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OBSERVATIONS OF EMPEROR GEESE FEEDING AT NELSON LAGOON, ALASKA

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Estuaries along the north side of the Alaska Peninsula provide essential habitat for most of the American population of Emperor Geese (*Chen canagica*) during migration (Petersen and Gill 1982). Most of the population passes through Nelson Lagoon in spring and fall, with over 40,000 birds recorded there (Gill et al. 1981). Little is known about the feeding activity of Emperor Geese while they are in estuaries, and the importance of estuaries as staging areas during spring and fall migration is poorly understood. Here I report observations on the feeding activity of Emperor Geese at one estuary (Nelson Lagoon).

Nelson Lagoon (56°00′N, 161°10′W) is a large (141 km²), shallow estuary with extensive flats (47% of the lagoon) exposed at mean low tide. There is a wide diversity of habitats in and around the lagoon, but geese use only the intertidal zone, beaches, and dunes (Gill et al. 1981). Intertidal substrates vary from mud to a mixture of sand and gravel. The daily tidal regime is two lows and two highs with a mean diurnal range of 5.4 m (Gill and Sanger 1979). Bivalves, including blue mussels (*Mytilus edulis*) and balthica macoma (*Macoma balthica*), and polychaete worms (primarily *Eteone longa*), dominate the benthic and epibenthic fauna; aquatic plants are rare in the intertidal zone.

The intertidal zone has been described in detail by Gill and Jorgensen (1979) and Petersen (1980, 1981). A peninsula and a series of long narrow islands separate Nelson Lagoon from the Bering Sea. Beaches above mean high tide zone are generally open sand cobble merging to sand dunes. The vegetation above the mean high tide zone is a dune elymus association (Viereck and Dyrness 1980) dominated by lyme grass (*Elymus arenarius*).

I systematically observed an average of 377 Emperor Geese (SE = 28.6, range 10–1, 995), in a 252-ha portion of the lagoon, feeding in the intertidal zone and roosting on the adjacent beach. Observations were made with a spotting scope at about three-day intervals from 20 April to 26 June and 25 August to 11 October 1977, and from 19 August to 30 September 1979. I counted the number of birds that were feeding and roosting every 2 h from 08:00 to sunset in 1977 ($n = 32$ days), and from 06:00 to sunset in 1979 ($n = 10$ days). Observations of geese in the dune areas and at night were made at irregular intervals.

I converted the percentage of geese feeding at each hour of the tide to angular transformations and tested them by using one-way analysis of variance tests (Sokal and Rohlf 1969).

RESULTS

Emperor Geese fed in the intertidal zone either by dipping their heads in water as deep as about 30 cm, or by walking in shallow water and feeding with only their bills in the water. Adult-plumaged and hatching-year birds appeared to use the same method of feeding, as geese of all age groups fed as family groups and in flocks with non-breeding or failed breeding individuals. After feeding, geese walked to the adjacent beach to roost. In fall, some geese left the intertidal zone and adjacent beaches at high tide and went to the dunes.

The height and stage of the tide influenced feeding activity in the intertidal zone during the two daily tide cycles. The percent of geese feeding differed significantly among the various tide stages ($F_{11, 182} = 12.31$, $P < 0.001$); most geese fed at low tide (Fig. 1), regardless of the time of day. Geese began feeding by 3 h before low tide and continued feeding through 3 h after low tide. Geese fed the same amount of time at each stage of the tide in spring and fall in both years.

DISCUSSION

Geese fed in intertidal areas when invertebrates were accessible. This feeding pattern left about half of each day for geese to roost on the beach (spring and fall), or feed or roost in the dunes (fall). This general pattern of feeding in the intertidal zone has been noted (Turner 1886, Murie 1959, Kenyon 1961); however, geese primarily ate aquatic vegetation exposed at low tide (Palmer 1976). At Nelson Lagoon, geese appeared to eat invertebrates.

My observations suggest that the intertidal zone may be an important feeding area for geese staging at Nelson Lagoon in spring and fall. Emperor Geese arrive on breeding areas with heavy accumulations of fat (Portenko 1972) and, like other geese nesting in the arctic (for a review see

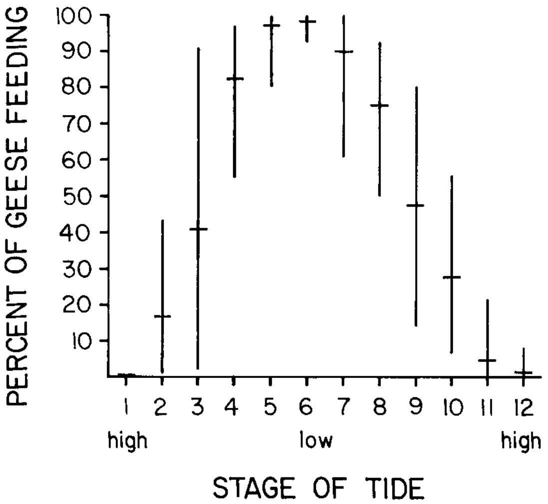

FIGURE 1. Percent of Emperor Geese feeding during each hourly stage of the tide as determined from 194 counts of birds. Horizontal bars show means, and vertical bars represent 95% confidence limits.

Raveling 1979), probably use those fat reserves during the nesting period. Therefore, factors affecting food resources in estuaries along the north side of the Alaska Peninsula in spring may directly influence the reproductive success of geese in summer.

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AERIAL INSECT-CATCHING BY AMERICAN KESTRELS

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Capture of flying insects by American Kestrels (*Falco sparverius*) has been reported by several authors (Locke 1961, Balgooyen 1976, Suring and Ault 1981). They describe a type of flycatching behavior in which birds sally out from a perch to capture individual insects at ground or perch height and return directly to the perch. Although I have seen such behavior four times, I describe here another aerial hunting technique that I have observed more frequently, and that apparently has not been reported previously in this species. Similar foraging behavior, variously described as "hawking," "swift-like," or "swallow-like," has been noted in several Old World falcons, including the Lesser Kestrel (*F. naumanni*; Chasen 1920, Sage 1967), Red-footed Falcon (*F. vespertinus*; Congreve 1929, Ticehurst and Whistler 1929), Eleonora's Falcon (*F. eleonorae*; Walter 1979), and European Hobby (*F. subbuteo*; Everett 1976).

While studying foraging behavior (Rudolph 1982), I watched kestrels with binoculars or telescope for 775 half-hour periods distributed evenly between 19 February and 8 July 1979. My study area, near Davis, Yolo Co., California (elevation 14 m), consisted mainly of flat, open agricultural fields divided by narrow strips of riparian vegetation. Most of my observations (89%) were on 10 individual birds, 8 of which (5 male, 3 female) showed what I call "aerial insect-catching behavior" ["flight-hunting" of Collopy and Koplin 1983—ed.]. Each of the 49 episodes I saw began when a bird flew directly out or upward from a perch, and then circled upward using a combination of soaring and flapping flight. This behavior, which is typical of raptors rising in thermal updrafts, contrasted sharply with the direct lateral flight seen in sallying flycatching episodes (e.g., Suring and Ault 1981).

To capture flying insects, birds banked, stalled, or dove abruptly and grasped the prey in the bill. Although kestrels and other raptors commonly use the feet as their capture "tools" (e.g., Everett 1976), Suring and Ault (1981) have also reported insect capture using the bill, and Balgooyen (1976) reported kestrels securing prey with the bill while foraging on the ground. Usually birds ate the insects while soaring, bringing the head down and one foot forward to