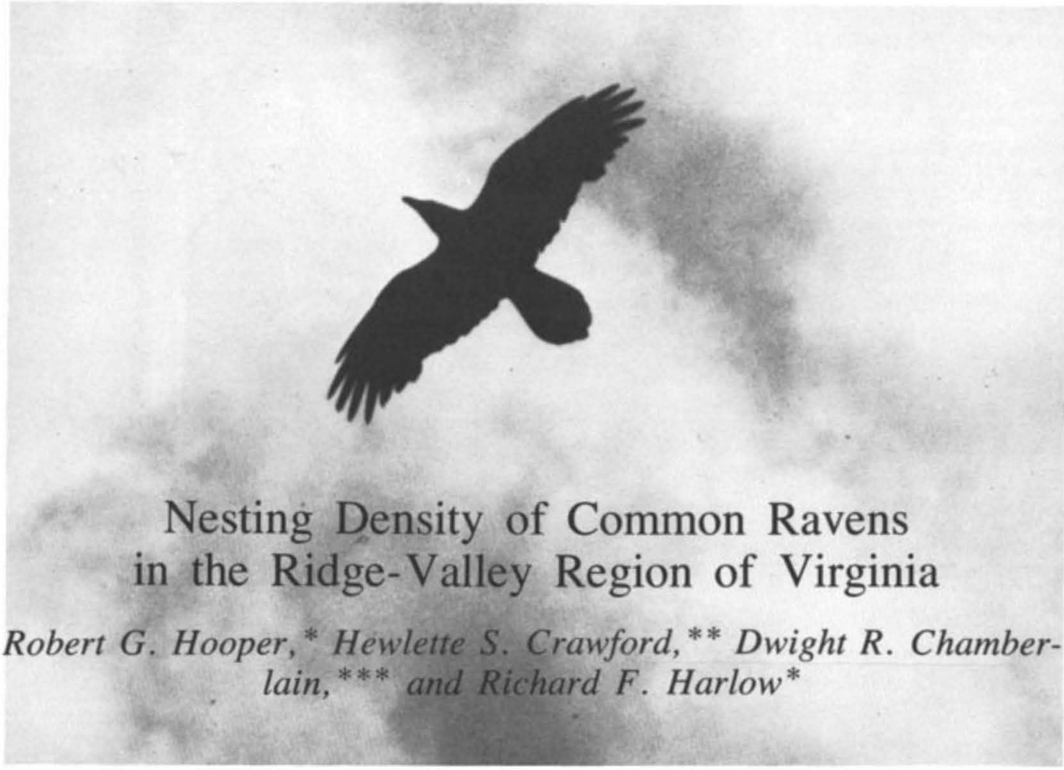

Nesting Density of Common Ravens in the Ridge-Valley Region of Virginia

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By the early 1900s the range of the Common Raven *(Corvus corax)* in the United States, excluding Alaska, had been reduced to less than half that of pre-Columbian times. Currently, a disjunct population of the raven occupies a narrow belt of the Southern Appalachian Mountains from northern Pennsylvania to northern Georgia. This population formerly extended to the Atlantic and was contiguous with the northern and western populations (AOU 1957).

Much of the raven habitat in the Southern Appalachians occurs on national forests and other public areas. Human activity increases yearly on these lands and those in private ownership are being developed at an increasing rate. The influence of timber cutting, road building, the juxtaposition of dwellings on this semi-wilderness species is not known. In 1972 we began a study to determine the habitat requirements of nesting ravens in Virginia. To help evaluate the impact of human activity on raven habitat, we needed to know how close ravens would nest to each other and the annual shifts in nesting sites. To accomplish this objective, we located active raven nesting sites in a portion of their range in Virginia. Results of our census are presented here. The habitat requirements of ravens and the influence of human activity on nesting ravens will be presented later.

STUDY AREAS

This study was conducted in the Ridge and Valley Physiographic Region of western Virginia, an area of numerous parallel ridges lying between the Valley of Virginia and the Allegheny Mountains of West Virginia. The main study area of 180 square miles probably encompasses as many cliffs as any commensurable area in Virginia (Fig. 1). We selected an area where the raven population would not be limited by the availability of cliffs for nesting. Some ravens nest in trees but tree nests are difficult to find in heavily forested regions. We suspect, however, ravens in Virginia prefer cliffs; only 3 of the 57 nests we have found were in trees.

Most of the cliffs in the main study area are Clinch Sandstone (Fig. 2), a resistant quartzite that is the backbone of the higher ridges of North, Mill, House, White Rock, Wilson, and Butt Mountains. Weaker layers of sandstone in these cliffs break away, creating overhangs and ledges

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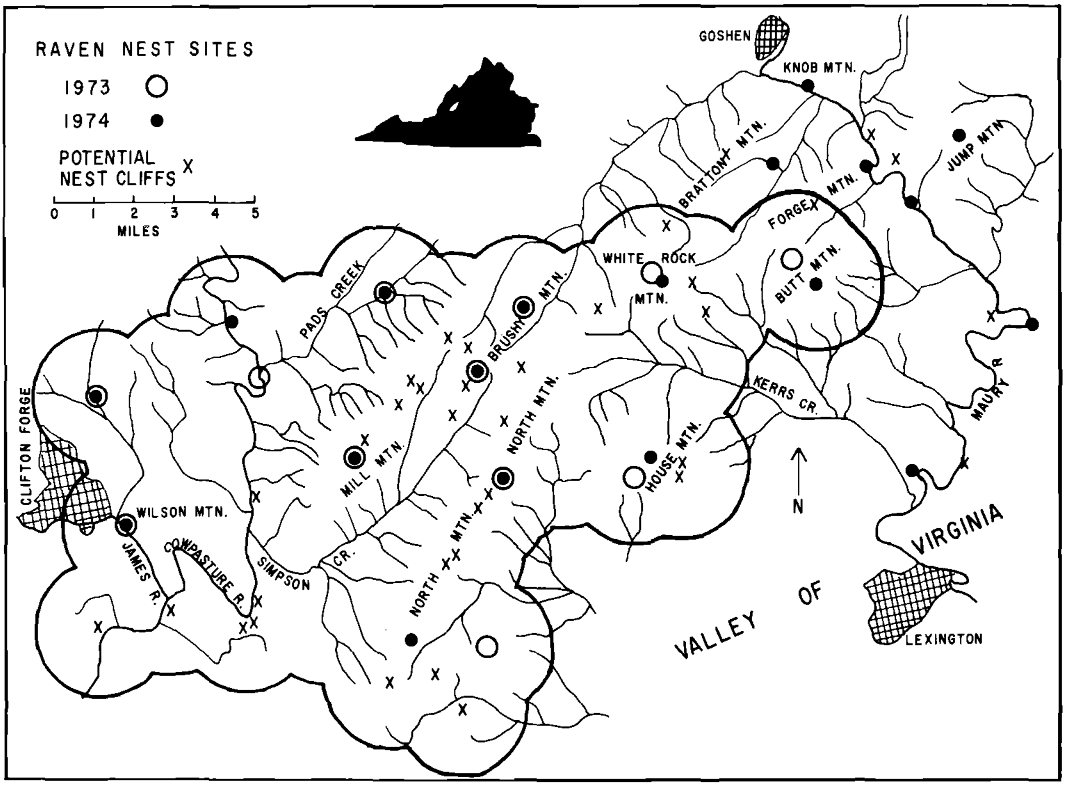

Fig. 1. Location of nest sites of Common Ravens in Virginia.

necessary for nesting. Suitable nest cliffs of Romney Shale are found in the Simpson Creek and James River Valleys. Pads Creek, Wilson Creek, and the Cowpasture River cut through Brallier Shale that forms suitable nesting cliffs. East of the North Mountain a broad band of Martinsburg Shale too friable to form cliffs extends into Kerrs Creek Valley.

Elevations in the main study area range from 980 feet above sea level along the James River to 3640 feet on House Mountain. Most of the ridges exceed 3000 feet above sea level and rise 2000 feet above their valleys. Oaks (*Quercus* spp.) and pines (*Pinus* spp.) in combination with other hardwood species cover about 95 per cent of the study area (see Braun 1967:225-231 for a good discussion of plant communities). Most of the remaining area is pasture for sheep and cattle.

About 50 per cent of the main study area is in the George Washington National Forest. White Rock and Butt Mountains are in the Goshen Wildlife Area owned and managed by the Virginia Commission of Game and Inland Fisheries. The northwest corner of the study area is in Douthat State Park. The remainder of the land is privately owned.

The human population is concentrated in Clifton Forge, along parts of the James and Cowpasture Rivers, lower Simpson Creek, and Kerrs Creek. Several tracts of 6 to 12 square miles have no permanent human residents and, except for Clifton Forge, the settled areas are rural. Ravens forage for carrion along the 60 miles of paved roads and 22 miles of railroad (Harlow *et al* 1975). Interstate Highway 64 is being built up Kerrs Creek and down Simpson Creek to Clifton Forge.

In 1974 we censused the Goshen area adjacent to the northeast end of the main study area (Fig 1). Nesting density on the Goshen area differed so greatly from that of the main study area that we have discussed results from the two areas separately. In most respects the Goshen area is similar to the main study area. The primary difference is that the Goshen area is a peninsula of nesting habitat surrounded on three sides by wide valleys that have few cliffs. Most of the Goshen area is owned and managed by the Virginia Commission of Game and Inland Fisheries and the Virginia State Park Commission.

The Valley of Virginia borders on the east side of the study areas. Cliffs are limited to river bluffs formed by streams cutting into the limestone floor of the valley. The forests are broken up by expanses of pasture. In 1974 we searched for raven nests along the Maury River in the Valley of Virginia.

In 1972, 40 square miles of mountains with few cliffs northwest of the main study area were searched for tree nests but none were found. Ground searches for tree nests were so inefficient that the results were inconclusive and the area was excluded from the data presented.

Fig. 2. A 120-foot quartzite cliff. Ravens nested under the overhang right.

Ravens typically start nest building in early February, complete a clutch before the second week in March, and fledge young in late April and early May. Temperatures in February, March, and early April vary between 25° and 75°. Snowfall is erratic and the ground is usually free of snow, although heavy snows have occurred as late as early April. Nests are generally protected from precipitation by overhanging ledges (Fig. 3).

METHODS

A systematic search of cliffs was made in March and April 1972, but only half the main study area was censused. Not all cliffs are suitable for nesting, and we eliminated from later searches remote rock out-crops unsuitable for nesting without affecting the accuracy of the census. During March and April of 1973 and 1974, we walked to the base of all potential nesting cliffs in the main study area and examined them for active nests. In 1974 the same procedure was followed in the Goshen area. Watching for raven activity from a distance was helpful, especially within 2 weeks of fledging, but did not substitute for going to the base of the cliff. Ravens were frequently seen near cliffs where no nest existed and active nests often had no visible raven activity for nearly 2 hours. The status of each nest was determined by examining its contents. Almost all nests were visited at least twice during the nesting season. We continually examined potential nesting trees in our daily travels. Nests of raptors which resemble raven tree nests were frequently found.

The distance from each active nest to the next closest active nest was measured and a mean distance to the nearest active nest was computed. To determine the boundary of the study area, we used one-half the mean distance to the nearest active nest as a radius from each active and potential nest site. The probability that an undetected active raven nest occurred in the study area was very low.

Fig. 3. Nestlings are protected from March weather by rocky projections.

RESULTS AND DISCUSSION

In 1972, we censused one-half the main study area and found seven nests. A complete census in 1973 and 1974 revealed 12 active nests both years. Although the location of nests changed in 1974 (Table 1), the mean distance to the nearest active nest was 3.2 miles compared to 3.0 miles in 1973. Half the mean distance for both years (1.6 miles) gave a study area of 180 square miles and one active nest per 15.0 square miles.

The density of one nest per 15.0 square miles was low compared to data from Britain (Ratcliffe 1962). Ratcliffe censused four areas from 1945 to 1961 and found one nesting territory per 6.6, 6.8, 7.4, and 17.6 square miles. In any one year the number of active nests in his study did not fall

Table 1. Shifts by ravens in the main study area from nest sites used in 1973 to alternate nest sites in 1974. Data for 1972 on seven nests were used in interpretation of movements.

Distance to Alternate Nest Site (Miles)	*Number of Nests*
0	4
0.01-0.50	4
0.51-1.00	2
1.01-1.50	1
1.51-2.00	1

more than 15 per cent below the maximum number of territories. Ratcliffe used the mean distance to the nearest active nest to determine the boundary of his study areas. Had he used one-half the distance, his densities would have been greater. Similarly, our density would have been sparser had we used the full mean distance to the nearest active nest instead of one-half of it. However, use of the full distance would have included a considerable area that we did not search and probably would have resulted in undiscovered nests biasing the density calculations.

Comparison of our data to Ratcliffe's data can best be made by use of the mean distance to the nearest active nest. No assumptions are necessary as to area searched or home range size as long as all nests were located. On our main study area, the mean distance to the nearest active nest of 3.0 and 3.2 miles was similar to the 2.9 miles for the least dense area in Britain. The three densest areas in Britain had a mean distance to the nearest active nest of 1.7 miles.

In 1974 on the Goshen area, we found five active nests with a mean distance of 1.8 miles to the nearest active nest. The Goshen area was only 17 square miles when one-half the mean distance to the nearest nest was used as a radius from the peripheral nests to the boundary. As Ratcliffe censused areas of 170, 259, and 441 square miles, our data from the Goshen area are not comparable to either his data or to the data from our main study area. One explanation for the high density on the Goshen area is that it is bordered on three sides by valleys where ravens have few opportunities to nest. The closest known nest to the Goshen area, aside from those on Butt and White Rock Mountains, was 4.2 miles southeast on the Maury River (Fig. 1). Ravens nesting on the edge of the Goshen area could have avoided contact with ravens that nested on Forge Mountain by foraging in home ranges acentric to their nests. When the five nests from the Goshen area were combined with the 12 nests from the main study area, the mean distance to the nearest active nest was 2.7 miles which delineated a study area of 200 square miles. The density for the combined areas was one active nest per 11.8 square miles.

Ratcliffe (1962) attributed the sparse population of his least dense area to a shortage of nesting cliffs. Availability of cliffs for nesting did not appear to limit the population on our main study area. We classified cliffs as potential and nonpotential nesting cliffs. A potential nesting cliff had one or more ledges that appeared usable as a nest site. Less than one-third of the potential nest cliffs were used (Table 2). Assuming that potential nesting cliffs at least 1.5 miles from an active nest site were available to other ravens for nesting, there were eight additional nesting cliffs on the study area that could have been used by a pair of ravens. If these sites were occupied in addition to the 12 active territories, the density of nesting ravens would have been one pair per 9.0 square miles. Sites were available for an even higher density if ravens in Virginia would nest as close together as those in parts of Britain. Thus, the number and distribution of cliffs did not appear to be limiting the raven population on our study area.

Table 2. Types of bedrock on the main study area and occurrence of nest cliffs.[1]

Stratum	*Number of Nest Cliffs* *Total*	*Active[2]*
Clinch Sandstone	36	12
Romney Shale	5	1
Brallier Shale	8	5
Martinsburg Shale	0	0
Totals	49	18

[1]A nest cliff has one or more suitable nesting ledges
[2]Includes alternate nest sites within a given territory

Ratcliffe (1962) and Allin (1968) frequently found different nest sites occupied in different years within a territory. We think the nests that were close together in the main study area (Fig 1) were alternate nest sites for a pair of ravens that occupied a given territory. Apparent shifts in location of active nest sites varied from 75 yards to 2.0 miles (Table 1). In the longest movement, a pair shifted 2.0 miles from the original site used in 1972 to an alternate site in 1973 and then back to the original site in 1974. Daily movements in any one year in their home range included flights over both sites. At the other extreme, the pair nesting at the mouth of Wilson Creek on the James River used the same site for three years, even though at least ten potential nest sites existed within 0.5 mile. Two other nest sites were used for three years without a shift. Another nest site was used in 1972 and 1973 but in 1974 the birds moved 0.3 mile to a different site Ravens in one territory used a different tree for nesting each year even though a suitable cliff was nearby. Harlow (1922) reported that a pair of ravens in Pennsylvania nested in a tree below a typical nesting cliff.

The closest nesting pairs on the main study area were 1.8 miles apart in 1973 and 1974. On the Goshen area in 1974, we found two active nests 1 4 miles apart. Ratcliffe (1962) often found three active nests in an area 1 mile in diameter. Craighead and Craighead (1956:268) found three raven nests in Wyoming that formed a triangle of about 1.7, 1.6, and 1.4 miles. The closest nests along the Colville River in Arctic Alaska were 3 5 miles apart (White and Cade 1971). The report by Eifrig (1904) of 25 pairs nesting in a colony in Maryland is probably erroneous.

On coastal cliffs, ravens will sometimes nest closer together. Ratcliffe (1962) reported three nests in 1000 yards, 15 in 17 miles, and four in 2 miles along coastal cliffs in England. Breninger (1904) found seven nests in less than 100 yarrds on San Clemente Island, California, but did not say if they were all active at the same time. As Ratcliffe (1962) pointed out, such high densities are on a linear rather than an area basis and thus cannot be directly compared to inland areas.

Of 35 nest attempts for which we knew the outcome, 63 per cent fledged young. Allin (1968) reported 80 per cent nest success in Wales and Dorn (1972) reported 58 per cent success in Wyoming. Number of young fledged per successful nest was 3.3 in Wales (Allin 1968), 2.9 in Wyoming (Dorn 1972), 2.6 in Britain (Ratcliffe 1962), and 2.5 in our study. Unfortunately, no meaningful comparisons can be made because Ratcliffe (1962) lacked data on nest success, and Dorn (1972) and Allin (1968) did not determine the nesting density.

So little is known about the ecology of the raven in Virginia that it is difficult to say what factors are regulating its population. However, on the main study area and the Goshen area the availability of nesting cliffs did not limit the population at its current level. Food supply could have affected the population by influencing the survival of asynchronously hatched nestlings. Mishaga (1974) found that starvation was the primary cause of mortality in nestling White-necked Ravens (*C. cryptoleucus*). Factors that affected the survival of juvenile and adult ravens could possibly be more important in regulating the population than reproductive success, but we have no data on mortality.

Ravens were apparently never extirpated from our general area in post-Columbian times. They were seen there in the 1920s (Sprunt 1956) when populations were thought to be low throughout the Southern Appalachians. Murray (1949) believed a large number of ravens nested in Rockbridge County, which includes part of our study area. It is doubtful whether the raven population we studied has decreased since the 1950s in view of the supposed increase throughout the Southern Appalachians. Due to the moderate population level that now exists, it also seems unlikely that any significant increase has occurred since Murray's (1949) observations.

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