

the first loon dove, the coyote turned and swam towards the flock. When it got within ca. 15 m, the birds began to run and make short dives; all were giving type 2 and type 3 tremolos. The coyote changed its direction 3 or 4 times in the next 3 min, apparently attempting to reach nearby loons. It then began a steady course to the northwest, and except for veering slightly to the north, continued in this direction for the next 25 min. During this entire time the loons, giving type 2 and type 3 tremolos, repeatedly approached the coyote, then either dove, or ran on the surface and then dove. After one of these approaches the coyote changed direction to the northeast and maintained a course parallel to and approximately 500 m from the north shore for another 22 min. Loon approaches decreased in frequency during this period, but every 4 to 5 min a loon appeared close to the coyote, gave a type 1 or type 2 tremolo and dove.

By 15:09 the coyote was noticeably lower in the water; in the next 5 min it changed direction 4 or 5 times and then stopped moving. The coyote apparently drowned at this point. A loon, in an erect posture, approached the floating carcass and dove without giving any vocalizations. We paddled across the lake and found the body floating 200 m from the north shore. The coyote had been in the water and swimming for 65 min and covered a distance of approximately 4 km.

The loons' movements before the initial attack suggested curiosity, or an attempt to become familiar with an unusual object in their environment. This seemed especially true of the bird who cautiously approached the coyote. The behavior after the attack corresponds well with Curio's (*Z. Tierpsychol.* 48:175-183, 1978) definition of mobbing: they remained close to the predator, changed their position frequently and gave a loud easily locatable call. Since the tremolo contains information concerning motivational intensity, it may act as signal for coordinating movements during mobbing. It would be interesting to determine, for example, if mobbing becomes more intense after a type 3 call from one of the birds.

Coyotes often hunt in shallow water (Moore, *J. Mammal.* 10:255, 1929; Springer, *J. Mammal.* 61:373-374, 1980), but we found no report of them swimming in pursuit of prey. Although unusual, the coyote's behavior is not surprising in view of the opportunistic nature of their hunting (M. Bekoff, pers. comm.). The coyote, however, had obvious difficulties navigating, and we believe the loons' behavior added to the animal's confusion.

It is unlikely that the loons actually killed the coyote. Although there are reports of loons attacking and killing geese (Zicus, *Auk* 92:611-612, 1975), there was no blood in the water near the coyote nor any obvious wounds on the body.

Loons often use the tremolo as part of a nest or chick distraction display (Barklow, pp. 23-44 in *The Common Loon: Proceedings of the Second North American Conference on Common Loon Research and Management*, 1979), but this is the first report of the use of the tremolo as a component of mobbing behavior.—WILLIAM E. BARKLOW, *Department of Biology, Framingham State College, Framingham, Massachusetts 01701*; and JUNE A. CHAMBERLAIN, *Department of Biology, Tufts University, Medford, Massachusetts 02155*. Received 14 Mar. 1983; accepted 12 Oct. 1983.

Violet-green Swallows Help Western Bluebirds at the Nest.—Recognized cases of interspecific cooperation in antipredator behavior (e.g., Stefanski and Falls, *Can. J. Zool.* 50:1513-1525, 1972), antiparasite behavior (e.g., Smith, *Nature* 219:690-694, 1968), and brood care (see Shy, *J. Field Ornithol.* 53:370-393, 1982, for a review of interspecific feeding) are growing in number. Cooperative relationships between species are especially interesting in light of sociobiological theory, because seeming altruism cannot be accounted for by kin selection (Dawkins, *The Selfish Gene*, Oxford Univ. Press, New York, 1976). As an outgrowth of a long-term program to monitor the reproductive success of Western Bluebirds (*Sialia mexicana*) near Corvallis, Oregon, we noted an unusual cooperative relationship between nesting bluebirds and Violet-green Swallows (*Tachycineta thalassina*).

In three independent situations, one in 1981 and two in 1982, Violet-green Swallows were observed occupying boxes in which Western Bluebirds were currently nesting, in-

dividuals of both species often occupying the nest box simultaneously. In all three cases, swallows were first discovered in the boxes when the bluebird nestlings were 12–13 days old. During the period of co-occupation, which extended up to the time of bluebird fledging, none of the swallow pairs were nesting, yet they provided active care to bluebird nestlings and participated in defense of the nest site.

On several occasions we observed the resident female swallow remove fecal sacs from the bluebird nest; sacs were carried 5–10 m away before being dropped. Although direct observation of bluebird nestlings was not possible, indirect evidence suggests that swallows also fed nestlings. Both male and female swallows paid frequent, brief visits to the nest in a pattern that resembled that of parents bringing food to chicks, and visits were interspersed with normal aerial foraging. Bluebird nestlings generally expel fecal sacs as they are being fed, and visiting swallows often perched briefly at the entrance hole, head thrust inside, before entering and immediately exiting with a fecal sac. From independent attempts to hatch abandoned bluebird eggs, we know that Violet-green Swallows can successfully hatch, feed, and fledge Western Bluebird nestlings that have been cross-fostered into their nest.

Cooperating male swallows actively defended the area around the bluebird nest site from other pairs of swallows, including both Violet-green and Tree swallows (*T. bicolor*). Males performed characteristic threat displays and vocalizations while perched on top of the box or nearby, and chased intruding swallows from the vicinity of the nest. Female swallows may have provided passive defense of the nest, as they commonly remained in the box, looking out, while both bluebird parents were away from the nest.

On 25–27 May 1982, one nest was observed closely to examine the interactions between parent bluebirds and resident swallows. Observations were divided into 60-s intervals for analysis ($n = 210$ intervals; median length of visit < 60 s for both species). During 20 intervals (9.5%) at least one individual of both species occupied the nest simultaneously without aggressive interaction. Each of the species appeared to visit the nest independently of one another; bluebirds alone were at the nest during 27 intervals (12.9%), swallows alone were present during 55 intervals (26.2%), and neither species was present during 108 intervals (51.4%; $\chi^2 = 1.233$, $df = 1$, $P = .267$). These data suggest that the bluebird parents did not return to the nest to repel visiting swallows, nor did the swallows avoid the parents by visiting the nest when bluebirds were absent.

Over a 6-year period, the mean percent of nestlings that survived to fledging on the Corvallis Bluebird Trail was 68% (yearly means ranged 33%–81%). In contrast, fledging success in the 3 nests with swallow helpers was 88%. These data are too few to compare statistically, but the apparent difference suggests a measurable benefit to bluebirds from swallows helping at the nest. Swallow helpers may not be inconsequential to the bluebird population, either: the 10 nestlings fledged in 1982 from nests with swallow helpers represent 12% of all bluebirds fledged in the study area that year.

The proximate cause of swallows helping at bluebird nests may be nest failure. In 2 of the 3 observed cases, the pair of swallows originally had built nests near the bluebird boxes, but in one case the nest was destroyed and in the other the swallow eggs were punctured by a House Wren (*Troglodytes aedon*). In 2 of 3 cases the swallows later nested in the boxes after the bluebird nestlings had fledged. Shy (op. cit.) hypothesized that interspecific feeding may not be merely anomalous, and that helpers may benefit from the experience of caring for nestlings in years in which they cannot nest themselves. Our observations suggest another possible benefit from helping; namely, that interspecific helpers gain access to limited nest sites soon after they are vacated by another species. Most of the available nest boxes in our study area are occupied each year (\bar{x} 1977–1980 = 56% of 153 boxes; \bar{x} 1981–1982 = 82% of 171 boxes). If suitable cavity nest sites are in short supply, then swallows may gain an opportunity to breed by helping bluebirds. Helping may enable a swallow pair to gain early access to a nest box in use, and later, after the bluebird parents and fledglings leave the box, the swallows are already established in a territory recognized by neighboring pairs of swallows. Woolfenden and Fitzpatrick (Bioscience 28:104–108, 1978) proposed a similar hypothesis to account for intraspecific helping at the nest and inheritance of territories in group-breeding Scrub Jays (*Apelocoma coerulescens*), which breed in relict scrub habitat in central Florida with similarly limited nest sites.

We thank the Audubon Society of Corvallis and the Oregon Department of Fish and Wildlife for their support of the Corvallis Bluebird Trail, and A. Ansell, M. S. Eltzroth, and J. Krabbe for their help with observing bluebird nests.—ELSIE K. ELTZROTH, 3595 NW Roosevelt Dr., Corvallis, Oregon 97330, and SCOTT R. ROBINSON, 685 NW Linden, Corvallis, Oregon 97330. Received 31 Aug. 1983; accepted 14 Feb. 1984.

Passerine Bird Densities in Shrubsteppe Vegetation.—In 1979 and 1980 we surveyed nesting passerine bird densities within the Bureau of Land Management's (BLM) Snake River Birds of Prey Study Area in southwestern Idaho. The BLM wished to estimate bird densities so that they could evaluate the importance of individual vegetation types to the production and maintenance of bird populations. We derived bird densities using line transect survey techniques (Burnham et al. 1981). Line transect sampling uses statistically sound procedures and unlike the numerous ad hoc survey techniques (see Ralph and Scott 1981 for an extensive review of available methods) in the ornithological literature, allows estimation of sampling variance. Without some measure of variance it is impossible to judge the precision of the density estimates and compare densities between times and areas.

Study site.—The Snake River Birds of Prey Study Area is located in southwestern Idaho along 110 km of the Snake River. The area is in an upper Sonoran life zone with an annual precipitation that ranges from 18 to 25 cm. Summers are hot and dry, and winters are mild. Vegetation within the Birds of Prey Study Area consisted of big sagebrush, *Artemisia tridentata*, and salt-desert shrub communities. A general description of the plant communities is given in Sharp and Sanders (1978). Birds were surveyed within 4 major vegetation types:

(1) **Big sagebrush** was nearly pure stands of big sagebrush with an understory of exotic forbs and grasses (primarily cheatgrass, *Bromus tectorum*).

(2) **Big sagebrush-winterfat mosaics** included a mosaic of big sagebrush and of winterfat (*Ceratoides lanata*) stands. Understory vegetation consisted primarily of cheatgrass, Sandberg bluegrass (*Poa sandbergii*) and exotic mustard species.

(3) **Salt-desert shrubs** occurred as nearly pure stands of a single species or as mixed stands including several shrub species. Shadscale (*Atriplex confertifolia*); bud sagebrush (*Artemisia spinescens*); winterfat; greasewood (*Sarcobatus vermiculatus*); Nuttall saltbush (*Atriplex falcata*); four-wing saltbush (*Atriplex canescens*); and horsebrush (*Tetradymia glabrata*) were shrubs occurring in this vegetation type. This vegetation type is a grouping of several vegetation types that was necessary to obtain adequate sample sizes for analysis (see below).

(4) **Grasses and forbs** were the result of fires in big sagebrush, winterfat, and salt-desert shrub stands. Immediately after a fire, exotic forbs such as Russian thistle (*Salsola kali*), tumble and tansy mustards (*Sisymbrium altissimum*, *Sophia pinnata*) colonize the area. Dense stands of cheatgrass follow within a few years.

Methods.—We located 23 transects in big sagebrush, 4 in big sagebrush-winterfat mosaics, 14 in salt-desert shrubs, and 13 in grass. Each transect was 4 km in length, and was located within a homogeneous stand of vegetation. Transect routes were measured and flagged prior to the actual survey (see Burnham et al. 1981 for a discussion of survey procedures). During the 4-week period of mid-April to mid-May of 1979 and 1980, each transect was walked once from first light until 0900. The survey was conducted during egg-laying and incubation and transects were walked only on days without inclement weather. Bird species were grouped into 4 categories: Horned Larks (*Eremophila alpestris*), Western Meadowlarks (*Sturnella neglecta*), sparrows, and other birds. Birds were grouped into these categories rather than analysis by individual species because of sample size considerations. A minimum of 40 and preferably 60 to 80 birds is needed for line transect analysis (Burnham et al. 1981). Lateral distances from the transect line were recorded in 5 m groupings to 30 m, then in two 30 m groupings to 90 m. Data from all transects within each vegetation type were combined and analyzed using the Fourier series estimator by program TRANSECT (Burnham et al. 1980).