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NESTING BY GOLDEN EAGLES ON THE NORTH SLOPE OF THE BROOKS RANGE IN NORTHEASTERN ALASKA

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Abstract.—Twenty-two Golden Eagle (*Aquila chrysaetos*) nesting territories and 31 occupied eagle nests were documented on the north slope of the Brooks Range in northeastern Alaska, 1988–1990, in an area previously thought to be marginal breeding habitat for eagles. The mean number of young/successful nest was 1.25 in 1988, 1.27 in 1989, and 1.13 in 1990; means did not differ significantly among years. Eighty percent (20/25) of the nestlings for which age was estimated were assumed to have successfully fledged. Nesting success was 79% (11/14) in 1989, the only year nesting success could be determined. Laying dates ranged from 23 March (1990) to 11 May (1989) with mean estimated laying dates differing significantly among years. Annual variation in nesting phenology coincided with annual differences in snow accumulations during spring. These results indicate that Golden Eagles consistently and successfully breed at the northern extent of their range in Alaska, although, productivity may be lower than that for eagles at more southern latitudes.

ANIDAJE DE *AQUILA CHRYSAETOS* EN LA PENDIENTE NORTE DE LA EXTENSIÓN BROOKS EN EL NORESTE DE ALASKA

Sinopsis.—Se documentaron 22 territorios de anidaje y 31 nidos ocupados de *Aquila chrysaetos* en la pendiente norte de la extensión Brooks en el noreste de Alaska entre 1988 y 1990, en un área considerada previamente como habitat reproductivo marginal para águilas. El número promedio de juveniles/nido exitoso fue de 1.25 en 1988, de 1.27 en 1989 y de 1.13 en 1990; los promedios fueron similares entre años ($P = 0.74$). Ochenta por ciento (20/25) de los anidantes para los cuales se estimó la edad se asume que fueron exitosos en dejar el nido. El éxito en anidar fue de 79% (11/14) en 1989, el único año en que se pudo determinar el éxito en anidar. Las fechas de anidaje fluctuaron entre el 23 de marzo (1990) y el 11 de mayo (1989) con el promedio estimado de fechas de ovoposición difiriendo entre años ($P = 0.0047$). La variación anual en la fenología de anidaje coincidió con con diferencias anuales en acumulaciones de nieve durante la primavera. Estos resultados indican que parejas de *Aquila chrysaetos* anidan consistentemente y exitosamente en el límite norte de su extensión en Alaska, aunque la productividad puede ser menor que la de águilas en latitudes más al sur.

Hobbie and Cade (1962), in the only published nesting survey of Golden Eagles (*Aquila chrysaetos*) on the north slope of the Brooks Range in northeastern Alaska, reported that most eagles seen were immature birds, and observed little evidence of nesting. They speculated that climatic conditions at this latitude were marginal to support a consistent nesting effort. More recent, but unpublished, investigations of Golden Eagles in this same area, which is now within the Arctic National Wildlife Refuge (ANWR), have focused on eagle distribution and abundance in relation to calving and post-calving activities of the Porcupine Caribou (*Rangifer tarandus*) Herd (PCH). Consistent with Hobbie and Cade (1962), these investigations have noted a preponderance of subadult Golden Eagles within the PCH calving grounds and adjacent areas (Mauer 1985, 1987; Roseneau and Curatolo 1976). Amaral and Benfield (unpubl. rep., U.S. Fish and Wildl. Service, Endangered Species Division, Anchorage, 1985), Mauer (1985, 1987), Roseneau (unpubl. rep., Northern Engineering Services, Calgary, Alberta, 1974), and White and Cade (unpubl. rep., American Museum of Natural History, New York, New York, 1975), however, also reported observations of Golden Eagles nesting on the north slope of ANWR.

In 1988, 1989 and 1990 intensive surveys of nesting Golden Eagles on the north slope of ANWR were conducted by the U.S. Fish and Wildlife Service (USFWS). The objectives of the surveys were: (1) to revisit known and locate new nest sites; (2) to determine occupancy of nests; (3) to estimate productivity; and (4) to determine prey species used by nesting eagles from prey remains collected at nests. Data from these surveys provide contemporary information on the distribution, relative abundance, productivity, phenology and prey selection of nesting Golden Eagles in northeastern Alaska, and insight on the reproductive biology of Golden Eagles at the northern extent of their distribution in North America.

STUDY AREA

The study area (centered at 69.5°N, 144.0°W) is in northeastern Alaska between the Canning River and the Canada border, north of the Brooks

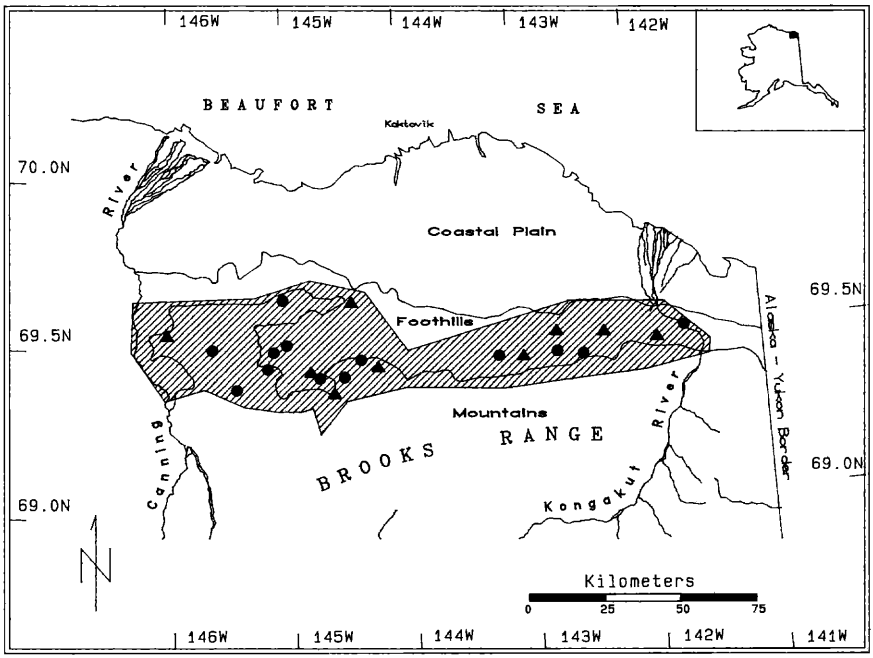

FIGURE 1. Location of the study area, major rivers, physiographic regions, and Golden Eagle nesting territories identified during breeding surveys on the north slope of the Brooks Range in northeastern Alaska, 1988–1990. A circle indicates a Golden Eagle nesting territory with 1 yr of use and a triangle indicates 2 yr of use.

Range divide (north slope; Fig. 1). This 5100-km^2 area encompasses three identifiable physiographic regions (Wahrhaftig 1965): the coastal plain, which is generally flat with elevations <300 m; the foothills, which are characterized by buttes and ridges 300–900 m in elevation; and the mountains, which have elevations >900 m and river valleys at elevations of 500–1000 m (Reynolds and Garner 1987; Fig. 1).

The climate is arctic, with short, cool, generally cloudy summers. Subfreezing temperatures and snow may occur any time during summer. Daily temperatures in July average about 5 C, and maximum temperatures rarely exceed 30 C. High (>40 kh^{-1}) and variable surface winds are common throughout the year (Searby 1968, Searby and Hunter 1971).

METHODS

We attempted to conduct two aerial nesting surveys each year. The purpose of the first, during the late incubation and early nestling stage (late May–late June), was to determine occupancy of all previously documented (Mauer 1987) nest sites and to search for additional nest sites. The second survey, late in the nestling stage (mid–late July), was to determine productivity and nesting success and to search for additional nest

sites. In 1988, two contiguous, partial nesting surveys were conducted. In 1989, two complete nesting surveys were conducted, with the exception that, during the first survey, approximately 18 km^2 in the eastern portion of the study area was not surveyed due to ground fog. In 1990, one nesting survey was conducted during the late nestling stage (mid-July) to determine productivity. Survey routes to locate potential nesting habitat such as cliffs, generally followed topography and drainages. This habitat was then surveyed intensively for nest sites. Surveys were conducted by one or two experienced observers primarily from a Bell 206 helicopter, although a PA18 Supercub also was used in 1988. An occupied nest was defined as a nest site with a pair of adults, eggs or nestlings present. We considered the number of occupied nests observed a conservative estimate, because of logistic (e.g., helicopter availability and support) and climatic (e.g., ground fog, strong winds) constraints of surveying such a large (5100 km^2), rugged (300–2700 m), and remote area. Locations of nests were recorded on U.S. Geological Survey 1:63,360 topographic maps.

Occupied nest sites were revisited during July. Nestlings were banded and measured, and prey remains at each nest site were collected or recorded. Nestling age was estimated from morphological characteristics (1988–1989) or, by comparison (1990) to a photographic key of known-age nestlings (Hoechlin 1976). Nesting phenology (estimated dates of laying, hatching and fledging) was determined from estimated ages at time of banding and by back-dating from that date assuming: (1) incubation started after the first egg was laid (Collopy 1980) and lasted 45 d; and (2) a nestling period, from hatching to fledging, of 70 d (Palmer 1988). To estimate fledging success, we considered nestlings that reached 56 d of age to have fledged successfully (80% of the average age at first flight [Steenhof 1987]).

RESULTS

We documented 22 different Golden Eagle nesting territories, 1988–1990 (Fig. 1). Nine nesting territories were occupied in 2 of the 3 yr (none for 3 yr). Overall, 31 occupied nests were observed (eight in 1988, 14 in 1989, and nine in 1990). Thirteen nesting territories were located in the foothills and nine were in the mountains. Occupied nest sites occurred between 69.36 and 69.64°N (mean = 69.47°N).

Mean number of young/successful nest was 1.25 (10/8) in 1988, 1.27 (14/11) in 1989, and 1.13 (9/8) in 1990; means were similar among years (H = 0.612; df = 2; P = 0.74). Of 25 nestling for which ages were estimated, 20 (80%) were assumed to have successfully fledged (age ≥56 d). Nesting success was 79% in 1989 (the only year nesting success could be determined) when 11 of 14 nesting pairs produced young (≥4 wk of age).

Mean estimated laying dates (Table 1) differed among years (H = 10.740; df = 2; P = 0.0047). The earliest estimated laying date was 23 March (1990), whereas the latest estimated fledging date was 3 September (1989).

TABLE 1. Nesting phenology of Golden Eagles on the north slope of the Brooks Range in northeastern Alaska, 1988–1990.

Year	*n*	Estimated laying date range (Mean, SE)	Estimated hatching date range (Mean, SE)	Estimated fledging date range (Mean, SE)
1988	8	15 Apr.–28 Apr. (22 Apr., 3.4)	30 May–12 Jun. (6 Jun., 3.4)	8 Aug.–21 Aug. (12 Aug., 3.4)
1989	8	5 Apr.–11 May (14 Apr., 5.1)	20 May–25 Jun. (29 May, 5.1)	29 Jul.–3 Sep. (7 Aug., 5.1)
1990	9	23 Mar.–21 Apr. (5 Apr., 10.0)	9 May–5 Jun. (20 May, 10.0)	15 Jul.–14 Aug. (29 Jul., 10.0)

Prey remains recorded at Golden Eagle nests included arctic ground squirrel (*Spermophilus parryi*), Dall sheep (*Ovis dalli*), caribou, Willow Ptarmigan (*Lagopus lagopus*), Rock Ptarmigan (*Lagopus mutus*), Short-eared Owl (*Asio flammeus*), Common Raven (*Corvus corax*), and a Water Pipit (*Anthus spinoletta*).

DISCUSSION

Golden Eagles reach the northern extent of their circumboreal breeding range at 69–70°N latitude (Cramp and Simmons 1980, Hobbie and Cade 1962, Palmer 1988, Poole and Bromley 1988), which is coincidental with the northern projection of the Brooks Range in northeastern Alaska. In arctic Alaska, the main breeding stronghold for Golden Eagles lies in the Brooks Range and associated mountains (White and Cade, unpubl. rep., American Museum of Natural History, New York, New York, 1975). In ANWR, Johnson and Herter (1989:123) reported that Golden Eagles were an abundant cliff-nesting raptor in the mountains, but a rare breeder of the inland coastal plain. Similarly, all of the nest sites observed during our study were located in the mountain and foothill regions. In neighboring Canada, at least 19 Golden Eagle nest sites (all unoccupied) were found on the coastal plain of northern Yukon; however, more sites were located farther south in the foothills and mountains away from the coast (Johnson and Herter 1989:123).

Hobbie and Cade (1962) suggested that climatic conditions on the north slope of the Brooks Range are marginal for consistent and successful breeding by Golden Eagles. Evidence from our study suggests that Golden Eagles breed consistently and successfully on the north slope of ANWR, although productivity may be lower than that for eagles at more southern latitudes. The mean number of young produced/successful pair in ANWR during our study was slightly lower than the 1.5 young/successful pair reported in Interior Alaska (Ritchie and Curatolo 1984), the 1.4 average observed on the north slope, Yukon Territory (Mossop et al., Interim rep., Fish and Wildl. Branch, Yukon Dept. Renewable Resources, NOGAP Proj., G-17, 1986), and the mean of 1.30 documented in the Northwest Territories (Poole and Bromley 1988).

The nesting phenology of Golden Eagles in our study was similar to that in other parts of Alaska, (Porcupine River, Denali National Park, and the Kilbuk Mountains) (Ritchie and Curatolo 1984; C. McIntyre, U.S. Natl. Park Serv., unpubl. data; B. McCaffery, U.S. Fish and Wildl. Serv., pers. comm.), northern Yukon (Mossop et al., Interim rep., Fish and Wildl. Branch, Yukon Dept. Renewable Resources, NOGAP Proj., G-17, 1986) and Northwest Territories (Poole and Bromley 1988). Estimates of nesting phenology and fledgling success in our study indicate that the nesting phenology of Golden Eagles on the north slope of ANWR is within the limits proposed by Hobbie and Cade (1962) for Golden Eagles to produce independent young prior to autumn migration.

Annual variation in the nesting phenology of Golden Eagles in ANWR, 1988–1990, can possibly be explained by annual differences in snow accumulation during spring. The latest date on record for snowmelt on the study area was in 1988 and the earliest on record was in 1990 (Fancy and Whitten 1991). Nesting phenology also was latest in 1988 and earliest in 1990 (Table 1). During years of late snowmelt, snow cover may limit the availability of prey species (Perrins 1970, Poole and Bromley 1988) or access to nest sites causing Golden Eagle nesting activities to be postponed. Johnson and Herter (1989) suggested that the breeding distribution and success of Golden Eagles in the Beaufort Sea region are related to the availability of Arctic ground squirrels. Arctic ground squirrels were the most commonly taken prey during this study based on remains collected at nest sites, but because prey remains were not quantifiable by period, the relative use of ground squirrels during the early nesting period, 1988–1990, could not be ascertained.

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