Waterfowl of North America: SWANS AND TRUE GEESE Tribe Anserini

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SWANS AND TRUE GEESE
Tribe Anserini

The approximately twenty extant species of swans and true geese are, unlike the whistling ducks, primarily of temperate and arctic distribution, especially in the Northern Hemisphere. It is thus not surprising that continental North America may lay claim to at least nine breeding species, or nearly half of the known total. Additionally, sufficient records of a tenth, the barnacle goose, are known as to warrant its inclusion in the book even though there is no indication that it nests in continental North America.

Several additional Old World species of geese and swans have been reported one or more times in North America, but the likelihood of at least some of these being escapes from captivity seems so great that their inclusion seems unjustified. These species include the red-breasted goose (*Branta ruficollis*), which has been collected in California at least five times and has also been seen in recent years in Texas, Pennsylvania, and Kansas, but is not known to nest nearer than central Siberia. The bean goose (*Anser fabalis*) has been reliably reported from Alaska (Byrd *et al.*, 1974), while the smaller pink-footed goose (*A. f. brachyrhynchus*) has been collected in Massachusetts (Bent, 1925) and seen in Delaware (*Audubon Field Notes*, 8:10, 9:235). Other Old World species that have been reported, such as the lesser white-fronted goose (*Anser erythropus*) and the bar-headed goose (*Anser indicus*), appear to have represented escapes from captivity, although a specimen of the former species was recently shot in Delaware (*American Birds* 27:597).

Geese and swans are generally large waterfowl that are almost entirely vegetarian in their diets. Swans forage predominantly in water, eating surface vegetation or tipping-up to reach underwater plants, but occasionally resort to eating terrestrial plants on shorelines or even in fields. Geese, however, forage both in water and on land, with some species such as brant foraging exclusively on aquatic life while others rely largely on terrestrial herbaceous plants. In most geese the cutting edges of the upper and lower mandibles are...
coarsely serrated in the manner of the pinking shears, providing an effective method of clipping off vegetation close to the ground. Like whistling ducks, swans and true geese have a reticulated tarsal pattern, lack iridescent or sexually dimorphic plumage patterns, and form strong, persistent pair bonds. Indeed, the fidelity of swan and goose pairs is legendary, although in actual fact this pairing behavior falls slightly short of their supposed perfect fidelity.

Although some authorities recognize a larger number of genera and species, recent investigators have generally recommended that only two or three swan genera be recognized (Coscoroba, Cygnus, and perhaps Olor) and that the genera of typical true geese be reduced to no more than three (Anser, Branta, and perhaps Nesochen). Likewise, species limits have been enlarged in recent years, so that the Old World and New World representatives of the arctic swans are now usually considered conspecific, the “blue goose” is generally recognized to be nothing more than a color phase of the snow goose, a single species of brant goose is recognized, and although a larger number of Canada goose races have recently been designated they are clearly part of an intergrading series of population complexes.
MUTE SWAN

*Cygnus olor* (Gmelin) 1789

Other Vernacular Names: None in general use.

Range: Breeds through the temperate portions of Europe and western Asia, as well as eastern Siberia. Introduced and locally established in New Zealand, Australia, and North America, especially along the northeastern coast, centering on Long Island.

Subspecies: None recognized. A variant, called the “Polish swan,” is known to be a color phase.

Measurements (after Delacour, 1954):

- Folded wing: Both sexes 560-625 mm. Frith (1967) reports males as 560-622 and females as 535-570 mm.
- Culmen: Males (from knob) 70-75 mm. Frith reports males as 70-85 and females as 73-90 mm.

Weights: Bauer and Glutz (1968) summarized available data. Males seldom weigh over 13.5 kilograms (29.7 pounds), and females should not weigh much over 10 kilograms (22 pounds). However, four old birds weighed between September and December averaged 16.225 kilograms (35.78 pounds).
pounds), with a maximum of 22.4 kilograms (49.39 pounds). Fisher and Peterson (1964) reported a maximum male weight of 50.6 pounds, an apparent record weight for flying birds. Scott et al. (1972) presented weight data indicating that although male mute swans average slightly heavier than male trumpeters (12.2 vs. 11.9 kilograms), female mutes average slightly lighter than female trumpeters (8.9 vs. 9.4 kilograms).

**IDENTIFICATION**

*In the Hand:* Mute swans are the only white swans that have generally reddish to orange bills with an enlarged black knob at the base (lacking in immatures), outer primaries that are not emarginate near their tips, and a somewhat pointed rather than rounded tail. The trachea, unlike those of native North American swans, does not enter the sternum.

*In the Field:* This large swan is usually seen in city parks, but may occasionally be seen as a feral bird under natural conditions, especially in the eastern states and provinces. The neck of the mute swan is seemingly thicker than those of the trumpeter and whistling swans, and while swimming the bird holds it gracefully curved more often than straight. Further, the wings and scapulars are raised when the birds are disturbed, rather than being compressed against the body. The orange bill and its black knob are visible at some distance. In flight, the wings produce a loud “singing” noise that is much more evident than in the native North American swans, and, additionally, mute swans rarely if ever call when in flight, as is so characteristic of the native species. A snorting threat is sometimes uttered by male mute swans, which is their apparent vocal limit.

**AGE AND SEX CRITERIA**

*Sex Determination:* Males are considerably heavier and larger than females, and individuals in excess of 10 kilograms are most probably males. Males also have larger black knobs at the base of the bill and most often assume the familiar threatening posture. For immature birds, internal examination is required to determine sex.

*Age Determination:* Any bird still possessing feathered lores or some brownish feathers of the juvenal plumage is less than a year old. Second-year birds may have smaller knobs and less brilliant bill coloration than is typical of older birds.
DISTRIBUTION AND HABITAT

Breeding and Wintering Distribution and Habitat: In North America the mute swan occupies a sedentary breeding and wintering range that is a direct reflection of human activities. There seems to be no historical account of the spread of the species in the Hudson Valley and on Long Island after it was originally released as a park bird. Being properly considered an exotic, the species was not included in bird lists until the 1930s, when the fourth (1931) edition of the A.O.U. Check-list noted that it had become established on the lower Hudson Valley and the south shore of Long Island, sometimes straying to the coast of New Jersey. East Coast hurricanes, such as the one that occurred in 1939, caused additional dispersal of birds previously confined to wealthy estates on Long Island and in Rhode Island. By 1949 the species had spread through much of Long Island and had also become well established in Rhode Island (Audubon Field Notes, 3:5; 10:370). By the late 1950s it was nesting along the entire shore of Rhode Island (ibid., 12:396), and a brood had been reported in the District of Columbia (ibid., 12:403). A secondary population center was simultaneously developing on upper Lake Michigan around Grand Traverse Bay and Lake Charlevoix (Edwards, 1966). Early counts of this population were reported by Banko (1960), who noted an increase from two birds in 1948 or 1949 to forty-one by 1956. Apparently initiated by a release of two birds in 1918, the flock consisted of at least six hundred by 1973, when efforts began to transplant and establish new flocks in Illinois, Texas, Ohio, Arkansas, Oklahoma, and New Mexico (Chicago Tribune, August 30, 1973).

The annual Christmas counts of the Audubon Society provide a rough index to the population growth of mute swans in North America. During the years 1949 through 1969, the numbers of such counts approximately doubled from 403 to 876, while the total number of mute swans counted increased from 374 to 1,644. The average total count for the ten-year period 1950–1959 was 504 birds, with an average of fewer than twenty stations reporting the species, while during the period 1960–1969 the average total count was 1,434 birds, with an average of thirty-four stations reporting mute swans.

In recent years, pioneering birds have occupied new localities for breeding. These include nestings in Massachusetts (Audubon Field Notes, 17:446), Delaware (ibid., 19:531; 20:557), New Hampshire (ibid., 23:638), and Connecticut (ibid., 24:583), plus isolated breedings in South Dakota (ibid., 22:618), Saskatchewan (ibid., 21:618; 23:618), Ontario (ibid., 23:584),
Breeding (hatched) and wintering (shaded) distributions of the mute swan in North America. Recent extralimital breeding records by apparently feral birds are also indicated.
and Virginia (*American Birds*, 26:842). A feral flock also occurs near Victoria, British Columbia (Ronald Mackay, pers. comm.).

**GENERAL BIOLOGY**

*Age at Maturity:* The earliest known age of reproductive maturity in North America has been reported as two (Johnston, 1935) or three (Willey, 1968) years, but studies in England indicate considerable variation may occur. Perrins and Reynolds (1967) indicated that three years of age is the most common time of initial breeding for females, but a few birds may breed at two and some may not breed until they are six years old. Initial breeding by males occurred between three to seven years of age. Minton (1968) found that of forty-three mute swans, half initially nested and raised young at the age of three, while an additional third did so the following year, with a slight tendency for females to mature earlier than males. Three birds did not breed until they were at least six years old.

*Pair Bond Pattern:* The strong pair bond of swans is well known. Minton (1968) reported that “divorce” (the changing of partners when both are still alive) among the paired population had an incidence of about 4 percent for nonbreeding pairs and 1 percent for breeding pairs. In cases where both birds survived to following years, 82 percent of the successful breeders and 78 percent of unsuccessful breeders remained paired. Of seventy-one pairings first studied in 1961, six were still intact in 1966. During the six-year study, eleven males and nine females were known to have had at least three different mates, but in several cases (twelve males and two females) birds that had apparently lost their mates remained on their nesting territory the following year. In some cases there was a gap of two or three years before re-pairing, while in others the birds apparently gave up pairing permanently.

*Nest Location:* Nests are usually built on islands or in shallow water, sometimes in colonies, with one English colony in Dorset having had as many as 500 nests (Scott and Boyd, 1957). Established breeders tend to use previous nest sites. Willey (1968) estimated the average size of twelve nesting territories as 4.4 acres (range 0.5 to 11.8 in Rhode Island). Minton (1968) noted that both breeding and nonbreeding pairs were more prevalent on small (10 acres or less) water areas than on larger ones, but considering availability, larger water areas were slightly favored. Likewise, streams were favored over canals or rivers (over 20 feet wide), especially by breeding pairs. Clean, weed-filled waters were also preferred over more polluted waters.

*Clutch Size:* Most studies indicate that about 6 eggs constitute an average clutch size for mute swans; Perrins and Reynolds (1967) reported such
an average for 92 nests. Studies summarized by Bauer and Glutz (1968) also indicate averages of between 5.8 and 6.2 eggs. Clutch sizes of up to 11 eggs laid by one female are known, and renesting attempts appear to average less, or about 4 eggs (Perrins and Reynolds, 1967).

**Incubation Period:** This is generally estimated as 35 to 36 days, with some estimates of up to 38 days (Bauer and Glutz, 1968). The female incubates, but the male actively protects the nest.

**Fledging Period:** This has been variously reported as four and a half months (Bauer and Glutz, 1968), 18 weeks (Lack, 1968), and 18 to 20 weeks (Scott and Boyd, 1967).

**Nest and Egg Losses:** Willey and Halla (1972) reported the loss of 87 eggs and young from a total of 236 in 47 nests after severe flooding and cold weather in Rhode Island in 1967. Minton (1968) reported a 59 percent nesting success among 352 pairs, and a 52 percent success for 11 renesting attempts, with 80 percent of the nest losses due to human disturbance or destruction.

**Juvenile Mortality:** Minton (1968) found that the average brood size (219 broods) at fledging over a six-year period was 3.5 birds, while the total number raised to fledging averaged 2.0 per breeding pair. Perrins and Reynolds (1967) likewise found an average brood size of 3.1 young for 83 broods, with an estimated 2.0 young raised per pair (including pairs that did not hatch any young at all) to September. They estimated that the average mortality rate between hatching and fledging was 50 percent, with an additional 23 percent mortality rate for the rest of the year. Willey (1968) estimated a prefledging mortality of 56.4 percent in 1968, with the snapping turtle apparently a primary predator of cygnets.

**Adult Mortality:** Perrins and Reynolds (1967) estimated that among immature birds there is a 67 to 75 percent survival (25 to 33 percent mortality) rate, while breeding adults have a survival rate of 82 percent, possibly decreasing after the sixth year of life. There is little difference in the estimated mortality rates of the two sexes. Ogilvie (1967) estimated a higher mortality rate of 40.5 percent for birds banded when under a year old and 38.5 percent for those banded when over a year old, with the possibly greater survival in the third and fourth years of life than during the first two. Overhead wires were found to be a major cause of mortality, with oiling, disease, fighting, cold weather, and shooting also accounting for some mortality.

**GENERAL ECOLOGY**

**Food and Foraging:** The food of mute swans is almost exclusively of plant origin and mainly consists of aquatic plants. Willey (1968) estimated
that adults eat an average of 8.4 pounds of vegetation per day. In general, the birds feed on subsurface plants they can reach when swimming or by tipping up in the manner of dabbling ducks. In England these include algae (Chara, Enteromorpha, Ulva, Nitella), pondweeds Zostera, Potamogeton, Ruppia), grasses, and other herbaceous plants (Gilham, 1956). Some terrestrial vegetation is also consumed, and sometimes small aquatic animals, including fish and amphibians, have been reported in the diet.

**Sociality, Densities, Territoriality:** Minton (1968) has studied population densities in England and reported a density of one pair (about 30 percent nonbreeders) per 5.5 square miles on his study area of 550 square miles. He noted that this represented about one breeding pair per 8 square miles, compared with earlier estimates of one pair per 16 square miles reported for England and Wales as a whole. The highest reported county densities were one pair per 3 square miles for Middlesex and one per 7 square miles in Dorset. Atkinson-Willes (1963) reported that the famous mute swan colony at Abbotsbury in Dorset averaged 66 pairs of breeding swans (range 39-104) in the years 1947–1956 and had an average total population of about 700 birds. A tradition of protection and abundant food in the form of Zostera and Ruppia account for this concentration of birds. Comparable figures are not available for North America, but the highest Christmas counts have usually occurred in central Suffolk County, where the total number of birds seen in a 15-mile-diameter area (176 square miles) has averaged 452 for the 1960–1969 period, or 2.6 per square mile. If Minton's estimate that 30 to 40 percent of the population represents breeding birds, this would represent a breeding density of nearly one pair per square mile, assuming no spring dispersal. Willey (1968) estimated that between 24.5 and 54.3 percent of the Rhode Island population represented potential breeders. Thus it would seem that, at least locally, mute swan breeding populations in North America may be as high as or higher than in Great Britain.

**Interspecific Relationships:** In Europe the mute swan is a species that nests largely in populated areas that support few other breeding waterfowl, and there is probably little competition with other species. Dementiev and Gladkov (1967) reported it tolerant toward other birds and sometimes occurring with nesting gray-lag geese. Willey (1968) stated that nesting birds may kill other swans that intrude into their nesting territories. He also considered them a substantial threat to humans, particularly children. Stone and Masters (1971) reported that six captive mute swans killed six adult geese and two adult ducks, as well as forty ducklings and goslings, during a twenty-month period.

**General Activity Patterns and Movements:** Mute swans are highly seden-
tary birds in Great Britain. Atkinson-Willes (1963) reported that only a small number of banded mute swans had been proven to have moved more than a hundred miles, and only two had been known to cross the English Channel. More recently, Harrison and Ogilvie (1968) noted that 10 of 2,700 band recoveries exhibited overseas movement from Great Britain, with recoveries from Holland, the Baltic coasts of East and West Germany, Sweden, and France, and many of these recoveries were related to severe winter conditions that forced birds to move from the continent to Britain.

According to Minton (1968), most movements of mute swans occur before their mating and acquisition of a territory, after which they become quite sedentary. Most pairs return to their territory year after year, with only 2 percent of the surviving paired population that Minton studied moving their territories more than five miles. Nonbreeding pairs and unsuccessful breeders frequently move to the nearest flock for molting in midsummer, while unsuccessful breeders molt on their territories and move into flocks during fall. Among paired birds, movements are usually less than ten miles, and only about 5 percent of the 450 paired birds studied moved farther than this. However, unsuccessful breeders are more likely to move greater distances than successful ones.

SOCIAL AND SEXUAL BEHAVIOR

Flocking Behavior: As noted, flocking occurs among nonbreeders and unsuccessful breeders during the midsummer molting period, and later in the fall these flocks are increased by the addition of family groups forced out of their territories by cold weather. Atkinson-Willes (1963) indicated eleven locations (mostly coastal) where accumulations of more than 250 swans have regularly been reported in Great Britain. The largest flocks are generally found on a 1,240-acre reservoir at Abberton, a summer molting area attracting up to nearly 500 birds maximally, and along the Essex coast at Mistley, where 800 to 900 birds are attracted to waste corn from a mill.

Pair-forming Behavior: Minton (1968) reported on the initial pairing behavior of 125 mute swans of known age. Nearly half of these were two-year-olds, another 30 percent were three-year-olds, and a few (one male, four females) took mates when only a year old. Most birds were paired for at least a year before they actually attempted to nest, with only 2 of 60 birds that were no more than two years old actually nesting that year. Birds tended to pair with others of about their own age, with a slight tendency for the males to be older than the females. Further, in 74 percent of the initial pairings neither
partner had ever been paired before. Birds pairing for the first time with a previously paired bird were generally replacements for dead mates.

**Copulatory Behavior:** Copulatory displays have been described by various persons, such as Boase (1959), Johnsgard (1965), and others. Precopulatory displays involve mutual bill-dipping and preening movements, with the neck feathers ruffled. Following treading, both birds rise in the water breast-to-breast, with necks and heads extended vertically but with wings closed; then they gradually arch their necks and settle back on the water.

**Nesting and Brooding Behavior:** After the establishment of a breeding territory, nests are constructed on land or shallow water. The nests are usually about a meter in diameter and 0.6 to 0.8 meter in height and are constructed in the form of a large mound of vegetation consisting of rushes, reeds, other herbaceous vegetation, and sometimes also sticks. The nest cup is lined with finer materials and also with down and feathers. The female typically does most of the nest construction, but the male helps gather material from nearby, passing it back toward the nest over his shoulder. Down-plucking may begin with the start of egg-laying, the initiation of incubation, or not until the last or penultimate egg is deposited. The female does the incubation, but is closely guarded by the male. The young typically leave the nest on the day after hatching and remain closely attended by both parents. The young often ride on the backs of one or both parents. The wing molt of both parents normally occurs during the fledging period of the brood (Bauer and Glutz, 1968; Dementiev and Gladkov, 1967, etc.).

**Postbreeding Behavior:** Successful breeders remain with their young well past the fledging time, usually until severe weather forces the families to retire to winter quarters and to merge with larger groups of swans. Typically, the young of the past year are driven out of the territory by their parents before the latter begin to breed again. Minton (1968) reported two cases in which young remained with their parents until the following summer or until molting, and in neither case did the parents breed during that year. Two cases of pairing between parents and offspring were noted by Minton. One involved the pairing of a female with its yearling son after the male parent had died, while the other involved a female observed paired with a two-and-one-half-year-old son. In neither case did actual nesting occur.
TRUMPETER SWAN  
*Cygnus cygnus* (Linnaeus) 1758  
*(Olor buccinator* of A.O.U., 1957)

Other Vernacular Names: Wild Swan.  
Range: Breeds in Iceland, Scandinavia, Russia, Central Asia, Siberia to Kamchatka, the Commander Islands, and Japan (*C. c. cygnus*); in North America, isolated breeding populations currently exist in southern Alaska, British Columbia, western Alberta, eastern Idaho, southwestern Montana, and Wyoming. Introduced and breeding at various national wildlife refuges in Oregon, Washington, Nevada, South Dakota, and elsewhere. Some movement occurs in winter, but most populations are not strongly migratory.

North American Subspecies:  
Measurements (after Banko, 1960):

Folded wing: Adult male 545-680 mm. (average 618.6), adult female 604-636 mm. (average 623.3).

Culmen: Adult male 104-119.5 mm. (average 112.5), adult female 101.5-112-5 mm. (average 107).

Weights: Nelson and Martin (1953) indicated an average weight of seven males as 27.9 pounds (12,652 grams), with a maximum of 38 pounds; the average of four females was 22.5 pounds (10,249 grams), with a maximum of 24.5 pounds. Banko (1960) reported that the minimum weight of eight males at least two years old was 20 pounds, while the minimum weight of fourteen females of similar age was 16 pounds. Eight males at least one year old had a minimum weight of 18 pounds, and four females of this age had a minimum weight of 15 pounds. Scott et al. (1972) reported the average weight of ten males as 11.9 kilograms, with a range of 9.1 to 12.5; seven females averaged 9.4 kilograms, with a range of 7.3 to 10.2. Hansen et al. (1971) also presented weight data indicating that ten adult males averaged 11.97 kilograms (range 9.5 to 13.6), and eleven adult females averaged 9.63 kilograms (range 9.1 to 10.4).

IDENTIFICATION

In the Hand: As noted in the whistling swan account, the dorsal surface of the sternum should be examined to be absolutely certain of species identification; the presence of a dorsal protrusion near the sternum’s anterior end is the best criterion of a trumpeter swan. Further, if the bird weighs more than 20 pounds (18 if less than two years old), measures at least 50 mm. from the tip of the bill to the anterior end of the nostril, and has entirely black lores or at most a pale yellow or gray mark on the lores, it is most probably a trumpeter swan.

In the Field: In the field, the absence of definite yellow coloration on the lores and a voice that is sonorous and hornlike, often sounding like ko-hoh, rather than higher pitched and sounding like a barking wow, wow-wow, are the most reliable field marks for trumpeter swans (Banko, 1960). Except within its known limited geographic range, an unknown swan should be identified as a trumpeter only with extreme care. Hansen et al. (1971) stated that the nearly straight culmen profile typical of this species, as compared with a concave culmen in the whistling swan, provides a useful clue for field identification.
AGE AND SEX CRITERIA

Sex Determination: Internal examination must be used for determining sex, since there are no known external sexual differences.

Age Determination: The grayish plumage of the juvenile is held during most of the first year of life, and the lores are likewise feathered for the first few months of life. At least in some cases, the birds may form pairs when twenty months old and begin nesting as early as thirty-three months after hatching (Monnie, 1966). Second-year birds thus may perhaps be distinguished from older ones on the basis of their incompletely developed sexual structures. Young birds have their forehead feathers extending forward to a point on the culmen, while in adults the feathers on the forehead have a more rounded anterior border. Although the birds are usually pure white at the age of twelve to thirteen months, a few dark feathers may persist somewhat longer (Hansen et al., 1971).

DISTRIBUTION AND HABITAT

Breeding and Wintering Distribution and Habitat: Although the trumpeter swan was once strongly migratory, the remaining flocks are now relatively sedentary, with the Canadian or Alaskan population undergoing limited migrations to southeastern Alaska and the western parts of British Columbia (Banko, 1960). Mackay (1957) concluded that swans breeding in the Peace River district of Alberta migrate to the northern United States and mix with swans from the Red Rock Lakes Refuge during winter months, while the breeding areas of those wintering in western British Columbia were still unknown. Hansen et al. (1971) confirmed that these birds represent the Alaskan breeding population. Banko considers the presence of permanently open water with associated aquatic vegetation, a certain amount of level and open terrain, and a minimum of heavy timber near watercourses as important features of winter habitat. The breeding habitat found in Red Rock Lakes Refuge are characterized by Banko as large shallow marshes or shallow (to four feet deep) lakes, of high fertility, with a profusion of aquatic plants of submerged and emergent growth forms, and generally untimbered but well-vegetated shorelines. Within Yellowstone Park the breeding lakes are generally deeper, more heavily timbered, higher in elevation, and represent more marginal breeding habitat. During the years 1954 to 1957 an average of 13 nesting pairs occupied Upper Lake (2,880 acres), 51 occupied River Marsh (8,000 acres), and 15.5 occupied Swan Lake (400 acres), a total average population of about 80 pairs on 11,280 acres, or 4.5 pairs per square mile.
Breeding (hatched) and wintering (shaded) distributions of the trumpeter swan in North America.
Besides the Red Rock–Yellowstone–Grand Teton population, other major nesting populations occur in Canada and Alaska. Marshall (1968) reported that the nesting population at Grande Prairie, Alberta, numbers about 100 birds, and in Alaska the birds nest commonly along the southern coast from Yakutat to Cordova and in the Copper River drainage. Additional Alaskan breeding grounds are in the Kantashna, Tanana, Susitna, and Koyukak river valleys, the vast Yukon River delta, the Kenai Peninsula, and the adjacent coast west of the Cook Inlet. The total Alaska population has been estimated at 2,800 swans, which, added to the Canadian population and an estimated 800 birds in the contiguous United States, may represent 4,000 to 5,000 birds (Denson, 1970, Hansen et al., 1971).

Transplants from Red Rock Refuge to other refuges have produced new breeding populations in the coterminous United States. Swans were introduced in Malheur Refuge in Oregon in 1939 and again in 1955, with the first successful breeding in 1958. That same year success occurred in Ruby Lake National Wildlife Refuge, Nevada, after releases in 1949. In 1960 birds were released in Lacreek National Wildlife Refuge in South Dakota, with the first successful nesting in 1963 (Monnie, 1966; Marshall, 1968). Later introductions were made at the Turnbull National Wildlife Refuge, Washington, and at the Hennepin County Park near Minneapolis, Minnesota. After nesting unsuccessfully in 1965 at Turnbull Refuge (Audubon Field Notes, 20:585), later attempts were more successful, and in 1970 a total of eight pairs nested, hatching sixteen young (ibid., 24:700). Besides these refuge nestings, other localized nestings or nesting attempts have been reported, such as those near Brooks, Alberta, and north of Battleford, Saskatchewan (Ronald Mackay, pers. comm.), near Terrace, British Columbia (Audubon Field Notes, 20:592), in southern Montana (ibid., 13:444; 24:702), and at Valentine National Wildlife Refuge in the Nebraska sandhills (as an offshoot of the Lacreek population). Marshall (1968) reported that forty-two public zoos then had at least one pair of swans, with reproduction occurring in at least four of these zoos. Because of these transplant successes and the recognition of the surprisingly large Alaskan population, the trumpeter swan was recently removed from the list of endangered species as determined by the United States Fish and Wildlife Service.

Although the trumpeter swan is not known to occur in the Aleutian Islands, the whooper swan (now generally regarded as being conspecific with the trumpeter) has been reported there several times (Byrd et al., 1974). There is no proof of breeding by whooper swans on these islands, however.
GENERAL BIOLOGY

Age at Maturity: Monnie (1966) reported that some known-age trumpeter swans (two out of nine) initially formed pairs when twenty months old, and initial nesting occurred the following year. Banko (1960) summarized evidence that nesting may begin as early as the fourth year of life or as late as the sixth year, but it would seem probable that these examples are atypical, and that initial nesting in the third year of life would be characteristic. Some captive swans do not begin nesting until much older, especially if they are reared under wild conditions. A pair in the Philadelphia Zoo first nested successfully in 1965, although the female (wild caught and of unknown age) had been in the zoo since 1959. Like mute swans, two-year-old pairs may establish territories, even though actual nesting is not attempted (Monnie 1966).

Pair Bond Pattern: Like other swans, trumpeters are monogamous and have strong pair bonds. Banko (1960) reported a single case of a trio living together, although the sex of the extra bird was not learned. Griswold (1965) also reported a captive trio, in which a male was paired with two females. Banko assumed that a permanent pair bond was typical of this species, and Hansen et al. (1971) found one case of a female remating with another swan in the year following the loss of her mate.

Nest Location: Banko (1960) reported on 109 nests observed in four seasons in Red Rock Refuge. Over 70 percent of these were located on or very near a previous nest site, with four sites used all four years. Island sites were preferred over shorelines, and fairly straight shorelines tended to be avoided. Highest concentrations occurred where irregular shorelines combined with numerous sedge islands to produce maximum habitat interspersion, producing maximum nest densities of one nest per 70 acres. Hansen et al., (1971) found that 32 of 35 Alaskan nests were in water from 12 to 36 inches deep, and 21 of 40 nests were in beaver impoundments between 6 and 14 acres in area. Stable water levels and tall, dense emergent plants apparently provide the necessary security, food supply, and nest support needed by these birds.

Clutch Size: Of 74 completed clutches observed by Banko, the average was 5.1 eggs, with a range of 3 to 9. Hansen et al. stated that 53 clutches from the Copper River area averaged 4.9 eggs, while 160 clutches from the Kenai region averaged 5.3 eggs. Yearly differences were noted, with small clutches typical of years having late springs and larger clutches typical of more favorable breeding seasons. The eggs are laid at two-day intervals.
Incubation Period: Estimates range from 32 to 37 days. Hansen et al. noted that six nests in the Copper River area had periods of 33 to 35 days. There is no good evidence that the male assists in incubation under natural conditions.

Fledging Period: Banko (1960) summarized data indicating that the fledging period is probably normally from 100 to 120 days, with known minimum and maximum periods of 91 and 122 days. A very similar range, from 90 to 105 days, has been reported for Alaskan birds (Hansen et al., 1971).

Nest and Egg Losses: Banko (1960) noted that egg-hatching success varied from 51 to 66 percent during three different years. During six years at Grande Prairie, Alberta, the comparable percentages ranged from 55 to 92 percent (Mackay, 1964), and three years’ data from the Kenai Peninsula, Alaska, indicate an average 82 percent hatching success (Hansen et al., 1971). Infertility and embryonic deaths appear to be the major causes of hatching failure, with egg predation being insignificant. A few Alaskan nests have been found destroyed by bears and wolverines (Gulo luscus).

Juvenile Mortality: According to Banko (1960), considerable preflight mortality occurs, with possibly 50 percent or more of the young being lost during this period. Most of this mortality occurs early in life, from apparently varied but uncertain causes. Monnie (1966) reported cygnet losses to great horned owls, and probably also raccoons, while Banko suspected minks or skunks might play a predatory role at the Red Rock Refuge. Hansen et al. (1971) found a rather low (15 to 20 percent) mortality rate for the first eight weeks and practically none afterwards.

Adult Mortality: Banko (1960) suspected that trumpeter swans are virtually free of most natural enemies once they have fledged and thought that only coyotes or golden eagles might be of possible significance as predators, although firm evidence for this was lacking. Starvation during severe winters may be a significant mortality factor, at least in Canada, while disease and parasites appear to be unimportant.

GENERAL ECOLOGY

Food and Foraging: Although small cygnets rely on high-protein foods such as aquatic insects and crustaceans, they progressively shift to a vegetable diet as they grow older. Banko (1960) summarized data on trumpeter swan foods and reported use of foliage and tubers of pondweeds (Potomogeton), water milfoil (Myriophyllum) leaves and stems, pond lily (Nuphar) seeds and leaves, water buttercup (Ranunculus) leaves, and a variety of additional...
herbaceous foods such as *Chara, Anacharis, Lemna, Scirpus, Sparganium, Carex, Sagittaria,* and other materials. When feeding in shallow waters, trumpeters use their strong legs and large feet to excavate the tubers and rhizomes of various aquatic plants, often forming large holes on the shallow bottoms of the Red Rock Lakes marsh. They also swim with the neck and head under water, pulling rooted materials off the bottom of the ponds. They are also readily able to remove duckweed (*Lemna*) or other small foods from the water surface by straining it through the bill in the manner of dabbling ducks and may feed heavily on duckweed when it is available. Vos (1964) described as “puddling” a characteristic rapid paddling of feet during swimming, apparently serving to stir food up from the pond bottom. This he observed mostly in an adult female, occasionally in its mate, and several times in a cygnet. Female swans of various species frequently perform this behavior when leading broods, apparently thus improving the foraging efficiency of the short-necked and weak-legged youngsters.

Sociality, Densities, Territoriality: Only during the winter season are trumpeter swans appreciably social, and then the limited areas of open water force a degree of sociality upon them. Banko (1960) noted that it is seldom that more than six or eight swans fly together in local flights unless they are simultaneously flushed. He included a photo of eighty birds occupying a small spring in mid-January, but mentioned that as early as February pairs and small flocks begin to spread out over the snowfields that overlie their breeding habitat. As noted earlier, the average refuge density between 1954 and 1957 was 4.5 pairs per square mile (142 acres per pair) on three major nesting habitats, and in the most favorable nesting habitats about 70 acres per nesting pair was recorded during one year. The actual size of the defended area was not determined, but Banko indicated that birds occupying open shoreline usually defended more area than did those nesting on islands, although shoreline nesters sometimes defended only a small bay area around the nesting site. Hansen *et al.* (1971) suggested that spatial isolation, rather than food supply or size of area, was important in determining territorial boundaries.

Interspecific Relationships: Trumpeter swans have no significant contact with whistling or mute swans on their breeding or wintering areas, and Banko (1960) reports that they are highly tolerant of other bird and large mammal species. Even among pairs on their breeding territory, the presence of geese, pelicans, cranes, or herons is usually not sufficient to cause aggression, although swans leading young are less tolerant than others. However, one case was found of a nesting swan’s killing a muskrat that approached a brood. Vos (1964) also noticed several threats by nesting birds.

General Activity Patterns: Vos (1964) reported on daily activity pat-
terns of three captive swans, which may not be wholly typical of wild birds. He noted that bathing, preening, sleeping, loafing, swimming, and foraging were performed several times daily and usually in unison by the pair. Preening bouts typically follow bathing and last for varying periods up to 85 minutes. Preening was followed by resting or sleeping, and favored resting spots were also used for preening and sleeping. Some sleeping periods lasted as long as 85 minutes, and the male usually had longer sleeping bouts than did the female. In total, the adult pair slept about the same amount of time during the egg-laying period, while later in the summer a month-old cygnet slept more than the total of both parents. In general, preening most commonly occurred early in the morning, early in the afternoon, and during the evening. Feeding occurred after the morning and evening preening periods, reaching a maximum in early afternoon, with a secondary evening peak.

Daily Movements: There are few good data on daily movements, but Monnie (1966) reported that local movements of up to about a hundred miles were noted at Lacreek Refuge over a prolonged period. Banko (1960) reported that flights during local movements were usually performed at lower altitudes than were longer flights.

SOCIAL AND SEXUAL BEHAVIOR

Flocking Behavior: This has been discussed earlier under sociality. Mackay (1957) mentioned that cygnets of a family evidently remain together for at least the first year after hatching, since three broodmates that were banded in Alberta in 1955 were all shot in Nebraska the following fall.

Pair-forming Behavior: Monnie (1966) reported that courtship among 20-month-old swans began in mid-January and continued until mid-March during which time among nine birds two apparent pairs were formed, plus a trio involving two males and a female, while two females remained unpaired. Monnie did not specifically indicate whether this courtship consisted of actual copulatory behavior or of mutual triumph ceremonies. Banko (1960) described the triumph ceremonies of this species, which are typically performed following the expulsion of a territorial intruder. However, he noted that mutual display also regularly occurs in the wintering areas among birds in flocks, although he did not clearly associate this behavior with pair formation. Triumph ceremonies involving more than two birds most probably represent participation by the past season’s offspring, if my observations at the Wildfowl Trust are also characteristic of wild birds.

Copulatory Behavior: Vos (1964) observed eleven copulations in captive trumpeter swans, all of which occurred in shallow water and ten of which
were seen between April 16 and 26, with the first egg being laid April 21. One copulation was also seen on July 12, or more than a month after hatching occurred. Typically, both sexes rise together in the water, variably extending the wings (Johnsgard, 1965) but with the male usually fully extending his, and usually, but not always, with both calling in unison. Finally, the wings are flapped once or twice, followed by bathing and then preening.

_Nesting Behavior:_ Most preliminary nest-building is by the female, but the male helps gather nesting material and to a limited extent may assist in nest construction. Females not only spend more time nest-building, but also are more effective in gathering materials (Vos, 1964). Vos did not observe the male actually incubating, but saw it sitting on the nest once during the egg-laying period. However, Griswold (1965) did report an instance of apparent incubation assistance by the male, inasmuch as both birds were once seen on the nest, with four eggs under one and three under the other. This is apparently the only report of possible incubation by the male. Banko (1960) reported one probable instance of renesting following nest destruction.

_Brooding Behavior:_ Following an incubation period of 32 to 33 days (Mackay, 1964) or 33 to 37 days, (Banko, 1960), the cygnets hatch, normally all at about the same time. However, Griswold reported a staggered hatching period in one pair. He noted that the first two young to hatch were seen entering the water initially when about 48 hours old, while the third left the nest when about 24 hours old. Griswold’s observations were complicated by the fact that two females were present, and both may have contributed to the clutch. Vos (1964) noted that for the first few weeks a young bird was closely guarded, with the two parents placing themselves on either side of the cygnet. However, the female was generally more closely associated with it. Normally when swimming the female led the cygnet, with the male following behind. In contrast to the mute swan, young trumpeter swans have never been seen riding on a parent’s back (Johnsgard and Kear, 1968). Griswold reported that by the age of about three months a female attained a weight of 14.5 pounds, and four males weighed from 13.5 to 16 pounds, collectively averaging about 15 pounds. Banko mentioned a 19-pound cygnet of preflight age, and Hansen _et al._ (1971) stated that such a weight may be attained in only eight to ten weeks.

_Postbreeding Behavior:_ There is no evident molt migration in trumpeter swans. In Alaska, nonbreeding birds gather in flocks on large, open lakes and begin their wing molt almost simultaneously, with nearly all of them beginning and terminating their flightless period within ten days of one another. A less regular molting pattern occurs in breeding birds. Males usually begin their wing molt early in the incubation period, or sometimes as late as after
the time of hatching. Females begin molting their flight feathers from 7 to 21 days after the clutch has hatched. Since the flightless period is about 30 days long, both members of a pair are rarely flightless simultaneously, and both sexes regain their flying abilities prior to the fledging of the young. In Alaska, some young may still be unable to fly at the time of freeze-up, and the birds seem to postpone their fall migration as long as possible, with family groups being the last to leave the breeding grounds (Hansen et al., 1971).
WHISTLING SWAN

*Cygnus columbianus* (Ord) 1815

(*Olor columbianus* of A.O.U., 1957)

Other Vernacular Names: Wild Swan, Whistler.

Range: Breeds in arctic parts of Russia and Siberia (*C. c. bewickii*), eastern Siberia (*C. c. jankowskii*), and in arctic North America from western Alaska across the northern parts of the Northwest Territories to Southampton Island, Nottingham Island, and the Belcher Islands. The North American population winters mostly along the Atlantic and Pacific coasts, but passes through the interior during migrations, and varying numbers overwinter in northern Utah.

North American Subspecies:

*C. c. columbianus* (Ord.): Whistling Swan. Considered by Delacour (1954) only subspecifically distinct from *C. c. bewickii*, the Bewick swan. Recognized by the A.O.U. (1957) as a separate species.

Measurements (after Banko, 1960):

- Folded wing: Adult male 501-569 mm. (average 538), adult female 505-561 mm. (average 531.6).
- Culmen: Adult male 97-107 mm. (average 102.6), adult female 92.5-106 mm. (average 99.9).

Weights: Nelson and Martin (1953) indicated an average weight of thirty-five males as 15.8 pounds (7,165 grams), with a maximum of 18.6 pounds; forty-two females averaged 13.6 pounds (6,167 grams), with a maximum of 18.3 pounds. Banko (1960) reported that seven males at least two years old had a maximum weight of 19.5 pounds, and twenty-one females of the
same age class had a maximum weight of nineteen pounds. Sherwood (1960) mentioned a male that weighed 19\% pounds. Scott et al. (1972) reported the average weight of twenty-nine males as 7.5 kilograms (range 7.4 to 8.8) and thirty-nine females averaged 6.6 kilograms (range 5.6 to 8.6).

**IDENTIFICATION**

*In the Hand:* Whistling swans can only be confused with trumpeter swans when being handled; the absence of a fleshy knob at the base of the bill readily separates them from mute swans. To be certain of identification, the upper surface of the sternum must be examined to see if a protrusion near its anterior end is present, which would indicate a trumpeter swan. If this point cannot be checked, the bird is probably a whistling swan if it weighs under 20 pounds, measures less than 50 mm. from the tip of the bill to the anterior end of the nostril, and has bright yellow or orange yellow spots on the lores.

*In the Field:* Unless both trumpeter and whistling swans are seen together, a size criterion is of little value in the field. Rather, the differences in their voices are perhaps the best field mark, in association with the presence or absence of yellow coloration on the lores. If the lores are completely black, the bird may be of either species, but if a prominent yellow to orange yellow mark is present, the bird is a whistling swan. Further, if the voice is sonorous and hornlike, often sounding like ko-hoh, it is a trumpeter, whereas the voice of the whistling swan is more like a high-pitched barking sound, wow, wow-wow (Banko, 1960).

**AGE AND SEX CRITERIA**

*Sex Determination:* No external differences in the sexes exist that would allow for sex determination without internal examination.

*Age Determination:* Birds possessing feathered lores and/or some grayish feathers persisting from the juvenal plumage are in their first year of life. Apparently the rate of sternal penetration of the trachea is fairly constant for the first three years, and by the second winter the tracheal loop starts to rotate and begin its expansion into the carina of the sternum (Tate, 1966). Together with the length of the tracheal perimeter within the sternum, the changes in the shape of the nasal bones are good indicators of age, according to Tate. First-year birds have a well-defined “V” groove formed by the nasals and lachrymals, which gradually alters by medial fusion with age, so that the V is nearly obliterated in old birds. In young birds the feathers of the forehead...
extend forward to a point in the midline, while in older birds this point gradually recedes until a smooth and rounded brow is formed.

**DISTRIBUTION AND HABITAT**

*Breeding Distribution and Habitat:* In North America the whistling swan has a breeding range well to the north of the trumpeter swan’s, in arctic tundra. Heaviest nesting concentrations in Canada are in the coastal strip from the west side of the Mackenzie Delta to the east side of the Anderson Delta, with sparser populations inland, especially south of the tree line (Banko and Mackay, 1964). This Northwest Territories population evidently winters on the Atlantic coast (Sladen and Cochran, 1969). In central and eastern Canada swans are usually absent from the rocky Precambrian shield, but occur wherever typical tundra occurs, north to Banks Island and south to about the Thelon River. In Alaska, major breeding areas are the north side of the Alaska Peninsula and adjoining Bristol Bay, the Yukon-Kuskokwim Delta, and, to a much lesser extent, the Kotzebue Sound area (Gabrielson and Lincoln, 1959).

*Wintering Distribution and Habitat:* Whistling swans winter in two widely separated areas. Approximately half the continental population winters in the Atlantic Flyway, primarily on Chesapeake Bay and Currituck Sound. The rest of the population winters in the Pacific Flyway, chiefly in the Central Valley of California. Some usually also overwinter in the Great Salt Lake valley of Utah, the numbers there being influenced by the severity of the winters (Sherwood, 1960). Normally their winter habitat includes sufficient aquatic plant life to provide adequate food, but during unusually severe winter conditions field-feeding in cornfields has been observed (Nagel, 1965).

Preferred wintering habitat in the Chesapeake Bay area consists of open and extensive areas of brackish water no more than 5 feet deep (Stewart, 1962). January counts in that region indicated the following percentage usage of available habitats: brackish estuarine bays, 76 percent; salt estuarine bays, 9 percent; fresh estuarine bays, 8 percent; slightly brackish estuarine bays, 6 percent; and other habitats, 1 percent. Freshwater areas are used primarily by early fall arrivals.

**GENERAL BIOLOGY**

*Age at Maturity:* Very little reliable information is available on the age of sexual maturity in whistling swans. They have been bred only rarely in captivity; Delacour (1954) reported a breeding by a five-year-old female with an
Breeding (hatched) and wintering (shaded) distributions of the whistling swan in North America.
older male, and Robert Elgas (pers. comm.) successfully bred a pair of hand-reared whistling swans when they were six years old. Two pairs of swans hatched from wild-taken eggs nested initially when they were four years old, according to William Carrick (pers. comm.). Scott (1972) believed that the closely related Bewick swans may normally breed initially at four years.

Pair Bond Pattern: Like the other swans, the pair bonds of this species appear to be strong and potentially permanent. Peter Scott (1972) reported that there had been no cases of “divorce” among hundreds of individually recognizable Bewick swans in seven years of observation, and up to three years have been required for bereaved swans to take a new mate. Dafila Scott (1967) reported that some swans have left in the spring with one mate and returned the next fall with a different one, suggesting that mate replacement sometimes occurs during a single breeding season. Some tentative pairing may occur during the second winter, but in six of seven cases she observed, these pairings had broken up by the following winter. Peter Scott (1972) noted, however, that some swans may remain with their parents for their second or even third winter of life.

Nest Location: Nests of whistling swans are typically well scattered over the tundra. Banko and Mackay (1964) reported that nest sites vary in location from the edge of water to the top of low hills a half mile from water, with small islands in tundra ponds being preferred locations.

Clutch Size: According to Banko and Mackay (1964), 4 eggs constitute the normal clutch, with as many as 7 being found at times. Lensick (1968, and in Scott et al., 1971) reported that 5 was the normal clutch size in good springs, with only 3 or 4 eggs usually present in cold, wet springs. The average clutch size of 297 clutches was 4.3, with a mode of 5 and a range of 1 to 7.

Incubation Period: Banko and Mackay (1964) estimated the whistling swan’s average incubation to be about 32 days. A slightly shorter incubation period (29 to 30 days) has been estimated for the Bewick swan (Dementiev and Gladkov, 1967). Robert Elgas (pers. comm.) noted a 30-day incubation period for Alaskan whistling swan eggs incubated under geese.

Fledging Period: Not definitely established for the whistling swan. Banko and Mackay reported that hatching occurs in late June or early July, while fledging occurs about the middle of September, suggesting an approximate 75-to 80-day fledging period. A remarkably short fledging period (40-45 days) has been suggested for the slightly smaller Bewick swan (Dementiev and Gladkov, 1967), but this hardly seems possible in view of the much longer periods reported for the other admittedly more temperate-adapted swans.

Nest, Egg, and Cygnet Losses: Virtually no quantitative information is available on hatching success, but Banko and Mackay (1964) estimated that
an average of only two or three cygnets per hatched clutch survived until fledging in autumn. By counting the percentage of the distinctively plumaged juveniles during fall and winter, estimates of productivity and mortality can be attained. Chamberlain (1967) noted that the percentage of young birds in the 1964–1965 winter season on Chesapeake Bay ranged from 9.46 to 13.9 percent, while in 1965–1966 it ranged from 8.22 to 12.1 percent, with the percentage of young highest during January counts because of the relatively later arrival of family groups than of nonbreeders. Compared to average brood sizes ranging from 2.55 to 2.63 young per pair in Alaska and the Northwest Territories, winter brood counts ranged from 2.15 to 2.63, suggesting a cygnet mortality of 18.25 to 25.49 percent. During the eight-year period between 1964 and 1971, in the Atlantic coast wintering population, the percentage of juveniles ranged from 4.8 to 14.6 percent (average 11.1) and the average number of cygnets per family varied from 1.54 to 2.24 (average 1.93) birds (J. J. Lynch, unpublished progress reports of productivity and mortality among geese, swans, and brant).

**Adult Mortality:** Information on adult mortality rates in whistling swans is lacking, since few are banded and in general they have not been legal game. Some information on the Bewick swan relative to annual survival can be obtained from the returns of individually recognized birds to the Wildfowl Trust in later years. Evans (1970) provides a listing of such sightings for a seven-year period for birds which were adults or second-year birds when first sighted and recognized individually. Of a total of 792 birds in this category, 287 were seen the subsequent winter season, indicating a minimum survival rate of 36.2 percent. However, 27.5 percent returned a third season, 26.6 a fourth, 34.3 a fifth, 28.6 a sixth, and 33 percent (6 of 18) returned seven years after initially being sighted. This rather astonishing number of birds at least nine years old indicates that the survival rate of swans must be relatively high, and the sightings of birds returning in the third and subsequent seasons suggest an annual survival rate of nearly 87 percent.

**GENERAL ECOLOGY**

**Food and Foraging:** Like the other swans, the whistling swan feeds predominantly on vegetable materials from aquatic plants. Martin *et al.* (1951) list grasses and sago pondweed (*Potamogeton pectinatus*) as major food in both the eastern and western populations, and additionally list wild celery (*Vallisneria*), lady’s thumb (*Polygonum persicaria*), horsetail (*Equisetum*), and bur reed (*Sparganium*) as important foods in one region or the other. Sherwood (1960) reported that tubers and seeds of sago pondweed were the
exclusive food of twelve specimens obtained in the Great Salt Lake valley, although other aquatic foods were available. Stewart and Manning (1958) and Stewart (1962) reported on the winter foods of swans in Chesapeake Bay and found that birds foraging in the preferred brackish estuarine bay habitat relied largely on wigeon grass (*Ruppia*) and to a lesser extent on sago pondweeds, with bivalve mollusks (*Mya* and *Macoma*) also being taken in considerable amounts. Four birds collected in fresh water estuaries had been feeding almost exclusively on wild celery, and four from estuarine marsh ponds had been eating wigeon grass, three-square (*Scirpus*), and grasses.

**Sociality, Densities, Territoriality:** During the nonbreeding season whistling swans are highly social, with flock sizes often numbering in the hundreds. Thompson and Lyons (1962) made observations on a flock of 1,022 swans during spring migration in Wisconsin and counted the birds in groups making local movements to and from foraging areas, mostly on fallow fields nearby. Nearly 35 percent of the flock counts were of paired birds, with units of 3, 4, or 5 birds also fairly common. This would suggest that yearling birds often remain with their parents during spring migration, although no attempt was made to distinguish young birds from adults. Apart from a small percentage of single birds, the remaining flock sizes gradually diminished in frequency up to a unit size of 13 birds. In the Bewick swans wintering at the Wildfowl Trust, up to three seasons’ young have been observed consorting with their parents, making flock units of 13 to 15 birds. Thus, it is apparent that even large flocks of swans have a well-developed substructure that is probably related to family bonding.

The low densities of swans on the breeding grounds is probably a reflection of territorial tendencies. Lensick (1968) reported nesting densities of from 130 to 320 hectares per pair (0.8 to 2.0 pairs per square mile) at the Clarence Rhode National Wildlife Range in Alaska. Smith and Sutton (in United States Fish and Wildlife Service, Special Scientific Report: Wildlife, No. 25) reported on swan densities based on aerial surveys in the Northwest Territories. In the wooded delta of the Mackenzie River they reported densities indicating a six-year (1948–1953) average of 1.5 swans per square mile. In the area between the Mackenzie and Anderson rivers, the comparable averages were: coastal tundra, 1.7; upland tundra, 1.3; and transition zone (to coniferous forest), 0.3 swans per square mile. In 1950 the area from the Armak River to Kent Peninsula was also surveyed and found to have a swan density of 0.16, while southwestern and southeastern Victoria Island had a density of 0.007. It would seem that a density of about one pair per square mile might be expected in favorable lowland tundra habitats.

**Interspecific Relationships:** Whistling swans probably have little normal
contact with either trumpeter swans or mute swans in the wintering areas and none in their breeding areas. Edwards (1966) noted the presence of wintering whistling swans in the flock of resident mute swans at Grand Traverse Bay, Michigan. Martin et al. (1951) and others have suggested that whistling swans may despoil the supply of duck foods in some areas, and certainly the preferred foods such as sago pondweed and wigeon grass are also used by many ducks. Wigeons and canvasbacks are species with habitat preferences and foods similar to those of whistling swans in the Chesapeake Bay region (Stewart, 1962). Sherwood (1960) mentions observing a considerable number of species of geese and swans feeding among swans without any visible intolerance on the swans’ part. He passed on the view that the swans may actually increase the forage for the ducks, both by pulling up more food than they actually consume and by possibly creating new sago beds by dissemination of seeds and tubers as well as by “cultivation” of the marsh bottom.

**General Activity Patterns and Movements:** Since swans typically feed on or closely adjacent to their nesting areas, they normally are not forced to move about extensively in search of food. Thompson and Lyons (1964) noted that pronounced diurnal foraging flights were not characteristic of the spring flock of whistling swans they studied and noted that average midday counts were only about 200 birds fewer than average morning or evening counts (749 and 771, respectively). Sladen and Cochran (1969) observed that swans rarely reached an altitude of 1,000 feet during local movements. At the Wildfowl Trust in England, the Bewick swans typically roost on the mud flats of the nearby Severn River and fly in twice daily to the Trust grounds to eat the grain put out for them. Or, they may stay at the Trust all day, returning to the river only after the late afternoon feeding period.

**SOCIAL AND SEXUAL BEHAVIOR**

**Flocking Behavior:** As noted above, whistling swans are to be found in flocks consisting of aggregated pairs and family groups at all times except during the nesting season. Such groups often merge in “staging areas” at various points along their migration routes; these areas provide a combination of abundant food and relative safety from large predators. They often consist of temporarily flooded fields or permanent water areas no more than about five feet deep. Bent (1925) noted that on the East Coast the swans often associate with Canada geese, on which they apparently rely for warning of possible danger. Fall flocks of from 10,000 to 25,000 swans have been reported in Alberta and Utah (Banko and Mackay, 1964).

**Pair-forming Behavior:** Very little is known of the pair-forming behavior
of whistling swans, but it is probably comparable to that of the better-studied Bewick swan. Peter Scott (1966) noted that two-year-old birds spent quite a lot of time in courtship display during the winter months. However, Dafila Scott (1967) mentioned that many of the pair bonds formed during the second winter are only temporary and usually are broken by the following winter. As with the other swans, pair formation is a gradual and inconspicuous process, with a major feature being the tendency of males to defend mates or potential mates and, after expelling intruders, to return to the female, where they join in a mutual triumph ceremony (Johnsgard, 1965). Differences in the head shape and bill patterning are apparently important bases for individual recognition among the arctic-breeding swans, and it is probable that individual differences in vocalizations may also play a role in mate recognition.

**Copulatory Behavior:** Like the trumpeter swan, copulation in whistling and Bewick swans is preceded by mutual head-dipping movements that closely resemble those of bathing birds. Unlike the mute swan, preening movements do not play a role in precopulatory behavior. As treading is terminated, the male releases his grip on the female's nape as both birds extend their necks strongly upward and utter loud notes, usually simultaneously extending and shaking their wings (Johnsgard, 1965).

**Nesting and Brooding Behavior:** The nests of whistling swans are usually mounds of moss, grasses, or sedges and are from one to two feet high (Banko and Mackay, 1964). In the Bewick swan it is typical that the pair uses an old nest site after some refurbishing, with the female lining the nest with down or sometimes feathers (Dementiev and Gladkov, 1967) The female usually assumes all the incubation duties, as with other white swans, but the male remains close by and actively guards the nest. Egg-laying begins shortly after arrival at the tundra breeding grounds in late May or early June, and hatching occurs in late June or early July (Banko and Mackay, 1964). In southeastern Victoria Island, at the northern edge of the species' range, the nests are constructed in as little as five days or less, and in one case a nest was built and three eggs were deposited in no more than eight days (Parmelee *et al*., 1967). Hatching there begins in early July, and young are probably still about into September, although the fledging period is still not definitely known. No doubt a critical relationship exists between the time of fledging and the first freezing weather, which may greatly influence breeding success during some years.

**Postbreeding Behavior:** The postnuptial molt of the adults occurs while the young are still flightless, the pen becoming flightless about two weeks after the young hatch, while the cob does so about the time the female regains her flight (Banko and Mackay, 1964). Assuming each may be flightless for about
a month, the adults should both have regained their powers of flight by the
time the young are about eighty days old, or nearly fledged themselves. At that
time, or mid-September, a fairly leisurely fall migration southward begins
through the interior of Canada along the Mackenzie River valley. By early
October, concentrations of up to 25,000 birds occur on Lake Clair and Rich­
ardson Lake in northeastern Alberta, after which the population splits into
two groups, according to whether the birds will winter in the western or
Atlantic coastal regions (Banko and Mackay, 1964).
Other Vernacular Names: Specklebelly Goose, Tule Goose.
Range: Circumpolar; breeding from western and northern Alaska eastward
across northern Canada to Keewatin, the western coast of Greenland, and
in arctic Eurasia excepting Scandinavia, Iceland, and Spitzbergen.
North American Subspecies (after Delacour, 1954):

* A. a. frontalis* Baird: Pacific White-fronted Goose. In North America,
breeds in arctic Alaska from the Bering Sea coast east to northeastern
Keewatin and winters in the western and southern United States and
adjacent Mexico.

* A. a. gambeli* Hartlaub: Gambel White-fronted Goose. Breeding grounds
uncertain, probably in the MacKenzie Basin (Elgas, 1970), with most
wintering occurring on the Gulf coast. Birds wintering in central Cali­
fornia (“Tule” white-fronted geese) have recently been proposed as a
new subspecies, *elgasi* (Delacour and Ripley, 1975).

* A. a. flavirostris* Dalgety and Scott: Greenland White-fronted Goose.
Breeds on the west coast of Greenland, wintering mainly in Ireland, but
occasionally reaching the eastern United States.

Measurements:

* A. a. frontalis*: Folded wing: adult males 380-441, adult females 362-419
mm. Culmen: adult males 44-56.5, adult female 42-54 mm. (Elgas,
1970).
A. a. gambeli: Folded wing: adult males 441-480, females 410-441 mm.  

A. a. flavirostris: Folded wing: males 410-455, females 392-420 mm.  
Culmen: males 45-57 mm. (Delacour, 1954).

Weights:
Pacific White-fronted Goose: Nelson and Martin (1953) reported that twenty-two males averaged 5.3 pounds (2,404 grams), with a maximum of 7.3 pounds; eighteen females averaged 4.9 pounds (2,222 grams), with a maximum of 6.3 pounds.
Tule White-fronted Goose: Nelson and Martin (1953) reported that twenty-one males averaged 6.6 pounds (2,993 grams), with a maximum of 7.5 pounds; thirteen females averaged 5.6 pounds (2,539 grams), with a maximum of 6.5 pounds. Swarth and Bryant (1917) reported somewhat higher weights, with six males averaging 7.25 pounds (3,288 grams) and four females averaging 6.31 pounds (2,861 grams).

IDENTIFICATION

In the Hand: This brownish goose can be recognized in the hand by its yellowish to reddish bill, which lacks a black “grinning patch,” and its yellow to orange feet. The distinctive white forehead and the black blotching on the undersides are completely lacking in immature birds, which are almost uniformly brown in color. Domestic grey-lag geese (Anser anser) might perhaps be confused with white-fronted geese, but these usually have pinkish feet and legs and are considerably larger throughout.

In the Field: Both on land or water and in the air, white-fronts are notable for their rather uniformly brownish coloration, which is relieved by their white hindquarters and, at close range, by white foreheads on the adults. Sometimes their orange legs may be seen in flight, but usually at least a few of the birds in a flock will show black spotting underneath. They are generally extremely wary birds, and often utter a cackling lee-lee or lee-lee-lee-k!, resembling taunting laughter, while in flight.

AGE AND SEX CRITERIA

Sex Determination: No plumage characters are available for external sex determination.

Age Determination: Birds in their first year of life have little or no abdominal spotting and have yellowish feet and legs. Second-year birds are ap-
parently adult in plumage and in the color of the bill and legs, although wild birds evidently do not breed before their third year (Boyd, 1962).

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: In Alaska the white-fronted goose breeds primarily in the northern portion and nests mainly near the coast. At Barrow and to the east it is a common coastal breeder, extending in marshy areas from one to twenty miles inland, with apparent centers of abundance at Smith Bay and the Colville Delta. White-fronts are also common nesters in the Kotzebue Sound and along the Noatak and Kobuk rivers, and in the Yukon-Kuskokwim region. The southern limit of breeding appears to be the base of the Alaska Peninsula (Gabrielson and Lincoln, 1959). In Canada the species breeds from the Alaska boundary eastward to the Perry River, north at least as far as Victoria and King William islands, and south to the Hanbury and Thelon rivers. The preferred breeding habitats are the muddy borders of small tundra lakes and the floodplains and mouths of arctic streams, where there are broad flats that often have grass-covered hummocks (Snyder, 1957). Dzubin et al. (1964) characterize the preferred nesting habitat as middle to low arctic vegetation, in open tundra, the borders of shallow marshes and lakes, river banks and islands, deltas, dry knolls, and hillocks near rivers and ponds. Two major types of topography are used for breeding: coastal tundra with little surface relief, and gently rolling upland tundra 50 to 700 feet above sea level with lakes and ponds in the depressions. Willow- and shrub-fringed streams and ponds are used by white-fronted geese to a greater extent than by other geese. Elgas (1970) found that birds he regarded as tule white-fronted geese in the Old Crow area of the Yukon inhabited unusually heavy brush and woody vegetation, rather than coastal tundra.

Wintering Distribution and Habitat: In the United States, most wintering habitat occurs in the Central Valley of California and on the Gulf coast of Louisiana and Texas. In Mexico considerable numbers of white-fronted geese occur in northern and central areas, with a few as far south as the coasts of Tabasco and Chiapas (Leopold, 1959). There the birds prefer interior or coastal marshes or wet meadows and usually fly out to stubble to feed on fallen grain or green plant material. Alkaline flats and sandbars are not used as much as by snow geese. In California, plains, fields, and swampy lowlands are used for roosting, while foraging is done in open fields. However, the tule white-fronted goose reportedly inhabits marshes overgrown with tules (Scirpus), cattails (Typha), or willow (Salix), and rarely forages in grain-

WHITE-FRONTED GOOSE 95
Breeding (hatched) and wintering (shaded) distributions of the white-fronted goose in North America.
fields. In these marshes the birds apparently forage primarily on the tubers and rhizomes of *Scirpus*, which they pull up from the bottom in water as much as one and one-half feet deep (Longhurst, 1955).

**GENERAL BIOLOGY**

*Age at Maturity:* Dzubin *et al.* (1964) reported that most white-fronted geese do not mature until their second or even third summer. Boyd (1954, 1962) believed that they do not breed until their third year. Two aviculturists who responded to a survey by Ferguson (1966) reported breeding by captive birds in their third year.

*Pair Bond Pattern:* Pair bonds are apparently permanent in these as in other true geese, but specific data appear to be lacking. Inasmuch as fall and winter flocks are obviously composed in part of family groups (Boyd, 1953; Miller and Dzubin, 1965), it seems clear that pair bonds are persistent in this species.

*Nest Location:* Nests are usually situated on flats or on a slight hummock, often bordering a lake or stream (Snyder, 1957). Dzubin *et al.* (1964) noted that nests are seldom far from water. Typically the nest is located on a slight incline or at the top of a hillock, so that visibility of the surrounding area is not restricted. Conover (1926) noted that all three nests he found were on small hills.

*Clutch Size:* Relatively little information on average clutch sizes is available. Kessel *et al.* (1964) reported an average clutch of 4.3 eggs for twelve nests in the Hooper Bay area, with a range of 3 to 6 eggs. Calvin Lensink (pers. comm.) found that 301 clutches from the Yukon-Kuskokwim Delta averaged 4.86 eggs, with yearly maximal and minimal averages of 5.32 and 3.72, respectively.

*Incubation Period:* The incubation length is somewhat uncertain, with estimates ranging from 22 to 28 days. Most estimates for the European race *A. a. albifrons* are for 27 or 28 days, but that of the Greenland white-fronted goose has been estimated at only 22-23 days (Fencker, 1950). This is close to the 21 to 22-day period determined by Brandt (1943) for a single nest in Alaska. According to him, seven eggs were deposited in a nest during a 10-day period. Conover (1926) also mentioned what probably was the same nest, with the clutch completed on June 1 and hatching completed on June 24.

*Fledging Period:* Dzubin *et al.* (1964) estimated a 6- to 7-week fledging period, while a more questionable 5-week period had been estimated for the Greenland white-fronted goose (Salomonsen, 1950).

*Nest and Egg Losses:* Few specific data appear to be available on nesting
success for North American white-fronted geese. Dzubin et al. (1964) indicated that the hatching rate is usually above 80 percent in good breeding years. Calvin Lensink (pers. comm.) found that Class I broods during the late 1960s and early 1970s in the Kuskokwim delta area collectively averaged 3.94 goslings for 79 broods, suggesting that hatching success may be fairly high. Hansen (1961) noted a nesting success of 89 percent (eight of nine nests) in one year.

Juvenile Mortality: Most data on juvenile mortality are from the Greenland and European populations of white-fronted geese. Boyd (1958) estimated a first-year annual mortality of 46 percent after banding and about 43 percent for second-year birds, compared to an adult mortality rate of 34 percent. Among European white-fronted geese wintering in England, Boyd (1959) noted that between 1947 and 1959 the mean brood size ranged from 2.7 to 3.6 and the proportion of young birds in the population varied from 14 to 46 percent. He believed that the marked differences in the yearly proportions of young birds must have resulted from variations in the percentage of adults which successfully bred rather than annual brood-size differences. Miller et al. (1968) estimated a first-year mortality rate of 44.1 percent for Saskatchewan-banded geese and estimated that juveniles were 2.4 times more vulnerable to mortality than were adults. The percentage of immature in migrating populations ranged from 11 to 38 percent and averaged 23 percent between 1960 and 1966.

Adult Mortality: Miller et al. (1968) estimated an average annual adult mortality rate of 31.3 percent for Saskatchewan-banded geese. This compared fairly closely to Boyd's (1958) estimates of 34 percent for adult Greenland white-fronted geese and 28 percent for adult European white-fronts.

GENERAL ECOLOGY

Food and Foraging: Records of foods taken during winter are rather limited, and Martin et al. (1951) list a variety of cultivated grain plants (wheat, rice, barley) as important foods. Native plants that are taken include the vegetative parts of various grasses such as panic grass (Panicum), saw grass (Cladium), wild millet (Echinochloa), and the rootstocks of cattail (Typha), as well as sedges and rootstocks of bulrushes (Scirpus). Hanson et al. (1956) noted that of six adults collected on their breeding grounds at Perry River, four had eaten horsetail (Equisetum) stems and branches, two had eaten blades or stems of cotton grass (Eriophorum), and one had consumed horsetail rootstalks. Barry (1967) found that twelve adult birds col-
lected between June and August on the Anderson River delta had been eating sedges and horsetail.

**Sociality, Densities, Territoriality:** White-fronted geese are relatively nongregarious and rarely occur in large flocks except perhaps during fall migration. Shortly after arriving at their wintering grounds they spread out and become inconspicuous (Miller *et al.*, 1968). Breeding densities are generally very low; the Pacific Flyway population of some 200,000 geese nest over an area of about 40,000 square miles in western Alaska, while the Central Flyway population of some 70,000 birds nest over 84,000 square miles of northern and eastern Alaska and 35,000 square miles of arctic Canada (Dzubin *et al.*, 1964). Although not colonial nesters, white-fronted geese do at times gather for nesting in favored locations, and Dzubin *et al.* reported that breeding densities in the best habitats of the Yukon-Kuskokwim delta area average 6 to 7 birds per square mile. In large areas of the Canadian arctic the estimated density was only 1 bird per 3 to 16 square miles. Averages for aerial surveys made during a six-year period indicate that in the Mackenzie Delta breeding populations averaged 0.4 geese per square mile, while in the upland and coastal tundra areas between the Mackenzie and Anderson rivers the average densities for the period were 1.4 and 1.2 birds per square mile. This illustrates well the tendency of white-fronted geese to favor upland nesting habitats. Bailey (1948) noted that near Barrow, Alaska, the birds often nested in small colonies, with fifteen to twenty pairs present within a quarter mile.

**Interspecific Relationships:** Little specific information on possible interspecific competition between white-fronted and other geese exists. During migration, white-fronts often mingle with and forage with Canada geese and seemingly consume much the same foods, but only rarely are they seen among flocks of snow geese. Nesting in the Hooper Bay area occurs in about the same habitats as are used by emperor geese, but the white-fronted geese show a distinct preference for nesting on small hills, while emperor geese nest on flatlands and closer to water (Conover, 1926). After hatching, the families move to inland tundra ponds, while emperor and cackling goose families utilize rivers and tidal sloughs. Major avian predators on nests are probably jaegers, while glaucous gulls consume considerable numbers of young goslings. Foxes, especially red foxes, also account for the loss of some nests and young, as may eagles and snowy owls (Dzubin *et al.*, 1964, Barry, 1967).

**General Activity Patterns and Movements:** During migration, white-fronted geese follow a very similar daily routine to that of Canada geese, and often forage with them. Miller and Dzubin (1965) noted that two feeding
flights are typical; one occurs in early morning and the other in late afternoon. White-fronts tend to be more wary than either snow geese or Canada geese, and this may serve to keep the species somewhat separated.

SOCIAL AND SEXUAL BEHAVIOR

**Flocking Behavior:** Large flock sizes are not typical of white-fronted geese, except perhaps during fall congregation and migration. Large flocks of molting birds do evidently occur in the vicinity of the upper Selawik River, northwestern Alaska, where flocks of 2,000 to 5,000 birds have been seen on two large lakes (United States Fish and Wildlife Service, Special Scientific Report: Wildlife, No. 30). Also, during the accumulations of birds in their fall staging areas in western Canada, peak populations of 25,000 to 50,000 birds have been found spread out on eight to twenty shallow lakes (Miller and Dzubin, 1965). Shortly after reaching their wintering quarters, however, the birds tend to spread out into smaller groups and become quite inconspicuous. Likewise during spring migration the flock sizes of birds passing through the Platte River valley of Nebraska are generally not very large, usually no more than a few dozen.

In studying the behavior of wintering flocks in England, Boyd (1953) reported that the wintering flocks often numbered several hundred birds, but as flock sizes increased, their unity of behavior decreased, with the larger flocks tending to break up into smaller units that acted independently.

**Pair-forming Behavior:** Little has been written on pair-forming behavior, but it apparently consists of the gradual development of individual associations during the second (or possibly third) winter of life, supplemented and strengthened by repeated use of “triumph ceremonies” between the paired birds (Boyd, 1954).

**Copulatory Behavior:** Copulation is preceded by mutual head-dipping associated with considerable tail-cocking and exposure of the white under tail coverts. After treading, both birds again strongly cock their tails, lift their folded wings, and call, with necks vertically stretched (Johnsgard, 1965).

**Nesting and Brooding Behavior:** The birds typically arrive at the nesting grounds in pairs (Bailey, 1948). Nesting is initiated shortly after the arrival at the breeding grounds, usually in the second half of May. A high degree of synchronization of nest initiation and egg-laying is not as evident in white-fronted geese as in the snow, cackling Canada, and Ross geese. The female constructs a nest that is usually lined with mosses, grasses, and finally down. The male does not normally approach the nest closely, but remains several hundred yards away. In spite of the birds’ large size and their tendency
to nest in hilly situations, the nests are extremely difficult to locate. Unlike the Canada goose but in common with emperor geese, incubating females usually do not attempt to leave the nest and sneak away unobserved at the first sign of danger. Instead, they suddenly flush from the nest when approached too closely. Even when the location of the nest is known, the brown plumage of the female so closely matches the dead tundra vegetation that it is nearly impossible to see her until she flushes.

With the hatching of the brood, the male joins the family and, at least in the Hooper Bay area, the families then tend to move to inland tundra ponds, well separated from families of emperor and cackling geese (Conover, 1926). Unlike snow geese, the families do not flock together, and, when frightened, the goslings typically scatter and dive in the thick cover (Barry, 1967).

Postbreeding Behavior: Little is known of possible molt migrations in the white-fronted goose. Such movements would seem probable, on the basis of observations indicated in the “Flocking Behavior” section above.
SNOW GOOSE

Anser caerulescens (Linnaeus) 1758

(Until 1973, regarded by the A.O.U. as Chen caerulescens and C. hyperborea)

Other Vernacular Names: Blue Goose, Wavy, White Brant, White Goose.

Range: Breeds in arctic Siberia, on Wrangel Island, and along the arctic coast of Alaska and Canada and adjoining islands to northwestern Greenland.
In North America, winters on the Pacific coast to California, the Gulf coast, the Atlantic coast south to North Carolina, and to a limited extent in the interior along the Mississippi and Missouri rivers.

Subspecies:

A. c. caerulescens (L.): Lesser Snow (Blue) Goose. In North America, breeds from Alaska east to Baffin Island and winters primarily in the central valley of California, the Gulf coast, and in the Mississippi Valley north to Missouri.

A. c. atlanticus (Kennard): Greater Snow Goose. Breeds in northwestern Greenland and on Baffin, Devon, and probably Grinnell islands and winters along the middle Atlantic coast south to North Carolina.

Measurements (after Delacour, 1954):


Weights:

Lesser Snow Goose: Cooch et al. (1960) reported that 467 adult males averaged 6.05 pounds (2,744 grams), while 522 adult females averaged 5.55 pounds (2,517 grams). Nelson and Martin (1953) report maximum weights of lesser snow (and blue) geese as 6.8 pounds for males and 6.3 pounds for females.

Greater Snow Goose: Nelson and Martin (1953) reported that twenty-one males averaged 7.3 pounds (3,310 grams), with a maximum of 10.4 pounds; thirteen females averaged 6.2 pounds (2,812 grams), with a maximum of 6.5 pounds.

IDENTIFICATION

In the Hand: Snow geese are likely to be confused in the hand only with Ross geese and perhaps with immature white-fronted geese. On examination of the bill, the presence of the black “grinning patch” and the absence of warty protuberances at the bill’s base should indicate a snow goose, and addi-
tionally no goose with a folded wing longer than 400 mm., a culmen longer than 50 mm., and a weight of more than 4 pounds (or 2,000 grams) would be a Ross goose. Young blue-phase snow geese sometimes are confused with young white-fronted geese, but the yellowish legs, feet, and bill and the lack of a black grinning patch will serve to distinguish young white-fronted geese. Domestic white geese might be confused by hunters with snow geese; these birds lack black wingtips and have no black grinning patch.

In the Field: Both in the air and on the ground or water, snow geese are readily identified by the partially or extensively white plumage, contrasting with the dark flight feathers. Wild snow geese call almost constantly, and their rather shrill, repeated “la-uk!” notes are reminiscent of barking dogs. In flight the emperor goose might be confused with a blue-phase snow goose, but this dark phase does not occur in the range of the emperor goose, and additionally emperor geese exhibit dark rather than white tail coverts in flight. Snow geese usually travel in larger flocks than do white-fronted geese, and even at a considerable distance the under wing coverts of white-fronts appear nearly as dark as their primaries, while in “blue” geese the anterior under wing coverts are much lighter, and they also show much more white around the head.

AGE AND SEX CRITERIA

Sex Determination: No plumage characters are available for sex determination without resorting to measurements.

Age Determination: The presence of a dull-colored, usually dusky bill, and legs and feet that are brownish to dusky, is indicative of a first-year bird. Juvenile white-phase birds are generally grayish in body tone, while juvenile blue-phase birds have little or no white on the head. Snow geese may attempt to nest when two years old, but only rarely succeed under natural conditions (Cooch, 1958). In captivity, snow geese normally breed at three years of age, but sometimes breed in their second year of life (Ferguson, 1966). Thus, an open oviduct or a fully developed penis would indicate a bird two years old or older.

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: In Alaska, the breeding evidence for the snow goose is limited to a few, mostly old, records, primarily from the vicinity of Barrow, and a recent report of nesting at Prudhoe Bay (Birds, 4:19 1972). Gabrielson and Lincoln (1959) also mentioned the finding of two nests near the mouth of the Kinak River in 1953. In Canada, however, the
Breeding (hatched) and wintering (shaded) distributions of the snow goose (lesser snow goose horizontal hatching, greater snow goose vertical hatching) in North America.
nesting range is extensive, from the Mackenzie River delta in the west to Ellesmere Island in the north, Baffin Island in the east, and Cape Henrietta Maria in the south. Within this range, the greater snow goose has the most northerly breeding range, including northern Baffin Island, Devon Island, Ellesmere Island, and adjacent Greenland (Snyder, 1967). Parmelee and MacDonald (1960) found the greater snow goose common on Forsheim Peninsula of Ellesmere Island and reported that it is known to nest on Bylot, Devon, Somerset, and Axel Heiberg islands, as well as northwestern Baffin Island and Thule, Greenland. The “blue” phase of the lesser snow goose has a breeding range centering from northern Hudson Bay to southwestern Baffin Island and occurring north to Victoria Island (Parmelee et al., 1967). Cooch (1963) reported that Bowman Bay, Baffin Island, had a frequency of blue-phased birds of 98 percent in 1960, while the percentages were 82 at Cape Dominion and 53 at Koukdjauk, Baffin Island. On Southampton Island, the “blue” phase comprised 33 percent at Boas River, while at Eskimo Point on the mainland of Keewatin it was 15 percent. At Perry River, Northwest Territories, it was 12 percent, and 1 percent was present as far northwest as Banks Island. The breeding habitat of lesser snow geese generally consists of low, grassy tundra associated with flat limestone basins or islands in braided deltas, and is usually near salt water (Cooch, 1961, 1964). Snyder (1967) has characterized the breeding habitat as low, flat tundra, usually near lakes, ponds, or on river floodplains. The greater snow goose, however, typically nests in habitats where stony terrain meets wet and grassy tundra. On Bylot Island the greater snow goose nests where the land is flat, marshy, and protected from the north by mountains (Lemieux, 1959).

Wintering Distribution and Habitat: Winter surveys performed by the United States Fish and Wildlife Service between 1966 and 1969 indicate that of an average winter count of some 1.2 million birds, about 40 percent occurred on the Pacific Flyway and adjacent Mexico. About 25 to 30 percent occurred in the Central Flyway, the same percentage in the Mississippi Flyways, and the remaining 5 percent (consisting mostly of greater snow geese) wintered on the Atlantic Flyway. In the Chesapeake Bay region, Stewart (1962) reported that the typical habitat of greater snow geese consists of salt-marsh cordgrass (Spartina alterniflora), which fringes the coastal bays or occurs as islands within them, and provides both food and cover for the geese.

The traditional wintering area of lesser snow and blue geese in the Mississippi Flyway has been the coast of Louisiana. Their attraction to the mud flats along the Mississippi Delta has apparently been produced by the growth of various grasses and sedges (Zizaniopsis, Scirpus, Spartina, Panicum, and Typha) whose roots provide favored foods (Bent, 1925). Snow geese also
commonly winter along the entire coast of Texas, but mainly occur on the brackish marshes and low prairies. The greatest concentrations are in Chambers and Jefferson counties, where up to 300,000 or more birds sometimes occur (Texas Game, Fish, and Oyster Commission, 1945). Sometimes considerable numbers also occur in northern Mexico, along the coast of northern Tamaulipas as well as in the interior *bolsones* of Chihuahua and Durango (Leopold, 1959).

The Pacific Flyway’s wintering concentrations are centered in California, from the Tule Lake and Klamath areas in the north to the Salton Sea in the south, with massive concentrations in the Central Valley. The Puget Sound region and the adjacent Frazer River delta of British Columbia is also an important wintering area for Pacific coast birds. This diverse range, from arid desert climates below sea level to moist and humid coastlines, encompasses an equally broad range of habitats. However, the common attraction would appear to be the availability of edible natural grasses or cultivated grainfields, with the bays, lakes, and marshes providing safe resting locations.

**GENERAL BIOLOGY**

*Age at Maturity:* According to Cooch (1958), snow geese may attempt to nest when two years old, but succeed only under ideal conditions. Of 44 responses by aviculturalists to a survey by Ferguson (1966), 31 indicated initial breeding the third year, 11 the second year, and 2 the fifth year. However, Lynch and Singleton (1964) concluded from age-ratio data that at least during favorable years the two-year-old segment of the adult flock must significantly contribute to breeding production. Barry (1967) found that 17 percent of the geese he banded as goslings were on the Anderson River breeding grounds two years later.

*Pair Bond Pattern:* Pair bonds in snow geese are apparently strong and often permanent. Pairing between white- and blue-phased birds is common but not random, with the offspring of all types of mating equally viable (Cooch, 1961).

*Nest Location:* Nesting of snow geese is typically in colonies, often numbering several thousand birds. Cooch (1964) reported nesting colonies exceeding 1,200 pairs per square mile, and noted that the largest known colonies are on Baffin Island, Banks Island, and north of Siberia on Wrangel Island. On Wrangel Island two kinds of nest location are typical (Uspenski, 1966). One is the colonial type (averaging 12 to 64 nests per hectare), in which 114,200 nests occurred on 3,700 hectares (or 12 nests per acre). The other type consists of small colonies or single pairs nesting with brant geese.
and Pacific eiders near the nests of snowy owls (*Nyctea scandiaca*). In the case of the large colonies the nests are protected by the concerted defense of the large number of birds, while in the second case the snowy owls, in protecting their own nests, also provide protection for the geese and ducks.

Soper (1942) reported that the nest is always placed on a slight grassy swell on the tundra, where the ground is relatively firm and well grown with mosses and grass. Most nests are built with plucked and shredded tundra moss and lined with fine grasses and down, while some are built with grass and chickweed and are smaller and less bulky than those made of moss.

**Clutch Size**: Clutch sizes of both phases of lesser snow geese are the same, 4.42 eggs prior to any losses due to predation or other sources (Cooch, 1961). Uspenski (1966) indicated an average clutch of 3.27 eggs for 645 nests on Wrangel Island, with the highest clutch average (3.55) in areas of high nesting density, apparently reflecting predation losses. Eggs are laid in colonies over a twelve-day period, and both phases begin and end all their egg-laying within the same interval. However, white-phased birds tend to begin their nesting slightly earlier than do blue-phased ones, according to Cooch. Lemieux (1959) reported that 22 greater snow goose clutches averaged 4.8 eggs, with clutches of early nests averaging 2.5 eggs more than those begun only four days later. Attempted renesting has not been reported.

**Incubation Period**: Cooch (1964) reported an incubation period of 22 or 23 days for lesser snow geese. Earlier (1961), he reported that white-phased birds have an average incubation period of 23.1 days, while blue-phased birds have a 23.6-day incubation period.

**Fledging Period**: Cooch (1964) reported that 42 days are required for obtaining flight in lesser snow geese. Earlier (1958), Cooch had estimated a fledging period of 49 days. Lemieux (1959) estimated a six-week fledging period for the greater snow goose, while Weller (1964) reports a five and one-half to six-week fledging period.

**Nest and Egg Losses**: Cooch (1961) has presented data to show that in an early (unusually mild spring) season an average of 19 percent of the eggs fail to hatch, from infertility, predation, flooding, or other causes. In a normal season this rises to 36.5 percent and in a retarded breeding season to 49.0 percent of the eggs, with the major increases occurring in losses resulting from flooding, desertion, and dump-nesting. Harvey (1971) also reported egg losses of 20 percent, mostly occurring late in incubation.

**Juvenile Mortality**: Cooch (1961) reported that the average brood size at the time of hatching was 4.22 for thirty-three broods he studied in 1952. By the twelfth week the average size of the brood had been reduced to 3.33 for
thirty-two broods, or an approximate twelve-week mortality of more than 20 percent. Lynch and Singleton (1964) presented productivity data on snow geese for the period 1949 to 1959, indicating that winter samples reported average brood sizes ranging from 1.6 to 2.7 and percentages of immatures ranging from as low as 1.8 percent to 54.9 percent. The percentage of adult-plumaged birds accompanied by young varied from 1.6 percent to as much as 75.7 percent, suggesting that in favorable years at least some two-year-old birds must successfully nest. On the basis of such figures and banding studies, a probable 60 percent first-year mortality rate has been suggested (Cooch, 1963). On the basis of band returns, Rienecker (1965) estimated a first-year mortality rate of 49.1 percent.

**Adult Mortality:** Cooch (1964) estimated that adult lesser snow geese have an annual mortality rate of about 30 percent, based on an analysis of banded birds. Boyd (1962) provided an independent calculation apparently based on these figures and concluded that the lesser snow goose had an adult mortality rate of 27 percent, compared with a rate of 23 percent for the greater snow goose. This compares closely with a 22.5 to 25 percent adult mortality rate for the population of lesser snow geese wintering on the West Coast (Rienecker, 1965).

**GENERAL ECOLOGY**

*Food and Foraging:* Foods of snow geese have been studied relatively little, and most available information is from the wintering areas. On the Atlantic coast, salt-marsh cordgrass (*Spartina alterniflora*) rootstocks are evidently major foods (Stewart, 1962; Martin *et al.*, 1951). On the Gulf Coast, a larger variety of foods are taken, including the rootstocks of bulrushes (*Scirpus*), cattail (*Typha*), cordgrass, salt grass (*Distichlis*), the seeds and vegetative parts of square-stem spike rush (*Eleocharis quadrangulata*), and other herbaceous materials (Martin *et al.*, 1951). Glazener (1946) noted that in the marsh areas of Texas snow geese feed on reeds (*Phragmites*), salt grass, cordgrass, cattails, smartweed (*Polygonum*), and sedges (*Carex* and *Cyperus*), while in prairie pastures they feed on a variety of grasses (*Andropogon, Paspalum, Festuca, Erachrostis, Panicum, Setaria*, and *Sporobolus*). In the rice belt of Texas snow geese also sometimes consume considerable amounts of rice. Lynch (1968) has pointed out that in recent years the lesser snow geese of the Gulf coast have deserted the coastal marshes and their traditional foods and now largely winter and forage in rice fields, cattle pastures, and other agricultural lands. This is not so true of greater snow geese, which
still feed mainly on “three-square” (Scirpus spp.) rhizomes. Limited samples from the western states indicate that rootstocks of bulrushes, vegetative parts of cultivated wheat, and various other plants are taken. Several authors have commented that the bird’s strong serrated bill is well adapted for pulling up and tearing roots. Coues (cited in Bent, 1925) mentions how the birds closely crop short grasses in the manner of domestic geese (Anser anser) and put to good use their toothlike bill processes while pulling up and consuming roots and culms. Glazener (1946) also said that, unlike the Canada geese, which graze, snow geese are mainly “grubbers.” Uspenski (1965) noted that while on their breeding grounds on Wrangel Island, the geese ate only the plants available in their immediate nesting area, and Barry (1967) reported a fairly catholic breeding-grounds diet, including sedges, ryegrass (Elymus), cotton grass (Eriophorum), willows, and horsetail (Equisetum).

**Sociality, Densities, Territoriality:** Snow geese are among the most social of all geese, and fall and winter flock sizes numbering in the tens of thousands of birds are not at all unusual. Cooch (1961) has mentioned the strong female ties that are present, at least through the first year. Such subadult birds remain with their parents until the latter’s early stages of incubation, when the subadults separate from the breeding colony and molt on its periphery.

Densities of snow geese on their breeding grounds are sometimes almost incredible. Uspenski (1965) reported approximately 300,000 birds and 114,200 nests on Wrangel Island in 1960, which he believed represented the main world nesting center for the species. As noted earlier, these 114,200 nests occurred in an area of 3,700 hectares, or a nesting density of almost 8,000 per square mile. Cooch (1964) noted that he was aware of nesting concentrations of 1,200 pairs per square mile, allowing an average territory size of only about two acres per pair. Ryder (1967) noted nest densities of up to 4.61 nests per 1,000 square feet in preferred mixed (birch and rock moss) habitats of Arlone Lake in the Perry River area, but the average for mixed and birch-dominated habitats was about one nest per 1,000 square feet, the equivalent of 45 nests per acre.

**Interspecific Relationships:** In general, snow geese form single-species nesting colonies, although Uspenski (1965) mentioned that on Wrangel Island the birds sometimes nest among brant geese or even close to the nests of snowy owls. Snow geese sometimes breed in close proximity to small Canada geese (Parmelee et al., 1967), and Nelson (1952) described at least two probable wild hybrids between these species. MacInnes (1962) remarked that the Baffin Island Canada geese he studied at Eskimo Point which nested among the blue-phased snow geese suffered as many egg losses to jaegers as did those nesting outside the colony. Barry (1956) noted that, while the brant
nested near the coastline of Southampton Island, the snow geese nested at least one-fourth mile inland from the high tide line.

Major egg predators of snow geese appear to be arctic fox (*Alopex lagopus*), as well as jaegers, gulls, and ravens. Jaegers are sometimes serious egg predators; Cooch (1961) mentioned that they destroyed all the eggs laid during the first two days of nesting at Eskimo Point in 1959, and also (1964) that they destroyed 49 percent of the eggs of brant geese and snow geese laid in poor habitat at Anderson River, Northwest Territories. Uspenski's (1965) clutch size data suggest that egg predators are most effective in colonies with low densities or at the periphery of nesting colonies and provide a possible explanation for the colonial nesting tendencies of this species. Herring gulls (*Larus argentatus*) may sometimes also be significant egg predators, as indicated by Manning’s (1942) observations on Southampton Island and by Harvey's (1971) more recent studies.

**General Activity Patterns and Movements:** Little specific information has been written on general activity patterns, which seem to be much like those of other geese. Roberts (1932) reported that in western Minnesota the spring migrants typically spent the night on a lake, left at sunrise, and fed until about 10:00 a.m. They then returned to the lake and waited until about 4:00 p.m. to come out once again to forage in stubble fields.

Glazener (1946) similarly noted that wintering snow geese in Texas typically left to feed in the morning somewhat later than the Canada geese, and most of them left *en masse*. They fed up to thirty miles from their roosting sites and moved to watering places in midmorning. Then they made a midafternoon flight to feed again and sometimes remained feeding until after dark. While the spring migration is typically a protracted one involving short daily movements and much local foraging activity, the fall migration across the continental interior is sometimes a nonstop flight to the wintering area. Cooch (1955) reported that in 1952 the population of lesser snow geese wintering on the Gulf coast flew nonstop from James Bay to Louisiana, an air distance of 1,700 miles, in less than sixty hours.

**SOCIAL AND SEXUAL BEHAVIOR**

**Flocking Behavior:** The large average size of snow goose flocks is well known; Spinner (1948) provided accurate counts of a greater snow goose spring flock of 13,494 birds and a fall flock of 2,659 individuals. Musgrove and Musgrove (1947) noted that during the spring in Iowa, flocks of 15,000 to 20,000 are commonly seen in areas of concentration, while scattered flocks of 500 to 10,000 may be found between these concentration points. They
gradually move up the river at the rate of about twenty miles a day, stopping at traditional concentration points that may at times hold nearly half a million birds.

Pair-forming Behavior: Pairs are apparently formed in snow geese, as they are in other species of geese, by the increasing association of individual birds and the development of pair bonds by the repeated performance of the triumph ceremony. This presumably occurs during the second winter of life, although the birds may not successfully nest until they are three years old. Pairing between color phases is common but does not occur randomly (Cooch, 1961), thus the incidence of intermediate (“hybrid”) geese is relatively low. Sibley (1949) estimated that at least 10 percent of the migrant geese he observed in eastern Kansas consisted of such birds. Cooch (1961) suggested that intermediate, or heterozygotic, individuals have been responsible for the northward spread by genes producing blue-phased birds, rather than through pioneering by pure blue-phased birds.

Copulatory Behavior: Copulation is preceded by the usual mutual head-dipping. After treading, the tail is not so strongly cocked nor are the wings raised so high as is typical of most species of Anser (Johnsgard, 1965).

Nesting and Brooding Behavior: The female constructs the nest with the materials at hand, usually mosses and grasses (Soper, 1942). Little down is present when the first egg is laid, but the down mat is luxuriant by the time the clutch is complete (Sutton, 1931). Only the female incubates, but the male stands close guard, often within fifteen feet of the nest (Barry, 1956). The female rarely leaves the nest voluntarily during incubation, but will forage some if driven off the nest (Manning, 1942). Manning reported that both sexes become very wary about four days prior to hatching, but after the young hatch the male becomes quite fearless. The female usually leads the young after hatching, while the male remains behind and protects the brood from intruders. Such families gather together into flocks containing about forty adults, then leave the nesting grounds.

Postbreeding Behavior: Adult birds undergo their molt while their offspring are still flightless, and during this time they may gather in fairly large flocks. Cooch (1957) described cases in which more than 15,000 flightless birds have been caught by being driven into large enclosures. Nonbreeding adults and subadults, having molted somewhat earlier than breeders, leave the breeding grounds about the time the young birds make their first flights, while adults and their young follow about three weeks later, or early September (Cooch, 1964).
ROSS GOOSE

Anser rossii Cassin 1861
(Chen rossii of A.O.U., 1957)

Other Vernacular Names: None in general use.

Range: Breeds mainly in the Perry River region of the Northwest Territories eastward along the Queen Maud Gulf to at least 97°02' W. latitude, and southward in the interior to at least 66°21' N. longitude (Ryder, 1967), and winters mostly in central California, with vagrant birds occasionally reaching the midwestern states and rarely the eastern states. Limited breeding also occurs on Banks and Southampton islands and on the McConnell River, Keewatin District.

Subspecies: None recognized.

Measurements (after Delacour, 1954):
- Folded wing: Males 360-380, females 345-360 mm.
- Culmen: Males 40-46, females 37-40 mm.

Weights: Nelson and Martin (1953) reported that eighteen males averaged 2.9 pounds (1,315 grams), with a maximum of 3.6 pounds; twenty-one females averaged 2.7 pounds (1,224 grams), with a maximum of 3.4 pounds.
IDENTIFICATION

In the Hand: Although the Ross goose is normally found only within a limited winter and summer range, it occasionally strays far from its usual migratory route, and individual birds may turn up almost anywhere. If examined in the hand, Ross geese exhibit a short bill (under 47 mm.) that may be black along the edges but has no definite “grinning patch” and in adult males is usually warty near its base, which is bluish. Ross geese also never exceed 4 pounds (or 2,000 grams), and their folded wing measurements never reach 400 mm.

In the Field: Ross geese are best distinguished by direct size comparison with snow geese when they are in the same flock, or by their comparable size to large ducks, such as mallards. The bluish base of the bill may be evident at fairly close range. Some birds of intermediate size and appearance have been seen in wild flocks, indicating that natural hybridization does occur and thus adds to the difficulties of field identification of Ross geese among snow goose flocks (Trauger et al., 1971).

AGE AND SEX CRITERIA

Sex Determination: No plumage characters are available for external sex determination.

Age Determination: Not yet closely studied, but apparently comparable to the snow goose. In general, immature birds are less conspicuously marked with gray than is the case with snow geese, and they are more difficult to recognize at comparable distances.

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: The initial discovery of the breeding range of the Ross goose was in the Perry River area, and until the early 1950s the species was believed limited to that region. However, it is now known to breed also on Banks Island (Manning et al., 1956), the McConnell River on the west side of Hudson Bay, and on the Boas River delta of Southampton Island (MacInnes and Cooch, 1963). Ryder (1967) found many previously unknown colonies south and east of the Perry River and noted that they were all on islands in lakes. These islands provide protection, in the form of rocks or shrubs, from wind and also to some extent from rain and snow. Flat islands lacking such protection were avoided, and the preferred lakes were not only sufficiently large to prevent predators from swimming across but also shallow enough (under five or six feet) to prevent ice bridges from being
Breeding (hatched) and wintering (shaded) distributions of the Ross goose in North America.
present at the start of the nesting season. Barry (1964) reported that Ross geese nearly always nest on remote island-studded lakes, eight to forty miles inland, in fairly dry surrounding countryside. Less often they nest along rivers or on lake shores. Ryder (1969) judged that the availability of food in the form of sedges and grasses is of major significance in determining the distribution of nesting colonies; also important are protection from flooding during the spring breakup and a source of nest cover in the form of shrubs or rocks. Islands that rise from ten to twenty feet above water level but which have sufficient level places to allow for growth of food and nesting materials provide optimum nesting habitat.

Wintering Distribution and Habitat: The primary wintering location of Ross geese is in central California, where they mix with and occupy similar habitats of the wintering lesser snow geese in the Sacramento and San Joaquin valleys as well as nearer the coast in Ventura and Orange counties (Bent, 1925). Recent records from the Salton Sea suggest a southern extension of the wintering range in that area (O'Neill, 1954). Kozlik et al. (1959) noted that geese color-marked at Tule Lake wintered throughout the Central Valley, but were not seen in the Imperial Valley, suggesting a possible different migratory route for birds wintering in that area. Marshall (1958) noted that following a mid-October arrival in the Klamath Basin, Ross geese move to the northern San Joaquin Valley, where they remain until February or March.

The last few decades have resulted in a surprising number of Ross goose records from east of the Rocky Mountains, mainly between Ontario and Texas. Apart from two very early (1910 and 1916) Louisiana records, most of them date from the 1950s or later. Sutton (1967) summarized these records for Texas (three records in 1953–1954), Oklahoma (one record in 1961), Kansas (one record in 1951), Colorado (one record in 1964), and Louisiana (one record plus the two early ones). In more recent winters Ross geese have become an almost annual occurrence in Texas (Audubon Field Notes, 23:352, 24:381), and they are also regular visitors to the Rio Grande Valley in New Mexico (Gary Zahm, pers. comm.). Most remarkable is a late-November flock of 200 at Squaw Creek National Wildlife Refuge, Missouri (Audubon Field Notes, 23:324). In the fall and winter of 1970–71 Ross geese were reported in North Carolina, Missouri, Colorado, Louisiana, Nevada, Texas, and New Mexico (American Birds, 25:545). A total of 79 Ross geese have been trapped with about 500 wild lesser snow geese during banding operations in the mid-1960s in Nebraska, and 4 of these banded birds have since been recovered in California, Mexico, and the Keewatin District of Canada (George Schildman, pers. comm.). The occurrence of some seemingly intermediate birds among such trapped birds also opens the possibility

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that hybrids between lesser snow geese and Ross geese may be present in unknown numbers. Trauger et al. (1971) have since reported on a number of such apparent hybrids.

**GENERAL BIOLOGY**

*Age at Maturity:* Ferguson (1966) reported that, of eight respondents to a questionnaire, six reported initial breeding of Ross geese at three years, and one each reported initial breeding in the first and second years of life.

*Pair Bond Pattern:* Presumably pair bonds are permanent in Ross geese, although specific data on this point are lacking. Ryder (1967) mentioned the strong attachment of males to incubating females and defense of the young; he also noted that family bonds are retained by yearlings until the incubation period of the next season's eggs is begun. Thus, it is evident that individual pairs must remain together throughout the nonbreeding period.

*Nest Location:* Nests are built on various habitats and substrates, but Ryder (1967) established that preferred nest sites are mixed habitats of small birch stands and rocks, while pure rock or birch habitats have intermediate preference, and open habitats of low tundra have the lowest nest usage. Ryder concluded that sufficient protection from the elements and ample space for grazing determine nest density in a particular location. In the preferred mixed habitat types, nests had an average density of 9.5 per 1,000 square feet, with a maximum of 20.6 nests in this area, or only 50 square feet per nesting pair.

*Clutch Size:* Ryder (1970b) reported a mean clutch size of 3.6 to 4.0 eggs prior to incubation in three years of study. Average clutch sizes in early nesting seasons averaged larger than those in late-starting seasons during these years. Nests started early in the nesting season averaged larger than those initiated only three to four days later. The interval between eggs averaged 1.5 days. Removing a few of the eggs from a nest did not seriously affect hatching of the remainder, but adding eggs to a completed clutch resulted in very low nesting success. Ryder (1970a) has suggested that the small average clutch size of this species has evolved in relation to the food available to the female before arriving on the nesting grounds, as represented by the maximum increases in body weight that she can carry during her spring migration. A small clutch size thus avoids depleting the postlaying energy reserves of the female and correspondingly increases the probability of her efficient incubation and brooding of her eggs and young. Ryder found no evidence of attempted renesting.

*Incubation Period:* On the basis of forty-five last eggs laid, Ryder (1967) determined the average incubation period as 22 days, with a range of
19 to 25 days. No incubation occurs prior to the laying the last egg, and only 2 percent of the nests had down present prior to the laying of the penultimate egg. After the laying of the last egg, however, 82 percent of the observed nests had down present.

**Fledging Period:** Since freezing weather typically occurs between forty and forty-five days after the time of hatching, the fledging period is evidently slightly more than forty days (Ryder, 1969).

**Nest and Egg Losses:** Ryder (1967) reported that of 351 eggs in ninety-one nests studied in 1963, 93.7 percent hatched, while in 1964 he found a 79.2 percent hatch of 230 eggs in fifty-nine nests. The percentage of eggs destroyed was remarkably low, being 2.2 and 14.4 percent for the two years, respectively, while the remainder of egg failures resulted from infertility or embryonic deaths. Arctic foxes caused high nest losses in 1964 at one locality, but avian predators caused few egg losses. In later studies, Ryder (1970b) reported yearly hatching success rates of 60.6 and 80.3 percent.

**Juvenile Mortality:** Ryder (1967) noted that the average brood size of ninety-nine broods from Perry River was 2.88 for broods not more than one week old. Fall flocks in Saskatchewan had an average of 2.72 young per family, and winter counts in California indicated an average of 1.65 young per family, or a total decrease in brood size of 42 percent.

**Adult Mortality:** No figures on adult mortality rates are available.

### GENERAL ECOLOGY

**Food and Foraging:** Little has been written of the foods of Ross geese. Hanson *et al.* (1956) reported that the gizzards of five birds collected on the breeding grounds included mostly sedges (*Eriophorum* and *Carex*) and some grass (*Poa*). Ryder (1967) examined twenty-six birds from the Perry River region and found some roots of grasses and sedges, leaves of grasses, sedges, and birch (*Betula*), and the stems and spikelets of grasses and sedges. Roots were consumed early in the season, while later on leaves and spikelets were utilized. No animal materials were found, even though several goslings were included in the sample.

Dzubin (1965) noted that during fall migrant geese in Alberta and Saskatchewan use large lakes for resting and fly out twice daily to wheat and barley fields, where they feed on waste grain.

**Sociality, Densities, Territoriality:** Sociality and associated densities on the breeding ground are even higher in the Ross goose than in the snow goose. Dzubin (1965) noted that spring flocks are much smaller and more scattered.
than fall groupings moving through Saskatchewan and Alberta, with fall staging areas in the Kindersley district often reaching peaks of 10,000 to 20,000 birds in the early 1960s. Dzubin (1965) noted that in 1964 about 3,000 birds occurred on five small lakes, another 4,500 occurred on four lakes, and 1,700 were on three small saline sloughs. Temporary puddles from 10 to 150 acres in size and containing spike rush (*Eleocharis*) mats were used heavily for resting and feeding. Marshall (1938) mentioned a single flock of 8,000 Ross geese in the San Joaquin Valley of California.

Breeding ground densities on preferred islands are often high; the total number of nests on five islands in Arlone Lake was 769 in 1963 and 906 in 1964. These islands had an average density of 4.26 nests per 1,000 square feet. Observations of two pairs provided territory estimates indicating maximum territory sizes of 8 and 12 feet in open and rock habitats, respectively. Nesting begins somewhat earlier in higher than in lower concentrations (Ryder, 1970b).

**Interspecific Relationships:** Ryder (1967) investigated possible competition with snow geese for nesting sites on Arlone Island and concluded that both species avoid open situations and prefer edge areas of birch or mixed habitats. However, he could not find any definite evidence of competition, since Ross goose densities and clutch sizes were as high in regions of high snow goose densities as they were in areas where snow goose densities were low. Food was abundant, and interspecific aggressive interactions were uncommon. Ryder believed that a future substantial increase in snow goose could, however, alter nesting space for Ross geese.

Ryder's studies indicated that, at least in his study area, avian nest predation was not a significant factor in affecting nesting success. However, arctic foxes apparently not only sometimes kill adult birds but also may cause stress by harassment during laying and sometimes cause great damage to nests. Ryder noted that 144 Ross goose nests and 122 snow goose nests were destroyed in one week during 1964; this caused the desertion of one island nesting colony.

In the wintering areas, Ross geese initially mingle with snow geese and white-fronted geese, but later tend to leave them and forage separately (Marshall, 1958). At this time they are associated mostly with cackling Canada geese, and feed mainly on green feed, whereas snow geese and white-fronted geese forage on rice fields and cereal croplands (Marshall, cited in Dzubin, 1965).

**General Activity Patterns and Movements:** Ross geese are apparently very similar to snow geese in their daily activities and movements. Dzubin
(1965) has documented the gradual shifting of fall migration routes in western Canada to a more easterly direction, associated with the loss of surface waters on the Canadian prairies since 1955. Kozlik et al. (1959) have also provided observations on wintering and spring migratory movements of color-marked birds.

**SOCIAL AND SEXUAL BEHAVIOR**

*Flocking Behavior:* Ryder (1967) noted that on their arrival at the breeding grounds, Ross geese are in small flocks of two to fifty birds. These represent family groups or their multiples, and when incubation begins, the nonbreeders flock together, leaving the nesting grounds at the time of hatching to undertake their molt migration. Shortly after hatching, units of two to fifteen families leave the nesting grounds and move to inland lakes and river courses. By three weeks after hatching, such postnuptial flocks may number as many as two hundred birds.

*Pair-forming Behavior:* By the time they reach their nesting grounds, the Ross geese are apparently already mated, and no copulatory or courtship behavior was noted by Ryder (1967). Copulations have been observed during spring migration in April, although it is apparent that they could not account for the fertilization of eggs laid in June. Triumph ceremonies were observed commonly by Ryder, and this behavior is known to be important in the formation and maintenance of pair bonds in geese.

*Copulatory Behavior:* The precopulatory behavior of Ross geese consists of the usual mutual head-dipping, which is followed by treading. Postcopulatory posturing is relatively weak (Johnsgard, 1965).

*Nesting and Brooding Behavior:* Ryder's (1967) study indicated that nest-building normally begins immediately after arrival at the nesting grounds and that considerable variation in nest construction occurs. During the egg-laying period the geese spend short periods at the nest site, with one bird grazing while the other defends the territory. The male usually leads the attack, with the female immediately behind. During this time territorial disputes are at a maximum, while when incubation begins the colony becomes noticeably silent. Only the female incubates, while the male remains near the nest and defends it. Females incubate with the head held up, as in snow geese, rather than with the head and neck on the ground, as in the genus *Branta*. Unless disturbed, the female covers the eggs with down when leaving the nest. After hatching, the male defends the brood, while the female leads them away from the source of danger.

*Postbreeding Behavior:* As mentioned earlier, families rapidly merge
into flock units, which may number several hundred geese within a few weeks after hatching. Loss of the flight feathers of adults is attained about fifteen to twenty days after the peak of hatching in early July. Within three weeks of hatching, the young have sheathed tail and flight feathers emerging. By the end of August the young are capable of flight and the birds prepare to migrate south.
EMPEROR GOOSE
Anser canagicus (Sewastianov) 1802
(Philacte canagica of A.O.U., 1957)

Other Vernacular Names: Beach Goose.
Range: Breeds in coastal Alaska from the mouth of the Kuskokwim River to the north side of the Seward Peninsula, St. Lawrence Island, and on the northeastern coast of Siberia. Winters on the Aleutian Islands and along the Alaska Peninsula probably to Cook Inlet with vagrant birds wintering in British Columbia and the western United States south to California.

Subspecies: None recognized.

Measurements (after Delacour, 1954):
- Folded wing: Males 380-400, females 350-385 mm.
- Culmen: Males 40-49, females 35-40 mm.

Weights: Average of six males was 6.2 pounds (2,812 grams), with a maximum of 6.8 pounds; nine females averaged 6.1 pounds (2,766 grams), with a maximum of 6.9 pounds (Nelson and Martin, 1953).
IDENTIFICATION

In the Hand: Emperor geese can hardly be confused with any other species when in the hand; the multicolored reddish bill lacking exposed “teeth,” the yellowish legs and feet, and a scalloped feather pattern of gray, black, and white are all unique.

In the Field: Along their very limited range, emperor geese are usually found along saltwater shorelines, where they occur in small flocks. The golden to orange staining on their white head feathers is conspicuous and contrasts with the otherwise grayish plumage. In flight, the lack of white feathers above or below the tail makes this species unique among geese. They also have relatively short necks and heavy bodies, associated with a rapid and strong wingbeat. In flight, the birds often utter a repeated kla-ha or an alarm note u-leegh.

AGE AND SEX CRITERIA

Sex Determination: No plumage characters are available for external sex determination.

Age Determination: Brown rather than black barring on the back and gray mottling on the head and neck indicate a bird in its first year.

DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: The emperor goose’s breeding distribution in North America is the most restricted of any goose species and is limited to the west coast and adjacent islands of Alaska. Gabrielson and Lincoln (1959) described the range as extending from Kotzebue Island on the north to the Aleutian Islands on the south, with the chief breeding occurring from the mouth of the Koskokwim River to the north side of the Seward Peninsula. The most eastern breeding record is reported for Cape Barrow, where a pair was taken in 1929, and the most southerly for Amak Island. It was uncertain to Gabrielson and Lincoln whether birds on St. Lawrence Island were nesters or simply nonbreeding and molting birds, but Fay (1961) has established that both breeding and molting does occur there. Bailey (1948) found that emperor geese were common nesters on the north shore of the Seward Peninsula and thought they were probably less common nesters on the north shore of Kotzebue Sound to at least Point Hope. Williamson et al. (1966) indicated that, although the emperor goose possibly breeds at Cape Thompson, it was rarely seen there.

Throughout their North American range, favored nesting habitats are in low, wet tundra, usually near the coast and often near lakes or ponds.
Breeding (hatched) and wintering (shaded) distributions of the Emperor goose in North America.
over (1926) reported that nesting at Hooper Bay occurred within ten miles of the coast. Spencer et al. (1951) noted that, although it nested in association with cackling geese twelve to fifteen miles from the coast in this area, it also nested farther inland with white-fronted geese and “lesser” (Alaska) Canada geese. Barry (1964) noted that ponds and marshes in low, rolling hills, inland from the tidal areas favored by brant, were preferred nesting habitat, with emperors, cackling Canada geese, and brant geese overlapping somewhat in their nesting habitat zones.

In Siberia, nesting occurs over a broad area adjoining the Bering Sea, and favored nesting habitats consist of coastal flats, islands in the mouths of small rivers emptying into the sea, and to some extent of swamplike marshes along the lower reaches of rivers flowing through tundra (Dementiev and Gladkov, 1967). Kistchinski (1971) also reported that coastal “lagoon” tundra and inland moss-sedge tundra represented the two main nesting habitats.

Wintering Distribution and Habitat: Virtually the entire emperor goose population of North America is believed to winter along the Aleutian Islands. Kenyon (1961) estimated a wintering population of 25,000 to 37,000 birds for the Aleutian Islands and added that, since large numbers may also winter along the Alaska Peninsula, the total winter population may be around 200,000 birds. The birds are abundant in winter around Kanaga Island, but have been reported all the way from the Sanak group to Attu (Murie, 1959). In some winters about 2,000 have been seen at Izembek Bay (Audubon Field Notes, 20:116, 22:114). They also winter on the Commander Islands, inhabiting stony, rubble-covered coasts (Dementiev and Gladov, 1967).

In recent winters increasing numbers of emperor geese have turned up along the West Coast, from California to British Columbia and inland Idaho. This is believed to be the result of the transferring of some emperor goose eggs to the nests of white-fronted geese by wildlife biologists, with a resultant shift in wintering movements (Audubon Field Notes, 24:633).

GENERAL BIOLOGY

Age at Maturity: Ferguson (1966) reported that fifteen of seventeen aviculturalists responding to a questionnaire indicated that initial breeding of captive emperor geese occurred when they were three years old, with the other two indicating two years and five years.

Pair Bond Pattern: Little documented information is available on this point, but most observers have noted strong pair bonds, which are presumably permanent.
**Nest Location:** Nests are typically placed near water, such as on an island, a bank, or in a large tussock (Conover, 1926). Sometimes the driftwood debris on the high tide line is chosen for concealing the nest (Barry, 1964). In the Hooper Bay region we noted (Kessel *et al.*, 1964) that thirteen nests were all in grassy marsh habitat, mostly within a few feet of water, but sometimes from twenty to forty feet from the nearest pond. Calvin Lensink (pers. comm.) reported that emperor geese nest farther from the coast than do brant and more often are found nesting along the main shoreline than on small islets. Around Hooper Bay they often nest in upland hummocks or “pingos” several yards from water, and on other coastal flats they may nest in clumps of wild rye (*Elymus*) well away from water.

**Clutch Size:** Of five hundred active nests that were found on the Yukon-Kuskokwim Delta between 1963 and 1971, the clutches averaged 4.72 eggs, with yearly means ranging from 3.83 to 5.59 (Calvin Lensink, pers. comm.). This area perhaps supports as much as 90 percent of the world’s emperor goose population and must represent optimum habitat; but in Siberia, clutch sizes are comparable, usually of 5 or 6 eggs (Dementiev and Gladkov, 1967). The egg-laying rate has not been reported.

**Incubation Period:** A 24-day incubation period has been generally reported for the emperor goose. Brandt (1943) estimated a period of approximately 25 days at Hooper Bay, the same period as Kistchinski (1971) determined for two nests in northeast Siberia.

**Fledging Period:** Apparently not yet definitely established.

**Nest and Egg Losses:** Losses to egg predators, principally jaegers, reduced the average clutch from 5.5 to 3.8 in one study (United States Department of the Interior Resource Publication 43, p.19, 1967), or an approximate 30 percent egg loss. Brood counts made in 1950 and 1954 (United States Fish and Wildlife Service, Special Scientific Report: Wildlife, Nos. 8 and 27) indicate an average brood size of 4.5 for 28 broods, suggesting a somewhat low early mortality, assuming no brood mergers occurred. Calvin Lensink (pers. comm.) reported an average of 3.85 goslings in 318 early (Class I) broods.

**Juvenile Mortality:** Fairly substantial losses of newly-hatched goslings to glaucous gulls have been noted by various observers (Brandt, 1943; Conover, 1926). Arctic foxes have also been reported to prey on both eggs and young where they are abundant (Barry, 1964).

**Adult Mortality:** No estimates of adult mortality rates are yet available for emperor geese.
GENERAL ECOLOGY

Food and Foraging: The emperor goose has been aptly called the “beach goose,” as a reflection of its littoral foraging tendencies. Cottam and Knappen (1939) have provided most of the available data on the foods of this species. In their sample of thirty-three stomachs, mostly from spring and summer specimens from Alaska, the contents were almost entirely (91.6 percent) vegetable material. Only two of the birds had been feeding predominantly on animal material, a finding in contrast to most earlier opinions on foraging tendencies of emperor geese. Major food sources consisted of algae (30.7 percent), eelgrass and pondweeds (13.9 percent), grasses and sedges (24.9 percent), unidentified plant fiber (22 percent), mollusks (3.7 percent), crustaceans (2.2 percent), and other animal materials (2.6 percent). Sea lettuce (Ulva and Enteromorpha) made up 17 percent of the total and occurred in twelve stomachs, while the remainder of the algae consisted of green algae. Eelgrass is apparently also a favored food, judging from its occurrence in the samples.

Murie (1959), in referring to wintering birds, commented on their use of kelp, sea lettuce, and Elymus shoots. Barry (1964) noted that young birds feed on aquatic insects and marsh grass at first, and later may consume berries. Dementiev and Gladkov (1967) mentioned that various invertebrates, particularly mussels and other mollusks and crustaceans collected in the tidal zone, are major sources of food. Quite possibly there are local or seasonal variations in the dependence upon animal foods by this species.

Sociality, Densities, Territoriality: Little has been written on this specific aspect of the emperor goose. During a few days in early June, I noticed a total of 400 to 500 emperor geese within a few square miles of the Hooper Bay marsh (Kessel et al., 1964), but these were mostly in groups of no more than a few dozen birds.

Brandt (1943) noted that during spring migration the geese moved northward in flocks of about 15 to 40 birds and that early arrivals at the nesting grounds were in pairs or small parties.

During the summer molt, emperor geese gather in large groups in favored localities. Fay (1961) noted that about 5,000 birds were present along one of the southern lagoons of St. Lawrence Island, out of a total summer population of 10,000 to 20,000 birds. Many of these were immature non-breeders, and Fay believed that St. Lawrence Island represents the principal summering area for the population of immatures produced in Alaska and Siberia.
Breeding densities have not been carefully estimated, but in the Hooper Bay area the emperor goose comprises about 10 percent of the breeding waterfowl population, which has been estimated at 130 birds per square mile (Spencer et al., 1951), so a density of 6 or 7 pairs per square mile would be indicated. This compares well with a more recent estimate made by Mickelson (1973) of 20 pairs on a four-square-mile study area. There were also 204 cackling goose pairs, 32 black brant pairs, 19 white-fronted goose pairs, and 42 spectacled eider pairs present on the area.

**Interspecific Relationships:** There would appear to be little if any competition between emperor geese and any other species of geese for food because of the emperors’ rather specialized diet, although in common with brant geese, they do consume substantial amounts of sea lettuce and eelgrass. Nesting is done in the same general habitat as is used by Canada geese and white-fronted geese, but suitable nest locations are never lacking in typical lowland tundra habitats.

Major egg predators would appear to be jaegers, although, following hatching, the young are taken by a variety of species, including glaucous and glaucous-winged gulls, three species of jaeger, and perhaps also the snowy owl (Brandt, 1943).

**General Activity Patterns and Movements:** During the long arctic summer days on the nesting grounds at Hooper Bay, there seemed to be no definite schedule of activities for the emperor geese. Nonbreeding birds or birds that were still in the process of egg-laying could be seen foraging around the edges of tundra ponds at almost any hour, usually in pairs or what appeared to be family groups of five to seven birds. They were far less wary and more “curious” than any of the other geese, and, when flushed, they would typically circle several times around the person flushing them, often almost at eye level, before flying away. Eskimos thus found them easy targets and, even with a single-shot .22-caliber rifle, could usually kill more than one bird from a flock before it finally left the area.

During early September at Izembek Bay, I have observed migrant birds foraging along the beaches in the tidal zone, and rarely if ever do they undertake daily flights to the tundra to feed on berries, as is typical of the Canada geese. Berries such as crowberries (*Empetrum*) are, however, eaten on the breeding grounds (Barry, 1964).

**SOCIAL AND SEXUAL BEHAVIOR**

**Flocking Behavior:** As noted earlier, large flocks of emperor geese are rarely encountered, except perhaps in summer molting areas (Fay, 1961).
The largest winter flock that I have found on record is 2,350 during a Christmas count at Izembek Bay, Alaska (Audubon Field Notes, 22:114).

Pair-forming Behavior: Pair formation probably occurs at the wintering areas, since the birds arrive at their breeding areas already in pairs (Bailey, 1948; Brandt, 1943). I observed no pair-forming behavior at Hooper Bay and saw no aggressive behavior in the small groups that moved about together, suggesting that they were family units. Observations of geese in captivity indicate that a typical triumph ceremony is present, which no doubt serves to establish and maintain bonds in emperor geese as in other goose species.

Copulatory Behavior: I have never observed a completed copulation, and the only apparent precopulatory behavior I have seen rather closely resembled normal feeding behavior on the part of both birds. Brandt (1943) noted that mating occurred in shallow water, just deep enough to allow the female to sink beneath the surface.

Nesting and Brooding Behavior: According to Brandt the female builds a nest in grasses usually close to water, first hollowing out a cup from 2.2 to 4.5 inches deep, enough to allow the female to be well concealed but also leaving an adequate accumulation of grasses and moss below. Incubation begins with the completion of the clutch, but little down is added until near the end of incubation, when it is liberally deposited. The male remains near the incubating female, but not as close as in white-fronted geese. Following hatching, the male joins the family and they move to rivers and sloughs near the coast, where the young forage for aquatic insects or may feed on sedges and tundra berries with their parents.

Post-breeding Behavior: Molting of breeding adults begins about two or three weeks after the young are hatched. It is probable that immature nonbreeders do not molt on the breeding grounds, but rather fly to St. Lawrence Island for molting, where “herds” of up to 20,000 flightless birds may accumulate during summer (Fay, 1961). Their flightless period occurs between mid-June and early August, or considerably earlier than that of breeding adults that have hatched their young in late June or July. Arrival of fall migrants at Izembek Bay may occur as early as mid-August; these early arrivals are presumably also nonbreeders. Apparently a sizable portion of the Asiatic population of emperor geese molt at Ukouge lagoon, on the northern coast of Siberia (Kistchinski, 1971).
CANADA GOOSE
Branta canadensis (Linnaeus) 1758

Other Vernacular Names: Cackling Goose, Canadian Goose, Honker, Hutchins Goose, Richardson Goose, White-cheeked Goose.

Range: Breeds across most of North America, from the Aleutian Islands across Alaska and northern Canada and south to the central United States. Resident flocks of larger subspecies are also established at many wildlife refuges, in some cases well beyond the probable original range of the subspecies. Also introduced into New Zealand, Great Britain, and Iceland.

North American Subspecies (based on Delacour, 1954):
- B. c. interior Todd: Hudson Bay (Todd) Canada Goose. Breeds in northern Quebec, Ontario, and Manitoba around Hudson and James bays, south to about 52° N. latitude and north as far as Churchill and the Hudson Strait.
B. c. maxima Delacour: Giant Canada Goose. Originally bred on the Great Plains, from the Dakotas south to Kansas, Minnesota south to Missouri, western Kentucky, Tennessee, and northern Arkansas. Now largely limited to captive flocks in wildlife refuges. Hanson (1965) considers the geese that breed in southern Canada from Alberta to Manitoba to represent this race.

B. c. moffitti Aldrich: Great Basin (Moffitt) Canada Goose. Breeds in the Great Basin of North America between the Rocky Mountains and the eastern parts of the Pacific states, intergrading to the north with parvipes and to the east with interior and probably originally also with maxima.

B. c. parvipes (Cassin): Athabaska (Lesser) Canada Goose. An intermediate and ill-defined form that links the larger, southern subspecies with the small, northern and tundra-breeding populations. Breeds from central Alaska eastward across northern Canada and southern Victoria Island to western Melville Peninsula and eastern Keewatin southward to the northern parts of the Canadian Prairie Provinces, where it intergrades with moffitti.

B. c. taverneri Delacour: Alaska (Taverner) Canada Goose. Probably breeds through much of the interior of Alaska, some distance from the coast, from the base of Alaska Peninsula to the Mackenzie River delta, intergrading locally with minima, occidentalis, and probably also with parvipes. Not recognized by the A.O.U. (1957); apparently considered part of minima and parvipes.

B. c. fulva Delacour: Queen Charlotte (Vancouver) Canada Goose. Breeds along the coast and islands of British Columbia and southern Alaska, north to Glacier Bay, largely nonmigratory.

B. c. occidentalis (Baird): Dusky (Western) Canada Goose. Breeds along the Prince William Sound, Cook Inlet, and inland through the Cooper River drainage, east to Bering Glacier.

B. c. leucopareia (Brandt): Aleutian Canada Goose. Rare; limited to a few of the Aleutian Islands such as Buldir; recently (1970) released on Amchitka. The name leucopareia has also been applied earlier (e.g., Aldrich, 1946) to the populations here recognized as parvipes and taverneri.

B. c. asiatica Aldrich: Bering Canada Goose. Extinct; once bred on the Commander and the Kurile islands.

B. c. minima Ridgway: Cackling Canada Goose. Breeds along the coast of western Alaska from Nushagak Bay to the vicinity of Wainwright, where it probably intergrades with taverneri.

B. c. hutchinsii (Richardson): Baffin Island (Richardson) Canada Goose.

**Measurements:**

Because of the extreme size variation of different subspecies, average measurements are of little significance unless the subspecies is known. The extreme ranges for adults are wing length 330 mm. (*minima*) to 556 mm. (*maxima*), and culmen length 26 mm. (*minima*) to 68 mm. (*maxima*).

**Weights:** Like linear measurements, weights vary greatly according to age, sex, and subspecies. The following summaries provide an indication of this variability:

- **Cackling Canada Goose:** 30 males averaged 4.4 pounds (1,005 grams), with a maximum of 5.6 pounds; 20 females averaged 3 pounds (1,360 grams), with a maximum of 5.1 pounds (Nelson and Martin, 1953).
- **Baffin Island ("Hutchesons") Canada Goose:** 31 males averaged 4.5 pounds (2,041 grams), with a maximum of 6.0 pounds; 37 females averaged 4.1 pounds (1,856 grams), with a maximum of 5.2 pounds (Nelson and Martin, 1953).
- **Alaska Canada Goose:** 31 males averaged 4.5 pounds (2,041 grams), with a maximum of 6.0 pounds; 37 females averaged 4.1 pounds (1,856 grams), with a maximum of 5.2 pounds (Nelson and Martin, 1953).
- **Athabaska Canada Goose:** 184 adult males averaged 6.10 pounds (2,766 grams), with a maximum of 7.87 pounds; 194 adult females averaged 5.45 pounds (2,471 grams), with a maximum of 7.25 pounds (Greib, 1970).
- **Dusky Canada Goose:** 36 adult males averaged 8.28 pounds (3,754 grams), with a maximum of 9.83 pounds; 26 adult females averaged 6.9 pounds (3,131 grams), with a maximum of 8.82 pounds, in late November and early December (Chapman, 1970).
- **Atlantic ("Common") Canada Goose:** 232 males averaged 8.4 pounds (3,809 grams), with a maximum of 13.8 pounds; 159 females averaged 7.3 pounds (3,310 grams), with a maximum of 13.0 pounds (Nelson and Martin, 1953).
- **Hudson Bay Canada Goose:** 44 adult males averaged 9.28 pounds (4,212 grams), with a maximum of 10.4 pounds; 45 adult females averaged 8.3 pounds (3,856 grams), with a maximum of 8.5 pounds (Raveling, 1968b).
- **Great Basin Canada Goose:** 10 adult males averaged 9.9 pounds (4,334 grams).
grams), and 9 females averaged 8.17 pounds (3,930 grams), with the maximum weight recorded for 190 geese being 15 pounds (Yocom, 1972).

Queen Charlotte ("Western") Canada Goose: 9 males averaged 10.2 pounds (4,625 grams), with a maximum of 13.8 pounds; 6 females averaged 7.8 pounds (3,537 grams), with a maximum of 9.5 pounds (Nelson and Martin, 1953).

Giant Canada Goose: 13 captive adult males averaged 14.39 pounds (6,523 grams), with a maximum of 16.5 pounds; 13 adult females averaged 12.16 pounds (5,514 grams), with a maximum of 14.19 pounds (Hanson, 1965).

IDENTIFICATION

In the Hand: Even in the juvenal plumage, the distinctive dark head and neck with the lighter cheeks and throat are evident. Because of this, the Canada goose could be confused only with the barnacle goose, from which the Canada can be distinguished by the absence of white feathers over the forehead connecting the white cheek patches. (Some large Canada geese may have a small white forehead patch that is discontinuous with the cheek markings.) Canada geese also lack the definite black and white tips on the upper wing coverts typical of barnacle geese.

In the Field: Even at great distance, Canada geese are usually readily recognized by their black heads and necks, brownish body and wings, and white hindpart coloration. This combination also applies to brant geese, but these small geese are limited to coastal waters and may be recognized by their short necks and ducklike size. The small races of Canada goose also have relatively short necks, with the neck length becoming progressively greater as the body size increases, so that the largest forms of Canada goose appear to be unusually long-necked. When in flight overhead the birds show uniformly dark under wing coverts of about the same color as the primaries and, except for their black necks, might be easily mistaken for white-fronted geese if the latter's dark abdominal spotting is not visible. The smaller races have high-pitched "cackling" calls sometimes sounding like luk-luk, while the larger forms have "honking" notes often sounding like ah-onk'.

AGE AND SEX CRITERIA

Sex Determination: Males average slightly heavier than females, but no consistent external plumage or soft-part differences appear to be present and usable for sex determination.
**Age Determination:** First-year Canada geese can be recognized by one or more of the following criteria: notched tail feathers, an open bursa of Fabricius averaging 27 mm. in depth (range 24-35 mm.), a pinkish red area of skin around the vent, and, in males, a penis that is pink, less than 10 mm. long, and not coiled or sheathed. Second-year birds have tail feathers lacking notches, a bursa of Fabricius that averages 20.5 mm. long (range 18-24 mm.), a pinkish red skin area around the vent, and, in males, a penis about 10 mm. long, and 4 mm. in diameter when unextended, and both coiled and sheathed. Older birds have tail feathers without notching, a bursa that is usually closed but may be open in about 40 percent of two-and-one-half-year-old geese, a naked skin area around the vent that is flesh red to purple, and, in males, a penis that is flaccid, dark red to purple, sheathed, and 50 to 100 percent larger than that of second-year birds. Females in their third year or older have open oviducts (Hanson, 1949). Higgins and Schoonover (1969) reported that Canada geese of the small arctic type can be aged with more than 90 percent accuracy by neck plumage characters. Adult geese of this type have their black neck markings sharply demarcated from the pale breast, whereas in immatures the colors gradually merge.

**DISTRIBUTION AND HABITAT**

*Breeding Distribution and Habitat:* Because of the extraordinarily great subspecific diversity in breeding habitats and the collective enormous breeding range of these races, no concise summary of distribution and habitat is possible for the Canada Goose. Virtually all of the nonmountainous portions of continental Canada and Alaska might be considered breeding range, as well as the Great Basin of the United States and, until recently, the northern prairies as well. Recent reintroduction of Canada geese into refuges and other managed areas throughout the northern states has blurred subspecific distinctions and has confused the picture as to original versus current or acquired breeding ranges.

Canada geese (*B. c. canadensis* and *B. c. interior*) using the Atlantic Flyway represent about 40 percent of the total population and breed through an extensive area in eastern Canada. This breeding area consists of two major habitat types, the forest-muskeg of the James Bay lowlands and the arctic tundra on the upper Ungava Peninsula, Cape Henrietta Maria, and on the Belcher Islands and other Hudson Bay islands (Addy and Heyland, 1968). Birds wintering in the Mississippi Flyway represent about 30 percent of the total population. They breed throughout a large area of central Canada and are largely represented by the Hudson Bay race *B. c. interior*. Their breeding
Breeding and wintering distributions of the Canada goose in North America. Approximate breeding distributions of subspecies are indicated.
habitats are generally similar to those just mentioned for Atlantic Flyway birds, and appear concentrated on the coastal strip of sedimentary deposits adjoining southern Hudson Bay (Hanson and Smith, 1950).

Canada geese using the Central Flyway consist of a complex of several breeding populations and subspecies. The larger forms include some Hudson Bay geese that breed to the west and southwest of Hudson Bay (Vaught and Kirsch, 1966), as well as some Great Basin Canada geese that breed on the prairies of western Canada and Montana. This population once included substantial numbers of giant Canada geese that bred in the tall prairies of the northern plains states, and restocking efforts have begun to develop new population nuclei in areas from Nebraska and Missouri to the Dakotas and Minnesota. Also using the Central Flyway are much smaller geese that include both the extremely small tundra-nesting Baffin Island race and the slightly larger Athabaska Canada goose, which also breeds from the arctic tundra southward through the boreal coniferous forests of Canada. MacInnes (1962) reported on the nesting habitat of tundra-nesting birds of this “tall grass prairie” population of Baffin Island Canada geese. Slightly to the west of this population, but also using the Central Flyway, is the “short grass prairie” population of small geese, which includes both the Athabaska and Baffin Island races of Canada geese that migrate through the high plains east of the Rockies. The breeding areas of this population include a broad and diffuse area of the Northwest Territories. The eastern segment of this population breeds primarily along the Arctic Ocean coast between longitudes 101° and 110° W., with a probable zone of interspersion with the tall grass population in the eastern region (Grieb, 1968). Birds breeding to the north along the coast of southeastern Victoria Island are typical *hutchinsii* and are likewise barren land breeders. The western segment, however, is composed predominantly of forest-breeding birds (presumably *parvipes*) that nest in the Mackenzie River drainage from 110° W. longitude west to the Yukon Territory and from about 58° N. latitude to the Arctic Ocean. Collection of an adult male *parvipes* from the north-central Brooks Range suggests that the western limit of this race may actually be in north-central Alaska (Campbell, 1969), although there is a good possibility that the birds seen and collected there were non-breeders that had migrated there for molting. The remaining major contributor to the Central Flyway is the “highline” population of Great Basin Canada geese or intergrades between that race and the Hudson Bay race. Typical Great Basin geese breed on the prairie areas of southwestern Saskatchewan, southern Alberta, and eastern Montana, while birds of uncertain racial status breed from the area of Portage la Prairie, Manitoba, westward to eastern Alberta and northward possibly to tree line (Grieb, 1966).
The Pacific Flyway likewise is made up of several population complexes. Six subspecies occur typically in this flyway. The nearly extinct Aleutian Canada goose is limited to a few (Buldir and possibly Amchitka) of the treeless Aleutian Islands, and the similar cackling Canada goose breeds on coastal tundra along the mainland of Alaska. Away from the immediate coastal strip, and especially along such major rivers as the Yukon, Kuskokwim, Kobuk, and Colville, the Alaska Canada goose (or "lesser," according to Gabrielson and Lincoln, 1959) is the typical breeding bird. To the south, toward the Copper River, Prince William Sound, and Cook Inlet, it is replaced by a larger and darker form, the dusky Canada goose, which breeds along this moist coastline from Cook Inlet to Bering Glacier, with maximum abundance in the Copper River delta (Hansen, 1962). To the south, along Alaska's coastal panhandle and on the adjoining islands and mainland of British Columbia, the even larger and more sedentary Queen Charlotte Canada goose breeds in a comparable climate and similar vegetational habitats. It is isolated by about a 300-mile hiatus from the range of occidentalis and breeds from Cross Sound near Glacier Bay south to Dixon or possibly somewhat into British Columbia (Hansen, 1962). Finally, in the interior river valleys, reservoirs, and lakes of the Pacific Flyway states from the eastern slopes of the Cascades across the Rocky Mountains to Montana and south to California, Nevada, Utah, and Colorado, the Great Basin Canada goose breeds over a diffuse but extremely extensive area. Yocom (1965) has mapped its breeding range and estimated its 1951 breeding population as about 17,000 birds.

Wintering Distribution and Habitat: Wintering habitats vary less than breeding habitats, and it is not unusual to find representatives of three subspecies mixing on migration routes and on wintering areas. There is a general inverse relationship between the size of the bird and the distance between its breeding and wintering areas, with the smallest races (Baffin Island and cackling) migrating to the most southerly wintering areas, while the largest forms (Queen Charlotte Island, giant, and Great Basin) are often virtually nonmigratory and may winter on their breeding ranges.

Definitions of typical wintering habitats no doubt differ according to region, but one useful analysis is that of Stewart (1962), based on studies at Chesapeake Bay. The habitat there is optimal because of the presence of extensive agricultural areas adjacent to open, shallow expanses of fresh, slightly brackish, or brackish estuarine bays, providing food in grainfields as well as in the shallow estuaries and providing roosting sites in the bays. In estuarine marshes or salt marshes smaller numbers were typical, and there they fed in Scirpus or cordgrass (Spartina) communities and roosted on larger marsh ponds or impoundments as well as on adjacent estuaries or bays. In the
interior United States, the increasing numbers of large reservoirs that remain ice-free all winter and are adjacent to grainfields have resulted in an increasingly delayed fall goose migration and progressively more northerly wintering areas in recent years, at least for the larger subspecies. This combination, then, of safe roosting sites and the availability of agricultural crops or other suitable foods would seem to be the prime requisites for wintering habitat. Documentation of such wintering population changes in the upper Mississippi Valley has been made by Reeves et al. (1968) for Illinois and Wisconsin birds. Apparently at least part of the stimulus for the development of goose overwintering at Horicon Refuge was the establishment of a resident flock and a reflooding of the marsh. Likewise, a simple combination of food and sanctuary was responsible for developing the famous flocks of geese at Horseshoe Lake, Illinois.

**GENERAL BIOLOGY**

*Age at Maturity:* There may be individual or racial variation on this point. Two-year-old females of the larger subspecies no doubt occasionally breed; Craighead and Stockstad (1964) found that between 27 and 36 percent of the wild female Great Basin Canada geese they studied bred at this age, as did all three-year olds. Brakhage (1965) indicated that a third of the two-year-old female giant Canada geese under observation nested, and Sherwood (1965) found that about three-fourth of such females produced eggs. Martin (1964) and Williams (1967) also reported breeding by two-year-old Great Basin Canadas. Evidently nearly all two-year-old male giant Canada geese are capable of breeding, and a very small portion of yearling males may attempt to breed (Brakhage, 1965). The small Canada geese breeding in the eastern arctic (*B. c. hutchinsii* in the broad sense) may exhibit incomplete nesting behavior and sometimes defend territories as two-year-olds. Williams (1967) reported that some captive Aleutian Canada geese nested and reared young at that age.

*Pair Bond Pattern:* Canada geese are monogamous and exhibit strong pair and family bonds. Separation from a mate, or its death, will result in the forming of a new pair bond, usually during the next breeding season (Hanson, 1965). Sherwood (1967) found that pairs can be developed in a few hours in older, experienced and “acquainted” geese, and these remained permanent as long as both remained alive. He found no polygamy, promiscuity, or pairing between broodmates. Pairing normally occurred on the nesting grounds, when the birds were two years old. Yearlings typically remained near their parents and rejoined them after the nesting season. Some yearlings formed
temporary pairs, and broodmates retained their family bonds well into their second year.

Nest Location: Nest locations vary greatly according to topography and vegetation. The same nest site may be used for several years (Martin, 1964). Hanson (1965) stressed the importance of muskrat houses as nest sites for marsh-nesting giant Canada geese, while in Manitoba common reed (Phragmites) is preferred over prairie grasses for nest construction (Klopman, 1958). Hardstem bulrush (Scirpus acutus) is a highly favored nesting site in the western states (Williams, 1967). MacInnes (1962) reported that tundra-nesting birds strongly favored small islands surrounded by open water, with fairly hard, dry tops. Williams concluded that several factors contribute to favorable nest locations. These include good visibility, a firm and fairly dry nest foundation, a close proximity to water, adequate isolation, and nearness to suitable feeding grounds and brooding habitat. Dimmick (1968) noted that 72 percent of 145 Great Basin Canada goose nests he studied were on islands, apparently the nesting site safest from predators. The highest nest density occurred near feeding areas, and 74.5 percent of the nests had excellent or good visibility. Sand was preferred over cobblestone for a nest substrate, and nests built over mud were elevated to keep the bottoms dry. The average distance to water was 45.7 feet, and shrubs or driftwood provided cover for the majority of the nests.

Clutch Size: In the case of the larger races of Canada geese, the clutch size is fairly consistently centered around 5 eggs, with averages of various studies (Williams, 1967) ranging from 4.6 to 5.7. Weller (in Delacour, 1964) could find no correlation between clutch size and geographic location among nineteen studies of larger Canada geese. Fewer data are available on the arctic-nesting races. MacInnes (1962) reported an average complete clutch size of 5.1 to 5.4 eggs for hutchinsii, and Gillham (cited in Spencer et al., 1951) reported an average clutch of 4.7 eggs for minima. The rate of egg-laying is slightly more than one day per egg in both the small races (MacInnes, 1962) and the larger forms (Williams, 1967).

Incubation Period: Unlike clutch size, incubation periods do apparently vary geographically. The largest forms of Canada geese require from 26 to 28.6 days (Hanson, 1965) for incubation, averaging 28 days (Williams, 1967). This compares with 25 to 28 days for the Hudson Bay Canada goose (Kossack, 1950) and 24 to 25 days for the east arctic hutchinsii (MacInnes, 1962). Further, although the more southerly-breeding races often attempt renesting (Atwater, 1959) if their first effort is broken up, MacInnes (1962) found no indications of renesting in his arctic study area.

Fledging Period: Like incubation periods, racial variations exist in fledg-
ing periods in relation to body size and length of the growing season. Hanson (1965) reviewed this relationship and noted that although the giant Canada goose requires from 64 to 86 days to attain flight, the cackling Canada goose has a fledging period of only 42 days. The estimated period for the Hudson Bay Canada goose was 65 days.

**Nest and Egg Losses:** Weller (in Delacour, 1964) has summarized published data on nesting success in the larger Canada geese. The average of nine studies was a 67 percent hatch of total nests studied, with a range of 24 to 80 percent. Hanson (1965) likewise reported an average nesting success rate of 58.6 percent based on nine studies of birds he considered to represent the giant Canada goose and a 71.1 percent average nesting success for eight studies of the Great Basin Canada goose. MacInnes (1962) reported a high nesting success rate (75 to 90 percent) for *hutchinsii* during two years of study, although it is typical of arctic-nesting waterfowl to exhibit great yearly fluctuations in productivity as an apparent result of annual weather variations.

**Juvenile Mortality:** Estimates of juvenile mortality based on brood size counts are not completely reliable, since brood mergers do occur. Hanson (1965) estimated an average brood size at the time of hatching, on the basis of all available data, as 4.2 young for the giant Canada goose and 4.1 for the Great Basin Canada goose. MacInnes (1962) reported that various studies indicated an 82 to 97 percent brood survival under wild conditions for the Great Basin Canada goose, and his studies on *hutchinsii* indicated an 85 to 90 percent brood survival during two years of study.

Following fledging, juvenile birds are subjected to considerably higher mortality than are adults, at least in part as a result of inexperience. MacInnes (1963) reported an annual mortality of 75 percent for juveniles as compared to 25 percent for adults in the tallgrass prairie flock, and Martin (1964) noted a 47 to 64 percent mortality rate in first-year birds compared to a 35 to 45 percent rate in adults. Vaught and Kirsch (1966) estimated a 35 to 50 percent mortality rate of immature Canada geese in the Swan Lake, Missouri, flock. Likewise, Hansen (1962) estimated a 56.9 percent annual juvenile mortality rate for the dusky Canada goose, compared with a rate of 28.9 percent for adults.

**Adult Mortality:** Grieb (1970) has summarized reported mortality rates for various populations of Canada geese and calculated a 38.9 percent adult mortality rate for the shortgrass prairie population (mainly Athabaska Canada geese). Annual adult mortality estimates include lows of 25 percent in adults of the tallgrass prairie flock and about 25 to 30 percent for adults in the Swan Lake flock, both of which consist predominantly of the Hudson Bay Canada goose (Vaught and Kirsch, 1966). Higher estimates of a 35 to
45 percent adult mortality rate have been made for the Great Basin Canada goose, while Hanson and Smith (1950) estimated an all-age annual mortality rate of 52 percent for the Horseshoe Lake flock. The data of Martin (1964), Williams (1967), and Hansen (1962) suggest adult mortality rates of about 30 to 40 percent for Canada geese in the western United States.

**GENERAL ECOLOGY**

*Food and Foraging:* Most studies of food habits of Canada geese are of wintering or migrating birds and may not be typical of breeding birds. Martin *et al.* (1951) summarized data from a variety of areas, indicating that the vegetative parts, particularly the rootstalks, of many marsh plants are consumed. Important plants include cordgrass (*Spartina*), salt grass (*Distichlis*), sago pondweed (*Potamogeton pectinatus*), wigeon grass (*Ruppia*), hardstem bulrush (*Scirpus acutus*), glasswort (*Salicornia*), and spike rush (*Eleocharis*). In a study of foods found in 263 gizzards and 31 crops from Lake Mattamuskeet, North Carolina, Yelverton and Quay (1959) found that sedges (mainly *Eleocharis* species and *Scirpus acutus*) made up 63 percent of the food volume, while grasses constituted nearly all the remainder, with corn grains being most important. Likewise, Stewart (1962) found that waste corn was the food of primary importance for Chesapeake Bay geese wherever it was readily available, while sprout growth of various grain crops was also consumed, together with the vegetative parts of various submerged plants. In large estuarine bay marshes and coastal salt marshes, the stems and rootstalks of such emergent plants as three-square (*Scirpus americanus* and *S. olneyi*) and cordgrass are taken in large quantities.

*Sociality, Densities, Territoriality:* Many recent studies, such as that of Raveling (1969a), have clearly established the fact that the basic social unit in Canada geese is the family. Raveling determined that it (adults and first-year young) remained intact all winter and always reassembled if separated. When captured and released together, initial separation occurred, but in no more than seven and one-half days the family was again intact. Rejoining of such families by yearling offspring of the past season was apparently fairly common. Although such yearlings sometimes formed temporary pair bonds during their second summer of life, these usually broke down, and either the birds returned to their parents, or the yearling siblings remained together through the fall and winter. In some cases, permanent pairing occurred in late winter or early spring between birds that had formed temporary pair bonds as yearlings. With the assumption of a permanent pair bond, the family bond is finally broken, and the potential depends both on specific
preferences on the part of both sexes and on relative male dominance in the vicinity of the female, as indicated by Collias and Jahn (1959). These authors believed that sexual behavior such as copulation facilitated pair formation, and they also established that a bird could recognize the voice of its mate even when unable to see it. Pair and family bonds are maintained and strengthened by repeated use of the triumph ceremony (Raveling, 1969a).

Estimates of breeding densities are available from various areas and apparently vary greatly. MacInnes and Lieff (1968) found marked differences in nest density of hutchinsii in adjacent kilometer square plots during the same year, as well as considerable differences in density of the same plots in two consecutive years. The highest density they reported for the two years was 13 nests in a square kilometer plot. Earlier (1962) MacInnes reported that optimum breeding habitat at McConnel River supported up to 6 nests per square mile. In his 55-square-kilometer study area (21.2 square miles) he reported 129 nests in 1966 and 99 in 1967, or an average density of 4.7 nests per square mile. Hansen (1962) reported some remarkable nesting densities of the dusky Canada goose in the Copper River delta. In 1954 there was an overall average density of 6.4 successful nests (8.0 calculated total nests) per square mile on an 88-square-mile area, while in 1959 one small (2.08-square-mile) nesting area had an average density of 108 nests per square mile. This area of high density nesting was limited to 12 square miles of river delta adjacent to the coast. Perhaps the finest goose nesting ground in all of North America occurs over an 800-square-mile area from Igiak Bay to about the southern tip of Nelson Island, Alaska, where goose breeding populations average 130 birds per square mile. In 1950 about 60 percent of these were cackling Canada geese, or an estimated 78 birds per square mile (Spencer et al., 1951). In 1951 three study plots totalling two square miles in area had an average density of 153 nests per square mile, of which about 40 percent were of cackling Canada geese (Hansen, 1961), or roughly 60 nests per square mile.

Some examples of extreme nest site proximity have been reported for the larger and more southerly breeding forms, as summarized by Williams (1967). He noted a case of 11 goose nests on a single haystack in Oregon and 31 nests on an island about one-half acre in size in California. Hansen (1965) also noted several other cases in which nest density ranged from 10 to 66 per acre. It would thus seem that basic territorial tendencies of Canada geese probably do not limit breeding densities or influence nesting distribution as much as do physical factors such as availability and distribution of suitable nesting sites.

Interspecific Relationships: Little has been specifically noted as to re-
relationships with other species and possible competition for food or nesting sites. In some areas the birds breed in close association with black brant (Spencer et al., 1951), while in other areas of eastern Canada they are found in association with snow geese. Some studies suggest that losses to predators of eggs and young are low compared to those resulting from flooding (Hansen, 1961), chilling, or other weather-related losses. Predators that have been responsible for high nesting losses include the coyote, red fox, striped skunk, raven, crow, magpie, and various gulls (Hanson, 1965). Of these, probably only the mammals are effective predators once the goslings have left the nest.

General Activity Patterns and Movements: Some studies on variations in activities according to time of day have been performed. Collias and Jahn (1959) noted that during the pre-egg stages, territorial activity is greatest early in the morning, as was also true of copulation frequency. All of the observed copulations were seen between twenty days prior to the laying of the first egg and the initiation of incubation.

Canada geese typically fly out to forage in early morning and late afternoon in areas where they cannot forage in roosting sites. Prior to taking flight, preflight intention movements, which consist of simultaneously lifting and shaking the head, are usually performed. Raveling (1969b) analyzed the occurrence of this signal and found it tended to be given least and for the shortest time by single birds. The number of signals and the length of time from the first signal to takeoff were found to increase progressively for pairs and families of three and four birds, while families of five exhibited a counter-trend. Raveling noted that, whereas a gander did not always respond to head-tossing by members of his family, they always responded almost immediately to his head-tossing. The importance of this signal in synchronizing and coordinating family activities is thus clearly apparent. Changes in vocalizations and the appearance of the distinctive upper tail covert pattern appear to be the major releasers for actual flight in these as in nearly all other geese.

A fairly complete survey of the general behavior patterns of Canada geese has been presented by Balham (1954).

SOCIAL AND SEXUAL BEHAVIOR

Flocking Behavior: Probably the first suggestion of the importance of the family in the formation of larger flocks of geese was that of Phillips (1916), whose conclusions have been fully confirmed by later investigators such as Raveling (1969a) and Sherwood (1965). Raveling (1968a) compared flock substructure at the time of takeoff, while in steady flight, and at the time of landing, and concluded that only at the time of landing, when
families almost invariably appeared together, did flock subunits clearly reflect actual family units.

*Pair-forming Behavior:* As has been noted above, permanent pair formation typically occurs in two-year-old birds, probably in late winter or early spring. Mutual association of two birds and their coordinated performance of the triumph ceremony after aggressive encounters provide the basic means of establishing a pair bond. Collias and Jahn (1959) described this process and noted that weather played a role in the intensity of pair-forming behavior, with cold weather tending to separate incipient pairs. After the selection of a nest site and associated establishment of a nesting territory, young of the past year are driven away from the parents and the female and her nest site are defended from all intruders. The importance of male protection was illustrated by one pair in which the male died during the incubation period and the female failed to hatch her young as a result of domination and disturbance from other pairs and unmated males.

*Copulatory Behavior:* Copulation in Canada geese is preceded by mutual head-dipping movements resembling bathing. It is usually initiated by the male, but the female soon participates and usually continues to neck-dip until the male prepares to mount her (Klopman, 1962). Postcopulatory display is mutual and usually consists of raising the breast upward, extending the neck and pointing the bill vertically upward, and partially extending the wings away from the body. Calls may be uttered by either or both birds.

*Nesting and Brooding Behavior:* Nest-building is normally done by the female almost exclusively, although the male may very rarely participate to a limited extent (Collias and Jahn, 1959). In one instance noted by Collias and Jahn a female built an entirely new nest from available materials in about four hours, and 45 minutes later had deposited her first egg in it. Down is usually added only after the first few eggs have been laid, and later on some contour feathers may also be placed in the nest. To a limited extent nest-building behavior may continue throughout the incubation period, which prevents the nest from becoming flattened down. While incubating, the female usually leaves the nest only two or three times a day, to rest, forage, drink, bathe, and preen, and usually is gone for less than an hour at a time. The process of hatching requires about a day, and the young remain in the nest the first night. Females typically leave the nest with their brood the day after hatching, but may bring them back to the nest for the next several nights for brooding (Collias and Jahn, 1959). Adoption of strange goslings is most likely to occur before they are a week old and if they and the parents’ brood are of about the same age, after which the adults are likely to attack strange goslings.
Postbreeding Behavior: According to Hanson (1965), females normally precede their mates in the postnuptial wing molt by a week to ten days, when the young are between thirty and fifty days old. Apparently about thirty-two days are required for Hudson Bay Canada geese to regain flight, while thirty-nine days were required for a single adult male giant Canada goose studied by Hanson. Nonbreeding Canada geese may perform substantial migrations to areas where they undergo their molt, particularly to the barren grounds of the Thelon River delta, Northwest Territories, where many large Canada geese may be seen in late summer (Sterling and Dzubin, 1967). Other subspecies probably undergo molt migrations as well. The dusky Canada goose may move to the western side of Cook Inlet, while the Queen Charlotte molts along Glacier Bay. The Alaska Canada goose perhaps molts along the arctic coast of Alaska, the Athabaska Canada goose between the Mackenzie and Anderson rivers in the Northwest Territories, and the Ungava Peninsula may be a molting area for Canada geese of the Atlantic Flyway (Sterling and Dzubin, 1967).
BARNACLE GOOSE
*Branta leucopsis* (Bechstein) 1803

Other Vernacular Names: None in general use.

Range: Breeds in northeastern Greenland, Spitzbergen, and southern Novaya Zemlya. Winters in Ireland, Great Britain, and northern Europe, with only rare occurrences in eastern North America.

Subspecies: None recognized.

Measurements (after Delacour, 1954):
- Folded wing: Both sexes 385-420 mm.
- Culmen: Both sexes 27-32 mm.

Weights: Boyd (1964) reported that twenty adult males captured in February averaged 4\(\frac{1}{8}\) pounds (1,870 grams), with a maximum of 4\(\frac{1}{2}\) pounds; fifteen adult females averaged 3\(\frac{3}{4}\) pounds (1,690 grams), with a maximum of 4\(\frac{1}{2}\) pounds.

**IDENTIFICATION**

*In the Hand:* This small, dark-breasted goose may be identified by its white cheeks and forehead, its black breast, and the grayish upper wing coverts that are distinctively tipped with black and white.

*In the Field:* Only an occasional visitor to North America, the barnacle goose nevertheless has appeared in a surprising number of localities, mainly along the eastern coast. It is slightly larger than a brant and differs from it
in having a predominantly white head and a light gray rather than dark grayish brown upper wing coloration. The underwing coloration is likewise light silvery gray and much lighter than that of the brant. The extension of the black neck color over the breast will readily separate the barnacle goose from the Canada goose, even at a great distance, and the contrast between the dark and light parts of the body is much greater as well. Its call is a barking, often repeated *gnuk*; a flock sounds something like a pack of small dogs.

AGE AND SEX CRITERIA

*Sex Determination:* No plumage characters are available for external sex determination.

*Age Determination:* The presence of gray flecking on the head and a somewhat grayish rather than entirely black neck will serve to identify first-year birds. The black and white markings on the upper surface of the wings are also less well developed in first-year birds, so that the upper wing surface appears somewhat duller and darker. The usual age of attaining sexual maturity is still not definitely established for this species, but Ferguson (1966) indicated that sixteen of twenty aviculturalists reported it as the third year, three reported it as the second year, and one as the fourth year.

OCCURRENCE IN NORTH AMERICA

Even prior to 1900 it was recognized that barnacle geese occasionally visit the eastern states. Bent (1925) summarized these early records, which were mostly for October and November and extended from Vermont through Massachusetts, Long Island, and North Carolina. Godfrey (1966) likewise summarized early and more recent records for Canada, which included specimens from Baffin Island and Quebec and sight records for Labrador and Ontario. A sight record for Nova Scotia has also been recently obtained (*Audubon Field Notes*, 24:617).

The only Pacific coast record would seem to be one for the Skagit Flats, Washington (Audubon Field Notes, 16:67). Although it is quite possible that some of these may represent escapes from captivity, there is no doubt that many of them represent wild birds that presumably originated in Greenland.
BRANT GOOSE
Branta bernicla (Linnaeus) 1758

Other Vernacular Names: American Brant, Black Brant, Brent.
Range: Circumpolar, breeding along arctic coastlines of North America and
Eurasia, as well as on Greenland, Iceland, and other arctic islands. Winters
on coastal areas, in North America south to northwestern Mexico and
North Carolina.

North American Subspecies:

B. b. hrota (Müller): Atlantic Brant Goose. In North America, breeds
on northern and western Greenland and on the mainland coast and
islands of northern Canada west to about 100° W. longitude.

B. b. nigricans (Lawrence): Pacific (Black) Brant Goose. In North
America, breeds in northern Canada from the Perry River and adjacent
islands westward to coastal Alaska. Considered by Delacour (1954)
to represent B. b. orientalis (Tougarinov), with nigricans restricted to
the questionably valid “Lawrence brant goose,” which is not recognized
by the A.O.U. (1957). The proper application of nigricans to any
population of brant is still questionable (Manning et al., 1956; William-
son et al., 1966)

Measurements (both races):
Folded wing: Both sexes 310-351 mm.
Culmen: Both sexes 29-38 mm.
Weights:

Atlantic ("American") Brant: 19 males averaged 3.4 pounds (1,542 grams), with a maximum of 4.0 pounds; 14 females averaged 2.8 pounds (1,270 grams), with a maximum of 3.9 pounds (Nelson and Martin, 1953).

Pacific ("Black") Brant: 26 males averaged 3.4 pounds (1,542 grams), with a maximum of 4.9 pounds; 15 females averaged 3.1 pounds (1,406 grams), with a maximum of 3.6 pounds (Nelson and Martin, 1953). Hansen and Nelson (1957) reported that 189 males averaged 3.19 pounds (1,447 grams), with a maximum of 4 pounds; 181 females averaged 2.87 pounds (1,302 grams), with a maximum of 3.81 pounds.

**IDENTIFICATION**

*In the Hand:* The tiny size (under 4 pounds, or 2,000 grams) will separate this species from all others except the smallest races of Canada geese, which have white on their cheeks instead of on the upper neck. Also, the central tail feathers of Canada geese extend beyond the tip of the tail coverts, which is not true of the brant goose.

*In the Field:* In their coastal habitat, brant are usually seen in small flocks on salt water some distance from shore, their white hindquarters higher out of the water than is typical of ducks. The head, neck, and breast of this bird appear black, the sides grayish to whitish. When in flight, the birds appear short-necked, and the white hindquarters contrast strongly with the black foreparts, while both the upper and lower wing surfaces appear grayish brown. The birds usually fly in undulating or irregular lines, rather than in V-formations like Canada geese, and have surprisingly soft and gutteral notes, *r-r-r-ruk* or *ruk-ruk.*

**AGE AND SEX CRITERIA**

*Sex Determination:* No plumage differences are available for external sex determination.

*Age Determination:* Yearling brant have conspicuous white edgings on their upper wing coverts, which allow for easy recognition of this age-class. At least one or more white-tipped secondary coverts will also identify yearling birds during their summer flightless period, according to Harris and Shepherd (1965), who also reported that at least some females apparently breed at two years of age. Yearling males have penile development ranging from the typical small and unsheathed juvenile condition to the full adult condition, while all older age classes of males have a fully adult penis condition.
DISTRIBUTION AND HABITAT

Breeding Distribution and Habitat: In Alaska, the Pacific brant breeds abundantly from the Kuskokwim Delta and Nelson Island northward along the coastline to the Yukon Delta and in smaller numbers northward and eastward to the Yukon border (Gabrielson and Lincoln, 1959). It also breeds uncommonly on St. Lawrence Island (Fay, 1960). In Canada it extends from the Alaskan border eastward to Perry River and north to Prince Patrick Island and probably Ellef Ringnes Island (Snyder, 1957). From Perry River and Prince Patrick Island eastward it is replaced by the Atlantic brant, which breeds north to Ellesmere Island, on Somerset Island, and on the mainland along Queen Maud Gulf, Cape Fullerton, Southampton and Coats islands, and southern Baffin Island (Snyder, 1957). The breeding locality and taxonomic validity of the Lawrence brant goose is unknown, which makes the suitable application of the trivial name nigricans uncertain.

The typical breeding habitat of brant geese is lowland coastal tundra, usually just above high tide line, which makes the nesting grounds highly susceptible to flooding by storm tides. Low islands of tundra lakes and dry inland slopes well covered with vegetation are used to some extent as well. In the Yukon-Kuskokwim Delta, the heart of the Pacific brant nesting habitat, nesting occurs on low, grass-covered flats dissected by numerous tidal streams in a belt two or three miles wide (Spencer et al., 1951). In this area the brant prefer the short sedge cover, with the highest nest density (up to 144 per square mile reported) found three to five miles from the coast (Hansen and Nelson, 1957). However, at Prince Patrick Island, at the northern edge of the range, the brant nest on grassy mountain slopes up to three miles inland and usually at least a mile from the coast. Nest densities there are much lower, with a dozen pairs scattered over several square miles, and the nests are several hundred yards apart (Handley, 1950).

Wintering Distribution and Habitat: According to midwinter survey averages, slightly more than half of the brant population winter on the Atlantic coast, while the remainder occur on the Pacific coast from British Columbia to Mexico.

On the West Coast, the preferred wintering habitat of Pacific brant consists of large areas of shallow marine water covered with eelgrass (Zostera marina), usually to be found in bay situations. In 1952, a total wintering population inventory revealed about 175,000 birds, 63 percent of which occurred in Baja California, mostly in Scammon Lagoon and San Ignacio Bay (Leopold and Smith, 1953). California also accounted for 25 percent (mostly in Humboldt Bay, Morro Bay, and bays in Marin County), Washington
Breeding and wintering distributions of the brant goose in North America. Horizontal hatching indicates breeding range of Pacific brant, vertical hatching that of Atlantic brant, and diagonal hatching apparent area of intergradation.
supported 9 percent (mostly in Puget Sound), and the remaining 3 percent were distributed along the coasts of Oregon, British Columbia, and southeastern Alaska. Smith and Jensen (1970) have also reported on Mexico's wintering brant population and documented a recent major shift from traditional wintering areas to coastal Sonora and Sinaloa, where over 35,000 birds wintered in 1969.

On the Atlantic coast, shallow expanses of salt water on coastal bays also are prime habitat, with the birds in the Chesapeake Bay area being most abundant along the barrier-beach side of the bays, concentrated wherever sea lettuce (*Ulva lactuca*) is abundant. Along the eastern Chesapeake, they concentrate in Tangier Sound and adjoining estuaries, especially where eelgrass and wigeon grass (*Ruppia*) are commonly found, and sometimes also occur in shallow areas of brackish water. The Chesapeake Bay flock represents about 5 percent of the Atlantic population, which is almost entirely restricted to the coastal area from Massachusetts to North Carolina (Stewart, 1962). Brant sometimes occur during migration on the lower Great Lakes (Sheppard, 1949), but generally are restricted as wintering birds to saltwater habitats.

**GENERAL BIOLOGY**

*Age at Maturity:* Harris and Shepherd (1965) reported that six of nineteen Pacific brant that they examined had evidently nested as two-year-olds, but that no yearlings showed any signs indicating breeding. Barry (1967) estimated that possibly 10 percent of the two-year-olds may breed during favorable nesting seasons.

*Pair Bond Pattern:* Presumably the usual strongly monogamous pair bond pattern typical of all geese applies to brant as well; at least no observations of wild or captive birds contradict this view. Einarsen (1965) noted that when Atlantic brant pairs occur on the Pacific coast, the pairs are generally inseparable, and he suggested that the reason for the lack of interbreeding on Prince Patrick Island, where both forms occur together, is that strong pair bonds have been formed prior to arrival at the breeding grounds and thus mixed pairing is rarely if ever developed.

*Nest Location:* As noted earlier, nests are usually located in low herbaceous vegetation often close to the high tide line, but sometimes in upland situations. Barry (1956) mentioned that the majority of the nests he observed in a colony on Southampton Island were on small river delta islands covered with low, thick grass and were less than a mile from the coast. Later (1962) he stated that preferred nesting habitat is covered with sedge mat vegetation.
extending only about one-quarter mile inland from the normal high tide line
and that over 90 percent of the brant nested in this zone. Einarsen (1965)

stated that small islands only a few square feet in area or a small promontory
extending out into a pond or lake are often selected. The nests are usually
bowl-shaped, and thus a sitting goose is able to flatten out on the nest so as
to be barely visible above ground level.

**Clutch Size:** Barry (1956) reported that clutch sizes in a colony con­taining 203 Atlantic brant nests varied in different areas from 3.77 to 4.41,
with an overall average of 4.0 and an observed range of 1 to 7 eggs. Hansen
and Nelson (1957) reported that 116 Pacific brant nests had an average
clutch of 3.5 eggs, and Gillham (cited by Einarsen, 1965) noted that in 1939
a sample of 83 Pacific brant nests averaged 4.96 eggs per clutch, while in
1940 a total of 108 nests averaged 3.8 eggs per clutch. This reduction in
clutch size was evidently related to a severe freeze occurring about eight days
after migration had terminated. Barry (1962) found a strong relationship
between weather and clutch size. In the favorable 1953 season he found an
average clutch of 4.6 eggs in 13 completed nests that had not yet suffered any
egg losses. In two seasons that were retarded by cold weather, not only were
the average clutch sizes smaller (4.3 for 109 completed clutches and 3.9
for 33 completed clutches), but also the nests that were started late had
smaller clutches than the earliest ones. The collective average clutch size for
853 nests was 3.94 eggs. The eggs are generally laid at the rate of one per
day, but frequently a day may be skipped toward the end of the egg-laying
period (Barry, 1956). At least one case of attempted renesting following
freezing weather has been reported (Gillham, in Einarsen, 1965). Barry
(1962) also mentioned that a few cases of attempted renesting occurred in
the colony he studied, but the clutches were not successfully completed.

**Incubation Period:** Barry (1956) reported the incubation period to be
24 days for ten of twelve nests, with one case each of 23- and 25-day periods.
Einarsen estimated a 25 to 28 day incubation period, but provided no basis
for this.

**Fledging Period:** Barry (1962) indicated that from 45 to 50 days are
required for young Atlantic brant to attain flight. Einarsen (1965) estimated
seven weeks for the Pacific brant.

**Nest and Egg Losses:** Because of the vulnerability of brant nests to
flooding, nest and egg losses are likely to be high in some years or in certain
locations. Barry (1962) noted that predation and other losses took 27 per­
cent of 723 eggs in marked nests during three years of study. During three
years in the Kashunuk study area of Alaska, the hatching success of Pacific
brant nests ranged from 81 to 85 percent (United States Fish and Wildlife
Specific data on possible flooding effects are not available, but Einarsen (1965) mentioned that the Yukon-Kuskokwim Delta had severe floods and storms in 1952 and 1963, with resultant high nest and brood losses. The 1963 storm, associated with high tides, flooded nearly the entire brant nesting zone in the Clarence Rhode National Wildlife Range, destroying thousands of eggs and young brant. However, Jones (1964) found that the percentage of immature brant seen during fall counts in Izembek Bay was sufficiently high (23 percent) to indicate that production in other areas was adequate to offset this localized complete loss. Burton (1960) concluded from age-ratio counts of brant geese in Europe that the 1958 breeding season in the Soviet arctic was associated with abnormally low temperatures during the summer months and must have been nearly a complete failure.

More recent counts by Jones (1970) indicate that the annual average incidence of juveniles in fall brant populations ranged from 18 to 40 percent between 1963 and 1969. Family groups contained averages of 2.58 to 2.86 juveniles. The percentage on apparent nonbreeders ranged from 31 to 69 percent over a four-year period, averaging 56 percent. During these years the percentage of juveniles averaged 25 percent, thus apparently a nonbreeding or unsuccessfully breeding segment of about 50 percent of adult-plumaged birds is typical even during years of good reproduction.

Juvenile Mortality: Studies in Alaska (United States Fish and Wildlife Service, Special Scientific Report: Wildlife, No. 68) indicate that the average brood size of the first-week young ranged from 3.4 to 3.8 birds in three different years. By the age of three weeks, the average brood size had been reduced to 2.2 to 3.2 birds. Finally, counts of juveniles in fall flocks at Izembek Bay suggest average family sizes of 2.58 to 2.86 juveniles per successful pair (Jones, 1970). Ignoring pairs that completely lost their eggs or young, it is evident that about half of the hatched young are lost before reaching the wintering grounds. These first-year birds are more vulnerable than adults to various kinds of mortality; Hansen and Nelson (1957) estimated an average annual mortality rate of 45.4 percent for juveniles based on direct recoveries of birds banded in Alaska.

Adult Mortality: Hansen and Nelson (1957) estimated an adult annual mortality rate of 21.8 percent on the basis of direct recoveries of birds banded as adults. If indirect recoveries through the sixth year are added, the estimated annual adult mortality rate is 32.2 percent. Boyd (1962) recalculated these figures and concluded that a mean adult mortality rate of 15 percent was typical of this population, compared to a 14 percent rate of brant wintering in Britain and 17 percent for birds breeding on Spitzbergen.
Food and Foraging: The close relationship between the distribution and abundance of eelgrass (*Zostera marina*) and the brant goose has long been recognized (Cottam *et al.*, 1944). Second in importance to eelgrass, and used by brant when eelgrass is absent or depleted by disease, is sea lettuce (*Ulva* spp., especially *U. lactuca*). In some areas wigeon grass (*Ruppia*) is used to a limited extent by Atlantic brant (Martin *et al.*, 1951). However, eelgrass is clearly the preferred food of both the Atlantic and the Pacific populations, and the most extensive eelgrass beds in the world occur in Izembek Bay, Alaska, which during the fall temporarily supports the entire Pacific coast brant population (Jones, 1964; Jones and Jones, 1966). Here, about a quarter million birds feed on about 40,260 acres of eelgrass lying just below the water surface or exposed during low tide. The leaves of the eelgrass form dense mats often arranged in windrows, along which the brant swim while feeding. The protein content of the eelgrass in this bay averages about 7 percent, while samples of eelgrass and sea lettuce from Washington and Oregon average about 15 percent (Einarsen, 1965).

Sociality, Densities, Territoriality: As might be expected in a species that nests in a colonial fashion, brant geese are relatively social and gregarious. Jones and Jones (1966) reported seeing little strife in flocks consisting of two or three family groups, but hostile encounters were common in larger fall flocks. These generally were initially related to maintaining the integrity of family groups. However, by early October hostile encounters between adults and juveniles indicated that the family bonds were being broken. This dissolution of family bonds was completed by late October, after which hostile encounters were again rarely seen, and the population consisted of a few very large groups containing all age groups. Thus, unlike most geese, family bonds are evidently not maintained through the first winter of life. Einarsen (1965) has also emphasized the gregariousness of brant geese, noting their strong tendency to “raft” and to breed in colonies.

Estimates of breeding densities have been made by Hansen and Nelson (1957), who noted that in the best nesting areas on the Yukon-Kuskokwim Delta nest densities of up to 144 per square mile occur in the short sedge zone some three to five miles from the coast. Barry (1956) reported a colony of about 700 nesting pairs in a stretch of coast about four and one-half miles long and usually less than one-quarter mile wide, or a little more than a square mile in area. Nesting density within this area varied considerably, with the highest density on the islands of the Boas River delta. The distribution of these islands, about a foot above high tide, evidently strongly affected the
breeding density. Thus, territoriality probably plays only a minor or negligible role in affecting brant nesting densities. Territories were maintained by bluffing rather than fighting, according to Berry, but sometimes birds would be chased off a nesting territory and “escorted” away for some distance.

_Interspecific Relationships:_ Barry (1956) noted that the brant colony he studied was entirely separated from the colony of blue and snow geese, which nested on higher ground at least one-fourth mile inland from the high tide line. In Alaska, the Pacific brant nests in association with cackling Canada geese on the Yukon-Kuskokwim delta, but again nesting occurs slightly closer to the coast (Spencer _et al._, 1951). Major avian predators of eggs are gulls and jaegers, especially the parasitic jaeger, but the arctic fox often causes heavy destruction to nesting colonies and probably is primarily responsible for the brant’s tendency to select coastal or delta islands for its nesting sites (Barry, 1967).

_General Activity Patterns and Movements:_ Einarsen (1965) has commented on the brant’s unusual flying ability, noting that he had clocked flying brant at a ground speed of 62 miles per hour, compared with 36 to 40 miles per hour for Canada geese. He also noted their relatively faster wingbeats (three to four per second) and more streamlined body and wing. When facing a head wind, the birds almost skim the wave tops, but even without strong head winds the birds do not fly high. Flocks usually are in long strings, undulating somewhat in flight, in marked contrast to the more highly organized flight formations of the larger geese. According to Einarsen, brant rarely reach a height of more than two or three hundred feet above the ocean and certainly rarely stray far from salt water. Lewis (1937) has, however, described the probable migration route across western Quebec between Hudson Bay and the brants’ wintering grounds on the Atlantic coast. The distance from the Gulf of St. Lawrence to James Bay or Ungava Bay is nearly 600 miles, apparently made in a nonstop flight at considerable height during the nighttime hours. Birds arriving at the mouth of the St. Lawrence in late spring are typically in small flocks, with 155 such flocks averaging about 40 birds and rarely exceeding 100 birds (Lewis, 1937). However, when the brant arrive at the nesting grounds on Southampton Island the flocks seldom exceed 20, and the birds are mostly paired (Barry, 1956).

**SOCIAL AND SEXUAL BEHAVIOR**

_Flocking Behavior:_ The generally gregarious nature of brant geese has already been mentioned. Even shortly after hatching their broods, families will sometimes merge. Barry (1956) mentions seeing six or eight adults with
ten or fourteen young swimming in a group, and Einarsen (1965) illustrates
two pairs of adults with nine or ten very recently hatched young being closely
convoyed. Typically a family consists of an adult swimming ahead, the young
birds, and the other adult taking up the rear, a trait that persists almost until
the families break up in the fall (Jones and Jones, 1966).

Flocking by nonbreeding birds is also typical of brant; Barry (1956)
noted that yearling birds remained separate from the nesting colony on South-
ampton Island. This group of about 200 birds flew out to feed each day in
flocks of 40 to 50 birds, and during the midsummer molt, they congregated
in a bay by the Boas River.

Pair-forming Behavior: Little has been written on pair-forming behavior
in brant. Barry (1956) observed two instances of possible courtship flights
involving three birds, but noted that nearly all the birds were mated prior to
arrival at their breeding grounds. Einarsen (1965) also mentions seeing sev-
eral trios of seemingly courting brant on their wintering grounds between mid-
January and late March. He believed that the female took the lead in these
flights and was followed by two or more competing males. Although such
flights may play a role in pair formation, it is highly probable that pair bonds
are formed and maintained in brant as in other geese, by the repeated per-
formance of the triumph ceremony between two birds. Such ceremonies may
be seen between paired birds in captive flocks. Jones and Jones (1966) men-
tioned seeing apparent hostility postures between wild birds that met and
moved away together, and noted that this behavior frequently was the means
by which a family member regained its own group.

Copulatory Behavior: Precopulatory behavior in brant consists of mutual
head-dipping movements that resemble bathing movements, but lacks the
strong tail-cocking elements present in many geese. At times this head-dipping
also takes the form of up-ending and is followed by mounting. The precopu-
latory display consists of the male lifting his bill, stretching his neck, and
calling, but neither sex exhibits wing-lifting or wing-spreading at this time
(Johnsgard, 1965).

Nesting and Brooding Behavior: Observations on nesting behavior have
been provided by Barry (1956). Pairs establish nesting territories as soon as
the habitat is free of ice and snow. The nest is usually a simple hollow about
two inches deep and nine inches across, with a sparse amount of grass pulled
up from the immediate vicinity of the nest. Down is deposited with the laying
of the first egg and increased with each additional one. Females cover the eggs
with down whenever they leave the nest, and during the egg-laying period the
male remains within 100 yards of the nest. However, once incubation is under
way, the female rests low and inconspicuously on the nest, with her neck ex-
tended along the ground. When she returns after feeding, the male escorts her until he is about 15 feet from the nest, and after the female is back on the nest he returns to a distance of about 50 to 100 yards to forage and keep watch. At times the male may fly at gulls and jaegers, chasing them from the vicinity of the nest.

When the young are hatched, they do not remain on the nest long, but are soon led out to the edges of the tidal flats, where they apparently feed on larvae and small crustaceans (Barry, 1956). Einarsen (1965) reported that the young also feed on the tender parts of sedges and, when disturbed, can effectively dive within a few days of hatching. Both sexes closely attend the young, although the adults become flightless about a week or ten days after the young are hatched. The flightless period lasts about thirty days; thus the adults are again able to fly about the time the young are fledged, and sometimes only shortly before the onset of freezing weather (Barry, 1962).

Post-breeding Behavior: With the arrival of freezing weather shortly after fledging, the adults and young gradually move to more southerly areas. In the case of the Pacific coast population, this is the Izembek Bay area on the northern tip of the Alaska Peninsula. Arrival there averages about August 25, and a mass departure occurs about eight weeks later (Jones, 1964). The fall migration route of the birds wintering on the Atlantic coast has been discussed by Lewis (1937), who noted that the east side of Hudson Bay and Ungava Bay are probably important fall staging areas.

King’s (1970) recent observations of large numbers of molting Pacific brant near Cape Halkett, Alaska, numbering perhaps as many as 25,000 birds, is of great interest. These congregations would suggest that birds breeding farther east or south in Canada may congregate there in nonproductive years, or that the Arctic Slope may support a greater breeding population of brant than had been previously believed.