Monitoring Occupancy of Nesting Areas and Reproductive Success of Golden Eagles in Denali National Park and Preserve, Alaska.

2007 Annual Report

Central Alaska Network, Vital Signs Monitoring Program

Golden Eagle nesting habitat, East Fork of the Toklat River. Photo by Carol McIntyre

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SUMMARY

I monitored the nesting area occupancy and reproductive success of Golden Eagles (*Aquila chrysaetos*) using data collected during two standardized aerial surveys in Denali National Park and Preserve (Denali) between 1988 and 2007. In 2007, occupancy of Golden Eagle nesting areas (91%), nesting rate (73%), and success rate (78%) were slightly higher than the long-term averages of those metrics. Fledging production (n = 72) was the second highest recorded in the study. During Golden Eagle surveys, I also collected data on the nesting area occupancy and reproductive success of Gyrfalcons (*Falco rusticolus*). In 2007, occupancy of Gyrfalcon nesting areas (46.7%) and success rate (42.8%) were lower than most previous years. Daily counts of snowshoe hare (*Lepus americanus*) and Willow Ptarmigan (*Lagopus lagopus*) were among the highest recorded in the study and indicated that populations of these cyclic vertebrates were reaching or were at the peak of their 8- to 11 year cycles. As in 2006, when hares were abundant, I noted a high number of non-territorial subadult Golden Eagles in the study area from June through August. Adult and subadult Bald Eagles (*Haliaeetus leucocephalus)*, were also noted in the study area in June and July, apparently drawn to the area by the abundance of hare.

Key words: Alaska, *Aquila chrysaetos*, Denali National Park and Preserve, *Falco rusticolus*, Golden Eagle, Gyrfalcon, monitoring, reproductive success.

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INTRODUCTION

Golden Eagles are large, diurnal raptors that nest across the Northern Hemisphere (Watson 1997). Although this species is found across a wide geographical range, it is most often found in mountainous regions that offer hunting opportunities in open landscapes dominated by short vegetation (Watson 1997). In North America, Golden Eagles are most common in the West, usually near open spaces that provide hunting habitat (Kochert et al. 2002). The distribution of Golden Eagles in Alaska is not well documented, but the larger concentrations of nesting populations occur in the Alaska Range and the Brooks Range. Golden Eagles occur in relatively high densities in the northeastern region of Denali National Park and Preserve, Alaska (Denali) (Kochert et al. 2002, McIntyre et al. 2006c).

In 1988, the National Park Service initiated a long-term program to monitor Golden Eagle nesting area occupancy and reproductive success (McIntyre and Adams 1999. McIntyre et al. 2006c). This monitoring program grew out of increasing interest in this species resulting from discovery of a large nesting population in this area in 1987 (McIntyre et al. 2006c). Before 1987, Denali park managers knew little about the distribution or size of the nesting population of Golden Eagles in Denali, and often relied on information provided by Murie (1944) to make inferences about this species in Denali. Results from a Golden Eagle nesting population inventory in 1987 provided new and exciting information about this species in Denali (McIntyre et al. 2006c). For instance, the 1987 inventory updated the number of known nesting areas from 10 to 15 to more than 60, a five or six-fold increase in the number of nesting areas. The inventory also highlighted the importance of this aerial predator in Denali's ecosystems (McIntyre et al. 2006c).

In 2004, the Central Alaska Monitoring Network (CAKN) selected *Fauna Distribution and Abundance* as one of its top three Vital Signs (along with *Climate/Weather*, and *Vegetation Structure and Function*) (MacCluskie and Oakley 2005). The *Fauna Distribution and Abundance* Vital Sign included monitoring efforts for a suite of vertebrate species including Golden Eagles in Denali (MacCluskie and Oakley 2005). Golden Eagles were selected as a Vital Sign monitoring component because they are a high trophic level predator, they response quickly to changes in their habitat and prey supplies (Watson 1997), and nesting populations can be monitored using highly efficient methods. Denali is one of the best places to watch Golden Eagles in North America; hence, Denali's visitors are also very interested in seeing and learning about this predator.

Denali contains one of the highest reported densities of nesting Golden Eagles in North America (Kochert et al. 2002). Long-term studies in Denali provide the only contemporary data on reproductive characteristics of a large migratory population of this species in northern North America. Results from the Denali Golden Eagle monitoring program and ensuing research projects have increased our understanding of Golden Eagle ecology in North America, particularly for northern migratory populations (McIntyre and Adams 1999, Kochert and Steenhof 2002, Kochert et al. 2002, McIntyre 2002, McIntyre and Collopy 2006, McIntyre et al. 2006a,b,c). Further, data collected in Denali is directly comparable to the only other large (>30 pairs), long-term (>30 years) data set for this species in North America, collected in the Snake River Birds of Prey National Conservation Area (McIntyre et al. 2006c) and provide a unique

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opportunity for comparing and contrasting the ecology migratory and resident populations of Golden Eagles.

Gyrfalcons also nest in relatively high densities in Denali (Swem et al. 1994). Gyrfalcons are the largest falcon in the world and they occupy a Holarctic Range throughout the Northern Hemisphere (Clum and Cade 1994). Gyrfalcons nest sympatrically with Golden Eagles in Denali, often using Golden Eagle nest structures for their own nesting attempts. Unlike the Golden Eagles that nest in Denali, adult Gyrfalcons are residents and live throughout the year in Denali. The nesting seasons of Gyrfalcons and Golden Eagles overlap in Denali, but the nestling cycle of Gyrfalcons is shorter than Golden Eagles and Gyrfalcon nestlings fledge several weeks earlier than most Golden Eagles. In Denali, the nesting season diets of both species overlap, with Arctic Ground Squirrel (*Spermophilus parryii*) and Willow Ptarmigan making up much of the nesting season diets for both species. Further, despite the high interest in Gyrfalcons, few monitoring or research efforts are focusing on this species in Alaska. As such, data collected on Gyrfalcons in Denali via the Golden Eagle monitoring program provide important information on this species in Alaska. Although CAKN did not select Gyrfalcons as a component of the Vital Signs Monitoring program, we continue to collect data on their nesting area occupancy and reproductive success concurrently with the Golden Eagle monitoring program.

In addition to providing contemporary information on the reproductive success of Golden Eagles and Gyrfalcons, this project provides park managers with information on the location and status of occupied nesting areas and nest sites of these species in Denali. This information is essential for protecting these sites from direct human disturbance during the nesting season.

This annual progress report summarizes results of monitoring activities for Golden Eagles and Gyrfalcons in Denali in 2007, summarizes some of our anecdotal observations, highlights some of the project's achievements, and plans for 2008.

STUDY AREA

The study area was in the northern foothills of the Alaska Range in northeastern Denali in central Alaska (63º 36'N, 149º 39'W) (Figure 1). The study area contained one of the highest reported densities of nesting Golden Eagles in North America (Kochert et al. 2002) and a relatively high density of nesting Gyrfalcons (Swem et al. 1994). Rugged, mountainous terrain interspersed by broad glacial valleys and upland areas characterized the 2,100 km^2 survey area. Elevations ranged from 427 m in the lowlands and river bottoms to 1,372 m along the foothill summits.

METHODS

This project has several measurable objectives including:

1. Estimate annual nesting area occupancy and nesting activities at all known nesting areas.
    a. Revisit all known nesting areas and assess their occupancy.
    b. Search for new and previously unknown nesting areas and assess their occupancy.
    c. Document egg laying at occupied nesting areas.
    d. Document nesting pairs that successfully raise $\geq$one fledgling.

e. Record the number of fledglings and calculate the number of fledglings produced per territorial and successful pair.

2. Estimate annual nesting phenology.
    a. Estimate age of nestlings during nest visits or the productivity survey.
    b. Calculate estimated dates of egg-laying, hatching, and fledging.

Terminology

I used terminology recommended by Steenhof (1987) to describe occupancy of nesting areas and reproductive success (Appendix A) (Figure 2). Steenhof (1987) suggested measuring Golden Eagle productivity based on the territorial population, rather than simply successful pairs; however, because many studies of Golden Eagle reproductive success do not include this measurement, I calculated two measurements of annual productivity to compare our results with other Golden Eagle studies in North America: 1) fledglings per territorial pair and 2) fledglings per successful pair (or mean brood size).

Surveys and Data Collection

I used two aerial surveys to assess nesting area occupancy and reproductive success of Golden Eagles and Gyrfalcons in Denali in 2007. I conducted the first aerial survey (occupancy survey) after the completion of most clutches, before most nest failures occurred, and before eggs hatched. The objectives of the occupancy survey were to document occupancy and nesting activity at nesting areas. I conducted the second aerial survey (productivity survey) after most nestlings reached 80% of their age at fledging, but before they left the nest (fledge). The objectives of the productivity survey were to count the number of nestlings and fledglings, and to document reproductive success.

Occupancy survey. I started planning for the occupancy survey in early January 2007. My first task was to contact the aircraft contractor (Quicksilver Air, Fairbanks, Alaska) and schedule a helicopter and pilot for the survey. (NOTE: this is a critical step of this program because of the limited number of Robinson R-44 helicopters and pilots available for this work). Several weeks before the survey, I reviewed the database and prepared a comprehensive map (1:250,000 scale) of the survey area containing the locations of all known Golden Eagle and Gyrfalcon nests in the study area. A week before the survey, I studied the map and developed a survey strategy based on location of nesting areas. I used this map to navigate and to record my observations during the aerial surveys. (NOTE: Weather is the main factor affecting the ability to carry off a successful survey; thus, the survey strategy must remain flexible in order to deal with weather conditions on the day of the survey. This includes making sure to schedule several additional days of survey time in the event that surveys cannot be conducted due to high turbulence etc.).

I conducted the occupancy survey over four days between 23 April and 26 April 2007 from a Robinson R-44 helicopter (Quicksilver Air, Fairbanks, Alaska). Surveys started at approximately 7:30 am and ended at approximately 6:30 pm. (NOTE: Surveys conducted after 7:00 pm often encounter problems with deep shadows that interfere with the observers' ability to see into nests). I used 10 x 40 binoculars during all aerial surveys. The 2007 occupancy survey

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required 11.5 hours of flight time. I based the occupancy surveys out of the Denali park airstrip and refueled at this and the Kantishna airstrip (just west of the study area).

As we approached each known nesting area during the occupancy survey, I instructed the pilot to fly the helicopter slowly (≤ 30 km per hour) and provided him with details on the exact location of each nest. The pilot generally oriented the helicopter about 100 meters in front of the nest cliff and about 100 meters above the nest, and I looked directly out my window into each nest to observe its contents. (NOTE: It was the pilot's responsibility to position the helicopter in the best position to allow me to observe nests). During nest observations, the pilot flew the helicopter as slowly as possible and often hovered. As soon as I detected evidence of occupation (i.e., incubating eagle, eggs, nest construction or decoration), I recorded my observations on the survey map, and instructed the pilot to leave the area. In cases where I detected an incubating eagle before we approached within 300 meters of the nest, I immediately instructed the pilot to leave the area and we proceeded to the next nesting area to avoid disturbing the incubating eagle.

If I could not determine the occupancy status of a nesting area from the helicopter, I returned to the area later that day after I completed making aerial observations at other nesting areas. I used this survey strategy to take advantage of good survey weather early in the morning before the build up of afternoon turbulence. During the return visits, I instructed the pilot to fly slowly in front of cliffs and rock outcroppings near the known nests as I looked for previously undiscovered or new nests. If I could not find any evidence of occupation from the air during the return visit, I instructed the pilot to land at a nearby vantage point and I made observations from the ground. During ground observations, I searched the immediate area for perched and flying eagles. If I located a perched or flying eagle, I maintained visual contact with it. These observations often led to evidence of occupation (i.e., copulation, territorial display, nest construction, territorial behavior). If I could not find evidence of occupancy after two consecutive hours of ground observations, I defined the area as "occupancy unknown" and revisited the area later in the nesting season to assess occupancy.

Foot surveys. From late May through mid-July, I made additional observations of nesting areas visible or easily accessible (within 5 miles) from the Denali park road and State Highway 3. I made observations to calibrate my estimates of nesting phenology (by making repeated observations of nestlings at occupied nests) and to assess occupancy in areas where occupancy was unknown.

Productivity survey. I started planning for the productivity survey in January 2007. My first task was to contact the aircraft contractor (Quicksilver Air, Fairbanks, Alaska) and schedule a helicopter and pilot for the survey. (NOTE: this is a critical step of this program because of the limited number of Robinson R-44 helicopters and pilots available for this work). Several days before the survey, I reviewed the survey map that I used during the occupancy survey and developed a productivity survey strategy. I used this map to navigate and to record my observations during the productivity survey. I conducted the productivity survey on 16 and 17 July 2007 from a Robinson R-44 helicopter (Quicksilver Air, Fairbanks, Alaska). During this survey, I made observations at all nests where I documented egg-layingduring the occupancy survey. I also revisited nesting areas where I could not document occupancy earlier in the nesting season. The productivity survey required 7 hours of flight time. I based the productivity

survey out of the Denali park airstrip, and refueled at this and the Kantishna airstrip during the survey.

At each occupied nest, I counted the number of nestlings and estimated their age to the nearest week based on their feather development. I also recorded the presence and number of addled (unhatched) eggs. I used 10 x 40 binoculars during all aerial surveys.

Documenting new nest sites. During all surveys and fieldwork, I searched for new or previously undocumented nest sites and recorded their location (latitude and longitude) using a Global Positioning System (GPS) and noted their location and characteristics on my survey map and in my field notes.

Documenting age structure of territorial population. I recorded the age class (adult or subadult) of all free-flying Golden Eagles observed during surveys using plumage characteristics described by Ligori (2004); however, I did not intentionally flush incubating Golden Eagles off their nests to assess their age class.

Documenting flush response during aerial surveys. I recorded the flushing response (yes or no) of incubating Golden Eagles and Gyrfalcons to the helicopter during the occupancy survey.

Calculating snowshoe hare and Willow Ptarmigan abundance indices. I counted the number of adult snowshoe hare and adult Willow Ptarmigan that I observed during routine fieldwork from 15 April through 30 June 2007. I used the number of individuals observed per field day per year as an index of their annual abundance (McIntyre and Adams 1999). I calculated this index to assess the response of Golden Eagles and Gyrfalcons to broad-scale changes in their primary spring prey resources, snowshoe hare and Willow Ptarmigan (McIntyre and Adams 1999).

Other observations. I recorded all birds observed during all aerial and ground surveys, and nest visits in my field notes. During the occupancy survey, I recorded locations and numbers of grizzly bears (*Ursus arctos*) and Dall sheep (*Ovis dalli dalli*) that I observed during the surveys. When I found a group of Dall sheep ewes, I made specific observations to determine if lambs were present. (Although lambing usually occurs after the occupancy surveys, I documented early lambing in May 2004.)

Optical equipment. I used Zeiss® 10 x 40 binoculars during all aerial surveys and ground observations, and a Kowa® spotting scope with a 20 to 60-zoom power eyepiece during all ground observations.

Data summaries

I calculated rates of nesting area occupancy, nesting and nesting success, and estimated overall population productivity and mean brood size for Golden Eagles in 2007. I calculated nesting area occupancy and success rate for Gyrfalcons in 2007. Appendix A contains definitions of metrics used to monitor nesting area occupancy and reproductive success. I assessed the correlation between number of occupied nesting areas and average productivity of Golden Eagles using Spearman rank correlations (Sergio and Newton 2003). For comparison purposes, I also

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used Spearman rank correlations (Sergio and Newton 2003) to assess the correlation between number of occupied nesting areas and average productivity of Peregrine Falcons (*Falco peregrinus*) along the upper Yukon River, Alaska, using data provided by Flamme et al. (2008).

RESULTS AND DISCUSSION

Survey effort

I monitored 89 Golden Eagle (Table 1) and 15 Gyrfalcon nesting areas in 2007. I observed all known Gyrfalcon nesting areas during the Golden Eagle surveys, but did not search for new or previously undocumented Gyrfalcon nesting areas during the surveys. Weather conditions during the occupancy survey were favorable for surveys and observations; however, we encountered severe turbulence in some areas and had to revisit some of these areas later in the occupancy survey. Weather conditions during the productivity survey were favorable for surveys and observations.

Golden Eagles

Nesting area occupancy and reproductive success. I detected 81 territorial pairs of Golden Eagles in 2007 (Table 1). Of these, 59 pairs (73%) produced eggs (nesting pairs) and 46 produced fledglings (successful pairs) (Table 1). Golden Eagle nesting area occupancy in 2007 was similar to 2006 (Figure 3). Rates of nesting and nesting success (Figure 4 and 5), and the two measures of productivity were higher in 2007 than in most other years of the study (Figure 6). As expected, Golden Eagle reproduction in Denali in 2007 was higher than the long-term average, apparently due to the abundance of snowshoe hare (Figure 7).

In some populations of longer-lived raptor species, particularly in areas with high nesting densities, productivity measured as the average number of nestlings per territorial or breeding pair decreased as the number of territorial or nesting pairs increased. For instance, average annual productivity of Bonelli's Eagles (*Hieraaetus fasciatus*) decreased when the number of territorial pairs increased in areas with high densities of nesting eagles (Carrete et al. 2006); decreased productivity was interpreted as a density-dependent response. Further, a high density nesting population of Peregrine Falcons (*Falco peregrinus*) along the upper Yukon River, Alaska (Flamme et al. 2008) exhibited a similar response; as the number of occupied sites increased from 1975 to 2007, the average number of nestlings produced per occupied site decreased (r^2 = 0.37, P = 0.0002). In contrast, average annual productivity of Golden Eagles in Denali was not correlated to the annual number of occupied territories (r^2 = 0.0005, P = 0.922) (Figure 8), suggesting that there is no density dependence response occurring in Denali.

Nesting phenology. Nesting phenology in 2007 was similar to other years; most Golden Eagles completed egg laying by mid-April and most fledglings left their nests by early August.

Age structure of territorial population of Golden Eagles. I observed 45 adult and 1 subadult Golden Eagles during the occupancy survey and 61 adult and 12 subadult Golden Eagles during the productivity survey. I could not assess the age of all territorial Golden Eagles in the study

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area because I did not intentionally flush incubating eagles off their nests during the occupancy survey and did not see all territorial eagles during the field season.

The lack of subadult Golden Eagles in the study area during the early part of the nesting season (April) suggests that the territorial population of Golden Eagles in Denali consists primarily of adults. The presence of subadult Golden Eagles in the study area during the later part of the nesting season (May, June, July, and August) suggests that non-breeding subadults visit the study area, but most likely they are not part of the territorial population. In 2007, non-territorial subadult Golden Eagles were likely taking advantage of the abundance of snowshoe hare in the study area.

Flushing response of Golden Eagles during aerial surveys. One incubating Golden Eagle flushed off its' nest during the occupancy survey in 2007. We approached this nest during the occupancy survey using standard protocol, but the eagle stood up and flushed off the nest when we were about 400 meters from the nest. I am not sure if the eagle flushed off the nest because of our presence or because an adult Grizzly Bear (*Ursus arctos*) was running below the nest when we were in the area, or a combination of both. After the eagle flushed off the nest, we circled around and watched the eagle fly several hundred meters away from the nest and then circle back and return directly to the nest to resume incubation. We returned to this nest during the productivity survey and observed two eight-week old fledglings.

From 1988 to 2007, the flushing rate of Golden Eagles was 0.80% (6 of 750). All of the Golden Eagles that flushed off their nest during the occupancy survey eventually returned to their nests and successfully raised fledglings. Additionally, nests where flush events occurred in one year were often used for a nesting attempt in the following year. Based on the lack of flushing behavior exhibited by incubating Golden Eagles and the success of eagles that flushed off their nests, I assume that our aerial survey technique of slowly approaching nests in full view of the incubating eagle reduces the probability of a flushing or startle response and has no negative effect of Golden Eagle reproduction.

Management activities. No wildlife closures were established near occupied Golden Eagle nesting areas in 2007.

Gyrfalcons

Gyrfalcon nesting area occupancy in 2007 was similar to 2006 (Figure 9). Success rate was high (Figure 9), but the sample size of successful nests was low (n = 5). The apparent decline in the occupancy rate of Gyrfalcons in Denali between 1988 and 2007 may result from incomplete surveys for this species, rather than from an actual decline in the number of territorial Gyrfalcons in the study area. (Current funding levels are not adequate for monitoring all known Gyrfalcon nesting areas in the study area.)

Management activities. Many park visitors observed the Gyrfalcons nesting on Marmot Rock in 2007. Gyrfalcons have been nesting on Marmot Rock since at least the early 1920's (Dixon 1938, Murie 1963). The nest sites on Marmot Rock are within 150 meters of the Denali park road. Bus drivers often stopped their buses and gave visitors opportunities to view perched

Gyrfalcons right from the bus. Although the nest site was not visible from the Denali park road, the adult Gyrfalcons often perched on a rocky ridge just east of the nest site and were easily visible from the Denali park road. Because the Marmot Rock nest is near one of the highest visited rest stops along the Denali park road, the Denali wildlife technicians implemented a temporary wildlife closure around the nest site from May through mid-August to protect the nesting effort from human disturbance. This closure included the immediate area around the nest, including Marmot Rock, and the outcropping and ridge immediately east of Marmot Rock. One nestling successfully fledged from this nest in late July. Another occupied Gyrfalcon nest was on the western edge of Eielson Bluffs less than 1 kilometer from the Denali park road. Because a well-used hiking trail runs along the top of Eielson Bluffs, the Denali wildlife technicians implemented a temporary wildlife closure around the Gyrfalcon nest site from May through mid-August to protect the nesting effort from human disturbance. Both closures were maintained for several weeks following fledging because the fledglings remained near their nests for several weeks after they fledged. The closure included the area surrounding the nest and the top of Eielson Bluff. Three nestlings successfully fledged from this nest in mid-July.

Abundance of Snowshoe Hare and Willow Ptarmigan

Numbers of snowshoe hare and Willow Ptarmigan observed per field day in 2007 were similar to numbers observed in 2006 (Figure 9). These counts suggests that these species were either reaching or were at the highest point of their 8- to 11 year cycles in 2007. Many park staff, shuttle and tour bus drivers, and local community members also noticed the high numbers of snowshoe hare in the area. Other biologists also recorded high numbers of snowshoe hare in other areas of interior Alaska (S. Dubois, ADFG, and J. Mason, Colorado State University, personal communications). New efforts to develop a long-term monitoring program for snowshoe hare in Denali (Maggie MacCluskie, NPS, personal communication) should be useful for monitoring the abundance of snowshoe hare in the future.

Noteworthy anecdotal observations during occupancy survey

Golden Eagles.

- I found several new Golden Eagle nest structures in historic nesting areas during the occupancy survey. Two of these nests were occupied by incubating Golden Eagles.

- For the first time in the 21-years of aerial surveys associated with this project, an adult Golden Eagle attacked the helicopter as we passed by its' occupied nest. The adult Golden Eagle was perched on top of a ridge approximately 200 meters above one of its' nest sites that contained an incubating Golden Eagle. As we passed slowly by the occupied nest, the perched adult left its' perch and dove directly at the helicopter. Within seconds, the eagle was approximately 20 meters in front of the helicopter. The pilot had already started to turn away from the nest cliff, and as we turned away, the eagle continued flying past the helicopter at a distance deemed "way too close" by the pilot and me. Luckily, we avoided a potentially dangerous mid-air collision between the eagle and the helicopter. The pilot and I agreed that this event might have been avoided if we had flown higher, rather than below, the perched eagle. In the future, we will avoid flying below eagles that are perched near their occupied nests.

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Other birds (listed chronologically).

- American Robin (*Turdus migratorius*), singing, Denali park headquarters, 23 April 2007.
- Townsend's Solitaire (*Myadestes townsendi*), singing, lower Big Creek, 24 April 2007.
- Dark-plumaged Red-tailed Hawk (*Buteo jamaicensis*), soaring, Big Creek, 25 April 2007.
- Varied Thrush (*Ixoreus naevius*), singing, Denali park headquarters, 25 April 2007.
- Dark-eyed Junco (*Junco hyemalis*), singing, Denali park airstrip, 26 April 2007.

Mammals.

- Adult Grizzly Bear walking directly below an occupied Golden Eagle nest on eastern side of Cathedral Mountain on 24 April 2007. As the bear walked beneath the nest, the adult Golden Eagle stood up and flew off the nest. The bear continued walking to the east, and the Golden Eagle returned to the nest and continued to incubate within 2 minutes of the bear's departure from the immediate area.

- Adult Grizzly Bear walking and napping on eastern side of Eielson Bluffs on 25 April 2007. Common Ravens (*Corvus corax*) were nesting in a small stick nest in the middle section of the bluff and Gyrfalcons were nesting in an old Common Raven nest on the western edge of the bluff. When the bear laid down, a Common Raven that was perched nearby flew up and landed about 5 meters from the dozing bear. The bear continued to doze as the Raven hopped around on the ground. The Raven remained perched by the sleeping bear when we departed the area.

Noteworthy anecdotal observations during June and July

Golden Eagles.

- Unusually high number of non-territorial subadult Golden Eagles in the study area from June through August this year, and many interactions between them and breeding adult Golden Eagles during July and August. Additionally, several adult and subadult Bald Eagles (*Haliaeetus leucocephalus*) in the study area in June and July 2007; these eagles apparently were hunting snowshoe hare.

- A large Golden Eagle stick nest in the upper East Fork of the Toklat River drainage was destroyed by a rockslide between the occupancy survey and productivity survey. The nest contained an incubating Golden Eagle during the occupancy survey, but resulted in failure apparently due to the rockslide destroying the nest. This nest was on loose talus slope and was very exposed to the elements. Despite its apparently precarious location, Golden Eagles had successfully raised fledglings in this nest several times between 1988 and 2006. There are at least two other Golden Eagle stick nests in this nesting area.

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Other birds.

- Two to three family groups of Northern Wheatears (*Oenanthe oenanthe*) south of the Denali park road near Stony Creek, 12 July 2007. In all groups, several fledglings were following and mobbing adults who were hunting and capturing caterpillars, moths, and butterflies.

- Small flock (4) of Bohemian Waxwings (*Bombycilla garrulous)* East Fork Research Cabin, 10 July 2007.

Mammals.

- Three adult Arctic Ground Squirrels eating Balsam Popular (*Populus balsamifera*) leaves next to East Fork Cabin, 13 July 2007. The ground squirrels were climbing Balsam Popular trees to eat fresh leaves. The squirrels climbed up to four meters high into the trees and out onto limbs to grab the newer leaves.

PRESENTATIONS, PAPERS AND OUTREACH ACTIVITIES

Peer-reviewed Papers

McIntyre, C.L., D.C. Douglas, and M.W. Collopy. 2008. Movements of Golden Eagles (*Aquila chrysaetos*) from interior Alaska during their first year of independence. Auk 125 (January 2008).

Presentations

McIntyre, C. L., D. C. Douglas, and M. W. Collopy. 2006. Migratory behavior and patterns of first-year Golden Eagles from central Alaska. North American Ornithological Conference, Vera Cruz, Mexico. October 2006.

McIntyre, C.L. Natural history of Golden Eagles in Alaska. Natural History of Alaska, University of Alaska-Fairbanks, November 2006.

McIntyre, C. L. 2007. Long-term Golden Eagle studies in Denali. NPS brown bag lunch seminar, Fairbanks, Alaska. March 2007.

McIntyre, C.L. Natural history of Golden Eagles. Denali Education Center, August 2007.

Murie Science and Learning Center Seminars

McIntyre, C.L. Ecology of birds of Denali. Field seminar, Murie Science and Learning Center, Denali Park, Alaska, June 2007.

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PLANS FOR 2008

Fieldwork. Occupancy and productivity surveys for Golden Eagles and Gyrfalcons will continue in Denali in 2008. We will also conduct fieldwork in late April 2008 to assess the probability of detecting an occupied nest. I also will resume feather collecting activities at a sample of occupied nests.

Data management, protocol update, data analysis, manuscripts, and presentations.

- *Data management*. Al Smith, data manager assistant with CAKN, and I made significant progress on completing the updated computerized database for this project in winter 2008, and I expect that the database will be completed in 2008.

- *Monitoring protocol*. I completed the final revisions to the CAKN Golden Eagle monitoring protocol in early 2008. I greatly appreciate the comments made by Dr. Bill Thompson, NPS Southwest Alaska Monitoring Network, and Susan Savage, wildlife biologist, US Fish and Wildlife Service, on the Golden Eagle monitoring protocol. Their comments greatly improved the protocol.

- *Photographic field guide to estimating age of nestlings*. I plan to complete a photographic field guide for estimating the age of nestlings during aerial surveys in 2008. Other biologists who have been conducting long-term Golden Eagles surveys using aerial surveys are reviewing a draft of this field guide. The field guide includes photographs of 10 age classes of nestling Golden Eagles, from several days after hatching until fledgling (10 weeks after hatching).

- *Data analysis.*

    - Data analysis plans include retrospective analysis of 20-year data set. This includes working with UAF biometricians to assess long-term trends using statistical program R and completing R-scripts to calculate routine annual summaries for monitoring metrics.

    - Dr. Julien Martin and Dr. Jim Nichols are using data from the Denali Golden Eagle monitoring project to assess patch-occupancy models to monitor Golden Eagles in Denali. I expect that this work will result in preparation of a manuscript.

- *Data sharing.*

    - Data on characteristics of Gyrfalcon nest sites were provided to Travis Booms, PhD candidate, University of Alaska-Fairbanks, for a statewide modeling project.

    - Data on distribution of Golden Eagle nesting areas in Denali were provided to the US Fish and Wildlife Service, Migratory Bird Management Office, and are being

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used to develop a population model for this species. The model is being developed to help assess the impact of harvesting Golden Eagles in the United States (D. Whittington, personal communications).

- *Manuscript preparation.* I am working on a manuscript "Spatial and temporal variation in Golden Eagle reproductive success in Alaska" with Brian McCaffery, US Fish and Wildlife Service. The manuscript includes analyses of the Denali data set as well as McCaffery's 14-year dataset from the Yukon River Delta National Wildlife Refuge.

- *Presentations.* I presented results of the Denali Golden Eagle monitoring project at the University of Alaska Fairbanks in November 2007 and at the Arctic Audubon's seminar series in January 2008. I expect to present results of the Golden Eagle monitoring project at the Alaska Bird Conference in March 2008, at the Murie Science and Learning Center and Denali Education Center in summer 2008, and the annual meetings of the Raptor Research Foundation in September 2008.

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LITERATURE CITED

Carrete, M., J.A. Sa´nchez-Zapata, J. L. Tella, J.M. Gil-Sa´nchez, and M. Moleo´n. 2006. Components of breeding performance in two competing species: habitat heterogeneity, individual quality and density-dependence. Oikos 112: 680-690.

Clum, N., and T. J. Cade. 1994. Gyrfalcon *(Falco rusticolus*). In The Birds of North America, No. 114, edited by A. Poole and F. Gill. The Birds of North America, Inc. Philadelphia.

Dixon, J.S. 1938. Fauna of the National Parks of the United States. Birds and mammals of Mt. McKinley National Park. Fauna Series No. 3. U.S. Government Printing Office. Washington, D.C.

Flamme, M.J., J. Burch, R.E. Ambrose, C. Florian, and N. Guldager. 2008. 2007 American Peregrine Falcon monitoring along the Upper Yukon River in Yukon-Charley Rivers National Preserve, Central Alaska Network. U.S. National Park Service Natural Resources Report NPS/YUCH/NRTR-2008/001/.

Kochert, M.N., and K. Steenhof. 2002. Golden eagles in the U.S. and Canada; status, trends, and conservation challenges. Journal of Raptor Research 36 (1 Supplement):32-40.

Kochert, M.N., K. Steenhof, C.L. McIntyre, and E.H. Craig. 2002. Golden Eagle *(Aquila chrysaetos*). In The Birds of North America, No. 684, edited by A. Poole and F. Gill. The Birds of North America, Inc. Philadelphia.

DRAFT

Ligori, J. 2004. How to age Golden Eagles. Techniques for birds observed in flight. Birding 32(2): 278-283.

MacCluskie, M., and K. Oakley. 2005. Vital Signs Monitoring Plan, Central Alaska Network, Vital Signs Monitoring Plan. August 2005. Unpublished report. U.S. National Park Service. Fairbanks, Alaska.

McIntyre, C.L. 2002. Patterns in nesting area occupancy and reproductive success of Golden Eagles (*Aquila chrysaetos*) in Denali National Park and Preserve, Alaska, 1988-99. Journal of Raptor Research 36 (1 Supplement): 50-54.

McIntyre, C.L., and L.G. Adams. 1999. Reproductive characteristics of migratory Golden Eagles in Denali National Park, Alaska. Condor 101:115-123.

McIntyre, C.L., and M.W. Collopy. 2006. The post-fledging dependence period of migratory Golden Eagles (*Aquila chrysaetos*) in Denali National Park and Preserve, Alaska. Auk 123:877-884.

McIntyre, C.L., M.W. Collopy, and M.S. Lindberg. 2006a. Survival probability and mortality of migratory juvenile Golden Eagles from interior Alaska. Journal of Wildlife Management 70:717-722.

McIntyre, C.L., M.W. Collopy, J. Kidd, A. Stickney, and J. Paynter. 2006b. Characteristics of the landscape surrounding Golden Eagle nest sites in Denali National Park and Preserve, Alaska. Journal of Raptor Research 40: 46-51.

McIntyre, C.L., K. Steenhof, M.N. Kochert, and M.W. Collopy. 2006c. Long-term studies of Golden Eagle ecology, Denali National Park and Preserve, Alaska. Alaska Park Science, Volume 5, Issue 1:42-45.

Murie, A. 1944. The wolves of Mt. McKinley. Mt. McKinley Natural History Association, McKinley Park, Alaska.

Murie, A. 1963. Birds of Mount McKinley National Park, Alaska Natural History Association, McKinley Park, Alaska.

Sergio, F., and I. Newton. 2003. Occupancy as a measure of territory quality. Journal of Animal Ecology 72: 857-865.

Steenhof, K. 1987. Assessing raptor reproductive success and productivity, p. 157-170. *In* B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird, [EDS.]. Raptor Management Techniques Manual. Scientific Technical Series No. 10. National Wildlife Federation. Washington, D.C.

Steenhof, K., and M.N. Kochert. 1982. An evaluation of methods used to estimate raptor nesting success. Journal of Wildlife Management 46:885-893.

DRAFT

Swem, T., C.L. McIntyre, R.J. Ritchie, P.J. Bente, and D.G. Roseneau. 1994. Distribution, abundance, and notes on the breeding biology of Gyrfalcons (*Falco rusticolus*) in Alaska, p. 437-444. *In* B-U. Meyburg and R.D. Chancellor, [EDS.]. Raptor Conservation Today, Proceedings of IV World Conference on Birds of Prey and Owls, Berlin, Germany.

Watson, J. 1997. The Golden Eagle. T& AD Poyser, London, United Kingdom.

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Table 1. Summary of Golden Eagle nesting area occupancy and reproductive success, Denali National Park and Preserve, Alaska, 1988 to 2007. Data are collected using two annual aerial surveys; the occupancy survey is conducted in late April to assess occupancy and nesting activities and the productivity survey is conducted in mid- to late July to assess nesting success and fledgling production.

Year	Nesting areas surveyed	Nesting areas occupied	Nesting pairs	Successful pairs	Fledglings
1988	69	60	45	35	50
1989	69	58	51	43	70
1990	73	58	47	34	53
1991	76	62	43	37	56
1992	83	69	39	18	25
1993	85	69	30	20	28
1994[a]	66	56	20	9	11
1995[a]	66	55	27	19	25
1996[a]	69	62	27	24	30
1997	82	69	48	35	58
1998	83	66	35	22	33
1999	83	72	54	42	69
2000	84	70	53	34	49
2001	81	67	43	22	29
2002	83	73	10	4	4
2003	84	71	25	13	19
2004	82	73	32	16	20
2005	86	76	42	28	38
2006	89	81	64	52	79
2007	89	81	59	46	72

[a] I decreased the study area size in 1994, 1995, and 1996 following recommendations of two U.S. Fish and Wildlife Service raptor biologists who suggested that it would be more cost-efficient to limit my surveys to a smaller study area. This recommendation proved to be poor for several reasons, and I resumed surveys in the entire study area in 1997.

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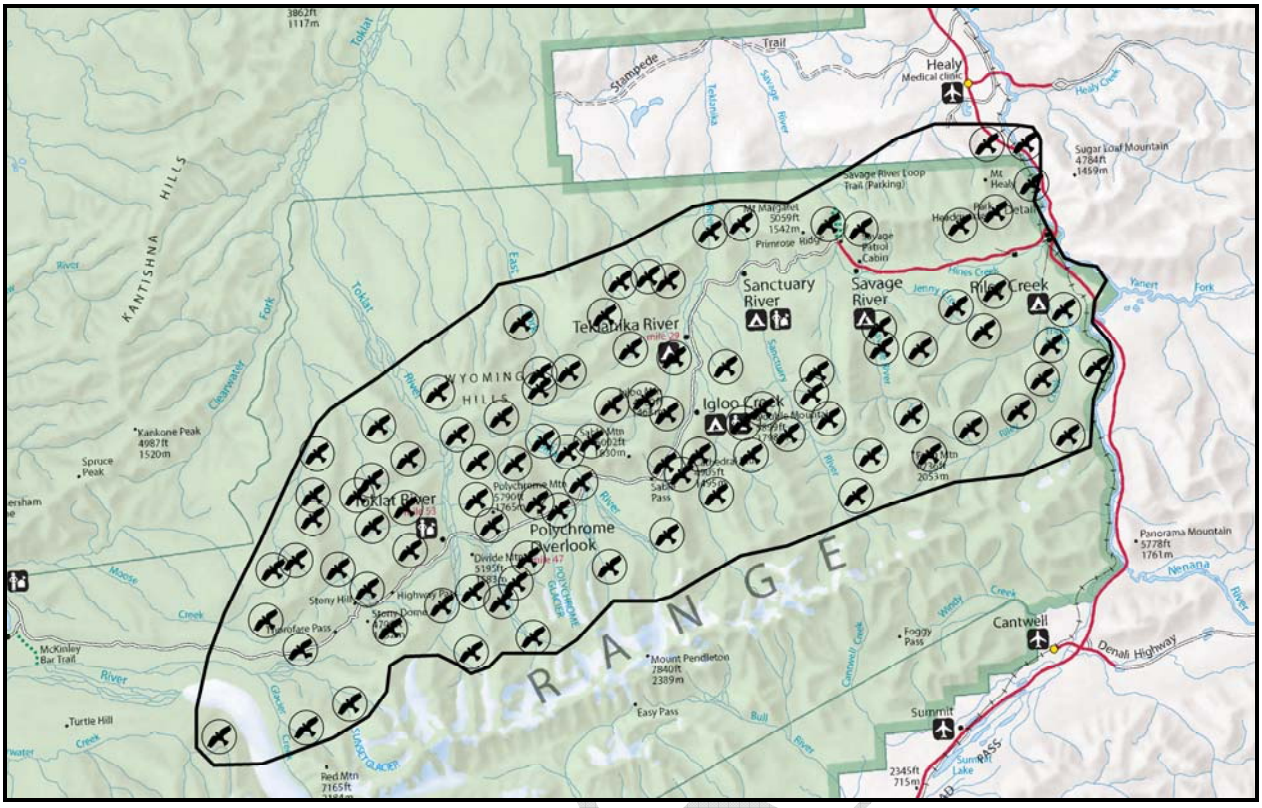

Figure 1. General location of Golden Eagle monitoring project study area (within the solid black line) in the northeastern corner of Denali National Park and Preserve, Alaska (shown as shaded on the map). The eagle symbols within the open circles show the approximate distribution of Golden Eagle nesting areas within the study area. The study area is approximately 2,100 km^2.

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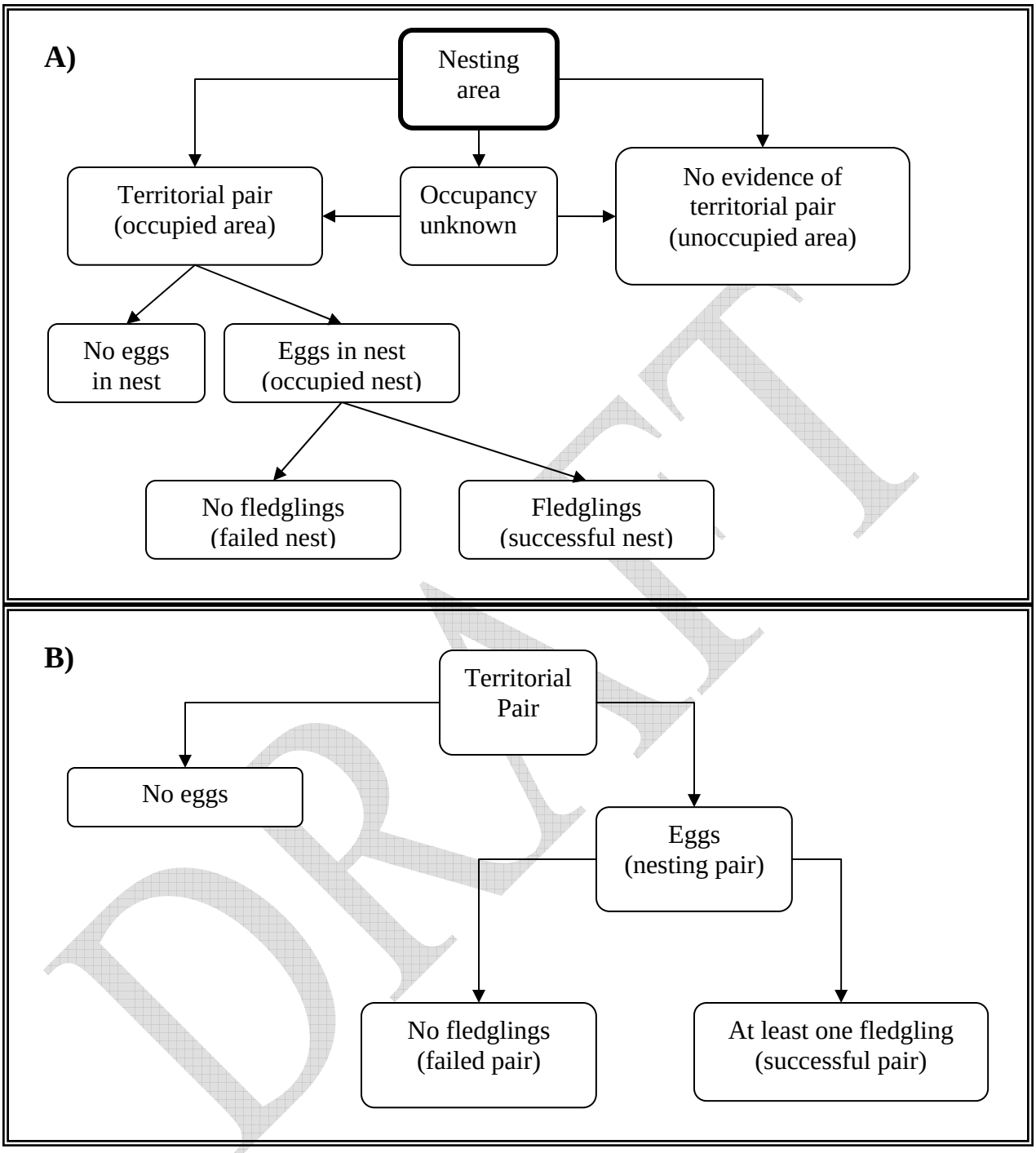

Figure 2. Decision tree for assessing occupancy of nesting areas and breeding success of Golden Eagles in Denali National Park and Preserve, Alaska. Chart A refers to the nesting area and nest structure and Chart B refers to the pair of Golden Eagles or Gyrfalcons.

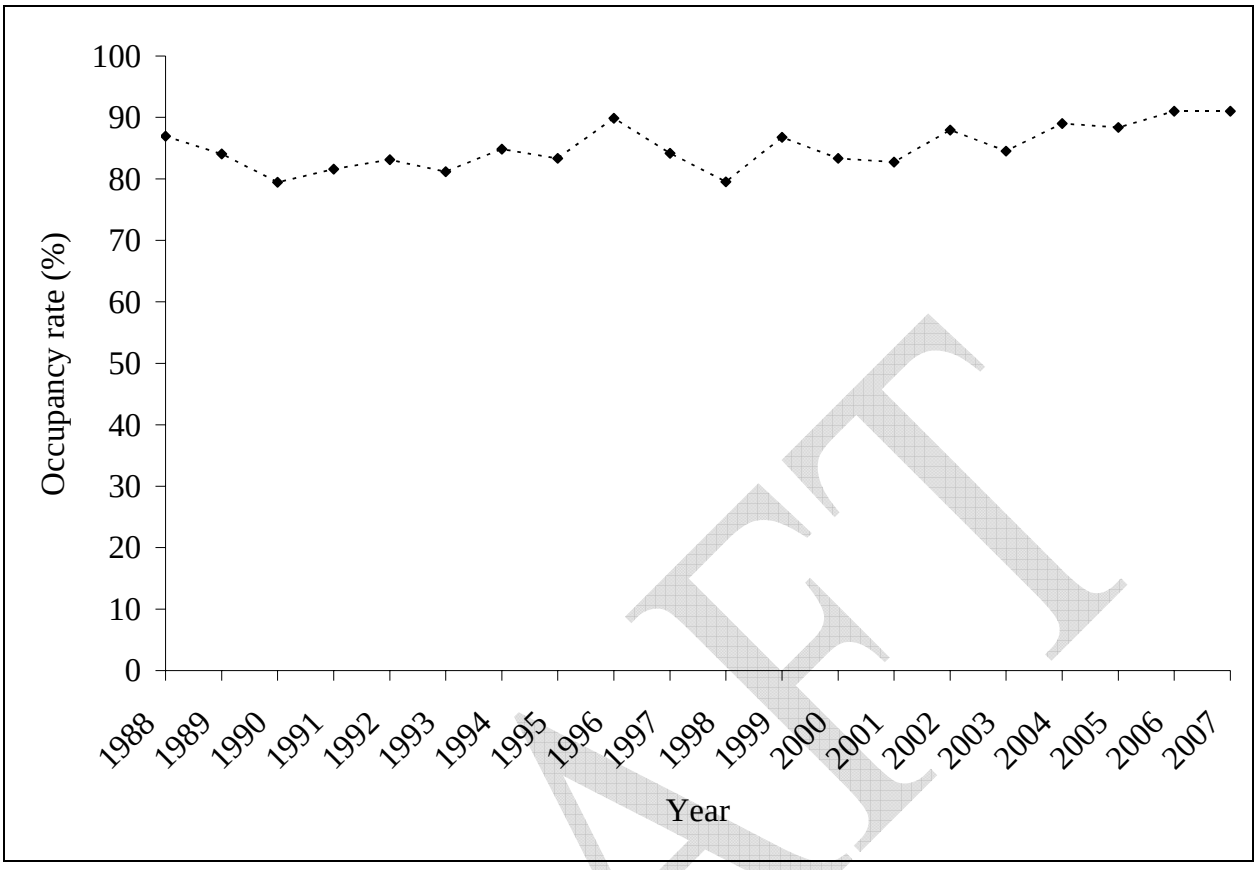

Figure 3. Summary of annual Golden Eagle nesting area occupancy, Denali National Park and Preserve, Alaska, 1988 to 2007. Nesting area occupancy is calculated as the percent of Golden Eagle nesting areas surveyed in a given year that contain a territorial pair.

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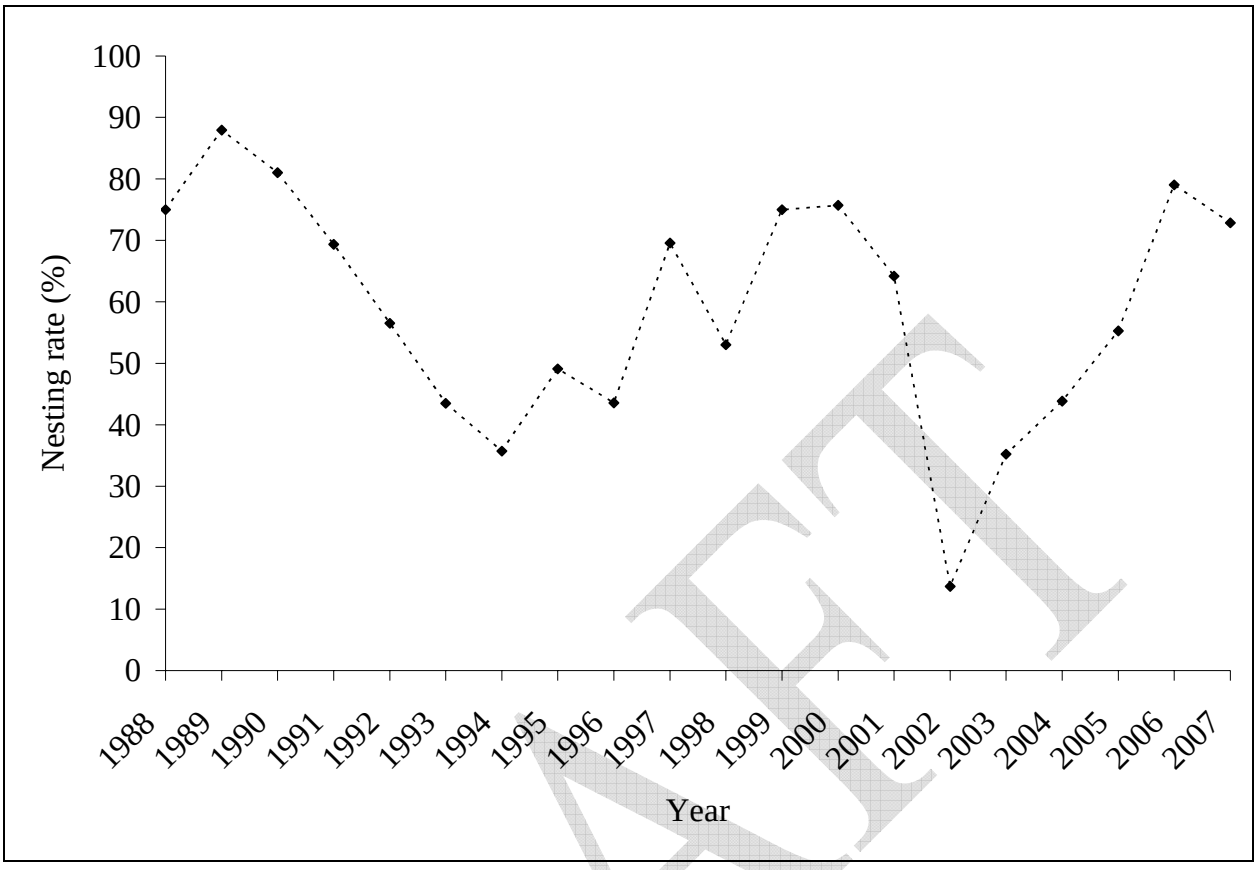

Figure 4. Summary of annual Golden Eagle nesting rate, Denali National Park and Preserve, Alaska, 1988 to 2007. Nesting rate is calculated as the percentage of occupied nesting areas that contain nesting pairs (a pair that produced a clutch of eggs).

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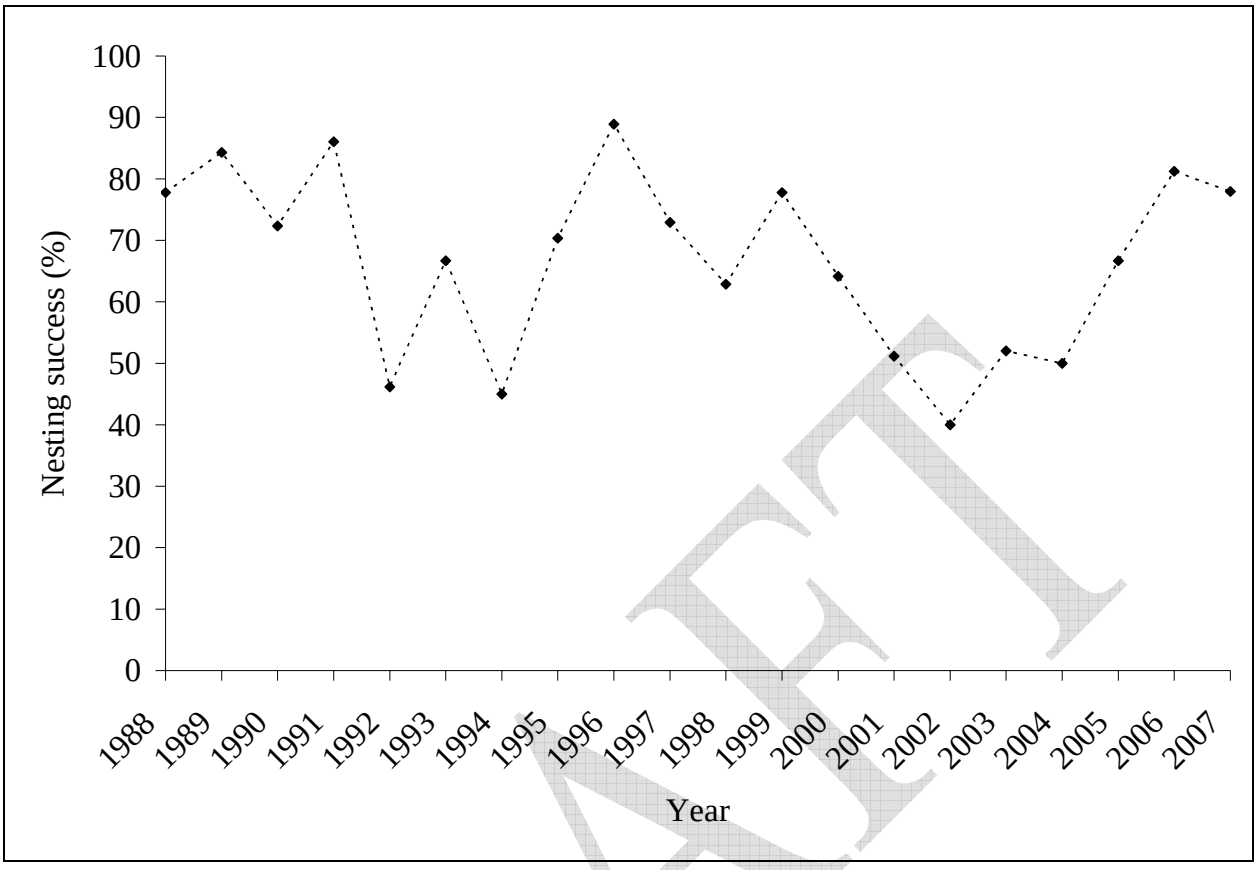

Figure 5. Summary of annual Golden Eagle nesting success, Denali National Park and Preserve, Alaska, 1988 to 2007. Nesting success is calculated as the number of successful pairs per occupied nesting area (or territorial pair).

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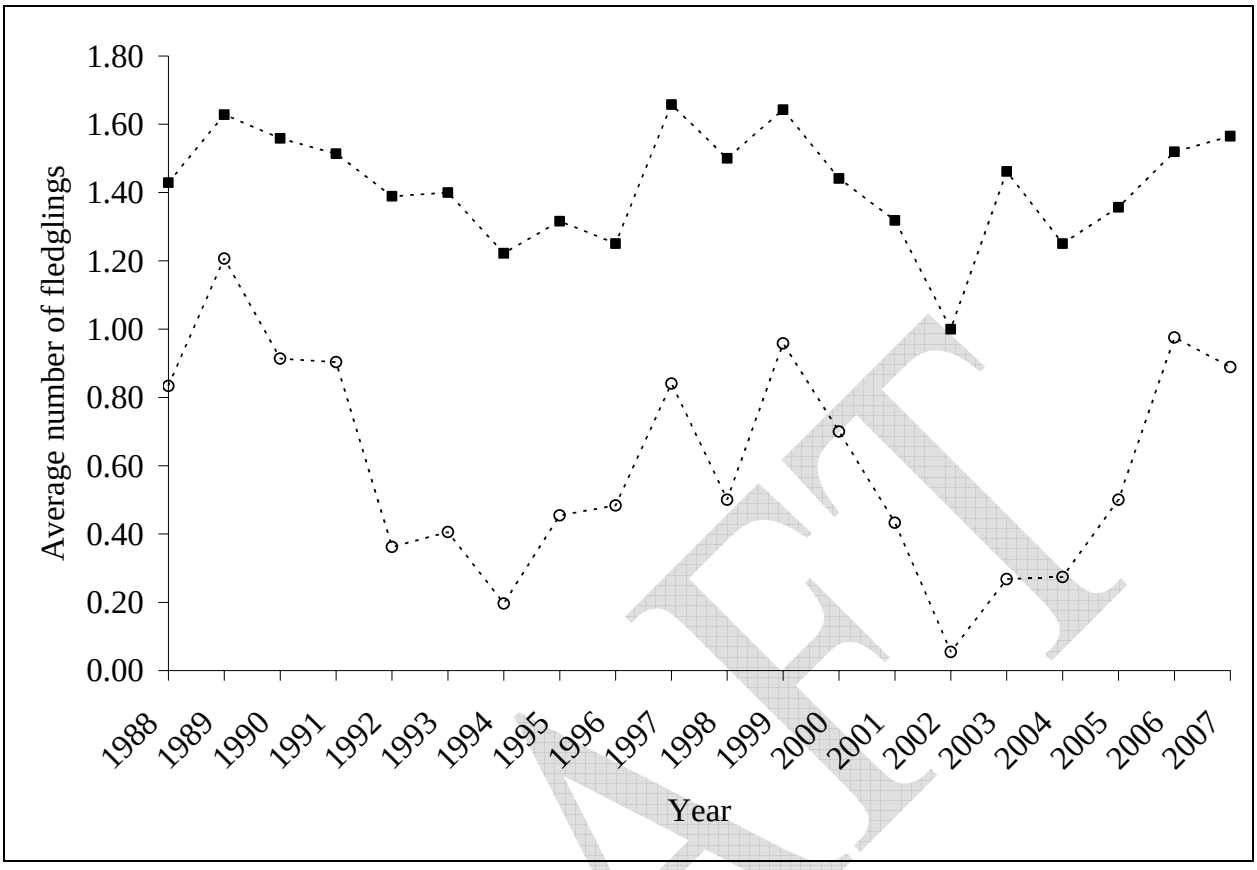

Figure 6. Summary of annual Golden Eagle fledgling production, Denali National Park and Preserve, Alaska, 1988 to 2007. Overall population productivity (bottom line with open circles) is calculated as the number of fledglings produced per occupied nesting area (or territorial pair). Mean brood size (top line with solid squares) is calculated as the number of fledglings produced per successful nest (or successful pair).

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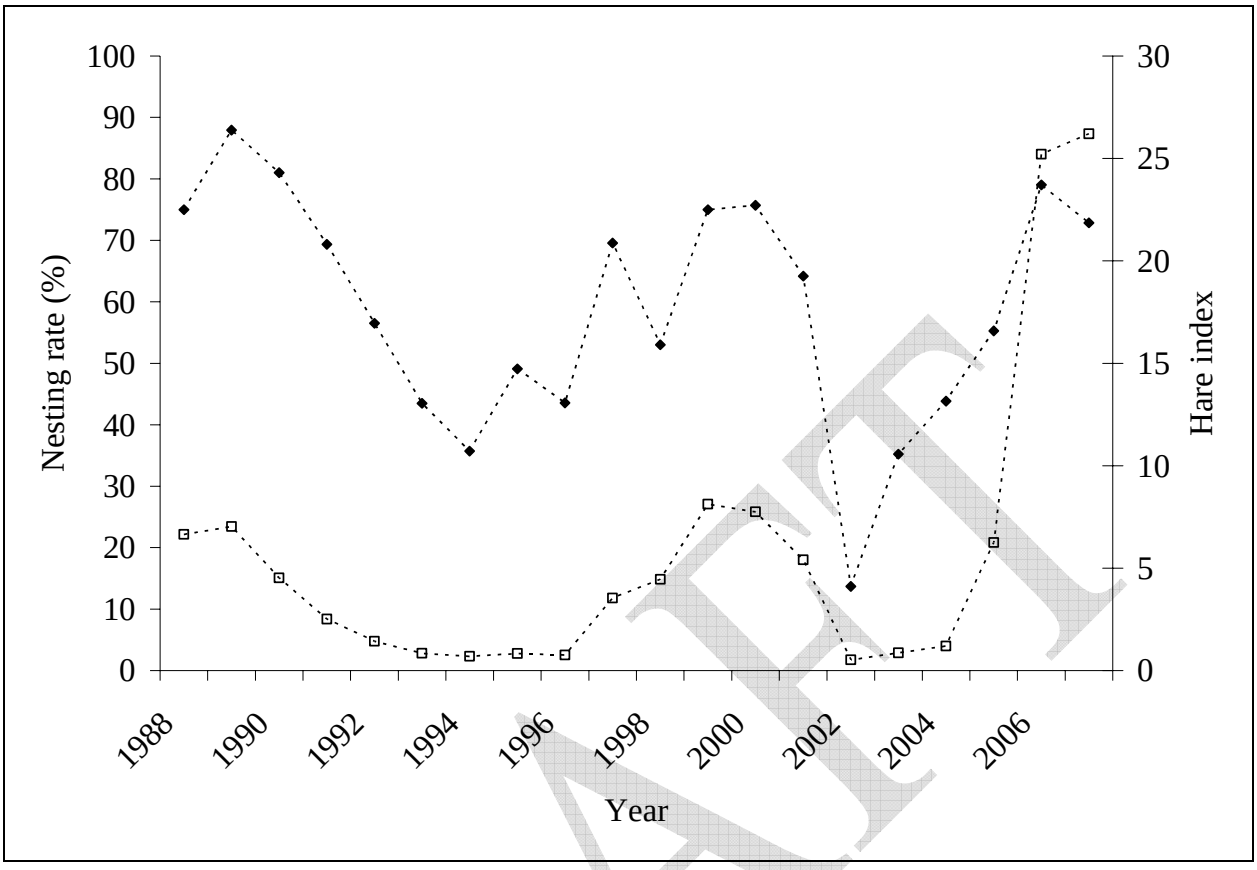

Figure 7. Annual nesting rate (%) of Golden Eagles (dashed line with solid diamonds) in relation to annual hare index (dashed line with open squares), Denali National Park and Preserve, Alaska, 1987 to 2007.

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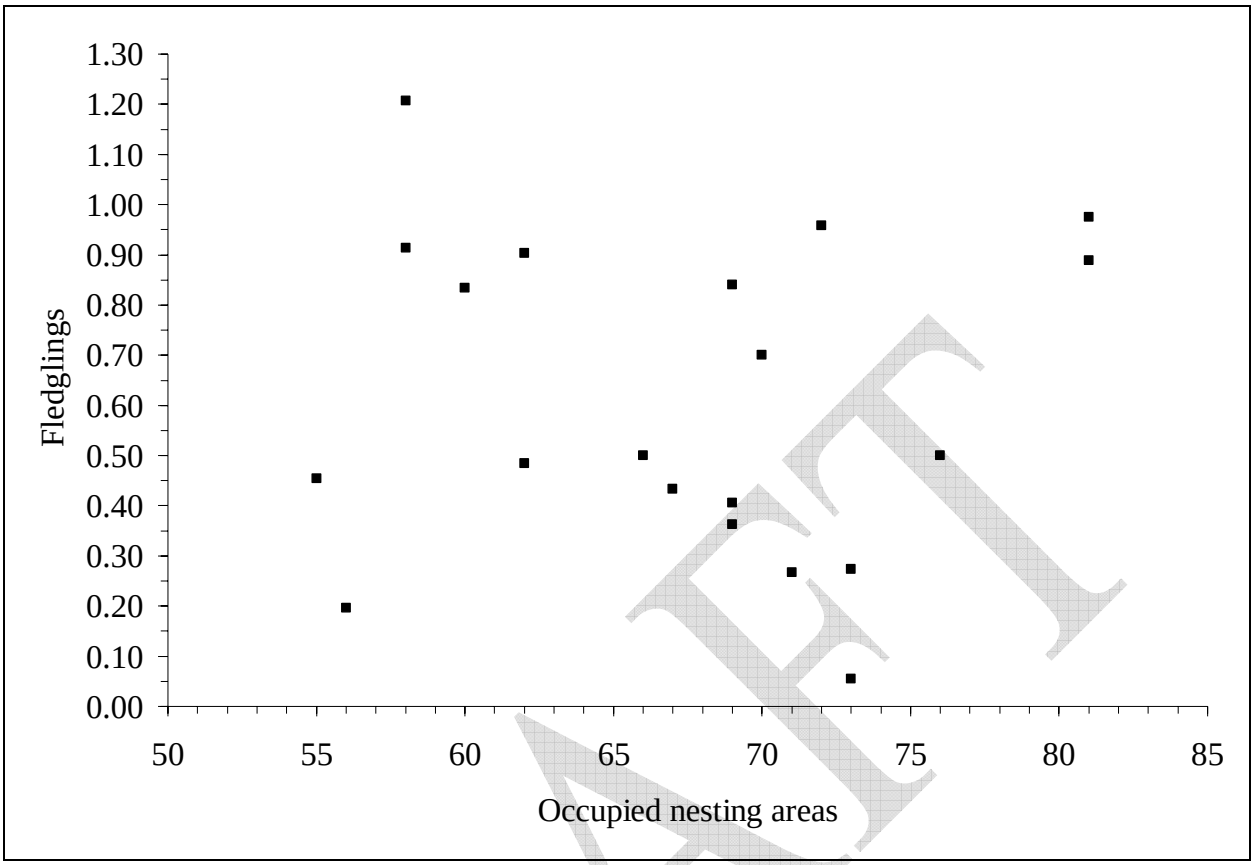

Figure 8. Golden Eagle productivity (fledglings per occupied nesting area) plotted against number of occupied Golden Eagle nesting areas, Denali National Park and Preserve, Alaska, 1988 to 2007.

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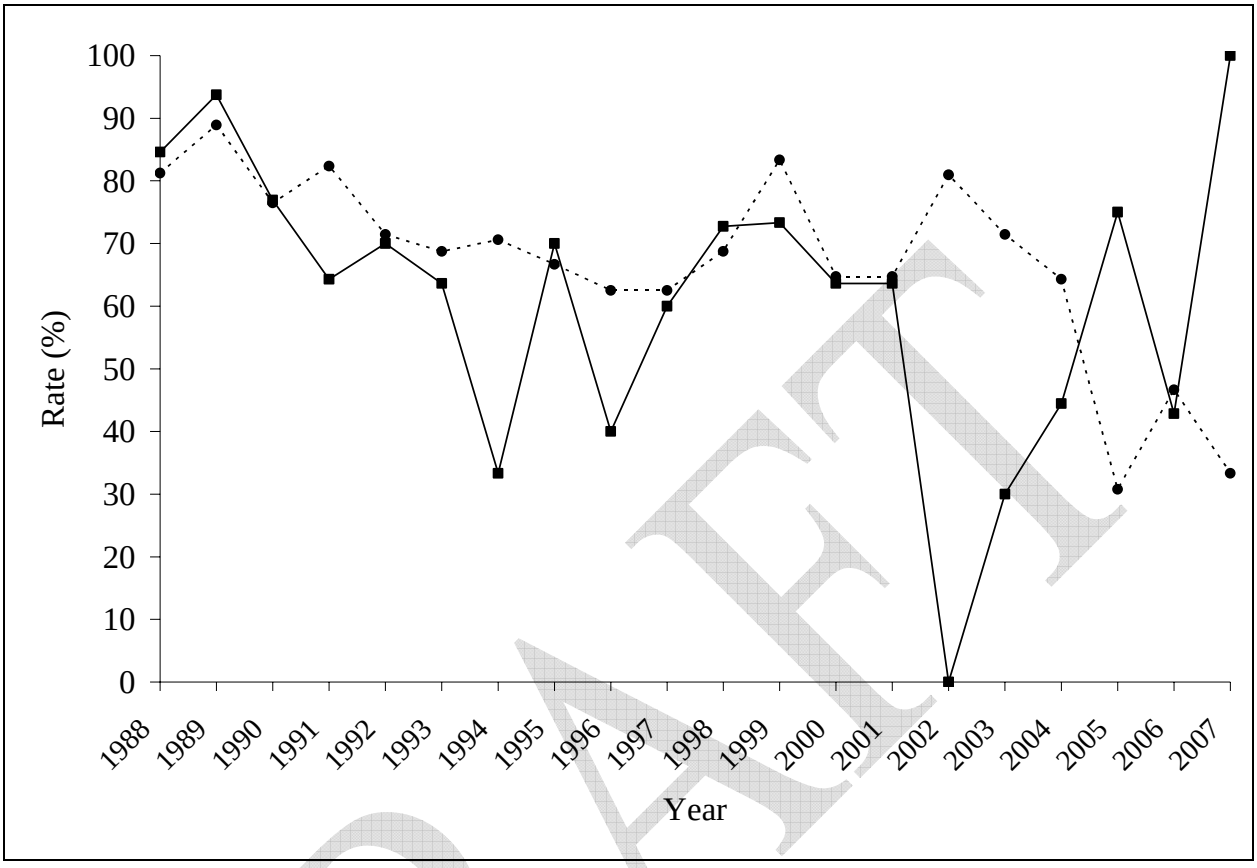

Figure 9. Annual Gyrfalcon nesting area occupancy (dashed line with solid circles) and success rate (solid line with solid squares), Denali National Park and Preserve, Alaska, 1988 to 2007. Nesting area occupancy is calculated as the number of occupied nesting areas per nesting areas surveyed. Success rate is calculated as the number of successful nesting pairs per territorial pair.

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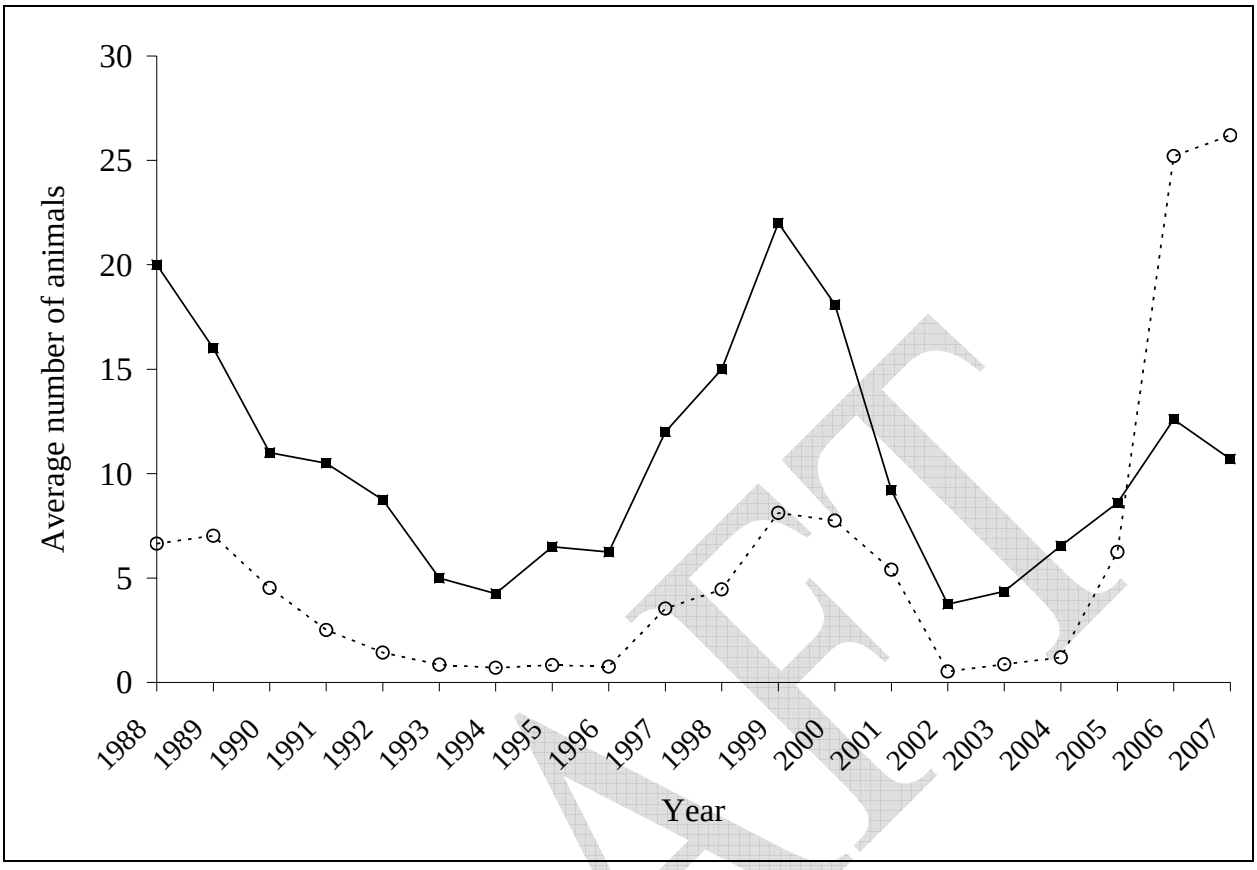

Figure 9. Annual abundance indices of snowshoe hare (dashed line with open circles) and Willow Ptarmigan (solid line with solid squares), Denali National Park and Preserve, Alaska, 1988 to 2007.

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Appendix A. Terminology used in Denali Golden Eagle and Gyrfalcon monitoring studies (following Steenhof 1987).

TABLE A-1. Terms used to describe nests and nesting areas.

Term	Definition
Nest	An individual nest structure or scrape.
Occupied nest	A nest occupied by a nesting pair.
Nesting area	A group of nests belonging to a pair of Golden Eagles or Gyrfalcons in a given year.
Surveyed nesting area	A nesting area surveyed in a given year.
Occupied nesting area	A nesting area occupied by a territorial pair of Golden Eagles or Gyrfalcons in a given year
Unoccupied nesting area	A nesting area not occupied by a territorial pair of Golden Eagles or Gyrfalcons in a given year. Observations must be made for $\geq$ 2 consecutive hours at a nesting area before categorizing it as unoccupied.
Occupancy unknown	A surveyed nesting area where occupancy could not documented in a given year
Occupied-breeding	A nesting area occupied by a pair that produced eggs (nesting pair).
Occupied-breeding successful	A nesting area occupied by a successful pair.
Occupied-breeding failure	A nesting area occupied by an unsuccessful pair.

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TABLE A-2. Terms used to describe Golden Eagles or Gyrfalcons.

Term	Description
Adult eagle	Golden Eagle with full adult plumage (Ligori 2004)
Subadult eagle	Golden Eagle with subadult plumage (Ligori 2004).
Juvenile eagle	Golden Eagle with juvenile (1st year) plumage (Ligori 2004).
Territorial pair	A pair of Golden Eagles or Gyrfalcons that defend a nesting area in a given year. Evidence of a territorial pair includes breeding and/or territorial behavior including incubation, eggs in a nest, nest refurbishment, and copulation.
Nesting pair	A territorial pair of Golden Eagles or Gyrfalcons that produced a clutch of eggs. Evidence of breeding includes incubating bird, eggs, nestlings, or any other indication that eggs were laid (e.g., fresh eggshell fragments in nest).
Nestling	A Golden Eagle <51 days of age and a Gyrfalcon <36 days old.
Fledgling	A Golden Eagle nestling that is ≥51 days old (80% of its age at fledging) or a Gyrfalcon nestling that is ≥36 days old. Steenhof and Kochert (1982) suggested this standard because most nestlings are large enough to count at this stage and mortality after this age is usually minimal.
Successful pair	A nesting pair of Golden Eagles or Gyrfalcons that successfully raises ≥one fledgling in a given year.
Unsuccessful pair	A nesting pair of Golden Eagles or Gyrfalcons that did not raise ≥one fledgling in a given year.

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