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SHEEP CARCASS AVAILABILITY AND USE BY BALD EAGLES

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Abstract.—We studied sheep carcass availability and use by Bald Eagle (*Haliaeetus leucocephalus*) in the Willamette Valley, Oregon, during winter 1990. We determined availability of sheep carcasses every 2–4 days along a 65-km transect. Bald Eagle numbers were counted weekly at five communal roosts. Counts ranged from 13 to 49; immatures consistently outnumbered adults. We calculated persistence rates of 137 sheep carcasses; those <200 m from a road or house were rarely used by eagles and persisted longer than carcasses farther away. Eagles were feeding on sheep carcasses in 83% of feeding observations along the transect, and 87% of 234 Bald Eagle castings contained wool. However, we found no evidence of eagle predation on sheep. Availability of sheep carcasses appears to be a primary factor influencing eagle use of the valley in winter. Our estimate of available sheep carrion/day was more than sufficient to meet the needs of the eagles wintering in the valley. However, if eagle numbers continue to increase or if carrion becomes less available, eagles may leave the valley. We recommend that ranchers make carcasses available to eagles away from sources of human disturbance, rather than burying them as is currently practiced. *Received 6 Aug. 1994, accepted 16 Dec. 1994.*

Bald Eagle (*Haliaeetus leucocephalus*) winter concentrations and communal roosts occur in areas where food is abundant. Concentrations have occurred in response to local fish runs (McClelland et al. 1982, Knight and Knight 1983), waterfowl (Isaacs and Anthony 1987), and large mammal carrion (Hancock 1964, DellaSala et al. 1989). Large mammal carrion scavenged by Bald Eagles often includes domestic livestock (Hancock 1964, Isaacs and Anthony 1987, DellaSala et al. 1989) and may be interpreted by ranchers as predation (O'Gara 1982). In the Willamette Valley of western Oregon, private landowners have reported Bald Eagle depredations on sheep, and at least six Bald Eagles have been reported shot or poisoned within the area since 1986 (G. Anderson, pers. commun.). Based on foraging observations and 45 castings, DellaSala et al. (1989) concluded that winter use of the Willamette Valley by Bald Eagles was related to the availability of sheep carrion and afterbirth. However, DellaSala et al. (1989) did not estimate carcass availability or attempt to determine if predation on lambs occurs. Our objectives were to determine the extent of Bald Eagle consumption of sheep carrion, the availability of carcasses in the valley, and if predation on lambs occurs.

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STUDY AREA AND METHODS

We conducted this study in the southern portion of the Willamette Valley between Eugene and Corvallis, Oregon, next to the foothills of the Cascade Mountains. Elevations on the valley floor range from 60 to 125 m, and prominent buttes rise 100–300 m higher. Annual precipitation (mostly rain) is about 90 cm, and temperatures during this study averaged 20°C (range = −31–41°C). Snow was infrequent, and snow cover never persisted for >two days during the study. The Willamette Valley has been largely converted to agricultural use; fields are bordered by black cottonwood (*Populus trichocarpa*), Oregon white oak (*Quercus garryana*), incense cedar (*Libocedrus decurrens*), and low-growing shrubs along fencerows. Primary land use in the valley is grass-seed production; grass fields provide abundant winter pastures for domestic sheep. Land use in the Cascade Mountains and the Coast Range is primarily for wood products.

We counted Bald Eagles at five communal roosts once each week from 16 January to 4 April 1990. All known roosts were counted simultaneously. Most counts began >2 h before sunset PST and ended at dark. We added the number of eagles present at the roosts when observations began to the number entering roosts to obtain a total. Bald Eagles were considered adults if their heads and tails were mostly white; all others were considered immatures unless age could not be determined.

We determined Bald Eagle food habits from castings collected at roost sites. Castings were analyzed to identify food items; prey were identified to species when possible and were expressed as percent occurrence (Marti 1987). We drove a 65-km line transect (Andersen et al. 1985) to gather data on distribution and abundance of Bald Eagles and sheep carrion. The location of the transect was chosen so that it ran parallel to and within easy flying distance of the five roosts. The maximum distance of any roost to the transect was 15 km, whereas eagles were observed feeding up to 24 km from the roosts. One or two observers searched for sheep carcasses and eagles by driving the route at about 40 km/h between 08:30 and 14:00 h PST every other day (15 Jan–14 Feb) or every third or fourth day (15 Feb–25 Apr). We alternated survey direction of the route. Our ability to detect carcasses differed for sheep with and without eagles feeding on them; therefore, we did not attempt to determine carcass densities. Thus, our estimates of carcass availability represent a minimum of sheep available within the study area. Sheep carcasses were assigned a number, each carcass position was mapped, and the condition was classified as intact, open, or hide and bones. We recorded the age of each sheep carcass (lamb, yearling, adult), number and species of birds present, and distance (m) to a road or house. On subsequent visits to carcasses, we noted use and changes in carcass condition until only hide and bones remained or the carcass had been removed. If we did not know the actual day a carcass was removed or when edible portions no longer remained, we considered that day to be the midpoint between visits. Dead lambs were examined for evidence of predation and were necropsied when necessary to determine if they had been killed by eagles. Lamb carcasses with evidence of subcutaneous hemorrhaging and internal bleeding at the site of puncture wounds along the back were assumed to be eagle kills (Wade and Bowns 1983).

We calculated carcass persistence rates (the daily probability that a carcass would remain in the field after detection) using the Kaplan-Meier survival estimation procedure (Kaplan and Meier 1958) modified for a staggered entry design (Pollock et al. 1989). Carcasses removed from the field were censored. Carcass persistence functions were compared for carcasses ≤200 and >200 m from a road or house using the log rank procedure described by Pollock et al. (1989). We used analysis of variance to test for differences in detection distance for carcasses with and without birds on them.

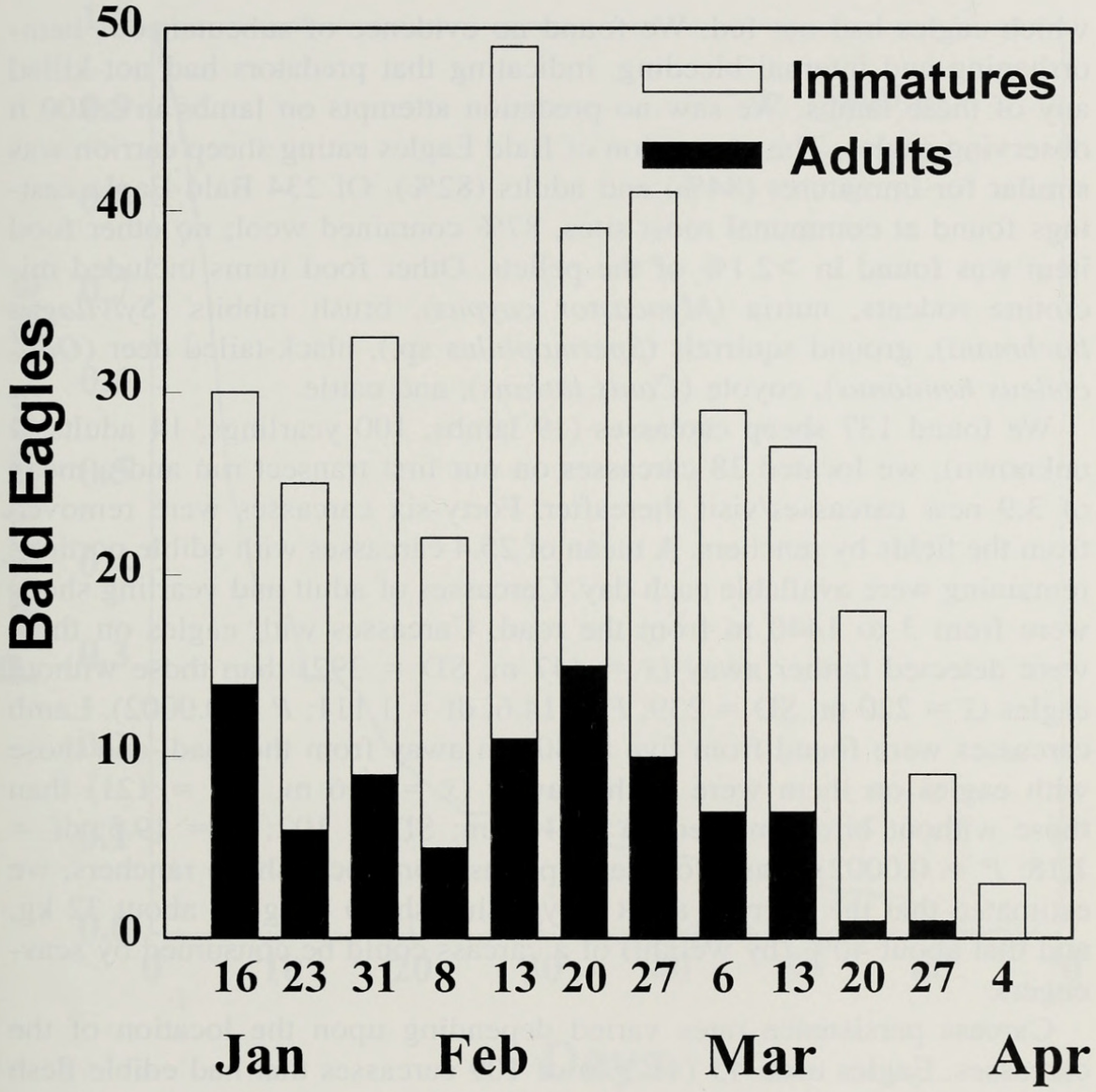

FIG. 1. Number of Bald Eagles observed at communal roosts in the Willamette Valley, Oregon, by date and age class, 1990.

RESULTS

We recorded 339 Bald Eagle sightings (240 immatures, 86 adults, 13 unknown) at five roosts between 16 January and 4 April 1990; the highest count (49) was on 13 February (Fig. 1). Immatures consistently outnumbered adults and remained in the valley longer than adults. We observed eagles feeding along the transect 203 times. Sheep carrion was being eaten in 83% of these observations, and eagles showed no preference for carcasses of lambs over carcasses of older sheep ($\chi^2 = 2.45$, df = 1, $P = 0.13$). We examined 21 lamb carcasses (including seven carcasses that were not found along the transect) on which eagles had fed and five on

which eagles had not fed. We found no evidence of subcutaneous hemorrhaging and internal bleeding, indicating that predators had not killed any of these lambs. We saw no predation attempts on lambs in >200 h observing eagles. The proportion of Bald Eagles eating sheep carrion was similar for immatures (84%) and adults (82%). Of 234 Bald Eagle castings found at communal roost sites, 87% contained wool; no other food item was found in >2.1% of the pellets. Other food items included microtine rodents, nutria (*Myocastor coypus*), brush rabbits (*Sylvilagus bachmani*), ground squirrels (*Spermophilus* sp.), black-tailed deer (*Odocoileus hemionus*), coyote (*Canis latrans*), and cattle.

We found 137 sheep carcasses (19 lambs, 100 yearlings, 14 adults, 4 unknown); we located 38 carcasses on our first transect run and a mean of 3.9 new carcasses/visit thereafter. Forty-six carcasses were removed from the fields by ranchers. A mean of 25.4 carcasses with edible portions remaining were available each day. Carcasses of adult and yearling sheep were from 3 to 1440 m from the road. Carcasses with eagles on them were detected farther away ($\bar{x}$ = 447 m, SD = 392) than those without eagles ($\bar{x}$ = 220 m; SD = 239; F = 14.6; df = 1,111; P = 0.0002). Lamb carcasses were found from five to 405 m away from the road, and those with eagles on them were farther away ($\bar{x}$ = 316 m, SD = 121) than those without birds on them ($\bar{x}$ = 108 m; SD = 102; F = 19.5; df = 1,18; P = 0.0002). Based on descriptions from local sheep ranchers, we estimated that the average adult or yearling sheep weighed about 32 kg, and that about 40% (by weight) of a carcass could be consumed by scavengers.

Carcass persistence rates varied depending upon the location of the carcasses. Eagles used 45 (41.3%) of 109 carcasses that had edible flesh on them when found. Carcasses ≤200 m from a road or house persisted longer than carcasses >200 m away (χ^2 = 25.39, df = 1, $P < 0.001$) (Fig. 2). About 54% of 137 sheep carcasses were considered accessible to eagles (>200 m from roads or houses); all of these carcasses had edible flesh on them, and 51% were used by eagles. Carcasses rarely persisted > six days before being completely consumed.

DISCUSSION

We believe that the abundance of sheep carrion in 1990 was the primary factor influencing the total number of Bald Eagles wintering in the Willamette Valley. Based on average weight and average number of carcasses, there was a total of about 325 kg of sheep carrion available along the transect/day. We estimated about 155 kg of sheep carrion was accessible to eagles and another 170 kg was present but unlikely to be used by eagles because of its proximity to roads and human habitation or be-

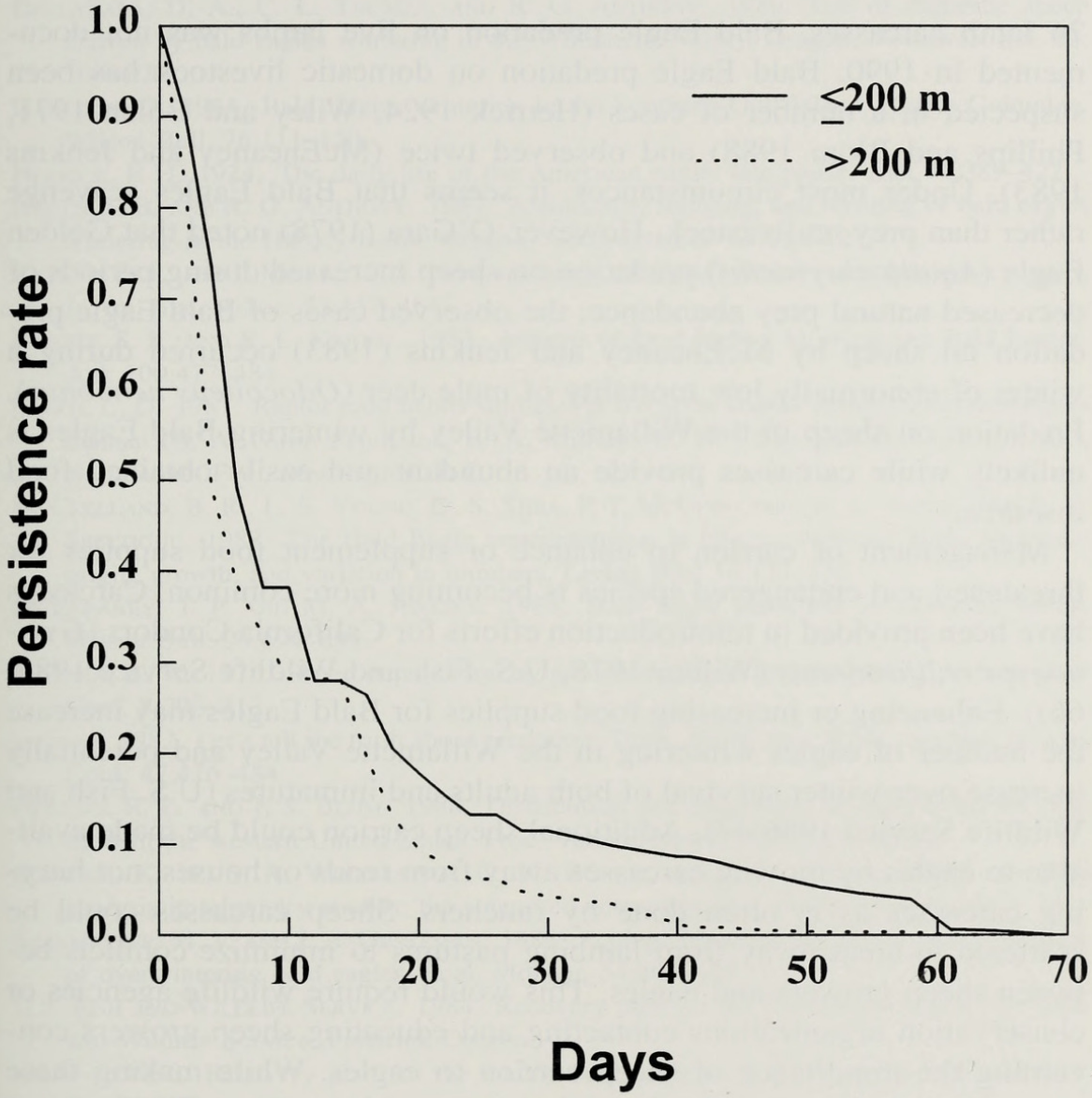

FIG. 2. Sheep carcass persistence rates (the daily probability that a carcass would remain in the field after detection) during winter in the Willamette Valley, Oregon, by distance from roads or houses.

cause the carcasses were intact. Stalmaster and Gessaman (1984) determined that a captive 4.5-kg Bald Eagle requires about 0.3 kg of rabbit/day, and free-ranging eagles require 0.7 kg/day, when the ambient temperature is 20°C. We counted an average of 28 eagles/coordinated roost count, which would require a total of about 20 kg/day of carrion. Thus, our estimate of available carrion/day was more than enough to meet the needs of the eagles in the area. Other scavengers, especially Common Ravens (*Corvus corax*) and coyotes, compete for carrion but are likely accommodated by the carrion surplus to eagle needs.

Based on our 203 foraging-eagle observations and our examination of

26 lamb carcasses, Bald Eagle predation on live lambs was not documented in 1990. Bald Eagle predation on domestic livestock has been suspected in a number of cases (Herrick 1924, Wiley and Bolen 1971, Phillips and Blom 1988) and observed twice (McEneaney and Jenkins 1983). Under most circumstances, it seems that Bald Eagles scavenge rather than prey on livestock. However, O'Gara (1978) noted that Golden Eagle (*Aquila chrysaetos*) predation on sheep increased during periods of decreased natural prey abundance; the observed cases of Bald Eagle predation on sheep by McEneaney and Jenkins (1983) occurred during a winter of abnormally low mortality of mule deer (*Odocoileus hemionus*). Predation on sheep in the Willamette Valley by wintering Bald Eagles is unlikely while carcasses provide an abundant and easily obtained food resource.

Management of carrion to enhance or supplement food supplies for threatened and endangered species is becoming more common. Carcasses have been provided in reintroduction efforts for California Condors (*Gymnogyps californianus* (Wilbur 1978, U.S. Fish and Wildlife Service 1984: 66)). Enhancing or increasing food supplies for Bald Eagles may increase the number of eagles wintering in the Willamette Valley and potentially increase over-winter survival of both adults and immatures (U.S. Fish and Wildlife Service 1986:47). Additional sheep carrion could be made available to eagles by moving carcasses away from roads or houses, not burying carcasses as is often done by ranchers. Sheep carcasses could be scattered in areas away from lambing pastures to minimize conflicts between sheep growers and eagles. This would require wildlife agencies or conservation organizations contacting and educating sheep growers concerning the importance of sheep carrion to eagles. While making these contacts, biologists could inform the growers about the unlikelihood of eagle predation on sheep and teach them to differentiate between predation and scavenging.

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