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RAPTOR RESEARCH

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FLIGHTS OF NESTING PEREGRINE FALCONS RECORDED BY TELEMETRY

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Abstract

Both adult Peregrine Falcons (*Falco peregrinus*) were radio-tagged to determine foraging behavior and other movements at an eyrie containing young in Sonoma County, California, April-June 1979. Equipment failure and terrain prevented a complete record of hunting flights by triangulation, but tracking data coupled with visual observations made near the eyrie permitted analysis of 139 flights by the female and 40 by the male. The adults tended to use corridors along ridges when arriving or departing the eyrie. When the female remained within 1 km of the eyrie 74% of her flights were along the ridge behind the eyrie, and often included perching. About 47% of all the female's flights were known to be farther than 1 km from the eyrie and these were generally made in all directions. The male seldom remained near the eyrie; at least 65% of his flights were farther than 1 km, and about one-third of these were along a single ridge extending several kilometers towards a broad valley. In 20 cases the adults were tracked to distances between about 3 and 8 km from the eyrie, and the average was about 5 km. Prey was apparently taken fairly uniformly in most directions from the eyrie.

Introduction

Despite the potential of radio telemetry for revealing movements of wide-ranging birds there are no published reports of telemetry studies on peregrines. The present work sought to describe the extent and direction of foraging flights of a pair of peregrines with young. The plan was to obtain bearings on the transmitter signal simultaneously from two receiver stations so that the position of the bird could be plotted by triangulation. Sets of bearings obtained at short intervals would allow the tracking of the flying bird. These data, combined with those from a full-time observer near the eyrie were to reveal the pattern of habitat use.

A good deal of information was gathered. However, equipment difficulties and problems of interpretation encountered are also of interest to those who may be considering similar studies on raptors.

Methods

Telemetry receivers were AVM Instrument RB-4 single-channel units with three sub-channels. The receiver antennas were four-element yagis mounted on a three-meter-long rotating mast equipped with a bearing disc. Transmitters were AVM SM-1 single stage units operated at 148.1 MHz and weighed about 12 g when potted in dental acrylic. The transmitter antenna was 0.28 mm diameter guitar wire. The transmitter was sewn to the underside of a center tail feather and the antenna tied with nylon thread to the feather four places along its length (Craighead and Dunstan, 1976).

Several tests established bearing error on a test transmitter 8 km from a receiver. The error averaged ± 5°, but one 8° error was obtained. Maximum line-of-sight range exceeded 15 km, but intervening terrain interrupted transmission.

When possible, bearings of instrumented birds were taken simultaneously by both tracking stations at 30 second intervals. The stations were in contact by two-way radio.

The two adults were trapped, hooded, instrumented, and immediately released. The female was trapped on 21 April and her transmitter operated until 1 June. The male was trapped on 2 June and his transmitter failed on 6 June. Both birds behaved normally after release and eventually fledged a brood of young in late June.

The field data, consisting of synchronous bearings taken by tracking stations, bearings taken by a single station, and notes taken by station operators and a full-time observer in view of the eyrie were collated in the following way. First, bearings were drawn for each day from the tracking stations on an overlay of a USGS 7.5 minute topographical map, and the time of the bearing was noted. Remarks from notes of station operators were included on the overlays. The notes of the eyrie observer, who kept detailed accounts of falcon movements, were included on the overlays for flights for which telemetry data were available. Last, the general routes of flights made each day were traced on overlays integrating telemetry bearings by triangulation, direction of transmitter signal when only one station received a signal, observer notes relating to signal strength, and departure and arrival at the eyrie as seen by the eyrie observer. The resulting routes did not represent the exact track of each flight by the two adults, but only its general course and distance. Often only a portion of a flight could be followed.

The routes taken by the adults were assigned one of seven corridors around the eyrie (Fig. 1). These corridors were used on nearly all flights to or from the eyrie and correspond to topographical features and landmarks often referenced in the field notes. If a bird departed on one corridor and returned on another, a flight was shown for each. All flights were placed in one of three groups: those that 1) did not range beyond 1 km of the eyrie, 2) exceeded 1 km, and 3) flights of uncertain distance.

Results

Figure 1 shows the distribution of flights along the corridors by the adults. Data plotted near the focus are for round-trip flights, simetimes interrupted by perching, which did not exceed 1 km from the eyrie. Some of these included hunting or defense. Data plotted away from the focus represent round-trip flights, or separate arrivals and departures, where the flight exceeded 1 km from the eyrie. These flights were presumably foraging flights. When a falcon returned to a corridor left earlier in the same flight another datum was recorded. Numbers along corridors show how many flights were of uncertain distance, they may or may not have exceeded 1 km.

The beacon of the adult female provided useful information on her position for 14 days in the period 27 April-31 May 1979. Flights less than 1 km centered on corridors C1 and C7, both included favored perches in view of the nest-cliff. Corridor C5 passes an apparent perching area southeast of the eyrie, but often the female's position there was uncertain because a ridge blocked radio reception. Flights exceeding 1 km are distributed asymetrically bo corridor. Of 64 such flights for the female on Fig. 1, 36% were on C5 to the southeast and only one flight was eastward from the eyrie over the deepest part of the east valley. Flights of uncertain distance also predominate on C5.

The adult male was instrumented in the period 3-6 June 1979. Of the 29 flights recorded, only 3 were less than 1 km. The remaining 26 flights were generally along all corridors except he made 9 flights on C2 southwest from the eyrie over the deepest part of the west valley (Fig. 1).

Twenty long flights by the adults were tracked beyond about 3 km from the eyrie (Fig. 2). Most of these flights were southward and four, including a 7 km flight, were substantiated by triangulation. The others were inferred by signal strength and flight duration. The average distance of these 20 flights was about 5 km and the most distant was about 8 km.

Foraging

In 92 instances, 20 for the female and 72 for the male, the observer near the eyrie saw inbound flights with prey. These flights suggest the regions of hunting success because adults carrying prey probably return directly to the eyrie from the site of the kill. The sightings, by corridor C1 to C7 were 16, 21, 13, 15, 8, 3, and 16 when the data for the adults are combined. Except for C5 and C6, inbound flights with prey used all corridors generally and prey was apparently obtained in most directions from the eyrie.

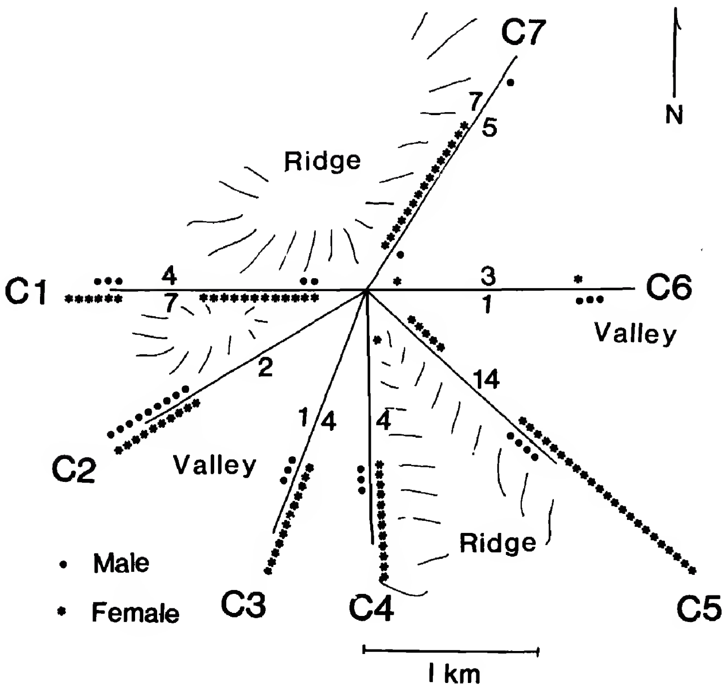

Figure 1. Distribution of flights about the eyrie by adult peregrines. The eyrie is at the focus of lines representing generalized corridors used by the birds. Data points near the focus are for flights shorter than 1 km, distal points are for flights exceeding 1 km, and numbers indicate flights that may or may not have exceeded 1 km.

Telemetry Problems

We experienced several problems with the telemetry system used that greatly curtailed the amount of information we obtained and reduced its precision:

1) Both transmitters failed long before the batteries would have been exhausted. The guitar-wire antenna on the female broke after about one month and thereafter only a weak, useless, signal could be obtained. The antenna on the male was sharply bent on the second day and no signal could be obtained after five days. Guitar-wire antennas may not be satisfactory on tail-mounted transmitters on active raptors.
2) A ± 5° error in bearing determination may be excessive for accurate tracking. In this study the receiver stations were about 3 km apart. Such an error could lead to a 2 km mis-location of the transmitter if it were lateral to a line between the receiver stations. A mis-location of up to about 5 km is possible if the transmitter were far away but near a line passing through the stations. Double yagi receiver antennas would reduce this error.
3) Where temporary receiver stations are set up and dismantled daily, equipment is subject to great wear. Transceivers for station-to-station communication, battery packs, and antennas, and their fittings, are especially prone to failure.
4) Transmissions in the telemetry bands normally used are useful only on a line-of-sight basis. Telemetry is not practical in hilly or mountainous country.

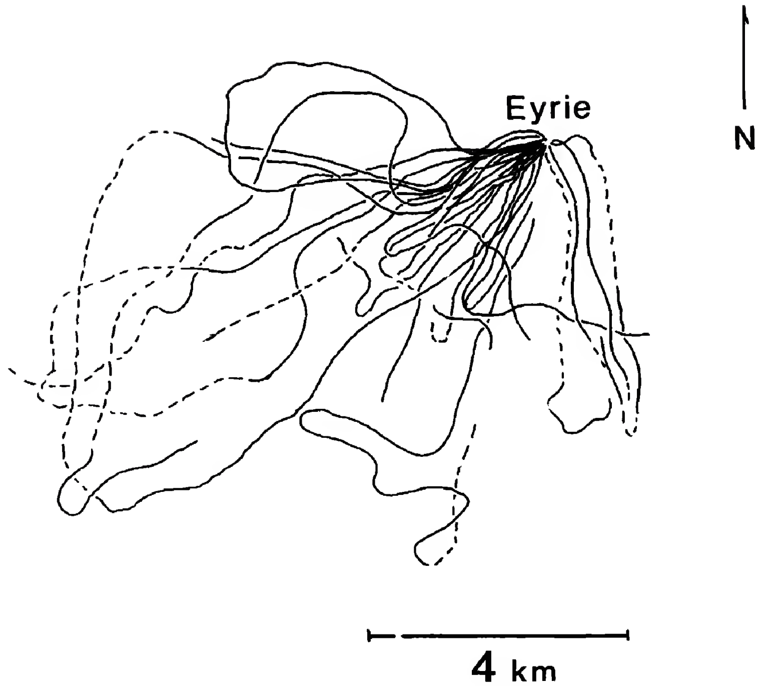

Figure 2. General orientations of 20 flights by adult peregrines that exceeded about 3 km from the eyrie. Dashed lines indicate uncertain flight paths.

Discussion

About 25% of the adult female's flights were within 1 km of the eyrie and centered on perching areas on the ridge behind the eyrie. When she flew over about 1 km from the eyrie, she favored corridors along ridges, especially one to the southeast. The adult male made very few short flights and hunted in nearly all directions from the eyrie, favoring a deep valley to the southwest. Of the 64 flights by the female definitely exceeding 1 km 12 exceeded about 3 km from the eyrie and two were about 8 km distant. Of 26 flights beyond 1 km for the male, 7 were beyond 3 km and two were about 7 km distant.

The pattern of use at this territory was one of foraging flights up to 7 km, and probably beyond, along most of the corridors around the eyrie. The female made proportionately fewer long foraging flights than the male, but when she left the vicinity of the eyrie she appeared to go as far as the male. In an earlier study, an instrumented adult female in Colorado showed a similar pattern of flights in all directions from an eyrie, but two long flights extended about 19 km from the eyrie (J. Enderson, unpublished data).

Long flights are harder to track than shorter flights and the equipment and system we used is inadequate for thorough tracking of such a wide-ranging species, especially in hilly terrain. Where there is a question of the use by peregrines of a specific area near an eyrie, we recommend a more direct approach: place radio-beacons on the adults and monitor the approaches of these birds with a receiver station at the specific area.

Acknowledgements

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POST-RELEASE FLIGHT AND FORAGING BEHAVIOR OF A BALD EAGLE HACKED IN WESTERN KENTUCKY

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Abstract

A Bald Eagle (*Haliaeetus leucocephalus*) hacked at Land Between the Lakes in the summer of 1981, was observed for 113 h from its release until its dispersal from the area. Eighty-three major flights were timed, with an average of one flight per 1.4 h. Longest flight time was nearly 25 minutes, and longest straight line distance covered during any single flight was approximately 3.0 km. Foraging success showed an improvement through time. The eagle exhibited many behaviors similar to other birds of the same age, but appeared to be advanced in the onset of soaring flight and capturing of live fish.

Introduction

Hacking is a technique of placing raptors on artifical nesting platforms remote from where they were hatched. They are fed and monitored with a minimum of human contact until capable of flight, when they are released into the wild. The biological premise is that when the birds are sexually mature they will return to the general area from which they were released to nest and raise young (Milburn 1979).

Bald Eagle (*Haliaeetus leucocephalus*) hacking was based on a successful Peregrine Falcon (*Falco peregrinus*) hacking program at Cornell University (Sherrod and Cade 1978). The state of New York pioneered Bald Eagle hacking in 1976 at Montezuma National Wildlife Refuge and has continued the program each year since. In 1980, the first two New York hacked eagles nested and successfully reared two eaglets (Nye 1980). This demonstrated that hacking is a promising means of reestablisng Bald Eagles in their former range.

The Tennessee Valley Authority (TVA) and the Tennessee Wildlife Resources Agency (TWRA) initiated a cooperative Bald Eagle hacking program during the summer of 1980. The goal was to reestablish a population of breeding Bald Eagles in western Kentucky and Tennessee. Bald Eagles formerly nested in this area, but the last documented successful

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nesting at Land Between the Lakes (LBL) occurred in the 1940's (Peterson 1973). Five Bald Eagles have been successfully hacked at LBL during the first 2 years. The eagle in this study was produced and parent-reared in captivity at the Columbus Ohio Zoo.

Study Area and Methods

Land Between the Lakes is a 68,000 hectare (170,000 acres) peninsula located between Kentucky Lake and Lake Barkley in western Kentucky and Tennessee (Fig. 1). There are many bays and coves along the 480 km of relatively undeveloped shoreline which offer seclusion from the main bodies of water and potential Bald Eagle nesting habitat. The hacking site is located along the Prior Bay shoreline of Lake Barkley (Lowe et al. 1981).

Radio telemetry equipment was utilized for short term monitoring of the eagle. The bird was banded with a U.S. Fish and Wildlife Service rivet band and a red plastic band for long term identification.

A small flat boat with an 85 hp motor was utilized for following the eagle. The bird's general location was established with telemetry equipment and pinpointed with 10X binoculars. Once located, a minimum distance of approximately 70 m at a right angle to the shoreline was maintained between the eagle and the boat to avoid forcing any movements and direction of movement. When tracking the eagle in flight a minimum distance of about 0.4 km was maintained for the same reasons. All time periods between dawn and dusk were similarily represented avoiding any time of day bias.

Flights that were observed were timed with a stopwatch; those that lasted more than 15 seconds were considered major flights. A flight was defined as the interval from one perch to another or from the time the eagle was seen in the air until it went out of view. Distance of a flight was determined by plotting perch locations on a topographic map and measuring straight line distance from perch to perch. Flight altitude was estimated. The term range refers to the maximum distance traversed during a particular period.

Foraging methods were observed and the frequency of foraging attempts and successes were quantified. Only those times when the eagle swooped and actually struck the water surface were considered foraging attempts. Foraging success was the percentage of foraging attempts in which a fish was secured.

Results

The eagle was observed for 113 h during which time 83 major flights were timed. The study was divided into four periods based on the eagle's movements: release and the first day, early, intermediate, and late periods.

Release and First Day

On Tuesday 7 July, the 14.5 week old eagle made its first flight at 0645 (CST), only a few seconds after biologists had removed one side panel from the hacking enclosure. The eagle alternated flapping and gliding without losing altitude and ascended twice. It banked and made several circular patterns as it flew in a southward direction. It landed about 9 m up in a tree with dense foliage that was slightly less than 0.4 km southeast of the hack site in a swampy subimpoundment. Total flight time was 70 seconds, and the altitude varied from 9 to 18 m. The eagle remained on this perch for 2.5 h before taking a second flight, which was similar to the first and lasted 1 min.

In late afternoon, the eagle soared above the tree tops for 4.5 min. and reached an altitude of 80 m. At sunset the bird was in the main section of Prior Bay, 0.8 km from the hack site.

Early period

This period lasted 3.5 days and was characterized by random movements about the main section of Prior Bay (Fig. 1). The eagle's range was less than 0.8 km, and it was never observed to approach within 0.5 km of the hacking tower. Most flights were short (less than 200 m) along the southern shoreline of Prior Bay or across the mouth of a small cove. All were under 18 m in height and no soaring was observed.

On 9 July, the eagle was observed capturing a live fish. The bird was perched in a shoreline tree about 10.5 m above the water when it suddenly left the perch flying directly towards the water. It struck the water surface about 4.5 m from the shoreline, submerging all but its wings and upper body. It immediately began moving towards the shore by using its wings in a paddling motion. When the eagle reached the shore it hopped onto a fallen log and a fish was observed in its talons.

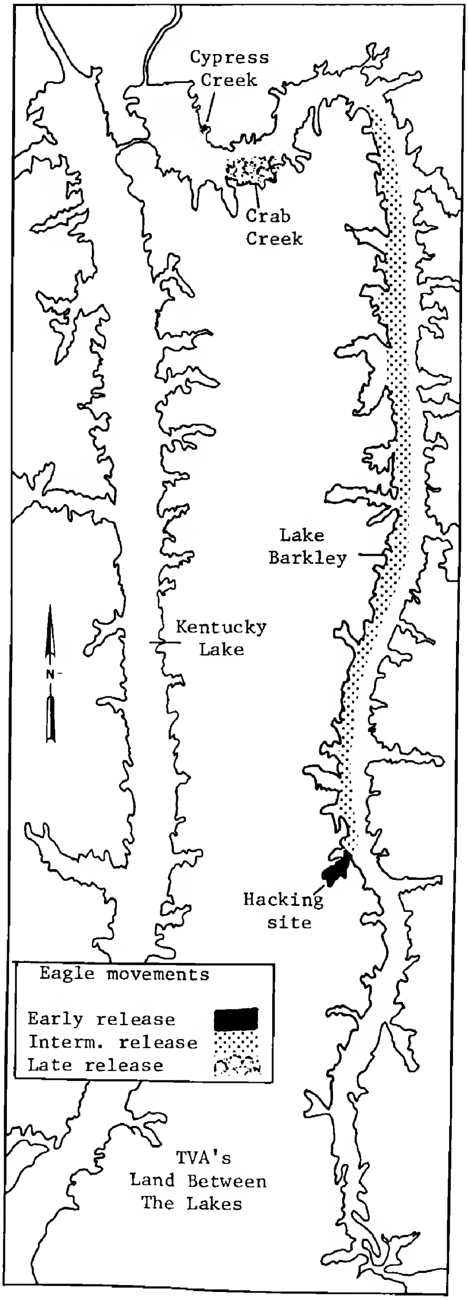

Figure 1. Movements of a fledgling Bald Eagle hacked at LBL.

Although no other prey capture was observed during this period, observation of certain behaviors indicate that the eagle was feeding. These included low altitude foraging searches along the shoreline and walking along the shoreline which could have been scavenging behavior. Foraging success for the period was 33% (1-3).

Intermediate Period

This period lasted 4.5 days and was characterized by consistent northward movements until the eagle reached the Crab Creek area of LBL (Fig. 1), some 40 km from the hack site. Although the eagle's circling flights sometimes took it a short distance south, when it finally landed it was always perched north of the previous perch. It's flight path followed the LBL shoreline of Lake Barkley, and use of the many bays along the route was minimal. Flight height usually varied between 3-18 m, and the longest distance was approximately 3.0 km. These movements resulted in an average range of 8.2 km per day.

During this period the eagle was first observed picking up dead fish off the water surface. All successful forages were at the end of lengthy flights of more than 2 min. Foraging success was 50% (8-16).

Late period

This period was characterized by a "settling in" as the eagle remained in the Crab Creek area for 29 days. The bird left the area once, when it spent 1 day, 9 August, in the Cypress Creek area (Fig. 1). The eagle's overall range for this period was approximately 2.0 km.

The majority of flights were low altitude foraging searches that involved a great deal of circling as the eagle scanned the water surface below. These were usually under 18 m in height, and covered a distance of less than 0.4 km from perch to perch. Soaring flights were also observed and they were usually along the shoreline where winds sweeping across the lake created an updraft. One in particular, on 21 July, lasted nearly 25 min.

The eagle became very adept at finding and picking up fish on the water's surface as evidence by a foraging success of 76% (16-21). Most feeding perches were just a few feet off the ground on low stumps or snags.

Dispersal

It is believed the eagle dispersed from the study area on 15 August. It was last seen on 11 August, but transmitter signals through the 14th indicated that it was still in the Crab Creek area. On 15 August there was no signal in the Crab Creek area or 2 km east or west of there. Several days later surface and aerial searches of both Lake Barkley and Kentucky Lake revealed no transmitter signals.

Discussion

The strength of the eagle's first day flights may be related to the age at which the bird was released. In wild nests, when most birds fledge at 11 or 12 weeks of age, first flight is usually a glide onto or near the ground (Harper 1974; Kussman 1977). Milburn (1979) observed similar flights in hacked fledglings and several times had to retrieve them from the ground because they could not attain lift. This problem seems to be avoided by keeping eaglets on the hacking tower an extra 2 or 3 weeks and allowing them to develop greater strength in the flight muscles (Lowe, R.L., per. comm.). The first-day flights of 5 hacked eagles at LBL support this contention. Milburn (1979) first observed soaring in hacked eagles at 3 or 4 weeks after release (15-16 weeks of age). Kussman (1977) intensively studied 8 fledgling Bald Eagles from wild nests and found an average of 32.8 days off the nest (16 weeks of age) before the onset of soaring activity.

It was unusual that the subject eagle was observed successfully hunting on the second day after release. Milburn (1979) observed 7 hacked eagles and did not witness it until 7 or 8 weeks after release (19-20 weeks of age). Harper (1974) never observed hunting behavior in 3 eagles for 20 weeks after they fledged. Kussman's (1977) earliest observation of scavenging was 6.5 weeks after fledging (18.5 weeks of age), and most birds were 5 months old before they exhibited this behavior.

Jaffe (1980) studied the foraging behavior of immature Bald Eagles in mid-summer and found that foraging success in immature eagles increased through time with an overall success rate of 80%. This compares favorably with the 76% foraging success here during the late period.

The condition of fish that the eagle captured was difficult to ascertain. Bald Eagles often take live fish, but being opportunistic feeders they frequently take dead or dying fish if available (Southern 1963; Bent 1961; Herrick 1933; Brown and Amadon 1968; Wright 1953; Broley 1958). Immature Bald Eagles tend to rely more heavily on dead fish than adults (Sherrod et al. 1976). I frequently saw dead fish floating on the surface of the water, and the eagle took these several times. The only instance when the eagle was observed to actually strike beneath the water surface for a fish was on the second day following release.

Movements of juvenile Bald Eagles are not well documented. Only Kussman (1977) and Harper (1974) have dealt with this subject in detail. Bald Eagles usually follow shorelines because of perch sites and fish availability. The methodical northward movement of the eagle in this study ended abruptly when it reached the northern boundary of Lake Barkley. Gerrard et al. (1974) correlated movements of juvenile Bald Eagles with wind direction, but subjective observations by the author indicated that winds were variable throughout this period.

This eagle and the other four hacked at LBL were never observed to return to the hacking tower after being released. All seven of the hacked eagles that Millburn (1979) observed returned regularly to the tower, but two birds hacked in Georgia never returned to the tower (Odum 1980). In wild nests, recently fledged Bald Eagles often return to the nest (Gerrard et al. 1974; Harper 1974), although some do not (Weeks 1975).

The eagle remained in the study area for 39 days after release. This is similar to the observations of Milburn (1979) who recorded variability in the dispersal times of hacked eagles in New York from 3.5 weeks to 14 weeks after release; and to Gerrard et al. (1974) who observed seven immature eagles in Saskatchewan and found that dispersal began at 20-21 weeks of age.

Acknowledgements

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ANNOUNCEMENT

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EFFECTS OF WEATHER ON ACCIPITER MIGRATION IN SOUTHERN NEVADA

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Abstract

Migrating Sharp-shinned Hawks (*Accipiter striatus*) and Cooper's Hawks (*A. cooperii*) were observed along a forested ridge surrounded by desert in the Spring Mountains of southern Nevada from 31 August until 17 October 1980. Greatest numbers of accipiters were counted on days cold fronts passed through our study area; however, fronts typically separated relatively homogeneous air masses, and passage produced no perceptible or consistent changes in surface weather variables (as measured at our study site). Analysis indicated that perceived migrant abundance, although strongly associated with cold front passage, was not related to surface weather conditions as many other studies have suggested. The "extra" accipiters observed on front days appeared between mid-morning and late afternoon. This is the period of the day when accipiters and other hawks frequently migrate at high altitudes riding thermal updrafts. We believe post-frontal atmospheric stability and strong winds aloft confined thermal activity to a narrow zone in the lower atmosphere on front days, which resulted in more accipiters migrating at lower altitudes. Increased counts probably resulted because: (1) a higher proportion of the daily flight occurred within visible range; (2) more accipiters may have sought lift from updrafts along mountain ridges as an alternative to thermal updrafts; and (3) migrating accipiters may have become reluctant to cross inhospitable deserts at lower altitudes, and instead directed flights over boreal forests along ridgetops. We suggest post-frontal atmospheric conditions may similarly affect raptor migration elsewhere, and future studies should more thoroughly investigate the role of weather in influencing the height of migration.

Introduction

Autumn raptor migration has been studied in few parts of North America, notably several localities in the east and midwest where large numbers of raptors concentrate under certain conditions (Heintzelman 1975). At these sites raptor counts are typically greatest following the passage of a cold front when surface winds switch to a westerly or northerly direction, barometric pressure rises, temperature falls, the sky clears, and often, wind speed increases (Mueller and Berger 1961, Haugh 1972). Many researchers have postulated a direct relationship between frontal changes in these weather variables, either singly or additively, and the magnitude of hawk migration (Mueller and Berger 1961, Haugh 1972, Hoffman 1981).

Strong cold front activity is not universal throughout North America in autumn. For

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For example, at low latitudes in the western United States autumn is a fairly stable meteorological period (Brown 1974, Sellers and Hill 1974) and most cold fronts separate relatively homogeneous air masses (hence are "weak"). Accordingly, many of the surface weather effects noted with front passage further north are absent. In an attempt to determine how weather influences raptor migration in this region, we observed migrating Sharp-shinned Hawks and Cooper's Hawks in southern Nevada for the bulk of the autumn migration period in 1980. This paper summarizes data collected and presents findings which, we believe, help explain the relationship between raptor migration and cold front passage.

Study Area

Observations were made from Potosi Mountain (Potosi), located 48 km west of Las Vegas in Clark County, Nevada (Fig. 1). Potosi is the southernmost peak in the Spring Mountains (Springs) and rises sharply out of a pass to an elevation of 2592 m, forming a narrow north-south ridge for about 6 km.

Like other mountain ranges in southern Nevada, the Springs rise abruptly from low elevation (900 m) valleys. Annual precipitation ranges from about 11 cm in valleys to 50 cm in mountains (Brown 1974). Vegetation typical of Transition, Upper Sonoran, and Lower Sonoran Life-zones occur in the area in broadly overlapping altitudinal zones. Boreal and Rocky Mountain conifer forests of bristlecone pine (*Pinus aristata*), limber pine (*P. flexilis*), and ponderosa pine (*P. ponderosa*) occur along ridgetops above 2430 m elevation. Cold temperate Great Basin conifer woodlands of pinyon pine (*P. Monophylla*) and juniper (*Juniperus* spp.) dominate at elevations between 2740 m and 1830 m. Below 1830 m warm temperate Mohave desert scrub associations of joshuatree (*Yucca brevifolia*) and creosotebush (*Larrea tridentata*) predominate (vegetation formation follow Brown *et al.* 1979, plant names follow Lehr 1978). Boreal forests in the Springs and nearby Sheep Mountains are isolated from other tracts of similar vegetation by at least 160 km of Upper and Lower Sonoran Life-zone vegetation (Fig. 1).

Methods and Data Treatment

Raptors were counted, captured, and banded from a blind in a clearing atop Potosi. Counts included all accipiters caught or enticed into the area as well as nonresponsive individuals. We initiated observations on 31 August 1980 and continued daily counts until 17 October 1980. Raptors were identified to species as conditions allowed and tallied by hour on daily count forms. Weather conditions were recorded at the start and close of each observation day and at least once each 2 h between start and close. Temperature, percent cloud cover, wind speed, wind direction, and barometric pressure were determined at each reading. Raptor counts and weather data were obtained for 34 complete days (i.e. beginning at 0800 h and continuing until 1700 h).

Using these and other data available to us we calculated three variables describing the accipiter migration and 14 variables describing weather conditions for each complete observation day (Table 1). We then placed each day into one of four groups according to prevailing wind direction (i.e. days dominated by northerly winds in one group, easterly winds in another, southerly in another, and westerly in another) and searched for bivariate and multivariate correlations between count and weather variables within groups. We also compared average daily counts between groups. Sample sizes were sufficient to yield meaningful conclusions for only two groups; days with southerly (n= 17 days) and westerly (n= 12 days) winds. Accordingly, we confined analysis of migration/weather relationships to this 29 day sample.

All analyses were performed on a Honeywell 6680 computer using STATPAC statistical packages with probability levels of $\alpha = 0.05$. Relations between two sets of variables were tested using product-moment correlation coefficients. Comparisons between means of two populations were conducted using the t-test (Sokal and Rohlf 1969) which requires no assumption of homogenity of variance nor equal sample sizes. Multivariate trends in weather data were determined using Principle Component Analysis (PCA). Care was taken to scale variables properly for PCA. PCA reduces a set of n raw variables (in our case, weather variables) to n components; each component consisting of a unique set of intercorrelated raw variables. In a PCA components are ranked so that each successive component accounts for a smaller proportion of total variance in the original data set. In most cases the first three components cumulatively account for 60 to 80 percent of the variance and additional components can be ignored (Levins 1968, Green 1974, Johnson 1977, Rotenbury 1978, Rotenbury and Weins 1980). In our analysis the first three components defined multifactorial gradients in total weather condition (as limited by the scope of our measurements). Component scores were calculated for each south and west wind day, and days were plotted along component axes. By comparing TAC on days falling in different positions along component axes (i.e. ordinating in different regions of the three-dimensional space), it was possible to assess the relationship between accipiter counts and general weather conditions.

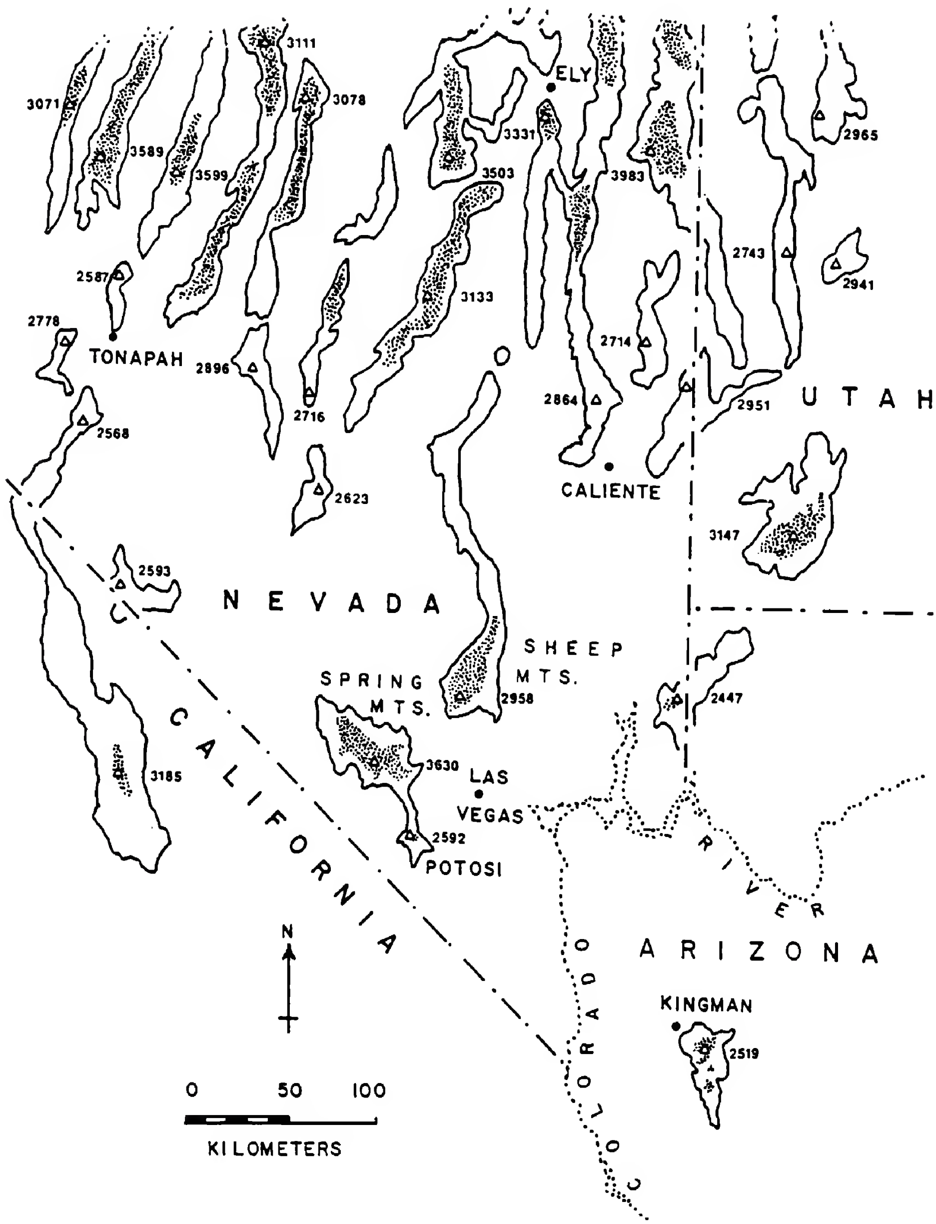

Fig. 1. Map of southern Nevada showing position of Potosi in relation to other physiographic features. Ranges with peaks over 2400 m are outlined (high peaks are marked for reference), and stippled areas delineate boreal islands of montane conifer forest vegetation.

Table 1 Description of accipiter count and weather variables calculated for each complete observation day.

No.	Code	Code
1.	Mean number total accipiters observed per h between 0800h and 1700	TAC
2.	Mean number Sharp-Shinned Hawks observed per h between 0800h and 1700h	TACST
3.	Mean number Cooper's Hawks observed per h between 0800h and 1700h	TACCO
4.	Maximum temperature (°F)	MXTEMP
5.	Temperature diversity[a]	HTEMP
6.	Average barometric pressure (cmHg)	AVBAR
7.	Barometric pressure diversity[a]	HBAR
8.	Average cloud cover (percent)	AVCC
9.	Cloud cover diversity[a]	HCC
10.	Equitability of cloud cover[b]	ECC
11.	Average wind speed (km/h)	AVWS
12.	Wind speed diversity[a]	HWS
13.	Equitability of wind speed[b]	EWS
14.	Prevailing wind direction	-
15.	24h barometric pressure change (cmHg)	-
16.	24th change in TAC	-
17.	Cold front passage[c]	-

[a]Calculated using the formula given in Shannon and Weaver (1949);

$$H = \sum_{i=1}^{s} P_i \ln P_i;$$

where Pi= proportion of readings in the ith measurement subdivision, s= the total number of subdivisions occupied, and H= the diversity index (HTEMP, HBAR, HCC, or HWS). For HTEMP each subdivision was 5°F. For HBAR each subdivision was 0.13 cmHg. For HCC each subdivision was 20 percent. For HWS each subdivision was 16 km/h.

[b]Calculated using the formula given in Power (1971);

$$E = H/H\max,$$

where H=HCC or HWS, and Hmax= lns, the maximum possible diversity index for s occupied subdivisions.

[c]Determined from NOAA Daily Weather Charts.

Results

Count Totals and Chronology of Migration

A total of 359 Sharp-shinned Hawks, 215 Cooper's Hawks, and 67 unidentified accipiters were observed. Accipiter counts varied from day to day in a series of peaks and troughs (Fig. 2). The mean interval between peaks for Sharp-shinned Hawks was 3.00 ± 1.04 days (1 SD). The mean interval for Cooper's Hawks was 2.91 ± 0.94 days. Intervals did not differ significantly between species ($p > 0.05$).

Seventy-two percent of Cooper's Hawks were observed during the first three weeks of September, with a noticeable peak between 10 and 19 September. Sharp-shinned Hawk migration appeared to increase during the first 10 days of September and remained relatively constant thereafter. Although observations did not cover the entire migration period for either species, Sharp-shinned Hawks appeared to migrate over a longer period of time than Cooper's Hawks.

Weather and Intensity of Observed Migration

Component patterns resulting from PCA for west wind days are summarized in Table 2, and the ordination of observation days is shown in Fig. 3. The first component described a gradient (from positive to negative in Fig. 3) from warm, wide ranging temperature; steady pressure; mostly clear skies; and light winds to low steady temperature; unsteady pressure; mostly cloudy skies; and strong winds. The second component described a gradient (from positive to negative in Fig. 3) from gusty to steady winds. The third component described a gradient (from positive to negative in Fig. 3) from steady sky conditions (i.e. completely overcast to completely clear) to variable sky conditions. Seven of eight west wind days with high TAC received positive scores on the first component, and six received negative scores on the third component. With one exception, days with low TAC received negative scores on the first component. This suggests that high TAC on west wind days was associated with warm, fair to partly cloudy weather, and light to moderate winds. Bivariate analyses supported this conclusion. TAC was negatively correlated with HBAR ($r=-0.53$ $p < 0.05$), AVCC ($r=-0.65$ $p < 0.05$) and HCC ($r=-0.72$ $p < 0.01$).

Component patterns resulting from PCA for south wind days are summarized in Table 3, and the ordination of observation days is shown in Fig. 4. The first component described a gradient (from positive to negative in Fig. 4) from warm temperature; high pressure; mostly clear skies; and steady winds to cool temperature; low pressure; mostly cloudy skies; and gusty winds. The second component described a gradient (from positive to negative in Fig. 4) from variable sky conditions and light winds to steady sky conditions and strong winds. The third component described a gradient (from positive to negative in Fig. 4) from wide ranging to steady temperature. Days with high TAC were relatively evenly distributed along all component axes. Bivariate analyses indicated there were no significant correlations between TAC, TACST, or TACCO and any of the weather variables used in PCA ($p > 0.05$ for all).

The direction and magnitude of 24 h changes in barometric pressure were not significantly correlated with changes in TAC regardless of wind direction ($n=34$ days) ($r=-0.06$, $p > 0.05$). Accordingly, a falling or rising barometer did not appear to influence count totals. There was, however, a significant difference in mean TAC and TACST between south and west wind days; both variables were greater with south winds ($p < 0.01$). Mean TACCO was also greater with south winds, but the difference was not statistically significant ($p > 0.05$).

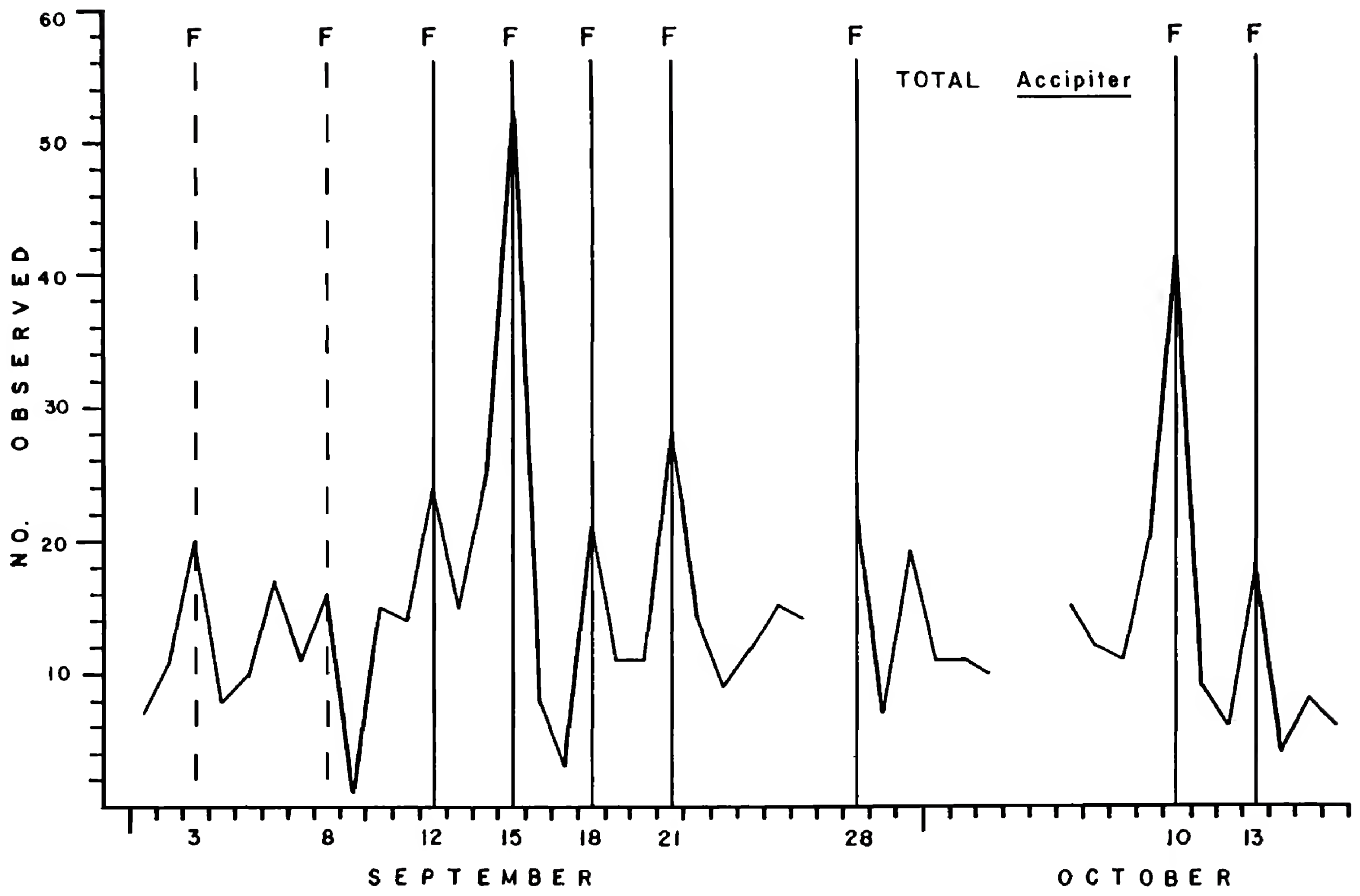

Fig. 2. Total accipiter counts (Sharp-shinned Hawks + Cooper's Hawks + unidentified accipiters) for complete observation days (0800h to 1700h). Vertical lines marked F indicate passage of a cold front. Dashed lines indicate front days not analyzed due to incomplete weather measurements.

Table 2. Factor loadings of weather principal components for days with west winds. Only significantly correlated ($p < 0.05$) values shown.

Component :	I	II	III
Eigenvalue :	5.09	1.48	1.26
% Variance :	50.89	14.80	12.64
Σ % Variance :	50.89	65.69	78.34
Variable			
Maximum Temperature (MXTEMP)	.92		
Temperature Diversity (HTEMP)	.79		
Average Barometric Pressure (AVBAR)			
Barometric Pressure Diversity (HBAR)	-.76		
Average Cloud Cover (AVCC)	-.92		
Cloud Cover Diversity (HCC)	-.88		
Equitability of Cloud Cover (ECC)			.76
Average Wind Speed (AVWS)			
Wind Speed Diversity (HWS)	-.73	.62	
Equitability of Wind Speed (EWS)		-.81	

There is strong evidence that differences in accipiter counts between south and west wind days were not related to wind direction per se, but resulted from a strong positive relationship between count totals and cold front passage (Fig. 2). Days of cold front passage at Potosi were always dominated by southerly winds, and mean TAC was significantly greater on frontal compared with nonfrontal south wind days ($p < 0.05$).

Most cold fronts which, according to daily weather charts, passed Potosi were weak and produced no perceptible change in weather conditions on Potosi. Furthermore, weather conditions on front days were highly variable. For example, front days were evenly distributed along all three south wind PCA components; of seven front days, three received positive scores and four negative scores on the first component, three were positive and four negative on the second, and three were positive and four negative on the third (see Fig. 4). This suggests accipiter counts were positively influenced by front passage regardless of weather conditions at our study site.

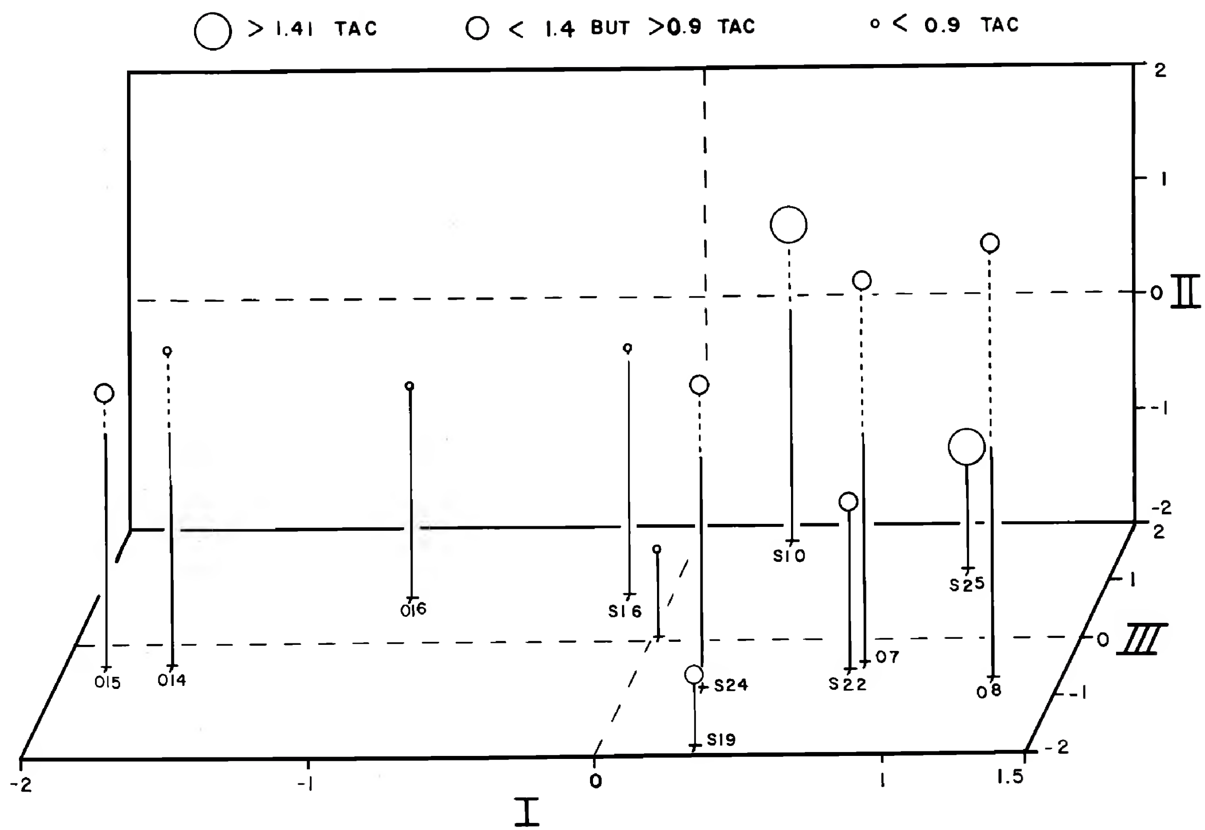

Fig. 3. Graphic ordination of west wind observation days on weather principle component axes. Each pin represents one observation day, and dates are marked at the base of each pin where S = September and O = October. Pinhead size indicates relative TAC (Total Accipiter Abundance, or mean number of total accipiters observed per hour) as defined in the key above graph. Small dashed lines on pins indicate positive scores on component II. Large dashed lines separate quadrates. See text and Table 2 for interpretation of the axes.

Table 3. Factor loadings of weather principal components for days with south winds. Only significantly correlated ($p < 0.05$) values shown.

Component :	I	II	III
Eigenvalue :	3.57	2.21	1.26
% Variance :	35.75	22.06	15.20
Σ % Variance :	35.75	57.81	73.01
Variable			
Maximum Temperature (MXTEMP)	.84		
Temperature Diversity (HTEMP)			.92
Average Barometric Pressure (AVBAR)	.66		
Barometric Pressure Diversity (HBAR)			
Average Cloud Cover (AVCC)	-.63	.60	
Cloud Cover Diversity (HCC)		.72	
Equitability of Cloud Cover (ECC)	-.71		
Average Wind Speed (AVWS)	-.67	-.64	
Diversity of Wind Speed (HWS)	-.68	-.64	
Equitability of Wind Speed (EWS)			

Although accipiter counts showed a consistent daily rhythm, the distribution of observations differed between front and nonfront south wind days (Fig. 5). On non-front days most Cooper's Hawks appeared in the morning, and a moderate proportion of Sharp-shinned Hawk observations occurred prior to 0930 h. On front days, however, most Cooper's Hawks were observed after mid-day and a relatively small proportion of Sharp-shinned Hawks were seen in the early morning. This indicates that for both species, increased counts on front days were the result of more individuals appearing during the late morning and afternoon hours rather than an overall increase in migrant numbers throughout the day.

Discussion

Accipiter migration occurred on all days with generally fair weather. High counts, however, were strongly associated with cold front passage and did not appear related to weather conditions on Potosi. Although it is possible that accipiters responded to changes in barometric pressure or temperature too small to be detected on our instruments, Mueller and Berger (1961) present evidence that such perception is unlikely in raptors. This leads us to conclude other factors associated with cold fronts affected migration. The most logical alternatives are that: (1) cold front passage caused changes in surface weather conditions to the north of Potosi, and these changes produced an increase in the volume of movement into our study area (i.e. more hawks were aloft over Potosi); or (2) front passage produced changes in atmospheric weather conditions (rather than changes in weather on Potosi) which altered flight conditions and resulted in more accipiters passing within our range of vision.

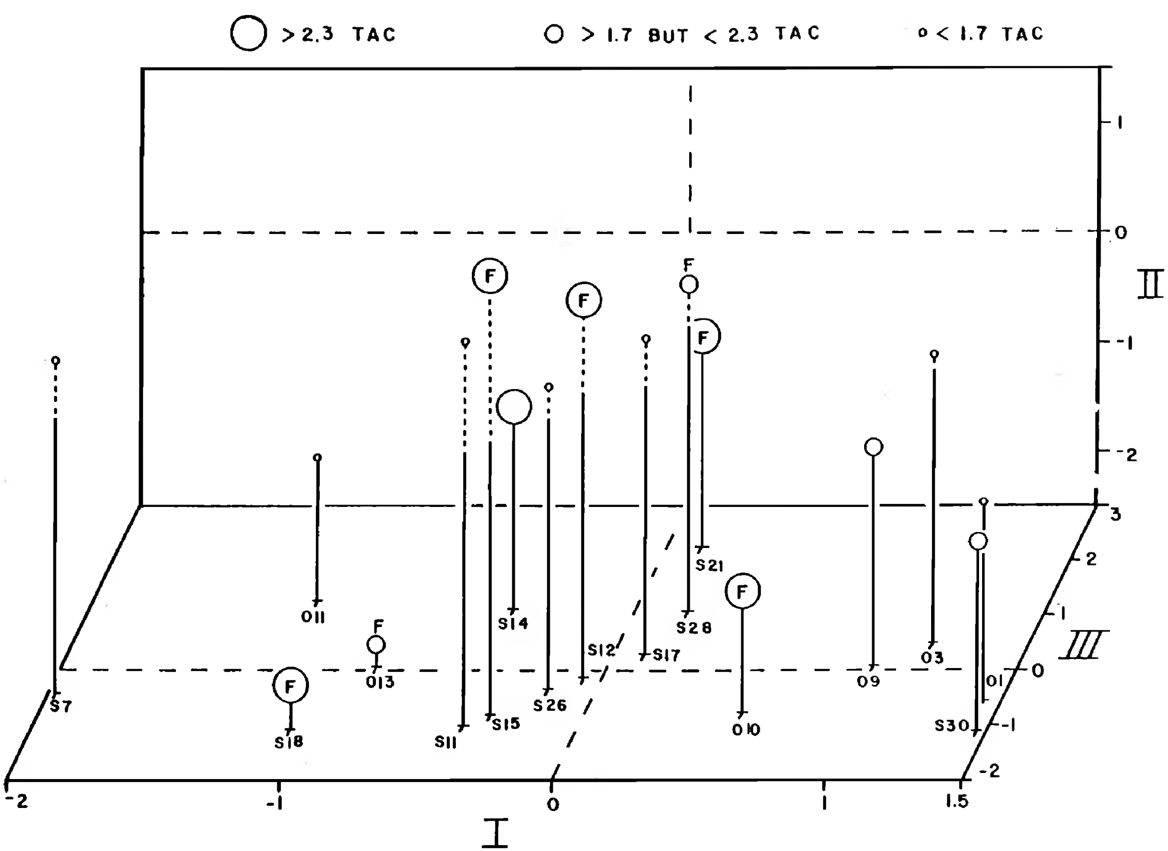

Fig. 4. Graphic ordination of south wind observation days on weather principle component axes. Each pin represents one observation day, and dates are marked at the base of each pin where S = September and O = October. Pinhead size indicates relative TAC (Total Accipiter Abundance, or mean number of total accipiters observed per hour) as defined in the key above graph. Small dashed lines on pins indicate positive scores on component II. Large dashed lines separate quadrates. Front days are marked F. See text and Table 3 for interpretation of the axes.

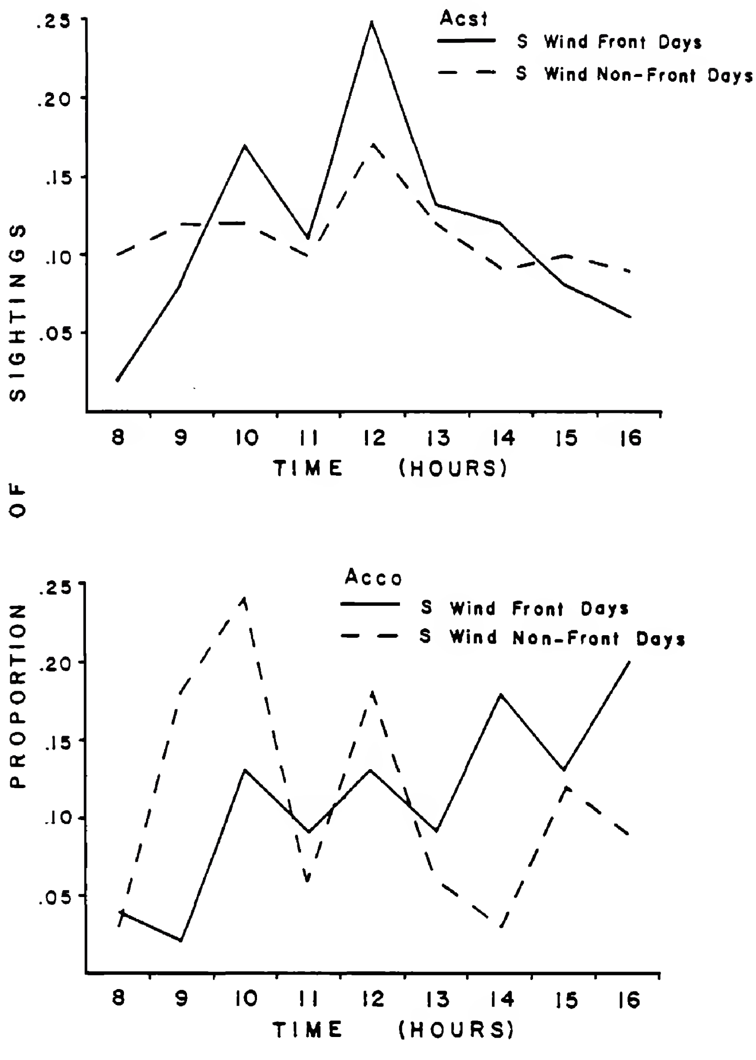

Fig. 5. Proportion of total number of Sharp-shinned Hawks (ACST) and Cooper's Hawks (ACCO) observed by hour on south wind days when cold fronts passed Potosi (S wind front days) and non-frontal south wind days (S wind non-front days).

We doubt the former factor was responsible. If the volume of accipiter movement increased further north it is unlikely all migrants from all affected latitudes would reach Potosi on the same day as the front; our counts would have been higher than normal not only on front days, but following days as well (see Fig. 2). Furthermore, if more hawks were aloft over Potosi on front days, counts for all periods of the day (rather than only specific hourly periods) should have been greater than normal (Fig. 5). On the other hand, the latter observation is perhaps the best evidence that local atmospheric conditions were responsible. Migrant raptors, including accipiters, are known to travel at high altitudes (above the range of visual detection by ground observers), and such flights may be particularly common in areas like southern Nevada where inhospitable expanses (deserts) must be crossed (Allen and Peterson 1936, Deelder and Tinbergen 1947, Evans and Lathbury 1973, Richardson 1975). High altitude flights by soaring birds are typically associated with (or initially depend upon) thermal updrafts and usually occur between mid-morning and late afternoon when thermal activity is greatest (Pennycuick 1979, Heintzelman 1975, Miller 1976, Thiollay 1980). The "extra" accipiters observed on front days at Potosi appeared almost exclusively during this period of the day, which suggests atmospheric conditions behind fronts resulted in a greater proportion of a normally high and/or dispersed mid-day flight occurring within visible range. We believe atmospheric conditions behind fronts forced accipiters to migrate at lower than normal altitudes.

Although we are uncertain how flight conditions changed, at least two meteorological factors may have been involved. Thermals form when a parcel of air near the surface becomes warmer than the surrounding air and begins to rise. The parcel continues to rise until it is sheered and disseminated by winds or, through radiation and intermixing, it reaches the same temperature as the air around it (Miller 1976). Accordingly, thermals are particularly prevalent and attain greatest heights on days when the atmosphere is unstable (i.e. when temperature decreases steadily with altitude) and winds aloft are light (Miller 1976). At the leading edge of a cold front, however, warm air is displaced up and over cool air near the surface; the actual front slopes back over the cool air mass. Behind the leading edge of the front, where the cool air is overlain by warm air, rising thermal parcels probably cease vertical motion upon penetrating the warm air layer. The resultant decrease in vertical motion produces stronger winds aloft (although not necessarily at the surface) because frictional drag with the surface is reduced (Miller 1976). These conditions could act to confine thermal activity to (and hence, force raptors to travel in) a relatively narrow altitudinal zone near the surface following front passage.

A simple lowering of flight height for any reason would increase the proportion of migrants visible to observers on the ground. In addition, however, it could increase use of ridges by migrating accipiters. Horizontal winds striking the sides of a ridge are deflected upward (declivity currents), and raptors make use of these currents to remain aloft and expedite passage on migration (Heintzelman 1975). On days when thermal activity was unrestricted migrants probably traveled directly across deserts around Potosi by gliding from thermal to thermal after mid-morning. With reduced high altitude thermal activity on front days, accipiters may have been forced to rely upon declivity currents to remain aloft throughout the day. It is also possible accipiters were reluctant to cross deserts at low altitudes; birds are often hesitant to cross inhospitable terrain at other than great heights (Deelder and Tinbergen 1947). This might further increase migrant use of ridges, which supported forest and woodland vegetation typical of accipiter habitat in the west (Reynolds 1982).

Although increased wind speeds have long been known to cause birds to fly at lower altitudes (Deelder and Tinbergen 1947), we know of no studies which suggest that a decrease in the altitude of migration behind fronts may be the initial factor contributing to high raptor counts at various autumn lookouts. Many researchers have implied that maximal numbers of hawks migrate behind fronts, and post-frontal surface weather conditions and geography act to concentrate migrants at particular locations (Mueller and Berger 1961 and 1967, Heintzelman 1975). Although radar studies have confirmed that large numbers of hawks are aloft following passage of many cold fronts, comparable or larger flights of some species occur unassociated with typical post-frontal weather and at altitudes and/or locations where they are indiscernible from usual lookouts (Robbins 1956, Evans and Lathbury 1973, Richardson 1975). We suggest that strong raptor movements probably occur during fair weather regardless of cold front activity in autumn, and typically at high altitudes where mountain updrafts are not influential and short water and desert crossings are not prohibitive. The volume of movement is probably more closely associated with the direction of winds aloft (Richardson 1975) and/or, as our findings indicate, thermal activity. Behind cold fronts, however, our data suggests flight may be restricted to lower altitudes. Under these conditions migration probably becomes more visible and concentrations appear because: (1) updrafts along ridges are sought out as an alternative to thermals; and (2) hawks become reluctant to cross expanses of atypical or unsuitable habitat. Although speculative, our findings point out the possibility that autumn raptor concentrations may be merely temporary glimpses of a nearly continuous and largely invisible movement. Analysis of raptor migration data should be conducted with this possibility in mind, and more intensive study of the affects of atmospheric weather conditions on both raptor and bird migration in general is warranted.

Acknowledgements

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HAWK MOUNTAIN RESEARCH AWARD. The Board of Directors of the Hawk Mountain Sanctuary Association announces its annual award for raptor research. Students wishing to apply for the $500 award should submit a description of their research program, a curriculum vita, and two letters of recommendation by 30 September 1983 to James J. Brett, Curator, Hawk Mountain Sanctuary, Route 2, Kempton, Pennsylvania 19529. The final decision will be made by the Board of Directors late in 1983.

Only students enrolled in a degree-granting institution are eligible. Both undergraduate and graduate students are invited to apply. The award will be granted on the basis of a project's potential to improve understanding of raptor biology and their ultimate relevance to conservation of North American hawk populations.

ACTIVITY PATTERNS OF BALD EAGLES WINTERING IN SOUTH DAKOTA[1]

by
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Abstract

Observations of Bald Eagles (*Haliaeetus leucocephalus*) wintering along the Missouri River floodplain in South Dakota showed that weather strongly influenced eagle activity patterns. Feeding activity peaked at −5° to 0° C and dropped significantly when wind speeds exceeded 20 km/h. Reduced feeding activity during unfavorable weather conditions apparently provided energy savings for eagles. Findings are consistent with theories of optimal time and energy allocation.

Introduction

The influence of weather on avian foraging activity is an important component of avian energetics (Schoener 1971). Rough-legged Hawk (*Buteo lagopus*) activity, for example, is strongly linked to weather conditions (Schnell 1967). Under certain weather conditions, both the success and frequency of Osprey (*Pandion haliaetus*) fishing efforts decline (Grubb 1977), and American Kestrel (*Falco sparverius*) activity apparently decreases with high winds and low temperatures (Enderson 1960). Similar effects would be expected for the Bald Eagle, and the impact should be especially critical during cold winter months when shorter days decrease the amount of foraging time available. Energetic considerations are important in the ecology of wintering Bald Eagles. Stalmaster (1981) has argued that eagles are "time minimizers" (Schoener 1971), restricting their flight and feeding time to optimize fitness. This paper examines the proportion of a wintering population engaged in feeding and foraging under different weather conditions and provides additional evidence that Bald Eagle foraging strategies minimize energy expenditure during winter.

Methods

Daily activity patterns of Bald Eagles were observed from November to March in 1974-75 and 1975-76 from three observation points on a 30 km^2 section of the Missouri River floodplain below Fort Randall Dam, South Dakota. In all, 8848 eagle sightings were recorded and categorized by activity. Weather conditions within 3 h of each observation were obtained from the Pickstown, South Dakota weather station, 1 km from the Fort Randall Dam. Eagles were considered "feeding" if they were observed consuming food or actively foraging from a

[1]Contribution from the Gaylord Memorial Laboratory (University of Missouri-Columbia and Missouri Department of Conservation cooperating), Missouri Cooperative Wildlife Research Unit (U.S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Department of Conservation, and University of Missouri-Columbia cooperating), Lake Andes National Wildlife Refuge, the National Wildlife Federation, the Office of Biological Services, U.S. Fish and Wildlife Service, and the Omaha District, U.S. Army Corps of Engineers; and from the Missouri Agricultural Experiment Station, Journal Series 9160.

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perch. I defined "food-searching" eagles as those that were not actively feeding or foraging but were associated with a feeding situation or a potential food source that was being used by other eagles. This category included eagles that were apparently "waiting" for a feeding opportunity (Stalmaster 1981). Eagles on the floodplain fed primarily on gizzard shad (*Dorosoma cepedianum*), goldeye (*Hiodon alosoides*), white bass (*Roccus chrysops*), and carp (*Cyprinus carpio*) (Steenhof 1976). Based on population counts throughout both winters, I estimated that at least 500 different individuals were observed during the study. I was unable to observe roosting activity of eagles in the floodplain communal roost, but on 20 days, I watched eagles departing from a communa roost near Lake Andes, approximately 10 km from the floodplain.

Results

Most eagles left the communal night roost in the half hour immediately before sunrise, although some stayed in the vicinity of the roost during the day. Times of earliest observed departures from the roost ranged from 13 to 38 minutes before sunrise ($\overline{x}$ = 27 minutes before sunrise, s.d. = 5.2). In general, eagles moved directly from the roost to feeding areas.

The percent of birds observed feeding and food-searching was significantly higher (X^2 = 239, $P < .05$) in the first 6 h after sunrise than later in the day (Figure 1). As in Stalmaster's

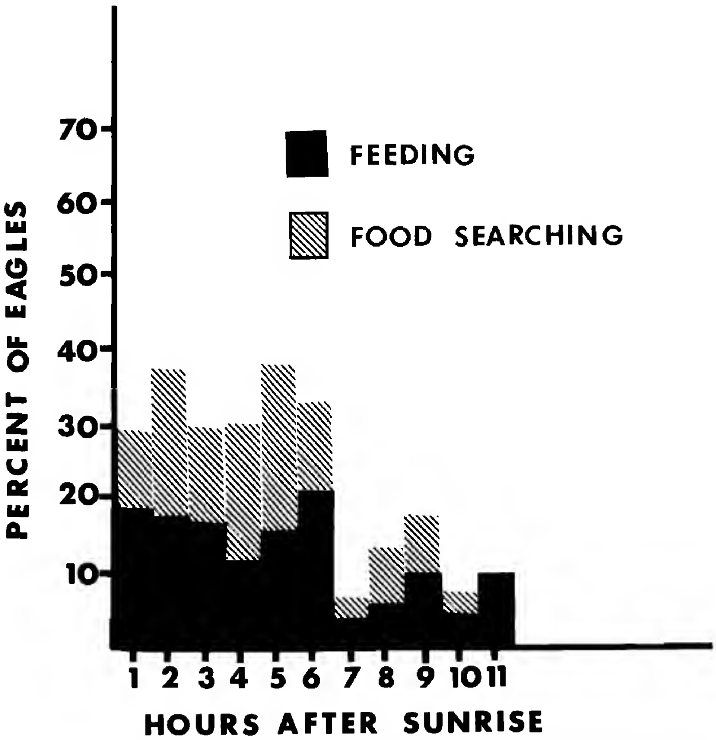

Figure 1. Percent of observed Bald Eagles feeding and food-searching in South Dakota in relation to time of day, 1974-76.

(1981) study, the bimodal pattern in feeding schedules described by Grewe (1966) and Servheen (1975) was not apparent. Increased morning feeding was probably due to daily variations in food availability (Steenhof 1976) as well as increased hunger in the morning (Stalmaster 1981).

The proportion of feeding and food-searching eagles peaked when temperatures were −5° to 0° C. and decreased with both higher and lower temperatures (Figure 2). Although this relationship was confounded by typically cold temperatures at preferred morning feeding times, the pattern persisted when morning and afternoon periods were considered separately (Figure 2). Warner and Rudd (1975) observed that hunting by Black-shouldered Kites (*Elanus caeruleus*) increased with decreasing ambient temperatures, and Fevold and Craighead (1958) showed that food consumption by a captive Golden Eagle (*Aquila chrysaetos*) increased with decreasing air temperatures. The ambient temperatures during this study, however, were colder than during the Golden Eagle and kite studies. Foraging at extremely cold temperatures may yield a net energy loss. Hayes and Gessaman (1980) calculated that American Kestrels could conserve up to 15% of their winter daily energy requirement by restricting activity at cold temperatures. Although this savings would be much less in the larger eagle, it may explain the observed foraging patterns.

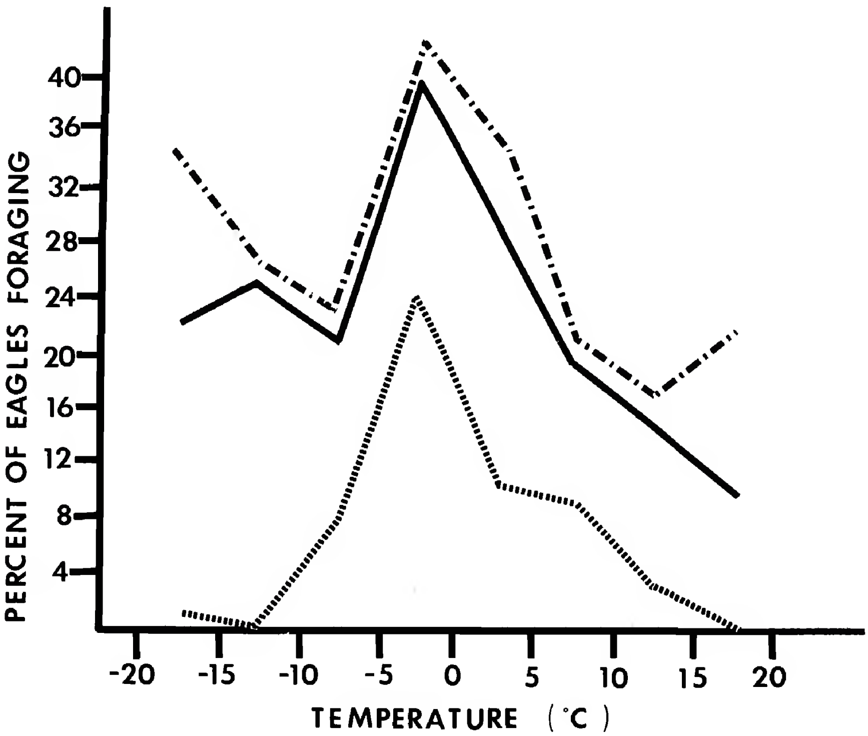

Figure 2. Percent of observed Bald Eagles feeding and food-searching in South Dakota in relation to temperature and time of day, 1974-76. The top line represents eagles observed less than 6 h after sunrise; the middle line represents all eagles observed; and the bottom line shows eagles seen more than 6 h after sunrise.

Wind velocity also influenced eagle feeding activity (Figure 3). The proportion of feeding and food-searching eagles was highest when wind speeds were 15-20 km/h, and the proportion dropped significantly ($X^2 = 45.2$, $P < 0.05$) when winds exceeded 20 km/h. Ueoka (1974) suggested that wind speeds of 8 to 15 km/h are optimal for Osprey maneuverability, and Grubb (1977) noted decreased fishing efficiency by Ospreys above 15 km/h. Wind speeds probably affect Bald Eagles similarly, and eagles apparently can save energy by not foraging when wind conditions reduce fishing efficiency. Kites apparently use this strategy, because Bammann (1975) noted that they did not hunt when winds exceeded 40 km/h. On the South Dakota study area, Bald Eagles did not leave the communal roost during a severe 2-day windstorm when winds gusted to 80 km/h. The roost was protected from the wind and afforded shelter to the eagles (Steenhof et al. 1980).

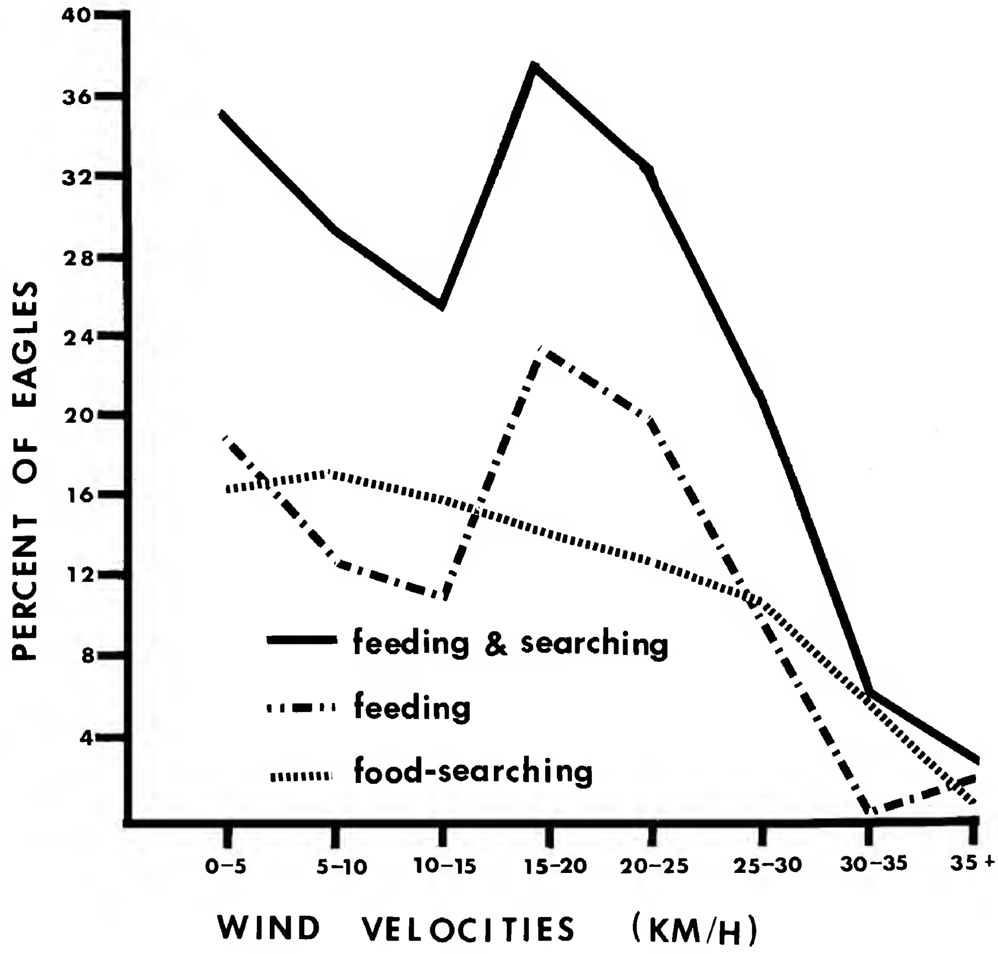

Figure 3. Percent of observed Bald Eagles feeding and food-searching in South Dakota in relation to wind velocity, 1974-76.

Soaring activity was also clearly influenced by weather. Soaring by eagles was recorded 22 times in 1975 and 1976. As in Preston's (1981) study of Red-tailed Hawks (*Buteo jamaicensis*), the incidence of soaring appeared to be related more to wind velocities than time of day, season or wind direction. Eagles soared during all months of the study, at all times of day, and during most prevailing wind directions. Wind velocities during soaring observations ranged from 7.4 to 25.9 km/h, with 82% of all soaring activity occurring in velocities between 12.9 and 22.2 km/h. Although these velocities are the same as those apparently preferred for foraging, the optimal conditions for these two activities apparently are not identical. Stalmaster (1981) noted that soaring by eagles in Washington was most common during warm periods. In this study, more than 70% of all soaring occurred when temperatures exceeded 0° C., the temperature above which foraging activity declined.

The data indicate that weather conditions strongly influence Bald Eagle feeding activity, and the findings are consistent with theories of optimal time and energy allocation (Schoener 1971). As colder temperatures raise energy demands, eagle foraging increases. At approximately −5° C., however, the benefit/cost ratio apparently does not favor foraging, and eagles begin to restrict feeding activity. Eagles also apparently reduce energy expenditures by not foraging when wind reduces foraging efficiency. Stalmaster (1981) estimated that eagles could survive for 2-3 days during winter without feeding. Thus, only unusually persistent severe storms would make this strategy of restricted feeding ineffective.

Acknowledgments

I thank L.H. Fredrickson and S.S. Berlinger for advice and guidance. S. Hoffman and two anonymous reviewers offered valuable criticisms and suggestions. G.F. Krause and S. Ward provided assistance in computer summarization of data. T. Box allowed me to use Utah State University computer facilities for further summarization, and T.L. Thomason typed the manuscript.

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MOUSE TRAP RECOVERED IN HARRIER NEST

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An annual vole (*Microtus* sp.) index is an important part of Hamerstrom's study of the Northern Harrier (*Circus cyaneus*) in central Wisconsin (Hamerstrom, F., Auk 96:370-374, 1979). Vole trapping on her study area began in 1964 and 28,911 trap nights have been accumulated by Hamerstrom and her coworkers through 1981. On 4 July 1981 I found evidence that a harrier had stolen a trap.

On 1 July, 120 traps were put out at about 2000 hours. When they were picked up at about 1200 hours 2 July, 1 trap was missing. Tufts of vole hair were found within 10 cm of the missing trap. On 4 July at 0945 hours I visited a harrier nest about 2.2 km from the trap-line. The nest has been deserted within the past 2 days, and an empty sprung trap lay upside down near the center of the nest. I believe it unlikely that the harrier carried an empty trap. It seems reasonable to conclude that the harrier was attracted to the trap by the presence of a vole in it. The vole may have been dead at the time it was taken since in a few instances harriers have been known to feed on carrion (Bent, U.S. Natl. Mus. Bull. No. 167, 1937:86; Randall, Wilson Bull. 52: 165-172, 1940; and Errington and Breckenridge, Am. Midland Nat. 17: 831-848, 1936). It is also possible that the vole may have been alive when the trap was taken because a few live voles have been found in sprung traps in previous years (Hamerstrom pers. comm.).

PRECOCIOUS NEST DEFENSE BEHAVIOR BY A SHARP-SHINNED HAWK

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On 22 July 1981 we observed 3 fledged Sharp-shinned Hawks (*Accipiter striatus*) in trees within 20 m of their nest in Door County, Wisconsin. They were food-calling (for a description of calls, see Beebe, F.L., Occas. Pap. B.C. Prov. Mus. 17. 163 pp., 1974) and we anticipated the return of an adult with prey for them. To capture adults, we placed a mist net within 3 m of the nest tree and 1 m of a tethered live Great Horned Owl (*Bubo virginianus*) (Hamerstrom F., Proc. Int. Ornithol. Congr. 13: 866-869, 1963). We moved about 20 m away and waited. Approximately 30 min later one of the young's food-call changed to a nest defense call and then it stooped at the owl, hit the net, but escaped. This behavior by the same fledgling occurred 4 times within the next 15 min before it was captured. Its weight (159 g) indicated a female and all her flight feathers had blood in quill; we estimated her age at 30-32 days. After banding and releasing, she immediately perched and uttered a nest alarm call (we believe at us for she could not see the owl from her position) before flying from view. The other 2 young had continued food-calling but they never uttered a nest alarm call.

F. Hamerstrom (pers. comm.) observed 2 similar occurrences where 2 recently fledged Northern Harriers (*Circus cyaneus*) were caught after stooping at decoy live Great Horned Owls. Acker (Auk 94; 374-375, 1977) reported an immature (65-70 days old) female Red-shouldered Hawk (*Buteo lineatus*), at hack, attempting to build a nest and feed 2 captive Northern Harrir chicks. These observations suggest that some behavior patterns commonly associated with breeding adults, are present soon after fledging in some raptors.

We would like to thank D. Amadon, D. Evans, M. Fuller, M. Gratson, and F. and F. Hamerstrom for their review of this note.

Book Reviews

Recent Advances in the Study of Raptor Diseases. Proceedings of the International Symposium on Diseases of Birds of Prey, J.E. Cooper and A.G. Greenwood, eds., 1981. Chiron Publications, Ltd., West Yorkshire, England. 165 pp. $25.00. (obtainable through CHIRON PUBLICATIONS, P.O. Box 25, Keighley, West Yorkshire BD22 7BA, United Kingdom.

This publication contains the edited proceedings of the First International Symposium on Diseases of Birds of Prey held in London, July 1 - 3, 1980. The text provides excellent clinical and surgical information for veterinarians treating raptors. The volume is divided into three parts: Part I - Pathology and Microbiology; Part II - Surgery and Anesthesia; and Part III - Medicine and Therapeutics. Two additional workshops are incorporated which contain topics on mortality factors in wild populations and captive breeding that will appeal to the raptor biologist, aviculturalist, and individuals involved with rehabilitation of raptors.

Highlights of Part I include discussion on bacterial flora and haematozoa of raptors, effects of chronic lead ingestion, causes of death in trained raptors and infectious diseases of birds of prey. Part II deals with anesthesia, surgical treatment of bumblefoot and diagnostic laparoscopy. Significant information is presented on the ossification of long bones in raptors, thermaplastic coating material in fracture repair and the use of external fixation is demonstrated with several illustrated case reports. The section on medicine and therapeutics contains discussion on avian malaria, serum chemistry profiles, aspergillosis, tuberculosis, management of bumblefoot and visual defects in raptors.

Topics on captive breeding include the influence of cross-fostering on mate selection in captive kestrels, microbiological aspects of egg hatchability in captive American Kestrels, breeding of condors at the New York Zoological Park, hand rearing of vultures and abnormal and maladaptive behavior in captive raptors.

The section on mortality factors in the wild included studies on the causes of mortality in British kestrels, problems of rehabilitation, maintenance energy requirements and rate of weight loss during starvation in birds of prey and the relationship of body weight, fat deposit, and moult to the reproductive cycles in wild Tawny and Barn Owls.

In summary, a program of well-respected speakers from several countries presented well illustrated material covering a wide range of selected topics based upon their experience and investigative studies in addition to reviewing applicable literature. It contains useful information for the veterinarian and avicultural personnel involved with breeding and rehabilitation of raptors.

Philip K. Ensley, D.V.M.

The Barn Owl. D.S. Bunn, A.B. Warburton, R.D.S. Wilson. 1982. buteo Books, Vermillion, South Dakota ($32.50). 264 pages, 1 color frontispiece, and 32 black and white plates.

In the preface, the authors state their main reason for producing this monograph on the Barn Owl (*Tyto alba*) was "the very fact that so little was known about the species. . .", and they set out to improve our understanding of this strigiform by drawing upon their combined 38 years experience with it in Britain and from both published and unpublished data from Britain, Europe, and elsewhere. Perhaps the most impressive feature of the monograph is its scope — chapters include topics such as Description and Adaptations, Voice, General Behavior, Food, Breeding, Movements, Factors Controlling Population. . ., and Distribution in the British Isles. Also included is a chapter on Folklore, as well as Appendices on development of young and techniques for observing Barn Owls. The sheer volume of information presented certainly leaves one with a better understanding of this interesting raptor, and in this sense the author's objective is attained.

Despite its good points, the professional is apt to be a bit disappointed. There is little hard data presented from the authors' own studies, and their most valuable contributions in the sections on territory and hunting methods are based primarily upon observations of diurnally active and unmarked individuals. One cannot help but wonder if the conclusions would differ had the subjects been marked and diurnal observations supplemented with radio-tracking at night. Chapters upon which the authors place considerable emphasis, particularly Voice, General Behavior, and Breeding, tend to be overly anthropomorphic and many of the conclusions the authors arrive at are not supported by compelling or even highly persuasive data. A shortcoming which I found particularly evident was a dearth of information from North America; many pertinent findings of comparative value concerning *T.a. pratincola* were not mentioned. This is particularly true in the section on possible conservation measures where nest boxes are discussed. Reference to the highly successful work in this area by Carl Marti and Phil Wagner in Utah (Marti el al. 1979. Nest boxes for the management of Barn Owls. Wildl. Soc. Bull., 7:145-148) would have greatly strengthened this section.

These faults are not likely to keep the nonprofessional from enjoying the monograph, and persons with an avid interest in owls will certainly want to obtain a copy if they can afford the rather steep price. The book should be especially interesting to those who have an occasional opportunity to observe Barn Owls and want to learn more about this intriguing species.

Brian A. Millsap

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