

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

**2006 Progress Report**

**Central Alaska Network, Vital Signs Monitoring Program**



Six-week-old Golden Eagle nestling. Photo by Carol McIntyre

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## SUMMARY

I monitored the occupancy of nesting areas 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 2006. In 2006, occupancy of Golden Eagle nesting areas (85.3%) was similar to other years, laying rate (93.7%) and fledging production (n = 75) were the highest recorded in the study, and success rate (83.3%) was the second highest recorded in the study. Daily counts of snowshoe hare (*Lepus americanus*) and Willow Ptarmigan (*Lagopus lagopus*) were the highest recorded in the study and indicated that populations of these cyclic vertebrates were reaching the peak of their 8 to 11 year cycles. I noted an unusually high number of non-territorial subadult Golden Eagles in the study area from June through August this year, and observed many interactions between them and breeding adult Golden Eagles during July and August. Subadult Golden Eagles, as well as adult and subadult Bald Eagles (*Haliaeetus leucocephalus*), were noted in the study area in June and July hunting snowshoe hare. During Golden Eagle surveys, I also collected data on nesting area occupancy and reproductive success of Gyrfalcons (*Falco rusticolus*). In 2006, occupancy of Gyrfalcon nesting areas (46.7%) and success rate (42.8%) were lower than most years. Other notable observations of raptors and owls in and near the study area in 2006 included: (1) 18 nesting pairs of Great-horned Owls (*Bubo virginianus*), including 1 successful pair in a cliff-nest historically used by Golden Eagles; 2) discovery of 3 previously undocumented occupied Peregrine Falcon (*Falco peregrinus*) nesting areas; and 3) frequent observations of Northern Harriers (*Circus cyaneus*) and Short-eared Owls (*Asio flammeus*). Additionally, we incidentally found 12 Northern Harrier and 4 Short-eared Owl nests during our routine fieldwork in 2006

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

## INTRODUCTION

Golden Eagles (*Aquila chrysaetos*) are large, diurnal raptors that nest 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 occupancy of nesting areas and reproductive success of Golden Eagles in Denali (McIntyre and Adams 1999, 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 are top-trophic level predators that respond quickly to changes in their environment. 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. The Denali Golden Eagle monitoring program and ensuing research projects have made substantial contributions to the 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 (>20 pairs), long-term (>15 years) data set for this species in North America, collected in the Snake River Birds of Prey National Conservation Area (McIntyre et al. 2006c).

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. Gyrfalcons nest in relatively high densities in Denali (Swem et al. 1994) and they often use Golden Eagle nest structures for their own nesting attempts.

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

This progress report summarizes results of our monitoring activities for Golden Eagles and Gyrfalcons in Denali in 2006 and highlights some of the project's achievements.

## STUDY AREA

The study area was the northern foothills of the Alaska Range in northeastern Denali in central Alaska (63° 36'N, 149° 39'W). The 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). The survey area was bounded on the east by the Nenana River, on the south by the crest of the Alaska Range, on the west by the Muldrow Glacier and Boundary Creek, and on the north by the northern foothills of the Alaska Range (also known as the Outer Range) (Figure 1). Rugged, mountainous terrain interspersed by broad glacial valleys

and upland areas characterized the 2,100 km<sup>2</sup> survey area (Figures 1 and 2). Elevations ranged from 427 m in the lowlands and river bottoms to 1,372 m along the foothill summits.

## METHODS

### Terminology

I used terminology recommended by Steenhof (1987) to describe occupancy of nesting areas and reproductive success (Appendix A) (Figure 3). Steenhof (1987) suggested that studies measure productivity based on the territorial population. Because many studies of Golden Eagle reproductive success do not include this measurement, I calculated three measurements of annual productivity to compare our results with other Golden Eagle studies in North America: 1) fledglings per territorial pair, 2) fledglings per laying pair, and 3) fledglings per successful pair.

### Surveys

I used two aerial surveys to determine nesting area occupancy and reproductive success of Golden Eagles and Gyrfalcons in Denali in 2006. I conducted the first aerial survey (occupancy survey) after completion of most clutches, before most nest failures occurred, and before eggs hatched. The objectives of the occupancy survey were to document occupancy and breeding 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.* A week before the start of the survey, I reviewed the database and prepared a comprehensive map (1:250,000 topographic map) of the survey area with the locations of all known Golden Eagle and Gyrfalcon nests in the study area. I used this map to navigate and to record my observations during the aerial surveys.

I conducted the occupancy survey over four days between 24 April and 28 April 2006 from a Robinson R-44 helicopter (Quicksilver Air, Fairbanks, Alaska). Surveys started at approximately 7:30 am and ended at approximately 6:30 pm. I used 10 x 40 binoculars during all aerial surveys.

As we approached each known nesting area, I instructed the pilot to slow down 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 (Figure 4). During nest observations, the pilot flew the helicopter as slow as possible and often hovered. As soon as I detected evidence of occupation, I recorded my observations on the survey map, and we continued on to the next area. In cases where I detected an incubating eagle before we approached within 300 meters of the nest, I quickly instructed the pilot to leave the area and proceed 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 afternoon turbulence built up. During the return visits, I instructed the pilot to fly slowly in front of cliffs and rock outcroppings as I looked for previously undiscovered or new nests. If I could

not determine occupancy from the air during the return visit, I instructed the pilot to land at a nearby vantage point and made observations from the ground. If I could not determine occupancy after two hours of ground observations, I defined the area as “occupancy unknown” and revisited the area later in the nesting season to determine occupancy.

*Productivity survey.* I conducted the productivity survey on 21 July 2006 from a Hughes 500 helicopter (Temsco Helicopters, Juneau, Alaska). (NOTE: I used the park-based helicopter for this survey because no Robinson R-44 helicopters were available). Several days before the survey, I reviewed the survey map that I used during the occupancy survey. I used this map to navigate and to record my observations during the productivity 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.

*Ground-based observations.* I observed occupied Golden Eagle and Gyrfalcons nests located within view of the Parks Highway and the Denali park road throughout the nesting season to calibrate estimates of nesting phenology. I used 10 x 40 binoculars and a 20-60x power spotting scope during observations.

*Nest visits.* As part of a collaborative project with Sandy Talbot, Molecular Genetics Lab, U.S. Geological Survey (USGS), Alaska Science Center, I am collecting shed feathers at a sample of nest sites to extract DNA and to identify individual eagles and monitor their fidelity to nesting areas. Poor weather during late June and early July prohibited us from collecting feathers in 2006. Feather collections will continue in 2007.

*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 on my survey map.

*Documenting age structure of territorial population.* I recorded the age (adult or subadult) of all Golden Eagles observed during surveys following Ligori (2004); however, I did not intentionally flush incubating Golden Eagles off their nests.

*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 saw during routine fieldwork from 15 April through 30 June 2006. I used the number of individuals observed per field day per year to calculate an index of their abundance (McIntyre and Adams 1999). I calculated this index to examine 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. During the occupancy survey, I recorded locations of grizzly bears (*Ursus arctos*) and locations and numbers of Dall sheep (*Ovis dalli dalli*). I made specific observations of groups of Dall sheep ewes to determine if lambs were present. (Although lambing usually occurs after the occupancy surveys, I documented early lambing in May 2004.)

## **Data summaries**

I calculated rates of nesting area occupancy, laying, and success, and estimated overall population productivity, fledglings per occupied nest, and mean brood size for Golden Eagles in

2006. I calculated nesting area occupancy and success rate for Gyrfalcons in 2006. Appendix A contains definitions of metrics used to monitor nesting area occupancy and reproductive success.

## RESULTS AND DISCUSSION

### Survey effort

I monitored 56 to 82 Golden Eagle nesting areas in the study area from 1988 to 2006, and 75 nesting areas in 2006 (Table 1). I monitored 13 to 18 Gyrfalcon nesting areas in the study area from 1988 to 2006; I monitored 15 Gyrfalcon nesting areas in 2006. Note that I observed Gyrfalcon nesting areas opportunistically during the Golden Eagle surveys because there are not sufficient funds available through CAKN to observe all Gyrfalcon nesting areas in the area. I will continue to monitor as many Gyrfalcon nesting areas as possible with the current level of funding.

Weather conditions during the first, third, and fourth days of the occupancy survey were favorable for surveys and observations. Weather conditions on the second day of the occupancy survey were poor (winds >30 mph, snow squalls, and extreme turbulence) and no surveys were conducted on this day. Thunderstorms, rain and wind during the period when we scheduled nest visits prevented us from visiting occupied nests in 2006. Weather during the productivity survey was favorable for surveys and observations.

### Golden Eagles

*Nesting area occupancy and reproductive success.* I detected 64 territorial pairs of Golden Eagles in 2006 (Table 1). Of these, 60 pairs (93.7%) produced eggs. I documented egg production by observing 60 incubating eagles. I documented 50 successful nests and 75 fledglings. Golden Eagle nesting area occupancy in 2006 was similar to most other years (Figure 5), but laying rate and success rate (Figure 5), and all three measures of productivity were higher than in most years of the study (Figure 6).

As expected, Golden Eagle reproduction in Denali in 2006 was higher than the last several years, apparently due to the increasing abundance of snowshoe hare. Similar to many other northern predators, breeding Golden Eagles in Denali respond to changes in snowshoe hare abundance and more eagles laid eggs (Figure 7) and raised more fledglings in years when the snowshoe hares were abundant.

I cannot compare Golden Eagle reproductive success measured in Denali in 2006 with estimates of reproductive success of that species elsewhere in Alaska because no other surveys for this species were conducted in 2006.

*Nesting phenology.* Nesting phenology in 2006 was similar to other years; 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 74 adult and 12 subadult Golden Eagles during the productivity survey. I could not determine the age of all territorial Golden Eagles in the study 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.

A territorial Gyrfalcon was harassing the lone subadult Golden Eagle observed during the occupancy survey close to Marmot Rock near the Polychrome rest area. The subadult Golden Eagle did not appear to be associated with an occupied nesting territory.

The lack of subadult Golden Eagles in the study area during the early part of the nesting season 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 suggests that non-breeding subadults visit the study area, but most likely, they are not part of the territorial population. In 2006, 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.* No incubating Golden Eagles flushed off their nest during the occupancy survey in 2006. From 1988 to 2006, 5 of 691 (0.0072) incubating Golden Eagles observed during the occupancy survey flushed off of their nest when we approached with a helicopter; however, all of the Golden Eagles that flushed eventually returned to their nests and successfully raised fledglings. 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.

*Management activities.* One occupied Golden Eagle nest was within 100 meters of the Denali park road at the southern end of Igloo Canyon. A subadult female and an adult male rebuilt this nest in 2005, but did not use it for a nesting attempt that year. The immediate area around the nest was easily accessible by anyone capable of hiking up the steep slope near the nest. I observed an incubating adult Golden Eagle on the nest during the 2006 occupancy survey and monitored the nest from a nearby hillside after the nestlings hatched during early June. Although the nest is relatively close to the Denali park road, I decided not to request a temporary wildlife closure at the site unless it was necessary to prevent disturbance. In late June 2006, the Denali wildlife technicians observed a park visitor carrying a tripod and camera with a large lens along the Denali park road near the nesting area. The visitor relayed information to the wildlife technicians that a Golden Eagle was nesting on a nearby hillside. The wildlife technicians immediately alerted me that at least one visitor knew about the nest; hence, I requested that they implement a temporary wildlife closure to prevent disturbance at this nest. The wildlife technicians eliminated the closure in mid-August after the fledglings left the nest and immediate area. An adult male and adult female occupied the nest in 2006 and successfully raised three nestlings.

## **Gyrfalcons**

Gyrfalcon nesting area occupancy in 2006 was lower than all other years of the study (Figure 8). Success rate was high (Figure 8), but the sample size of successful nests was low ( $n = 3$ ). The apparent decline in the occupancy rate of Gyrfalcons in Denali between 1988 and 2006 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.

Many tour and shuttle bus drivers inquired about the empty nest sites on Marmot Rock in 2006 and assumed that Gyrfalcons were not nesting in the area. Gyrfalcons nested successfully in the Marmot Rock nesting area in 2006, but they used a nest originally constructed by Common Ravens (*Corvus corax*) below the Polychrome Rest Stop, not the nests on Marmot Rock. The 2006 nest site was not visible from the Denali park road.

### **Snowshoe hare and Willow Ptarmigan abundance**

Counts of snowshoe hare and Willow Ptarmigan indicated that the abundance of both species increased from 2005 to 2006 (Figure 9). I observed more snowshoe hare in the study area in 2006 than in any other year of the study (Figure 9). Many park staff, shuttle and tour bus drivers, and local community members noticed the high numbers of snowshoe hare in the area. Other biologists also recorded an increase in the abundance 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 response of Golden Eagles to changes in this important prey resource in the future.

### **Noteworthy observations**

*Golden Eagles.* We noted an unusually high number of non-territorial subadult Golden Eagles in the study area from June through August this year, and observed many interactions between them and breeding adult Golden Eagles during July and August. In several cases, I witnessed an adult Golden Eagle hit a subadult in midair and drive it to the ground. Further, Jeff Wells, at least one tour bus driver, and I observed a wing-tagged subadult Golden Eagle in the Igloo Creek and Sable Pass region in late June and early August. Researchers working on an autumn migration project tagged this eagle in Montana between 2002 and 2005 (D. Bittner, personal communications). Additionally, we observed several adult and subadult Bald Eagles (*Haliaeetus leucocephalus*) in the study area in June and July 2006; these eagles apparently were hunting snowshoe hare.

*Other raptors.* Other notable observations of raptors and owls in and near the study area in 2006 included at least 18 nesting pairs of Great-horned Owls (*Bubo virginianus*), including one successful pair in a cliff-nest historically used by Golden Eagles, discovery of three previously undocumented occupied Peregrine Falcon (*Falco peregrinus*) nesting areas, and frequent observations of Northern Harriers (*Circus cyaneus*) and Short-eared Owls (*Asio flammeus*). Additionally, we found 12 Northern Harrier and 4 Short-eared Owl nests incidental to other fieldwork in 2006; in comparison, we found two or three Northern Harrier nests and rarely found Short-eared Owl nests annually in the past 19 years.

## **PRESENTATIONS, PAPERS AND OUTREACH ACTIVITIES**

### **Peer-reviewed Papers**

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. 2006. 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. 2006. Characteristics of the landscape surrounding Golden Eagle nest sites in Denali National Park and Preserve, Alaska. *Journal of Raptor Research* 40: 46-51.

### **Scientific manuscripts in review**

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

### **Articles in non-peer reviewed publications**

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

### **Presentations**

McIntyre, C.L., M.W. Collopy, and M.S. Lindberg. Survival of migratory juvenile Golden Eagles from interior Alaska. Raptor Research Foundation annual meetings, Green Bay, Wisconsin, October 13, 2005.

McIntyre, C.L. Studies of migratory Golden Eagles in Denali National Park and Preserve, Alaska. Visiting Scientist Seminar, Acopian Center for Conservation, Hawk Mountain Sanctuary, Kempton, Pennsylvania, October 17, 2005.

McIntyre, C.L. Natural history of Golden Eagles in Alaska. Natural History of Alaska, University of Alaska-Fairbanks, November 30, 2005.

McIntyre, C.L. Birds of the Boreal Seminar: Raptors of interior Alaska. Alaska Bird Observatory, April 2006.

McIntyre, C.L. Long-term monitoring of Golden Eagles in Denali. Central Alaska Monitoring Network semiannual meeting, Glennallen, Alaska, 3 May 2006.

McIntyre, C.L. Across western North America with Denali's Golden Eagles. Alaska Museum of Art and History, Anchorage, Alaska, May 14, 2006.

McIntyre, C.L. Natural history of Golden Eagles. Osher Lifelong Learning Institute, September 22, 2006.

McIntyre, C.L., M.W. Collopy, and M.S. Lindberg. Survival probability of migratory juvenile Golden Eagles from Denali National Park. The Wildlife Society annual meetings, Anchorage, Alaska, September 23-27, 2006.

## **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 23-25.

## **ACKNOWLEDGMENTS**

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Table 1. Data collected during two annual aerial surveys on Golden Eagle nesting area occupancy and reproductive success, Denali National Park and Preserve, Alaska, 1988 to 2006.

<b>Year</b>	<b>Nesting areas surveyed</b>	<b>Nesting areas occupied</b>	<b>Laying pairs</b>	<b>Successful pairs</b>	<b>Fledglings</b>
1988	56	47	37	28	38
1989	66	50	45	35	58
1990	66	46	38	28	47
1991	66	51	35	29	43
1992	70	57	36	19	26
1993	68	55	25	17	23
1994	68	58	19	8	9
1995	68	59	27	19	25
1996	72	62	26	23	30
1997	72	63	45	33	54
1998	70	62	34	21	31
1999	76	71	55	43	71
2000	80	72	54	35	50
2001	80	70	45	25	31
2002	73	65	10	4	4
2003	77	66	29	13	15
2004	82	71	30	17	19
2005	77	67	41	29	40
2006	75	64	60	50	75

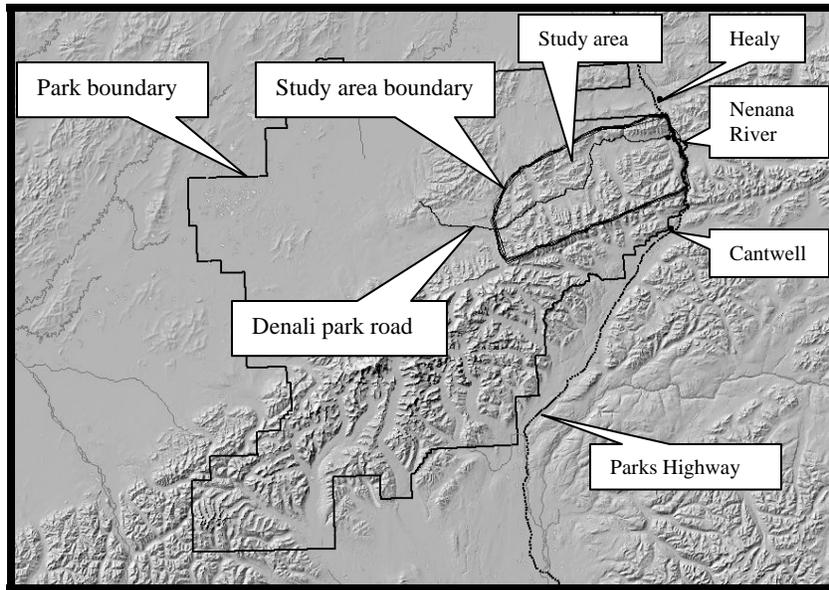


FIGURE 1. General location of study area for Golden Eagle monitoring project, Denali National Park and Preserve, Alaska. The study area is approximately 2,100 km<sup>2</sup>.



FIGURE 2. Golden Eagle nesting and foraging habitat, Denali National Park and Preserve, Alaska. Looking north towards the Wyoming Hills along the west side of the East Fork Toklat River, 24 April 2006. Note snow free conditions on south-facing slopes. Photograph by Carol McIntyre.

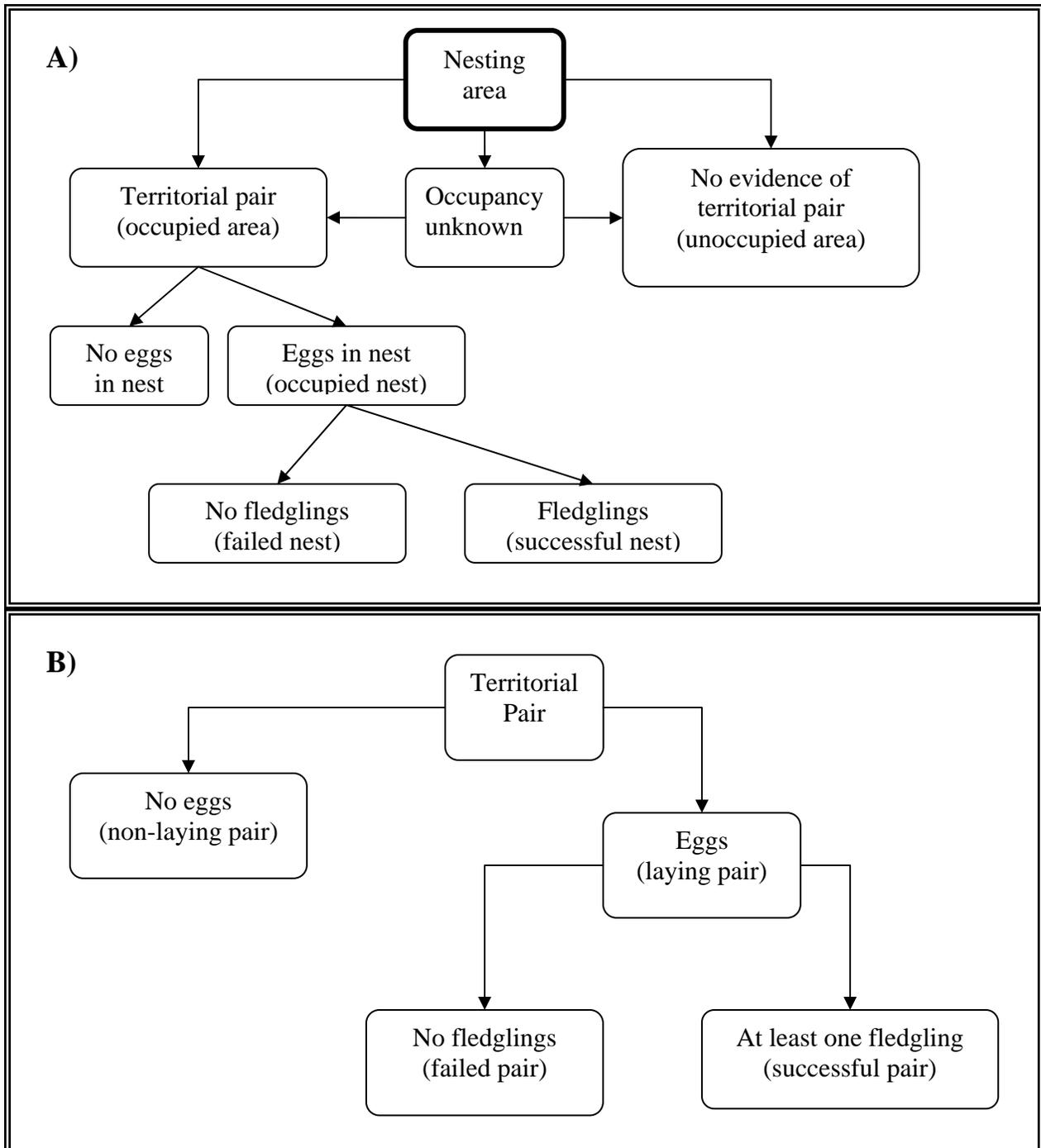


FIGURE 3. Decision-making process for determining occupancy of nesting areas and breeding success. Chart A refers to the nesting area and nest structure and Chart B refers to the pair of Golden Eagles or Gyrfalcons.



FIGURE 4. Snow-covered cliff with Golden Eagle stick nest (above) and close-up of incubating Golden Eagle on snow-covered stick nest (below), upper Savage River, 24 April 2006, Denali National Park and Preserve, Alaska. Photographs by Carol McIntyre.

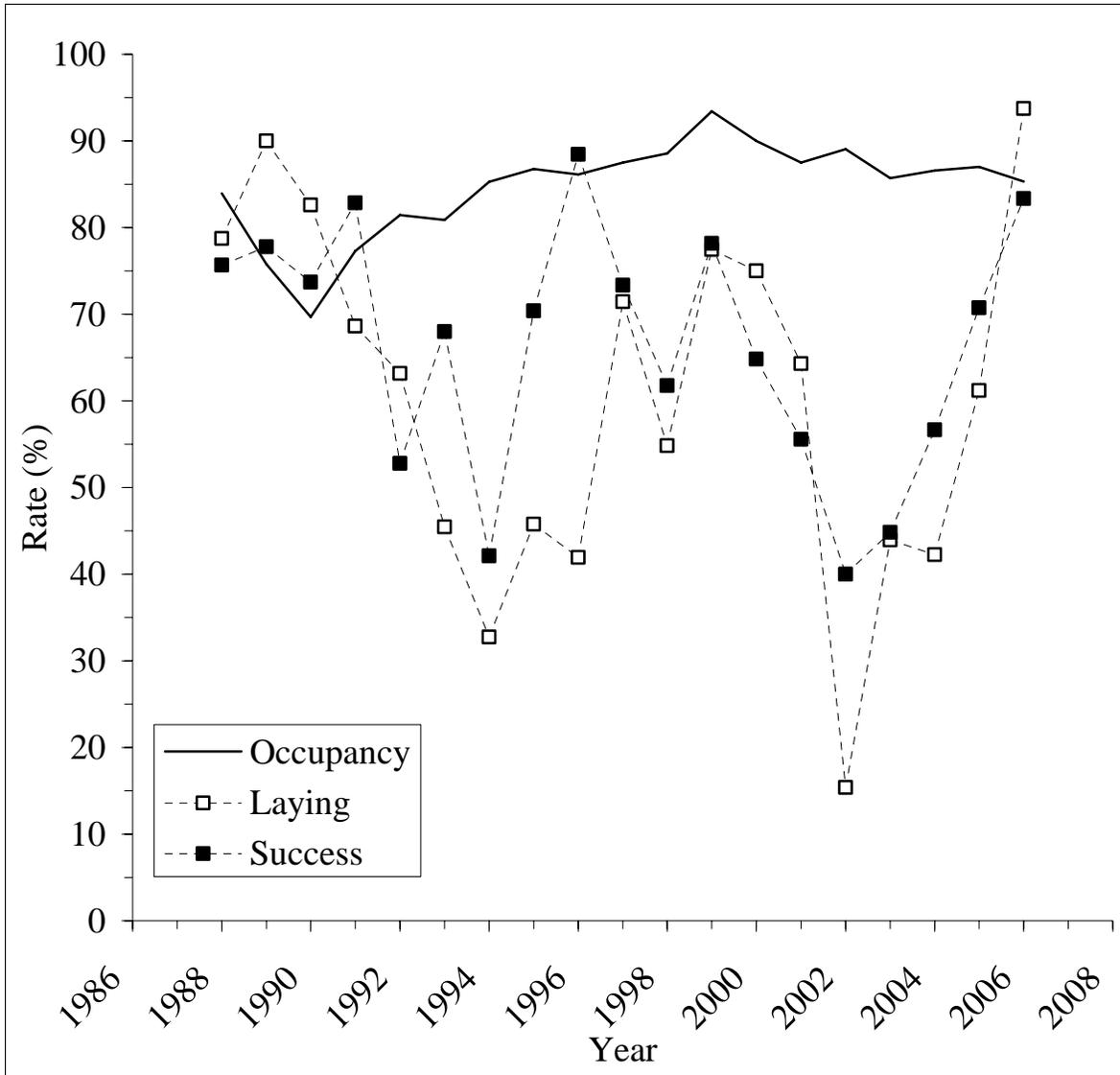


FIGURE 5. Annual Golden Eagle nesting area occupancy rate, laying rate, and success rate, Denali National Park and Preserve, Alaska, 1988 to 2006.

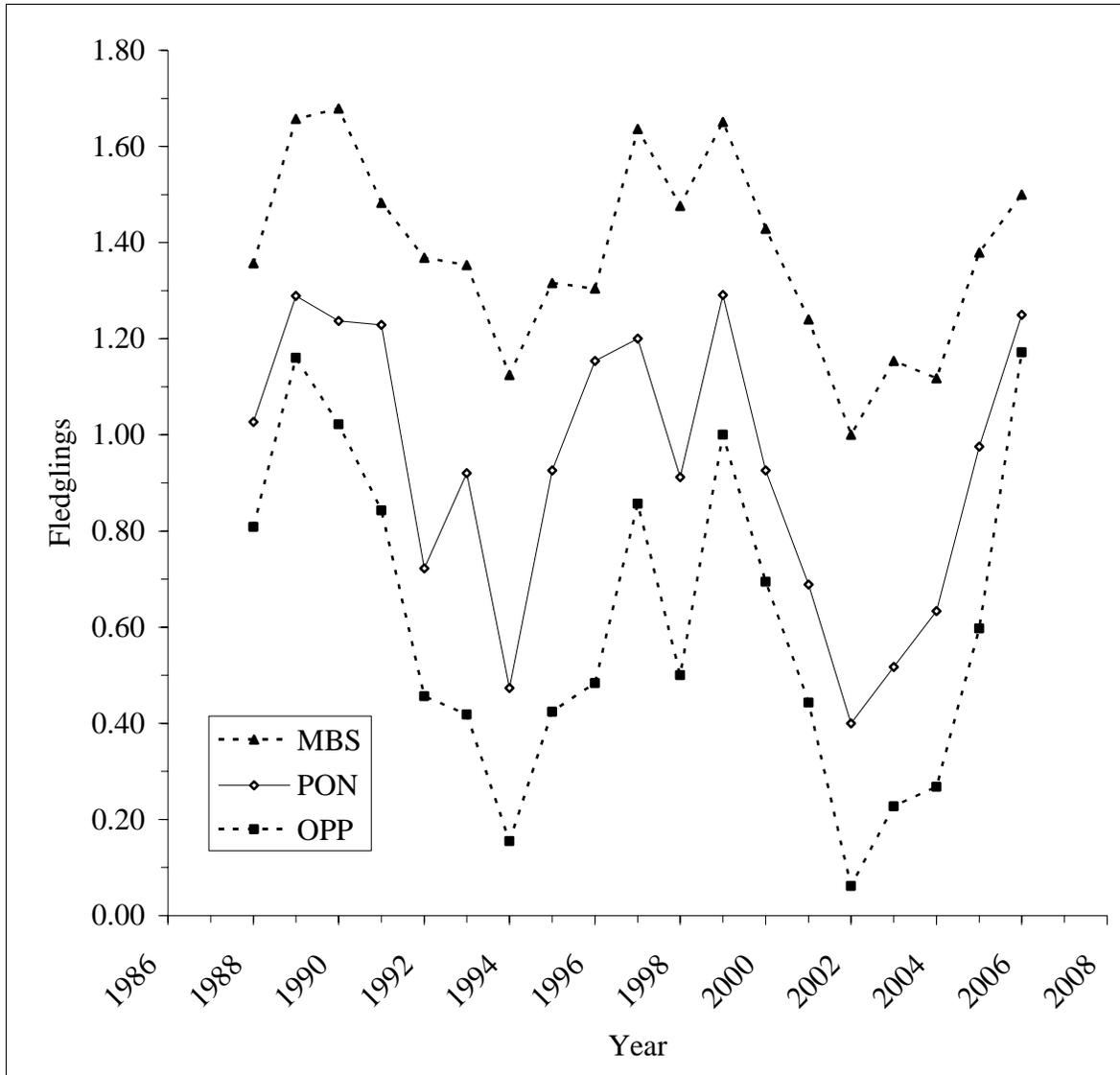


FIGURE 6. Annual measurements of Golden Eagle productivity, Denali National Park and Preserve, Alaska, 1988 to 2006. Overall productivity (OPP) is the number of fledglings produced per occupied nesting area, productivity per occupied nest (PON) is the number of fledglings produced per laying pair, and mean brood size (MBS) is the number of fledglings produced per successful nest.

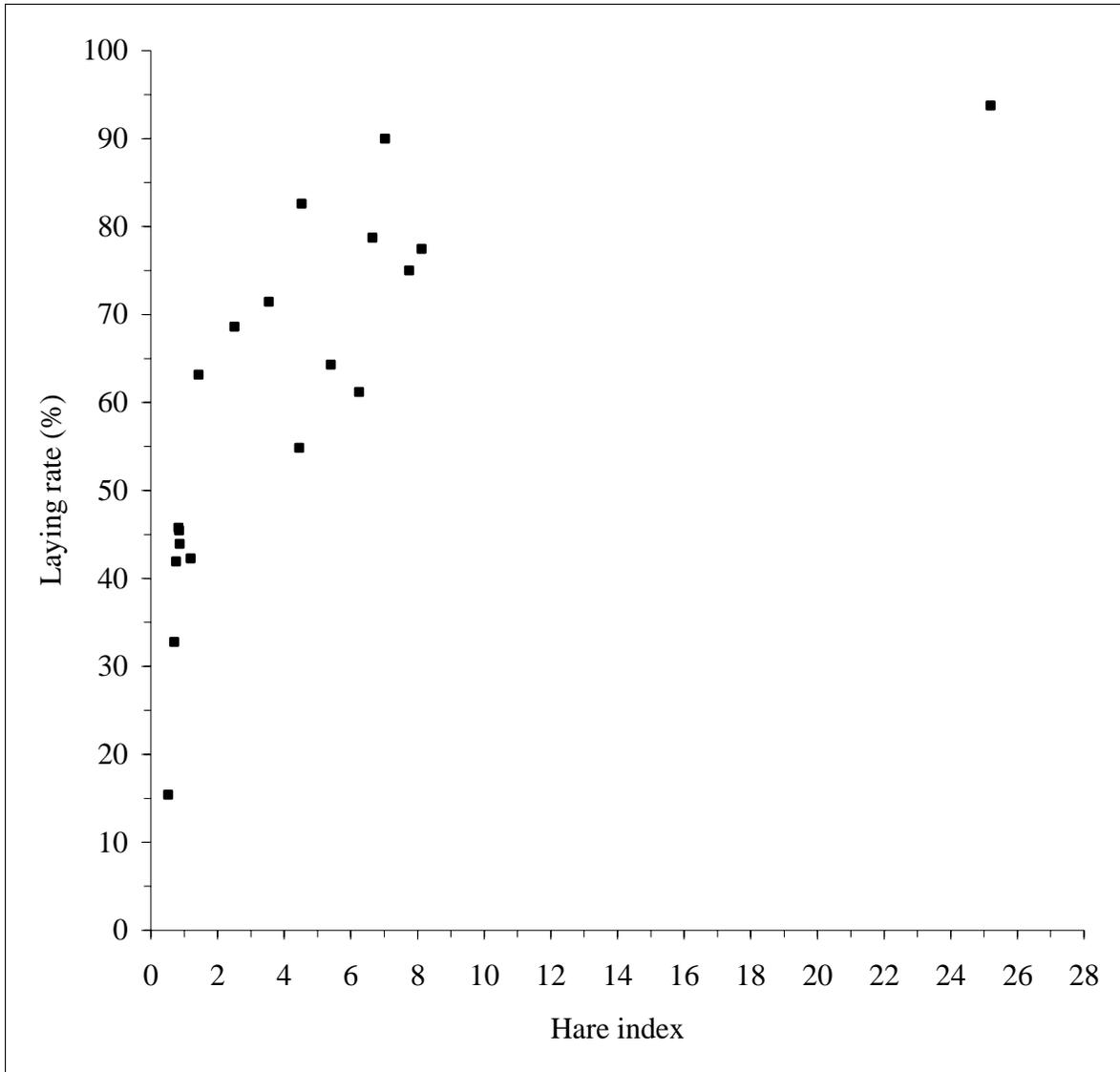


FIGURE 7. Annual Golden Eagle laying rate (percentage of territorial pairs with eggs) in relation to the number of snowshoe hares detected each field day, Denali National Park and Preserve, Alaska, 1988 to 2006. The point in the upper right corner of the graph represents 2006.

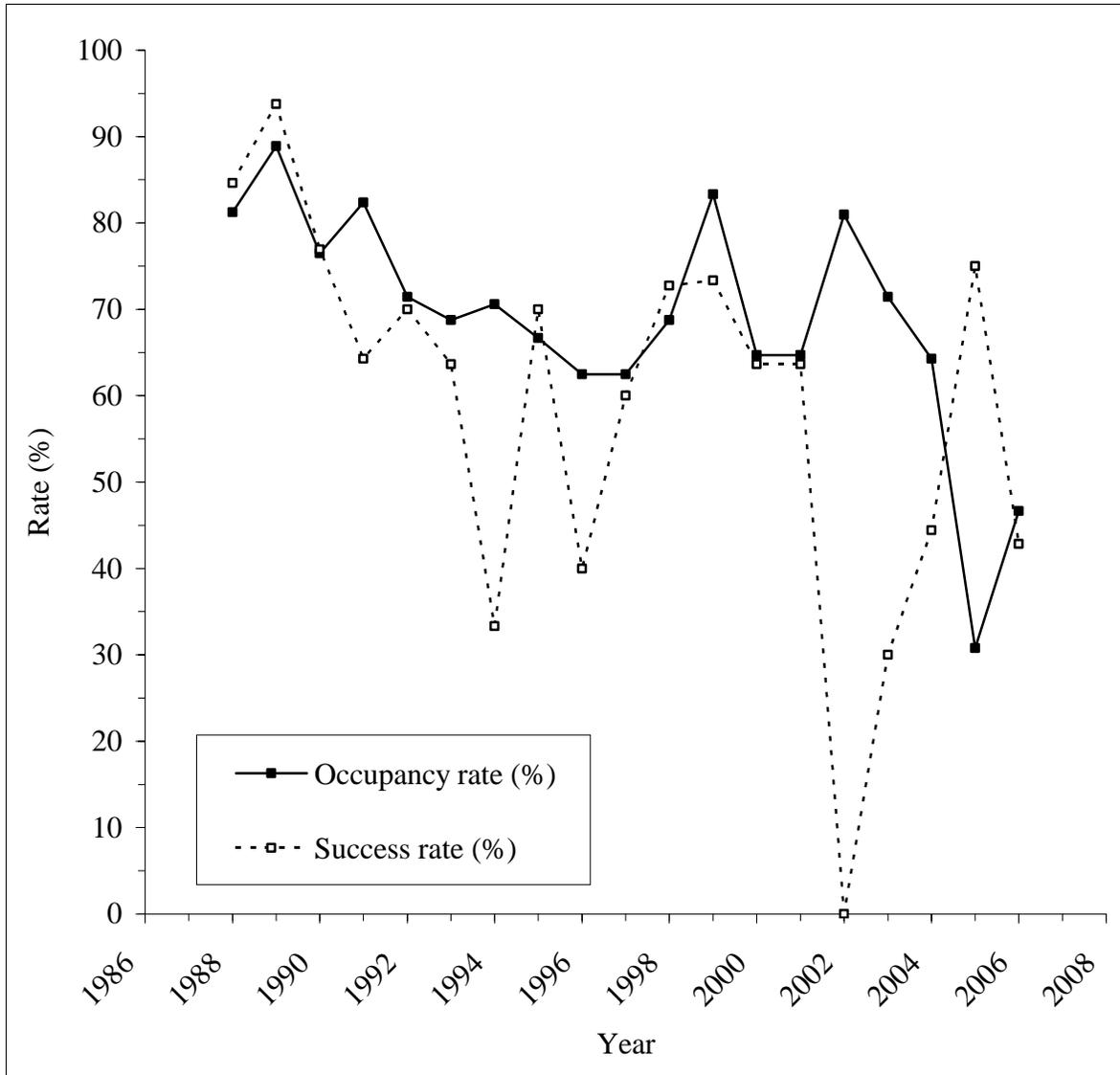


FIGURE 8. Annual nesting area occupancy and success rate (%) of Gyrfalcons, Denali National Park and Preserve, Alaska, 1988 to 2006.

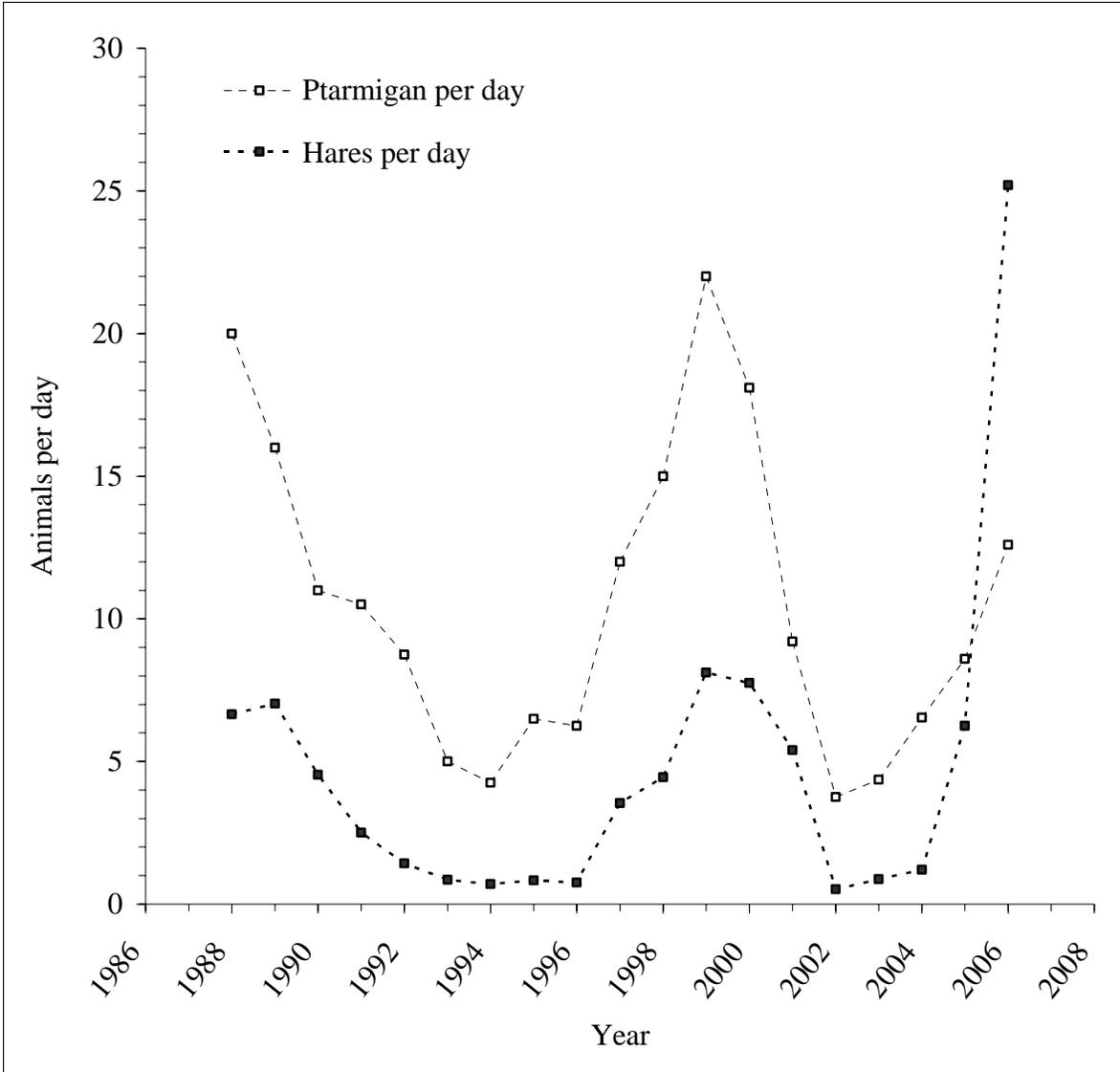


FIGURE 9. Annual abundance indices of snowshoe hare and Willow Ptarmigan, Denali National Park and Preserve, Alaska, 1988 to 2006.

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

TABLE A-1. TERMS TO DESCRIBE NESTS AND NESTING AREAS.

Term	Definition
Nest	An individual nest structure or scrape.
Occupied nest	A nest occupied by a laying 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 $\geq$ two consecutive hours at a nesting area before categorizing it as unoccupied.
Occupancy unknown	A surveyed nesting area where occupancy could not determined in a given year
Occupied-breeding	A nesting area occupied by a laying pair
Occupied-breeding successful	A nesting area occupied by a successful pair.
Occupied-breeding failure	A nesting area occupied by an unsuccessful pair.

TABLE A-2. TERMS 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 (1 <sup>st</sup> 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.
Laying 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 $\geq 51$ days old (80% of its age at fledging) or a Gyrfalcon nestling that is $\geq 36$ days old. Steenhof and Kochert (1982) suggested this standard because most young are large enough to count at this stage and mortality after this age is usually minimal.
Successful pair	A laying pair of Golden Eagles or Gyrfalcons that successfully raises $\geq$ one fledgling in a given year.
Unsuccessful pair	A laying pair of Golden Eagles or Gyrfalcons that did not raise $\geq$ one fledgling in a given year.