1979 aided in locating habitats for nest searches. Nest searching was not stratified due to the small number of Vancouver Canada goose nests reported in the literature. Ground searches were made with crew members approximately 20 m apart. Habitats searched were forest, forest edge, grass/sedge meadows, grass/sedge tidal flats, shorelines of beaver ponds, muskeg, intertidal zones, islands, riparian zones, and shorelines of freshwater lakes.

Nests initiated in 1979 were defined as having at least 1 egg or fresh egg and down. Nests initiated from previous years were defined as having weathered egg fragments and/or down. Since down usually appears near the completion of the clutch (Collias and Jahn 1959, Hanson 1959, Brakhage 1965, Cooper 1978) nests with down were assumed to have had eggs. Nests from previous years were used only for analysis of nest site vegetation.

Each nest was flagged 10 m from the nest site. Nest elevation above sea level and above ground was recorded. The distance from high tide line, the shoreline of freshwater, and the nearest nest was measured. The area of freshwater adjacent to the nest site was measured or estimated. Aspect of each nest site and exposure of north (316-45^{o}), east (46-135^{o}), south (136-225^{o}), and west (226-315^{o}) was recorded. Percent slope was measured with an Abney level. Wind velocity at each nest site was measured with a hand-held Dywer wind meter and direction recorded. Wind velocity and direction for the region was obtained from the National Weather Service, Juneau, Alaska.

The time and date were recorded during the initial nest visit. Presence of an incubating bird and the distance it flushed from the observer were recorded. The distance to the second bird if present was estimated. The number of unhatched eggs per nest was recorded and the length and width of eggs were measured to the nearest 0.1 mm with vernier calipers. Nest material and condition of the nest were recorded, and initiation and hatching dates were estimated by a float technique similar to that described by Westerkov (1950).

Trapping of incubating geese was attempted during the latter half of incubation (Sowls 1955, Weller 1957, Coulter 1958) in order to place radio transmitters on females for monitoring brood habitat use.

Nests were revisited after the expected hatching date. Nests were classified into 3 categories; successful, abandoned, and predated. The number of eggs hatched, unhatched, infertile/unincubated, those with dead embryos, and the number of young dead in the nest was recorded for successful nests. For each abandoned nest I recorded the number of eggs, number of infertile or unincubated eggs, and the number with dead embryos. For each destroyed nest I recorded the number of eggs, stage of incubation, and cause of destruction. Causes of predation were identified when possible by methods of Giles (1969) and Rearden (1951). A production estimate was calculated utilizing methods similar to Naylor (1953), Geis (1956), and Steel et al. (1957). Nest success was the percent of nests which hatched an egg. Hatching success was the percent of eggs hatched by successful nests. Total hatching success was the percent of all eggs laid that hatched; including successful and unsuccessful nests.

Nest materials were estimated by percentage, and non-vegetative substrate and nest diameter were recorded. The percent ground cover within 1 m of the outside of the nest was classified by estimating the percent of exposed soil or rock. Visual obstruction of the nest was estimated as the percent of the nest obstructed from view at a distance of 5 m at cardinal points. Vegetative board readings were taken from the nest (Giles 1969) at cardinal points 5 m distant. Canopy cover readings were taken at cardinal points 5 m from the nest with a spherical densiometer (Lemmon 1956), and canopy photos (35 mm) were taken at the nest site with a 24 mm wide angle lens (Berger 1972). Dominant vegetation included each species which accounted for a minimum of 10% of the total vegetation. Plant communities were described for the general area within 0.8 km of the nest.

I divided my study into 3 time periods: pre-incubation (8-23 April), incubation (24 April-7 June), and post-incubation (8 June-9 August). These time periods were set arbitrarily by backdating 2 nests with known hatching dates and allowing for a 28 day incubation period (Collias and Jahn 1959, Brakhage 1965, Johnsgard 1978).

Brood Rearing Biology

Brood observations were conducted from fixed locations and by ground searches. Age of broods was estimated by plumage development (Yokum and Harris 1965). Brood size and age were recorded and the adults were classified as breeders, non-breeders, or unknown. Brood size was divided into family units (1-8 geese) and creches (9+ geese), in order to test habitat use and brood size. The number of brood observations rather than the total number of birds observed was used in the statistical analysis of brood data. Habitats were classified as lake, river, forest, forest edge, grass/sedge meadow, grass/sedge intertidal zone, intertidal zone, beaver pond, muskeg, island, and open saltwater. Behavior of the geese, tide stage, and time were recorded during observations.

Telemetry

Telemetry equipment was purchased from Telonics, Mesa, Arizona. Radio transmitters weighed 70 g and were back-mounted on geese. A Yagi hand-held antenna system was used with an AVM model LA12 receiver. Movements were determined by methods devised by Hanson and Progulske (1973). Days were divided into 4 time periods (TP): 1) 2200-0400, 2) 0401-1000, 3) 1001-1600, and 4) 1601-2159 hr. Tide stages (TS) were recorded as 1) low tide, 2) mid-low, 3) mid-tide, 4) mid-high, and 5) high tide. Radio telemetry locations (via triangulation) were made during all time periods except for TP 1 and during all tidal stages. Wind, cloud cover in 10% increments, sunshine, and the intensity of rain were recorded for each radio telemetry triangulation.

Food Habits

Geese were collected for analysis of esophageal and proventriculus contents (Swanson and Bartonek 1970). Attempts were made to collect birds which had been actively feeding for at least 10 minutes (Krapu 1974).

Food contents were placed in an 80% ethanol or 10% formalin solution immediately after collection. Analysis of food contents follows methods described by Swanson et al. (1974).

Morphological Measurements

Morphological measurements were taken on geese following the measurements of Ratti et al. (1977). Measurements were taken to the nearest 0.1 mm using vernier calipers. Age, sex, and tail and wing measurements were recorded. Measurements were analyzed using Johnson et al. (1979) discriminant function analysis for Vancouver Canada geese.

Geese were neck and leg banded. Collars were alpha-numerically coded black-on-red and were provided by the Alaska Department of Fish and Game. Leg bands were standard U.S. Fish and Wildlife Service bands.

General Observations

General observations were recorded for all observed geese. Habitat, tide stage, and time period classifications for general observations were identical to that used for brood rearing and telemetry work. The number of geese, pairs, and family groups were recorded in flight, on landing, and on ground or water. Behavioral displays described by Klopman (1962), Johnsgard (1965), Raveling (1969 and 1970), and Radesater (1975) were also recorded. Molt condition, activity of birds (feeding, loafing, or in flight),and their reactions to observers were recorded.

Statistical Analysis

Data were analyzed by chi-square, paired *t*, and analysis of variance tests. Statistical procedures follow Steel and Torrie (1960).

RESULTS

Nesting

Stationary observations to locate nests yielded poor results. Breeding behavior was evident during this time. Several copulations were observed and females collected for food habits had advanced follicular development indicating egg laying. From 8 April to 7 June, I conducted 1,640 hours of goose observations and nest searching activities. Major areas searched in Seymour Canal were Windfall Harbor, Swan Cove, King Salmon Bay, Hole-in-the-Wall, Winning Cove, and Swan, Bug, Windfall, Dorn, Faust, Buck, and Tideman islands. Although these areas were not searched in their entirety, the various habitat types in each were surveyed. Other areas and small islands in the canal area were searched.

Thirteen nest scrapes or bowls (Kossack 1950:637) were found in the forest. Most scrapes were at slightly higher elevations than the surrounding substrate, near the base of trees, and in some cases had goose droppings adjacent to them. One observation was made of 2 geese creating a nest scrape in the forest. One goose was picking at the ground and had cleared moss and twigs from a 6 cm diameter circle. The goose sat several times on this spot. The second bird remained with it uttering steady, soft honks. None of 6 scrapes revisited were used as nest sites. Geese were first observed utilizing trees for perch sites on 25 April (Fig. 2). Ninety-six percent of the 28 tree observations (72 birds) occurred during the incubation period (Table 1). Use of trees was most frequent between 0401 - 1000 hr (Table 2). Chi-square analysis indicated more use of trees than expected for morning hours (TP 2) and

Figure 2. Vancouver Canada goose utilizing a tree for perching on Admiralty Island, Alaska, 1979.

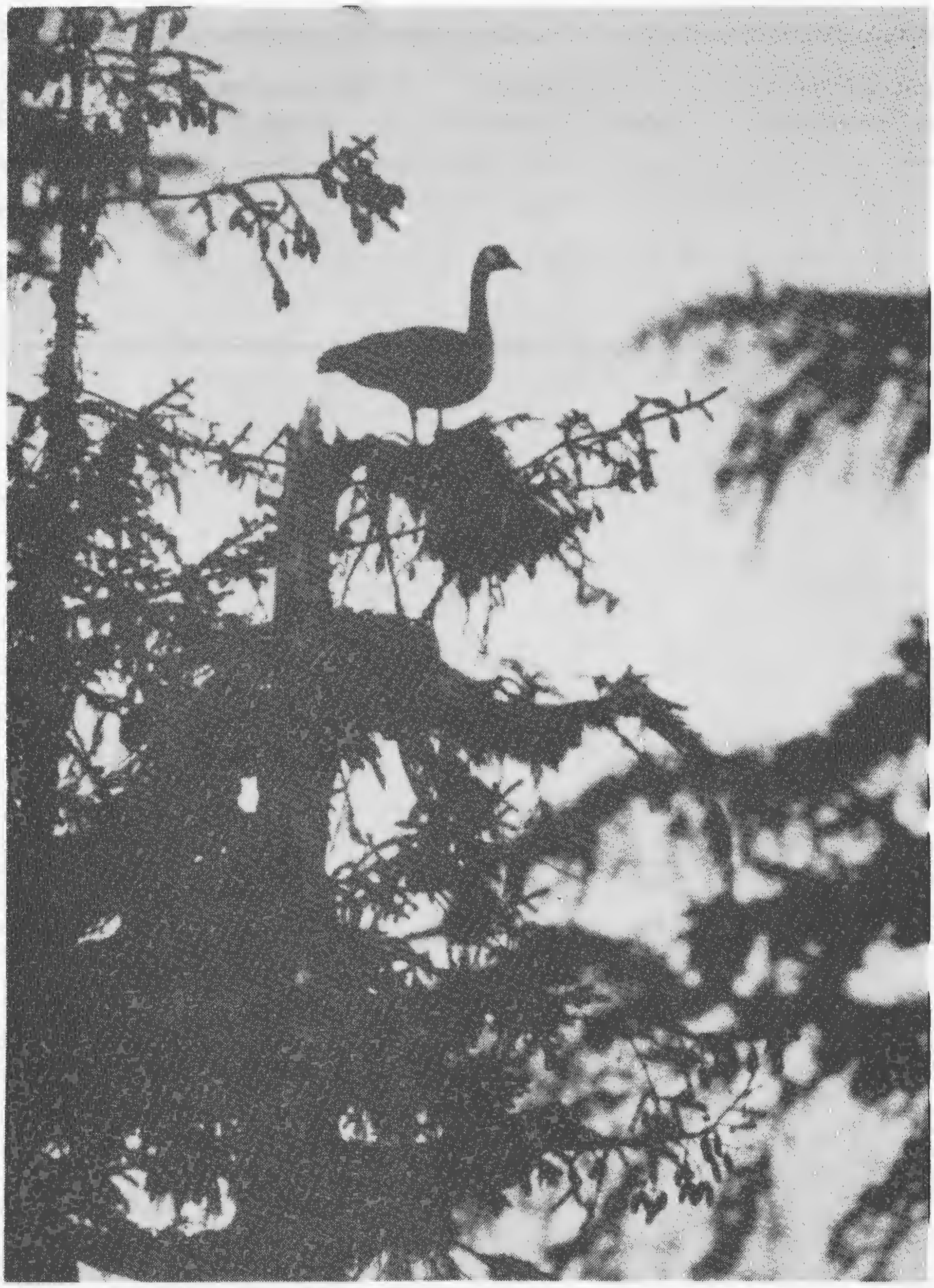


Table 1. Numbers of Vancouver Canada geese observed perching in trees during the pre-incubation, incubation, and post-incubation periods in Seymour Canal, Admiralty Island, Alaska, 1979.

Study Period	Pre-incubation 8-23 April	Incubation 24 April-7 June	Post-incubation 8 June-9 Aug
# Observations	0	27	1
# Geese	0	70	2

Table 2. Chi-square analysis of habitat use and time periods using the numbers of Vancouver Canada geese observed in Seymour Canal, Alaska, 1979. Molting geese observed in Fools Inlet are not included in this table.

Time Period		Habitat							
		Lake	Forest	Forest Edge	Grass Inter	Inter Zone	Open Salt	In Flight	Tree
2 (0401-1000)	Obs.	111	13	23	228	413	73	68	57
	Exp.	82.7	22.3	58.7	250.2	371.5	105.7	79.8	15.2
3 (1001-1600)	Obs.	161	68	188	370	721	279	178	13
	Exp.	165.9	44.8	117.8	502.0	745.2	211.9	160.0	30.4
4 (1601-2159)	Obs.	121	25	68	591	631	150	133	2
	Exp.	144.4	38.9	102.5	436.8	648.4	184.4	139.2	26.4

$X^2 = 396.653$ d. f. = 14 $P < .0001$

less use than expected in the afternoon (TP 3 and 4). Geese utilized the upper portion of trees. They were observed perched on perpendicular limbs and on small branches near the crown.

Ground searches for nests were made in areas adjacent to pair use. Irregular terrain and dense vegetation made nest searching difficult. An average of 86.3 man-hours of nest searching was conducted to locate each of 19 nests initiated in 1979. Nest searching efficiency increased as local nesting habitat became evident. All nests located were in latter stages of incubation. The first nest was located on 1 May and the last known unhatched nest was predated on 29 May. Seven additional nests from previous years were located, 3 with egg fragments and down and 4 with down in the nest bowl.

Of the 26 nests located, 1 was on an island in muskeg, 1 on a small peninsula of a beaver pond, 2 on the forested edge of lakes, and 22 were in the forest--1 of which was at the top of a 9 m spruce snag.

Twenty-two of the nests were located on Tideman Island. The first nest located on Tideman Island was on 9 May and concentrated searching efforts on Tideman did not begin until late in the incubation period, 15 May. Swan Island, an island similar to and north of Tideman, was partially searched. No nests were found and little goose sign was observed on Swan Island.

Means and ranges for elevation above sea level and above ground, distance to high tide line, and slope are given in Table 3. Nests were usually associated with some form of forest interior water, but were an average of 357 m from the nearest tidal beach. The mean distance all nests were from freshwater was 30.5 m. Ten forest nest sites were an

Table 3. Physio-graphical features of 26 Vancouver Canada goose nests located in Seymour Canal, Admiralty Island, Alaska, 1979.

	Elev Above Sea Level	Elev Above Ground	Dist High Tide	Dist to Nearest Nest	% Slope
Mean	30.4 m	73.4 cm	356.8 m	225.5 m	12.3
Range	10-84 m	0-900 cm	73-800 m	80-831 m	0-93

average of 65.8 m (range 0.5-145 m) from bodies of water having surface areas larger than 0.8 ha. Fifteen forest nests were an average of 7.0 m (range 0.3-43.0 m) from shallow pools of water averaging .0036 ha (Table 4).

Four nests had a northerly exposure, 5 an easterly, 11 a southerly, and 4 a westerly; 2 had an exposure of 360°. Nest exposure was non-significant ($P > .0611$). Wind speed was significantly lower at nest sites ($P < .001$) than the general area. Percent dominant vegetation within 1 m and 5 m of the nest is reported in Table 5. The only significant difference in vegetation between measurements at 1 m and 5 m was moss. The mean ground cover within 1 m of the nest was 96.8%. Table 6 gives the mean diameter at breast height (DBH) and height for tree species within 5 m of the nest.

Vegetation obscuring view of the nest was relatively light resulting in vegetative board readings, 5 m distant from cardinal points, of 15.2, 17.3, 17.2, and 17.4 (Giles 1969). Vegetation obstructing the view of the nest 5 m distant was 61.0, 46.6, 61.6, and 65.6% at the cardinal points. Percent canopy cover above all nests for densiometer and photo measurements were 87.6 and 84.1%, respectively. Paired t-tests showed no significant ($P < .05$) difference in the densiometer versus photo interpretation of canopy cover. Canopy cover readings at 5 m distant from the cardinal points were 69.6, 66.0, 69.7, and 57.2%. Dunnett's (t) multiple range test indicated a significant difference between canopy cover above the nest versus 5 m distant. Table 7 lists the means DBH and height for tree species adjacent to nests. Vegetation analysis and percent slope of all forest nest sites were similar to the

Table 4. The relationship of distance and water-body size to 25 Vancouver Canada goose nests located in Seymour Canal, Admiralty Island, Alaska, 1979.

	Area of Water Body		
	≤ 0.01 ha	> 0.8 ha	All Nests
Number of Nests	15	10	25
Distance to Water			
Mean	7.0 m	65.8 m	30.5 m
Range	0.3-40.0 m	0.5-145.0 m	0.3-145.0 m
Average Area of Water	.0036 ha	4.4 ha	1.8 ha

Table 5. Percent dominant vegetation located within 1 m and 5 m of 26 Vancouver Canada goose nests analyzed by Paired t-test located in Seymour Canal, Admiralty Island, Alaska, 1979.

	Moss[a]	*Vaccinium* spp.	Rusty Menziesia[b]	Bunch Berry[c]	Sedge[d]
1 m	40.8	16.8	9.0	6.4	8.4
5 m	24.4	21.2	12.2	4.0	15.4
Significance (d. f. 24)	0.0007	0.8777	0.9147	0.0714	0.9723

[a] *Sphagnum* spp.

[b] *Menziesia ferruginea*

[c] *Cornus canadensis*

[d] *Carex* spp.

Table 6. Measurements of trees within 5 m of 26 Vancouver Canada goose nests located in Seymour Canal, Admiralty Island, Alaska, 1979.

	Sitka Spruce	Lodgepole Pine	West. Hem.	Mtn. Hem.	Cedar	Crab Apple[b]	Red Alder[c]	Snag	Unk.
Mean DBH[a] cm	13.8	15.6	11.3	11.7	9.5	13.1	7.9	11.9	-
Mean Height m	6.7	7.8	5.6	5.3	6.1	5.0	4.5	4.0	-
Number	37	60	121	58	57	11	8	60	8
Percent	8.8	14.3	28.8	13.8	13.6	2.6	1.9	14.3	1.9

[a] Diameter Breast Height

[b] *Malus fusca*

[c] *Alnus oregona*

Table 7. Measurements of trees adjacent (1 m) to 25 Vancouver Canada goose nests located in Seymour Canal, Admiralty Island, Alaska, 1979.

	Sitka Spruce	Lodgepole Pine	West. Hem.	Mtn. Hem.	Alaska Cedar	Snag	Unk.
Mean DBH cm	42.8	22.2	24.4	13.0	17.3	22.4	-
Mean Ht. m	13.5	10.1	12.1	6.5	9.7	6.3	-
Numbers	4	11	10	4	3	5	8
Percent	8.9	24.4	22.2	8.9	6.7	11.1	17.8

vegetation description of F4 and F5 poorly drained soils (U.S. Forest Service Classification System).

Nest construction was simply a scraped depression in the moss with additional materials added to the rim. Materials used in nest construction were moss (35.6%), down (31.5%), Carex spp. (17.1%), twigs (12.5%), bark (2.1%), conifer needles (1.9%), and leaves (0.6%). The average outside nest diameter was 43.2 cm. Humus was the dominant substrate for all nests. One nest from this study provided evidence of previous use, having old nesting material and egg remains below the active nest.

An incubating bird was present at all unhatched nests. The average distance the incubating bird flushed from the approaching observer was 8.5 m. At 50% of the active nests a second bird was present at an average distance of 24.3 m. A total of 3 adult geese were present at a nest site in 2 instances. Geese were occasionally observed perched in trees adjacent to nests.

Clutch sizes ranged from 2-6 eggs with a mean of 4.4 ± 1.3. Thirty-six eggs were measured. Length range was 81.5-94.0 mm with a mean of 86.1 ± 3.14. Width range was 51.5-61.8 mm with a mean of 56.4 ± 2.76. Of 18 nests with known results, 10 hatched successfully (nesting success 55.6%). Hatching success was 95.7% and total hatching success was 62.0%.

Avian predation was identified in several instances. During a nest trapping attempt, a raven was seen flying 3 m above a pair of geese which were on the ground 3 m from their nest. One goose flew toward the raven in an apparent attack. The raven retreated and the goose returned to its mate. Thirteen predated eggs were found throughout the study area.

The shells were intact except for a side being eaten out and the insides were clean with no blood vessels present.

Brood Rearing

The first brood observation occurred on 28 May. Gosling age was estimated at less than 1 week. A total of 45 brood observations occurred between 28 May and 5 August. Observations of broods were limited to forest, forest edge, grass intertidal and intertidal zones, and open water. Brood observations are presented by month in Table 8.

Brood movements were extensive. One pair of geese with a 2 week old brood was observed to swim 4.8 km across open water. Broods on large bodies of water or beach areas would often flee into the forest and conceal themselves rather than swim from observers. Broods were difficult to locate in the forest. Breeding adults with goslings were nearly nonvocal in the forest except when flushed. After goslings had approached flight stage they would still run into the forest if they were near the forest edge. If pursued by observers they would fly.

Assuming a fairly synchronous hatch, I considered weekly intervals after my first brood observation to be representative of gosling age. This method was used because I rarely had an unobstructed view of broods long enough to allow an accurate estimation of age-class. Chi-square analysis of habitat use and weekly time periods after the first brood observation indicated habitat was not utilized randomly throughout the gosling growth period (Table 9). Statistical analysis of brood habitat use revealed no significant differences among time periods ($P < .096$) or tide stages ($P < .0473$). Chi-square analysis indicated greater use of forest habitat by single family units than by creches (Table 10).

Table 8. Number of Vancouver Canada goose brood observations by month in Seymour Canal, Admiralty Island, Alaska, 1979.

	May	June	July	August	Total
No. Obs.	5	30	9	1	45
Obs. Hrs.	128	459	284	104	975
Obs./Hr.	0.04	0.07	0.03	0.01	0.05

Table 9. Chi-square analysis of habitat use by Vancouver Canada goose broods the first 2 weeks after the first brood sighting compared to the number of sightings for the remainder of the study period in Seymour Canal, Admiralty Island, Alaska, 1979.

		Habitat			
		Forest	Forest Edge	Grass & Inter	Open Water
27 May - 10 June	Obs.	7	1	2	2
	Exp.	2.9	2.4	4.8	1.9
11 June - 5 Aug	Obs.	4	8	16	5
	Exp.	8.1	6.6	13.2	5.1

$X^2 = 11.0419$ d. f. = 3 $P < .0115$

Table 10. Chi-square analysis of habitat use and the size of Vancouver Canada goose broods in Seymour Canal, Admiralty Island, Alaska, during 1979 using numbers of brood observations.

		Habitat			
Size of Brood		Forest	Forest Edge	Grass & Inter	Open Water
1-8	Obs.	8	1	8	3
	Exp.	4.0	3.5	9.0	3.5
9+	Obs.	0	6	10	4
	Exp.	4.0	3.5	9.0	3.5

$X^2 = 11.9365$ d. f. = 3 $P < .0076$

Brood rearing areas were compared to nesting habitat using vegetative board readings, vegetation analysis, and canopy cover. The average vegetative board reading was identical to that obtained for nest sites, 16.8. Vegetation analysis and canopy cover were analyzed using 2-way analysis of variance; no statistically significant differences were found between nest sites and brood rearing areas. Species composition, mean DBH, and the height of trees in brood rearing areas are given in Table 11.

Brood Telemetry

All attempts to nest trap incubating birds failed; however, 3 goslings were captured and fitted with back-mounted radio transmitters at 6, 8, and 9 weeks of age. Thirty-one radio telemetry locations were made from 49 attempts. Radio locations were not used for habitat evaluation on goslings after the date of their estimated flight stage. Habitat use of transmittered goslings is given in Table 12. The average distance radioed goslings penetrated the forest was 182.9 m. Figure 3 delineates the area used for each transmittered gosling during telemetry readings.

Molting Flock

I observed a molting flock of approximately 300 geese at Fools Inlet. Table 13 presents weekly observations of the molting flock. Table 14 includes general observations of geese (molting geese excluded) on the general study area by 2 week periods.

Undisturbed molting geese were seen feeding at distances up to 0.4 km into the forest. Chi-square analysis revealed that habitat use

Table 11. Measurements of trees within 5 m radius of Vancouver Canada goose brood observation areas in Seymour Canal, Admiralty Island, Alaska, 1979.

	Sitka Spruce	Lodgepole Pine	West. Hem.	Mtn. Hem.	Alaska Cedar	Crab Apple	Red Alder	Snag
Mean DBH cm	6.6	17.6	6.9	7.9	34.5	7.4	9.1	10.0
Mean Ht. cm	3.7	9.3	3.5	3.8	14.5	4.0	6.0	3.9
Number	8	8	49	42	2	10	9	19
Percent	5.4	5.4	33.3	28.6	1.4	6.8	6.1	12.1

Table 12. Summary of telemetry data collected on Vancouver Canada goose goslings prior to flight in Seymour Canal, Admiralty Island, Alaska, during 1979.

Transmitter No.	Habitat Locations		Av. Distance Moved From Last Location	Av. Distance Into Forest	No. Days Locations Taken	Range of Days Locations Taken
	Forest	Open Water				
3661	4	-	245.8 m	223.9 m	3	29 July-7 Aug
3662	17	1	581.2 m	196.6 m	6	20 July-7 Aug
3665	2	3	544.1 m	128.1 m	3	29 July-7 Aug
Total	23	4	-	-	12	20 July-7 Aug
Mean	-	-	457.0 m	182.9 m	-	-

Figure 3. Movements of 3 transmittered Vancouver Canda goose goslings on Tideman Island, Alaska, 1979.

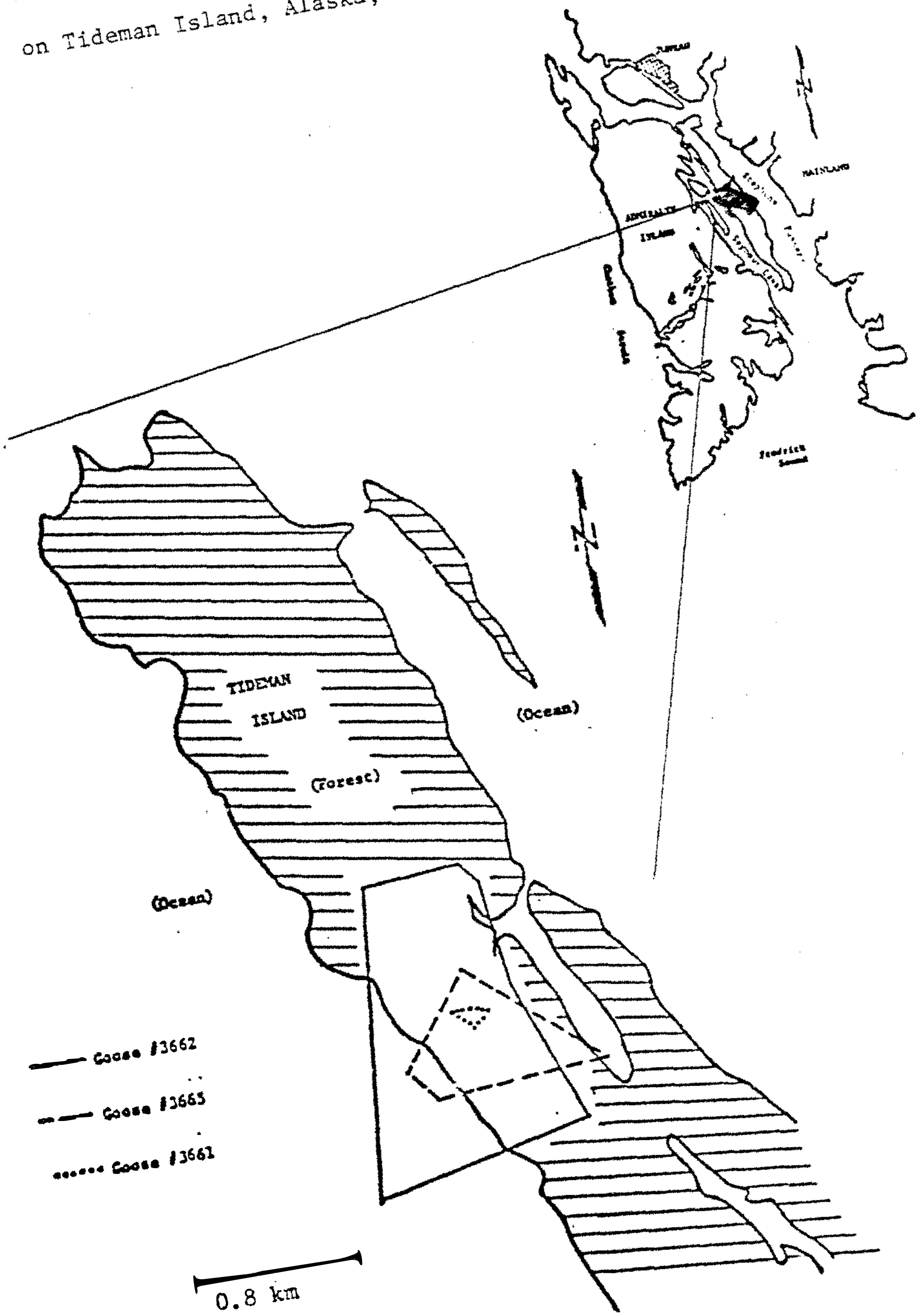


Table 13. Numbers of molting Vancouver Canada geese observed in Fools Inlet by 1 week periods in Seymour Canal, Admiralty Island, Alaska, 1979.

	25 June- 1 July	2-8 July	9-15 July	16-22 July	23-29 July	30 July- 9 Aug
Goose Numbers	422	433	426	238	847	35
Obs. Days	1	2	3	4	4	2
No. Geese Obs. Per Day	422	216.5	142.0	59.5	211.8	17.5

Table 14. General observations of Vancouver Canada geese in Seymour Canal, Admiralty Island, Alaska, 1979. Molting geese observed in Fools Inlet are not included in this data.

	8-21 April	22 April-5 May	6-19 May	20 May-2 June	3-16 June	17-30 June	1-14 July	15-28 July	29 July-9 Aug
Goose Numbers	1,694	808	348	472	395	605	58	91	220
Obs. Days	14	14	9	11	8	9	9	11	9
No. Geese Obs. Per Day	121	57.7	38.7	42.9	49.4	67.2	6.4	8.3	24.4

was non-random through daily time periods ($P < .0001$, Table 15) and was influenced by tide stage ($P < .0001$, Table 16).

Three molting geese and 1 gosling were fitted with radio transmitters in Fools Inlet. Sixty-nine attempts to locate birds by triangulation resulted in 28 successful locations. Six aerial locations were made by personnel of the Alaska Department of Fish and Game. Habitat use and movement data are presented in Table 17. The molting grounds used by radioed geese during telemetry work are shown by Figure 4. Sightings and radio locations of geese recorded after the study period by personnel of the Alaska Department of Fish and Game and the U.S. Forest Service are listed in Appendix A.

General Observations

I obtained 505 general observations on 4,704 geese in 1979. These observations do not include molting geese in Fools Inlet. Ninety-seven percent of all behavioral ceremonies were observed during the pre-incubation and incubation period (Table 18). Chi-square tests of flock size in relation to pre-incubation, incubation, and post-incubation were significant ($P < .008$, Table 19). Table 2 presents chi-square analysis of habitat types and time periods. Chi-square analysis of habitat use (grass tidal and intertidal) and tide stage is presented in Table 20. Chi-square analysis of habitat use and pre-incubation, incubation, and post-incubation periods is presented in Table 21.

Food Habits

Sixteen adult geese and 11 goslings (age 2-8 weeks) were collected for analysis of summer food habits. Of these, 14 were males and 13 were

Table 15. Chi-square analysis of habitat use and time periods using numbers of molting Vancouver Canada geese observed in Fools Inlet, Admiralty Island, Alaska, 1979.

Time Period		Habitat: Grass Tidal	Inter Tidal	Open Salt	Forest Edge	Forest	In Flight
2	Obs.	0	0	339	35	0	0
(0401-1000)	Exp.	54.8	32.4	195.2	73.8	11.7	6.1
3	Obs.	202	192	569	429	75	36
(1001-1600)	Exp.	220.3	130.2	784.4	296.7	46.9	24.4
4	Obs.	150	16	345	10	0	3
(1601-2159)	Exp.	76.8	45.4	273.5	103.4	16.4	8.5

$X^2 = 614.423$ d. f. = 10 $P < .0001$

Table 16. Chi-square analysis of habitat use and tide stage of molting Vancouver Canada geese observed in Fools Inlet, Admiralty Island, Alaska, 1979.

Tide Stage		Habitat: Grass Tidal	Inter Tidal	Open Salt	Forest Edge	Forest	In Flight
1	Obs.	2	0	208	0	0	10
	Exp.	32.3	19.1	114.8	43.4	6.9	3.6
2	Obs.	0	22	8	0	0	10
	Exp.	5.9	3.5	20.9	7.9	1.2	0.7
3	Obs.	0	51	106	82	0	0
	Exp.	35.0	20.7	124.7	47.2	7.5	3.9
4	Obs.	275	22	371	57	75	18
	Exp.	120.0	70.9	426.9	161.5	25.6	13.3
5	Obs.	75	113	560	335	0	1
	Exp.	158.9	93.9	565.7	214.0	33.9	17.6

$X^2 = 1133.414$ d. f. = 24 $P < .0001$

Table 17. Summary of telemetry data collected on molting Vancouver Canada geese in Fools Inlet, Admiralty Island, Alaska, 1979.

Transmitter No.	Habitat Location: Forest	Habitat Location: Forest Edge	Habitat Location: Open Water	Av. Distance Moved From Last Location	Av. Distance Into Forest	No. Days Locations Taken	Time Period
3658	9	0	0	1,172.2 m	254.2 m	8	17 July-9 Aug
3659	6	0	2	2,085.9 m	810.8 m	11	13 July-9 Aug
3663	1	0	0	-	-	6	24 July-9 Aug
3664	10	1	0	724.0 m	386.2 m	12	12 July-9 Aug
Total	26	1	2	-	-	37	12 July-9 Aug
Mean	-	-	-	1,327.4 m	483.7 m	-	-

Figure 4. Movements of 3 transmittered molting Vancouver Canada geese in Fools Inlet, Admiralty Island, Alaska, 1979.

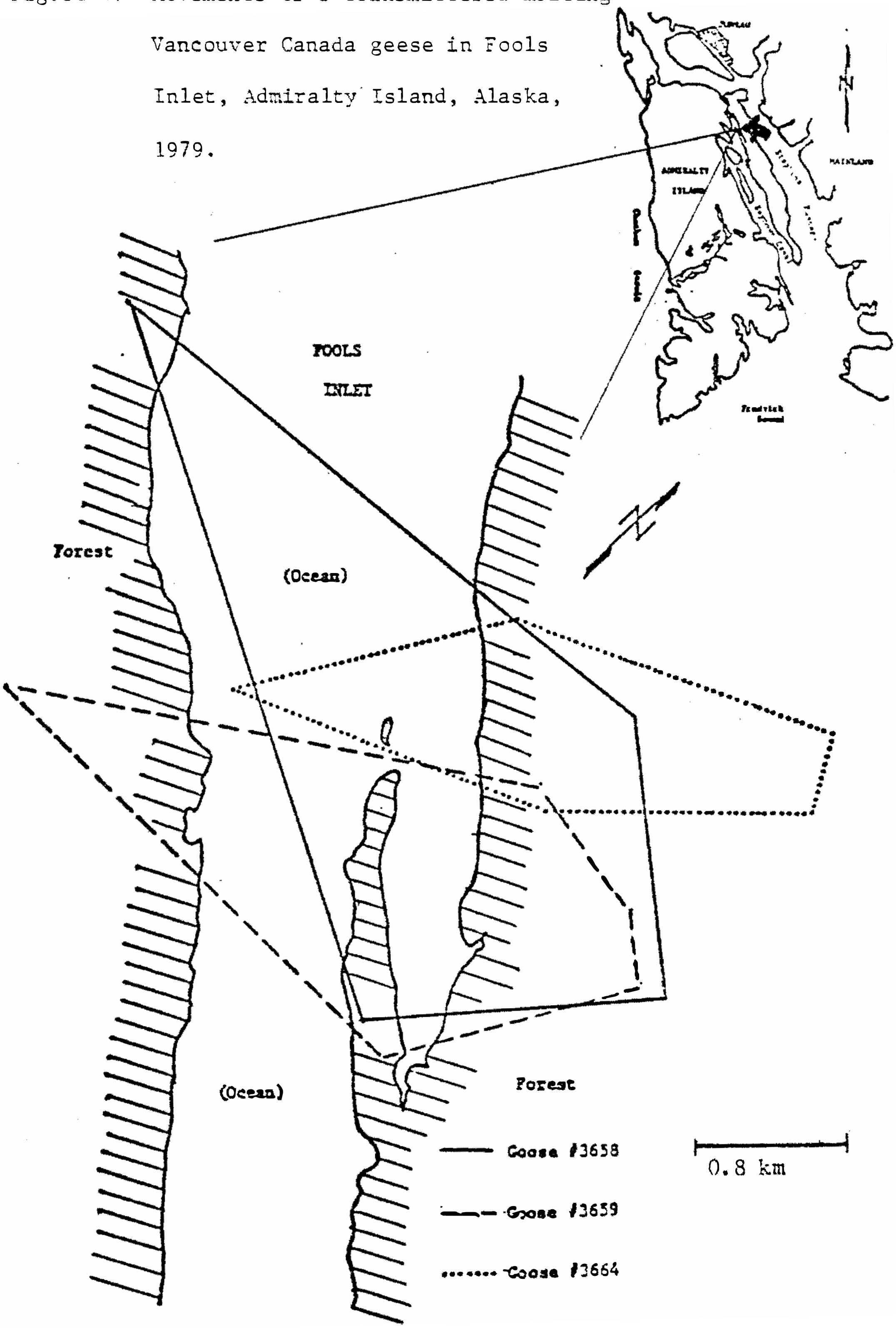


Table 18. Behavioral displays by Vancouver Canada geese during the pre-incubation, incubation, and post-incubation periods in Seymour Canal, Admiralty Island, Alaska, 1979.

Behavioral Ceremonies	8-23 April	24 April-7 June	8 June-9 Aug	Total
Triumph	18	23	2	43
Head Toss	17	19	0	36
Head Pump	7	2	0	9
Attack/Chase	22	14	2	38
Biting	2	1	0	3
Copulation	3	1	0	4
Total	69	60	4	133

Table 19. Chi-square analysis of Vancouver Canada goose flock size during the pre-incubation, incubation, and post-incubation periods in Seymour Canal, Admiralty Island, Alaska, 1979.

No. Geese/Flock		Pre-incubation	Incubation	Post-incubation
1	Obs.	13	25	8
	Exp.	17.2	21.5	7.3
2	Obs.	56	86	11
	Exp.	57.3	71.4	24.2
3-9	Obs.	65	67	30
	Exp.	60.7	75.6	25.6
10-19	Obs.	25	32	13
	Exp.	26.2	32.7	11.1
20+	Obs.	28	23	17
	Exp.	25.5	31.8	10.8

$X^2 = 20.611$ d. f. = 8 $P < .0083$

Table 20. Chi-square analysis of habitat use and tide stage using numbers of Vancouver Canada geese observed in Seymour Canal, Admiralty Island, Alaska, 1979. Molting geese observed in Fools Inlet are not included in this data.

Tide Stage[a]		Habitat: Grass Tidal	Habitat: Inter Tidal
1	Obs.	26	303
	Exp.	132.2	196.8
2	Obs.	232	331
	Exp.	226.2	336.9
3	Obs.	209	294
	Exp.	202.1	300.0
4	Obs.	481	560
	Exp.	418.2	622.8
5	Obs.	241	283
	Exp.	210.5	313.5

$X^2 = 166.35$ d. f. = 4 $P < .0001$

[a] 1 = low tide, 5 = high tide

Table 21. Chi-square analysis of habitat use compared to pre-incubation, incubation, and post-incubation periods using numbers of Vancouver Canada geese observed in Seymour Canal, Admiralty Island, Alaska, 1979. Molting geese observed in Fools Inlet are not included in this data.

Habitat Type		8-23 April	24 April-7 June	8 June-9 Aug
Grassy Intertidal	Obs.	372	286	531
	Exp.	547.9	365.5	275.6
Intertidal	Obs.	992	624	155
	Exp.	816.1	544.5	410.4

$X^2 = 519.08$ d. f. = 2 $P < .0001$

females. Six geese were collected in open water, 10 in the intertidal zones, 2 in muskeg, 4 at the forest edge, and 5 in the forest. Collection dates ranged from 24 April-28 July. Food habits data are presented in Table 22.

Geese became less observable on the study area as incubation began. After hatching, adults with broods were secretive and collecting geese for food study was difficult. Although my data indicate extensive feeding in forests, observations of broods and molting geese feeding in the forest were rare. Thus, it was nearly impossible to observe birds actively feeding prior to collection as recommended by Krapu (1974). Molting geese that were collected on open water normally had an empty esophagus and proventriculus.

Only traces of invertebrates were found in food samples. Plant material comprised the bulk of food items. Skunk cabbage (*Lysichiton americanum*) was first observed being utilized for food the first half of June. Goslings fed by eating the leaves of the plant down to the midrib (Fig. 5). Patches of skunk cabbage in areas of high brood use were devastated. Molting geese also used skunk cabbage. Fecal contents of goslings and molting geese also indicated use of blueberries.

Measurements and Banding

Eleven male and 14 female geese captured or collected on the study area were measured. All measurements were consistent with those reported for this subspecies by Ratti and Timm (1977). These data were also subjected to discriminant function analysis as described by Johnson et al. (1979) and met the criteria reported for *B. c. fulva.* Thirty geese were

Table 22. Esophageal and proventriculus contents of 27 Vancouver Canada geese collected in Seymour Canal, Admiralty Island, Alaska, 1979.

Food Item			
Scientific Name	Common Name	Percent Occurrence	Aggregate Percent
Plant			
Lysichiton americanum	Skunk cabbage	22.7	23.8
Ulva spp.	Sea lettuce	9.1	10.0
Vaccinium spp.	Blueberry (berries)	9.1	10.0
Vaccinium spp.	Blueberry (leaves)	9.1	5.6
Picea sitchensis	Sitka spruce (needles)	9.1	5.6
Equisetum spp.	Horsetail	9.1	5.5
Plantago maritima	Goose tongue	9.1	5.4
Elymus mollis	Beach ryegrass	9.1	5.0
Carex lyngbyaéi	Sedge	4.5	5.0
Zostera marina	Eel grass	4.5	5.0
Puccinellia nutkaensis	Alkali grass	4.5	5.0
Listera cordata	Orchid	4.5	0.2
Sphagnum spp.	Moss	4.5	Tr
Unidentified		40.9	14.6
Animal			
Gastropoda	Snails	4.5	Tr
Hemiptera	True bugs	4.5	Tr
Amphipoda	Scuds	4.5	Tr

Figure 5. Photo of Vancouver Canada goose feeding damage to skunk cabbage (Lysichiton americanum) comparing normal and depredated leaves in Seymour Canal, Admiralty Island, Alaska, 1979.

fitted with neck collars and U.S. Fish and Wildlife Service leg bands. Neck banded geese were seen during the study period but no collar number identification could be made. Banding information on geese banded during the study is given in Appendix B.

DISCUSSION AND CONCLUSIONS

Tree Use

Tree use during the nesting period was associated with the breeding biology of Vancouver Canada geese. Above ground perching may provide excellent observability for nest site selection in addition to protection from predators. During nest trapping, returning pairs often landed in adjacent trees and remained in the trees for 10-45 minutes before landing near the ground nest sites. Although observations were limited, antagonistic behavior was observed between perching geese, which may reflect competition for perching sites. Intruders did not appear to seriously alarm geese perched in trees; birds often remained perched and relatively silent during my approach. I commonly observed a single goose loafing in a tree adjacent to an incubating goose; thus, trees appeared to serve as loafing sites for males.

From reports available in scientific literature, I assume Vancouver Canada geese are the only subspecies of geese commonly utilizing forest trees for perching. Ratti (1973) located a Vancouver Canada goose nest on a sphagnum moss covered bough of a spruce tree and also reported observing geese perching in trees. Craighead and Craighead (1949) reported 1 goose nest (*B. c. moffitti*) in an old red-tailed hawk nest along the Upper Snake River in Wyoming. The notable difference between these reports is the Vancouver Canada goose actually constructed the nest by removal of moss, creating a nest bowl (Ratti pers. comm). Tree nests are difficult to locate in the dense Southeast Alaska forests. The common occurrence of tree perching geese suggests that tree nesting by Vancouver Canada geese may be more common than indicated by existing data on nests.

Nesting

Of the various habitat types, forest habitat was the most difficult to search. Of all nests located, 85% were in relatively dense forest, indicating the importance of this habitat type to nesting birds. Others have reported the avoidance of forest and dense shrubs by nesting Canada geese (Klopman 1958, Sherwood 1968, Kaminski and Prince 1977, Cooper 1978). However, nest sites in heavy shrub and tree growth have been reported by Geis (1956), but not with the frequency observed in this study. The significant difference between canopy cover above the nest versus 5 m distant was partially attributed to the location of 25 of the 26 nests at the base of trees. Kossack (1950:637) and Sherwood (1968:78) reported Canada goose nests adjacent to stumps or logs with an unobstructed view. Canopy cover above the nest may reduce avian predation.

A bird observed adjacent to a nest site was assumed to be the paired male. However, I was unable to ascertain the status of a third goose at 2 nest sites; two explanations appear plausible: (1) idle non-breeding birds, or (2) nesting birds having a nest I failed to locate.

Mean clutch size was lower than that reported for the giant Canada goose (*B. c. maxima*), the western Canada goose (*B. c. moffitti*), and lesser Canada goose (*B. c. interior*) (Hanson 1965). Younger nesting females are reported to have smaller clutches (Brakhage 1965, Hanson 1965, Cooper 1978). The ages of nesting Vancouver Canada geese in this study were unknown and may have influenced clutch size. My estimate of clutch size may also have been biased by avian predators removing eggs from nests. Vermeer (1970) reported that predation is not always followed by desertion of the nest. Egg dimensions for Vancouver Canada geese are similar to those reported by Bellrose (1976) and Manning (1978) for other Canada goose subspecies. Nest success, hatching success, and total hatching success was also comparable to other Canada goose subspecies (Hanson 1965:165).

Potential nest predators present on Admiralty Island were mink (Mustela vison), river otter (Lutra canadensis), marten (Martes americana), brown bear (Ursus middendorffi), Steller's jay (Cyanocitta stelleri), northwestern crow (Corvus caurinus), and the common raven (Corvus corax). Identification of nest predators was difficult; however, I suspect avian predators influenced total hatching success on Tideman Island. Craighead and Craighead (1949:58-59) described similar observations of ravens in nesting areas. I concluded that the predated eggs found throughout the study area conformed to the description of avian predation by Rearden (1951).

Nests appeared to be more concentrated on Tideman Island than on other areas surveyed, although nest searching was distributed throughout the study area. Habitat types on Swan Island appeared to be similar to Tideman Island. However, brown bear sign was abundant on Swan Island while no bear sign was observed on Tideman Island during the study period. Tideman Island has a reputation among local people for very little bear activity. Although I did not observe brown bear predation on nests, black bear (Ursus americanus) predation has been reported on

Vancouver Canada goose nests (Ratti pers. comm.). Four ground nests were found on Admiralty Island proper, indicating Vancouver Canada geese will nest in areas of high bear concentrations. One can only speculate as to the influence of bear predation on nest site selection by geese on the study area.

Culbertson et al. (1971) and Hanson and Browning (1959) reported vegetation type to have little effect on nest site selection. McCabe (1979) found that plant species around the nest were not as important as the cover they provided. In this study, moss showed the only statistical difference among vegetative species less than 1 m and 5 m from the nest site. Moss in Southeast Alaska is a dominant ground cover; thus, I conclude little biological significance. Williams and Sooter (1940) noted suitable brood rearing areas to be a factor in nest site selection. Since no significant differences were identified between forested nesting sites and forested brood rearing habitats in this study, I concluded that nesting geese may have selected breeding areas for the availability of brood rearing habitat rather than specific nesting requirements.

The small pools of water adjacent to 60% of the nests did not appear to provide adequate escape protection from ground predators. Hanson (1965) and Kaminski and Prince (1977) noted that an important factor to nesting geese was the availability of bodies of water of moderate to large size; this does not appear to be a requirement of Vancouver Canada geese. I suspect the seclusion offered by forests may substitute for the necessity of large bodies of open water in close proximity to nest sites.

Habitat Use

The number of brood observations per unit effort of searching decreased during the course of the study (Table 8). Broods were relatively easy to locate in the forest when they were less than 2 weeks old. At this age, goslings were not highly mobile and were vocal when an observer approached. Parent geese remained close to the goslings. Beyond 2 weeks of age the broods easily escaped observation due to increased mobility and decreased vocalization. As breeding adults neared the molting period, they also became relatively non-vocal. My low number of observations for July were likely due to (1) the increasing age of goslings and (2) the onset of molt in adult geese.

Broods generally avoided open water, although they were observed crossing large water areas. Culbertson et al. (1971) described similar long distant movements by Canada goose broods. The data from Table 9 indicated that goslings less than 2 weeks of age used forest habitats extensively and slowly shifted to use forest edge and intertidal zones with age and growth. This conclusion was supported further by the low probability of observing a brood in dense forest foliage compared to other habitat types.

Location of birds via triangulation at ground level was difficult in forested, irregular terrain having a dense wet understory. The accuracy of hand-held antenna systems has been evaluated by Biggins and Pitcher (1978). Although I feel our radio locations had less error than the hand-held system of Biggins and Pitcher, I am aware of some inaccuracy in our locations. However, telemetry locations in conjunction with direct observations of broods, and numerous observations of droppings and molted feathers substantiated the extensive use of forests by adults and broods. I suspect that habitat use by broods was influenced by non-breeding adult geese. Broods may use more open habitats when in the presence of large numbers of non-breeders. Ratti (pers. comm.) also reported a large creche and non-breeding birds using an open meadow. "One group had 45 adults with 37 goslings. When approached, only 20 adults remained with the goslings while 25 flew from the area" (Ratti 1973:31). Non-breeding adult geese present with broods also inflated the number of geese per brood observation.

Broods were observed as distinct units and as creches similar to observations of grouping by other subspecies (Miller and Collins 1953, Brakhage 1965). Undisturbed creches were observed to disband into distinct family units and later reassemble. Single broods were most commonly found in the forest while creches were in areas promoting grouping such as lake edges, intertidal flats, and semi-open meadows. Creches are reported to reduce aerial predation as isolated young birds are less likely to notice predators and would be easier to prey on than an individual in a tightly moving group (Kear 1970:383). The safety provided by numbers may explain creche utilization of open habitat more often than single family broods. Creches and extensive use of forest habitat may reduce avian predation. Bald eagles (Haliaeetus leucocephalus), crows, and ravens are common on Admirality Island. Nesting birds and young broods utilizing open water, beach, or intertidal zones would be highly susceptible to these aggressive avian predators. Thus, eagles, crows, and ravens may have strongly influenced the utilization (via natural selection) of forest habitats. Broods appeared to undergo a period of adjustment to flight. I assume goslings ran into the forest after flight stage had been reached, rather than fly from observers, because it took time for them to abandon the use of forests as escape cover.

Molting Flock

Subadult, non-breeding, and unsuccessful nesting Canada geese commonly undergo molt migrations (Sterling and Dzubin 1967). Molt migrations in Vancouver Canada geese have been documented. Adam's Inlet, in Glacier Bay National Monument, has the largest known concentration of molting Vancouver Canada geese (Ratti et al. 1977). I suspect the molting flock observed in Fools Inlet represents geese from the general vicinity of Seymour Canal. Molting geese were observed in Fools Inlet as early as 1958 (M. Perensovich, Pers. comm.).

Goose observations per day declined abruptly from late June to early July periods on the general study area (Table 13) while they simultaneously appeared in Fools Inlet (Table 14). This represents the time that non-breeding geese would be expected to arrive on molting grounds. An increase in observations occurred from the 15-28 July to the 29 July-9 August in the study area (Table 13) while a simultaneous decrease was observed in Fools Inlet during the same periods (Table 14). This shift in observations coincided with geese completing molt and dispersing from the molting area throughout the general study area.

Molting geese also used forested habitat for concealment. My first observation of geese on the molting grounds occurred when a small group of geese ran into the forest when approached. They flew, however, when followed by observers into the forest. The molting flock, which at this time could still fly, reacted in this manner.

When approached by boat, flightless geese on water or in the intertidal zone would flee into the forest. A group of 75 geese so approached fled into the forest and were followed by 2 searchers within 5 minutes. No geese were located after an extensive search. Ratti (pers. comm.) reported similar behavior by flightless Vancouver Canada geese in Adams Inlet. Forest use, indicated by radio locations, was reconfirmed by ground surveys. I suspect that forest use decreased the number of observations on molting geese; similarly, goose observations on the general study area were probably also reduced by forest use during the molting period.

Saltwater was utilized most during morning and late afternoon by molting geese, while forest edge was utilized heavily during midday (Table 15). Grassy intertidal zones were also utilized heavily during late afternoon and were likely associated with saltwater use during that time period. Data from Table 16 indicated the higher grassy intertidal zone was used more than expected as tides increased (TS 4) and covered lower intertidal regions. Grassy intertidal zone use was less than expected at high tide (TS 5) when a good portion of this zone was covered by water. When high tide occurred, geese avoided open water and utilized higher elevations and forest edge. Geese were presumably following the tide line.

Human disturbance on molting grounds has caused molting geese to desert molting sites (Sterling and Dzubin 1967). Disturbance also affected selection of molting lakes by diving ducks (Bergman 1973). I feel that our disturbances caused abandonment of a protected grassy intertidal brood rearing area. Known molting sites should be provided some protection from human disturbance during the molting period.

General Observations

Geese became secretive and difficult to observe during the post-incubation period. Consequently, most observations of behavior occurred during the pre-incubation and incubation periods (Table 18). Observations of 2-bird groups declined in the post-incubation period (Table 19). The decline was likely due to the secretive nature of pairs with broods or the association with non-breeding birds. Copulations by Vancouver Canada geese were similar to those described by Klopman (1962). Group size counts of landing geese could not be evaluated (Raveling 1968).

As previously noted with Table 2, chi-square analysis indicated that birds did not use various habitat types randomly through daily time periods. Observed versus expected values for grassy tidal flats indicated less use during midday (TP 3) and more use than expected for late afternoon (TP 4). This probably reflected feeding habits. The observed use of the intertidal zone for TP 2, 3, and 4 was similar to the expected use. The use of the forest edge in TP 3 was more than expected. Geese may use the forest edge for loafing during midday.

Data in Table 20 also indicated that utilization of grass tidal and intertidal habitat zones was influenced by tide stage. Geese were observed less than expected in the higher grassy intertidal zones during low tide (TS 1); thus, use of the intertidal zone was higher than expected during low tide. Geese may have moved to the lower intertidal regions for feeding when the area is free of tidewater.

The data in Table 21 revealed heavy use of the intertidal zones during the pre-incubation period. Use of this zone steadily declined with time and corresponded with a shift to greater utilization of the grassy intertidal zone during post-incubation periods. The pre-incubation period was a time of low plant growth in the grassy intertidal zone. Ocean based foods are less abundant in the grassy intertidal zone than in the lower non-vegetated intertidal region, which undergoes daily tidal fluctuations. I suspect that during early spring the intertidal zone provided more food. As plant growth commenced during the incubation period, more geese began to use the grassy intertidal zone. This shift in habitat use was also compatible with the more secretive behavior of birds during incubation and post-incubation periods.

Food Habits

Food habits of Vancouver Canada geese indicated predominant use of plant matter. Food habit studies of other Canada goose subspecies have shown extensive use of green forage and cereal grains (Bellrose 1976). Skunk cabbage was an important food item used by Vancouver Canada geese. Hanson (1965) reported giant Canada geese feeding on a different genus and species of skunk cabbage, *Symphocarpus foetidus*, in Wisconsin. Both species of skunk cabbage belong to the Arum Family, *Araceae*. I suspect skunk cabbage to be a more important food item during brood rearing than indicated by the food habits data. Owen (1972:89-90) felt "that grazing geese rely on ingesting a large amount of food, up to

25% of their body weight per day, which they pass through rapidly and digest inefficiently." Owen concluded (1972:91) "that maintaining a high rate of food intake is more important to geese, which digest their food inefficiently, than is selecting the most nutritious diet possible." Therefore, the presence of an abundant food source such as skunk cabbage, may be an important factor in management of Vancouver Canada geese during brood rearing and the molting period. Addy and Heyland (1968:17) stated that in the Atlantic Flyway Canada geese "have forsaken their traditional aquatic habitats and have become primarily upland feeders." In a similar fashion, Vancouver Canda geese have demonstrated feeding adaptability by utilizing forest plant species as food.

Cottam et al. (1944) found primarily eelgrass, _Ulva_, sedges, and grasses in the diet of black brant _(Branta bernicla nigricans)_ in Alaska, British Columbia, and California. His Alaskan birds were collected where eelgrass was not abundant and they contained a higher proportion of grasses and sedges and animal food.

I suspect that Vancouver Canada geese may rely more on animal food matter during the winter months when plant foods are not as available or abundant. Future research should examine winter feeding ecology.

Management Implications to Timber Harvest

Nesting and brood rearing by Vancouver Canada geese occurred on forest habitats classified by the U.S. Forest Service as poorly drained (F4 and F5) soil types. F4 soils have a Site Index (SI) rating of 120 for Sitka spruce (intermediate productivity). Timber on these soils is valuable for the second growth stands that occur after harvest.

F5 soils have an SI rating of 80 and are not suited to production of commercial timber due to excess moisture. Preservation of forests on F5 soil types for goose management appears to be compatible with present timber harvest policy. However, some conflict may exist with utilization of timber on F4 soils. The immediate and long-term effects of logging on these soil types is unknown from the data obtained in this study.

The main objective of this study was to obtain baseline biological information on the Vancouver Canada goose in a relatively undisturbed (unlogged) area. Research in newly logged and second growth forests is needed to assess the impact of logging on the biology of the Vancouver Canada goose. In addition, more data are needed to ascertain the association of poorly drained forest sites to nesting and brood rearing habitat. Due to limited sample size of nest locations, the apparent importance of poorly drained forests to goose nesting ecology may be biased.

Conclusions Summary

This study disclosed that Vancouver geese have ecological adaptations and behavior unique among all subspecies of Canada geese. Vancouver geese are highly adapted to forest habitats, commonly use trees for perching during the incubation period, and heavily utilize a forest plant species as a summer food that has not previously been reported as a food item for waterfowl.

Several tentative conclusions can be reached regarding environmental factors important to nesting and brood rearing. The geese do not require large bodies of water for escape cover, as reported for most waterfowl.

Forest habitat, especially forest zones on poorly drained soils, appear to be preferred for nesting and early brood rearing. Optimal nesting conditions may be associated with low bear density and skunk cabbage may be the most important food item during the nesting and brood rearing period.

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APPENDIX

Appendix A. Sightings and radio locations of Vancouver Canada geese reported in Seymour Canal, Admiralty Island, Alaska.

Collar No./Radio No.	Area Located	Date	Location Techniques
No. unidentifiable	Mole Harbor	19 Aug 1979	Visual
KA-26 (688-23026)	Gambier Bay Admiralty Island	5 Sept 1979	Shot
KA-40 (688-23040)	Tideman Island	2 Sept 1979	Shot
#3664 & #3658	Fools Inlet	13 Feb 1980	Telemetry
#3658	Fools Inlet	28 Feb 1980	Telemetry
#3658 & #3661	Fools Inlet	5 March 1980	Telemetry
No. unidentifiable	Pack Creek	26 March 1980	Visual
#3665 & #3662	Tideman Island	3 April 1980	Telemetry
#3664	Fools Inlet	3 April 1980	Telemetry

Appendix B. Banding information of Vancouver Canada geese banded during the study period in Seymour Canal, Admiralty Island, Alaska, 1979.

USFWS Band No.	Collar No.	Location Banded	Date	Sex	Age
688-23002	KA02	T46S-R69E Sect. 14	2 July	M	5 wk
688-23003	KA03	T46S-R69E Sect. 10	2 July	M	5 wk
688-23004	KA04	T46S-R69E Sect. 10	2 July	F	5 wk
688-23005 Radio #3664	KA05	T44S-R69E Sect. 30	6 July	M	Imm
688-23006	KA06	T44S-R69E Sect. 30	6 July	M	Ad
688-23007 Radio #3659	KA07	T44S-R69E Sect. 30	6 July	F	Imm
688-23008	KA08	T44S-R69E Sect. 30	6 July	F	Ad
688-23009	KA09	T44S-R69E Sect. 30	6 July	F	Ad
688-23010	KA10	T44S-R69E Sect. 30	6 July	M	Ad
688-23011	KA11	T44S-R69E Sect. 30	6 July	M	Ad
688-23012	KA12	T44S-R69E Sect. 30	6 July	F	Ad
688-23013	KA13	T44S-R69E Sect. 30	6 July	F	Ad

Appendix B. Continued

USFWS Band No.	Collar No.	Location Banded	Date	Sex	Age
688-23014	KA14	T44S-R69E Sect. 30	6 July	F	Imm
688-23015	KA15	T44S-R69E Sect. 30	6 July	M	Ad
688-23016	KA16	T44S-R69E Sect. 30	6 July	M	Imm
688-23017	KA17	T44S-R69E Sect. 30	6 July	F	Imm
688-23018	KA18	T44S-R69E Sect. 30	6 July	F	Ad
688-23019 Radio #3662	KA19	T46S-R69E Sect. 16	16 July	F	7 Wk
688-23020	KA20	T45S-R69E Sect. 2	14 July	M	Imm
688-23021	KA21	T45S-R69E Sect. 2	14 July	M	Imm
688-23022	KA22	T45S-R69E Sect. 2	14 July	F	Imm
688-23023 Radio #3658	KA23	T44S-R68E Sect. 25	16 July	F	Imm
688-23024	KA24	T44S-R68E Sect. 25	16 July	F	Imm
688-23025	KA25	T44S-R69E Sect. 31	18 July	F	Ad
688-23026	KA26	T44S-R69E Sect. 25	24 July	M	6 Wk
688-23027 Radio #3663	KA27	T44S-R68E Sect. 25	24 July	M	6 Wk

Appendix B. Continued

USFWS Band No.	Collar No.	Location Banded	Date	Sex	Age
688-23028	KA28	T44S-R68E Sect. 25	24 July	M	Ad
688-23029	KA29	T44S-R69E Sect. 31	24 July	M	7 Wk
688-23030	KA30	T44S-R69E Sect. 31	24 July	M	7 Wk
688-23040 Radio #3662	KA40	T44S-R69E Sect. 23	29 July	M	9 Wk

Goose (9 week old male) with radio #3665 has neither leg-band or neck collar.