NESTING HABITAT OF COMMON RAVENS IN VIRGINIA

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The Common Raven (*Corvus corax*) inhabits a region 80–160 km wide extending along the Appalachian Mountains from northern Georgia to northern Pennsylvania. The raven is generally described in the regional literature as a wary species that avoids man and his activities by nesting on cliffs in remote mountainous areas at high elevations (Harlow 1922, Murray 1949, Stupka 1963:101–103, and others). A species with these characteristics could be seriously disadvantaged by intensive use of the southern Appalachians for recreation and raw materials. This study was conducted to better define the ecological latitude in which the raven exists in a portion of the southern Appalachians.

STUDY AREA AND METHODS

Study area.—The study was conducted northwest of Radford, Salem, and Lexington, and southeast of the West Virginia state line. Quartzite cliffs occur on ridges and in water gaps. Shale cliffs are usually adjacent to streams. Limestones and dolomites form bluffs on the Maury and New rivers. Valley elevations are 275–305 m on the James River and 470–538 m on the New River, while ridges rise to 1318 m above sea level. Over 85% of the study area is forest and the remainder is pasture and urban area. Mountain slopes are forested with mixtures of oaks (*Quercus* spp.) and other hardwoods. Xeric ridges are covered in Virginia, Table Mountain and pitch pine (*Pinus virginiana, P. pungens,* and *P. rigida*). Mesic ravines are forested with hemlock (*Tsuga canadensis*), white pine (*P. strobus*), yellow poplar (*Liriodendron tulipifera*), and other hardwoods (Braun 1967:225–242).

The 7000 km^2 study area has a population approaching 20 people per km^2. Areas of 10–25 km^2 with less than 1 person per km^2 are scattered throughout. A 2000 km^2 strip adjacent to the southeastern boundary supports over 90 people per km^2.

Ravens have inhabited the study area continuously since pre-Columbian times but no data exist on past abundance. A 518 km^2 segment of the study area had 1 active nest per 30.6 km^2 (Hooper et al. 1975). I consider this to be a moderate density based on densities in Britain of up to 1 nest per 17.1 km^2 (Ratcliffe 1962).

Methods.—I searched for raven nests during March and April of 1972 to 1974. Nest building began in late January, and most nests had eggs by 8 March. Nestlings fledged in late April and early May. From 2 to 6 visits were made to each nest site to determine if it was active and the number of young fledged. Nestlings that lacked visible sheaths on their contour feathers as the birds sat in the nest fledged in less than 7 days and were at least 35 days old. I considered birds that reached this stage of development as "fledged." Dorn (1972) found nestling periods in Wyoming to be 39–45 days.

Twenty-eight territories were found. Because birds in 13 territories used alternate nest sites in different years, 41 nest sites were found. I determined the outcome of nesting attempts in 5 territories during all 3 years, in 10 territories during 2 years, and in 9 territories in only 1 year.

TABLE 1
PRODUCTIVITY OF RAVEN NESTS IN RELATION TO ALTITUDE AND ROADS

Altitude or Distance	Total Nest Attempts	% Success	Number Fledged (% Successful Nests) 1	2	3	4	Mean Number Fledged	p[a]
Altitude								
<580 m	19	68.4	0.0	23.1	46.2	30.8	3.08	.001
≥580 m	25	64.0	31.0	25.0	18.8	25.0	2.37	
Distance to Road								
<.4 km	23	73.9	11.8	17.6	41.2	29.4	2.88	>.05[b]
≥.4 km	21	57.1	25.0	41.7	16.7	16.7	2.25	

[a] $P \leq .05$ was considered significant.
[b] Tabular U = 64 and calculated U = 66.5.

The Mann-Whitney U-test was used to evaluate differences among and between means (Siegel 1956). Values for U with probabilities less than .05 were considered significant.

RESULTS

Characteristics of nest sites.—Eighteen nest sites were found between 335–579 m above sea level, 12 between 580–879 m, and 11 between 880–1130 m. The lowest nest site at 335 m was just above the lowest point in the study area. Few cliffs existed above the highest site at 1130 m. Nest success was similar above and below 580 m, but significantly more young were fledged in successful attempts below 580 m than at higher altitudes (Table 1).

All but 3 nest sites were on cliffs. The use of cliff sites of a particular type of rock was roughly proportional to the abundance of that type. Quartzite, the most common cliff forming rock, composed 27 of the nest cliffs. Seven sites were on shale cliffs, 3 on limestone cliffs, and 1 on a tufa deposit. Height of nest cliffs varied from 4.9 to 38.1 m and averaged 19.7 m. Nests that were always successful during the study were no higher on cliffs than nests that always failed (Table 2). Nest ledges faced south to west at 18 sites and north to east at 10 sites. The main ridges ran northeast-southwest and most cliffs were at the ends of ridges and in water gaps. The other 10 cliff sites were on the sides of ridges.

Profiles of nest cliffs had several consistent characteristics. All cliff nests were sheltered by overhanging ledges of 2 cm to 600 cm, measured from the front of the cup. Cliffs were undercut below the nest ledge at 63.2% of the

TABLE 2
COMPARISON OF RAVEN NEST SITES THAT HAD SUCCESSFUL NEST ATTEMPTS TO SITES THAT FAILED[a]

Type of Site	Number	Mean (m)	Range (m)	p[b]
Height of Nest Ledge				
Success	20	11.2	3.8–19.8	.32
Failure	8	9.9	5.2–18.3	
Height of Cliff				
Success	20	19.6	4.9–38.1	.44
Failure	8	18.6	9.7–27.4	
Distance to Road				
Success	23	513	60–1450	.26
Failure	8	865	80–2410	
Distance to Dwelling				
Success	23	853	60–1920	.43
Failure	8	1366	320–4830	

[a] Sites with both successes and failures were not included.
[b] $P \leq .05$ was considered significant.

sites and nearly vertical at 31.6%. At 5.3% of the sites the rock face sloped away from the nest ledge. One nest was in a cavity in the side of a cliff and another was wedged in a vertical crevice. The other 36 nests were on ledges that were usually shielded by a rock buttress on one or both sides. Mean width of 13 ledges was 63.5 cm and the range 38–107 cm. Eight nests averaged 61.3 cm wide with a range of 41–91 cm. Ledges often sloped away from the cliff, and at 4 sites a small shrub helped hold the nest on the ledge. Rock faces were too steep and protected from weathering near nest ledges to support the large foliose lichens that covered more exposed surfaces. One end of a nest ledge on a limestone cliff extended beyond the overhang and the exposed portion was covered with bleeding heart (*Dicentra eximia*). This was the only instance where forbs or grasses were seen on a nest ledge.

Search of a 104 km^2 area without cliffs revealed no tree nests, but I could not be sure none existed. In a 518 km^2 area that was intensively searched, one nest was found in a Virginia pine and 2 in shortleaf pines (*Pinus echinata*).

TABLE 3
DISTRIBUTION OF RAVEN NEST CLIFFS BY HEIGHT AND DISTANCE FROM HUMAN DWELLING

Distance to Dwelling	Height of Nest Cliff			
	Number of Cliffs		Mean[a] Height (m)	Range (m)
	< 15 m	≥ 15 m		
<.8 km	5	13	21.6	4.8–38.1
≥.8 km	7	13	18.0	9.1–30.5

[a] Means were not significantly different ($p = .14$).

The nests were built by ravens that occupied 1 territory. In 1972 they attempted to build on a cliff about 50 m from the nest tree but the ledge was too steep to hold the nest. A nest of previous years was found on a cliff about 220 m from the tree nest and within 50 m of a newly constructed road. In 1973 and 1974 the birds built within 250 m of the 1972 nest, but farther from the road. These birds fledged 4 young in 1972, 3 in 1973, and 2 in 1974.

The percentage of the area that was forested within 0.8 km and 1.6 km of nest sites was obtained from 7.5-min topographic maps. I did not determine home ranges, but adult ravens on several occasions flew over 2 km from the nest. I saw 1 bird fly about 3 km from its nest. Thus 0.8 km and 1.6 km are probably within the home range of most nesting pairs. Within 0.8 km of the nests, the mean area in forest cover was 90% and the range 20–100%. The mean area in forest cover within 1.6 km of the nests was 86% and the range 28–100%.

Relation of nest sites to human activity.—Nearly as many low nest cliffs (< 15 m) were found less than 0.8 km from a dwelling as were found in more secluded locations and an equal number of taller cliffs were found in both categories (Table 3). Successful nest attempts averaged closer to roads and dwellings than unsuccessful ones, but differences were not significant (Table 2). Successful nest attempts less than 0.4 km from a road averaged more fledglings than attempts farther away, but the difference was not quite significant (Table 1).

Ravens exhibited 2 general behavior patterns when I was near their nests. In 16 territories the birds were evasive and seldom vocal. They would fly into sight then quickly disappear. Often they repeated this pattern several times but rarely flew close to the nest or intruder. Some birds would soar 400–800 m away but within sight. In 8 territories the birds appeared defensive and were vocal. A rapid "*kack-kack . . .*" was usually given. This call was given on 3 occasions when ravens near their nests were diving at Red-

tailed Hawks (*Buteo jamaicensis*). A sharp single "*hark*" was given by some birds when I was at the nest. This call was given by a tame raven when deprived of food for short periods or when threatened (D. R. Chamberlain, pers. comm.). Other calls were also heard near nests but these were the prominent ones when I was in direct contact with a nest. Defensive birds flew within 50 m or less of intruders. One bird landed on the cliff 7 m above a worker and another dove within 3 m. In both cases the man could touch the nest.

Birds in a given territory usually reacted similarly during each visit. Striking changes were noted in different years in 3 territories, perhaps indicating a replacement of mates. At 2 nest sites, birds that were normally evasive to humans reacted defensively when Red-tailed Hawks flew close to the nests. Unusually defensive birds in another territory became evasive when I found a prematurely fledged nestling at the base of the cliff. Residents of homes 60, 90, and 150 m from a nest did not know of its existence, although a former resident knew the nest had been active at least since 1961. The nest was on a river bluff and the houses were on top, 50 m above the river. The ravens were probably evasive to attract so little attention from people living above them. When I found the nest in 1974 the ravens were defensive and gave the "*kack*" call until I was 200 m downstream and out of sight. Since ravens cannot defend a nest against a human, an evasive reaction seems more adaptive than a defensive one, particularly since defense advertises the presence of a nest. However, 50% of the pairs classified as defensive and 44% classified as evasive nested within 0.4 km of a road or dwelling. In one case an extremely evasive pair of ravens may have jeopardized nest success through inattention to nestlings. The nest failed in all 3 years of the study and may have been unsuccessful for 3 years prior to the study, according to observations of a local fisherman. The nest was on a 27 m cliff and was well-protected from direct human intervention. However, the cliff was 150 m from a popular trout stream and a frequently traveled road. In 14 trips by the nest site, adults were seen only twice and were evasive both times. The oldest nestling I saw was about 10 days old.

The nest most subject to human activity was on private land and the owner permitted interested groups to visit the nest for short periods. On one occasion in 1972, about 20 people were below the nest ledge and a climber rappelled to the nest. Two young were fledged that year. In 1973, a graduate student rappelled to the nest once a week throughout the nesting cycle, and 4 young were fledged. The site was not used for nesting in 1974 or 1975, although a pair of ravens frequented the cliff in January of both years. Adults at this site were evasive. At only one site did I suspect destruction of a nest by humans. The nest was on a 9.6 m cliff 40 m from a road and clearly visible to people passing in cars.

DISCUSSION

Selection of nest sites.—Cliff profile—a suitable ledge with an overhang above and steep rock face below—was one of 2 factors apparent in the selection of a particular cliff as a nest site. Similar sites have been described by others (Harlow 1922, Bent 1946, Ratcliffe 1962, White and Cade 1971). The lack of deviation from this profile in the nest sites I found is important, because cliffs with these attributes are relatively scarce in the southern Appalachians. The second factor was the proximity of other active raven nests. In a 518 km^2 segment of the study area, the mean distance to the nearest active nest was 4.3 km and the closest nests were 2.2 km apart (Hooper et al. 1975). Although scarcity of potential nest cliffs probably limit some local populations in the southern Appalachians, a surplus of suitable cliffs was available in the above-mentioned portion of the study area. Ratcliffe (1962) thought the density of nesting ravens, unless nest sites were scarce, was determined by a proximity tolerance limit of nesting pairs to each other and that the limit in a particular area was dependent upon the food supply. The regular spacing of active nests, the moderate density of nesting pairs, and the surplus of suitable nest cliffs suggest that overall food supply may have been regulating the population to a large extent in my area. But, until a surplus of potential breeders is demonstrated and other facets of the population dynamics examined, the above hypothesis lacks support.

Because tree nests were difficult to find in the heavily timbered area in which I worked, I did not adequately assess their relative value. In the 518 km^2 area previously mentioned, birds in 1 of 17 territories nested in trees. Since a surplus of cliff sites existed, there was little need to use trees. Ravens nest extensively in trees in other regions, and such sites may be more important in the southern Appalachians than my data indicate. In Pennsylvania, Harlow (1922) found cliff nests outnumbered tree nests about 8 to 1.

Altitudinal relationships.—Only 27% of the nest sites I found were over 880 m above sea level and 44% were below 580 m. Although nesting at lower altitudes is probably not a recent adaptation, specific nest locations mentioned in the regional literature were all above 880 m (Bailey 1913, Jones 1933, Hostetter 1938, Tyrrell 1945, Murray 1957). Murray (1957) mentioned a nest near a hard-surfaced road that was probably below 880 m. About 1950 a resident of Giles County found a raven nest with young at 518 m near the New River. One site at 335 m on the Maury River was active as early as 1961. Thus, nesting occurred at low altitudes in the 1950's if not sooner. The frequency of nest sites found at lower elevations could indicate an increase in the raven population.

Although the difference I found in production of fledglings at high and low altitudes was significant ($p \leqslant .001$), the biological implications are not

known. A similar but non-significant relationship between altitude and productivity was reported by Allin (1968) in Wales. I probably worked at the low end of the altitudinal range of the raven in the southern Appalachians. Jones (1933) reported a nest at 1500 m in Virginia. Most sightings of ravens in the Smoky Mountains of Tennessee and North Carolina were above 1070 m (Stupka 1963). More recently, W. D. Zeedyk (pers. comm.) has sighted birds primarily at 1070–1900 m in North Carolina. Nests have been reported at these elevations (Stupka 1963; B. A. Sanders, pers. comm.). Reduced production of fledglings with increasing altitudes, particularly if the trend continues above elevations I worked, is potentially an important factor in the population dynamics of the raven in the southern Appalachians.

Stupka (1963) thought ravens were more plentiful in the Great Smoky Mountains prior to creation of the National Park when livestock was pastured at the higher elevations. The distribution of food within my study area could have been a cause of higher productivity at the lower elevations. A greater food supply probably existed in the valleys, where railroads, houses, farms, and most roads were located. Investigation of raven food habits in the study area indicated considerable foraging was done at lower altitudes (Harlow et al. 1975). Ravens nesting at higher elevations may have to spend more time hunting for food, or have to fly farther to find it. If so, the efficiency of adults feeding their nestlings would be affected, perhaps contributing to increased mortality in nestlings through starvation. That starvation is a major cause of mortality in nestlings of other corvids was shown by Holyoak (1967) for *Corvus frugilegus* and *C. corone*, and by Mishaga (1974) for *C. cryptoleucus*.

Interactions with humans.—Ravens in the southern Appalachians have a reputation of avoiding human contact by living in remote areas. However, many nested relatively close to human residences and probably relied on human activities for a substantial part of their food. Ravens were persecuted in former times (Sprunt 1956), but I believe killing of the species by man is currently of minor importance in Virginia. I found no evidence that ravens in my area caused loss of sheep as reported in the West (Larsen and Dietrich 1970). The only nuisance reports I had on ravens were on a flock that dug grubs from a golf green and on a single bird that took balls from another course. Several birds were destroyed as a result, but these were isolated incidents. Thus, there is little reason for man to molest ravens in Virginia. The apparent restriction of ravens to higher and remoter areas in other parts of the southern Appalachians suggests that persecution may still be a problem in those sections.

Hickey (1942) found that the minimum acceptable height for a Peregrine Falcon (*Falco peregrinus*) nest site was inversely related to its remoteness

and directly related to the amount of molestation by man. Ratcliffe (1962) found the same relationship for the raven and Peregrine in England, but a similar one was not apparent in my data. Only 17.2% of the raven nest cliffs in England within 0.8 km of a main road or dwelling were less than 30 m tall compared to 77.8% in this study. Also, nest success in Virginia was higher and number of young fledged greater within 0.4 km of roads than farther away.

Raven nest cliffs probably have been used for centuries and occupancy of a given site may have continued as the landscape slowly changed. During years of inactivity, evidence of past nesting remained perhaps to serve, along with the general suitability of the cliff, as a stimulus to birds seeking a nest site. Of course, many former sites in the southern Appalachians are no longer in use, especially in Alabama and Kentucky where the species was extirpated (Imhof 1962, Mengel 1965), as well as throughout the region where present densities are low. Hickey (1942) thought the occupancy of a given site by Peregrines in face of human disturbance was determined by the personality of the resident birds. Personality differences in ravens were noted by Harlow (1922), Ratcliffe (1962), and Dorn (1972). The ability of ravens I studied to cope with human activity near their nest varied greatly and apparently played a role in nesting success of sites close to roads and dwellings. However, the overt reaction of ravens to humans near their nests was not apparently related to the birds' tolerance of disturbance.

Human activity, in my judgment, should be curtailed near active nests, despite the tenacity of some nesting pairs. The actual distance to restrict activity depends on the terrain and type of activity. In general, pedestrians should not be permitted within 200 m of a nest if they are visible to birds on the nest cliff, or within 100 m if they are hidden from view. Vehicular traffic as close as 100 m to a nest would not create excessive disturbance if parking areas are not provided within 200 m. However, road construction within 200 m could cause desertion. Overlooks should not be built on top of nest cliffs. Rockclimbing should be discouraged on active nest cliffs from 15 January until the nestlings fledge in late April or early May. These guidelines are more liberal than I had originally thought possible. Although a few birds may be adversely affected by humans within 200 m of the nest, I believe most will not. Unless physically harassed, many birds would accept closer contact.

SUMMARY

Common Ravens in Virginia were primarily cliff nesters. The major factors apparent in selection of a nest site were cliff profile, determined by a suitable ledge with an overhang above and steep rock face below, and the distance to other active raven nests, the closest 2.2 km and the average 4.3 km. Nest cliffs averaged 19.7 m in height. No significant difference was found between heights of successful and unsuccessful sites.

Nest cliffs close to human activity were not taller than those in remote areas. Observed proximity of roads and dwellings to nests had no significant effect on nest productivity. Nest sites were found between 335–1130 m above sea level, with 44% below 580 m. Successful nests below 580 m fledged a mean of 3.08 young compared to 2.37 at higher elevations. Starvation of nestlings, due to a loss of feeding efficiency in adults nesting at higher elevations, was suspected.

ACKNOWLEDGMENTS

I am especially grateful to the Harold H. Bailey Research Trust for providing the Rockbridge Alum Springs Biological Laboratory as a base for the fieldwork in 1972–1974. The help of C. A. Dachelet, D. R. Chamberlain, H. S. Crawford, T. Ziegler, R. F. Harlow, T. C. Cutler, and R. N. Conner made the study possible as well as pleasurable. The cooperation of the Virginia Commission of Game and Inland Fisheries, George Washington and Jefferson National Forests and many private landowners is appreciated. D. R. Chamberlain, H. B. Tordoff, C. M. White, and W. D. Zeedyk made helpful comments on the manuscript.

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