RESULTS OF A HELICOPTER SURVEY OF CLIFF NESTING RAPTORS IN A DEEP CANYON IN SOUTHERN IDAHO

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ABSTRACT - In 1980 a helicopter survey of cliff nesting raptors was conducted along Salmon Falls Creek, a deep canyon in southern Idaho. The most numerous species recorded was the Red-tailed Hawk (*Buteo jamaicensis*) followed by the Golden Eagle (*Aquila chrysaetos*), Prairie Falcon (*Falco mexicanus*), and Common Raven (*Corvus corax*). Great Horned Owls (*Bubo virginianus*), Barn Owls (*Tyto alba*), and Turkey Vultures (*Cathartes aura*) were recorded when they flushed from cliff faces. Numbers of Prairie Falcon nests and Barn Owls flushed may have been related to land use practices near the canyon. Inter-nest distances, productivity, nest exposure and the behavioral response of nesting adults are presented for the 4 principle nesting raptors. A comparison of the results of a simultaneous boat survey revealed that the helicopter survey was faster and more accurate in determining total active and inactive nests.

Nesting densities of raptors in the intermountain west have been determined for several locations (Platt 1971, Smith and Murphy 1973, Howard et al. 1976, Seibert et al. 1976, Thurow et al. 1980). However, except in the Snake River Birds of Prey Area (BPSA), few nesting surveys have been conducted in deep canyons in this region (USDI 1979a). The data reported herein were gathered in 1980 during a helicopter survey of Salmon Falls Creek, a deep canyon in southern Idaho.

STUDY AREA AND METHODS

The northern part of Salmon Falls Creek flows for approximately 103 km from the Nevada border north to its confluence with the Snake River in Idaho. The creek is small with a mean daily flow in water-year 1980 of 4.59 m^3/sec (provisional information from the U.S. Geological Survey, Boise, Idaho). The area around the creek is cool desert (Odum 1971) dominated by shrubs where native vegetation remains. Native habitat has largely been replaced by introduced grass seedings (primarily *Agropyron cristatum*) or agriculture over large portions of the study area.

The study area was divided into 4 segments based on vegetation and physiographic features, and distances (creek-km) were measured beginning at the Nevada border. The southernmost segment (1) is characterized by a meandering stream and a 20 km long reservoir contained within a relatively shallow (50 ± 11 m) cliff-lined boundary. It is surrounded by *Artemesia arbuscula*/grass seedings. The Salmon Falls Creek Dam marks the northern end of segment 1. Beginning at the dam, the creek flows through a deep (145 ± 26 m) gorge to creek-km 62 (segment 2) and is surrounded predominantly by *Artemesia tridentata*/grass seedings to at least 3.5 km away from its rim. In the succeeding segment (3) the vegetation bordering the east side of the creek is agriculture, while the west side is covered with *A. tridentata*/grass seedings. The final segment (4) begins at creek-km 81 and is bordered on the east predominantly by agriculture and on the west by a mixture of *A. tridentata*/grass seedings and agriculture.

In 1980 from 28-30 May and on 5 June we flew in a Hiller 12E helicopter for about 16 h inventorying cliff nesting raptors in the gorge. Nesting data were collected on all raptor species except American Kestrels (*Falco sparverius*). Nest location, status (an active nest was one where adults or young were present or which obviously had recently fledged young), estimated exposure, and the behavior of adults toward the helicopter were recorded. To minimize flight time and disturbance to raptors, nest parameters were not recorded for every inactive nest, and we did not tarry at active nest sites if we were unable to count nestlings immediately.

Because cavity nests are difficult to find, we did not attempt to determine nest sites of Barn Owls, Great Horned Owls, or Turkey Vultures, but did record them when we flushed these birds from cliffs. Nests of Prairie Falcons were recorded when adults were flushed near a pothole or ledge (usually with white-wash beneath it), when young were observed, or when adult(s) defended against the helicopter.

Nest site characteristics and distances between nests were measured on topographic maps, and nest elevations were determined on maps at a point on the canyon rim above the nest. It should be noted that when 2 nests were close together and neither was close to another, the effect on our data was to double the inter-nest distance in calculation of the mean. Because we recorded nest exposure in 16 directions our sample size was too small for statistical analysis. Therefore, we lumped this information into 4 general directions to increase sample size.

Gross vegetational patterns were determined by placing a grid of 144 randomly selected spots (after Marcum and Loftsgaarden 1980) on aerial photographs of the study area in each major vegetation type. The percents of spots falling on: 1) agriculture, 2) *A tridentata*/grass seeding, 3) *A. arbuscula*/grass seeding, and 4) other (roads, canyon, water) were then calculated. The grid used to select the 144 random spots covered a square area (approximately 92.16 km^2), the corners of which (farthest random point possible) were about 6.8 km from the center of the canyon.

RESULTS AND DISCUSSION

Nesting Density. — The most numerous nesting raptors in the canyon were Red-tailed Hawks, Golden Eagles, Prairie Falcons, and Common Ravens (Table 1). A comparison with the BPSA reveals that Salmon Falls Creek is an area of lower raptor density. The diversity of nesting raptors is also lower since no Ferruginous Hawks (*Buteo regalis*) were found nesting on cliffs in Salmon Falls Creek (Table 2). The density of nesting raptors in Salmon Falls Creek is, however, larger than reported for the Rio Grande River Gorge (Ponton 1980).

Table 1. Distribution of Raptor Nests/km (N), Raptors Flushed/km (F) and Vegetational Coverage in Salmon Falls Creek, Idaho.

Segment	Golden Eagle (N)	Prairie Falcon(N)	Red-Tailed Hawk(N)	Common Raven(N)	Great-Horned Owl(F)	Barn Owl(F)	Turkey Vulture(F)	Estimated Vegetational Cover: Agri-culture	*Artemesia tridentata*/ seedings	*Artemesia arbuscula*/ seedings	Other
1	0.13	0.7*	0.13	0.13	0.10	0.00*	0.03	0%	0%	88%	12%
2	0.28	0.27*	0.15	0.12	0.09	0.00*	0.00	0%	92%	0%	8%
3	0.21	0.31*	0.31	0.16	0.21	0.16*	0.00	29%	61%	0%	10%
4	0.10	0.05*	0.33	0.05	0.14	0.19*	0.00	70%	21%	0%	9%
Total	0.18	0.17	0.21	0.12	0.13	0.07	0.01				
Total Observations:	19	18	22	12	13	7	1				

*Statistical significance ($P < 0.05$), X^2 test.

There were more active eagle nests in the parts of the canyon bordered by *A. tridentata*/grass seedings, but more Red-tailed Hawk nests in the part of the canyon bordered by agricultural lands, although neither were significantly higher ($P > 0.05$). An important prey of Golden Eagles near our study area is the Black-tailed Jack Rabbit (*Lepus californicus*) (Seibert et al. 1976, USDI 1979a), a lagomorph that is dependent upon native sagebrush communities (USDI 1979a) like those in segments 2 and 3. Red-tailed Hawks, on the other hand, are a more diverse feeder and may be better able to utilize areas of the canyon bordered by agriculture.

There was a significant difference in the number of Prairie Falcon nests and Barn Owls flushed in different segments of the creek. Prairie Falcons were noted more frequently in areas bordered by *A tridentata*/grass seedings than in parts bordered by *A. arbuscula*/grass seedings or agriculture. Barn Owls on the other hand, were flushed from the canyon walls only in segments bordered by agricultural lands. These results may reflect a response to some environmental factor, such as climate, since segment 1 is higher and cooler than segment 4. However, Prairie Falcons feed on small mammals which can be adversely affected by agriculture (USDI 1979a), while Barn Owls may prefer nest sites near agricultural lands (USDI 1979b). There was no significant difference in the numbers of Great Horned Owls and Turkey Vultures flushed or Common Raven nests and vacant stick nests seen in different segments of the canyon.

Inter-nest distances. — Distances between con-

Table 2. A Comparison of Nesting Density (Nests/km) of Selected Raptors and Total Raptor Diversity Among 3 River Gorges in the western United States.

	Salmon Falls Creek Idaho	Snake River Birds of Prey Study Area Idaho	Rio Grande Gorge Colorado and New Mexico
Golden Eagle	0.18	0.19	0.04
Prairie Falcon	0.17	1.32	0.10
Red-tailed Hawk	0.21	0.37	0.18
Common Raven	0.12	0.76	0.12
Total	0.68	2.64	0.44
# of species found	9	10	5

Table 3. Straight-Line Inter-nest Distances in Km of Adjacent Conspecific Raptor Nests in Salmon Falls Creek, Idaho, and Average Inter-nest Distances in Km for Adjacent Conspecifics in the Snake River Birds of Prey Study Area Over 8 years (After USDI 1979a).

	Salmon Falls Creek $\bar{X}$ ± S.D. (min.)	BPSA Inter-nest distance (smallest min.)
Golden Eagle	4.39 ± 2.3(1.56)	3.46(0.97)
Prairie Falcon	4.13 ± 3.7(0.58)	0.65(0.09)
Red-tailed Hawk	3.91 ± 3.0(0.32)	2.08(0.35)
Common Raven	7.48 ± 7.3(0.10)	Not recorded

specific nests were variable (Table 3). Mean and min. inter-nest distances, especially for Prairie Falcons, are larger than observed in the BPSA and reflect the difference in raptor densities of the 2 areas (USDI 1979a). It should be noted that because the Snake River Canyon is comparatively wide, territorial spacing of raptors along the canyon is probably minimized.

The greatest mean conspecific inter-nest distance in our study area was among Common Raven nests. Ravens also showed the smallest min. nesting distance (0.1/km) of any conspecific nesting pair, perhaps reflecting weak intraspecific territoriality in ravens as noted by Knight and Call (1980). Common Ravens also nested close to Red-tailed Hawks and Prairie Falcons (Table 4). Close nesting of ravens to raptors has been noted elsewhere, hypothesizing a commensal relationship (Knight and Call 1980). Golden Eagles displayed the greatest $\bar{X}$ distances to their nearest neighbors in Salmon Falls Creek.

Productivity. — We recorded the number of young (most were late nestlings) in nests of 2 species. The mean number of young in 16 Golden Eagle nests was 1.94 ∓ 0.68 (range 1-3) which is comparable to the mean number of young fledged per successful nesting attempt (1.62) of Golden Eagles in the BPSA and comparison area (USDI 1979a). We observed a mean of 2.79 ∓ 0.79 (range 2-4) young for 19 Red-tailed Hawk nests. A similar figure (# of young fledged/successful nesting attempt = 2.70) has been noted in the BPSA (USDI 1979a).

Nest Exposure. — Nest exposures for all active and many vacant stick nests are contained in Table 5. The 2 rows of data resulted when we arbitrarily lumped the observed 16 exposures into quadrants which correspond nearly to NW, NE, SE, SW and then rotated the boundaries of our quadrants 45° so that the easterly and northeasterly exposures were not divided.

In the first treatment of the data, nests were oriented significantly more to the quadrant bet-

Table 4. Inter-nest Distances ($\bar{X}$ km + S.D.) of nearest neighboring raptor nests in Salmon Falls Creek, Idaho.

Species:	Golden Eagle	Red-tailed Hawk	Prairie Falcon	Common Raven
Nearest Neighbors:				
Golden Eagle	0	1.46 ± 0.80 N = 4	1.06 ± 0.54 N = 5	1.68 ± 0.73 N = 4
Prairie Falcon	0.75 ± 0.17 N = 7	0.73 ± 0.51 N = 6	0.73 ± 0.25 N = 2	0.35 N = 1
Red Tailed Hawk	1.53 ± 0.77 N = 8	0.84 ± 0.45 N = 6	0.75 ± 0.55 N = 8	0.58 ± 0.32 N = 5
Common Raven	0.18 ± 0.63 N = 4	0.48 ± 0.32 N = 6	0.75 ± 0.38 N = 3	0.10 N = 2

Table 5. Exposures of Active and Inactive Stick Nests in 4 Segments of Salmon Falls Creek as Determined by 2 arbitrary analyses.

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Segment 1	Segment 2	Segment 3	Segment 4
N | NNE 8 | 5 17* | 8	N | NNE 6 | 10 12 | 10	N | NNE 4 | 9 8 | 4	N | NNE 7 | 13 6 | 13
8 | NE/ENE 10 | 7 13	7 | NE/ENE 5 | 13 13	7 | NE/ENE 7 | 7 4	4 | NE/ENE 8 | 19* 8

*Statistically significant (P— 0.05), Chi-square test.

ween south and west-northwest in segment 1. Therefore, it appears that the Red-tailed Hawks and Golden Eagles, which built most of these nests, oriented them in a southwesterly direction. When the quadrant boundaries were rotated, a significant number of nests in segment 4, the lowest part of the canyon (elevations in segment 4 are about 500 m lower than in segment 1) are oriented nearly to the east. This may indicate that nest exposure and elevation (and thus temp) are related in Salmon Falls Creek. Seibert et al. (1976) found that Golden Eagles in northern Nevada avoided building nests with a northern exposure in a significant number of cases. Similarly, Mosher and White (1976) have shown that exposure of Golden Eagle nests at higher elevations, or in more northerly latitudes, are exposed to the south, while the reverse is true for nests at lower elevations, or in southerly latitudes.

Behavioral Response to the Helicopter. — Behavioral responses were observed at 29 Golden Eagle, Red-tailed Hawk, and Prairie Falcon nests. No adults were seen at the remaining 30 active nests.

We observed Golden Eagles near active nest sites on 6 occasions, always perching almost motionless while watching the helicopter pass-by. Page and Seibert (1973) have reported similar behavior in nesting Golden Eagles. Prairie Falcons, by contrast, flew about the helicopter calling 9 times (we could see their mouths open and close) or on 6 occasions flushed from the cliff and flew away. Once we observed Prairie Falcons near a nest diving on a Black-billed Magpie (*Pica pica*) perched well away from the cliff. This activity may have been redirected behavior (Wallace 1979) induced by our presence. Red-tailed Hawks exhibited the greatest variability in their responses to the helicopter.

Adults either defended by circling and calling (once), perched near the nest and watched the helicopter (on 4 occasions) or sat tightly on the nest (on 3 occasions). The latter response may have occurred due to adults still brooding young, since Carrier and Melquist (1976) observed a similar response to helicopters by incubating Osprey (*Pandion haliaetus*). Lee (1980) found that most raptors which were perched or nesting on transmission towers were tolerant of a helicopter used in nest surveys, although some Red-tailed Hawks tried to attack the helicopter as it approached their nest site. He also noted that birds which were on nests containing eggs or young remained on the nest when the helicopter flew past.

The Helicopter Survey and a Boat Survey Compared. — Two other biologists surveyed Salmon Falls Creek Reservoir by boat (Alan Sands and Sam Mattise, pers. comm.) while we surveyed the reservoir by helicopter. In addition to being a faster technique, other advantages of the helicopter in raptor surveys are reflected in comparison of survey results. We observed 40 active and inactive raptor nests from the helicopter, while from the boat only 31 were noted. Five different locations were thought to be possible Prairie Falcon nests by the boat survey team because of the presence of white-wash. From the helicopter these were found to be either perches or stick nests not visible from the boat due to the low angle of observation. The same 3 Red-tailed Hawk nests and 3 Golden Eagle nests were found by both survey techniques, but the boat surveyors mistook an alternate nest site for the actual Golden Eagle nest. Four raven nests were found by the boat survey while 3 were located from the helicopter. Both survey techniques produced 1 active Prairie Falcon nest, although they were at 2 different locations, illustrating the difficulty in detecting active cavity nests from the air. The greatest disparity in the results of the 2 techniques is that only 15 of 30 vacant stick nests observed from the helicopter were found by the boat survey team. Three of the stick nests recorded on the boat survey were not found from the air, but 11 recorded from the helicopter were not found by boat.

The angle of observation is the most important factor in differences between the 2 techniques. However, since the boat survey took longer, more time was allowed to see and hear nesting raptors, so that the same number of active stick nests and an additional cavity nest was found by the boat survey team.

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USE OF INTRODUCED PERCHES BY RAPTORS: EXPERIMENTAL RESULTS AND MANAGEMENT IMPLICATIONS

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ABSTRACT - Fourteen dead trees and 9 man-made perches were placed in the Sachuest Point National Wildlife Refuge, Rhode Island between 1977 and 1979 for use by the open country raptor community that inhabits the area during fall and winter. On 120 days during fall and winter 1978-79 and 1979-1980 raptors were observed on the introduced perches 525 times. American Kestrels (*Falco sparverius*), Short-eared Owls (*Asio flammeus*) and Northern Harriers (*Circus cyaneus*) in that order were the most frequent users. In all, 10 raptor species used the dead trees and 4 species used man-made perches. Kestrels displayed a preference for trees over constructed perches in 1979-80, but not in 1978-79. Kestrels used the perches for hunting, resting and prey consumption, but other raptors used them mostly for resting. These results suggest that introduced perches could play an important role in raptor conservation efforts.

Elevated perches are a habitat requirement of most birds of prey for hunting, resting and feeding (Brown and Amadon 1968, Brown 1976). The importance of perches has been documented by several investigators who noted the activity of raptors when first seen (Schnell 1968, Craighead and Craighead 1969, Marion and Ryder 1975, Bildstein 1978). The Red-shouldered Hawk (*Buteo lineatus*), Red-tailed Hawk (*Buteo jamaicensis*), Rough-legged Hawk (*Buteo lagopus*), Golden Eagle (*Aquila chrysaetos*) and American Kestrel (*Falco sparverius*) were perched during 50% or more of the observations of 1 or more of these authors. The importance of perches as a hunting substrate has been shown most clearly for American Kestrels. Several authors (Sparrowe 1972, Collopy 1973, Cruz 1976, Bildstein 1978) have found that kestrel attacks on prey were initiated from a perch in 71% or more of the attempts, and that the attacks initiated from a perch were more successful than attacks initiated from flight.

The erection of man-made perches, especially utility-line towers, has served as a passive raptor management tool by opening up millions of acres of habitat to hunting from stationary perches (Olendorff et al. 1980). For example, in Colorado, Stahlecker (1978) documented a concentration of raptors in the area immediately surrounding a newly constructed transmission line. Such findings have led to the introduction of elevated perches in suitable hunting range where tall perches are lacking (Christensen 1972, Snow 1974, White 1974, Steenhof 1977, Stumpf 1977, Hall et al. 1981). Herein I report the use of 2 types of raptor perches introduced into the Sachuest Point National Wildlife Refuge on the Rhode Island coastline.

STUDY AREA AND METHODS

Sachuest Point is an 86 ha peninsula extending into the Atlantic Ocean from the southeast corner of Aquidneck Island, Rhode Island. The vegetated interior of the point is bordred by a 5 km perimeter of rocky shoreline and cobble beaches. Shrub and herbaceous communities, which dominate the peninsula, are interrupted by a network of roads and scattered buildings abandoned by the U.S. Navy. Bayberry (*Myrica pensylvanica*) is the dominant shrub species. It reaches 3 m in height in the northern section of the point where it occurs in clumps (ca 100-300 m^2) which are interspersed with shorter, mixed stands of goldenrod (*Solidago tenuifolia*) and blackberry (*Rubus* sp.). In the southern part of the peninsula, bayberry from 0.5 to 1.5 m tall forms dense, isolated stands 0.5 to 3.0 ha in area which are surrounded by an herbaceous community. Grasses, especially Autumn Bent (*Agrostis perennans*) and Red Fescue (*Festuca rubra*), are common and occur either alone or beneath a forb layer dominated by goldenrod (*Solidago* spp.) and Black Knapweed (*Centauria nigra*). Shrubs provide the cover throughout 52% of the vegetated region of the study area