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J. Raptor Res. 22(1):1-2

COMMENTARY

YEAR-END MESSAGE FROM THE PRESIDENT

As usual, the highlight of our organization's year was the Annual Conference for 1987. We met in Boise, Idaho and if you missed it, you missed a lot. In addition to the regular meeting were two symposia. The first was a Workshop on Captive Propagation Techniques sponsored by The Peregrine Fund, Inc., and Boise State University, organized by Cal Sandford and Bill Burnham. There must have been more than 150 people participating in this symposium, alone. A broad range of topics, including genetics of captive populations, artificial insemination, incubation and rearing, were covered in an open forum. The second was a symposium and workshop on Western Raptor Management, sponsored by the National Wildlife Federation and organized locally by Mike Kochert. It covered a range of topics, including population status of various western raptors and ongoing techniques for mitigation. It was attended by over 300 people.

The 1987 RRF meetings themselves were opened with a keynote address by Governor Cecil Andrus who was instrumental in establishing the Snake River Birds of Prey Area. Following the keynote speaker was a full-day symposium, entitled Western Raptor Migration, sponsored by Boise State and the Hawk Migration Association of North America. Sixteen papers were presented on migration aspects of raptors in the western U.S., on topics ranging from movements of large numbers of raptors at the Golden Gate Bridge to metabolism of birds during migration. The scientific program, proper, began on day two. The 443 registrants at this year's meeting had the opportunity to listen to 74 presentations and view 18 poster presented papers.

The Local Committee provided numerous outlets for touring the Boise area, including the Snake River Canyon and the World Center for Birds of Prey. Prairie Falcons, Golden Eagles, Rough-Legged Hawks and Northern Harriers were seen in some quantity at Snake River while the Center tour astounded viewers with their modern facilities, Harpy Eagle pair, and row upon row of pairs of falcons from all over the world.

The banquet was well-attended, providing a mixture of raptor talk, RRF business and Halloween tomfoolery. The Local Committee, again, went above and beyond to provide an extraordinary evening for everyone. Tom Smylie of Albuquerque, New Mexico provided the evening's entertainment with his excellent slide show of the Peregrine migration occurring over the Dry Tortugas. The RRF extends its appreciation to the U.S. Fish and Wildlife Service, Tom Smylie's employer, for supporting Tom's participation in our meeting.

Several grants and awards were given at the banquet this year. The Tully Award, a $500 research grant, given in memory of Steve Tully, was given to Kelly Hogan. The award was given for Kelly's proposal entitled: "Radio tracking of the foraging ecology of Prairie Falcon in the Trans Pecos region of the Chihuahuan Desert." Information about this research award is available from the Chairperson for this award committee, Ms. Lisa Langelier, % The Peregrine Fund, 5666 West Flying Hawk Lane, Boise, Idaho 83709.

The Andersen Award, a plaque for the best student paper was given to Thomas Hamer of Western Washington University for his presentation entitled: "Interspecific competition between Barred and Spotted owls in western Washington." Information about this award for next year's RRF meeting can be obtained from Dr. Keith Bildstein, Chair, Andersen Award, Department of Biology, Winthrop College, Rock Hill, South Carolina 29733.

The Leslie Brown Memorial Award, a research grant of $500 this year, was given to Geoff and Hilary Welch for a proposal to study the migration of raptors in Djibouti. They will be cinematographically documenting a recently discovered raptor migration of vast proportions in this north African country adjacent to the Red Sea. With any luck, and a few contributions, we will be able to double the award for 1988! Information about this award can be obtained by writing to me at Eco-Analysts, Inc., 4718 Dunn Drive, Sarasota, Florida 34233.

A special award was given by the Local Committee to Idaho Power Company for their pioneering efforts to implement procedures protecting raptors from electrocution on their powerline grids, installing nesting platforms on these towers and otherwise mitigating the effects of their powerline system on raptors. Much of this work was at the urging of Mr. Richard Thorsell, Environmental Program Manager for the Edison Electric Institute. He was honored and given an award for his continuing support.

It was quite a meeting and the 1988 conference in St. Paul, Minnesota promises to be just as good! The call for papers was included with the *Journal of Raptor Research,* Volume 21(3). If you are a student, please take note of the changes in the requirements for the submission of papers for the Andersen Award—it is easier now. Other opportunities for member involvement in this year's meeting include submission of nominees for the President's Award and competition for research funds through the Brown and Tully awards—now is not too early to be making some plans if you are interested.

This has been a particularly rewarding year to me, personally. I have had the pleasure of seeing the organization continue to mature and expand its services to both members and the resource. We have been able to contribute to some valuable research and increase communication among professionals throughout the world. This past year, of course, had a bittersweet end when my tenure as President came to a logical and planned end. Although I honestly did not know if I was going to be able to maintain my composure at the Annual Banquet, when the time came, I was filled with pride and appreciation for the support you, the Membership, have provided over the last six years.

But, enough of the Swan Song. Your new President, Gary Duke, has come forth with a lot of new and good ideas. Please give him and your professional organization the support you gave me. Tell Gary, your Board Members and Officers how we can provide better service. Encourage at least one colleague to join RRF this year and let people know what services and products RRF provides.

I look, optimistically, to the future under Gary's direction and hope to see you in St. Paul next fall.—**Jeffrey L. Lincer, Former President.**

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TURKEY VULTURE SURVEYS IN CUBA

Carlos Wotzkow and James W. Wiley

Abstract.—Turkey Vultures (*Cathartes aura*), were surveyed monthly in Cuba from March 1982–January 1983. A total of 25 371 vultures were tallied in 7186 km (3.5 vultures/transect km) of roadside counting along main highways leading from the city of La Habana (northwestern Cuba) to the city of Las Tunas (southeast). Numbers of vultures counted declined substantially beyond 200 m from the transect road. Density of vultures observed within 200 m of the road along the transect route was 0.06/ha. Highest counts were obtained in March, April and June. Turkey Vulture flying activity was greatest during the periods 0900–1200 H and 1400–1700 H.

In recent years Turkey Vulture (*Cathartes aura*) numbers have declined in parts of North America (Brown 1976; Wilbur 1983; Alvarez del Toro and Phillips *in* Wilbur 1983). Ellis et al. (1983) reported Turkey Vultures common over most of Latin America in 1978 and 1979, and Webster (1975, 1978) suggested that numbers of wintering Turkey Vultures have increased in the lower Río Grande valley of Texas. Wilbur (1983) characterized the Turkey Vulture as an abundant species, but one that should be carefully monitored. Aside from the studies of Santana et al. (1986a, 1986b), little is known of Turkey Vultures in the West Indies. Populations in Puerto Rico and Hispaniola may have been introduced from Cuba (Wetmore 1916; Garrido and Garcia Montaña 1975; Dod 1978), although Santana et al. (1986a) argue that vultures arrived in the southern Greater Antilles by natural range expansion once forests were cleared and livestock was introduced by European colonists in the 1800s. The species is common in all regions of Cuba, as well as on the Isle of Pines (Isle of Youth) and coastal cays (Garrido and Garcia Montaña 1975).

Our objectives were: 1) to collect vulture population data along established routes to serve as a baseline for comparison with future surveys and in determining long-term trends in vulture populations in Cuba; 2) to conduct a preliminary study of seasonal trends in vulture detectability; and 3) to determine activity patterns of vultures in Cuba.

Study Area and Methods

We used a "road count" method (reviewed in Fuller and Mosher 1981, 1987; see also Ellis et al. 1983; Hubbard 1983; Andersen et al. 1985) to conduct 11 surveys along a 670.5 km transect route (public highways) at monthly intervals beginning in March 1982 and ending in January 1983 (Table 1). The route extended from La Habana (Havana) on the northwestern coast 268 km to the southeast through the interior to Santa Clara (Villa Clara Province) and continued 402.5 km to the southeast through the interior along the Carretera Central ("Central Highway") from Santa Clara to Victoria de las Tunas (Fig. 1). Surveys were discontinued while passing through towns and cities, thus counts were made along 654 km of the route (Table 1; the June 1982 count was reduced to 652 km due to rain). One observer (CW) conducted each survey.

Most of the transect route passed through flat, cultivated lands or rolling hills of <200 m elevation, interspersed with remnant savannas of royal palm (*Roystonea regia*) and silk-cotton-tree (*Ceiba pentandra*) or royal palm and saman (*Pithecellobium saman*) and dry brush- and woodlands. View was largely unobstructed, although a small section has low secondary brush. However, the Carretera Central passes through some woods and hills which reduced detection distances.

Annual average temp along the survey route fluctuates between 23°C and 26°C, with extremes of 1°C and 38°C (Instituto Cubano de Geodesia y Cartografía 1978). Average summer temp ranges from 25°–28°C with July and August being the warmest months. Average winter temp ranges from 21°–24°C with the lowest temp in February. Annual rainfall averages 1000–1600 mm. May through October is the period of greatest rainfall (average 800–1200 mm); November through April is the dry season (200–400 mm).

Surveys were conducted using public transportation (bus, car or truck) at an average speed of 72.7 km/hr along the route. Surveys took approximately nine hr to complete and most surveys were conducted on two different days, resulting in the second part of the survey being an average of three d (range one–nine) after the first (Table 1). Surveys were completed in one d in August and November 1982 and in January 1983. Vultures were counted on both sides of the road and numbers tabulated in one of 14 horizontal distance (m) categories from the road as follows 0–25, 26–50, 51–100, 101–150, 151–200, 201–250, 251–300, 301–350, 351–400, 401–450, 451–500, 501–550, 551–600, and >600 m. However, these increments proved to be too narrow for the level of observer accuracy attained during the surveys. We later modified distance categories (and combined earlier observations) as follows: 0–100, 101–200, 201–400, 401–600, and >600 m.

Activity and time of day were noted for each vulture

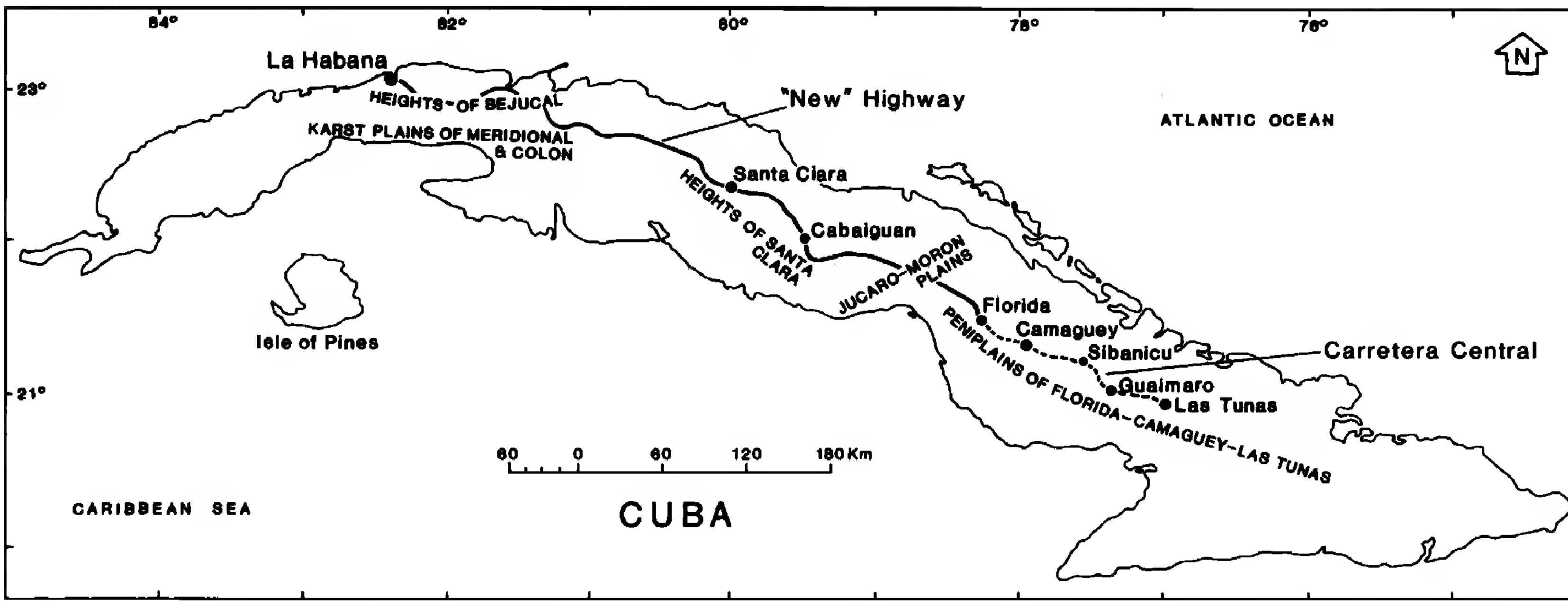

Figure 1. Turkey Vulture survey route along the "New Highway" and Carretera Central in Cuba, and major geographic features along route.

sighted. Flying activity was weighted according to sampling effort because all periods were not sampled equally. General weather conditions (clear, partly cloudy, complete cloud cover, rain; wind conditions) were recorded. Counts were not made during periods of poor visibility.

Individual transects were divided into seven equal segments (93 km each) to estimate variances of vultures observed within surveys and to allow statistical comparisons among the surveys. Also, numbers of vultures observed were compared among six regions (range 50–100 km in

Table 1. Summary of Turkey Vulture transect conditions and chronology, La Habana to Victoria de las Tunas, Cuba, March 1982–January 1983.

Survey		Transect							
		Start		Finish		Distance (km)	Survey Time (hr)	Mean Speed (km/hr)	Weather Index[b]
No.	Date	Town	Time[a]	Town	Time[a]				
1	22 Mar	La Habana	0815	Camagüey	1755	536	7.5	72.0	4.5
	25 Mar	Las Tunas	0730	Camagüey	1250	114	1.8	64.0	5.0
2	8 Apr	La Habana	0730	Sibanicú	1735	582	7.8	74.6	2.0
	12 Apr	Las Tunas	1010	Sibanicú	1155	72	1.2	72.7	2.0
3	26 May	Santa Clara	0905	Las Tunas	1600	384	5.2	73.9	4.0
	29 May	Santa Clara	1230	La Habana	1640	268	4.2	64.3	4.0
4	12 Jun	La Habana	1315	Santa Clara	1640	268	4.3	63.1	4.0
	16 Jun	Las Tunas	1000	Santa Clara	1702	384	4.9	78.9	5.0
5	5 Jul	La Habana	0745	Guáimaro	1805	612	8.3	73.4	5.0
	7 Jul	Las Tunas	1020	Guáimaro	1101	42	0.7	60.0	3.0
6	13 Aug	La Habana	0600	Las Tunas	1718	656	9.5	69.0	4.0
7	20 Sep	Las Tunas	1020	Santa Clara	1710	384	4.9	78.4	4.0
	29 Sep	Santa Clara	0830	La Habana	1215	268	3.8	75.6	5.0
8	8 Oct	La Habana	0900	Sibanicú	1810	582	7.1	82.0	3.0
	11 Oct	Las Tunas	0800	Sibanicú	0907	72	0.9	77.4	4.5
9	29 Nov	Las Tunas	0900	La Habana	1845	654	8.4	77.9	3.0
10	20 Dec	La Habana	0900	Camagüey	1758	540	6.9	78.8	3.5
	24 Dec	Las Tunas	0952	Camagüey	1133	114	1.4	80.3	3.0
11	8 Jan	La Habana	0615	Las Tunas	1702	654	9.4	69.6	1.0

[a] Eastern time zone.

[b] Weather index: 5 = clear, 4 = mostly clear, 3 = mostly cloudy, 2 = complete cloud cover, 1 = complete cloud cover with occasional rain.

length) which reflected differences in habitat along the survey route.

Parametric analyses were used unless data were non-normal; in those cases, nonparametric tests were applied. Chi-square goodness of fit tests (Zar 1974:80–81) were used to determine normality. Analysis of variance (ANOVA) and Spearman rank correlation coefficients (r_s) follow Zar (1974). Significance level was set at 0.05.

RESULTS AND DISCUSSION

Weather during the surveys was mostly clear (Table 1); only one short period of rain precluded data collection along a two km section of the route during June 1982. Wind speed was consistently low (i.e., ≤20 kph) during the surveys. We found a moderate correlation between sky conditions and number of vultures counted; i.e., fewer vultures was seen on cloudy than on clear days (r_s = 0.3890, df = 18, 0.05 < P < 0.10). A total of 7186 km were surveyed in 11 counts, with a total of 25 371 vulture sightings. An average of 2306.5 (±623.19 S.D.) vultures/survey were sighted (range = 1503–3363; Table 2), or an average of about 3.5/transect kilometer. Santana et al. (1986a) reported substantially fewer vultures (means for four transect segments ranged from 0.002–0.9/km) from roadside counts in southwestern Puerto Rico, as did Hubbard (1983) in New Mexico (0.03/km).

We noted peaks in March, April and June numbers of birds observed (Table 2). Counts were substantially lower during the periods July–October and December–January (ANOVA; F = 9.56, df = 10, 66; P < 0.01). However, our small sample size (single monthly surveys) and the variation in sky conditions do not allow a realistic evaluation of seasonal variation in vulture numbers. Sky conditions were poor (complete cloud cover) in January, and only fair (mostly cloudy) during the December count, which might explain the low numbers of birds counted during those surveys. However, the weather was good to excellent (clear or mostly clear) during the July–October surveys (Table 1). Although Turkey Vultures have not been reported as migratory in Cuba previously (Wilbur 1983), two birds marked (patagial color streamers) in south Florida have been observed near La Habana (Wotzkow, pers. observ.). Such movements, along with possible local movements in response to seasonal food distribution, may have influenced local numbers of vultures along our survey route. Breeding season for Turkey Vultures has not been clearly defined for West Indies populations, but nests have been found in Cuba in February (eggs), April (older nestlings), and May (young nestlings) (Davis 1941; Jackson 1983). Thus, low counts in July, August and October were not likely due to parental attendance at nests.

Table 2. Results of surveys for Turkey Vultures, La Habana to Victoria de las Tunas, Cuba, March 1982–January 1983.

Survey No.	Month	Number: Vultures Sighted		Number: Vultures/km
1	March	3363		5.2
2	April	2726		4.2
3	May	2369		3.6
4	June	3358		5.2
5	July	1649		2.5
6	August	1924		2.9
7	September	2384		3.7
8	October	1917		2.9
9	November	2141		3.3
10	December	2037		3.1
11	January	1503		2.3
	Total	25 371	Mean	3.5

Vulture flight activity differed during the day. Activity was low before 0800 H, and declined substantially after 1800 H (Fig. 2). Two peak periods of activity were observed: one between 0900 H and 1200 H and a second between 1400 H and 1700 H.

Number of vultures observed was inversely related to the distance from the transect line (r_s = −0.900, P < 0.01). Observations of vultures declined substantially beyond 200 m, suggesting that detection was less likely beyond that distance (Fig. 3). The number of vultures observed within 201–400 m from the transect was about 32% less than the numbers detected in closer ranges. Numbers of vultures observed within 401–600 and >600 m from the transect were only 13.1% and 6.4% of the number we counted within 200 m. An alternative explanation to birds being less detectable at distances >200 m may be that vultures concentrated along roads for food (i.e., road kills). A check study is needed to determine if vultures are clustered along roads and to verify error rates of placing observations into distance segments away from the transect line.

Vulture abundance (and detectability) were analyzed among the six segments of the transect that reflected habitat differences. Vulture counts were weighted to compensate for reduced flying activity

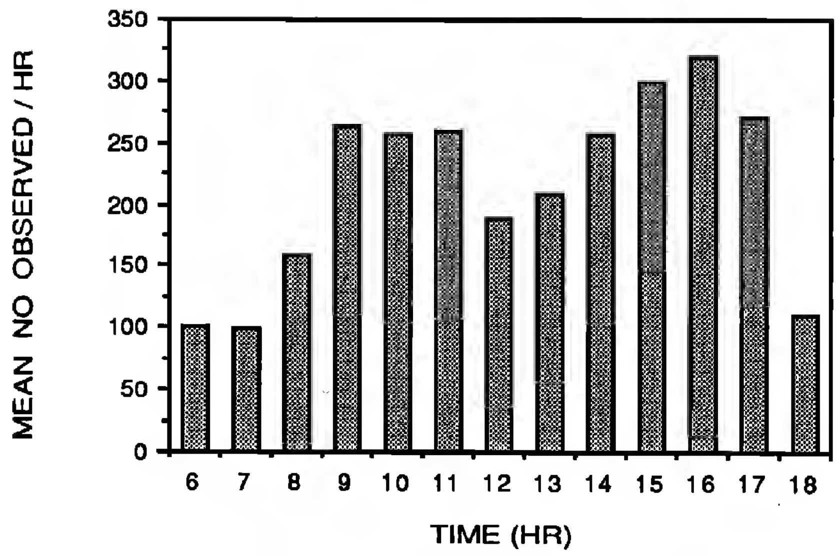

Figure 2. Turkey Vulture activity, expressed as mean number of birds (N = 25 371) observed per hour through day during 11 roadside surveys in Cuba, March 1982–January 1983.

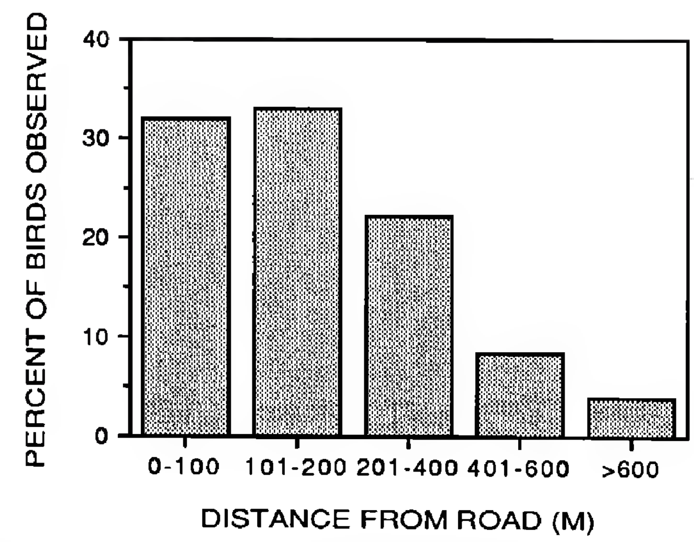

Figure 3. Percent of Turkey Vultures (N = 25 371) observed within five distance segments during 11 surveys in Cuba, March 1982–January 1983.

(thus increased visibility) before 0900 H, between 1200–1400 H, and after 1700 H. Vultures counted within the six regions along the survey route differed (ANOVA; F = 9.12, df = 6, 70; $P < 0.01$). Highest counts occurred in segments that had greater vegetative and physical variety (e.g., Alturas de Santa Clara and Peniplano de Florida-Camagüey-Tunas). Counts were lowest in the plains and cultivated areas. Santana et al. (1986a) also reported fewer vultures in agricultural areas of Puerto Rico. In our surveys calculated density of observed vultures ≤200 m of the road was 0.06/ha (287 440 ha sampled in 11 surveys).

Cuban vulture populations are subject to the same factors that might adversely affect vulture populations in other regions (i.e., habitat modification, chemical pesticides, persecution, and to a lesser extent man-related accidents; reviewed by Wilbur 1983) and should be monitored. We recommend that vulture surveys be conducted at 5–10 yr intervals to detect changes in population levels in Cuba. Roadside count methods appear suitable for these surveys. However, we make the following recommendations for improving survey methods: 1) conduct counts along regular transect routes throughout the year to determine if seasonal fluctuations in numbers are real; 2) if counts vary through the year, survey during low count periods (e.g., January, July, August and October in this study) to exclude possible influx of migrants for a conservative population estimate; 3) conduct surveys between 0900–1200 H and 1400–1700 H on clear days; and 4) conduct more frequent counts which could be completed in a single day.

ACKNOWLEDGMENTS

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ROAD TRANSECT COUNTS FOR RAPTORS: HOW RELIABLE ARE THEY?

BRIAN A. MILLSAP AND MAURICE N. LEFRANC, JR.

ABSTRACT.—Biases in roadside counts of randomly placed three-dimensional models of perched Red-tailed Hawks (*Buteo jamaicensis*), Cooper's Hawks (*Accipiter cooperii*), and Sharp-shinned Hawks (*A. striatus*) were investigated. Counts were performed by seven, two-person survey teams in five vegetation types in September 1983 and March 1984 at Dulles International Airport in Fairfax and Loudoun counties, Virginia. Larger models were consistently seen more frequently than smaller models in grassland but not in forest or woodland. Models were more visible in grassland than in forested vegetation. Foliage structure variables accounted for 58% of variation in model detectability among vegetation types.

Overall, survey teams detected between 5.4% (deciduous forest in summer) and 48.4% (grassland in winter) of the models. Density indices calculated with line and strip transect methods were compared with known density. A modification of the mean visibility method produced the most accurate population estimates, whereas unadjusted counts had the highest precision.

Quantification of raptor populations is difficult and costly. Most raptors are widely distributed, occur in a variety of habitats and are secretive. Accordingly, survey techniques useful for other birds are often ineffective when used to survey raptors (Fuller and Mosher 1981).

A widely used raptor survey technique is the road transect, which yields sample sizes sufficient for quantitative analysis and is relatively inexpensive. In most cases researchers using road transects to survey raptors repeatedly drive a specified route at speeds of 15-40 km/hr on calm, clear days. One to two observers count all raptors sighted in a strip 0.4-0.8 km wide on either side of the road (Craighead and Craighead 1956; Johnson and Enderson 1972; Stahlecker and Belke 1974; Marion and Ryder 1975; Woffinden and Murphy 1977; Craig 1978; Wilkinson and Debban 1980; Peterson 1979; Diesel 1984). Road transects have been used to obtain indices to raptor density or relative abundance in order to assess or compare population structure, seasonal population changes, habitat use, distribution, yearly population trends and to determine activity (Craighead and Craighead 1956; Mathisen and Mathisen 1968; Johnson and Enderson 1972; Woffinden and Murphy 1977). Modifications of the technique also have been used to survey populations of rare or endangered species (Southern 1963; Sykes 1979).

Raptor road counts are affected by a number of inherent biases, principally intra- and interspecific variation in species detectability (Fuller and Mosher 1981). Many researchers have assumed that all raptors within a surveyed area were detected while others have acknowledged that not all are observed. Some researchers have developed correction factors to compensate for individuals not counted (Craighead and Craighead 1956; Millsap 1981); others have cautioned against literal interpretation of data collected from densely vegetated habitats or for less observable species (Mathisen and Mathisen 1968; Kiff and Axelson 1977; Craig 1978). Other sources of bias include variations in terrain and alterations in roadside vegetation that affect visibility; variation in raptor dispersion with changes in perch availability; variability in prey abundance; change in activity of raptors with weather, season and time of day; and differences in observer expertise (Cade 1969; Stahlecker and Belke 1974; Fuller and Mosher 1981).

Effect of biases on road transect data remain poorly understood since the technique has not been evaluated in an area where raptor populations are known. A number of techniques are available to adjust transect data for passerine birds (e.g., Emlen 1971; Burnham et al. 1980; Anderson and Ohmart 1981; Ramsey and Scott 1981; Tilghman and Rusch 1981). Compared to raptor road transects, however, passerine transects are shorter, sample sizes are often larger, habitat and terrain is generally more homogeneous and travel by foot through undisturbed vegetation is possible. Nevertheless, a modification of one or more techniques, when applied to raptor road counts, might improve reliability of population estimates (Andersen et al. 1985).

Objectives of this study were to 1) evaluate the accuracy and precision of population indices from unadjusted road transect data for three raptor species

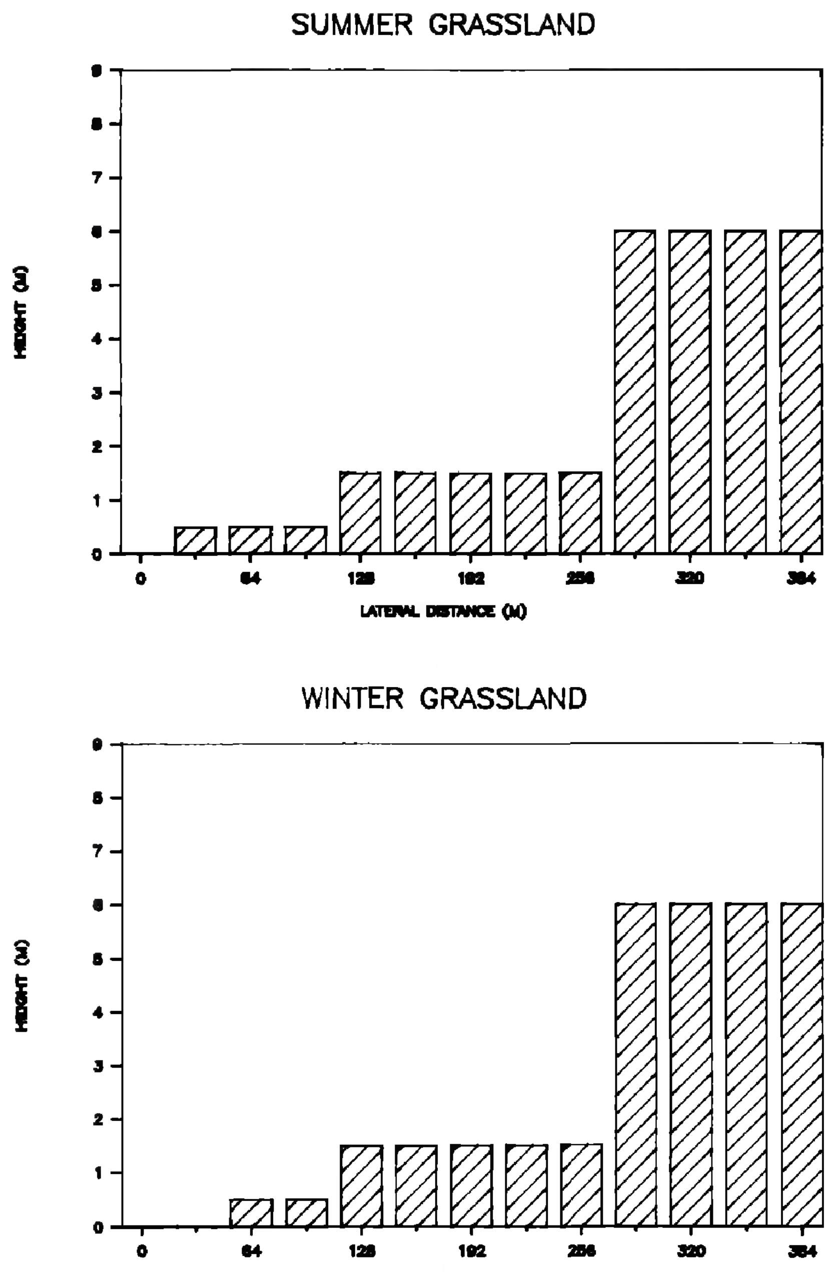

Figure 1. Vegetation profile of grassland vegetation type, Dulles Airport, Virginia. Lateral distance refers to the mean distance perpendicular to the roadway at which ≥½ density board was obstructed by vegetation. Shaded region represents the portion of the sample strip not visible to observers.

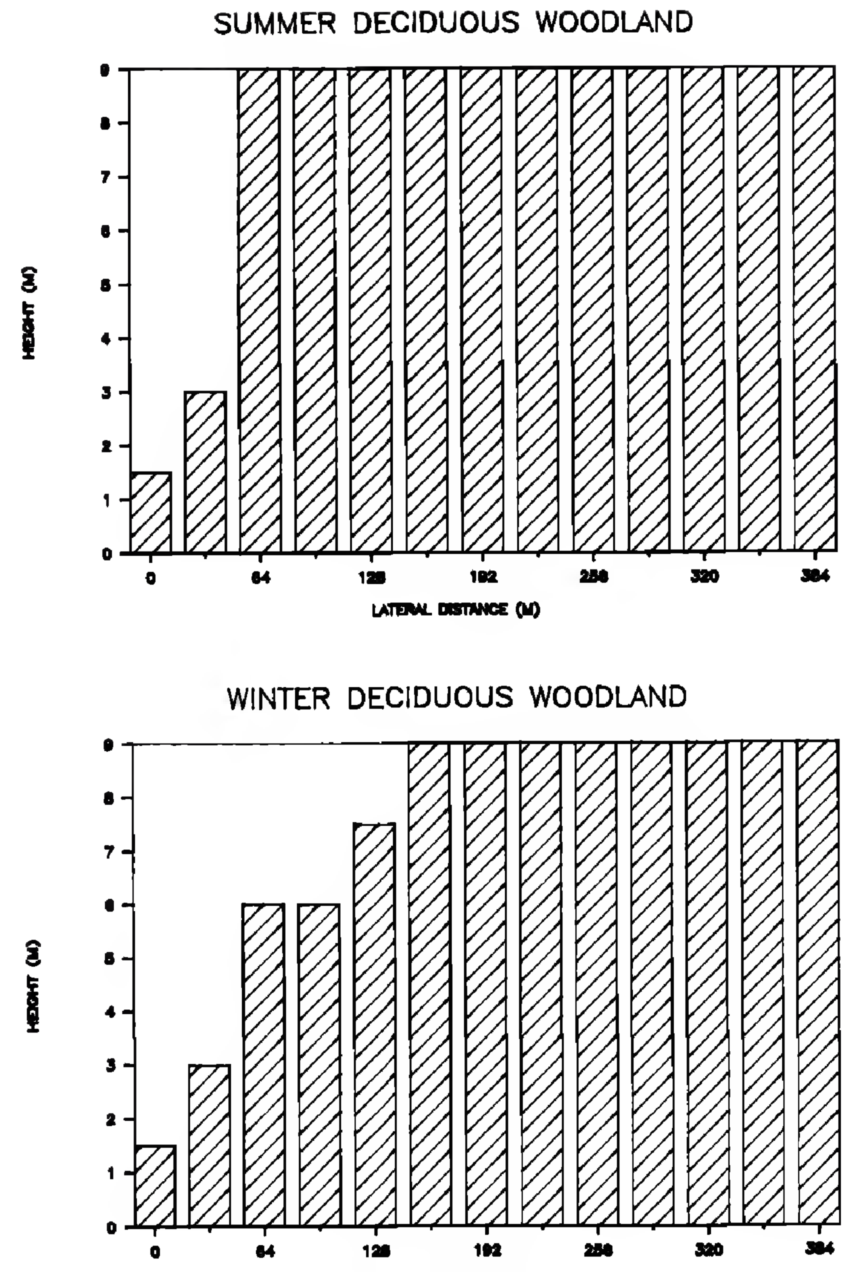

Figure 2. Vegetation profile of deciduous woodland vegetation type, Dulles Airport, Virginia. Lateral distance refers to the mean distance perpendicular to the roadway at which ≥½ density board was obstructed by vegetation. Shaded region represents the portion of the sample strip not visible to observers.

of known density in five vegetation types, and 2) determine if line and strip transect analysis techniques improve accuracy and precision of road count density estimates.

Study Area and Methods

The study was conducted on the 59 km^2 Dulles International Airport complex, located in Fairfax and Loudoun counties, Virginia. Oak (*Quercus* spp.)-pine (*Pinus* spp.) forest is the climax plant community although seral stages ranging from open grassland, eastern red-cedar (*Juniperus virginiana*) woodland and oak forest are represented. Airport property is closed to public access, and unimproved roads are present through all vegetation types.

Data Collection. Data were collected from May 1983–March 1984. A 29.5 km transect was established along existing roadways that passed through five different vegetation types: grassland, deciduous woodland (second growth deciduous forest ≤12 m in height), deciduous forest (mature deciduous forest), coniferous woodland (red-cedar stands ≤10 m in height), and coniferous forest (planted loblolly pine [*P. taeda*]). Homogeneous vegetation plots were identified along the transect route in each vegetation type. Size and number of plots in each type were in proportion to each type's abundance along the transect. Plots started at the edge of the road and were 402 m wide. Plot length varied with the extent of homogeneous vegetation (range = 390–1520 m). A total of 13 plots was selected in summer and 14 in winter (four [summer] or five [winter]

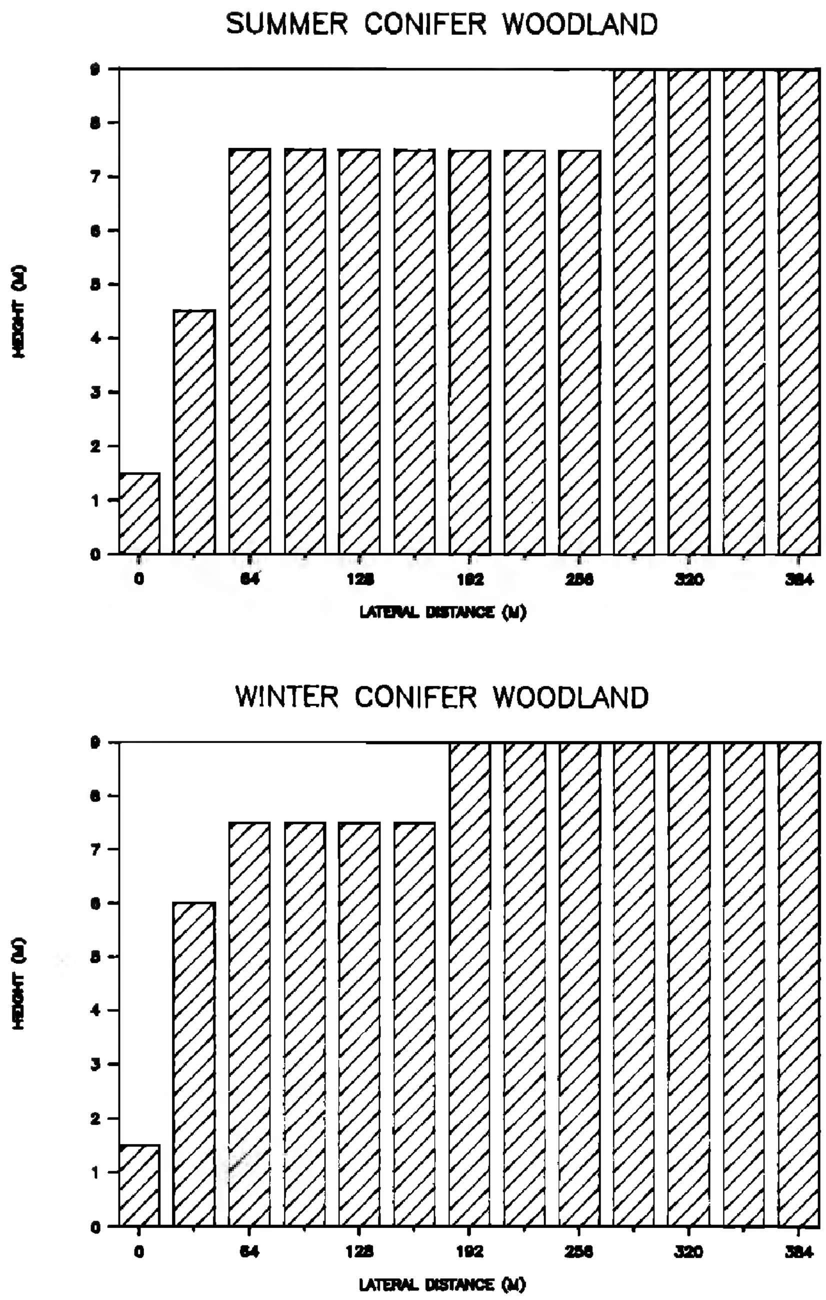

Figure 3. Vegetation profile of conifer woodland vegetation type, Dulles Airport, Virginia. Lateral distance refers to the mean distance perpendicular to the roadway at which ≥½ density board was obstructed by vegetation. Shaded region represents the portion of the sample strip not visible to observers.

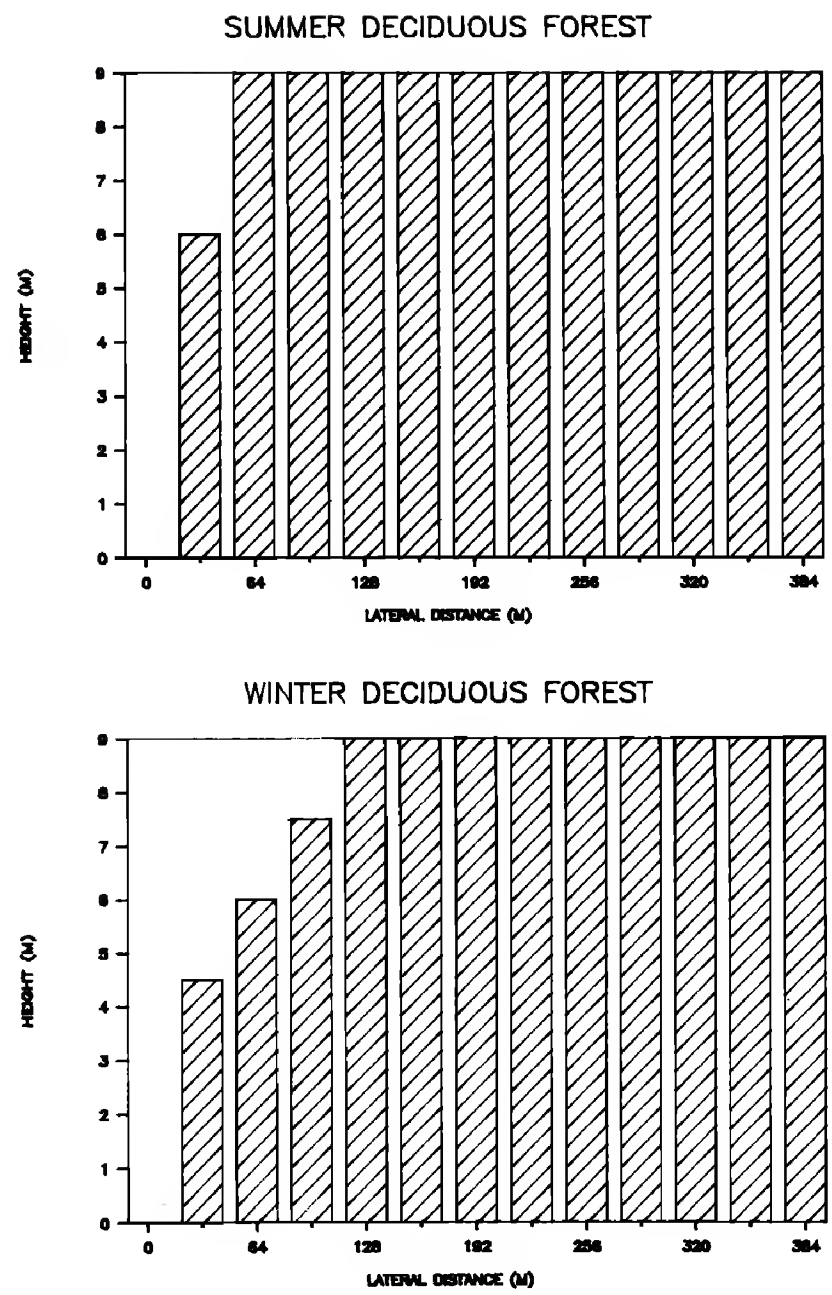

Figure 4. Vegetation profile of deciduous forest vegetation type, Dulles Airport, Virginia. Lateral distance refers to the mean distance perpendicular to the roadway at which ≥½ density board was obstructed by vegetation. Shaded region represents the portion of the sample strip not visible to observers.

in grassland, two in deciduous woodland, two in coniferous woodland, two in deciduous forest, and three in coniferous forest).

Horizontal foliar density was measured using a density board along 107 randomly selected transects stratified among plots (MacArthur and MacArthur 1961; Hays et al. 1981). Transects were oriented perpendicular to the road and covered the full width of the plot (402 m). Horizontal foliar density was measured at standardized height intervals (1.5, 3.0, 4.5, 6.0, 7.5 and 9.0 m) and set lateral distances (25 points from 0–402 m at 16 m intervals) along each transect. Distance from the road at which ≥½ of the density board was obscured by vegetation was determined at each point for each height interval. Measurements taken in winter (January) and summer (July) were used to calculate relative degree of vegetative screening and amount of habitat visible to observers in each vegetation type during each season (Figs. 1–5).

We constructed three-dimensional styrofoam models that resembled perched Sharp-shinned Hawks (*Accipiter striatus*) (summer: N = 35; winter: N = 32), Cooper's Hawks (*A. cooperii*) (summer: N = 46; winter: N = 45), and Red-tailed Hawks (*Buteo jamaicensis*) (summer: N = 24; winter: N = 24). The number of models of each type was determined by logistic constraints and availability of material. Models were randomly placed along the transect in vegetation plots. To facilitate random placement, plots were gridded into 16 m^2 cells. Each model was randomly allocated to a cell, height class (0%–10%, 10%–20%, . . . , 80%–100% of the maximum vegetation height in the cell),

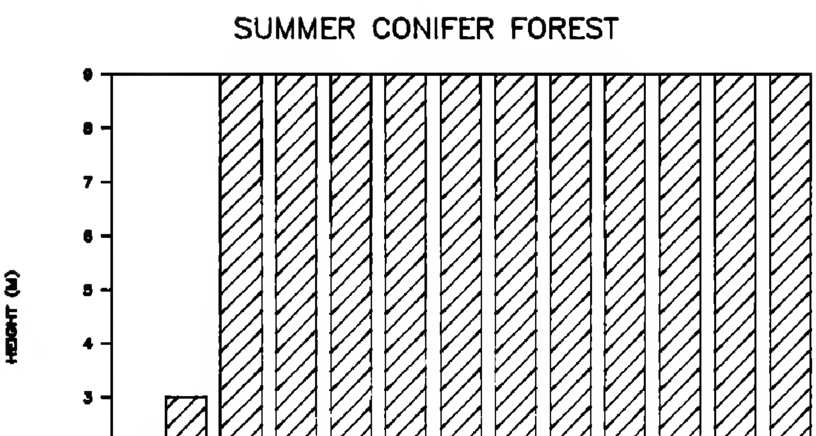

Figure 5. Vegetation profile of coniferous forest vegetation type, Dulles Airport, Virginia. Lateral distance refers to the mean distance perpendicular to the roadway at which ≥½ density board was obstructed by vegetation. Shaded region represents the portion of the sample strip not visible to observers.

side of the perch substrate and facing direction (north, south, east or west). Models were placed on the outside of the tree or shrub (meeting height requirements) that was closest to the center of the cell. No models were placed higher than 10.5 m for logistical reasons, even though tallest vegetation exceeded this height in deciduous and coniferous forest. Models randomly allocated to locations impossible to observe from the transect were relocated randomly until a potentially detectable site was selected. All locations used were considered in analyses, so that our total model population size was 598 in summer (141 Red-tailed Hawk, 265 Cooper's Hawk, and 192 Sharp-shinned Hawk models) and 339 in winter (80 Red-tailed Hawk, 129 Cooper's Hawk, and 130 Sharp-shinned Hawk models).

Seven teams of two observers each drove the transect at speeds from 25–42 km/hr and counted models under similar weather and lighting conditions once in each season.

Data Analysis. Differences in model detectability among model types and vegetation types were evaluated using one- and two-way ANOVAs, followed by T-method unplanned comparisons of groups (Sokal and Rohlf 1981). Analyses were based on the arcsine transformation of the proportion of models detected (Sokal and Rohlf 1981).

Multiple regression analysis on model counts in each of the 27 study plots (13 in summer; 14 in winter) was used to assess effects of vegetative structure on detectability. Vegetation variables used were: 1) foliage height diversity (Hays et al. 1981); 2) foliage volume index, calculated as the mean lateral distance at which ≥½ of the density board was obscured by vegetation over all height increments; 3) visible plot area, calculated as the maximum lateral distance at which ≥½ the density board was obscured by vegetation at any height interval × length of the plot, and divided by the total plot area (assuming a 402 m lateral width); 4) visible plot volume, calculated as the visible volume in each height interval (plot length × lateral distance at which ≥½ density board was obscured by vegetation × 1.5 m) summed over all height intervals and divided by total volume (plot length × 402 m × 9 m); and 5) maximum overstory vegetation height in the plot. Regression was performed using Statistical Package for the Social Sciences (Nie et al. 1975).

Accuracy of model density indices and relative abundance estimates calculated using the following line and strip transect methods were evaluated: 1) unadjusted counts (i.e., raw counts); 2) Emlen's estimator based on perpendicular distances (Emlen 1971); 3) the bounded count method (Robson and Whitlock 1964; Overton 1971); 4) the Fourier series estimator (Burnham et al. 1980, as used by Andersen et al. 1985); and 5) a modified version of the mean visibility method (Hirst 1969) using the bounded count approach. Fourier series estimator performs best with sample sizes ≥40 and for monotonic decreasing detection curves with a well defined shoulder near the center line (Burnham et al. 1980). We did not calculate density indices using the Fourier series estimator in cases where these conditions were not met. Modified mean visibility method involves the same procedures as bounded count (i.e., [two × the largest number of individuals detected on one of a series of counts in sample strip] − the second highest count is taken as the best estimate of population size for the strip), except that density indices were based on volume of roadside habitat actually visible to observers

Throughout, accuracy is defined as the closeness of the estimate to the true or known value, expressed as a percent of the true value. Accuracy bias is defined as the absolute value of (accuracy minus 100%). Precision is defined as the closeness of repeated measurements, and is expressed as the coefficient of variation (CV).

RESULTS

We were unable to adequately test for differences in detectability among teams of observers. Pooled summer and winter counts showed no significant interteam differences (one-way ANOVA; 0.25 >

Table 1. Mean % of hawk models detected by model type and by vegetation type in summer (N = 7) and winter (N = 7) on road transect counts at Dulles Airport, Virginia, 1983–1984.

MODEL TYPE		GRASSLAND	DECIDUOUS WOODL.	DECIDUOUS FOREST	CONIFEROUS WOODL.	CONIFEROUS FOREST	VEG. TYPES COMBINED
		($\bar{x}$GR)	($\bar{x}$DW)	($\bar{x}$DF)	($\bar{x}$CW)	($\bar{x}$CF)	($\bar{x}$VEG)
			Summer[a]				
Red-tailed Hawk	($\bar{x}$RT)	44.1	14.3	6.8	32.4	8.0	11.3
	95% CL	41.7–46.5	13.2–15.4	5.9–7.7	11.9–25.9	6.6–9.3	10.3–12.2
	CV	3.8	14.7	24.1	40.0	18.5	10.8
Cooper's Hawk	($\bar{x}$CH)	39.1	7.4	5.6	6.9	6.4	9.4
	95% CL	34.8–39.1	6.2–7.9	2.0–9.1	5.6–8.3	3.4–9.4	8.5–10.4
	CV	12.5	17.7	68.4	20.9	50.3	10.9
Sharp-shinned Hawk	($\bar{x}$SS)	21.0	4.8	7.1	16.5	6.8	7.1
	95% CL	16.5–26.3	2.3–7.2	5.2–9.1	10.1–22.9	4.2–9.3	5.1–9.1
	CV	27.7	55.3	29.0	42.2	40.9	30.6
Model types combined	($\bar{x}$MOD)	33.9	7.0	5.7	11.8	7.7	9.2
	95% CL	29.0–37.7	6.0–8.1	4.6–6.8	10.0–13.6	6.3–9.2	8.0–10.4
	CV	12.9	16.6	20.8	16.7	20.5	14.0
			Winter[b]				
Red-tailed Hawk	($\bar{x}$RT)	71.9	10.5	19.4	4.9	3.4	10.3
	95% CL	63.5–79.4	0.2–20.6	12.5–26.1	3.1–2.0	1.1–2.5	8.4–12.3
	CV	15.5	106.5	22.2	38.4	68.6	20.7
Cooper's Hawk	($\bar{x}$CH)	70.0	22.2	13.1	5.1	6.2	13.8
	95% CL	63.6–75.9	14.4–30.0	8.4–17.8	4.1–6.1	2.8–7.5	11.1–16.5
	CV	12.0	38.6	38.9	20.3	41.8	21.1
Sharp-shinned Hawk	($\bar{x}$SS)	30.9	7.8	3.6	6.6	9.7	8.7
	95% CL	16.6–44.4	5.7–9.8	1.5–5.7	3.5–9.6	7.6–11.7	7.1–10.3
	CV	50.4	28.4	62.2	50.0	23.1	20.3
Model types combined	($\bar{x}$MOD)	48.4	13.7	9.4	5.8	6.8	11.3
	95% CL	29.5–65.2	9.2–17.8	6.5–12.2	4.5–7.3	5.0–8.6	9.5–13.2
	CV	44.0	32.0	33.3	25.7	28.6	18.0

[a] Mean accuracy was significantly different among vegetation types and model types (2-way ANOVA; $P < 0.05$). T-method unplanned comparisons (experimentwise $\alpha \leq 0.05$) (Sokal and Rohlf 1981) indicated that, among model types, $\bar{x}$RT > $\bar{x}$CH in deciduous and coniferous woodland; $\bar{x}$RT > $\bar{x}$SS in grassland, and in deciduous and coniferous woodland; and $\bar{x}$CH > $\bar{x}$SS in grassland and deciduous woodland. Among vegetation types, $\bar{x}$GR > $\bar{x}$DW, $\bar{x}$DF, $\bar{x}$CF for all model types; $\bar{x}$GR > $\bar{x}$CW for Red-tailed and Cooper's Hawk models; $\bar{x}$CW > $\bar{x}$DF, $\bar{x}$CF for Red-tailed and Sharp-shinned Hawk models.

[b] Mean accuracy was significantly different among vegetation types and model types (2-way ANOVA; $P < 0.05$). T-method unplanned comparisons (experimentwise $\alpha \leq 0.05$) (Sokal and Rohlf 1981) indicated that, among model types, $\bar{x}$RT > $\bar{x}$CH in deciduous forest, $\bar{x}$CH > $\bar{x}$RT in deciduous woodland and conifer forest; $\bar{x}$RT > $\bar{x}$SS in grassland, deciduous forest; $\bar{x}$SS > $\bar{x}$CH in conifer forest; $\bar{x}$CH > $\bar{x}$SS in grassland, deciduous woodland, and deciduous forest; $\bar{x}$SS > $\bar{x}$CH in conifer forest. Among vegetation types, $\bar{x}$GR > $\bar{x}$DW, $\bar{x}$DF, $\bar{x}$CW, $\bar{x}$CF for all model types; $\bar{x}$DW > $\bar{x}$CF for Cooper's Hawk models.

$P > 0.10$), but the large within-group variance (due to seasonal disparities in detectability) potentially masked between-group effects. Data from all survey teams were pooled in subsequent analyses.

There was a significant difference in detection rates among model types (Table 1), but small sample sizes and a randomized method of model placement potentially introduced bias. Differences varied seasonally and among vegetation types. In grassland in both summer and winter Red-tailed Hawk and Cooper's Hawk models were detected more frequently than Sharp-shinned Hawk models. In other vegetation types there were no consistent differences in accuracy with model type. Counts of Red-tailed

Table 2. Accuracy bias and precision of density indices by vegetation type for hawk models based on road transect counts at Dulles Airport, Virginia, 1983–1984.

	Accuracy Bias[a]			
Technique	Red-tailed Hawk	Cooper's Hawk	Sharp-shinned Hawk	Models Pooled
		Summer grassland		
Unadjusted count	55.9	60.9	79.0	66.7
Emlen's	94.1	85.4	43.7	38.7
Bounded count	49.9	40.0	58.8	49.9
Mean visibility	0	0	33.4	10.0
Fourier series	ND[b]	59.6	65.1	62.4
		Winter grassland		
Unadjusted count	28.1	30.0	69.1	51.6
Emlen's	124.8	8.5	19.7	27.4
Bounded count	30.3	10.8	58.0	30.6
Mean visibility	0	16.7	0	10.0
Fourier series	ND	ND	41.2	41.2
		Summer woodland		
Unadjusted count	77.6	92.8	89.7	86.9
Emlen's	33.1	64.5	58.8	60.6
Bounded count	76.2	91.8	89.1	89.3
Mean visibility	0	10.0	10.0	6.7
Fourier series	42.5	ND	36.5	37.1
		Winter woodland		
Unadjusted count	92.3	87.7	92.8	90.0
Emlen's	70.0	35.4	65.2	54.4
Bounded count	90.2	83.8	89.4	86.6
Mean visibility	0	33.9	14.4	24.3
Fourier series	11.0	24.2	9.6	3.6
		Summer forest		
Unadjusted count	92.2	94.0	93.1	93.0
Emlen's	58.6	73.6	72.5	54.5
Bounded count	89.7	90.1	89.7	87.9
Mean visibility	8.5	17.7	13.6	14.2
Fourier series	60.5	71.6	36.0	55.9
		Winter forest		
Unadjusted count	89.2	91.1	93.3	92.4
Emlen's	63.5	58.3	73.4	66.1
Bounded count	70.0	81.8	92.3	86.7
Mean visibility	22.4	26.8	29.3	24.5
Fourier series	63.4	112.7	10.6	47.9
		Vegetation types pooled[c]		
Unadjusted count ($\bar{x}$)	72.6A	76.1A	86.2A	80.3A
CV	35.6	33.0	11.5	21.4
Emlen's ($\bar{x}$)	74.0A	54.3A	55.6B	50.3B
CV	42.8	51.5	37.2	28.8
Bounded count ($\bar{x}$)	67.7A	66.4A	79.6A	71.8A,B
CV	34.8	50.1	20.6	35.0

Table 2. Continued.

	Accuracy Bias[a]			
Technique	Red-tailed Hawk	Cooper's Hawk	Sharp-shinned Hawk	Models Pooled
Mean visibility ($\bar{x}$)	5.2B	17.5B	16.8C	15.0C
CV	175.0	68.5	74.8	51.3
Fourier series ($\bar{x}$)	44.4A	67.0A	33.2C	41.4B
CV	27.0	27.1	62.6	50.0

[a] Accuracy bias was calculated as the absolute value of the percent of models present that were detected or accounted for minus 100%.

[b] No Fourier series density estimate was calculated because fewer than 40 models of this type were detected (with data pooled over survey teams) or detection functions did not appear monotonic decreasing.

[c] Mean accuracy was significantly different among methods for all model types (1-way ANOVA; P < 0.05). Means in columns that do not share a letter (A, B, C) differ significantly (T-method for unplanned comparisons [Sokal and Rohlf 1981]; experimentwise $\alpha = 0.05$)

Hawk models were generally most precise, but CVs of Red-tailed Hawk model counts were not smaller than those for other model types more often than could be expected by chance (binomial probability = 0.136).

Accuracy was significantly higher in grassland than in other vegetation types. In general detectability was greater in conifer woodland and winter deciduous woodland than in forests. Count precision was also greatest in grassland; CVs were smallest in grassland more often than expected by chance (binomial probability = 0.016).

Foliage volume index, visible plot volume and foliage height diversity contributed significantly to variation in model detectability among sample plots ($R^2 = 0.58$, $F = 10.65$, $P < 0.001$, df = 3,23). Partial regression coefficients were biased due to multicolinearity, but foliage volume index appeared to be the most important single variable (contribution to $R^2 = 0.39$).

In grassland, models of all three types were detected with about equal frequency to lateral distances of 100 m. Detectability of Sharp-shinned Hawk models dropped sharply beyond this distance, whereas detectability of Red-tailed Hawk and Cooper's Hawk models began dropping sharply at about 300 m. Detectability of all models dropped simultaneously at lateral distances 32–48 m in woodland and forest.

Accuracy bias of various density indices differed significantly (Table 2). In general, mean visibility, Fourier series and Emlen's method yielded the most accurate results; mean visibility was by far the most accurate. Unadjusted counts yielded estimates that averaged only 20% of actual values. Even in grassland, accuracy of unadjusted counts averaged only 33% (summer) to 48% (winter) over all plots. However, unadjusted counts were more precise than adjusted counts. CVs for density indices tested ranged from 21%–175%; range for unadjusted counts was from 12%–36%.

Discussion

Two important differences exist between our experiment and actual raptor counts. First, hawks do not randomly select perches (Marion and Ryder 1975). Experienced observers develop a search image, based in part on perch-site characteristics, for particular species or groups of species (e.g., buteos) (Craighead and Craighead 1956; Cade 1969; Fuller and Mosher 1981). Thus, a difference in detectability on actual raptor counts is likely between experienced and inexperienced observers. Second, movement by live birds would increase detectability and boost accuracy. Despite these differences, we believe many of our findings have application to counts of raptors.

Many researchers have concluded that small raptors are detected less frequently than large raptors on road transect counts (Craighead and Craighead 1956; Mathisen and Mathisen 1968; Fitch et al. 1973). Despite potential bias, our results suggest the size of models consistently affected detectability only in open vegetation, where observers regularly sighted models >100 m away from the vehicle. In closed vegetation, such as woodland and forest, observers seldom detected models >48 m away due to the screening effects of vegetation. At <48 m variation in model detectability did not appear to be related to model size.

Variation in accuracy of counts among vegetation types has been suspected as a major bias in road transect counts (Hiatt 1944; Cade 1969; Millsap 1981). Our results support the intuitive hypothesis that volume and distribution of foliage are primary factors affecting detectability. For stationary models differences in average detectability between grassland and forest were as high as 46%. Even in grassland, accuracy ranged from 40% (summer) to 85% (winter) among plots. As noted above, however, under actual conditions bias would probably not be as severe.

Our results suggest that adjustment of counts to account for detectability differences will usually improve accuracy but may lower precision. Line or strip transect estimators should be considered in studies comparing abundances of different species or of a single species in different vegetation types. Unadjusted counts might be superior, however, in monitoring studies where trends in raptor numbers over time along the same transect route is the object of interest.

Both line and strip transect methods are based on assumptions that are difficult to meet using roads as transects. Line transect estimators have the following assumptions and requirements (Burnham et al. 1980):

Assumption 1) All raptors on the transect line are detected.

Assumption 2) Raptors do not flush away from the transect line before being observed.

Assumption 3) No raptors are counted twice.

Assumption 4) Perpendicular distance measures are accurate.

Assumption 5) Sightings are independent.

Assumption 6) If the transect line is not randomly placed, that raptors are distributed randomly with respect to the transect.

Andersen et al. (1985) and Smith and Nydegger (1985) justified using line transect estimators on road transect data from southeastern Colorado and southwestern Idaho, respectively. Nevertheless, we believe that Assumption 6 above is violated in many raptor road transect studies because transect routes are not randomly selected and some raptor species probably avoid and others might be attracted to roadside areas to differing degrees in different habitats. Under these conditions inferences to nonroadside target populations might not be appropriate. Strip transect methods assume that all objects within the strip are observed or accounted for (Eberhardt 1978), an assumption that was not met in our study with models. Detection rates decreased sharply for all models beyond 32 m in forest and, for Sharp-shinned Hawk models, beyond 100 m in grassland. Detection rates would likely be greater for hawks, but it is unlikely that all individuals would be detected in all habitats.

Although our results show that accuracy and precision can be greater with a strip transect technique (mean visibility method using bounded counts), Burnham et al. (1985) determined that line transect methods are generally more efficient. Regardless which approach is taken, presenting results based on volume of habitat searched allows more direct comparison of results between studies than do other measures of search effort. Raptors per km^2, per km driven, or per hour do not take into account effects on sample area size of screening vegetation and topography. A disadvantage is the additional time required to measure vegetation variables necessary to calculate volume estimates. A range finder used to measure distances to screening vegetation might expedite such measurements.

Road transect counts are most appropriate for sampling raptor populations in open vegetation. The chief difficulty in woodland and forest vegetation is obtaining suitable sample sizes. We were unable to perform Fourier series analyses in four of 18 comparisons due to inadequate sample sizes (i.e., $N \leq 40$). An alternative to road transect counts is available for sampling breeding woodland raptors; playback recordings of calls have been used with good success to estimate the proportion of area occupied by a species during the breeding season (Geissler and Fuller 1986; Fuller and Mosher 1987). When feasible this method appears superior to road transect counts in woodland and forest.

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FORAGING BEHAVIOUR OF THE BROWN GOSHAWK (*Accipiter fasciatus*) IN SOUTHEASTERN AUSTRALIA

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Abstract.—Five search and four attack techniques were identified for the Brown Goshawk (*Accipiter fasciatus*) foraging in southeastern Australia. Twenty (37%) of 54 observed attacks of known outcome were successful. Adults were significantly ($\chi^2 = 13.8$, $P < 0.001$) more successful than first-yr juveniles. Trapping efforts indicate most foraging activity occurs in early morning and late afternoon and that female and first-yr goshawks forage in more open habitat than males and adults.

The Brown Goshawk (*Accipiter fasciatus*) is common and widespread in Australia (Blakers et al. 1984). A medium-sized raptor (mass: female $\bar{x}$ = 561 g, N = 121, male $\bar{x}$ = 349 g, N = 82; Aumann 1988a) with long tarsi and relatively long, pointed wings (Wattel 1973), the species lacks the extremely long middle toe characteristic of the small bird-eating accipiters (Brown and Amadon 1968). In this study Brown Goshawk foraging behaviour is described, and considered in terms of the morphology of the species.

Study Area and Methods

During February 1980–March 1985 approximately 7500 hr was devoted to a field study of Brown Goshawk biology in a rural (65% cleared to pasture) area at Macclesfield (37°54′S, 145°30′E), 50 km east of Melbourne, southeastern Australia. In addition to chance observations of foraging activity made in the course of this project, five known foraging sites were monitored from hides for a total of approximately 40 hr in the early morning and late afternoon. These sites were Common Starling (*Sturnus vulgaris*) nocturnal roosts (two) in streamside vegetation, hedges (two) used by House Sparrows (*Passer domesticus*) and a concentration of grazing European Rabbits (*Oryctolagus cuniculus*) on pasture adjacent to a two ha woodlot. Supplementary observations totalling approximately 30 hr were undertaken from hides at Werribee and Lysterfield Lake, respectively 40 km southwest and 35 km southeast of Melbourne. The former area has a large rabbit population throughout the year, and the latter a large Common Starling roost in a reedbed. While observations at Macclesfield were conducted more or less uniformly throughout the year, Werribee and Lysterfield Lake observations were restricted to winter.

Observed instances of foraging activity were categorized using nomenclature and definitions for search and attack techniques of Fox (1981) and Baker-Gabb (1980) with minor modifications. On occasions an attack was difficult to classify. For example, a "direct flying attack" could develop into a "chase" if the prospective prey took flight. In such instances only the initial attack technique was recorded. Some attacks involved several attempts to catch prey. For example, a Brown Goshawk seen to make several passes through a flock of birds with capture attempts on each pass was regarded as having made one attack. If an attack was then abandoned (by perching or flying away) any subsequent resumption constituted additional search and attack observations.

Trapping data were used to investigate temporal and habitat related aspects of Brown Goshawk foraging at Macclesfield. Trapping occurred during early March–late August 1980 and 1981, late February–late July 1982 and late January–late April 1983. Traps used were similar to those of Kenward and Marcström (1983), baited with live, white Feral Pigeons (*Columba livia*). Between eight and 12 traps were set at any one time for a total of approximately 15 000 hr. Placed on the ground in 49 randomly scattered positions over a 64 km² area, traps were set for 60–90 hr at a time and checked three times/d: at 1030 H, 1530 H and sunset (all times ±45 min). Trapping positions were categorized using three habitat classes, and capture times (i.e., the times when captured goshawks were removed from traps) were grouped into three intervals based on checking times. Trapping data were recorded only for goshawks at first capture in order to prevent bias resulting from repeated captures of individuals. Captured and observed goshawks were aged as "first year" or "adult" on the basis of plumage characteristics and sexed by size (Aumann 1988a).

Results

Brown Goshawks used five search and four attack techniques in 54 instances of foraging of known outcome (Table 1). Perch hunting was the most commonly used search technique (23 records) followed by ground hunting (12 records) and fast contour hunting (10 records). Direct flying attacks represented nearly 50% of all observed attacks, and were used in conjunction with four search techniques.

Low perches such as earth mounts and paddock fence posts were used by female Brown Goshawks foraging for rabbits and rodents at Werribee. Although perches used were exposed, each could be reached unseen by low level approach flights within the confines of nearby irrigation channels. Prey were attacked while grazing on roadsides 0–8 m from fencelines, and escape to heavier vegetation within

Table 1. Brown Goshawk foraging methods and success rates in southeastern Australia [% successful attacks (N attacks of known outcome)].

Search/Attack Technique	Prey	Male First Yr	Male Adult	Female First Yr	Female Adult	Unknown	All
Perch Hunting							
Direct flying attack	mammal	—	—	0 (2)	50 (2)	—	25 (4)
Direct flying attack	bird	0 (1)	—	0 (3)	67 (3)	100 (1)	38 (8)
Glide attack	mammal	0 (1)	—	20 (5)	100 (3)	—	44 (9)
Chase	bird	—	—	0 (1)	100 (1)	—	50 (2)
Fast Contour Hunting							
Direct flying attack	mammal	—	—	0 (1)	50 (2)	—	33 (3)
Direct flying attack	bird	—	25 (4)	—	—	—	25 (4)
Chase	bird	0 (2)	—	—	100 (1)	—	33 (3)
Soaring and Prospecting							
Direct flying attack	mammal	—	—	0 (1)	—	—	0 (1)
Direct flying attack	bird	—	—	0 (1)	100 (1)	—	50 (2)
Direct flying attack	reptile	—	—	—	100 (1)	—	100 (1)
Flushing from Cover							
Direct flying attack	mammal	—	—	0 (1)	—	0 (1)	0 (2)
Direct flying attack	bird	—	100 (1)	—	—	—	100 (1)
Ground Hunting							
Pounce and snatch	insect	29 (7)	—	40 (5)	—	—	33 (12)
Unknown							
Direct flying attack	bird	—	0 (1)	—	—	—	0 (1)
Chase	bird	—	—	—	100 (1)	—	100 (1)
All Techniques	mammal	0 (1)	—	10 (10)	71 (7)	0 (1)	32 (19)
All Techniques	bird	0 (3)	33 (6)	0 (5)	86 (7)	100 (1)	41 (22)
All Techniques	all	18 (11)	33 (6)	15 (20)	80 (15)	50 (2)	37 (54)

paddocks was prevented by attack direction. When hunting Common Starlings at Lysterfield, goshawks of both sexes perched in eucalypts (*Eucalyptus* spp.) bordering the lake, in a single Swamp Paperbark (*Melaleuca squarrosa*) emerging from the reedbed starling roost or on the ground within the reedbed itself. Such positions were often occupied >30 min prior to evening starling arrival. Elsewhere, foraging goshawks occupied perches for one to five min before transferring to another position. Most (21 of 23) attack flights launched from perches were <50 m in length and approximately half were <20 m long.

Table 2. Temporal trapping rates for Brown Goshawks captured at Macclesfield, southeastern Australia [% captured/time interval (number captured)].

Time Interval[a]	Male First Yr	Male Adult	Female First Yr	Female Adult	All
Early morning	34 (17)	22 (7)	35 (24)	34 (18)	32 (66)
Midday	8 (4)	25 (8)	10 (7)	17 (9)	14 (28)
Late afternoon	58 (29)	53 (17)	55 (38)	49 (26)	54 (110)

[a] Time intervals defined on the basis of trap check times: early morning—goshawks removed from traps at 1030 H (±45 min); midday—goshawks removed from traps at 1530 H (±45 min); late afternoon—goshawks removed from traps at sunset (±45 min).

Table 3. Habitat differences in capture rates for Brown Goshawks trapped at Macclesfield, southeastern Australia [number of captures/100 trap hours for each habitat].

		Male		Female		
Habitat[a]	Trap hr	First Yr	Adult	First Yr	Adult	All
Type 1	9709	0.4	0.2	0.6	0.4	1.5
Type 2	4680	0.2	0.3	0.2	0.3	1.1
Type 3	992	0.2	0.1	0.1	0.2	0.7

[a] Habitat type 1: trap on pasture with some isolated trees; no woodland >2 ha within 500 m of trap; habitat type 2: trap on pasture with some isolated trees; unbroken woodland >3 ha within 100 m of trap; habitat type 3: trap within an area of woodland >4 ha; no cleared land within 200 m of trap.

However, goshawks twice left perches and chased birds for distances >100 m.

When fast contour hunting for House Sparrows at hedges, male Brown Goshawks flew rapidly alongside the hedge (approximately 0.5 m below the top), crossing over the top once or twice on each pass. Females used a similar search technique at Werribee. By flying rapidly along the channels (just below ground level) and crossing over the top at frequent intervals surprise, short distance, direct flying attacks were launched at grazing mammals. Brown Goshawks at Macclesfield were twice observed to fly just within woodland bordering pasture and then suddenly dash out to attack prey.

During early autumn, first year Brown Goshawks were observed to forage for grasshoppers (*Teleogryllus* spp.) by walking around on well-grazed paddocks while peering from side to side and ahead. Pounce and snatch attacks involved a few quick steps at selected insects before jumping toward them with feet thrust forward.

Brown Goshawks were observed to make four attacks from "prospecting" flights 70–100 m above the ground. Other attacks were made after flushing rabbits or birds from cover by flying or jumping at sheltering vegetation.

Of search techniques recorded >10 times, perch hunting was used most by females and fast contour and ground hunting most by males. Females were observed to attack mammals more often and birds relatively less often than were males. Data were too few for statistical comparison, and no sexual differences were apparent in the use of attack methods. Ground hunting was observed only for first year birds, and no other age differences were apparent in searching behaviour (Table 1).

Twenty (37%) of 54 observed Brown Goshawk attacks of known outcome were successful. Adults were significantly ($\chi^2 = 13.8$, $P < 0.001$) more successful than first year birds (67% vs. 16%). There was no significant success difference between sexes. All search and attack techniques produced success rates of 30%–50%. No significant success rate differences for different prey types were found (Table 1).

More than 90% of observed instances of Brown Goshawk foraging behaviour occurred before 1000 H or after 1500 H. Pre-dawn and post-sunset foraging were seen on two and nine occasions, respectively. Of 204 goshawks trapped at Macclesfield, only 28 (14%) were first captured in the midday interval compared with 66 (32%) and 110 (54%) in the early morning and late afternoon intervals, respectively (Table 2). Temporal difference in trapping rate was significant ($\chi^2 = 49.4$, $P < 0.001$). There were no significant age or sex differences in trapping rate with relation to time of day.

Trapping rates for Brown Goshawks at Macclesfield were more than twice as high in open than in heavily wooded habitat (Table 3). First year goshawks were trapped significantly more often ($\chi^2 = 9.5$, $P < 0.05$) in open habitat and less often in wooded habitat than adults. Although females were trapped at approximately 1.7 times the rate of males in open habitat and at the same rate in more wooded habitats, the sexual difference was not significant ($\chi^2 = 3.1$, $P \nless 0.05$).

Discussion

Studies on raptor foraging behaviour are usually biassed because techniques observed and capture success rates derived may be artifacts of the sites/seasons/time of day observations were made. Furthermore, data points are usually few in relation to those available for other avian groups. The major potential sources of bias in this study were as follows: 1) sites specifically used for foraging observation may have favoured the use of particular foraging techniques (e.g., perch hunting at Werribee and Lysterfield and fast contour hunting at Macclesfield hedgerows). Certain techniques may also be recorded disproportionately often in "random" observations (Newton 1987); 2) if different foraging techniques were appropriate at different sites the extent of sexual niche partitioning with respect to technique utilization may have been exaggerated, since only females were observed at Werribee and only males at Macclesfield hedgerows; and 3) prey availability at Werribee and Lysterfield may have inflated capture success rates above the Brown Goshawk "average."

The impact of these potential bias sources was unknown because data were too few for each age/sex class to allow intersite comparison, and because the only previously published study of Brown Goshawk foraging with more than four data points was also for females wintering at Werribee (Baker-Gabb 1984).

Apart from data provided by Czechura (1979) and Baker-Gabb (1984), Brown Goshawk foraging has been known only from isolated observations. Nevertheless, there are anecdotal literature records for all search and attack techniques reported in this study (Carter 1903; Batey 1907; Fletcher 1918; Salter 1960; Stokes 1973; Mooney 1981, 1987; Hollands 1984). Perch hunting, the search technique most commonly recorded here, was also observed frequently by Czechura (1979) and Baker-Gabb (1984): four of four and 15 of 24 foraging records, respectively, in spite of other techniques being more "observable" (Newton 1987). In general perch hunting consumes less energy than techniques involving prolonged flight (Schmidt-Nielsen 1972; Gessaman 1973), even in the "short-stay" form reported here for the Brown Goshawk and previously for other accipiters (Kenward 1982; Newton 1987). Wattel's (1973) contention that perch hunting is a preferred foraging technique for heavy accipiters is supported by the results of this study, particularly in that perch hunting was more used by female than male Brown Goshawks.

Search techniques with a greater flight component (soaring and prospecting, flushing from cover and fast contour hunting) preceded less than a third of Brown Goshawk attacks observed in this study, and approximately a quarter of attacks by females. These techniques have all been reported for other accipiters (Schnell 1958; Smith 1963; Newton 1987) although fast contour hunting appears common only for smaller forms (Tinbergen 1946; Peeters 1963; Mordue 1982). Both large and small accipiters soar to prospect for prey, possibly locating concentrations prior to initiating other search techniques (Fox 1981; Newton 1987). In spite of high wing loading (Aumann 1988a) the Brown Goshawk soars well, and soaring may be under-represented in the search data since post-soaring attacks would have been difficult to see.

Foraging observations at Macclesfield and Lysterfield mostly involved short distance attacks on airborne birds or insects. Long tarsi presumably facilitate aerial capture by Brown Goshawks: although lacking the long middle toes thought to be correlated with taking prey in flight (Brown and Amadon 1968) the species eats numerous birds (>60% of dietary items, N = 1769; Aumann 1988b).

Brown and Amadon (1968) considered 25% an "average" capture success rate for raptors. However, bird and mammal eating species usually have lower success rates than those taking predominantly fish or insects (Wakeley 1978). On this basis, the 37% capture success rate recorded here for Brown Goshawks is high and possibly attributable to favourable conditions at foraging sites. Furthermore, the definition of "attack" used here inflates capture success rate in comparison to those estimated in studies where every flight deviation toward prey was considered an attack. Czechura (1979) found high capture success rates for three Australian accipiters hunting quail (Family Phasianidae and Family Turnicidae), although data were few.

While foraging success increases with age for some avian species (Recher and Recher 1969; Dunn 1971), there has been little quantitative evidence of foraging success increasing with age for raptors. The high success rate found here for adult in comparison to first year Brown Goshawks is interesting. Mueller and Berger (1970) reported adult Sharp-shinned Hawks (*A. striatus*) to select prey more "wisely" than younger birds, and Fox (1981) found more experienced accipiters to exhibit greater flexibility in use of search techniques.

As in this study, trapping data can be used to investigate temporal and habitat related aspects of foraging for and within species if it can be assumed that Brown Goshawks enter traps when and where they normally forage and if traps are placed more or less randomly over an area rather than where goshawks are expected. This method of investigating foraging is superior to the use of "random" observations in that: 1) far more data points can be obtained in a given time period; 2) trapped goshawks can be identified to species with certainty: most observers find it hard to distinguish male Brown Goshawks from female Collared Sparrowhawks (*A. cirrhocephalus*) where the two species are sympatric, 3) trapped goshawks can be sexed with certainty;

and 4) data is not derived solely from goshawk foraging in observer presence.

Given the requisite assumption, for the specific case of the Brown Goshawk, trapping data here supported long-held perceptions about accipiters: [e.g., that early morning and late afternoon are important foraging times (Brown and Amadon 1968) and that females and first year birds forage in more open habitat than males and adults (Opdam 1975; Marquiss and Newton 1981; Newton 1987)]. Trapping rate differences also provided preliminary evidence that the Brown Goshawk forages more in open habitat with some woodlots than within extensive woodland. While long-winged accipiters probably use more open habitat than short-winged forms (Wattel 1973), low trapping rates within woodland at Macclesfield may have been due to comparatively low trap visibility.

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MOVEMENTS AND SURVIVAL OF RELEASED, REHABILITATED HAWKS[1]

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ABSTRACT.—During 1985 and 1986, nine rehabilitated hawks [eight Red-tailed Hawks (*Buteo jamaicensis*); one Red-shouldered Hawk (*B. lineatus*)] were radio-tagged and released in an area of bottomland hardwoods and agricultural lands in southeastern Louisiana. Four Red-tailed Hawks survived for more than two wk after release and were thought to be acclimated to the wild. One Red-tailed Hawk died, and the Red-shouldered Hawk was shot. Adverse weather may have contributed to the Red-tail's death. Telemetric contacts ranged from less than one d-60 d. Loss of radio contact with released birds may have been influenced by migration, dispersal from release site, transmitter failure and/or transmitter range.

A 1978 survey revealed that approximately 225 active wildlife/raptor rehabilitation programs exist in the United States with a combined potential of treating 7000 raptor patients/yr (Duke et al. 1981). Many birds are rehabilitated and released back into the wild; however, few quantitative data on survival and movements of released raptors exist (Servheen and English 1976, 1979; Duke et al. 1981; Daniels 1984; Kimmel and Zwank 1983). We here report on post-release movements and survival of rehabilitated hawks in southern Louisiana.

METHODS

During 1985 and 1986, personnel at Louisiana State University (LSU) School of Veterinary Medicine Raptor Rehabilitation Unit made available nine rehabilitated hawks for release: eight Red-tailed Hawks (*Buteo jamaicensis*) and one Red-shouldered Hawk (*B. lineatus*) (Table 1). Raptors were considered releasable when in the opinion of the attending veterinarian birds demonstrated proper flight skills and sufficient foot and leg strength for prey capture. Two Red-tailed Hawks and the Red-shouldered Hawk were equipped with an 11-g tail-mounted transmitter with a 28 cm whip antenna (Wildilfe Materials, Inc., Carbondale, Illinois; mention of brand names does not imply endorsement by the U.S. Government) (Table 2). Two Red-tailed Hawks were each instrumented with a 25-g, two-stage tail-mounted transmitter equipped with a 28-cm whip antenna. Advertised range of the lighter transmitters was 1.6-2.4 km; estimated battery life was 250-300 d. Heavier transmitters had an estimated battery life of 150-180 d and an advertised range of 9.6-12.8 km. Tail-mounted transmitters were sutured to the ventral surface of central rectrices following procedures established by Kenward (1978). Antennas of lighter transmitters were tied to the rachis of a central rectrix at 10-15 mm intervals. Antennas were not attached to a rectrix of Red-tailed Hawks equipped with heavier transmitters.

Four Red-tailed Hawks were equipped with 23-g, two-stage transmitters (Telemetry Systems, Inc., Mequon, Wisconsin) equipped with a motion-sensitive mercury switch and a 44.5-cm whip antenna. Range and battery life were comparable to 25-g transmitters. Due to frayed and broken rectrices, transmitters were attached using a back-pack configuration (Dunstan 1972) consisting of a 0.64-cm wide elastic harness. Transmitters were attached at least three hr prior to release. Aluminum U.S. Fish and Wildlife Service leg bands were also fitted to each bird prior to release.

Radio-tagged birds were released on the LSU Ben Hur (Ben Hur) Biological Research Area located approximately 7 km south of Baton Rouge. The study area consists of approximately 943 ha of agricultural croplands (cereal grains), aquacultural ponds, bottomland hardwoods and improved pasture grazed by sheep, cattle and horses. The area surrounding Ben Hur is primarily croplands (cereal grains) and improved pasture grazed by cattle and horses except for a residential area along the northwest boundary and the Mississippi River to the south. Raptors observed or heard in the area included Red-shouldered Hawk, Red-tailed Hawk, Broad-winged Hawk (*Buteo platypterus*), Sharp-shinned Hawk (*Accipter striatus*), Northern Harrier (*Circus cyaneus*), American Kestrel (*Falco sparverius*), Mississippi Kite (*Ictinia mississippiensis*) and Barred Owl (*Strix varia*). Although the Great-horned Owl (*Bubo virginianus*), Common Barn-Owl (*Tyto alba*) and Eastern Screech-Owl (*Otus asio*) were never observed or heard, Lowery (1974) stated that all are permanent residents in Louisiana and thus could have been present in the study area.

Rehabilitated birds were released on six separate occasions (Table 2) at three different sites (A, B, and C) on the study area. Release Site A was located on a levee between bottomland hardwoods and aquacultural ponds. Site B was on the edge between a pasture and a 57-ha tract of bottomland hardwoods, and site C was in an area dominated by pasture interspersed with trees. Released raptors were monitored at least every two hr during the initial 48 hr post-release. Attempts were made to relocate each transmittered bird at least four d/wk at random times during daylight hours. Visual contact was attempted if birds had not moved substantially during one wk.

Telemetry locations were determined by triangulation.

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Additional locations were recorded when telemetered birds were observed. When radio contact was lost, an aerial survey of the area was conducted (1985 only). Locations and movements were recorded on USGS topographic maps. Habitat use was determined visually.

RESULTS

Two Red-tailed Hawks (No. One and Two) and the Red-shouldered Hawk (No. Three) were released during July 1985 (Table 2). The transmitter attached to hawk No. One was operating at the time of release; however, contact after release was never established. Following release, hawk No. Two remained within 0.6 km of the release site in an area of clearings and bottomland hardwoods for two d. Contact was lost for the next four d and on 20 July the bird was relocated 3.0 km to the southwest of the release site near the Mississippi River. For the next eight d No. Two remained along the river and adjacent pastures. The hawk was observed three times during the period and flight did not appear impaired. On 29 July hawk No. Two was 1.9 km west-northwest of the release site in an agricultural area 0.5 km west of a residential community. After this date, extensive ground and air searches, extending to a radius of 10 km from the last known location and along both sides of the Mississippi River for 50 km, failed to relocate the bird. Hawk No. Two was tracked a total of 15 d.

During the first three d following release, hawk No. Three remained along a powerline right-of-way that traversed a forested area between the release

Table 1. Clinical history of eight Red-tailed Hawks and one Red-shouldered Hawk rehabilitated by the Louisiana State University School of Veterinary Medicine Raptor Rehabilitation Unit.

SPECIES	I.D. NUMBER	REASON ADMITTED
Red-tailed Hawk	1	Fractured ulna from gunshot
Red-tailed Hawk	2	Penetrating wound of orbit requiring enucleation
Red-Shouldered Hawk	3	Juvenile that had fallen from nest; admitted with inflammation of the iris and a thiamine deficiency
Red-tailed Hawk	4	Lost forward toe in leg-hold trap
Red-tailed Hawk	5	Found along roadside with compound fracture of radius and ulna
Red-tailed Hawk	6	Confiscated by Louisiana Department of Wildlife and Fisheries
Red-tailed Hawk	7	Soft tissue injury of the left wing
Red-tailed Hawk	8	Wing fracture
Red-tailed Hawk	9	Confiscated by Louisiana Department of Wildlife and Fisheries

Table 2. Data on radio-tagged, rehabilitated hawks, released at Ben Hur Biological Research Area, East Baton Rouge Parish, Louisiana, 1985–86.

SPECIES	I.D. NUMBER	ADMISSION DATE	RELEASE DATE	AGE AT RELEASE	WEIGHT AT RELEASE (G)	TRANSMITTER TYPE	ATTACHMENT TECHNIQUE	LENGTH OF TRACKING PERIOD
Red-tailed Hawk	1	7 Jan 85	15 Jul 85	Juvenile	1145	I[a]	tail	0 days
Red-tailed Hawk	2	14 Apr 85	15 Jul 85	Adult	1070	I[a]	tail	15 days
Red-shouldered Hawk	3	10 May 85	22 Jul 85	Juvenile	500	I[a]	tail	59 days
Red-tailed Hawk	4	10 May 85	24 Oct 85	Juvenile	1315	II[b]	tail	14 days
Red-tailed Hawk	5	15 Feb 85	24 Oct 85	Juvenile	1425	II[b]	tail	5 days
Red-tailed Hawk	6	25 Apr 85	6 Mar 86	Juvenile	1167	III[c]	back-pack	48 days
Red-tailed Hawk	7	10 Dec 85	6 Mar 86	Juvenile	1321	III[c]	back-pack	60 days
Red-tailed Hawk	8	Jan 86	8 Mar 86	Juvenile	unknown	III[c]	back-pack	30 days
Red-tailed Hawk	9	25 Apr 85	13 Apr 86	Juvenile	1000	III[c]	back-pack	0.2 days

[a] Wildlife Materials, Inc., 11-g, 1-stage.
[b] Wildlife Materials, Inc., 25-g, 2-stage.
[c] Telemetry Systems, Inc., 23-g, 2-stage, mercury switch.

site and a residential area. From 26–30 July the bird remained near powerlines adjacent to the southeast corner of a residential area. From there No. Three moved southeast 0.5 km into an area of clearings and scattered trees and remained for one wk. Subsequently, contact as lost for 14 d. The bird was relocated in a wooded area 0.6 km west of its last location and remained there from 22 August until 4 September. No. Three was observed flying near the residential area numerous times. Contact was again lost for 10 d, and on 14 September the bird was relocated 0.7 km to the northwest in a recently cleared area adjacent to a residential backyard. On 17 September, No. Three was observed flying over the residential area, and later that day a resident of the community found the bird with a gunshot wound in one wing. The bird had survived 59 d after release and was recovered 0.7 km west of the release site. Except on one occasion, No. Three was always located within 0.4 km of the residential area and never farther than 1.6 km from the release site.

Red-tailed Hawks No. Four and Five were released during the fall of 1985 (Table 2). Hawks No. Four and Five remained within a 0.5-km area for five d after release. Radio contact was lost with No. Five on 28 October and never reestablished. Hawk No. Four was found dead on 11 November 0.5 km north of the release site where it had remained for 17 d. Cause of death could not be determined. The bird appeared to have been dead only a few days when recovered. Hurricane Juan passed through southern Louisiana on 25 October with strong winds and heavy rains which affected the area for seven d.

Red-tailed Hawks No. Six and Seven were released on 6 March 1986 (Table 2). During the first day after release, hawk No. Six did not move more than 0.3 km from the release site. During the second day, however, the bird was observed catching and eating prey and interacting aggressively with a resident Red-tailed Hawk. The resident hawk failed to immediately chase No. Six out of the area during the encounter; yet by the end of the second day, No. Six had moved 0.7 km to the north. This encounter was the only aggressive display witnessed during the study. For the next 47 d hawk No. Six remained along a 1.0 km section of a small, tree-lined bayou adjacent to pastures and croplands. Contact was lost after 22 April and never reestablished. Hawk No. Six was last located 1.1 km from the release site.

During the first two d post-release, hawk No. Seven's movements were limited to occasionally flying between two trees 50 m apart. On 9 March hawk No. Seven was observed on the ground as if attempting to capture prey; however, success could not be determined. Hawk No. Seven remained within 0.8 km of the release site for 21 d, except for 28 March when the bird was located 1.3 km southeast of the release site. From 1–9 April locations were widely scattered. Distances between subsequent locations averaged <1 km with one distance measuring 3.2 km. After 9 April, hawk No. Seven was located along a 3.0 km section of the Mississippi River and remained within 0.7 km of the river until contact was lost after 4 May. Final location was 3.9 km southwest of the release site.

Red-tailed Hawk No. Eight was released 2 d after Nos. Six and Seven (Table 2). Movements centered around aquaculture ponds located west of the release site from time of release to 6 April when contact was lost. Hawk No. Eight remained within 1.4 km of the release site for the entire 30 d observation period. Final location was 1.2 km west of the release site.

Hawk No. Nine, an immature Harlan's Red-tailed Hawk (*B. j. harlani*) was relesaed at 0900 H on 13 April 1986. At 1155 H the bird was observed soaring over a pasture 0.3 km south of the release location. By 1250 H only a very weak radio signal could be heard from the northwest. An extensive ground search extending to a radius of 8.0 km from the release site and 24 km to the northwest failed to relocate hawk No. Nine.

Length of monitoring period ranged from 0–60 d (Table 2). One Red-tailed Hawk had died, and the gunshot Red-shouldered Hawk had to be readmitted to the rehabilitation unit. Four Red-tailed Hawks lived for at least two wk after release. For each Red-tailed Hawk monitored more than one d, the longest distance traveled ranged from 0.5–4.8 km ($\bar{x}$ = 2.1, N = 6). For Red-tailed Hawks monitored for at least 30 d (N = 3), modified minimum area home ranges (Harvey and Barbour 1965) were 0.46–4.00 km^2.

Discussion

Five (55%) of released rehabilitated raptors (one Red-shouldered Hawk and four Red-tailed Hawks) successfully acclimated after release based on mortality studies that show Red-tailed Hawks die within two–three wk without food (J. C. Dobbs, Univ. Calif., Davis, pers. comm.); however, the Red-shouldered Hawk was sufficiently debilitated to require veterinary care 59 d post-release. One released hawk died. Ultimate status of the remaining three Red-tailed hawks could not be assessed.

Except for two Red-tailed Hawks, all released, rehabilitated hawks remained near release sites for the first few days. Lack of muscle tone due to captivity could have limited early activities (Servheen and English 1976, 1979), as activity range eventually increased. Additionally, unfamiliarity with release area and pre-release feeding may have affected post-release hunting behavior.

Duke et al. (1981) noted that season of release had a marked effect on average movements of rehabilitated hawks. Hawks released during migration periods were recovered at much greater distances from their release site ($\bar{x} = 486$ km) than were hawks released during nonmigratory periods ($\bar{x} = 23.4$ km). Migratory urge may have been the impetus for hawk No. Nine to leave the area immediately after release on 13 April 1986. Harlan's Hawks breed in Alaska and some parts of Canada (Mindell 1983), winter in the south-central United States (Mindell 1985) and rarely remain past late March in Louisiana (Lowery 1974).

Hawk No. Six encountered a resident Red-tailed Hawk that was apparently defending a territory (Janes 1984). Territorial attacks from resident hawks could also be responsible for dispersal of rehabilitated birds from release sites and could potentially affect the fate of introduced rehabilitated raptors. Release of rehabilitated raptors during fall and winter when territorial defense may be less intense (Craighead and Craighead 1956) could reduce intraspecific conflicts. Additionally, fall and winter releases of rehabilitated migrant raptors would allow time for birds to strengthen and hone hunting skills before migrating. Redig and Duke (1978), however, advocate release of rehabilitated raptors as soon as birds are medically and physically fit, unless adverse weather conditions exist (e.g., winter in northern climates). Retention of rehabilitated hawks for extended periods in captivity could increase vulnerability of birds at release (Duke et al. 1981).

Short reception ranges of lighter transmitters rendered long-term contact with released birds impossible. Signal range (100–700 m) was less than most movements recorded and much less than the advertised range (1.6–2.4 km). Reduced transmission range was partially an artifact of forested habitats used by released raptors as heavy foliage attenuates signal strength (Cochran 1980). Longer range transmitters would be especially important for investigation of woodland raptor species, such as Red-shouldered hawks and Great-horned and Barred Owls (Oberholser 1938; Lowery 1974).

Range of larger transmitters (approximately 10 km) used with six of the rehabilitated Red-tailed Hawks was much greater. Nonetheless, contact was lost with five birds. Loss of contact may not have been due to monitored raptors leaving the area but could have been due to transmitter failure or impairment. Great-horned Owls will remove transmitter antennas while preening which results in greatly reduced transmitter range (P. J. Zwank, unpubl. data).

Hurricane Juan (25–31 October 1985) could have contributed to the death of hawk No. Four. Adverse weather may also have been responsible for loss of contact with hawk No. Five (28 October). Newton (1979) stated that adverse weather can increase mortality rates among raptors because food requirements for individual birds may increase while the bird's ability to procure food is hampered. Additionally, a raptor's susceptibility to disease also increases with bad weather (Newton 1979).

What prolonged effect various injuries had on survival or behavior of birds could not be assessed. Prey capturing proficiency of Red-tailed Hawk No. Four with a forward toe missing may have been impaired; however, Servheen and English (1976) suggested that as long as no more than two forward toes were missing on released rehabilitated Bald Eagles (*Haliaeetus leucocephalus*), survival should not be adversely affected. Ingram (1983) speculated that birds with only one eye could be released and survive if given an adequate chance during captivity to adjust to loss of depth perception based on the release and survival of a one-eyed Golden Eagle (*Aquila chrysaetos*). Red-tailed Hawk No. Four was often observed landing accurately on perches during the two wk following release and apparently had adjusted to loss of depth perception.

The Red-shouldered Hawk was not released any closer to a residential area than any of the other hawks but was the only individual to remain in and around a suburban community. The bird had developed skills to survive in the wild; unfortunately, the conspicuous soaring and perching habits of many raptor species make them especially vulnerable to human persecution (Newton 1979). We suggest releasing rehabilitated raptors in localities where human encounters would be the least frequent in order to increase chance of survival.

McCrary (1981) considered transmitter weight the most important factor in a telemetry study, and transmitter packages on Red-shouldered Hawks that were 4.5% or less of body weight caused no noticeable effects. Dunstan (1977) determined that transmitters weighing 6% of body weight can be tolerated by most raptors. In our study U.S. Fish and Wildlife Service authorization limited transmitter weight to 3% or less of body weight on all rehabilitated hawks. We did not notice any adverse effect due to the transmitter package and have no reason to suspect that transmitter weight adversely impacted released birds.

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AN ANALYSIS OF BIRD ELECTROCUTIONS IN MONTANA

Thomas A. O'Neil

Abstract.—Fifty incidents of reported electrocutions were analyzed that occurred in Montana between October 1980 and December 1985 and involved 61 birds. The Golden Eagle (*Aquila chrysaetos*) was the most common bird reported and was involved in 54% of all cases. Statistical analysis suggested that birds were not disproportionately electrocuted when comparing pole, vegetation and terrain types. However, a pole along a hilly grassland had twice the potential to kill multiple numbers of birds than a pole along a flat agricultural terrain. Mitigative measures when incorporated proved to be successful.

Since 1970, bird electrocutions have drawn the attention from industry and government agencies alike (Boeker, E. L., and P. R. Nickerson, *Wildl. Soc. Bull.* 3:79-81, 1975) and subsequent awareness has increased through the efforts of the Edison Electric Institute (Olendorff, R. R. et al., *Raptor Res. Rep. No.* 4., St. Paul, Minnesota. 111 pp. 1981). Here, I report 50 incidents of electrocution in Montana occurring between October 1980 and December 1985 involving 59 raptors and two herons. This paper is based on mortality reports that were voluntarily completed on dead birds found underneath or near a distribution or transmission line by electric utility personnel or reported to the utility by the public.

Raptors are primarily electrocuted by low voltage lines (Miller, D. et al. 1975, *in* Olendorff et al. 1981). Electrocutions can occur when wings contact two conductors (phase to phase) or conductor to ground wire (phase to ground). Typically, conductors are spaced 0.6-1.2 m apart. Low voltage lines include distribution lines with a voltage range of 2.3-25 kV and transmission lines with voltages up to 69 kV (Olendorff et al. 1981).

Methods

I reviewed and summarized mortality reports that contained data on: date of discovery, approximate date of mortality, location, species, age, sex, suspected cause of mortality, pole type, vegetation (forest, grassland, etc.) and terrain (hilly, flat, etc.). Reports were condensed annually and filed with the U.S. Fish and Wildlife Service, Office of Permits, Denver Regional Office, Denver, Colorado and Special Agent-In-Charge of Law Enforcement, Great Falls, Montana. Recovered carcasses were either buried on site or delivered to a state or federal agent.

Chi-Square statistic (Snedecor, G. W., and W. G. Cochran, Statistical Methods. The Iowa State Univ. Press, Ames, IA. 593 pp. 1967). was used to test for significant variations among pole configurations, vegetation types, or terrain differences. The hypothesis was birds are not disproportionately electrocuted when comparing pole, vegetation, and terrain types.

Results and Discussion

Birds were found and reported throughout the year with eight species of birds electrocuted during the study period (Table 1). Date of mortality, sex and age of the birds involved often could not be determined with confidence, and are not included for discussion. Table 2 gives site data at time of discovery and shows that 61% of electrocutions occurred on poles with either double crossarms (i.e., configurations with two or more crossarms) or a transformer present. Thus, poles that deviate from a single crossarm may have greater electrocution potential or may disporportionately attract raptors or other birds. However, such potential or attraction does not appear to be significant (χ^2 = 1.6, P = 0.25).

The Golden Eagle (*Aquila chrysaetos*) was electrocuted more frequently than any other species (Table 1) and was involved in 54% of all cases reported. Most eagles select landing sites in response to prevailing winds and visibility (Nelson, M. W., *Aware Mag.* 51:9-12, 1975). Poles with double crossarms and transformers are frequently used to strengthen

Table 1. Reported bird electrocutions in Montana for 1980-85.[a]

Species	Number
Golden Eagle (*Aquila chrysaetos*)	32
Great Horned Owl (*Bubo virginianus*)	12
Red-tailed Hawk (*Buteo jamaicensis*)	2
Swainson's Hawk (*Buteo swainsoni*)	2
Goshawk (*Accipiter gentilis*)	1
Cooper's Hawk (*Accipiter cooperii*)	1
Raven (*Corvus corax*)	1
Great Blue Heron (*Ardea herodias*)	2
Unidentified owl	7
Unidentified hawk	1

[a] No data were reported for 1981.

Table 2. Summary of bird electrocution site data in Montana for 1980–85.

Site Data	Year[a] 1980 Cases	1980 Birds	1982 Cases	1982 Birds	1983 Cases	1983 Birds	1984 Cases	1984 Birds	1985 Cases	1985 Birds	Total Cases/Birds
Pole Type											
Single Crossarm	1	1	7	7	2	2	2	3	3	4	15/17
Double Crossarm	3	5	0	0	11	12	2	2	2	3	18/22
Transformer Present[b]	0	0	3	4	2	3	3	3	4	5	12/15
Other	0	0	0	0	1	1	2	4	2	2	5/7
Vegetation Type											
Grassland	4	6	7	7	14	15	7	10	6	8	38/46
Agriculture	0	0	3	4	1	1	1	1	4	5	9/11
Other	0	0	0	0	1	2	1	1	1	1	3/4
Terrain Type											
Flat	0	0	7	8	6	7	6	7	8	9	27/31
Hilly	4	6	3	3	10	11	3	5	3	5	23/30
Total	4	6	10	11	16	18	9	12	11	14	50/61

[a] No data were reported for 1981.
[b] Includes pole types that also had single and double crossarms.

corners and at deadends of distribution lines where prevailing winds and visibility can be favorable for landing or visual food searching. In addition Golden Eagles have a wing span which makes them more susceptible to electrocution.

Site data also suggestd that higher bird mortality occurred in grassland habitats than in the less diverse agricultural lands. Nonetheless, the number of electrocutions observed vs. expected was not significant ($\chi^2 = 1.8$, $P = 0.20$). Finally, total number of birds killed in either flat or hilly terrain was about the same and did not differ from what would be expected ($\chi^2 = 2.1$, $P = 0.16$). However, a pole along a hilly grassland had twice the potential to kill multiple numbers of birds than a pole along a flat agricultural terrain.

When the electric utility was made aware that specific poles were electrocuting raptors, mitigative measures were initiated consisting of altering pole configuration to reduce the potential for raptor electrocution using one or more of the techniques suggested by Miller et al. (1975). For instance, in reviewing mortality data I found that one 25 kV line about 1.8 km long was associated with 14 raptor electrocutions (6 in 1980 and 8 in 1983). The line was upgraded to 69 kV in 1984, and at that time conductor spacing was increased to eliminate electrocutions and elevated raptor perches installed at four locations. To date the most common technique has been to attach an elevated perch to poles. In all cases where mitigative measures have been incorporated there were no reports of further electrocutions.

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Short Communications

Capture and Telemetry Techniques for the Lined Forest-falcon (*Micrastur gilvicollis*)

Bert C. Klein and Richard O. Bierregaard

The Lined Forest-falcon (*Micrastur gilvicollis*) is found in tropical forest throughout most of Amazonia. Recently, Schwartz (1972, *Condor* 74:399–415) described the species as being distinct from the Barred Forest-falcon (*Micrastur ruficollis*). Although the Lined Forest-falcon is the most common raptor in some thoroughly surveyed Amazonian forests (e.g., the Minimum Critical Size of Ecosystem project area 70 km north of Manaus, Brazil, pers. obs.; Manu, Peru, S. Robinson, pers. comm.), the bird is only rarely observed and biologically poorly known. Morning calling censuses and banding data indicate that densities of two to four pairs/100 ha may not be uncommon (Klein and Bierregaard, in press). High densities and small home ranges of 40–50 ha (Klein and Bierregaard, in press) make the Lined Forest-falcon an ideal raptor for further behavioral study using radio telemetry in dense tropical forests. Our objectives here are to outline techniques for capturing and attaching transmitters to the Lined Forest-falcon.

Although BCK has called the Barred Forest-falcon to within four meters in Costa Rica by imitating prey alarm calls, such had no apparent effect with the Lined Forest-falcon. Many of our unintentional falcon captures in the past (>70) were from Forest-falcon attacks on passerines in mist nets. In an attempt to capture Forest-falcons, we played tape recorded passerine distress calls (*Turdus albicollis*) near nets with live passerines placed directly in the nets as decoys. We did this during four d for three to four hr each day in areas where Lined Forest-falcons were recently heard. No observed Forest-falcon responses were recorded with this technique. Playing calls of conspecifics did elicit a response from Forest-falcons in three of seven tries. Falcons approached the tape recorder and vocalized but always remained high in the canopy above mist nets. The closest and most frequent approaches occurred between 0600–0700 H.

Four Forest-falcons were captured with bal-chatri traps (Berger and Mueller 1959, *Bird Banding* 30:18–26). Falcons often fed in the afternoon in the same area they called from in the morning. Thus, we were able to mark locations during calling periods and return later with a bal-chatri trap baited with a live juvenile chicken (180–250 g). Traps were checked every two hr throughout the day. We were successful with three of eight tries. In another attempt bal-chatri traps were placed in the forest in a manner visible from long distances. Three traps used for a total of 14 days resulted in the capture of one Forest-falcon and one juvenile Ornate Hawk-eagle (*Spizaetus ornatus*).

Mist nets were also placed in close proximity to birds calling at or just before dawn. Although nets remained open all morning, the three falcons captured during 10 attempts were not captured until late morning or early afternoon when falcons tried to take passerines caught in the nets.

Transmitters (6–7 g) were placed at the base of central rectrices on four birds weighing from 200–220 g (see Fitzner and Fitzner 1977, *N. Am. Bird Bander* 2:56–57). Although one of four tagged birds did lose the transmitter-attached feather after nine d, tail mounts presented no obvious problems. The other three transmitters remained on birds for at least 27–30 d when transmissions ceased.

Transmitter back-pack mounts (10 g) were placed on two additional Forest-falcons. Transmitter packs were attached with 7 mm braided nylon string on one bird and a flat, elastic string provided by the transmitter manufacturer on the other. Strings passed over the birds' shoulders, tied just below the crop, tied again 2 cm lower near the legs and went between the legs and onto the back. Backpack transmitters remained on birds without any observed ill effects until transmissions stopped after three mo. The ease with which the Lined Forest-falcon accepts transmitters, is captured in relatively large numbers, and can be followed in dense tropical forest makes it an ideal raptor for further study.

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Additional Bald Eagle Nesting Records from Sonora, Mexico

Bryan T. Brown

The Bald Eagle (*Haliaeetus leucocephalus*) is known to breed in western Mexico only on coastal Baja California (Henny et al. 1978, *Auk* 95:424; Conant et al. 1984, *Raptor Res.* 18:36–37) and in the Rio Yaqui drainage of Sonora (Brown et al. 1987, *Wilson Bull.* 99:279–280), where the first reported nest from the mainland of Mexico was found. Discovery of a nest in an interior, non-coastal situation suggested that Bald Eagles could be nesting in other portions of Rio Yaqui drainage.

Three additional sections of Rio Yaqui drainage were surveyed by boat for breeding Bald Eagles during winter of 1986–87 and spring of 1987 (Fig. 1). These sections were chosen for survey because large, perennial rivers were believed to be suitable eagle nesting habitat, and because of ease of logistical access. A 105-km portion of the Rio Aros, largest tributary of the upper Rio Yaqui, between Natora (elevation 660 m) and the confluence with Rio Bavispe (confluence elevation 440 m) was surveyed twice. A 65-km stretch of Rio Bavispe between Granados (elevation 520 m) and the confluence with Rio Aros was surveyed once. And an 80-km portion of upper Rio Yaqui from the confluence of Rio Aros and Rio Bavispe to El Raspadero mine at the head of El Novillo Reservoir (elevation 330 m) was surveyed three times. In addition known eagle nests previously identified by Brown et al. (1987, *Wilson Bull.* 99:279–280) along lower Rio Yaqui from El Novillo Dam and Reservoir to Onabas were resurveyed twice. All study rivers were surveyed by airplane on 25 January 1987. Survey dates and locations are summarized in Table 1. Survey dates were chosen to coincide with the expected eagle breeding season.

An average of 15–20 km of river were surveyed each day. All potential tree or cliff nest sites within 0.5 km of the river were examined with binoculars and spotting scopes. One to six observers looked for the presence of Bald Eagles each day from camp and from the river. Potential nest sites were examined more thoroughly in areas where adult eagles were seen flying or perched.

Three active Bald Eagle nests were discovered. One nest was located on Rio Aros and two nests were located on upper Rio Yaqui. Two nests (one on Rio Aros and one on upper Rio Yaqui) were found during boat surveys, and one nest was found during aerial survey on 25 January 1987. In addition an eagle nest in a large Hecho Cactus (*Pachycereus pectin-aboriginum*) on lower Rio Yaqui, described by Brown et al. (1987, *Wilson Bull.* 99:279–280),

Table 1. Bald Eagle survey dates and breeding activity at four active nests along the Rio Yaqui and tributaries, Sonora, Mexico, December 1986–July 1987.

Study Area	Survey Dates	Summary of Breeding Activity by Nest	
Rio Aros		**Cliff Nest**	
	14–21 Dec.	?	
	25 Jan.	?	
	23 Feb.–2 Mar.	2 ad. present, 1 incubating	
Rio Bavispe	25 Jan.	No nests found	
	24–29 Mar.	No nests found	
Upper Rio Yaqui		**Fig Nest**	**Cliff Nest**
	21–23 Dec.	?	2 ad. seen in area
	25 Jan.	?	1 ad. incubating
	2–5 Mar.	2 ad. present, 1 incubating	2 ad., 2 nestlings
	29 Mar.–1 Apr.	2 ad. present, 1 incubating	2 ad., 2 lg. nestlings
Lower Rio Yaqui		**Hecho Nest**	
	25 Jan.	?	
	2 Apr.	2 ad., 2 lg. nestlings	
	12–15 July	1 ad., 1 fledgling nearby	

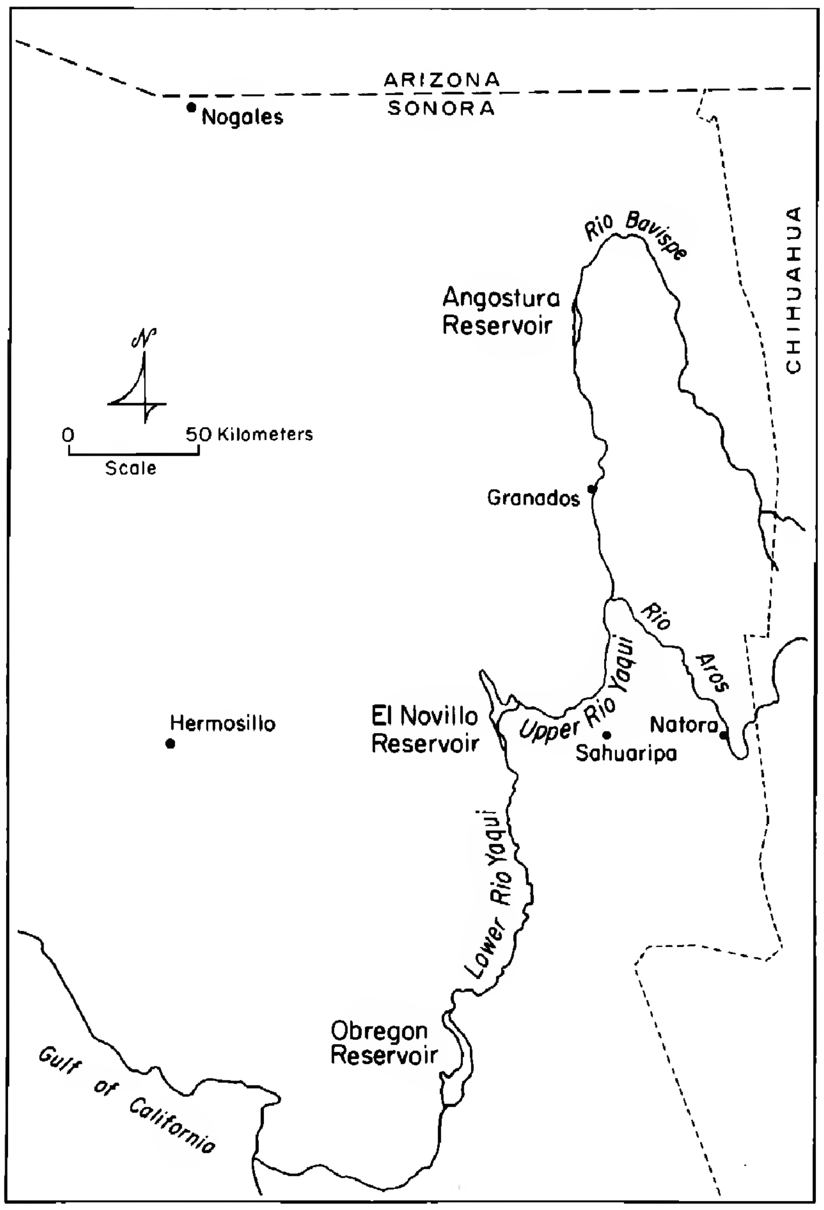

Figure 1. Study area for Bald Eagle nesting surveys in the Rio Yaqui drainage of Sonora, Mexico, from December 1986–July 1987.

was active during the spring of 1987. Thus, four active Bald Eagle nests were known for Sonora in 1987.

An adult Bald Eagle was discovered sitting in an incubating position in a large nest on Rio Aros (near 29°22'N, 108°58'W; elevation ca 520 m) on 27 February 1987. The nest was 60 m above the river surface on a horizontal ledge of a large, broken, northerly-facing cliff partially covered with vegetation. Outside diameter of the nest was estimated at 1.9–2.6 m and outside depth 0.3–0.6 m. The nest could not be checked for contents. Another adult eagle was perched nearby or flying in the immediate vicinity during the entire observation period from 0735–1210 H (Table 1). The success of this nest was unknown.

No eagle nests were discovered on Rio Bavispe surveys (Table 1).

An eagle nest on upper Rio Yaqui was discovered on 3 March (near 29°28'N, 109°15'W; elevation ca 420 m) 40 m above the river surface on a large northerly-facing cliff, against the roots and trunk of a large Fig tree (*Ficus petiolaris*). One adult eagle sat in the nest in an incubating position during the observation period from 1145–1400 H, and another adult perched near the nest at 1315 H. The nest could not be checked for contents but was estimated to have an outside dia of 1.6 m and an outside depth of 2.3 m. The nest was again visited on 29–30 March Both adults were present, and one adult sat in the nest in an incubating position during the entire observation period (Table 1). No nestlings could be seen in the nest and no prey deliveries were noted. The success of this nest was unknown.

A second nest on upper Rio Yaqui (near 29°11'N, 109°16'W; elevation ca 350 m) had been suggested when two adult eagles were observed near the site during a December 1986 boat survey of upper Rio Yaqui. A single adult eagle was seen sitting in the nest in an incubating position on 25 January 1987. The nest was 50 m above the river surface on a horizontal ledge on a large northerly-facing cliff. The nest was revisited on 4–5 March when two adults and two nestlings, estimated to be ca two wks old, were present. The nestlings were completely covered with dark gray down feathers and no contour feathers were visible. The nest was again visited on 31 March and 1 April, when two adults were present, as well as two large nestlings (ca six wks old) completely covered with contour feathers (Table 1). Nesting success at this site was unknown.

A potential alternate nest on upper Rio Yaqui was found 80 m above the river surface and 1.5 km further downstream on a horizontal ledge on a northerly-facing cliff. The nest was estimated to have an outside dia of 1.6 m and an outside depth of 0.6–1.0 m.

Eagle nests in Hecho Cactus and a dead Mesquite tree (*Prosopis glandulosa*) on lower Rio Yaqui described by Brown et al. (1987, *Wilson Bull.* 99:279–280) were visited on 2 April 1987. The Mesquite nest was not active, but two adults were present near the Hecho nest, which contained two completely feathered nestlings ca six wks old. Both nests were rechecked on 13 July. One adult was present near the Hecho nest, from which the nestlings had apparently fledged. The Mesquite nest had been destroyed in a fire, which appeared to have been set only a few days before by a local farmer to clear vegetation from his fields. A fledgling Bald Eagle was observed along lower Rio Yaqui 15 km south of the Hecho nest on 13 July (R. Mesta, pers. comm.) and could have been one of the young fledged from the Hecho nest (Table 1). However, the success of the Hecho nest was unknown.

Four active nests found in Sonora in 1987 establish that the range and population size of breeding Bald Eagles in the North American southwest are larger than previously known, and that the single active eagle nest discovered on lower Rio Yaqui in 1986 (1987, Brown et al., *Wilson Bull.* 99:279–280) was not an anomaly. Based on the extent of potentially suitable breeding habitat which has not yet been surveyed, breeding Bald Eagles could be relatively widespread along large, perennial rivers of Sonora.

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AN UNUSUAL WINTER BALD EAGLE NEST IN SOUTHERN CALIFORNIA

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In recent decades Bald Eagle (*Haliaeetus leucocephalus*) populations have seriously declined throughout the southern portion of their range, and the species is listed as endangered by the U.S. Department of the Interior and many states (Bickett 1982). In California Bald Eagles have historically nested from southern California (primarily along the coast and the Channel Islands) north throughout much of central and northern California (Grinnell and Miller 1944). Small numbers of eagles still breed in northern California, primarily around large bodies of water in northeastern counties (Lehman 1979; McCaskie et al. 1979). Although Bald Eagles no longer breed in southern California, the area does support a small winter population (Garrett and Dunn 1981). During the 1986 mid-winter Bald Eagle survey, 598 Bald Eagles were reported in California (Jurek 1986), 55 of which were in southern California (south of Pt. Conception). During a 1986 statewide nesting survey, 68 pairs of adult Bald Eagles occupied breeding territories, and 44 successful breeding pairs produced 68 fledglings (Calif. Dept. of Fish and Game 1986). All nests were in the northern portion of the state at least 600 km north of the San Jacinto Valley. Here, we report on a recently constructed Bald Eagle winter nest in the San Jacinto Valley, southern California, and present observations of nest building and roosting behavior during a two yr period.

The San Jacinto Valley is located in west central Riverside County at an elevation of approximately 500 m. Land use is predominantly agriculture (grain and alfalfa (*Medicago sativa*) production; dairy farming) interspersed with fallow fields, waterfowl hunting and remnant patches of native riparian woodlands. The valley is surrounded on three sides by rugged hills (up to 808 m) of inland sage scrub (*Artemisia californica*). Climate during winter months is mild with low precipitation ($\bar{x}$ = 36.9 cm/yr) and temp seldom below freezing (Bailey 1966).

On 26 January 1985 at 0725 H we observed an adult Bald Eagle perched on a live Eucalyptus (*Eucalyptus globulus*) tree. The eagle flew to an adjacent agriculture field, picked up a stick in flight, returned to the same Eucalyptus tree and landed on the rim of a large stick nest where another adult eagle was perched. The second eagle took the stick in its bill and positioned it into the nest. Similar nest building behavior lasted for over an hour even while the ranch owner, whose residence is <60 m away, moved about under the nest tree. When both birds perched together on the same branch, we noticed a slight difference in their size. We tentatively concluded that we were observing a mated pair. A pair of Bald Eagles has been seen at the same tree each year for the previous four yr with one of the eagles usually arriving in late November and the other within a few days (F. Ybarrola, pers. comm.). Both leave the valley mid- to late-March, and the eagles first built a nest in winter 1981–82. We observed nest building activity on seven of twelve d in January and February 1985.

The Eucalyptus tree supporting the eagle nest is 35 m in height (measured by clinometer) with a breast height diameter (DBH) of 1.1 m—the tallest tree in a row of eleven trees and one of the tallest trees in the San Jacinto Valley. The nest is about 1.5 m in dia, 1.8 m in height, and 28.6 m above the ground near the main trunk. The closest major water impoundment, Lake Perris, is 3 km from the nest site. The nest site measurements are well within the range of those reported for active or formerly active sites in northern California (Lehman 1979).

Differences between the San Jacinto Valley nest and those in northern California include tree species (all nests studied in northern California were in conifers) and distance from open water (none of the 93 nests in northern California were more than 1.6 km from open water).

We occasionally observed the eagles foraging from the nest tree. On 5 February the eagles fed on a Black-tailed Hare (*Lepus californicus*) carcass in a fallow field approximately 1 km from the nest. On 13 February one of the eagles left the tree to catch a Beechey Ground Squirrel (*Spermophilus beecheyi*) flushed by a tractor, then returned to the nest where both eagles fed on the squirrel. The eagles were also seen capturing Botta Pocket Gophers (*Thomomys bottae*) several times. The eagles left the roost three to five hr after sunrise ($\bar{x}$ = 4.5 hr, N = 7). We regularly followed the larger of the two eagles to a foraging site at a complex of waterfowl hunt clubs approximately 6 km from the nest; we were unsuccessful at following the other eagle.

In the winter of 1985–86 only one eagle was consistently observed at the nest throughout the winter, although both had participated in nest building the previous winter. On 11 December 1985, two d after arrival of the second eagle, both birds were observed carrying and rearranging sticks at the nest. Nest building behavior was again observed on 9 January 1986; subsequently, only one eagle regularly remained at the nest. A second eagle was observed only three times during the remainder of the winter. On one instance a Golden Eagle (*Aquila chrysaetos*) was seen near the nest tree. Immediately, the second Bald Eagle, which had not been seen for over a week, appeared and vigorously chased off the Golden Eagle.

Jurek (1986) reported that new nesting in Sierra County (in 1985) and El Dorado County (in 1986) may provide some evidence of a southward breeding range expansion in the Sierra Nevadas. The only previously reported Bald Eagle nest in Riverside County was at Lake Elsinore (Heller 1901). Snow (1973) believes the construction of dams and reservoirs in recent decades has created new Bald Eagle habitat. Although we did not see the eagles copulate or display other reproductive behaviors, nest building may indicate a potential for the resumption of Bald Eagle breeding in southern California.

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THREE BALD EAGLE NESTS ON A MINNESOTA TRANSMISSION LINE

ROBERT T. BOHM

Although the Golden Eagle (*Aquila chrysaetus*) and Osprey (*Pandion haliaetus*) commonly nest on transmission line structures, the Bald Eagle (*Haliaetus leucocephalus*) has not been reported to nest on power poles. Recently, however, several Bald Eagle nests on transmission lines have been documented. In 1987 Bald Eagles built a nest on a wooden H-frame structure in Florida (P. A. Quincy, Florida Power and Light Co., pers. comm.). This note presents information on one 1986 and two 1987 Bald Eagle nests on a Minnesota transmission line.

The nests occurred on a 250 kV direct current transmission line, although on structures of different design (Fig. 1). Each nest fledged two young, was between 21 m and 24 m from the ground and was within 1 km of a lake or river. All were in heavily wooded areas where there appeared to be an adequate supply of natural nest sites available. Two of the nests probably belonged to the same adult pair as they were less than 1 km apart and used alternatingly in 1986 and 1987. The pair nested on a structure in 1986 that was used by Ospreys in 1985, then moved to a structure in 1987 that was used by Ospreys in 1986. In 1986 the Osprey nest was active in late May, deserted by mid-June and, as mentioned, then used by eagles in 1987. No Ospreys nested near this pair of eagles in 1987. The third Bald Eagle nest, in 1987, was also situated on a structure used in 1985 and 1986 by Ospreys.

Transmission line nests were relatively small in comparison to the nests Bald Eagles build in trees in northern Minnesota. Although the powerline nests may have been smaller due to the absence of supporting branches, the eagles may simply have used old or remodeled Osprey nests. The nests rapidly deteriorated as the nesting season progressed. The young eagles, after fledging, continued to use the nests for perching and, by late summer, two of the three nests had completely fallen apart.

Bald Eagle use of transmission lines may become more common as young fledged from these nests, as well as from nests on other man-made platforms and towers, reach breeding age. An increasing Bald Eagle population, a lack of natural nest sites and a proliferation of transmission lines may interact to influence eagle use of powerlines in future years.

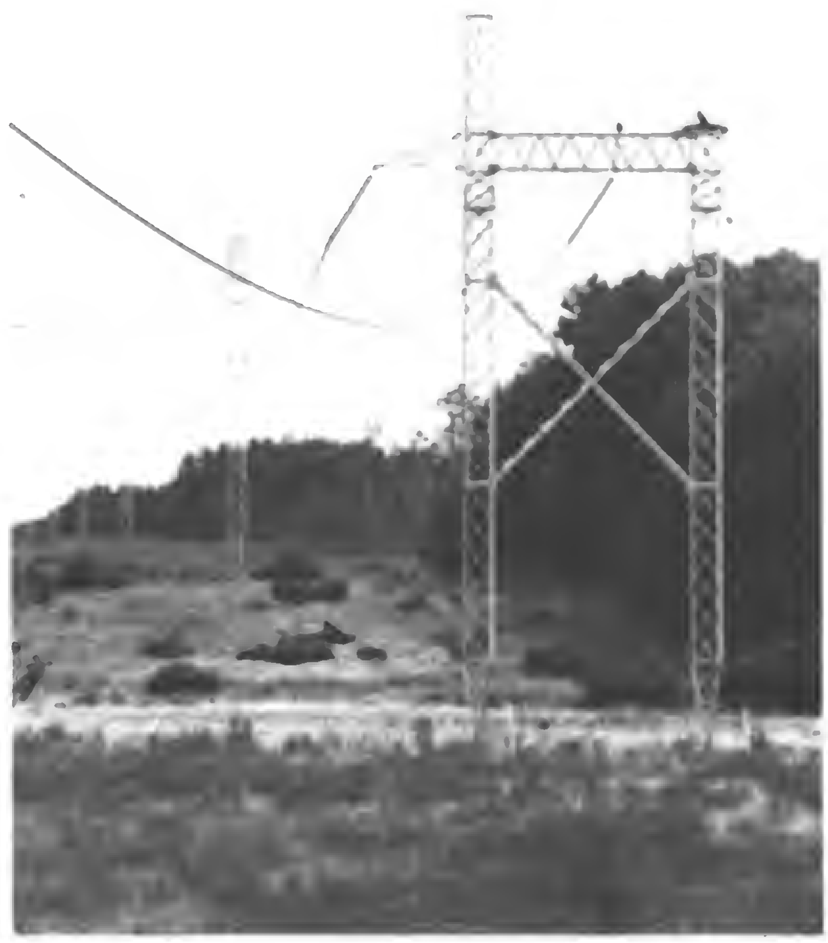

Figure 1. Immature Bald Eagles perching at their 1987 nest.

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News and Reviews

Resolution #87-01 Earth Day

WHEREAS, the quality of soil, water, atmosphere and biosphere continue to decline,

WHEREAS, public awareness of the problem has also declined since that of the late 1960s,

AND WHEREAS, much of this awareness arose from the celebration of Earth Day on 22 April 1970, nearly 20 years ago,

THEREFORE, be it resolved that The Raptor Research Foundation, Inc. will actively contact other environmentally-oriented organizations to urge them, and work with them, to attempt to increase public concern about the aforementioned declines.

BE IT FURTHER RESOLVED, that public events, e.g., "Earth Day," be scheduled to assist in this effort, potentially as a rejuvenation and celebration of the first Earth Day.

THE RAPTOR RESEARCH FOUNDATION, INC.

JEFFREY L. LINCER, PRESIDENT
THE RAPTOR RESEARCH FOUNDATION, INC.

Raptor Management Techniques Manual by B. A. Giron Pendleton, B. A. Millsap, K. W. Cline, and D. M. Bird (EDS.). 1987. 420 pp. Published by the National Wildlife Federation, Washington, D.C. $30.00. (Available from the Federation, 1421 Sixteenth Street, N.W., Washington, D.C. 20036-2266. Add $2.75 postage charge and specify item # 79780).

The manual is a nice concept for presenting material that can be added to through time. For this, the volume is in loose-leaf binder style with plenty of room for additional sections. At the same time, however, pages are numbered sequentially so additional sections would have to be numbered separately and new material could not be inserted within specific sections. But, I am getting ahead of myself without first commenting on the format of content.

There are four sections separated from each other by colored tabbed pages. They are: Introduction, Field Research Techniques, Management Techniques, and Laboratory Research Techniques. Each section has a variable number of chapters that in turn vary in length and content. It is worth mentioning a number of these chapters to give a flavor for content breadth.

The Introduction contains chapters on raptor literature, aging and sexing techniques, and federal laws that relate to raptor management. The Field Research section has six chapters dealing with surveys, food studies, habitat evaluation, capturing and marking, and assessment of reproduction. The Management section contains four chapters on disturbance impacts, habitat management, and augmentation of wild populations. Lastly, the Laboratory section has six chapters dealing with systematics, physiology, toxicology, pathology, and captive breeding (the last seems to be sort of an afterthought as it may not best be placed here).

Each chapter is an outline of the absolute wealth of knowledge, or lack thereof, for that topic. Each chapter has its own literature cited section and for the Laboratory Research Technique section alone I counted over 400 literature citations (doubtless some of the same ones were repeated in the different chapters). This, however, is a gauge to the amount of relevant material brought together in one place.

Some chapters contain considerable amounts of material that appear in other publications and, in fact, chapters in alternate publications are by the same authors as those in the Techniques Manual. Three publications that quickly came to mind as I read certain chapters (and I think raptorphiles should be aware of the other publications) were.

Zoo and Wild Animal Medicine, 1986, M. Fowler (ED.), Saunders, Philadelphia, PA; *Estimating Numbers of Terrestrial Birds,* 1981, C. J. Ralph and J. M. Scott (EDS.), *Studies in Avian Biology,* No. 6, Cooper Ornith. Soc., Allen Press, Lawrence, KS; and *Inventory and Monitoring of Wildlife Habitat,* 1986, A. Y. Cooperrider, R. J. Boyd, and H. R. Stewart (EDS.), U.S. Bureau of Land Manage., Wash., DC. I do not point out this overlap as a negative, because one of the functions of the Manual is to bring all this material together in one place, but rather I mention it to draw attention to other sources with some similar material of interest. On the other hand, many chapters (e.g., Raptor Literature) are largely fresh, original material.

I was unable to establish a cutoff date for gathering of material, but I would mention three additional sources of literature that should be added to the list of sources covering raptor information in Table 1.1. *Avocetta* is published in Italy and contains numerous raptor articles. Two devoted entirely to raptors are *Gabar* (not only the genus of hawk in Africa, but an acronym for "Growth and Biology of African Raptors") published out of southern Africa, and *Australian Raptor Association News* published out of New South Wales, Australia.

My preference on content of the Manual would have been to add two additional chapters. Migration counts is covered in about four-fifths of a page and seemingly for the amount of effort and people involved with this technique as a way of assessing and managing raptors, the topic deserved a several page chapter. Additionally, in the Laboratory Research Techniques section a separate chapter dealing with biochemical methodology—genetics, DNA studies, trace element studies, to mention a few topics—seems well in order since during the past 5 yrs there have been numerous such studies. The number of papers is only going to increase annually in years to come.

My impression was that the overwhelming amount of information was derived from or oriented toward diurnal raptors and that more data on nocturnal raptors might have been desirable (perhaps the partitioning of information is as it should be, however, since there are about 280 species of diurnal raptors not counting "condors" and about 150 owl species). Regardless, however, of whether one is interested in diurnal raptors or nocturnal raptors, or whether one includes the "American condors" with these taxonomic groups, the manual is a must. It comes in a handsome red binder about 70 cm across the back and only about three-fourths full of pages so there is plenty of room to add new "techniques" as they emerge.—**Clayton M. White**

Southeast Raptor Management Symposium and Workshop.—The National Wildlife Federation and Virginia Polytechnic Institute and State University will host the Southeast Raptor Management Symposium and Workshop 14–16 Sept. 1988 in Blacksburg, Va., at the Donaldson Brown Center for Continuing Education. Participating states include Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. Symposium workshops will encourage participants to discuss regional issues related to raptors and to develop management recommendations.

Sessions on 14 September will focus on raptor status reports, legal protection for raptors, public education, population ecology, restoration, and predation. On 15 September, land use, protection and management will be discussed, as will survey and monitoring techniques. A habitat management workshop will be offered and that evening a raptor identification workshop will be conducted. Brainstorming sessions designed to identify regional raptor issues and proposed recommendations will conclude the symposium on 16 September.

The symposium is the fourth in a series of five regional symposia sponsored by the National Wildlife Federation's Institute for Wildlife Research. The Department of Fisheries and Wildlife Sciences at Virginia Polytechnic Institute and State University is hosting this symposium. Proceedings of the symposium will be published as part of the Federation's Scientific and Technical Series.

For more information, contact the National Wildlife Federation, Institute for Wildlife Research, 1400 Sixteenth St., N.W., Washington, D.C. 20036-2266 or call (703) 790-4268.

The Journal of Raptor Research is distributed quarterly to all current members. Original manuscripts dealing with all aspects of general ecology, natural history, management and conservation of diurnal and nocturnal predatory birds are welcomed from throughout the world, but must be written in English. Contributors should submit a typewritten original and **three** copies of text, tables, figures and other pertinent material to the Editor. **Two** original copies of photographic illustrations are required. **All submissions must be typewritten double-spaced** on one side of 8½ × 11-inch (21½ × 28 cm) good quality, bond paper. Number pages through the Literature Cited section. The cover page should contain the full title and a shortened version of the title (not to exceed 30 characters in length) to be used as a running head. Author addresses are listed at the end of the Literature Cited section. Provide an abstract for each manuscript more than 4 double-spaced typewritten pages in length. Abstracts are submitted as a separate section from the main body of the manuscript and should not exceed 5% of the length of the manuscript.

Both scientific and common names of all organisms are always given where first appearing in the text and should conform to the current checklists, or equivalent references, such as the A.O.U. Checklist of North American Birds (6th ed., 1983). Authors should ensure that all text citations are listed and checked for accuracy. If five or fewer citations appear in the text, place the complete citation in the text, following these examples: (Brown and Amadon, Eagles, Hawks and Falcons of the World. McGraw-Hill, New York, 1968), or Nelson (*Raptor Res.* 16(4):99, 1982).

Metric units should be used in all measurements. Abbreviations should conform with the Council of Biology Editors (CBE) Style Manual, 5th ed. Use the 24-hour clock (e.g., 0830 and 2030) and "continental" dating (e.g., 1 January 1984).

A more detailed set of instructions for contributors appeared in *J. Raptor Res.*, Vol. 21, No. 1, Spring 1987, and is available from the Editor. Send all manuscripts for consideration and books for review to the Editor.