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THE COMMON RAVEN

by Richard L. Knight
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Frontispiece. Common raven at nest on cliff in Idaho. Photo by Al Bammann.

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INTRODUCTION

Throughout the centuries, the raven has captured the imagination of people from all walks of life. Conner et al. (1976) stated that "when the calls of the raven pierce the dawn they engender all that is wild and free." The raven has long been considered a symbol of wilderness. From earliest times, innumerable legends, stories, and beliefs have been built around the bird. Ravens are not only conspicuous, but amazingly intelligent. It is, therefore, not surprising that they have often figured in folklore, legends, and literature. Goodwin (1976) discussed how the raven, with its black plumage, harsh voice, and carrion-eating habits, left a strong impression on early civilizations.

Sprunt (1956) suggested that a certain fear and animosity toward the raven existed in remote areas of the Blue Ridge Mountains settled by Anglo-Saxons. Their attitude toward the raven had, no doubt, been handed down from generation to generation. In Norse mythology, the raven was sacred to the god Odin, whose two ravens, Thought and Memory, flew about the world all day and at evening returned to their master to tell him what was going on. The raven was also used as a land-finder by sea-going people. According to folklore, Iceland was first discovered in this manner (Goodwin, 1976).

In much of western Europe, including the British Isles, the raven acquired a reputation as a bird of evil omen. This was partially due to its association with Viking raiders who carried with them emblems of the raven.

To the Alaskan and Canadian Coast Indian tribes, the raven was considered a hero, recognized by all, yet having many different names. The Tlinget called it Yel, while it was Txamsem to the Tsimshian Tribe. On Vancouver Island, it was called Meskwa, the Greedy One, but to the Bellabella, it was Hemaskas, Real Chief. The Haida called the raven Nankislas, He Whose Voice is Obeyed, and used it as one of their two main crests (Ayre, 1961). The Rivers Inlet Tribe knew it as Kwekwaxawe, Great Inventor, while the Tahltan Tribe called it Sketco, Great Raven.

To those many and diverse tribes of the northern Pacific Coast, the raven was portrayed more often, and in more ways, than any other creature of legend. It was Raven the transformer, the trickster, the Big Man who created the world; put the sun, moon, and stars in the sky; the fish in the sea; salmon in the rivers; and food on the land. He manipulated the ocean tides to assure daily access to beach resources, and gave the tribes fire and water, placed the rivers, lakes, and cedar trees over the land, and peopled the earth (DeArmond, 1975).

These early people believed the raven was capable of turning itself into anything at any time. It could dive beneath the sea, ascend into the sky, or make things happen merely by willing it. Its behavior was often motivated by greed, and it took great pleasure in teasing, cheating, and tricking, although all too often the tables were turned on it (DeArmond, 1975).

Today, the raven finds itself in an equally perplexing position. Accused of being either highly destructive or economically important, it nevertheless has attracted an ever increasing following of people who admire it for its intelligence, beauty, and interesting behavior.

Stewart Janes (1980, pers. comm.) described the raven in this way: "First, I will say that I have found ravens to be the most exasperating birds to work with. They are indistinguishable as individuals, essentially non-territorial, masters at concealing nests, and in general, smarter than man."

This Technical Note has been prepared to give a better understanding of this bird, not so much for its unique place in history and legend, as for its role in living systems and its relationship to raptors and other important wildlife. It frequently competes directly for food with several species of raptors, often killing small rodents to eat and robbing eggs and young from other birds' nests. On the other hand, its nests are often used by owls and other raptors as their own platforms, without which they might be unable to nest in some areas.

The raven is a complicated species, with many complex inter-relationships with other wildlife and with man. It is hoped that this publication will provide an insight into its life, habits, and both the beneficial and adverse influences on the lives of various kinds of wildlife and on man.

SPECIES DESCRIPTION

There are three subspecies of common raven: Corvus corax principalis, Corvus corax sinuatus, and Corvus corax clarionensis. Oberholser (1918) considered the raven subspecies to be almost wholly without differences in size and proportion. Willett (1941) noted several factors that make it difficult to recognize differences in the subspecies, including color similarity and individual variation in size within the same region (often so great that even a fairly large series of specimens obtained at random may be misleading). Since little information exists on migratory movements, it is unsafe to assume that birds taken outside the breeding season are members of the breeding population where they were secured. Only size and proportion are useful in distinguishing races.

Willett (1941) considered C. c. principalis, with its heavy bill and tarsus, to be the largest subspecies. C. c. sinuatus is also large, but has a slender bill and tarsus. C. c. clarionensis is the smallest of the three subspecies.

The common raven is the largest all-black species in family Corvidae in the world (Goodwin, 1976), being 30 to 50 percent larger than the common crow (Corvus brachyrhynchos). In flight, ravens can be distinguished from crows not only by the larger size, but by the fact that a raven's tail is wedge-shaped while the crow's tail is typically quite round (Conner et al., 1976).

Kerttu (1973) developed aging techniques for the common raven and proposed three age classes. During the hatching year, the soft palate is pink to spotted, the iris is gray to half brown, and the dull plumage is initially smooth with much wear of primaries after half a year. Second year birds have soft palates that are light pink to gray in color, the iris is half to completely brown, and the plumage is progressively molted during the summer into adult coloration. Third year and older birds have dark mouths, a brown iris, and metallic black plumage. The molt occurs from June to December with little wear in flight feathers. Murray (1949) reported a sighting of an all-white raven by woodcutters in the Blue Ridge Mountains during the 1940's.

DISTRIBUTION: PAST AND PRESENT

The common raven is a holarctic species that is found from sub-arctic Alaska through northern Canada, and south through the western United States and Mexico. It is also found in central and eastern North America, including Minnesota, Wisconsin, northern Michigan, central Ontario, southern Quebec, and Maine, and south from the Appalachian Mountains to northwestern Georgia (Kerttu, 1973; Fig. 1).

Historically, Dickey (1915) described the raven's range in the eastern United States as the Alleghany Mountains of northern Georgia to the Adirondack Mountains of northern New York and the mountains of parts of New England. In the lowlands, the birds were sometimes found on the Virginia and New Jersey coasts. Dickey (1915) considered them to be most abundant on the Maine Coast. In the interior, ravens were found nesting in the mountains of central Pennsylvania and on the higher ridges of Virginia, West Virginia, Kentucky, and North Carolina.

Within the past century, the raven was eliminated from Alabama and Kentucky (Hooper, 1973). Prior to 1875, ravens were present throughout the breeding season across the Canadian prairie provinces, extending down into the Dakotas. The disappearance of the raven in this area was attributed to widespread use of baited traps, poisons, and the disappearance of the buffalo (Hooper, 1973; Houston, 1977). Jollie (1976) attributed the disappearance of the raven in the midwest to the clearing of forests and the conversion of land to agriculture.

Recently, the raven has been reinvading the historic range and colonizing new areas. White et al. (1975) observed ravens nesting on the Coastal Plains in Alaska in 1974, the first reported nesting that far north. They believed that the presence of people and oil pipeline work camps provided food resources that enabled ravens to extend their breeding range northward. In 1977, Eustis (1978) saw a pair of nesting ravens in southern Michigan, which was the first confirmed raven nest in that area since the big logging era in the 1800's. Howe (1978) reported ravens being seen in northeastern United States localities where they had not been seen for decades. Ravens have also recently been seen in Massachusetts, northern New Jersey, eastern Pennsylvania, southeastern Kentucky and Ontario, and in the northern Sierras of California, where they were formerly rarely seen.

Figure 1. Range of the common raven in North America (Kerttu, 1973).

STATUS AND POPULATION TREND

The common raven was offered complete protection in 1974 by the U.S. Fish and Wildlife Service due to an international agreement with Mexico. The common raven is considered to be a resident species over most of its range, although some wandering and local migration of immature and non-breeding birds does occur (Sprunt, 1956; White and Cade, 1971; Goodwin, 1976).

The common raven was considered a fairly common breeding bird as late as the early 1900's in the southern Appalachian Mountains from northern Pennsylvania to northern Georgia (Bendire, 1895; Harlow, 1922; Murray, 1949; Sprunt, 1956). Harlow (1922) and Sprunt (1956) attributed the decline to persecution by humans, largely due to superstitious ignorance. The raven, however, is apparently extending over much of its former range in the Appalachians, including along the coast in the middle and southern Atlantic states (Sprunt, 1956) where it historically occurred (A.O.U., 1957). This increase is attributed to less shooting of the birds by man, creation of the Great Smokey Mountain National Park, and a greater abundance of food (scraps) left at camps and picnic grounds by tourists on the Blue Ridge Parkway (Murray, 1949; Sprunt, 1956; Hooper, 1977).

In the Upper Peninsula of Michigan, the raven was considered common prior to the 1900's. Barrows (1912) indicated a population decline, and Leopold in 1938 (Anon., 1967) felt the raven was becoming less common and deserved special protection in Michigan. In the mid-1950's, however, DeVos (1964) considered the raven to be increasing in range and numbers and attributed the increase to a greater number of highway animal kills.

The number of common ravens is generally thought to be increasing in the West and in Alaska for a variety of reasons. Frank C. Craighead, Jr. (1980, pers. comm.) observed a 366 percent increase in ravens within a 12 square mile area at Moose, Wyoming between 1947 and 1975. Houston (1968) suggested that an abundant artificial food source provided by park service garbage dumps might be maintaining an artificially high raven population. McBee (1937), White and Cade (1971), and Ferguson et al. (1976) mentioned that ravens were extending their range and numbers by using artificial nesting structures such as abandoned buildings, oil derricks, and windmills.

LIFE HISTORY

REPRODUCTION

Courtship and Territory Occupancy

Common ravens show great fidelity to nesting sites. Ratcliffe (1962) found raven populations in England to be stable from year to year, and White and Cade (1971) described active raven nesting sites in Utah that had been occupied as early as the 1920's. Smith and Murphy (1973) found that the raven showed the greatest population stability on their Utah study area, with four pairs of ravens occupying their respective territories for four consecutive years. Bendire (1895) mentioned that ravens became attached to a nesting sight and nested there each year even though their eggs or young were taken away during successive seasons. Ratcliffe (1962) observed that nesting cliffs would often remain occupied in successive years even after being robbed or destroyed annually. In Virginia, Murray (1935) reported that nesting cliffs are used year after year and that one nest was visited every year for 11 years without driving the birds away. Jones (1935) reported that a pair occupied the same cliff for 14 years.

Mating generally occurs among ravens during the second or third year. Pairs tend to stay away from other ravens throughout the year (Jollie, 1976), although they may frequent communal roosts in the late fall and winter months (Conner et al., 1976). They mate for life, possibly because of this real or relative isolation, although Jollie (1976) believed that exchange of mates occurs more often than is reported in the literature. Both Lorenz (1970) and Jollie (1976) observed that some raven pairs were "happier" than others and attributed this to their individualistic behavior. Tufts (1916) shot the female of a nesting pair in Nova Scotia, and within 10 days, the male had a new mate and had continued nesting.

Courtship displays begin in February (Harlow, 1922; Zirrer, 1945; Dorn, 1972; Brown, 1974). This consists of pursuit flights, aerial maneuvers, mutual feather preening, and strutting. Lorenz (1970) described the strutting display as: the head held high, "ears" raised, throat puffed out, wings slightly spread from the body, belly feathers extended down and laterally below the wings, and tail slightly fanned. Dorn (1972) observed that both members of a pair usually strut simultaneously.

Nest Building

There is a difference of opinion about whether ravens reuse a nest. Jones (1935) stated that no part of the previous year's nest is

used again the following year, whereas Stiehl (1978) observed ravens using the same nest for several years. He was unable to detect a correlation between nesting success and reuse of a nest. Of eight identifiable pairs of ravens observed in 1967 and 1977, four pairs used the same nests both years, and four pairs changed nest locations. Stiehl (1978) also observed the alternating use of raven nests by golden eagles, red-tailed hawks, great horned owls (Bubo virginianus), and common ravens.

Hooper et al. (1975) observed in Virginia that ravens typically start nest building in early February, and in Pennsylvania, Harlow (1922) found that nest building started between the 7th and 15th of February. In Wyoming, Dorn (1972) first observed nest construction on March 29, and Bowles and Decker (1930) observed that nest building in Washington frequently began in early March.

Harlow (1922) determined that nest building takes between 14 and 18 days, and Dorn (1972) observed a pair of ravens in Wyoming that spent at least 10 days constructing a new nest in an aspen (Populus tremuloides) tree.

Harlow (1922) and Bowles and Decker (1930) both observed that nest building was done almost exclusively by the female, but Dorn (1972) and Stiehl (1978) found that both pair members participated in nest construction. The nests are usually large, yet well-defined structures that conform in contour with the ledge or crotch on which they are placed. Tree nests as a rule occupy the highest available strong crotch.

Harlow (1922), Dorn (1972), and Stiehl (1978) provide detailed observations of nest construction. Large sticks are first stacked for a foundation with a loose basket woven about the perimeter of the base. Harlow (1922) observed that ravens usually break dead branches for the base, and that some are over 3/4 inches in diameter and 3 feet long. Dorn (1972) similarly noted that ravens break most of the sticks from trees, although occasionally a bird was observed removing nest material from an inactive raven nest. Twigs are broken off and carried to the nest with the bill. If nesting material is dropped enroute to or at the nest, no attempt is made to recover it. Smaller twigs are placed in the basket and woven into the outer framework until the structure is approximately eight inches deep.

A layer of soil between 0.4 and 1.1 inches deep is formed at the bottom of the basket. It is not known how the soil is carried to the nest. The soil-bottomed stick nest is then lined with a variety of material, the most common being the hair of nearly anything including deer, sheep, cows, horses, dogs, skunks, cats, opossum, coyotes (Canis latrans), or rabbits. It is not uncommon to find shredded bark, grass or moss being used. Bowles and Decker (1930) observed that raven nests in Washington's desert often consisted of different kinds of

wire as well as bones. Stiehl (1978) found a coyote tail in one nest bowl, and Harlow (1922) observed a deer tail in another. Bits of paper, cloth, and clothing are also commonly found in nest bowls.

Nest Defense

Intraspecific nest defense by common ravens is usually weak. In Wyoming, Dorn (1972) watched flocks of ravens wander through nesting territories with impunity and speculated that flocks of conspecifics may inhibit nest defense. Nest defense against raptors, crows, and humans varied considerably, although the individual variation observed was usually constant (Dorn, 1972; Hooper, 1977).

Dorn (1972) observed a pair of nesting ravens that often vigorously harassed a pair of red-tailed hawks nesting a quarter mile away. In Pennsylvania, Harlow (1922) noted that ravens easily intimidated red-tailed and broad-winged hawks near a nest. He also observed ravens harassing crows and at times driving them from sight.

Ravens are exceedingly wary about the nest site when humans are nearby (Bowles and Decker, 1930; Murray, 1949). Before the eggs hatch, an incubating raven will normally attempt to slip off the nest quietly when a human approaches. After hatching, however, ravens will often fly overhead, calling frequently (Dorn, 1972).

Stiehl (1978) determined two types of responses to humans near a nest. In areas of heavy human disturbance, he noted, ravens were quick to flush from a nest, whereas at nest sites with infrequent human disturbance, female ravens remained tenaciously on the nest when approached by humans. In Alaska, Brown (1974) had a raven dive at him as he was climbing the nest tree. The partly folded wings produced a "whissh" sound, and Brown speculated that the diving displays were intended to frighten off potential predators.

Hooper (1977) observed that in 16 out of 24 nesting territories in Virginia, ravens evaded and were seldom vocal when humans approached. In the other eight territories, the birds appeared defensive and were highly vocal. Evasive birds usually left the nest vicinity and would soar within sight of the nest at distances of 1,200 to 2,400 feet. Defensive birds uttered rapid "kack-kack" or "hark" calls and flew within 150 feet or less of the intruders.

Bowles and Decker (1930) approached a nest site in Washington where both birds performed a remarkable display of aerial tumbling, then perched on the cliff 50 feet from the nest site. The ravens then gave a series of calls, described as "quacking like a duck" and "bawling like a cat".

Both Tyrrell (1945) and Dorn (1972) observed ravens breaking tree branches and pecking vigorously at tree limbs when humans approached the nests. Tyrrell (1945) reported that one raven would break off twigs in its bill, shake them strongly, then drop them to the ground.

In Oregon, Janes (1976) visited a raven nest where the pair "threw" rocks at the observers. The ravens picked up at least six rocks with their bills and "threw" them down at the two individuals. The largest rock was 3 inches in diameter and 1 inch thick and had apparently been partially buried. Subsequent visits to the nest site failed to provoke any further rock throwing.

Nesting Period

In a study of ravens in Britain, Ireland, Wales, and Scotland, Holyoak (1967) found that although ravens breed later farther north, they nest no later at higher elevations than at lower elevations at the same latitude.

Several days usually elapse between the completion of the nest and the laying of the first egg (Dorn, 1972). Harlow (1922), however, observed that this period varied among individual pairs from 3 days to a week.

Harlow (1922) noted that over a 3-year period, nesting ravens in Pennsylvania laid their eggs between February 22 and April 5, while Tyrrell (1945) in Shenandoah National Park, and Hooper (1977) in the southern Appalachians of Virginia, found eggs in most nests around the first week of March.

For 4 years, Smith and Murphy (1973) found the average egg-laying dates of nesting ravens in Utah to be between March 27 and April 2, with extremes between March 19 and April 8. Dorn (1972) calculated the egg-laying dates of nesting ravens in Wyoming to be between April 7 and May 14. Over a 3-year period in the Birds of Prey Natural Area in Idaho, the mean egg-laying dates were between March 29 and April 4 (Kochert et al., 1975, 1976, 1977). The earliest recorded egg-laying date was March 1 and the latest observed date was May 10.

Bowles and Decker (1930) and McBee (1937) noticed that in Washington, complete clutches are usually found by the first week of April, although eggs are first laid as early as March 14, and as late as May 20. They also observed that if the first set of eggs is removed, it is not uncommon for another set, and in some cases a third, to be laid in the same nest. Bowles and Decker (1930) found that the second or third sets would often contain one egg less than the first. Dorn (1972) found no evidence of second clutches or renesting, even though three clutches were destroyed during egg-laying or incubation.

In Oregon, Stiehl (1978) observed an initial refractory period after the laying of the first egg, which was followed by the laying of two eggs, then an egg daily until the clutch was complete. Both Harlow (1922) and Bowles and Decker (1930) determined that eggs were laid daily until the clutch was complete.

Ravens begin incubation after laying the first egg (Stiehl, 1978), although Dorn (1972) speculated that true incubation may start gradually as the brood patch becomes more vascularized. Harlow (1922) also observed that during severe weather, ravens remain on the nest from the time the first egg is laid. Although Tyrrell (1945), Bent (1964) and Conner et al. (1976) observed both sexes sharing incubation duties, Harlow (1922), Bowles and Decker (1930), and Stiehl (1978) determined that only the female incubates the eggs, with the male providing food for the female. When not gathering food, the male will "stand guard" near the nest on a perch with a commanding view of the area (Stiehl, 1978).

Bancroft (1927) reported that ravens in central California required two weeks to incubate their eggs, although others (Harlow, 1922; Tyrrell, 1945; Dorn, 1972; Conner et al., 1976; Stiehl, 1978) have determined the incubation period to be approximately 21 days. Dorn (1972), Conner et al. (1976), and Stiehl (1978) observed that hatching is asynchronous, and Dorn noted that the eggs hatched at intervals of a day or less. Stiehl (1978) reported that almost invariably one egg of a clutch failed to hatch. This occurred with such regularity that he felt clutch size could be accurately determined by adding one to the number of hatchlings at 7 to 10 days old.

Smith and Murphy (1973) found that the average hatching dates of ravens in Utah over a 4-year period were between May 1 and May 12. The earliest observed hatching date was April 27, and the latest was May 18.

In Idaho, Kochert et al. (1975, 1976, 1977) observed that the average hatching date over 3 years varied between April 26 and May 4, with the earliest observed hatching date being April 12, and the latest being May 28.

Hooper (1977) reported that ravens in Virginia fledged in late April and early May. Harlow (1922) observed in Pennsylvania that ravens can fly short distances from the nest after 4 weeks, but Conner et al. (1976) noted that they left the nest when 6 to 7 weeks old.

In Wyoming, Dorn (1972) noted an average of 42 days between the hatching of the first egg and the fledging of all surviving young in a nest. The range was 39 to 45 days. In Oregon, Stiehl (1978) determined that ravens fledged at about 41 days of age.

Smith and Murphy (1973) determined the average brood departure dates in Utah over 4 years to be between May 7 and June 12. The earliest brood departure date observed was May 3, and the latest was June 23. At the Birds of Prey Natural Area in Idaho, Kochert et al. (1975, 1976, 1977) observed the average fledging dates to be between June 1 and June 3, with some fledging as early as May 12, and others as late as July 9, which was a renesting attempt. The latest date at which young were still seen near the nest site over a 3-year period was August 6. This gave a breeding season of 197 days.

Dorn (1972) observed that after fledging, adults continue to feed the young for at least a week, with some family groups together for a month after fledging. The nest site remains a center of activity until mid-July for most ravens in the Harney Basin, Oregon, at which time a change in food availability or preference alters that location (Stiehl, 1978). Stiehl (1978) observed two distinct post-fledging patterns, depending on whether the nesting attempt was early or late. When the nesting attempt was early, the post-fledging period averaged approximately 6 weeks, whereas when the nesting attempt was made late in the season, the post-fledging period was compressed to about a week.

The Young Raven

In Oregon, Stiehl (1978) observed that any unhatched eggs remain in the nest from 4 to 7 days after the hatch of the clutch, and speculated that the adult ravens consumed the eggs. Gwinner (1965) reported that ravens remove and eat eggshells of any unhatched eggs.

When ravens are born, they are naked, orange in color, and sightless. Stiehl (1978) was unable to elicit response to calls from ravens at 1 day post-hatch, but at 3 days, the same calls elicited a begging behavior. At about one week old, the young are still naked, but have doubled in size, and their eyes are functional at 12 to 14 days (Conner et al., 1976; Stiehl, 1978).

Stiehl (1978) noted that young ravens are most vulnerable to predation during the first 2 weeks after hatching, during which 71 percent of the dated nest depredations occur. Dorn (1972) and Kochert et al. (1975, 1976) determined that most raven mortality occurs before or during incubation, primarily because of hatching failures and nest abandonment. In New Mexico, Mishage (1974) determined that most nesting mortality of white-necked ravens (Corvus cryptoleucus) occurs during the initial one-third (less than 16 days) of the nestling period and attributed it to starvation and human disturbance.

Stiehl (1978) reported that young ravens over 14 days of age remain silent in the nest when approached. He surmised that the high

mortality rate during the first 2 weeks may be the result of indiscriminate vocalizations by the blind young which could have attracted predators.

In Wyoming, Dorn (1972) observed that parents brood the young almost continuously during the first few days after hatching and then continue to brood their young for at least 2 more weeks. Brooding attentiveness decreases over time, and Dorn never observed adults brooding their young during the day at 25 to 28 days of age. In Idaho, Kochert et al. (1977) observed that the female broods the young, and that brooding was not observed after the young were more than 23 days old.

Kochert et al. (1977) found that females performed 72 percent of 183 observed nest maintenance visits. Nest maintenance consists of carrying off fecal sacs, casts, and discarded food. The female also probes and fluffs the nest.

Dorn (1972) noted that both parents feed the nestlings by regurgitation, bringing only enough food for one nestling on each nest visit. Older nestlings were fed every 3 to 5 minutes during one morning observation period, while younger nestlings were fed only once during a one-and-a-half hour morning observation period. Kochert et al. (1977), in their definitive study of raven nest behavior, observed adult ravens visiting nests to feed young an average of 50.9 times a day, with no observed correlation between feeding frequency and time of day or stage of brood-rearing. An average of 1.5 young were fed per visit. They did observe that some of the young were fed more than others, but not significantly more. Mishage (1974) noted that 10 out of 11 starved white-necked raven nestlings were either the youngest or next to the youngest, indicating that discriminate feeding and/or the ability to compete for food does exist.

At about 30 days of age, young ravens become more active in the nest. During the last week in the nest, Dorn (1972) observed that increased activity caused the nests to gradually disintegrate, and the young frequently moved from the disintegrating nests to adjacent tree limbs before they could fly. Stiehl (1978) noted that sustained flight was impossible for young ravens, and even short flights were difficult and usually followed by frequent calls, gaping, and panting.

Dorn (1972) found that adults continue to feed fledged young for at least a week, and Kochert et al. (1977) noted that individual broods of ravens are usually not found near the nest site any longer than 2 weeks after fledging. They noted that although ravens did move as a group out of the canyon, they did not necessarily remain in family units. In Wyoming, Dorn (1972) observed family groups still together a month after fledging and noted that the young of the same brood often fed and loafed together at a dump site.

Productivity

Ravens in Europe are unique in that they show a decrease in clutch size from the south to the north (Holyoak, 1967). Smith and Murphy (1973) in Utah observed that raven clutches varied from three to seven eggs and averaged 5.35 eggs over four nesting seasons. Dorn noted that the average clutch size in Wyoming was 5.4 eggs, with a range of three to six eggs. In Oregon, Stiehl (1978) observed an average clutch size of 6.0 eggs in 45 nests, with clutch sizes varying from three to seven eggs. In the Birds of Prey Natural Area in Idaho, Kochert et al. (1975, 1976, 1977) noted that mean clutch size varied from 5.08 to 5.30, and clutch size again varied from three to seven eggs.

Kochert et al. (1977) reported that 54 percent of the eggs hatched in nests for which both the clutch size and the number hatched were known, but noted that since ravens clean their nests of unhatched eggs, it is difficult to assess embryonic mortality. During a 3-year period, Kochert et al. noted that raven reproductive losses were greatest during incubation, with hatching failures and nest abandonment being the greatest causes. Of 54 eggs that did not hatch, 20 disappeared from nests prior to the hatching date, 25 failed to hatch from undetermined causes, and 9 were abandoned.

In Utah, Smith and Murphy (1973) observed that between 1967 and 1970, ravens successfully hatched 70.5 percent of all their eggs. They noted that nest desertion was observed in every raptor species in their study area, with the exception of the raven and Cooper's hawk (Accipiter cooperii). In Wyoming, Dorn (1972) determined that nesting mortality occurred before or during hatching, and that hatching mortality was 35 percent.

Stiehl (1978) noted that in Oregon, almost invariably one egg of a clutch failed to hatch. During a 2-year period, 69 to 71 percent of the eggs in all clutches hatched.

In 1975 and 1976, in the Birds of Prey Natural Area in Idaho, Kochert et al. (1975, 1976) found that the maximum hatching ravens per nesting attempt averaged 3.30 to 3.66, with a range of from 0 to 7. In 1977, Kochert et al. noted that the number of hatchlings per breeding attempt was 3, with the mean brood size among nests that hatched young being 4.8. Stiehl (1978) noted that in Oregon the average brood size of 51 nests during a 2-year study was 4.2, with a range of from 0 to 6 young.

In Virginia, Hooper et al. (1975) observed that an average of 2.5 young fledged in 35 nesting attempts where the outcome was known. In Wyoming, Dorn (1972) determined that an average of 1.67 young fledged per nest from 24 nests where the outcome was known. In 10 of these

nests, no young fledged, and no more than 4 young fledged from any one nest. Smith and Murphy (1973) noted that in their Utah study area, ravens averaged 2.57 young fledged per nest over a 4-year period.

Kochert et al. (1975, 1976, 1977) probably have the most complete information on the fledging of common ravens. In Idaho, they found that for each year during a 3-year period, ravens fledged between 2.1 and 2.45 young per pair, 2.4 and 2.88 young per nesting attempt, and 3.7 and 3.88 young per successful attempt. Stiehl (1978) observed that a mean of 2.3 young fledged per pair in 53 Oregon nests, and Stewart Janes (1980, pers. comm.), also in Oregon, observed that 3.3 young fledged in 18 nesting attempts, and 3.9 fledged in 15 successful nests.

Hooper et al. (1975) reported that of 35 nesting attempts in Virginia, 63 percent fledged young. In Wyoming, Dorn (1972) calculated that the nestling survival of 14 nests, for which both clutch size and number of fledgings were known, was 19 percent, although she felt the actual value was higher. She noted that of seven nests that failed after hatching, four failed before the young were 2 weeks old. Possible predators included hawks, other ravens, owls, and martens (Martes americana). She observed that in areas frequented by flocks of non-breeding ravens, no raven nests were successful. The mortality rate continued to increase as nestlings became older. One young died when it was approximately 4 1/2 weeks old. The dead nestling was not removed from the nest. Holyoak (1967) observed that in England ravens also failed to remove large, dead young from the nest.

Smith and Murphy (1973) determined that the overall fledging success of ravens for 4 years in Utah was 47.4 percent. This varied from a low of 40.9 percent in 1969 to a high of 57.1 percent in 1967.

During three years at the Snake River Birds of Prey Area in Idaho, Kochert et al. (1975, 1976, 1977) noted that between 5 and 11 percent of the adult population did not breed. Nesting success over 3 years averaged between 63.0 and 71.1 percent per pair and 74.0 and 78.0 percent per attempt. In 1977, nestling survival at eight nests was 69 percent. Of 40 nestling mortalities over 3 years, 15 died as a result of human disturbance, 13 disappeared from nests prior to the expected fledging date, 7 died of unknown causes, 4 died from predation, and 1 died following the death of a parent.

Stiehl (1978) noted that of 85 nesting attempts during a 2-year period in Oregon, 60 percent were successful in fledging one or more young. Of 34 nesting failures, 20 were the result of depredation, 7 were attributed to insufficient food supply, 5 were due to human

disturbance, and 2 occurred where the nests had fallen from their locations. Seventy-four percent of the hatched young fledged. Stiehl noted that most predation occurred within a week of hatching, although two nests were destroyed at 35 days after hatching. Coyotes, raccoons, weasels (Mustela spp.), great horned owls, and humans were suspected as being primarily responsible for nest depredations.

FOOD HABITS

The common raven is adapted to widely scattered and limited food supplies (Jollie, 1976) as well as to a broad spectrum of foods (White and Cade, 1971). Tyrrell (1945) described the raven's food as anything edible, alive or dead, that it can catch, kill, disable, or pick up. Its diet is no doubt almost as varied as that of the crow, of which the greater part is carrion, with small mammals next in importance. Stewart Janes (1980, pers. comm.) observed in Oregon that different pairs of ravens have distinct diets, with some leaning heavily toward a vegetarian diet, others being scavengers, and some being successful predators, living on Belding ground squirrels (Citellus beldingi) and weasels (Mustela spp.).

Bendire (1895) described ravens as feeding principally on carrion, dead fish and frogs, insects, worms, mussels, snails, and small rodents, as well as on refuse from kitchens and slaughterhouses. They have also been seen feeding on the seeds of poison oak (Rhus diversifolia), the hulls of wild oats (Avena fatua) (Hoffmann, 1920), and on cactus fruits in California (Ross, 1925); capturing chickens in New Brunswick (McManus, 1935); feeding on scraps at logging camps on Vancouver Island (Pearse, 1938); eating Mormon crickets (Anabrus simplex) in Utah (Knowlton, 1943), and water insects, small fish, amphibians, grasshoppers and mice in Wisconsin (Zirrer, 1945). During July in Michigan, ravens have been seen eating blueberries (Mahringer, 1970), and have reportedly eaten ptarmigan (Lagopus spp.) and microtines in Alaska (White and Cade, 1971).

Larsen and Dietrich (1970) reported 35 lambs lost to a single pair of ravens in Oregon during 1 week. McBee (1937) commented that although ravens in Washington were accused of killing lambs, he had never heard sheepmen complain of losing any.

Many authors have commented on the importance of carrion to ravens, particularly during times of food stress, such as during the winter season (Feilden, 1909; Nelson, 1934; Mylne, 1961; Ratcliffe, 1962; Brown, 1974; Temple, 1974; Harlow et al., 1975; Stiehl, 1978). White and Cade (1971) speculated that in arctic Alaska, ravens may be seasonally heavily dependent on gyrfalcons (Falco rusticolus) for carrion killed by ptarmigan. Turcek and Kelso (1968) observed ravens

in captivity storing pieces of carrion and bones, indicating that wild birds are also capable of caching food, a highly desirable trait for any vertebrate that at times is dependent on a variable food source.

Several major studies of raven food habits have been conducted in different parts of North America. Harlow et al. (1975) analyzed 435 castings of ravens in Virginia and determined they are primarily scavengers on opossums (Didelphis marsupialis), domestic sheep, deer (Odocoileus virginianus), and rabbits (Sylvilagus spp.), and are predatory on small mammals such as mice, moles, and shrews. Dumps and roadways provide a regularly used supply of food.

In Jackson Hole, Wyoming, Dorn (1972) found that ravens are both scavengers and predators, with their diet reflecting the availability of food. During the winter, ravens feed mostly at garbage dumps and, to a lesser degree, on carcasses of moose (Alces alces), elk (Cervus canadensis), and deer (Odocoileus hemionus). Non-breeding flocks of ravens continue to feed at the garbage dumps during the summer, while nesting birds feed mainly on small mammals (75 percent of 111 pellets from 12 nest sites) such as Microtus spp. and Citellus spp. Insect remains and pieces of eggshells were found in only eight (7 percent) of the pellets.

Kochert et al. (1976), at the Birds of Prey Natural Area in Idaho, observed that Townsend ground squirrels (Spermophilus townsendi) comprised 93 and 70 percent of nesting ravens' food biomass in 1975 and 1976, respectively. Young ravens were observed consuming large numbers of beetles and scorpions. In 1977, adults were observed delivering remains of desert horned lizards (Phrynosoma platyrhinos), side-blotched lizards (Utah stansburiana), and snakes to raven nestlings (Kochert et al., 1977). Red meat (presumably carrion) was delivered during 72 of 1,284 (5.6 percent) nest visits.

In the eastern Great Basin Desert of Utah, Smith and Murphy (1973) found in 1969 and 1970 that nesting ravens relied heavily on mammals, which comprised 55.1 percent of the prey and 96.2 percent of the total prey biomass. Lagomorphs (Lepus californicus and Sylvilagus spp.) comprised 23.9 percent of the prey and 93.2 percent of the total prey biomass. Almost two-thirds of the jackrabbits were immatures or juveniles, indicating that some were taken as carrion. Birds comprised 11 percent of the prey, but only 1.9 percent of the total prey biomass. Dermestids and unidentified beetles were the most frequently taken invertebrates.

In Harney Basin, Oregon, Stiehl (1978) analyzed 2,202 food items found in castings of nesting birds. Mammals, mainly Lepus spp. and Microtus spp., were the most important food items, with avian eggs

being second, and avian parts (feathers, down and body parts) being third. During late July through September, it appeared that grasshoppers (Melanoplus spp.) were the dietary staple.

Carriion was used in all seasons, although less in the summer months than at other times of the year. Stiehl (1978) observed that ravens seemed to prefer grasshoppers to carrion and that in late summer, carrion feeding increased as the number of grasshoppers decreased. In October and November, ravens fed primarily in harvested grain fields, and carrion became increasingly important as winter approached.

Stiehl (1978) believed that winter in Harney Basin was the period of highest food stress for ravens. Due to lower mean winter temperatures and shorter days, ravens needed more food, but had less foraging time. They appeared to rely more on predation during this period, but also used opportunistic food sources, such as cultivated grain wastes, dead carp, dead range animals, and placentae from cattle parturition.

Immature, non-breeding ravens were observed feeding heavily on waterfowl eggs during the spring (Stiehl, 1978). A flock of 40 to 60 ravens was often seen in prime waterfowl nesting areas and was sometimes seen carrying eggs.

HUNTING METHODS

Jollie (1976) described the common raven's foraging habitat (other than vegetation, climate, and most other biotic factors) as being strongly contoured, such as along sea cliffs.

Angell (1977) noted the advantages of the raven's black color. Black feathers absorb solar energy and decrease the temperature gradient between the skin and its outer feathers. Over a 24-hour period, a raven could show a net energy advantage over a non-black bird of comparable size. This enables ravens to live in cold areas, such as the Arctic, where they are able to stay year-round and take advantage of a continuous food supply. Its black color is also an advantage in extremely hot areas where it assists in a quick warming through solar energy absorption. This enables desert ravens to forage in the early morning and late afternoon and evening, hunting crepuscular prey and scavenging at garbage dumps, or along a stretch of highway (Angell, 1977). Stiehl (1978) considers the raven to be primarily a sight hunter.

In the Birds of Prey Natural Area near Boise, Idaho, Wolfe (1977) observed ravens foraging most often near a burned sagebrush (Artemisia tridentata) flat, an area of sparse sagebrush and croplands near the canyon. He also observed that ravens foraged most often in late afternoon and were flexible in using all types of perch sites.

Conner et al. (1975) observed ravens feeding alongside of common crows and starlings (Sturnus vulgaris) at a sanitary landfill in Virginia, relying on sentinal crows for warning of possible danger. Ravens did not enter the landfill until the sentinel crows were in position, and after being frightened, were the last species to return to the landfill to resume foraging. Conner et al. (1975) speculated that such a behavioral adjustment might enable ravens to more safely exploit a potentially hazardous food source and possibly increase their overwinter survival.

Several interesting aspects of the raven's foraging behavior have been reported. Mallory (1977) pointed out their adaptability and described their feeding behavior as a learned food-gathering strategy, as opposed to a simple opportunistic approach. In Minnesota, Harrington (1978) observed that ravens were attracted by wolf (Canis lupus) howling during the fall and winter and theorized that ravens often investigate such activities for the presence of carrion. Mech (1970) reported ravens following wolves or wolf tracks hoping to find carrion.

Montevecchi (1978) described how ravens in Newfoundland flushed black-legged kittiwakes (Rissa tridactyla) from their nests by dropping tufts of grass from above, by approaching them suddenly and closely while calling loudly, and even by physical attack.

Zirrer (1945) observed ravens in Wisconsin hunting amphibians on foot by turning over leaves and pieces of decaying wood or by boring holes in soft mud. He also saw them chasing frogs, and once saw a raven harass a domestic cat, which was carrying a mouse, into dropping the mouse and then distract the cat while another raven made off with the mouse.

Mallory (1977) observed a raven in Ontario flying from a perch and breaking the tunnels of voles (Microtus pennsylvanicus) to expose and flush the mammals.

Marquiss et al. (1978) witnessed a pair of ravens in Britain robbing voles from short-eared owls (Asio flammeus). After observing concentrations of foraging ravens along the Trans-Canada Highway, Conner and Adkisson (1976) suggested the ravens were feeding on migrant birds killed by passing vehicles.

VOCALIZATIONS

The common raven is believed to have a repertoire of vocalizations as extensive as any bird species, although this repertoire is nearly equalled by that of the crow (Brown, 1974; Jollie, 1976). Brown (1974) discovered that ravens in Alaska have a range of vocal

frequencies that extends from 300 cycles per second (c/s) to 2,300 c/s for fundamental frequencies, and harmonics extended above 8,000 c/s. Raven calls carry considerable distances and are thus well suited for communicating in dense habitat (Ross, 1925; Zirrer, 1945; Brown, 1974).

Determining the raven's exact repertoire is complicated by individual variability and plasticity of behavior (Bowles and Decker, 1930). Brown (1974) was able to identify over 30 distinct call categories on the basis of audible and audiospectrographic characteristics. He was able to detect up to 10 sub-syllables in some of the calls, although most contained only one. "Kaww" and "Koww" calls were the most frequent vocalizations and were extremely variable within the population. Harlow (1922) described male ravens as having a much deeper and stronger call than females. The call of young ravens is easily distinguishable up to the age of 6 months (Harlow, 1922).

SOCIAL BEHAVIOR

Corvids, including ravens, are believed to have the most complex playing behavior known among birds (Ficken, 1977). Thompson (1964) observed ravens carrying pieces of twigs and heather and dropping and catching them in mid-air, and Elliot (1977) observed ravens hanging upside down by their beaks and feet from a tree branch. Dorn (1972) witnessed ravens tearing off small pieces of paper with their bills and saw two ravens tugging on a piece of paper until it tore. Gwinner (1966) considered play behavior among ravens to be contagious with birds showing a great deal of individual variation and invention in developing complex behavioral sequences.

Dorn (1972) observed ravens in Wyoming displacing other ravens perched on a gravel pile only to be displaced themselves by other ravens. The ravens displayed similar behavior as they sat on a fence rail. One would sidle along the fence and attempt to dislodge another. The displaced birds would fly and land and then displace others from the rail.

Another commonly observed form of social behavior is aerial soaring (Rubey, 1933; Hutson, 1945; Zirrer, 1945; Hewson, 1949; Hurrell, 1951; Lockley, 1953; Hewson, 1957; Davis, 1967; Dorn, 1972; Brown, 1974). Flocks of ravens, ranging from several pairs to over 100 birds, engage in spectacular aerobatic and soaring flights near hills or cliffs that provide thermals.

Hurrell (1951) and Brown (1974) believe that ravens are attracted to areas with good thermal characteristics when social flying, and Hewson (1957) believed that the stimulus for social flying is the

sight of other ravens already playing or soaring in a thermal. Davis (1967) observed that ravens fly over a mile to join an aerial display.

There is disagreement over exactly the time of year that social flying occurs, its purpose, and whether it consists of mated pairs and/or non-breeding birds. It does appear that, depending on the time of year, mated pairs, as well as non-breeding birds, do participate in social flocking (Jollie, 1976). Coombes (1948) and Brown (1974) believe that social flocking is not motivated by food.

Jollie (1976) considers the raven to be an aggressive bird with a relatively greater tolerance distance than other related species, and reports that a dominance hierarchy exists during such times as feeding. Dorn (1972), however, was unable to discern any hierarchy within a flock of birds at a Wyoming garbage dump, but did observe that some sort of flock integrity was maintained through calling. This was also observed by Brown (1974), who felt that a social hierarchy did exist at an Alaskan dump. He believed that this was maintained by threatening and submissive postures. Adults were never seen fighting, but juveniles frequently fought.

ROOSTING

Communal roosting is a common feature of corvid behavior. It is generally believed that winter roosts are comprised of breeding and non-breeding birds, but that during the nesting season, only non-breeding birds occur in roosting and feeding flocks. Coombes (1948) and Ratcliffe (1962) believe that mated pairs roost alone on their breeding territories during the winter.

Cushing (1941) observed up to 200 ravens roosting in a bushy canyon along the coast of Marin County, California. This roost had apparently been used for at least 9 years. Some birds that frequented the roost traveled over 40 miles each day between the roosting and foraging sites and back.

In the Baraga Plains, Michigan, Mahringer (1970) observed a communal roost with a maximum of 60 birds. This roost site was used from June until mid-August when logging operations began.

Lucid and Conner (1974) reported a winter communal roost in Virginia of over 100 birds. The roost was in a clump of hemlocks (Tsuga canadensis) that the researchers located by observing the aerial soaring and aerobatics of the ravens over the roost site before settling down for the night. This roost site had apparently been used for several years. Temple (1974) described a roost of about 10 ravens that had been active for several years in abandoned buildings in Alaska.

Perhaps the largest communal roost of ravens in North America is located within dense growths of bulrush (Scirpus acutus) at the Malheur National Wildlife Refuge in Oregon (Stiehl, 1978). Ravens roost directly on the frozen substrate or on slightly elevated S. acutus stems. On January 4, 1977, 836 ravens were counted at the roost site. Banded birds that used this winter roost were seen as far as 298 miles away during other seasons indicating that the roost attracted ravens from considerable distances. During 1976 and 1977, the roost was active from mid-October until mid-March, with a maximum number of ravens observed in early January.

Several pre-roost areas were located within a mile of the roost area. Stiehl (1978) observed that ravens might or might not include stops at pre-roost sites. He observed that birds that arrived early did stop at the pre-roost site, while late arrivals flew directly to the roost site. Flights from the pre-roost area to the roost site were low and direct. When over the roost site, the birds folded their wings and tumbled into the S. acutus.

Morning activity in the roost began before sunrise. Shortly after vocalizations began (croaks and buzzes), the ravens would start leaving the roost. Initial flights were short, between 1,200 and 3,000 feet, and in small groups. From these staging areas, long, almost continuous flights would take the ravens to grain fields and carrion sites up to 28 miles away (Stiehl, 1978).

HABITAT REQUIREMENTS

FACTORS INVOLVED IN NEST SITE SELECTION

Much of the raven's success in fledging young is dependent on the nest site. Jollie (1976) described a pair that nested at one cliff for 14 years, but were only successful in fledging young once because the nesting cliff was in an area inhabited by people. Nest site selection, as well as habitat preference, is largely learned, which could explain why some ravens nest in trees in areas containing cliff sites (Jollie, 1976). In Virginia, Harlow (1922) observed that raven pairs always use the same nesting substrate regardless of whether that substrate was the most available.

In England, Ratcliffe (1962) noted that physiographical and geological diversity affected ravens' breeding density. The smallest nesting cliff used depended on what was available and was therefore related to topography (Ratcliffe, 1962; Stiehl, 1978). Cliffs from 200 to 500 feet high were most favored. The largest cliffs were used the most regularly by nesting ravens since they provided the most security.

Ratcliffe (1962) noted that small and unsuitable nesting cliffs are used only if they are far enough from main roads and habitations. Of 34 raven nesting cliffs that were less than 50 feet high, only 6 were less than a mile from human habitation. Conversely, of 87 raven nesting cliffs that were within a half mile of human habitation, only 15 were less than 100 feet high.

In Virginia, however, Hooper (1975) found that nearly as many nesting cliffs that were less than 45 feet high were found less than a half mile from human habitation as were found in more secluded locations, and that an equal number of taller cliffs were found in both locations. On the average, more successful nesting attempts occurred closer to roads and dwellings than did unsuccessful ones, and successful nesting attempts less than a quarter mile from a road averaged more fledglings than did attempts farther away. This may have been due to food availability, since more suitable prey could be found in the valleys and near railroads, houses, farms, and most roads.

Harlow (1922) seldom found a nest in Virginia less than 50 feet high and found some on cliffs up to 200 feet high, but noted that the height of the nesting cliff was of secondary importance. Hooper (1977), also in Virginia, observed nesting cliffs between 15 and 114 feet, averaging 59 feet high. Nests that were higher on cliffs were no more successful than the lower nests. Conner et al. (1976) observed that the typical nest cliff height was between 30 and 60

feet, and Murray (1949) found nesting cliffs in Virginia from 75 to 100 feet high, with nests placed from 20 to 60 feet from the base of the cliff.

In Idaho, Kochert et al. (1977) noted that ravens seemed to nest on smaller cliffs than did other raptor species, with nests found between 17 feet above the cliff base and 12 feet below the cliff top. The total relief and lateral extent of a nesting cliff were just as important as the sheer height of the cliff.

McBee (1937) noted that nesting cliffs in Washington were never high, averaging between 40 and 50 feet. Decker (1930) found that six nesting sites were an average of 22 feet above the cliff base, with a range of 12 to 40 feet, and 11 feet below the cliff top, with a range of 10 to 12 feet.

Ratcliffe (1962) noted that ravens in England did not nest above 2,700 feet elevation, but preferred nesting between 1,250 to 1,500 feet because of the severe climate at higher elevations. Although ravens are capable of nesting in severe weather, the prolonged snow cover and low temperatures above 2,500 feet elevation were believed to restrict nesting. On the other hand, raven nests were seldom found below 500 feet above sea level (Ratcliffe, 1962), mainly due to an absence of suitable nesting cliffs and high human disturbance.

Hooper (1975) noted that ravens in Virginia nested between 1,005 and 3,390 feet, although this was probably due to cliff availability. Eighteen nests were found between 1,005 and 1,737 feet, 12 between 1,740 and 2,637 feet, and 11 between 2,640 and 3,390 feet. The number of nests fledging at least one young was no different above and below 1,740 feet, but significantly more young were fledged per successful nest attempt below 1,740 feet than at higher elevations.

Smith and Murphy (1973) found that the average elevation of nesting ravens in their Utah desert study area was 5,950 feet, with a range of 5,590 to 6,320 feet. White and Cade (1971) believed that the altitudinal limit for nesting ravens in Alaska was 3,500 to 4,000 feet and that many magnificent cliffs were therefore unsuitable for nesting.

In England, Ratcliffe (1962) noted that most nesting cliffs faced between north and east, although actual nest site exposure deviated by as much as 90 degrees. He believed that nest exposure did not influence the choice of nesting cliff or site. Nesting cliffs in Virginia faced northeast to southwest, with 18 nest sites facing south to west and 10 facing north to east. Ten other nest sites were on the sides of ridges (Hooper, 1975). In Utah, Smith and Murphy (1973) determined that 57.1 percent of the nest sites faced west, 28.6 percent faced north, and 14.3 percent faced south. They also observed that all the raven nests had overhangs preventing direct exposure.

Protective overhangs are apparently common to most raven cliff nests (Harlow, 1922; Wolfe, 1929; Jones, 1935; Murray, 1949; Ratcliffe, 1962; White and Cade, 1971; Smith and Murphy, 1973; Conner et al., 1976). Harlow (1922) observed that since egg-laying often begins in February when winter storms are common, an overhang assures protection. Ratcliffe (1962) also noted that overhung nests are protected from wind, falling stones and ice. In Virginia, Hooper (1975) noted that overhanging ledges ranged from .8 to 236 inches.

NEST SITES

Ratcliffe (1962) observed that in England ravens usually use several nest sites and several nesting cliffs. Ten different nest sites was the maximum found on a single cliff. In some cases, individual pairs had up to six alternate nesting cliffs, although two or three was the norm. Usually, one nesting cliff was preferred over the others, although the others were occasionally occupied (Fig. 2). Ratcliffe (1962) observed that alternate nesting cliffs were seldom more than 3 miles apart. Hooper et al. (1975) noted that ravens in Virginia used alternate nesting sites varying from 75 yards to 2 miles apart.

Jollie (1976) believed that cliff sites are better than non-cliff sites since a large nest can more easily be built on a ledge than in a tree. Thus, trees are used only when absolutely necessary. In Pennsylvania, Harlow (1922) found that cliff nests outnumbered tree nests eight to one. When trees were used, they usually were the tallest available, with good cover at the tops. Dorn (1972) located 32 nests in cottonwood or aspen trees in Wyoming that were between 15 and 100 feet high. Fig. 2A depicts a raven nest in a Yucca in New Mexico.

Until 1945, tree nesting was unusual in the Scottish border counties, but after suitable cliffs were occupied, ravens began nesting in trees (Ratcliffe, 1962). Tyrrell (1945) noted that where cliffs were not available, ravens often constructed nests in tall pines. Although Tyrrell observed the same tree nests being used year after year, Harlow (1922) reported that tree nests were never used two years in a row. Hooper (1975) located only three tree nests in a 322-mile area. The nests belonged to the same pair that attempted to build a nest on a cliff but failed because the ledge was too steep to hold the nest.

Ravens are remarkably adept at using man-made structures for nesting sites. Dorn (1972) observed a nest in a hay shed, and Truesdale (1908), Bowles and Decker (1930), and Congdon (1948) observed ravens in California and Washington nesting in abandoned barns and houses. Bowles and Decker (1930) also saw ravens using railroad trestles, telephone poles, and windmills as nesting sites.

Figure 2. Natural nesting sites of common ravens on cliffs or rocky outcroppings.

Figure 2A. Nest of common raven in Yucca in New Mexico.

Thompson (1919) reported a pair of ravens nesting in a 75-foot high transmission tower that carried a 130,000 volt transmission line. Of 65 nests at the Birds of Prey Natural Area in Idaho, Kochert et al. (1977) observed that 61 were on cliffs, 1 was in a tree, 1 was on an artificial platform, and 2 were on powerline structures. The authors of this Technical Note have also found ravens nesting under bridges, on wooden and steel power poles, in windmill structures, and on water pumping platforms. Figs. 3 and 3A show some common artificial nest sites.

TERRITORY SIZE

There is some confusion as to whether or not ravens are truly a territorial species. In Oregon, Stewart Janes (1980, pers. comm.) observed that ravens did not appear to defend territories. Extensive home range overlap occurred, yet the even spacing suggests that some form of territoriality existed. Smith and Murphy (1973) detected very little intraspecific home range overlap in Utah, even though the ravens were known to have large home ranges, and considerable overlap did occur with other raptor species. Dorn (1972) observed intra-specific territorial defense in which the defenders were vocal and the intruders were silent. Yet she also observed at times that intra-specific nest defense was weak, with a breeding pair chasing an intruder only a short distance. When a flock of conspecifics invaded a nesting territory, the breeding pair would perch near their nest and remain silent. Craighead and Craighead (1969) noted that although the nesting territory was defended against other ravens and hawks, the entire range was not.

Ratcliffe (1962) felt that ravens in England were not territorial in the sense that they aggressively defended an area. Yet he noticed that they were evenly spaced throughout an area with most pairs keeping their nesting sites a certain distance apart. Nest locations were markedly nonrandom, indicating that some factor was operating to keep nesting pairs spaced. Ratcliffe (1962) speculated that something other than aggression, such as aerial displays or psychological inhibitions, may have been the actual mechanism, but that the effect on distribution was nevertheless indistinguishable from that produced by territorialism.

In four distinct areas in England, varying in size from 170 to 441 square miles, Ratcliffe (1962) determined that the average territory size ranged from 6.6 to 17.6 square miles. In these same four areas, the average minimum distance between nests was 1.7 miles in three of the areas and 2.9 miles in the fourth. The Anglesey sea cliffs on the British Isles supported four nesting pairs on a linear distance of 2 miles.

Figure 3. Common raven nests on artificial or man-made structures. Ravens will nest in a wide variety of artificial sites from bridges to windmills.

Figure 3A. A raven nest in a grain elevator in Washington state.

Hooper et al. (1975) observed a density of one pair per 19 square miles in a 322 square mile area in Virginia. The mean distance to the nearest active nest was 3.0 miles in 1973 and 3.2 miles in 1974. In Pennsylvania, Harlow (1922) observed that the nearest distance between any two pairs of nesting ravens was six miles, and in Wisconsin, Zirrer (1945) observed that raven territories averaged 10 miles in diameter. Dorn (1972) noted that ravens in Wyoming nested at least a half mile apart, although there were two pairs that were separated by a hill with their nests only a quarter mile apart. Also in Wyoming, Craighead and Craighead (1969) found the home ranges of three pairs of ravens to be 3.62 square miles.

In Utah, Smith and Murphy (1973) determined that the average distance between nests was 1.08 miles, ranging from 0.55 to 1.84 miles. The average home range was 2.53 square miles.

The Birds of Prey Natural Area in Idaho has one of the most dense raptor populations in North America. According to Kochert et al. (1975), 49 pairs of ravens nested there in a 52 square mile area. In 1976, they found that the average minimum distance between raven nests was 1.56 miles and attributed more than 50 percent of the variation in raven pair numbers to cliff availability. Numbers were higher in areas with more nesting cliffs.

In Oregon, Stiehl (1978) observed that raven nest density in Harney Basin averaged one pair per 13.6 square miles in 1976, and one pair per 15.7 square miles in 1977. Elsewhere in Oregon, Stewart Janes (1980, pers. comm.) determined that home ranges were between 3 and 6 square miles.

R. Wayne Campbell (1980, pers. comm.) observed that two pairs of ravens nested only 300 yards apart for over 6 years at the Lt. Governor's house in Victoria, British Columbia. In Alaska, White and Cade (1971) reported that nesting ravens averaged 21.1 miles apart, with a range of 3.5 to 102 miles.

INTERSPECIFIC RELATIONSHIPS

The relationship between ravens and a wide variety of other species has been well documented by numerous observers. Ficken (1977) states that ravens may "play games" with different animals, including man, while Jollie (1976) cautions that much of what has been called "play" involves an aggressive outflow of spirit. White et al. (1975) stated that ravens can compete with raptors and can unfavorably modify to some degree their habitat. They noted that ravens in large numbers may be detrimental competitors, often using similar food sources.

Perhaps the best documented relationship between ravens and other species is that which exists with falcons. It is generally considered a commensal relationship (White and Cade, 1971). Bowles and Decker (1930) and Decker and Bowles (1930) were the first to comment extensively on the relationship between prairie falcons (Falco mexicanus) and ravens. In Washington, Parker (1973) observed ravens nesting within 20 feet of a pair of prairie falcons that were nesting in an abandoned raven nest. Since the nesting requirements of the two species are almost identical, prairie falcons often use old raven nests. Decker (1931) mentioned finding six raven nests in Washington being used by prairie falcons. Additionally, he stated that "without ravens to build nests where suitable cavities are missing, the prairie falcon would not be there." Bowles and Decker (1930) and Porter and White (1973) have observed a similar phenomenon.

Howard et al. (1978) reported that in an undisturbed habitat in Idaho, prairie falcons represented almost 30 percent of the raptor population and ravens 14 percent, but in areas where farming was intensive or where there was an abundance of cheatgrass (Bromus tectorum) or crested wheatgrass (Agropyron cristatum), the number of ravens equalled or surpassed the number of prairie falcons.

Although ravens usually initiate nesting earlier than do prairie falcons and are, in many areas, living within their territories, prairie falcons are still able to usurp raven nests (Decker and Bowles, 1930).

Harlow (1922) reported a raven nest within 40 feet of an active peregrine falcon (Falco peregrinus) eyrie, while Jones (1935) observed ravens and peregrines nesting only a few hundred feet apart on a cliff in Virginia. The peregrines were nesting in an inactive raven nest. Harlow (1922), Jones (1935), Craighead and Craighead (1939), and Murray (1949) felt that peregrine falcons were dominant over ravens, although Cade (1971) observed ravens nesting 50 yards from a pair of peregrines in the Alaskan Arctic where the ravens were usually the aggressors in almost continuous territorial battles. Ratcliffe (1962) was not aware of any case in which nesting ravens had displaced peregrines, although he had observed peregrines and ravens nesting

only 10 yards apart. Porter and White (1973) observed no evidence of a beneficial relationship between peregrine falcons and other cliff nesting species in Utah that was similar to the relationship between the prairie falcon and raven.

The gyrfalcon and raven are both early breeders and have almost identical nesting requirements in the Arctic (Cade, 1960; White and Cade, 1971). White and Cade (1971) observed the two species nesting only 60 yards apart, while Jenkins (1978) witnessed ravens and gyrfalcons in Greenland successfully nesting only 150 feet apart. Cade (1960) felt that gyrfalcons sometimes expelled ravens from suitable nesting cliffs when there was limited space, but pointed out that ravens have free access to such cliffs during years when gyrfalcons do not nest because of food shortages.

White and Cade (1971) described a possible commensal relationship between ravens and gyrfalcons in which ravens favorably modified the gyrfalcons' nesting environment by their stick nests. At the same time, ravens augmented their diets by scavenging the remains of gyrfalcon prey.

In Utah, Smith and Murphy (1973) found that golden eagle (Aquila chrysaetos) nesting sites overlapped considerably with those of the common raven. Marquiss et al. (1978) reported that four nesting pairs of ravens were displaced by golden eagles. Rubey (1973), Smith and Murphy (1973), and Dunstan (1975) observed that interactions between the two species were initiated by the ravens. Dunstan (1973) speculated that ravens and golden eagles might mutually benefit from the overlap if one located carrion that could be used by both. When two golden eagles flew over a group of 40 ravens feeding on carrion in Washington, the ravens took flight with much calling until the eagles passed on.

Jollie (1976) observed that ravens seldom attack crows, which can outclimb and outmaneuver the larger bird. As individuals, the ravens dominate the crows, although crows can dominate when in large enough numbers to harass the raven (Zirrer, 1945; Jollie, 1976).

Zirrer (1945) and Williamson and Rausch (1956) reported goshawks (Accipiter gentilis) chasing ravens, and Zirrer observed goshawks excluding ravens from a summer feeding area. He also observed a single eastern kingbird (Tyrannus tyrannus) driving off a group of six ravens from a pond where they had been feeding and near where the kingbird had a nest.

Bowles and Decker (1931) observed male red-winged blackbirds (Agelaius phoeniceus) driving three ravens from a nesting area in Washington. In a barn in California, Truesdale (1908) found an active raven nest with five eggs in which a pair of barn owls (Tyto alba)

were also nesting. Smith and Murphy (1973) observed ravens attacking golden eagles, red-tailed hawks (Buteo jamaicensis), prairie falcons, and American kestrels (Falco sparverius). Craighead and Craighead (1939) observed a raven climbing above and attacking a broad-winged hawk (Buteo platypterus). In Alaska, Cade (1961) observed a pair of ravens nesting within 100 yards of a pair of rough-legged hawks (Buteo lagopus), and reported almost continual territorial battles between those two pairs and an adjacent nesting pair of peregrine falcons, with the ravens initiating most of the fighting.

Summary of the Ecological Importance of Ravens

1. Ravens provide nesting platforms for many species of raptors.
2. They feed on carrion and help in the breakdown of organic material.
3. They serve as "aerial advertisers" of carrion to other scavenging species.
4. Ravens help "dampen" cyclic fluctuations of certain rodents.
5. They are involved in the lives of a great many other species of animals and birds, causing harassment, death, or stress in many, while having beneficial influences on many others.
6. Their high intelligence permits them to perform many unusual and unexpected acts in Nature. They are highly social at certain times of the year.

LIMITING FACTORS

Jollie (1976) considered the common raven to be one of the most generalized species known as far as the variety of habitats it occupies. It can be found from the far north, where it not only nests but also winter, through the boreal and conifer forests of North America, across the American Desert, north to Labrador, down the Appalachian Mountains to Georgia and throughout Mexico.

The common raven is a long-lived species, has a relatively large clutch size, and shows remarkable population stability and an attachment to historic nesting sites. Nesting success ranges from seldom producing young to fledging three to four young per year. A substantial portion of the population is composed of non-breeding birds which act as a buffer to the overall population and which can attempt to breed in peripheral habitat and colonize new areas (Jollie, 1976).

NESTING SITES

The natural supply of nesting sites in the raven's diverse habitats does not appear to limit its population (Jollie, 1976). Because of its adaptability in using a wide assortment of artificial structures, the raven is virtually assured of finding a nesting site.

In England, Ratcliffe (1962) reported that suitable nesting sites were often not used, indicating that some other factor was limiting the population. Hooper et al. (1975) noted that since less than one-third of the potential nest cliffs were used in their Virginia study area, the number and distribution of cliffs did not appear to be a limiting factor. White and Cade (1971) considered the nesting cliff in Alaska to be the most important physical feature around which the raven centers its life. The distribution of nesting ravens was closely associated with the occurrence of these nesting sites, yet there were suitable cliffs and bluffs available which were not used. White and Cade (1971) speculated that through some sort of social convention or tradition, ravens perhaps restricted nesting to certain cliffs.

FOOD

The common raven has also adapted to widely scattered and variable food sources (Jollie, 1976). Because they live in such a wide variety of habitats and are omnivorous, the raven population is not usually limited by food. Although there were seasonal variations in food supplies in Ratcliffe's (1962) study area in England, the

total food supply was available in excess and remained constant from year to year. Therefore, in this study area, the food supply did not appear to directly limit the population.

Marquiss et al. (1978) found that in southern Scotland and northern England, the raven's food supply increased with deterioration of the land productivity, since there was higher domestic sheep mortality in areas of overlying acidic rock. Thus, they concluded that raven dispersion and density were based mainly on food supply. They also found that ravens bred less often and produced later, smaller broods in areas that had been heavily afforested. By 1974 and 1975, only 55 percent of the formerly occupied nesting areas were still occupied, and breeding pairs had declined by 44 percent. This appears to be the best available evidence of the importance of food, substantiating the belief that a lack of food may limit raven populations and/or density.

In Virginia, Hooper et al. (1975) believed that food supply could have affected the raven population by influencing the survival of asynchronously hatched nestlings. Significantly more young were fledged in successful nesting attempts at lower elevations. This may have been the result of a greater food supply existing in the valleys where railroads, houses, farms, and most roads were located (Hooper, 1977). Ravens that nested at higher elevations may have had to spend more time foraging away from the nest, which could have affected nestling survival.

In Michigan, Mahringer (1970) noted a sharp decline in the population density of ravens during the summer of 1969 and attributed it to a decline in food availability and disturbance of raven feeding and roosting activities.

Dorn (1972) in Wyoming and Stiehl (1978) in Oregon indicated that winter appeared to be a time of food stress, at which time ravens relied heavily on garbage, carrion and cultivated grain wastes. Since winter may be a critical time of food stress for ravens, perhaps the communal roosting habit would be especially advantageous. Ward and Zahavi (1973) discussed how communal roosting and colonial nesting increased efficiency in locating an unevenly distributed food supply.

HUMAN DISTURBANCE

Ratcliffe (1962) observed that while human disturbance, such as shooting, rock climbing, rock quarrying, and egg collecting from raven nests did cause temporary reduction in the number of nesting ravens, it did not appear to have had any permanent effect on breeding density. In Scotland and England, Marquiss et al. (1978) observed that raven nesting sites were abandoned where rock climbing took place, and another nesting cliff was deserted following the construction of a

small reservoir and pumping house below the nest. In addition, several clutches were taken by egg collectors and two cases of poisoning were reported.

Hooper (1977) noted that in Virginia, the shooting of ravens was of only minor importance, although several birds that dug for grubs on a golf green and another that robbed golf balls were shot. The ability of ravens to adjust to human disturbance varied greatly. The nests most subject to human disturbance fledged young in two successive years, then were not used for two succeeding years. Harlow (1922) believed that neither egg collecting nor shooting were serious factors in the decline of raven populations in Pennsylvania, but that roads or houses built too close to nesting cliffs did cause nest abandonment. Murray (1949) visited a nesting site for 11 years without causing the ravens to abandon the nest. A nesting cliff would be used again and again, even if the birds were often disturbed by humans (Tufts, 1916). Both Tyrrell (1945) and Sprunt (1956) believed that human persecution was the primary factor in the decline of ravens in the eastern United States.

In Idaho, Kochert et al. (1977) noted that fewer ravens fledged from nests that were first visited during incubation (1.7 young per attempt) than were visited after the young were at least one to two days old (between 1.6 and 5.0 young per attempt). Nests visited for food habit data at 4-day intervals had higher fledging rates than did control nests (Kochert et al., 1976). This was considered to be more a result of careful research techniques than an inference that egg and nestling survival were independent of human activity.

LOGGING

Harlow (1922) remarked that lumbering near raven nest sites in Pennsylvania, as well as the encroachment of civilization, were the main reasons for their decline. Mahringer (1970) noted that the declining attendance in a communal roost in Michigan coincided with logging operations in that area.

CHEMICAL CONTAMINATION

Ratcliffe (1970) failed to detect any significant eggshell thinning of 205 raven eggs from various parts of Britain following the introduction of DDT. Marquiss et al. (1978) likewise failed to detect any eggshell thinning. In addition, organochlorine levels were very small and, compared with birds of prey, would have had no influence on raven breeding performance or population.

Kochert et al. (1975) tested the total mercury level in one Idaho raven egg and found it to be below the level that would cause death or physiological malfunctions in raptors.

ECONOMIC CONSIDERATIONS

Ross (1925) reported that ravens on Catalina Island, California, picked out the eyes of new-born lambs, but were unable to hurt young goats. In Washington, McBee (1937) stated that although ravens were reported to have killed lambs, he had never heard sheepmen complain of losing sheep. Larsen and Dietrich (1970) reported that in Oregon, ravens killed newborn lambs by driving their beaks into an eye socket before the lamb could get to its feet. From cursory collection of dead lambs in their study area, 72 were believed to have been killed by ravens.

Bowles and Decker (1930) considered ravens near breeding waterfowl to be highly injurious because of the number of eggs and young they destroyed. In Wyoming, Dorn (1972) determined that ravens did not have a detrimental effect on any animal population in the study area, but Craighead and Craighead (1969) and Dimmick (1949) believed ravens were important predators on waterfowl eggs and young. Dorn (1972) speculated that individual ravens may have learned that human activity causes waterfowl to flush from their nest, and this provides an opportunity for predation on either the eggs or young of these nests.

At Malheur Lake, Oregon, Ferguson et al. (1976) considered the raven to be the principal cause of nesting failure among greater sandhill cranes (Grus canadensis), since windmills and other artificial nesting sites in the area have enabled ravens to nest closer to the lake. Stiehl (1978), in his intensive study of raven food habits in the Harney Basin, Oregon, determined that ravens nesting in wetland areas near high waterfowl concentrations were more likely to be involved in nest depredations, but concluded that this was not a priori evidence of waterfowl predation. He noted that individual pairs were responsible for the majority of the nest depredations. Stiehl (1978) noted that much of the waterfowl predation might have been by non-nesting birds that frequent the waterfowl areas in the summer.

Dorn (1972) and Stiehl (1978) believed that closing dump sites would probably decrease the number of ravens frequenting an area. Stiehl (1978) also indicated that live trapping of ravens in the winter months might be an effective way to decrease their numbers. Live decoy ravens and large volumes of carrion are needed to successfully trap birds. Stiehl (1978) recommended that trapped ravens should be relocated a minimum of 124 miles from the trap site. He believed that the direct shooting of birds was impractical and would have a minimal affect on population reduction.

Larson and Dietrich (1970) suggested that baiting with cubed meat treated with DRC-1339 would be a successful technique for controlling large numbers of ravens. Injections of DRC-1339 in the eyes of

carcasses was effective where only a few ravens were involved. Stiehl (1978) suggested that .0338 U.S. fluid ounce of water containing .0007 ounce DRC-1339 injected in eggs would be effective in selectively reducing the population. Stiehl (1978) recommended that any management plan for reducing the number of ravens should include a comparison of pre-management predation rates with post-management predation rates, as well as a comparison of the management area with a control (non-management) area.

Another viable alternative to waterfowl predation management would be to improve waterfowl nesting habitat. Stiehl (1978) discussed the implications of waterfowl renesting and the importance of nesting cover to waterfowl production and suggested that habitat improvement was more beneficial and effective than raven control operations.

SPECIES AND HABITAT MANAGEMENT RECOMMENDATIONS

1. Kochert et al. (1976) found that nest visits, if properly conducted, did not affect the number of ravens fledged from nests. Nevertheless, ravens are susceptible to disturbance near nest sites. Rock climbing activities, for example, will cause ravens to abandon a nesting cliff. Logging operations and general human disturbance may cause ravens to abandon communal roost areas and feeding sites.
2. Common ravens are easy targets for shooters. Many people are not aware that crows, magpies (*Pica pica*), and ravens are fully protected under the Migratory Bird Treaty Act. Public education is extremely important to make people aware of the uniqueness and ecological importance of the common raven.
3. Any proposed or current developments on Bureau of Land Management administered lands, or developments on other private or public lands, should be studied for their possible effect on ravens. Nesting sites, communal roosts, and feeding concentration areas should be identified prior to any development, and the impact on ravens should be assessed.
4. Further studies are needed to determine the food requirements of common ravens and their economic impact on other animal populations. Stiehl (1978) determined that most waterfowl depredation at Malheur National Wildlife Refuge was the result of non-breeding birds that summer near waterfowl production areas and was not necessarily caused by nesting birds. This information is critically important in any management plan.
5. Nesting sites, communal roosts, and feeding areas should be located and mapped on BLM-administered lands. Baseline information is critically important before management decisions can be made. These areas should not be advertised to the general public, since many people are unaware that ravens are protected by law and that visiting nests and removing young is illegal. People are often fascinated by the possibility of obtaining a young raven as a pet. Not only is this illegal, it is also difficult to raise ravens in captivity. Well-intentioned people who simply want to see a raven nest are often unaware of the implications of causing premature fledging or causing parents to miss a feeding. Hooper (1977) recommended that human activity be curtailed within the vicinity of nesting sites, although the actual distance to restrict activity would depend on the terrain and type of activity. In general, he recommended that pedestrians should not be permitted within about 650 feet of a nest if they are visible to the birds from the nesting sites, or within about 300 feet if they are hidden from view. He suggested that vehicular traffic could be allowed as close as 320 feet to a nest, but that parking

areas should be kept at least 600 feet from the nest. Road construction within 600 feet of a nest could cause nest desertion. Hooper (1977) suggested that rock climbing on nesting cliffs be restricted from January 15 until the nestlings fledged in April or May.

Disturbing ravens at communal roost areas is equally harmful. In most cases, once ravens have been flushed from a roost site, it may take considerable time and energy to resettle for the night. This also applies to winter feeding areas. The energetics of ravens have not been studied intensively in the field, yet it is known that ravens experience food stress during winter months.

6. Dorn (1972) and Stiehl (1978) suggested closing artificial food sites, such as dumps and landfills, to promote a more natural situation and to discourage concentrations at these areas. Dorn (1972) cautioned that ravens have learned to associate human disturbance of waterfowl with unprotected nests and to deliberately search for the unprotected eggs and young. Any anticipated research that might create such a situation should consider the impacts of raven predation on the species studied. Stiehl (1978) suggested that habitat improvement would be a preferred management alternative to the destruction of ravens. Live-trapping and removing birds is feasible during the winter, although trapped birds should be released at least 124 miles from the trap site. Discriminate use of DRC-1339 is feasible in selectively eliminating individual birds. Stiehl (1978) recommended that .0338 U.S. fluid ounce of water containing .0007 ounce DRC-1339 injected in eggs would be effective in selectively reducing the population.

PROTECTIVE MEASURES INSTITUTED

1. In 1974, the common raven was included in the Migratory Bird Treaty Act which gave it complete protection in North America.
2. In 1971, the Bureau of Land Management established the Snake River Birds of Prey Natural Area in Idaho, which exhibits a unique concentration of nesting raptors, including ravens. In 1977, Kochert et al. (1977) observed 57 nesting pairs of ravens in this area and 120 nesting pairs in the total Birds of Prey Study Area.
3. There are no known attempts of captive breeding or reintroduction of common ravens.

RESEARCH TECHNIQUES

Call (1978) summarized three important uses for raptor habitat data:

1. To be knowledgeable on important nesting, feeding, wintering, and roosting areas in order to give adequate consideration to these areas in land management decisions.
2. To determine and monitor the effects of man's activities on nesting or life phases of raptors.
3. To ascertain general trends in raptor populations and productivity, by species, and the probable reasons for those trends.

Call (1978) suggested that whenever an adult raven is seen during the nesting season, there is probably a nest nearby at a suitable site, and if the observer watches the bird, it will go to the nest site (recognizing, of course, that there are non-breeders in all populations).

Craighead and Craighead (1969) stated that approximately 85 percent of raptor (including raven) nests were found relatively easily, but that the remaining 15 percent required recording and mapping of all field sightings. Tree nests were more easily located during the winter months when they could be plotted on a map and checked again in the spring. The most productive time to locate nests, however, was prior to general leafing out and during the early period of nest site selection and territorial defense when raptors were especially conspicuous (Craighead and Craighead, 1969). Locating nests was simplified by the fact that raptors regularly space their nests within an area. When one knows approximately how far apart the species normally nests, the observer can then determine how many nests an area might support.

Mahringer (1970) studied the population dynamics of ravens in Michigan and determined the most productive method of surveying numbers and distribution was use of a survey route. Results from the survey route were augmented with counts at a communal roost and at a feeding area.

Cannon nets have been used successfully in trapping ravens by Dorn (1972) in Wyoming and Mahringer (1970) and Kerttu (1973) in Michigan. Mahringer (1970) captured a total of 148 ravens with cannon nets. Two cases of mortality resulted from the trapping.

Neither Mahringer (1970) nor Kerttu (1973) had any success in trapping ravens with a drop-in trap similar to that designed by Aldous (1938) and Coldwell (1968), but Stiehl (1978) experienced excellent

success with a drop-in trap (Fig. 4) similar to that of Coldwell (1972). Cattle carcasses were used as bait with live raven decoys tethered in the vicinity. A total of 99 birds were captured in 44 trap days during February and March. The trap was inspected at two-day intervals and was most successful following periods of snow. Schwan and Williams (1978) were successful in capturing ravens in Alaska with Havahart single-end traps baited with Purina Dog Chow.

Mahringer (1970) marked trapped ravens with combinations of two or three colored leg bands. The color bands were .75 inch wide by 3 inches long vinylite strips (Grand Rapids Rubber Products Company, Grand Rapids, Michigan) formed by heating and shaping around a wooden dowl. Colors used were green, orange, red, white, and yellow. In addition, Mahringer (1970) implanted tail feathers with different colored goose quills (Herters, Incorporated, Waseca, Minnesota) and trimmed them to conform to normal feather shape.

In Wyoming, Dorn (1972) marked captured ravens with an orange patagial tag (Fig. 5), of a double thickness of Safe-T-Flag vinyl plastic cemented together and fastened to the upper surface of the patagium with a two-piece, aluminum ear button (Fig. 5). A number-symbol combination was painted on both sides of each tag with Ram-Cote black vinyl upholstery paint.

In Idaho, Kochert et al. (1977) placed patagial wing markers of Herculite 80 (Herculite Protective Fabrics, 1107 Broadway, New York 10010) on the ravens (Fig. 6). In addition, remiges and/or retrices of some ravens were painted with an acrylic base fabric paint for specific temporary identification.

Stiehl (1978) in Oregon marked ravens with wing markers made of Saflag (Safety Flag Corp. of America, Pantucket, Rhode Island) and Herculite (Vaughn Brothers, Portland, Oregon; Fig. 7). The material was cut in a dumbbell shape, about 8 x 4 inches. White, yellow, blaze orange, aurora pink, signal green, light blue and dark blue colors were used to give 63 possible color combinations. Markers were attached to the wing with the aid of a hand riveter, and .1 x .4 inch aluminum rivets together with .1 inch aluminum backup plates on each side. Stiehl (1978) observed no harmful effects of the wing markers on ravens and noted that one bird captured 11 months after tagging showed no negative effects.

In his studies of raven vocalizations in Alaska, Brown (1974) used a Uher 4000 Report-L recorder and an AKG Model CK9 directional microphone to make recordings of the birds. Audiospectrograms were produced on a Kay Electric Company Sonograph Model 7029A.

Hoffman (1920) noted that using raven castings to determine food habits was difficult when the birds fed on refuse or carrion because there was not enough substance to hold the pellets together for any

SIDE VIEW

TOP VIEW

Figure 4. Diagram of a drop-in trap that has been used successfully on ravens (from Stiehl 1978).

Figure 5. Patagial tag assembly: (a) top view of the ear button, (b) side view of top and bottom halves of button, (c) two halves put together, (d) the button after crimping, and (e) the patagial tag with button in place (after Dorn, 1972).

Raven

Figure 6. General shape and size of wing marker used on common ravens in Idaho (Kochert et al. (1977)).

Figure 7. Diagram of a patagial marker for ravens (top) and suggested method of attachment of patagial marker to wing of raven (bottom) (Stiehl (1978)).

length of time. Kochert et al. (1977) noted that the high frequency of red meat carrion in the raven's diet made it difficult to quantify predation rates by conventional means.

ONGOING RESEARCH PROJECTS

1. Michael N. Kochert and associates of the Bureau of Land Management, have been studying ravens in the Snake River Birds of Prey Natural Area in Idaho since 1974. They have researched the raven's complete nesting biology including feeding and movement studies. Theirs is perhaps the most exhaustive study ever conducted on nesting requirements and breeding biology of the common raven in North America.
2. Stewart W. Janes has studied the raptor-raven complex in the Oregon desert for six years. He has concentrated on the breeding biology of the common raven and its relationship with other raptors.
3. Dr. Norman F. Sloan, Michigan Technological University, has been studying the common raven in Michigan since 1968. Two graduate students, Mahringer, (1970) Kerttu (1973) have completed Master of Science degrees on population dynamics and aging techniques of the common raven. Dr. Sloan is currently preparing a manuscript on raven nesting requirements in the Upper Peninsula of Michigan.
4. Dr. Robert G. Hooper, a research biologist for the U.S. Forest Service, studied common ravens in Virginia between 1972 and 1974 and continues to monitor their activities in the southern Appalachians.
5. Dr. Richard B. Stiehl, University of Wisconsin, studied the biology of the common raven at Malheur National Wildlife Refuge from 1975 to 1977. All aspects of raven biology were included, although the study concentrated on food habits of nesting, non-breeding, and wintering ravens.
6. Dr. Malcom Jollie, Northern Illinois University, has conducted observational studies on ravens and corvids in general since 1936.
7. Tony Angell (1977) has conducted general behavioral studies on the common raven for the past decade.
8. Dr. Richard N. Conner, Virginia Polytechnic Institute and State University, is studying the biology of the common raven in Virginia.
9. Richard L. Knight, Dr. Richard E. Fitzner, and Tracy L. Fleming have been studying the common raven in the Columbia Basin, Washington since 1977. Their study involves breeding biology, food habits, and winter ecology as they relate to different habitat types.

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ORGANIZATIONS ACTIVELY INVOLVED WITH
THE WELFARE OF RAVENS

1. National Audubon Society, 950 Third Avenue, New York, New York 10022

The major objective of the National Audubon Society is to advance public understanding of wildlife, its habitat and all natural resources, and how wise use and intelligent treatment relate to human progress.

2. Raptor Research Foundation, c/o Dr. Donald R. Johnson, Department of Biological Sciences, University of Idaho, Moscow, Idaho 83843

The Raptor Research Foundation stimulates, coordinates, directs, and conducts research on the biology and management of birds of prey, and promotes a better understanding and appreciation of the value of these birds. The Raptor Research Foundation publishes Raptor Research, which has articles about the common raven.

3. Raptor Information Center, The National Wildlife Federation, 1412 Sixteenth St. NW, Washington, D.C. 20036

The Raptor Information Center is concerned with the general welfare and biology of all raptor species. It has recently published two excellent bibliographies, on the owls of the world and the other on the bald eagle.

4. The Nature Conservancy, 1800 North Kent Street, Arlington, Virginia 22209

The Nature Conservancy is a national conservation organization that receives its support from the public. Its objective is to preserve and protect ecologically and environmentally significant land and the diversity of life it supports.

5. Bureau of Land Management, Washington, D.C. 20240

The BLM administers approximately 60 percent of the Federal lands, most of which are located in the western states. These lands are managed under multiple-use principles, including outdoor recreation, fish and wildlife production, livestock grazing, timber, industrial development, watershed protection, and mineral production.

The BLM is responsible for research and management of the Snake River Birds of Prey Natural Area in Idaho. The biologist directly working on management plans is Michael N. Kochert, Boise District, Bureau of Land Management, 230 Collins Road, Boise, Idaho 83702.

LITERATURE CITED

- Aldous, S.E. 1938. A cage trap useful in the control of white-necked ravens. Wildl. Res. Manage. Leaf. BS-27.
- American Ornithologist's Union. 1957. Check-list of North American Birds. A.O.U., 5th ed.
- Angell, T. 1977. The efficient use of energy: One family's strategies. Pac. Search 11:12-14.
- Anonymous. 1967. Report of Huron Mountain Wildlife Foundation, 1955-1966.
- Ayre, R. 1961. Sketco the raven. Macmillan Co. of Can. LTD, Toronto.
- Bancroft, G. 1927. Notes on the breeding coastal and insular birds of central lower California. Condor 29:188-195.
- Barrows, W.B. 1912. Michigan bird life. Spec. Bull., Dept. Zool. Physiol., Mich. Agr. Coll.
- Bendire, C. 1895. Life histories of North American birds, from the parrots to the grackles with special reference to their breeding habits and eggs. Government Printing Office, Washington, D.C.
- Bent, A.C. 1968. Jays, crows, and titmice. Vols. I & II. Dover Publs., Inc., New York.
- Bowles, J.H., and F.R. Decker. 1930. The ravens of the state of Washington. Condor 32:192-201.
- Bowles, J.H., and F.R. Decker. 1931. Limicolae smearing mud on their eggs. Murrelet 12:82.
- Brown, R.N. 1974. Aspects of vocal behavior of the raven (Corvus corax) in interior Alaska. M.S. thesis, Univ. Alaska, Fairbanks.
- Cade, T.J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. Univ. California Pub. Zool. 63:151-290.
- Call, Mayo W. 1978. Nesting habitats and surveying techniques for common western raptors. BLM Technical Note No. 316, Denver Service Center, Bureau of Land Management, Denver, Colo., 80225.
- Coldwell, C. 1968. Raven banding in Nova Scotia. I.B.B. News 39:68-69.

- Coldwell, C. 1972. Raven banding in Nova Scotia. *Bird-Bander*. 43:288.
- Conner, R.N., and C.S. Adkisson. 1976. Concentration of foraging common ravens along the Trans-Canada Highway. *Can. Field-Nat.* 90:496-497.
- Conner, R.N., I.D. Prather, and C.S. Adkisson. 1975. Common raven and starling reliance on sentinel common crows. *Condor* 77:517.
- Conner, R.N., I.D. Prather, and J.W. Via. 1976. The raven: Symbol of wilderness. *Wildl. North Carolina* 40:12-13.
- Coombes, R.A.H. 1948. The flocking of the raven. *Brit. Birds* 41:290-294, 386.
- Congdon, R.T. 1948. American raven nesting in houses. *Auk* 65:130-132.
- Craighead, F.C., Jr., and J.J. Craighead. 1949. Nesting Canada geese on the upper Snake River. *J. Wildl. Manage.* 13:51-64.
- Craighead, J.J., and F.C. Craighead, Jr. 1939. A battle of wits. Pages 110-123 in *Hawks in the hand*. Houghton Mifflin Co., Boston.
- Cushing, J.E., Jr. 1941. Winter behavior of ravens at Tomales Bay, California. *Condor* 43:103-107.
- Davis, P. 1967. Raven's response to sonic bang. *Brit. Birds* 60:370-371.
- DeArmond, D.B. 1975. Raven. Alaska NW Publ. Co., Anchorage.
- Decker, F.R. 1931. Prairie falcon's nest. *Oologist* 48:96.
- Decker, F.R., and J.H. Bowles. 1930. The prairie falcon in the state of Washington. *Auk* 47:27-31.
- DeVos, A. 1964. Range changes of birds in the Great Lakes region. *Am. Midl. Nat.* 71:489-502.
- Dickey, S.S. 1915. The northern raven. *Oologist* 32:106-107.
- Dimmick, R.W. 1968. Canada geese of Jackson Hole, their ecology and management. *Wyo. Game Fish Comm. Bull. No. 11*.
- Dorn, J.L. 1972. The common raven in Jackson Hole, Wyoming. M.S. thesis, Univ. Wyoming, Laramie.

- Dunstan, T.C. 1976. Activity, hunting patterns, territoriality, and social interactions of birds of prey in the Snake River Birds of Prey Natural Area, Idaho. Pages 63-131 in Snake River Birds of Prey Research Project, annual report, 1976, BLM, Boise.
- Elliot, R.D. 1977. Hanging behavior in common ravens. Auk 94:777-778.
- Eustis, O.B. 1978. Common raven nesting in Alpena County. Jack-Pine Warbler 56:45.
- Ferguson, D., J. Hall, M. McDermid, L. Nelson, P. Rubin, and M. Trimble. 1976. Birds and human structures in the Oregon desert. Pac. Search 11:10-11.
- Ficken, M.S. 1977. Avian play. Auk 94:573-582.
- Feilden, H.W. 1909. Ravens as scavengers. Br. Birds 3:57-58.
- Goodwin, D. 1976. Crows of the world. Cornell Univ. Press, Cornell.
- Gwinner, E. 1964. Untersuchungen uber das Ausdrucks-und Sozialverhalten des Kolkraben (Corvus corax L.). X. Tierpsychol. 21:657-748.
- Gwinner, E. 1965. Beobachtungen uber Nestbau and Brutpflege des Kolkraben in Gefangenschaft. J. Ornithol. 106:145-178.
- Harlow, R.C. 1922. The breeding habits of the northern raven in Pennsylvania. Auk 39:399-410.
- Harlow, R.F., R.G. Hooper, D.R. Chamberlain, and H.S. Crawford. 1975. Some winter and nesting season foods of the common raven in Virginia. Auk 92:298-306.
- Harrington, F.H. 1978. Ravens attracted to wolf howling. Condor 80:236-237.
- Hewson, R. 1949. Gathering of ravens. Brit. Birds 42:181.
- Hewson, R. 1957. Social flying of ravens. Brit. Birds 50:432-434.
- Hoffmann, R. 1920. A raven pellet. Auk 37:453-454.
- Holyoak, D. 1967. Breeding biology of the Corvidae. Bird Study 14:153-168.
- Hooper, R.G. 1973. Raven haven. Virginia Wildl. 34:6-7.
- Hooper, R.G. 1977. Nesting habitat of common ravens in Virginia. Wilson Bull. 89:233-242.

- Hooper, R.G., H.S. Crawford, D.R. Chamberlain, and R.F. Harlow. 1975. Nesting density of common ravens in the Ridge-Valley region of Virginia. *Amer. Birds* 29:931-935.
- Houston, C.S. 1977. Changing patterns of Corvidae on the prairies. *Blue Jay* 35:149-155.
- Houston, D.B. 1968. The Shiras moose in Jackson Hole, Wyoming. *Grand Teton Nat. Hist. Assoc. Tech. Bull.* No. 1.
- Howard, R.P., L.O. Wilson, and F.B. Renn. 1976. Relative abundance of nesting raptors in southern Idaho. *Raptor Res.* 10:120-128.
- Howe, M.A. 1978. The changing seasons. *Amer. Birds* 32:968-976.
- Hurrell, A.G. 1951. Ravens using thermals. *Brit. Birds* 44:88-89.
- Hutson, H.P.W. 1945. Roosting procedure of Corvus corax laurence Hume. *Ibis* 87:455-459.
- Janes, S.W. 1976. The apparent use of rocks by a raven in nest defense. *Condor* 78:409.
- Jenkins, M.A. 1978. Gyrfalcon nesting behavior from hatching to fledging. *Auk* 95:122-127.
- Jollie, M. 1976. Species interrelationships of three corvids. *Biol.* 58:89-111.
- Jones, F.M. 1935. Nesting of the raven in Virginia. *Wilson Bull.* 47:188-191.
- Kerttu, M.E. 1973. Aging techniques for the common raven (Corvus corax principalis Ridgway). M.S. thesis, Michigan Tech. Univ., Houghton.
- Knowlton, G.F. 1943. Raven eats Mormon cricket eggs. *Auk* 60:273.
- Kochert, M.N., A.R. Bammann, R.P. Howard, J.H. Doremus, M. DeLate, and D. Donahue. 1975. Reproductive performance, food habits, and population dynamics of raptors in the Snake River Birds of Prey Natural Area. Pages 1-50 in *Snake River Birds of Prey Research Project, annual report, 1975*, BLM, Boise.
- Kochert, M.N., A.R. Bammann, J.H. Doremus, M. DeLate, and J. Wyatt. 1976. Reproductive performance, food habits, and population dynamics of raptors in the Snake River Birds of Prey Natural Area. Pages 1-57 in *Snake River Birds of Prey Research Project, annual report, 1976*, BLM, Boise.

- Kochert, M.N., A.R. Bammann, K. Steenhof, J.H. Doremus, M. DeLate, J. Oakley, and T. Hamer. 1977. Reproductive performance, food habits, and population dynamics of raptors in the Snake River Birds of Prey Natural Area. Pages 1-39 in Snake River Birds of Prey Research Project, annual report, 1977, BLM, Boise.
- Larsen, K.H., and J.H. Dietrich. 1970. Reduction of a raven population on lambing grounds with DRC-1339. J. Wildl. Manage. 34:200-204.
- Lockley, R.M. 1953. Aerial assembly of ravens in December. Brit. Birds 46:347-348.
- Lorenz, K. 1970. (Translated by Robert Martin) Studies in animal and human behaviour. Vol. 1, Harvard Univ. Press, Cambridge.
- Lucid, V.J., and R.N. Conner. 1974. A communal common raven roost in Virginia. Wilson Bull. 86:82-83.
- Mahringer, E.B. 1970. The population dynamics of the common raven (Corvus corax principalis Ridgeway) on the Baraga Plains, L'Anse, Michigan. M.S. thesis, Michigan Tech. Univ., Houghton.
- Mallory, F.F. 1977. An ingenious hunting behavior in the common raven (Corvus corax). Ont. Field Biol. 31:53.
- Marquiss, M., I. Newton, and D.A. Ratcliffe. 1978. The decline of the raven (Corvus corax) in relation to afforestation in southern Scotland and northern England. J. Appl. Ecol. 15:129-144.
- McBee, C. 1937. Unusual nesting sites of the American raven. Oologist 44:58-59.
- McManus, R. 1935. Feeding habits of the raven in winter. Auk 52:89.
- Mech, L.D. 1970. The wolf: The ecology and behavior of an endangered species. Nat. Hist. Press, Garden City.
- Mishaga, R. 1974. Notes on a synchronous hatching and nesting mortality in white-necked ravens. Wilson Bull. 86:174-176.
- Montevocchi, W.A. 1978. Corvids using objects to displace gulls from nests. Condor 80:349.
- Murray, J.J. 1949. Nesting habits of the raven in Rockbridge County. Raven 20:40-43.
- Mylne, C.K. 1961. Large flocks of ravens at food. Brit. Birds 54:206-207.
- Nelson, A.L. 1934. Some early summer food preferences of the American raven in southeastern Oregon. Condor 36:10-15.

- Oberholser, H.C. 1918. The common ravens of North America. Ohio J. Sci. 18:213-225.
- Parker, R.C. 1973. Prairies and people: A current look at prairie falcon management and status in Washington. Wash. Wildl. 25:18-23.
- Pearse, T. 1938. A remarkable influx of ravens into the Comox District, Vancouver Island, B.C. Murrelet 19:11-13.
- Porter, R.D., and C.M. White. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young Univ. Sci. Bull., Biol. Ser. 18:1-74.
- Ratcliffe, D.A. 1962. Breeding density in the peregrine (Falco peregrinus) and raven (Corvus corax). Ibis 104:13-39.
- Ratcliffe, D.A. 1970. Changes attributed to pesticides in egg breakage frequency and eggshell thickness in some British birds. J. Appl. Ecol. 7:67-115.
- Ross, R.C. 1925. Field notes on the raven. Condor 27:172.
- Rubey, W.W. 1933. Flight maneuvers of the raven. Bird Lore 35:143-145.
- Schwan M.W., and D.D. Williams. 1978. Temperature regulation in the common raven of interior Alaska. Comparative Biochem. Physiology 60A:31-36.
- Smith, D.G., and J.R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young Univ. Sci. Bull., Biol Ser. 18:1-76.
- Sprunt, A., Jr. 1956. Is the raven coming back in the Southeast? Audubon Mag. July-Aug. 170-171, 182-183.
- Stiehl, R.B. 1978. Aspects of the ecology of the common raven in Harney Basin, Oregon. Ph.D. thesis, Portland State Univ., Portland.
- Temple, S.A. 1974. Winter food habits of ravens in the Arctic Slope of Alaska. Arctic 27:41-46.
- Thompson, A.L. 1964. A new dictionary of birds. McGraw-Hill, New York.
- Thompson, J.W. 1919. An unusual raven's nest. Oologist 35:99, 103-104.

- Truesdale, F. 1908. A raven's nest in a barn. *Oologist* 25:183-184.
- Tufts, R.W. 1916. Northern ravens in Nova Scotia. *Oologist* 33:196-200.
- Turcek, F.J., and L. Kelso. 1968. Ecological aspects of food transportation and storage in the Corvidae. *Comm. Behav. Biol. Part A*, 1:277-297.
- Tyrell, W.B. 1945. A study of the northern raven. *Auk* 62:1-7.
- Williamson, S.L., and R. Rausch. 1956. Interspecific relations between goshawks and ravens. *Condor* 58:165.
- Wolfe, L.R. 1929. Collecting rent from the falcons and ravens. *Oologist* 46:16-20.
- Ward, P., and A. Zahavi. 1973. The importance of certain assemblages of birds as "information-centres" for food-finding. *Ibis* 115:517-534.
- White, C.M., and T.J. Cade. 1971. Cliff-nesting raptors and ravens along the Colville river in Arctic Alaska. *Living Bird* 10:107-150.
- White, C.M., T.D. Ray, and L.W. Sowl. The 1970-1972 raptor surveys along the Trans-Alaska oil pipeline. Pages 222-228 in World Conference on birds of prey, Vienna, 1975.
- Willett, G. 1941. Variation in North American ravens. *Auk* 58:246-249.
- Wolfe, M. 1977. Raptor utilization of desert habitats. Pages 82-101 in Kochert, M.N., ed. Snake River Birds of Prey Research Project, annual report 1977, BLM, Boise.
- Zirrer, F. 1945. The raven. *Passenger Pigeon* 7:60-67.

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