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Swallow-tailed Kite (/Species-Account/bna/species/swtkit/introduction/)
Snail Kite (/Species-Account/bna/species/snakit/introduction/)

Golden Eagle

Aquila chrysaetos

Order: ACCIPITRIFORMES
Family: ACCIPITRIDAE

Sections

Version: 2.0 — Published January 1, 2002
Michael N. Kochert, Karen Steenhof, C. L. McIntyre, and Erica H. Craig

Listen (https://download.ams.birds.cornell.edu/api/v1/asset/522059?__hstc=226533890.a9f4d500ff87f4cb1d6e7ee48278f77e.1580232055716.1581559168423.1581613390146.5&__hssc=2265338

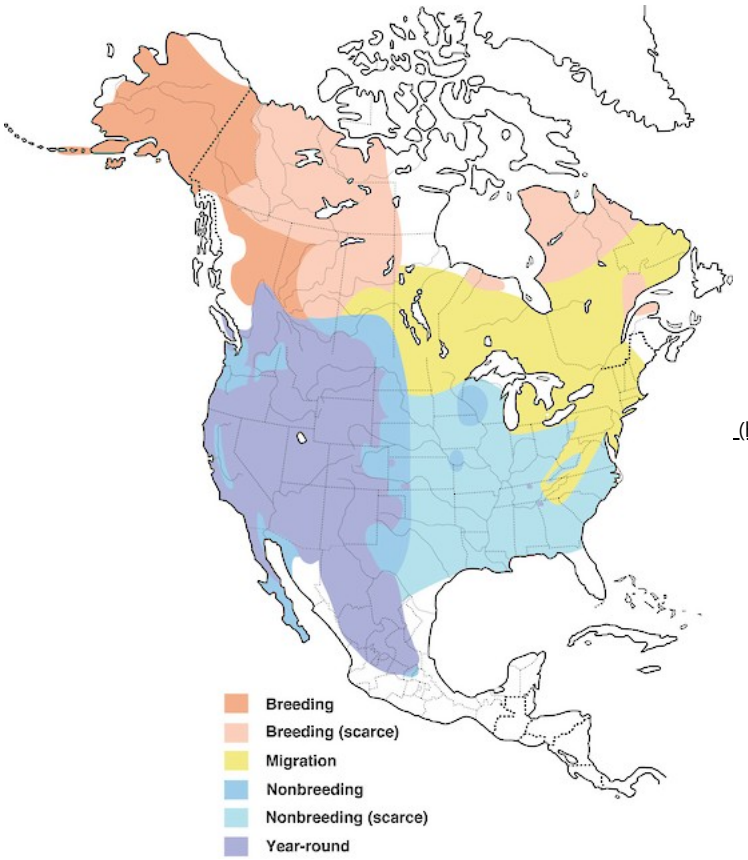

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Figure 1. Distribution of the Golden Eagle in North America.

This species winters locally within the areas shown. This species also breeds in Europe and Asia. See text for details.

(https://download.ams.birds.cornell.edu/api/v1/asset/24915381?_hstc=226533890.a9f4d500ff87f4cb1d6e7ee48278f77e.1580232055716.1581559168423.1581613390146.5&_hssc=226533890.6.1581613390146&_hsfp=1377133

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Adult Golden Eagle, Goshute Mountains, Nevada, October 1999.

Note the small-headed and long-tailed appearance, as well as the glowing golden neck hackles on this bird. Note uniformly dark ventral plumage, and missing (molted) central tail feathers. ; photographer Jerry and Sherry Liguori

The Golden Eagle inhabits a wide range of latitudes throughout the Northern Hemisphere and uses a variety of habitats ranging from arctic to desert. Rare in the eastern half of North America, it is most common in the West near open spaces that provide hunting habitat and often near cliffs that supply nesting sites. Northern breeders migrate thousands of kilometers to wintering grounds; southern pairs tend to be resident year-round. As one of North America's largest predatory birds, this eagle has been prominent in human lore and culture, inspiring awe, reverence, and sometimes fear and hatred. Humans kill Golden Eagles both intentionally and accidentally by trapping, shooting, poisoning, and electrocution; at the same time, urbanization, agricultural development, and wildfires encroach on this eagle's traditional shrub-steppe foraging habitat. The species persists, but some U.S. nesting populations may be declining. In the twenty-first century, humans will determine the fate of this species and its habitat.

The Golden Eagle has astonishing speed and maneuverability for its size and uses a wide variety of hunting techniques to capture prey, including soaring, still-hunting from a perch, and low contouring flight. Although capable of killing large prey such as cranes, wild ungulates, and domestic livestock, this species subsists primarily on rabbits, hares, ground squirrels, and prairie dogs. Most do not acquire a nesting territory until they are at least 4 years old, after they have molted into Definitive plumage. Once an individual establishes a territory, it tends to stay there, defending an area of approximately 20–30 square kilometers from conspecifics. A territory may contain up to 14 nests, which a pair maintains and repairs as part of their courtship. The nesting season is prolonged, extending more than 6 months from the time eggs are laid until young reach independence. A typical Golden Eagle raises an average of only 1 young per year and up to 15 young over its lifetime. Pairs commonly refrain from laying eggs in some years, particularly when prey is scarce. The number of young that Golden Eagles produce each year depends on a combination of weather and prey conditions. The black-tailed jackrabbit (*Lepus californicus*) is a key prey species throughout much of the range, and eagle reproductive rates fluctuate with jackrabbit population cycles.

Although much information on Golden Eagle life history comes from studies in Europe (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)), important North American research has provided insights about developmental behavior (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)), survival rates (Hunt 2001 (/Species-Account/bna/species/goleag/references#REF43277), Harmata 2002 (/Species-Account/bna/species/goleag/references#REF33297)), and migration (Brodeur et al. 1996 (/Species-Account/bna/species/goleag/references#REF33286), Craig and Craig 1998 (/Species-Account/bna/species/goleag/references#REF56185), CLM). Much information about Golden Eagle ecology comes from southwestern Idaho, where research on this species has been conducted in and near the Snake River Birds of Prey National Conservation Area (NCA) for more than 35 consecutive years, beginning with Hickman (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)). NCA studies have focused on diet (Beecham 1970 (/Species-Account/bna/species/goleag/references#REF43245), Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273), Steenhof and Kochert 1988 (/Species-Account/bna/species/goleag/references#REF10330)), food consumption/energetics (Collopy Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226), Collopy 1983a (/Species-Account/bna/species/goleag/references#REF43255), Collopy 1983b (/Species-Account/bna/species/goleag/references#REF33290)), parental care and feeding ecology (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)), long-term reproduction (Steenhof et al. Steenhof et al. 1983 (/Species-Account/bna/species/goleag/references#REF56196), Steenhof et al. 1997 (/Species-Account/bna/species/goleag/references#REF10331)), dispersal (Steenhof et al. 1984 (/Species-Account/bna/species/goleag/references#REF17488)), home-range characteristics (Dunstan et al. 1978 (/Species-Account/bna/species/goleag/references#REF38078), Marzluff et al. 1997b (/Species-Account/bna/species/goleag/references#REF43288)), and effects of habitat alterations on nesting populations (Steenhof et al. 1997 (/Species-Account/bna/species/goleag/references#REF10331), Kochert et al. 1999 (/Species-Account/bna/species/goleag/references#REF33304)). Despite the wealth of information from this one study area, much remains unknown about populations in other parts of this eagle's range, particularly Alaska and western Canada. New work in these areas is shedding light on Golden Eagle ecology and may suggest differences between northern migratory populations and southern resident ones.

Recommended Citation

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Golden Eagle

Aquila chrysaetos

Order: ACCIPITRIFORMES
Family: ACCIPITRIDAE

Sections

Breeding

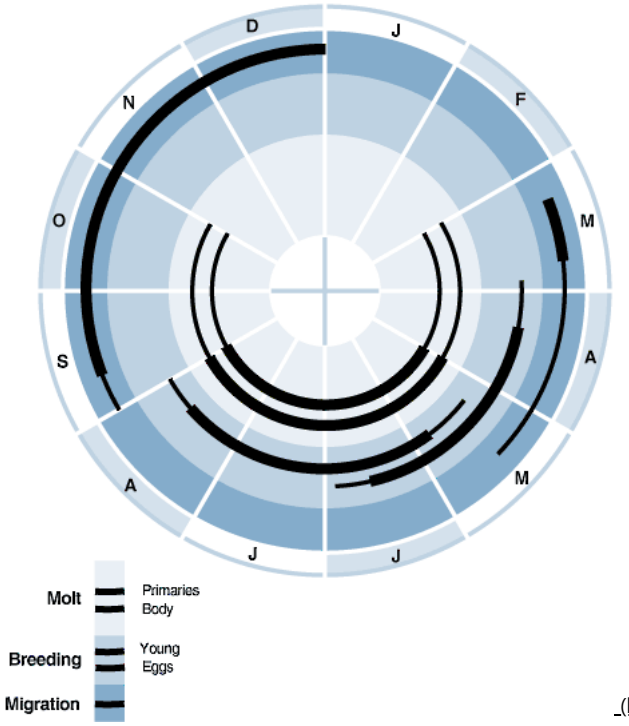

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Fig. 3. Annual cycle of breeding, migration, and molt, Alaska.
of migratory Golden Eagles in Alaska. Thick lines show peak activity; thin lines, off-peak.

Phenology

Pair Formation

In temperate areas, where pairs remain on nesting territory year-round, new pairs form throughout the year soon after lost mates are replaced (*n* = 13; Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263), Hunt et al. 1997 (/Species-Account/bna/species/goleag/references#REF10265), USGS unpubl.). Pair formation begins upon return to breeding areas in Denali National Park, AK, from late Feb to mid-Apr (CLM). Courtship and nest selection can last >1 mo (MNK). In sw. Idaho, aerial displays, stick-carrying, and vocalizing started in late Jan, with a peak in mid-Feb (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)). Resident pairs in the Diablo Range, CA, participate in courtship and nest-building from Dec to Jan (Hunt et al. 1997 (/Species-Account/bna/species/goleag/references#REF10265)).

Nest-Building

Residents add material to nests year-round; may begin refurbishing nests in autumn, with activity peaking from late Jan to early Mar (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). In s. California, nest construction began in fall and continued through winter (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263)). Nest-building began in Dec in Oklahoma and Jan in Texas (Palmer 1988c (/Species-Account/bna/species/goleag/references#REF38067)). Duration of nest-building varies, and is probably longer for residents than migrants. Nest construction usually begins 1–3 mo prior to egg-laying; nest-building began 95 d prior to incubation in Japan (Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206)). Bowl construction (see Nest, below) is the last phase of nest-building and occurs in the last 3–4 wk before egg-laying (CLM).

First/Only Brood Per Season

Only 1 brood/season, but will renest when eggs fail to hatch (see Eggs, below). Laying dates vary among populations (Appendix 2 (/Species-Account/bna/appendix/goleag/APP1001684)) and among years (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188), Camenzind Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184), Beecham and Kochert 1975 (/Species-Account/bna/species/goleag/references#REF10212), USGS unpubl.). Laying begins as early as late Jan and early Feb in sw. Idaho and s. California (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263), Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)) and as late as late Mar–early May in central and n. Alaska (McIntyre 1995 (/Species-Account/bna/species/goleag/references#REF33307), Young et al. 1995 (/Species-Account/bna/species/goleag/references#REF10355); Figure 3 (https://download.ams.birds.cornell.edu/api/v1/asset/25009741?__hstc=226533890.a9f4d500ff87f4cb1d6e7ee48278f77e.1580232055716.1581559168423.1581613390146.5&__hssc=226533890.7.1581613390146&__hsfp=1377133
Latitude and elevation may account for variation in laying dates among populations (Baglien 1975 (/Species-Account/bna/species/goleag/references#REF33284)); eggs laid later at more northern latitudes and higher elevations (Appendix 2 (/Species-Account/bna/appendix/goleag/APP1001684)). Along Front Range of Rocky Mtns. in Wyoming, Colorado, and New Mexico, lays earlier in south and at lower elevations (Boeker and Ray 1971 (/Species-Account/bna/species/goleag/references#REF43249)). In w. Arizona, laying dates may be synchronized with rainfall patterns and reproductive periods of prey (Millsap 1981 (/Species-Account/bna/species/goleag/references#REF8575)). In sw. Idaho, hatching dates related to both winter severity and jackrabbit abundance; eagles hatched earlier when rabbits were abundant and later after severe winters (Steenhof et al. 1997 (/Species-Account/bna/species/goleag/references#REF10331)). Hatching dates range from 10 Mar to 25 Jun in w. North America (Appendix 2 (/Species-Account/bna/appendix/goleag/APP1001684)). Young usually fledge when 45–84 d old (see Fledgling stage, below); young in nest from early May to late Aug in central and n. Alaska (McIntyre 1995 (/Species-Account/bna/species/goleag/references#REF33307), Young et al. 1995 (/Species-Account/bna/species/goleag/references#REF10355); Figure 3 (https://download.ams.birds.cornell.edu/api/v1/asset/25009741?__hstc=226533890.a9f4d500ff87f4cb1d6e7ee48278f77e.1580232055716.1581559168423.1581613390146.5&__hssc=226533890.7.1581613390146&__hsfp=1377133
Postfledging dependence period varies (see Fledgling stage and Immature stage, below). Nesting chronology in Denali National Park, AK, closely parallels chronology of arctic ground squirrel populations: Eagles arrive at nesting areas before ground squirrels emerge from hibernation, but brood-rearing coincides with peak abundance of ground squirrels; onset of migration coincides with onset of hibernation in ground squirrels and hoary marmots (*Marmota caligata*) in Sep (CLM).

Nest Site

Selection Process

Unknown which sex selects nest site; females may have selected nest sites in San Diego Co., CA (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263)).

Microhabitat

Usually nests on cliffs; also in trees (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193)), on ground (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193)), clay cliffs (Houston 1985a (/Species-Account/bna/species/goleag/references#REF10263)), river banks (Phillips et al. 1990 (/Species-

Account/bna/species/goleag/references#REF43301)), and human-made structures, including windmills, observation towers (Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184)), nesting platforms (Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)), abandoned gold dredges (Petersen et al. 1991 (/Species-Account/bna/species/goleag/references#REF31791)), and electrical transmission towers (Steenhof et al. 1993 (/Species-Account/bna/species/goleag/references#REF8222), Hunt et al. 1999b (/Species-Account/bna/species/goleag/references#REF10266)). Many nests have a wide view of surrounding area (Beecham 1970 (/Species-Account/bna/species/goleag/references#REF43245)) or are on prominent escarpments (Bates and Moretti 1994 (/Species-Account/bna/species/goleag/references#REF10210)). Proximity to hunting grounds an important factor in nest-site selection (Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184)). In northern areas, weather conditions at beginning of nesting season are a critical factor in choice of nest-site location (Morneau et al. 1994 (/Species-Account/bna/species/goleag/references#REF10294)). Average annual snowfall may limit distribution of nest sites; in sw. Montana, nests usually built below areas receiving >500 cm of snow (Baglien 1975 (/Species-Account/bna/species/goleag/references#REF33284)).

Cliff nests are built on several rock substrates including sandstone, shale, granite gneiss, limestone, basalt, and granite (Schmalzried 1976 (/Species-Account/bna/species/goleag/references#REF10318), USGS unpubl., CLM). Usually avoids building nests on loosely cemented materials such as breccias, conglomerates, or agglomerate sluff (Baglien 1975 (/Species-Account/bna/species/goleag/references#REF33284)).

Cliff nests most common throughout most of North America; trees nests more common in ne. Wyoming (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193), Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)), central Coast Range in California (Hunt et al. 1999b (/Species-Account/bna/species/goleag/references#REF10266)), and coastal Washington (Eaton 1976 (/Species-Account/bna/species/goleag/references#REF10241), Bruce et al. 1982 (/Species-Account/bna/species/goleag/references#REF10224)). Nests in a wide variety of trees, including ponderosa pine (*Pinus ponderosa*; Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)), several oak species, California laurel (*Umbellularia californica*), eucalyptus (*Eucalyptus* sp.), California sycamore (*Platanus racemosa*; Hunt et al. 1995b (/Species-Account/bna/species/goleag/references#REF43278)), Douglas fir (*Pseudotsuga menziesii*; Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191)), Fremont cottonwood (*Populus fremontii*; Bates and Moretti 1994 (/Species-Account/bna/species/goleag/references#REF10210)), and white spruce (*Picea glauca*; Ritchie and Curatolo 1982 (/Species-Account/bna/species/goleag/references#REF43304), CLM). In n. Wyoming, prefers large pines rather than cottonwoods (Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)). Nesting trees usually the largest or one of the largest trees in a stand (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193)), isolated or on the fringe of small stands of timber (Baglien 1975 (/Species-Account/bna/species/goleag/references#REF33284)), and <500 m from large clearcuts or open fields (Bruce et al. 1982 (/Species-Account/bna/species/goleag/references#REF10224)). In w. Washington, nests near clearcuts <10 yr old; may benefit from openings in dense timber formed by fire and logging (Thomas 1977 (/Species-Account/bna/species/goleag/references#REF10335), Servheen 1978 (/Species-Account/bna/species/goleag/references#REF10321), Anderson and Bruce 1980 (/Species-Account/bna/species/goleag/references#REF43241)). Avoids building nests in dense stands (Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)). In Wyoming, nests usually in upper one-third of nest tree (Schmalzried 1976 (/Species-Account/bna/species/goleag/references#REF10318), Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193), Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)). Larger trees may improve nest stability and longevity, and placement in upper portion of tree may improve accessibility for adults (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193)).

Heights of nesting substrates range from 0 to 107 m. At 4 study areas, nesting cliffs averaged 35.5 m, height of cliff nests 20.7 m (Table 1 (/Species-Account/bna/appendix/goleag/APP1002499)). Nest-tree heights ranged from 38 to 72 m in w. Washington, with nests ranging from 20 to 64 m high (n = 6; Anderson and Bruce 1980 (/Species-Account/bna/species/goleag/references#REF43241)). Occasionally nests on the ground where cliffs and trees are scarce, primarily in Nevada (Seibert et al. 1976 (/Species-Account/bna/species/goleag/references#REF43307)), Wyoming (Menkens and Anderson 1987 (/Species-

Account/bna/species/goleag/references#REF56193)), and N. Dakota (Ward et al. 1983 (/Species-Account/bna/species/goleag/references#REF10346)). Ground nests tend to be on hillsides (Ward et al. 1983 (/Species-Account/bna/species/goleag/references#REF10346)).

Tree nests were close to water courses in ne. Wyoming (Menkens and Anderson 1987 (/Species-Account/bna/species/goleag/references#REF56193)); nests in n. Wyoming and se. Montana were in large trees in the bottom of isolated drainages (Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)). Cliff nests 9.1–60.9 m above Noatak River, AK (mean 37 m, *n* = 25; Amaral and Gardner 1986 (/Species-Account/bna/species/goleag/references#REF43240)). All nests on Porcupine River, AK, were within 400 m of the river, with 84% within 100 m of the river (*n* = 37; Ritchie and Curatolo 1982 (/Species-Account/bna/species/goleag/references#REF43304)). Nests 0.05–1.2 km from water in se. Wyoming (mean 0.3 ± 0.05 SE [*n* = 30]; MacLaren et al. 1988 (/Species-Account/bna/species/goleag/references#REF33305)), 1.2–8.1 km from water in w. Washington (*n* = 6; Anderson and Bruce 1980 (/Species-Account/bna/species/goleag/references#REF43241)), and 1.6–8.0 km from water in n. Utah (mean 2.1 ± 2.9 SD [*n* = 7]; Peterson 1988a (/Species-Account/bna/species/goleag/references#REF60858)). In s. California, trees on slopes provide panoramic views of foraging habitat and may provide wind lift for flight; trees on valley floors rarely used as nest sites (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263)). Tree nests in w. Washing-ton were on slopes ranging from 30 to 88% (*n* = 6; Anderson and Bruce 1980 (/Species-Account/bna/species/goleag/references#REF43241), Bruce et al. 1982 (/Species-Account/bna/species/goleag/references#REF10224)).

Nest

Construction Process

See Phenology, above. Usu-ally refurbishes and reuses existing nests; from 1980 to 2000, only 9.5% of breeding pairs nesting on Snake River Canyon cliffs used new nests each year (range 0–18, *n* = 841 nesting attempts). New nests may or may not be used the year constructed (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263), MNK); some nests in sw. Idaho not used for up to 6 yr after construction (USGS unpubl.). Nest construction is sometimes rapid, but usually prolonged; nest-building took 4–6 wk in Texas (Palmer 1988c (/Species-Account/bna/species/goleag/references#REF38067)). Brings sticks and branches to ≥1 nests in autumn and winter; approximately 1 mo before egg-laying, brings softer materials to a selected nest to form a “bowl” within the nest (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). Sometimes adds material to alternate nests prior to laying eggs (Bergo 1987 (/Species-Account/bna/species/goleag/references#REF10214), MNK). Nest-building in San Diego Co., CA, usually occurred 10:00–13:00, or after morning hunt completed (Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263)); nest-building in Texas occurred between dawn and 11:00 (Palmer 1988c (/Species-Account/bna/species/goleag/references#REF38067)). Both sexes participate nearly equally in nest-building prior to incubation (Bergo 1987 (/Species-Account/bna/species/goleag/references#REF10214), Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206)), and both sexes add fresh vegetation (greenery) to nest throughout nesting season; female makes most deliveries during brood-rearing (Bergo 1987 (/Species-Account/bna/species/goleag/references#REF10214), Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206)). In sw. Idaho and se. Oregon, 50% of sites contained fresh nesting material during latter stages of nesting cycle (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)). All sites in Denali National Park, AK, during brood-rearing stage (*n* = 189) contained fresh nesting material (CLM).

Structure And Composition Matter

Wide variety of vegetation for nest-building; usually reflects flora of immediate vicinity (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188), CLM). Individual pulls at base of vegetation, breaking it off; uses a technique similar to tearing prey. Carries sticks and other vegetation to nest in bill or feet, depending on size of item. Often weaves sticks into existing nest structure. Less frequently uses animal bones, shed antlers (Ellis and Bunn 1998 (/Species-Account/bna/species/goleag/references#REF10244)), and human-made objects, including wire and parts of fence posts (Schmalzried Schmalzried 1976 (/Species-

Account/bna/species/goleag/references#REF10318)), as nesting materials. Bowl lined with a wide variety of vegetation types, including shredded yucca (*Yucca* spp.), grasses, dry yucca leaves (Slevin 1929 (/Species-Account/bna/species/goleag/references#REF10323), Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263)), strips of inner bark, dead and green leaves, soft mosses and lichens (Gabrielson and Lincoln 1959 (/Species-Account/bna/species/goleag/references#REF56655)), and Douglas fir and pine boughs (Jollie 1943 (/Species-Account/bna/species/goleag/references#REF10269)).

Dimensions

In Arizona and w. Washington, smaller than Bald Eagle nests. Arizona nests (n = 12; Grubb and Eakle 1987 (/Species-Account/bna/species/goleag/references#REF10252)): 175.7 cm long (range 121.9–264.2), 119.8 cm wide (range 83.8–203.2), and 65.0 cm high (range 12.7–200.7). Lined portions of 8 nests 93.6 cm long (range 53.3–185.4), 79.0 cm wide (range 38.4–160.0). Tree nests in w. Washington: 0.9 m deep with 1.2–1.5 m diameters (n = 6; Anderson and Bruce 1980 (/Species-Account/bna/species/goleag/references#REF43241)). Sticks in 12 Arizona nests: 58.4 cm long (range 7.6–177.8), 1.2 cm diameter (range 0.4–5.3); weighed 64.2 g (range 5–820). Largest nest on record, in Sun River, MT, was 6.1 m tall and 2.59 m wide (Ellis 1986 (/Species-Account/bna/species/goleag/references#REF43265)).

Microclimate

Nest-site exposure may be a factor in nest-site selection (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294)); certain exposures may protect nests from prevailing inclement weather (Watson and Dennis 1992 (/Species-Account/bna/species/goleag/references#REF56199), Morneau et al. 1994 (/Species-Account/bna/species/goleag/references#REF10294)), minimize intense (direct) sunlight that puts nestlings at risk of overheating (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294), Watson and Dennis 1992 (/Species-Account/bna/species/goleag/references#REF56199)), reduce exposure to cold (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294), Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)), avoid prevailing winds (MacLaren et al. 1988 (/Species-Account/bna/species/goleag/references#REF33305), Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)), and minimize exposure to down-drafts (Eaton 1976 (/Species-Account/bna/species/goleag/references#REF10241)). Usually nests on south-facing cliffs in northern areas (>60°N). Of 714 nests in Alaska (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294), Ritchie and Curatolo 1982 (/Species-Account/bna/species/goleag/references#REF43304), CLM), Yukon (Hayes et al. 1980 (/Species-Account/bna/species/goleag/references#REF43275), Yukon Dept. Renew. Resour. Yukon Department Of Renewable Resources 1982 (/Species-Account/bna/species/goleag/references#REF43328)), Northwest Territories (Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)), and Quebec (Morneau et al. 1994 (/Species-Account/bna/species/goleag/references#REF10294)), 54% were on south-facing cliffs, 18% on west-facing cliffs, 14% on north-facing cliffs, and 14% on east-facing cliffs. Pairs farther south less likely to select south-facing sites; of 423 nests in Montana (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191), Baglien 1975 (/Species-Account/bna/species/goleag/references#REF33284)), Wyoming (Schmalzried 1976 (/Species-Account/bna/species/goleag/references#REF10318)), Idaho (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188), USGS unpubl.), Oregon (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)), and Nevada (Seibert et al. 1976 (/Species-Account/bna/species/goleag/references#REF43307)), 37% on south-facing cliffs, 22% on north-facing cliffs, 21% on east-facing cliffs, and 20% on west-facing cliffs. Nest orientations can differ within study areas, with more south-facing nests at higher elevations (Craig and Craig 1984b (/Species-Account/bna/species/goleag/references#REF43258)). In many study areas, all exposures were used (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191), Lockhart 1976 (/Species-Account/bna/species/goleag/references#REF43287), Seibert et al. 1976 (/Species-Account/bna/species/goleag/references#REF43307)).

May use south-facing sites at northern latitudes simply because they are the only nesting habitat free of snow when territories are first occupied in spring (Amaral and Gardner 1986 (/Species-Account/bna/species/goleag/references#REF43240)). Alternatively, selection for south-facing cliffs may be a

strategy to minimize exposure of incubating birds to cold (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294), Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)). Early in breeding season, south-facing sites in central Canadian Arctic benefit from direct radiation and high reflectance radiation, while being in the lee of prevailing northerly winds (Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)). Later in nesting season, nestlings in these poorly protected nest sites may be exposed to high temperatures unless the nest is provided with shade (Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)). Parents may spend more time brooding or shading to protect young from overheating in unshaded south-facing nests. In temperate areas, appears to select nest sites that avoid direct sunlight to protect nestlings from overheating and to decrease brooding time required of adults (Mosher and White 1976 (/Species-Account/bna/species/goleag/references#REF43294)). Of 418 nests in the Snake River Canyon, ID, 12.7% had 5–25% shading, and 54.8% had 25–100% shading (USGS unpubl.). In Boulder Co., CO, no nest was in direct sunlight for >2–4 h/d (Jollie 1943 (/Species-Account/bna/species/goleag/references#REF10269)), and 33% of nests in sw. Montana had exposures that provided shade from hot afternoon sun (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191)).

Sixteen of 30 nests (53.3%) in e. Hudson Bay had overhangs (Morneau et al. 1994 (/Species-Account/bna/species/goleag/references#REF10294)). Percentage of nest covered by overhang averaged 38.3% at 41 nests in the central Arctic (Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)) and only 3.7% at 7 nests in n. Utah (range 0–20; Peterson 1988a (/Species-Account/bna/species/goleag/references#REF60858)). Although overhangs protect nests from sun, rain, snow, and ice formation (Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273), Poole and Bromley 1988a (/Species-Account/bna/species/goleag/references#REF59100)), falling rocks or soil can kill incubating or brooding eagles or nestlings (Phillips et al. 1990 (/Species-Account/bna/species/goleag/references#REF43301)). Avoids building nests in areas with major down-drafts; selection of slopes with updrafts may conserve energy and thereby enhance reproductive success (Eaton 1976 (/Species-Account/bna/species/goleag/references#REF10241)). Most nests inaccessible to humans and mammalian predators (requiring either a ladder or ropes to be reached by humans): 80.2% in sw. Idaho (USGS unpubl.) and 87.3% in Denali National Park, AK (CLM).

Maintenance Or Reuse Of Nests, Alternate Nests

Often constructs alternate nests. Number of supernumerary nests/territory ranges from 1 to 14, usually 2 or 3 (MNK). In a 2-yr study in Utah, 11 of 21 pairs had >1 nest (Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184)), and 20 of 36 pairs had alternate nests in a 5-yr study in Montana (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191)). All 65 pairs nesting on cliffs in the Snake River Canyon used >1 nest/territory during 30 yr (USGS unpubl.). Alternate nests can be separated by <1 m or >5 km (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191)); number of nests and distances between them may be related to terrain features and proximity of other nesting pairs (Boeker and Ray 1971 (/Species-Account/bna/species/goleag/references#REF43249)). Some pairs use same nest every year but repair and add material to alternate nests until eggs are laid (Mcgahan 1966 (/Species-Account/bna/species/goleag/references#REF56191), Boeker and Ray 1971 (/Species-Account/bna/species/goleag/references#REF43249), USGS unpubl.). Other pairs switch nest sites from year to year; reuse of nests not apparently associated with previous year's success (Boeker and Ray 1971 (/Species-Account/bna/species/goleag/references#REF43249), USGS unpubl.).

Eggs

Shape

Short-ovate to ovate or rarely elliptical-oval (Bent 1937b (/Species-Account/bna/species/goleag/references#REF23961)).

Size

Mean length 74.5 mm (range 67.5–85.7); mean breadth 58.0 mm (range 49.4–64.3, *n* = 63 eggs; Steinbeck 1884 (/Species-Account/bna/species/goleag/references#REF10332), Bent 1937b (/Species-Account/bna/species/goleag/references#REF23961)); 20 clutches averaged 74.4 mm ± 3.40 SD × 57.3 mm ± 1.63 SD (Palmer 1988c (/Species-Account/bna/species/goleag/references#REF38067)).

Mass

Averaged 141.4 g (range 113.9–176.6, *n* = 30; Hanna 1930 (/Species-Account/bna/species/goleag/references#REF43273)).

Color

Base color varies from white to "cream-buff" or pinkish white. Usually evenly marked small blotches, spots, or fine dots unevenly distributed or concentrated at one end. Some are evenly sprinkled with small dots. Colors of markings are "bay" and various shades of browns. Some eggs have large blotches of drabs overlaid with browns (Bent 1937b (/Species-Account/bna/species/goleag/references#REF23961)).

Surface Texture

Rough.

Eggshell Thickness

Thickness of eggshells collected pre-1947 differed little from those collected during the post-DDT era; mammal-feeding habits (see Food habits: diet, above) resulted in little biomagnification of organochlorine pesticides and minimal eggshell-thinning (Anderson and Hickey 1972 (/Species-Account/bna/species/goleag/references#REF46340), Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273)). Shell thickness of pre-1947 clutches from w. North America averaged 0.583 mm ± 0.003 SD (*n* = 290). Shell thickness of eggs collected during the 1960s and 1970s (Reynolds III 1969 (/Species-Account/bna/species/goleag/references#REF10312), Beecham 1970 (/Species-Account/bna/species/goleag/references#REF43245), Anderson and Hickey 1972 (/Species-Account/bna/species/goleag/references#REF46340), Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273)) averaged 0.593 mm for Idaho (*n* = 51), 0.637 mm for Montana (*n* = 7), 0.580 mm for Alaska (*n* = 4), 0.605 mm for California (*n* = 9), and 0.623 mm for Utah (*n* = 17).

Mean empty shell weight, 13.04 g (range 11.02–14.30) based on 1,083 eggs (Reynolds III 1969 (/Species-Account/bna/species/goleag/references#REF10312), Anderson and Hickey 1972 (/Species-Account/bna/species/goleag/references#REF46340), Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273)).

Clutch Size

Typically 1–3, rarely 4 (Degroot 1928 (/Species-Account/bna/species/goleag/references#REF43260), Ray 1928 (/Species-Account/bna/species/goleag/references#REF10310), Gordon 1955 (/Species-Account/bna/species/goleag/references#REF10249)). A California nest contained 5 eggs, but 1 egg apparently laid prior to the others (Degroot 1928 (/Species-Account/bna/species/goleag/references#REF43260)). Number of eggs averaged 1.99 in 332 clutches from 8 studies in 5 western states (n. California, *n* = 21; n. Colorado *n* = 52, central Utah, *n* = 49; sw. Idaho, *n* = 160; sw. Montana, *n* = 50); 14% contained 1 egg, 76% 2 eggs, and 10% 3 eggs (Slevin 1929 (/Species-Account/bna/species/goleag/references#REF10323), Jollie 1943 (/Species-Account/bna/species/goleag/references#REF10269), Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184), Reynolds III 1969 (/Species-Account/bna/species/goleag/references#REF10312), Arnell 1971 (/Species-Account/bna/species/goleag/references#REF43242), Olendorff 1973 (/Species-Account/bna/species/goleag/references#REF57538), USGS unpubl.). Clutches with 3 eggs most common in years when prey is abundant (USGS unpubl.). No clinal variation in clutch size. Clutch size not related to laying date in sw. Idaho (*n* = 115; USGS unpubl.). No data on whether age of female affects clutch size.

Egg-Laying

In captivity, eggs laid at mostly 3- to 4-d intervals (mean 3.5 d, *n* = 35), with 2 cases of 7 and 10 d between second and third egg (Kish Kish 1970 (/Species-Account/bna/species/goleag/references#REF10272), Kish 1972 (/Species-Account/bna/species/goleag/references#REF43281); Hamerstrom 1971 (/Species-Account/bna/species/goleag/references#REF10253), Grier 1973b (/Species-Account/bna/species/goleag/references#REF10251)). Laying intervals in the wild range from 3 to 5 d (*n* = 4; Gordon 1955 (/Species-Account/bna/species/goleag/references#REF10249), Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206)). Incubation begins with first egg, leading to asynchronous hatching (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). Renesting occurred in only 0.01% of 674 nesting attempts in sw. Idaho (USGS unpubl.), and in 1.0% of 200 attempts in Scotland (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)); average of 24 d after failure of first clutch (range 19–30, *n* = 13; Dixon 1937 (/Species-Account/bna/species/goleag/references#REF43263), Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184), Morrison and Walton 1980 (/Species-Account/bna/species/goleag/references#REF59983), Dennis 1983 (/Species-Account/bna/species/goleag/references#REF10236)).

Incubation

Onset Of Broodiness And Incubation In Relation To Laying

No information.

Incubation Patch

Present in both sexes; more developed and conspicuous in females (R. Jackman pers. comm.).

Incubation Period

Female settles in incubation posture on nest before first egg is laid (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Estimated average incubation period 42.4 d (range 41–45, *n* = 11 clutches; Abbott 1924 (/Species-Account/bna/species/goleag/references#REF10202), Gordon 1955 (/Species-Account/bna/species/goleag/references#REF10249), Mitchell Mitchell 1968a (/Species-Account/bna/species/goleag/references#REF10291), Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184), Reynolds III 1969 (/Species-Account/bna/species/goleag/references#REF10312), Beecham 1970 (/Species-Account/bna/species/goleag/references#REF43245), Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206), Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)).

Parental Behavior

In sw. Idaho, females did all nocturnal and 82.6% of diurnal incubation (*n* = 11 nesting attempts); males relieved incubating females 2.1 times daily ± 0.1 SE. Male incubation bouts averaged 49.4 min ± 4.7 SE; 17 of 111 male-initiated change-overs (15.3%) involved food transfers to the female on or near the nest (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Inattentiveness by male may force female off eggs to forage and ultimately abandon nesting effort (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)).

Hardiness Of Eggs Against Temperature Stress; Effect Of Egg Neglect

Eggs can tolerate cooling, but the precise amount is unknown. At least 1 egg hatched from a clutch of 2 in sw. Idaho after being exposed to snowy and cold conditions (0° C) for at least 1 to 5 h during late incubation (MNK).

Hatching

Hatching asynchronous (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)); hatching interval between first and second eggs 96.5 h (*n* = 1; Aoyama et al. 1988 (/Species-Account/bna/species/goleag/references#REF10206)). From Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) (*n* = 1): Chick vocalizations (chirping) begin up to 53 h before hatching. First heard calling from egg 15 h 10 min before pipping; individual egg hatching may last >36 h.

Eaglet activity increased from 26 h 50 min after pipping until emergence. Female may assist hatching by caving and separating egg. Eaglet surged against shell every few seconds at 35 h after pipping, and egg was broken completely around a belt about a third from the blunt end 35 h 15 min after pipping. Wing emerged at 35 h 19 min, ends of shell separated at 36 h 30 min, and nestling free 37 h 20 min after pipping.

Young Birds

Condition At Hatching

Average 110.6 g (range 105–115, *n* = 7) within 1 d of hatching in the wild (Sumner Sumner 1929b (/Species-Account/bna/species/goleag/references#REF10333), Sumner 1929c (/Species-Account/bna/species/goleag/references#REF10334); Ellis 1973b (/Species-Account/bna/species/goleag/references#REF56186)). Down dries within 2 h of hatching (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). At hatching, covered with short grayish-white "pre-pennae" down (Brown and Amadon 1968 (/Species-Account/bna/species/goleag/references#REF9577)). Ear holes open, beak black, egg tooth prominent, feet and legs pale flesh colored, talons white to flesh colored (Sumner Sumner 1929b (/Species-Account/bna/species/goleag/references#REF10333), Sumner 1929c (/Species-Account/bna/species/goleag/references#REF10334); MNK). Capable of limited locomotion; weak and feeble, eyes partially open, unable to detect movement (Sumner Sumner 1929b (/Species-Account/bna/species/goleag/references#REF10333), Sumner 1929c (/Species-Account/bna/species/goleag/references#REF10334)). Altricial; must be fed by parent.

Growth And Development

Increases in mass follow a general sigmoid growth pattern (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243), Collopy 1986 (/Species-Account/bna/species/goleag/references#REF33291)). Mass ranges from about 100 g at hatching to about 500 g at 10 d. From then growth is linear, reaching asymptote at 40–45 d. Female nestlings had slower growth rates but significantly higher asymptotic weights (mean 3,803 g; *n* = 102) than males (mean 3,233; *n* = 85; Collopy Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226), Collopy 1986 (/Species-Account/bna/species/goleag/references#REF33291)). Nestlings attain maximum body mass at approximately 50–60 d after hatching (Collopy 1986 (/Species-Account/bna/species/goleag/references#REF33291)).

Growth of alar, caudal, humeral, spinal, ventral, capital, crural, and femoral feather tracts linear with no apparent difference between sexes (*n* = 3 [Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)]; *n* = 23 [Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226)]). Seventh primary 269 to 316 mm and left center rectrix 191 to 253 mm at 65 d. Alar and caudal tracts continue to grow to full length after fledging (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Foot-pad growth linear between 6 to 31 d; reaching asymptote between 31 and 35 d (*n* = 23; Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273)). Mean foot-pad size differed significantly between male and female nestlings beginning at 21–25 d. Foot-pad size averaged 148.6 mm for female and 134.9 mm for male nestlings 46–59 d old (*n* = 107; Kochert 1972 (/Species-Account/bna/species/goleag/references#REF10273)).

Depends on parents to regulate body temperature (i.e., brooding and shading) for first 20 d after hatching (Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). Prone to heat stress and death in extreme conditions; responds to heat stress by moving to cool objects or shaded portions of nest, or by panting (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Droops wings to dissipate heat and spreads wings to absorb radiant energy, dry plumage, or dissipate heat (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Wing spread first seen around 7 wk of age.

Behavior

See Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) for details on preening, scratching, defecation, and casting of pellets. Intersibling conflicts occur frequently and occasionally result in siblicide, particularly when food is limited (Edwards and Collopy 1983 (/Species-Account/bna/species/goleag/references#REF43264), Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). When attacked by sibling, subordinate chick turns away, partially spreads tail, lowers head, and remains still to suppress aggression; aggressive interactions wane between

10 and 13 d, but continue sporadically to late brood-rearing (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Late-season agonistic behavior related to lack of food (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Larger, most aggressive chick, typically a female, receives most food (Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226)). Subordinate chick is some-times starved or forced from nest (Sakaguchi and Chiba 1988 (/Species-Account/bna/species/goleag/references#REF33311)). Probability of siblicide depends on sex and order of hatching sequence, with siblicide more than likely to occur when a female hatches before a male in the brood (Edwards and Collopy 1983 (/Species-Account/bna/species/goleag/references#REF43264), Bortolotti 1989a (/Species-Account/bna/species/goleag/references#REF10220)). In sw. Idaho, aggression occurred in all nests with 2-chick broods observed from blinds, and resulted in 1 death in 3 (43%) of 7 broods (Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226)). Siblicide accounted for 7% of 41 nestling mortalities in sw. Idaho (Beecham and Kochert 1975 (/Species-Account/bna/species/goleag/references#REF10212)) and 6 (40%) of 15 nestling losses in central Europe (Kropil and Majda 1996 (/Species-Account/bna/species/goleag/references#REF56190)).

From Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) . Aggressive interactions with parents increase with nestling age. Nonaggressive billing of adults begins around 20 d of age, but is aggressive by day 40 and continues until fledging. As fledging age approaches, regularly engages in rush attacks (running and flapping wings) when parents enter nest; occasionally foot-stabs parents. Mantles prey to protect food from parent and nest mate, beginning about 40 d of age. Occurred in all nests with >1 young (*n* = 3 nests) and is associated with development of self-feeding.

Locomotion

From Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) (*n* = 4 chicks) and Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226) (*n* = 12). Able to distinguish objects at 7 d, but probably incapable of acute visual discrimination at <10 d (Sumner 1929b (/Species-Account/bna/species/goleag/references#REF10333), Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). During first week, spends >95% of the day in lie position; subsequently, proportion of day spent lying decreases. Begins sitting at 1 d old; begins to stand at 17–20 d. No difference between male or female chicks in development of lying, sitting, or standing. Wing-flapping, performed while sitting, first seen about 9–10 d old. Performed while standing, as chicks grow older. Flapping begins to increase during week 5, with frequency increasing linearly until fledging. Males developed flapping at a significantly greater rate than females. See Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) and Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226) for details.

Parental Care

Brooding

Males in Idaho spent 74% of perched time at locations away from nest. Male almost never broods; female broods and shades young from hatch to about 45 d of age (observed once at 50 d; Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243), Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Time spent brooding to 19 d related to wind chill (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Percentage of day brooding/shading decreases linearly from >80% at 1–10 d of age to <5% at 40 d (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Female broods young nightly until 17–42 d after hatch (mean 29) and roosts on nest until 17–54 d (mean 40; Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)).

Feeding

From Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243) and Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227) . Both parents bring prey to nest, but male rarely feeds young directly. Adults may not feed young on hatch day; mean number of adult-fed meals/d increased rapidly during week 1 and decreased significantly during the nesting season (*n* = 10 broods). Biomass fed directly by

female increased until fifth week; then decreased with linear increase of self-fed meals by young. Young begin self-feeding at 34–37 d old, and successfully tear carcasses at 45–55 d; by week 8, young consume more by self-feeding than fed by adults; increases in self-feeding coincide with development of standing behavior. No direct feeding after fledging.

Meal size increases throughout the nesting season; estimated morsel size fed ranged from 6 mm at hatching to 15 mm at fledging (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243); Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226)). Although chicks in multiple-chick broods received more food from adults than 1-chick broods, they had lower consumption rates from self-fed meals during late brood-rearing (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Adult exhibits no chick bias in apportioning food, but dominant chick usually receives food first by intimidating subordinate chick (Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226), Edwards and Collopy 1983 (/Species-Account/bna/species/goleag/references#REF43264)).

From Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227) . Both sexes hunt throughout brood-rearing period. Over entire nesting season, males delivered significantly more prey/d (1.2 deliveries ± 0.28 SE; 1,030 g/d ± 284.6 SE; *n* = 8) than females (0.6 deliveries ± 0.44 SE; 387 g/d ± 270 SE; *n* = 8). Male provided almost all food during first 2 wk (83% of deliveries and 95% biomass). Female increased prey deliveries in third week of brood-rearing, with maximum contribution in seventh–ninth weeks (43% of biomass); similar delivery rates for sexes during weeks 7–10. Prey size did not differ between male and female, but differed among nests.

Overall prey-delivery rates averaged 1.8 items/d in sw. Idaho (range 1.0–3.1) and 0.9/d in w. Texas during brood-rearing (Lockhart 1976 (/Species-Account/bna/species/goleag/references#REF43287), Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Delivered larger prey in Idaho (1,153 g) than in Texas (947 g). Mean delivery rates in sw. Idaho increased from 1.5/d during first 5 wk of brood-rearing to 2.6/d during sixth–seventh weeks, then decreased to 1.6/d during final 2 wk; delivery rates did not differ between 1- and 2-chick broods (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)).

Nest Sanitation

Young expel feces several centimeters outside nest cup as early as 1 d, and consistently defecate over nest rim by 30 d (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)). Food accumulates at nests, and nests may contain prey in various stages of decomposition (MNK). Adults sometimes remove or consume prey remains uneaten by young (Macpherson 1910 (/Species-Account/bna/species/goleag/references#REF10281), Hunsicker 1972 (/Species-Account/bna/species/goleag/references#REF10264), Hoechlin 1974 (/Species-Account/bna/species/goleag/references#REF60456)), but uneaten prey not removed in 1,012 h of observation of 8 broods in Idaho (Collopy 1983a (/Species-Account/bna/species/goleag/references#REF43255)). May remove dead nestlings <3 wk old (Palmar 1954 (/Species-Account/bna/species/goleag/references#REF43297), USGS unpubl.). Brings in green plant material throughout the season to cover debris or perhaps repel ectoparasites (Wimberger 1984 (/Species-Account/bna/species/goleag/references#REF33319), Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348)). Ectoparasites can be abundant in nest material (see Demography and populations: disease and parasites, below). Several species of nonparasitic arthropods occur in eagle nests (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188)). Most have no effect on eagles, but Ellis (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)) reported retarded growth and weight loss of nestlings from a Montana nest where dermestid beetle larvae (*Dermestes* sp.) consumed prey items in the nest.

Carrying Of Young

Reports of parents carrying fledging-age young are rare and anecdotal (*n* = 4; Palmer 1988c (/Species-Account/bna/species/goleag/references#REF38067)). Not recorded during intensive studies of fledging behavior (Dunstan et al. 1978 (/Species-Account/bna/species/goleag/references#REF38078), Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243), Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226), Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345), Bahat 1992 (/Species-Account/bna/species/goleag/references#REF33285), O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)).

Cooperative Breeding

Occasional reports of trios (see Behavior: sexual behavior, above).

Brood Parasitism by Other Species

None reported.

Fledgling Stage

Departure From Nest

For several weeks prior to fledging, nestlings flap wings and hop in practice flights; intensity increases as fledging approaches (see Young birds, above). Young leave nest as early as 45 d of age (USGS unpubl.) and as late as 81 d (Gordon 1955 (/Species-Account/bna/species/goleag/references#REF10249)). In sw. Idaho, 101 chicks from 61 broods averaged 64.4 d (range 45–77) old at departure from nest (USGS unpubl.). Mean age at first flight was 10.1 wk (*n* = 28) in w. North Dakota (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). Departure from nest includes falling, jumping, walking, or flying. Departure can be abrupt, with young jumping off and using a series of short, stiff wing beats to glide downhill or being blown out of nest while wing-flapping; often includes a short flight on unsteady wings followed by an uncontrolled landing (Camenzind Camenzind 1969 (/Species-Account/bna/species/goleag/references#REF56184), CLM). Many departures before capable of flight are associated with chicks exposed to thermal stress or nest parasite infestations (USGS unpubl.). Occasionally young fledge unsuccessfully and are grounded; in most cases, parents feed and care for grounded young (Hickman 1968 (/Species-Account/bna/species/goleag/references#REF56188), MNK, CLM). No evidence, other than an anecdotal report (Miller 1918a (/Species-Account/bna/species/goleag/references#REF10289)), that adults force young out of nests to encourage fledging. Adults may facilitate fledging by decreasing prey deliveries during last few weeks of brood-rearing (Collopy 1984 (/Species-Account/bna/species/goleag/references#REF10227)). Self-sustained flight not usually achieved until >64 d of age (Brown and Amadon 1968 (/Species-Account/bna/species/goleag/references#REF9577)).

Growth

During post fledging, muscle mass of juveniles develops, and flight feathers reach full growth (Jollie 1947 (/Species-Account/bna/species/goleag/references#REF10268)). Because mass and skeletal growth reaches asymptote prior to fledging (Collopy 1980 (/Species-Account/bna/species/goleag/references#REF10226)), mass fluctuates depending on food intake, and skeletal growth and development are minimal during postfledging (M. Collopy pers. comm.).

Association With Parents Or Other Young

Associates with parents and siblings for varying times after fledging; migrants may break association sooner than residents. Young stay with parents 1–6 mo after fledging (USGS unpubl.). At 1 nest in United Kingdom, fledglings stayed ≤70 m from nest for 2 wk, and male delivered food at safe perches near nest (Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345)). Females rarely provided food to fledged young in sw. Idaho; females made <5% of prey deliveries during postfledging period (M. Collopy pers. comm.). Siblings moved together after fledging in w. North Dakota, and usually stayed within 300 m of each other up to 121 d postfledging (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). Before independence, fledglings exhibit nonaggressive social behavior (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). Fledglings mutually preen or “nibble” when perched together (Ellis 1979 (/Species-Account/bna/species/goleag/references#REF10243)), display “play” catching and plucking of prey together (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)), and stoop, talon-touch, and talon grapple (Grant and McGrady 1999 (/Species-Account/bna/species/goleag/references#REF10250)). Agonistic interactions between parents and offspring or between siblings rare, except just before or after fledglings gain independence (Walker Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345), Walker 1988 (/Species-Account/bna/species/goleag/references#REF33317); Bahat 1992 (/Species-

Account/bna/species/goleag/references#REF33285); Watson 1997 (/Species-Account/bna/species/goleag/references#REF10348); Grant and McGrady 1999 (/Species-Account/bna/species/goleag/references#REF10250); O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)).

Ability To Get Around, Feed, And Care For Self

Flying ability develops slowly, partly a consequence of incomplete flight-feather growth (Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345)). In Israel, females developed flying skills, flew longer distances, and moved farther from nest site sooner than males (Bahat 1992 (/Species-Account/bna/species/goleag/references#REF33285)). Distance of fledglings from their nest increased significantly with time in w. North Dakota, but sexes did not differ in distance moved (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). Movements >5 km not observed until >29 d after fledging; movements >10 km not observed until >98 d after fledging in N. Dakota (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). First hunting attempts 28–68 d after fledging in Alaska, Israel, and England (Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345), Bahat 1992 (/Species-Account/bna/species/goleag/references#REF33285), CLM). Fed at carcasses 35 d after fledging, and bathed 30 d after fledging (Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345)). Juveniles seek shade or lie prostrate in the sun with wings open and tail fanned during exceptionally hot weather (Walker 1987 (/Species-Account/bna/species/goleag/references#REF10345)).

Immature Stage

In United Kingdom, independence estimated 75–85 d after fledging, when adults began territory defense displays toward their young (Walker 1988 (/Species-Account/bna/species/goleag/references#REF33317)). Dependency on parents probably reduced to ≤2 mo at northern end of range in Alaska (Brooks Range and Seward Peninsula; Kessel 1989 (/Species-Account/bna/species/goleag/references#REF61012)). Fledgling dispersal and independence 32–70 d (mean 56 d) after fledging in Denali National Park, AK, and coincided with in-itiation of migration. Most fledglings left natal areas in Denali within 20 d of one another (n = 48), but no evidence that young accompanied parents at onset of autumn migration or that siblings moved together (CLM).

Annual movements of first-year eagles from Denali averaged >5,500 km, with individuals migrating south to w. Canada and w. U.S. in autumn and north to w. Yukon and Alaska in spring (CLM). First-year eagles from Denali remained on wintering areas longer than adults and returned to northern latitudes 5–12 wk after adults (CLM). Most first-year eagles from Alaska showed tenacity to wintering areas; most did not wander once they reached the end of autumn migration (CLM). First-year eagles from Alaska returned to Alaska and Yukon during their second summer, but did not return to their natal areas (CLM).

Postindependence movements at temperate latitudes involve nonlinear wandering beyond the natal area (O'Toole et al. 1999 (/Species-Account/bna/species/goleag/references#REF10300)). First-year eagles banded in Snake River Canyon, ID, dispersed from natal areas in nearly all directions (Steenhof et al. 1984 (/Species-Account/bna/species/goleag/references#REF17488)). Most individuals did not move beyond boundaries of adjacent states; 78% of encounters were <100 km, and 1% of encounters were >1,000 km from banding locations (Steenhof et al. 1984 (/Species-Account/bna/species/goleag/references#REF17488)). First-year eagles from sw. Idaho did not move significantly farther than older birds; 8 of the 9 most distant (>500 m) encounters were of birds >1 yr old (Steenhof et al. 1984 (/Species-Account/bna/species/goleag/references#REF17488)). Subadults in the Altamont Pass area, CA, tend to be sedentary, showing only local or intrarange movements during the year (Hunt et al. 1999b (/Species-Account/bna/species/goleag/references#REF10266)).

Radio-telemetry and banding data from Scotland suggest that as subadults reach breeding age, they tend to return to natal areas (Grant and McGrady 1999 (/Species-Account/bna/species/goleag/references#REF10250)). May gain territories by killing territory holders (Hunt et al. 1995b (/Species-Account/bna/species/goleag/references#REF43278), Grant and McGrady 1999 (/Species-Account/bna/species/goleag/references#REF10250)).

Behavior (/Species-Account/bna/species/goleag/behavior)

Demography and Populations (/Species-Account/bna/species/goleag/demography)

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