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Habits of Bald Eagles Wintering along the Crooked River, Oregon

Abstract

Bald eagles (*Haliaeetus leucocephalus*) were observed in the upper Crooked River drainage in central Oregon from January to April, 1986 and 1987 to locate roosts and to describe roosting habitat, eagle abundance, and foraging behavior. The number of eagles peaked at ≈115 during the weeks of 10 March 1986 and 2 March 1987. Large mammal carcasses (deer and cattle) were the primary food source for eagles during January and February. Ground squirrels (*Spermophilus* spp.) were important food during March and April. Twelve communal night roosts were generally in the largest trees in the vicinity of feeding areas and were isolated from human activities. All roost trees but one cottonwood (*Populus deltoides*) were conifers and were the dominant, open-structured individuals in forest stands. Results indicate that: 1) substantially more bald eagles (100+) utilize eastern Oregon in winter than was previously thought, 2) use of large mammal carrion by bald eagles can be enhanced by not placing carcasses in pits, opening intact carcasses to expose flesh and viscera, and placing carcasses at least 250 m from human activities, and 3) large (63-152 cm diameter at breast height) coniferous trees that are near feeding areas and isolated from human activities are chosen for communal night roosting. Management of bald eagle roosting habitat should include maintenance of stands of large coniferous roost trees, planting of deciduous trees with horizontal limb structure (e.g., cottonwood) near feeding areas, and protection of riparian zones from livestock grazing.

Introduction

Bald eagles often roost communally near abundant sources of food during winter. In the Pacific Northwest, waterfowl concentrations (Keister *et al.* 1987, Isaacs and Anthony 1987) and spawning salmon (McClelland *et al.* 1982, Stalmaster *et al.* 1979) attract large numbers of bald eagles, and communal night roosts are common in these areas. The reason for communal roosting is poorly understood (Anthony *et al.* 1982, Keister *et al.* 1985). One function may be for communicating locations of food (Ward and Zahavi 1973).

Peak counts of 32-55 bald eagles, primarily foraging on large mammal carrion, were reported along the Crooked River in central Oregon during winter, 1978-1984 (U.S. Bur. Land Manage., unpubl. data), but only one roost was located (R. Hickenbottom, U.S.D.A. For. Serv., pers. comm.). Because of the threatened status of the species (U.S. Dept. Inter. 1978), concerns were raised about the possible effects of timber management on unknown communal roosts along the Crooked River. As a result, we studied the habits of bald eagles wintering along the Crooked River, Crook Co., Oregon during the winters of 1986 and 1987. Our objectives were to locate roosts and describe roosting habitat, eagle abundance, and foraging behavior.

Study Area

The study area, located in central Oregon, included the Crooked River drainage from Prineville Reservoir east (upstream) to Rager Ranger Station (Figure 1). The Crooked River, above Prineville Reservoir, drains the Ochoco Mountains to the north, the Blue Mountains to the east and southeast, and the Maury Mountains to the south. Elevations range from 986 m at Prineville Reservoir to 2111 m at Lookout Mountain in the Ochoco Mountains. The climate is semi-arid with low annual precipitation (mean = 30 cm), low humidity, and a wide range between daily maximum and minimum temperatures (Franklin and Dyrness 1973).

Most of the floodplain of the Crooked River and its major tributaries is privately owned and has been converted to pastureland. Individual or small groups of deciduous trees are scattered in the river valley. Natural vegetation zones vary by elevation and aspect; dominant species in order of increasing elevation are juniper (*Juniperus occidentalis*), ponderosa pine (*Pinus ponderosa*), and grand fir (*Abies grandis*) and Douglas-fir (*Pseudotsuga menziesii*) (Franklin and Dyrness 1973).

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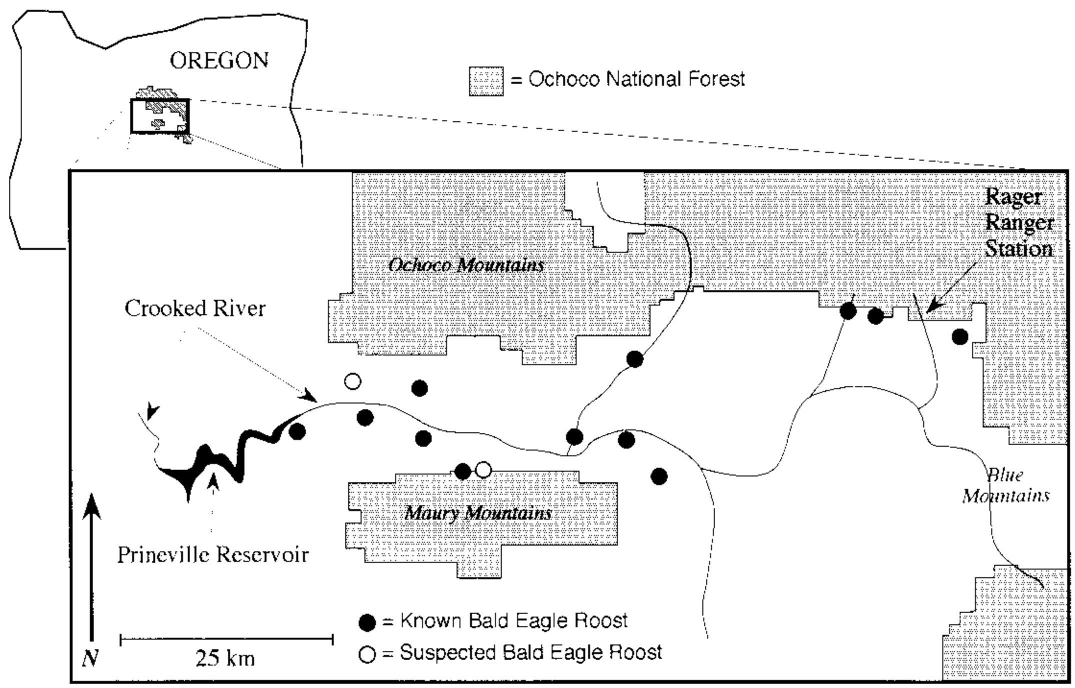

Figure 1. Map showing the study area for wintering bald eagles and locations of communal night roosts along the Crooked River in central Oregon, 1986-1987.

Methods

Counts of bald eagles were conducted weekly from January through April, 1986 and 1987, to estimate the bald eagle population and to determine principal feeding areas and foods. We began counts at 0900 h, after most eagles had left night roosts to feed, and tried to complete counts by 1300 h so that birds leaving the feeding areas to soar, loaf, or return to roosts were not missed. Counts were made by two parties of one or two people driving all-weather, public roads. Each party covered ≈ 1/2 of the study area by driving slowly (16-64 km/h) in opposite directions from a starting point at Milepost 46 on Highway 380. We stopped at 0.4-3.2 km intervals to scan the surrounding area with binoculars and spotting scope and try to locate every eagle present. Age class (adult = all white head and tail, subadult = any degree of brown in head or tail feathers, or unknown = plumage not distinguishable), location, activity, and time were recorded for each eagle observed.

Aerial counts of eagles were conducted weekly from 27 February to 26 March 1986 at the same time as driving counts. Aerial counts were made by a pilot and two observers, flying low (100-500 m) and slow (95-130 km/h) over the driving survey route in a Cessna 172 fixed-wing aircraft. Age class, location, activity, and time were recorded for each bald eagle observed. Air and ground counts were used to calculate a double-survey estimate of population size (Magnusson *et al.* 1978):

$$N = [(S_1 + B + 1)(S_2 + B + 1) / (B + 1)] - 1$$

where:

N = the population estimate
S_1 = bald eagles seen from the air but not from the ground
S_2 = bald eagles seen from the ground but not from the air
B = bald eagles seen by both surveys.

We used differences in counts of adults and subadults between survey types to calculate S_1, S_2, and B. For example, an air survey count of 21 adults + 9 subadults (30 eagles) and a ground survey count of 20 adults + 15 subadults (35 eagles) would yield an S_1 value of 1 [(21 − 20) + 0], an S_2 value of 6 [0 + (15 − 9)], and a B value of 29 (20 + 9); therefore, $N = [(1 + 29 + 1)(6 + 29 + 1) / (29 + 1)] - 1$ would result in a population estimate of 36 eagles.

Carcass surveys were conducted twice weekly during 1986 and once per week during 1987, by one or two people driving the survey route. During those surveys we searched for new carcasses and observed bald eagle activity at previously located carcasses. Location, species, description (age class, size, and color), and condition (1 = apparently intact, no meat showing; 2 = open, meat showing but no part of the skeleton exposed; 3 = part of the skeleton exposed, >50% of the meat remaining; 4 = <50% of the meat remaining; 5 = stripped, apparently little or no meat remaining) were recorded for all mule deer (*Odocoileus hemionus*) and cattle carcasses. Condition was recorded only during the first observation of the carcass in 1986. In 1987, carcass condition was recorded during each observation. Age class, distance from carcass, and activity (feeding, flying, perching, flushing due to disturbance, etc.) of eagles within 500 m of carcasses were recorded during each observation. Additional carcass observations were made when counting eagles.

Flights of eagles leaving feeding areas during late afternoon were observed and mapped. If a consistent pattern of flights to a particular area was observed, that area was searched for a communal night roost. Once a roost was located, roost counts were conducted weekly, as long as eagles continued to use the roost. Eagles were counted leaving roosts at dawn or arriving at roosts at dusk. Age class, flight direction and altitude, and time were recorded for each bald eagle observed. During 1987, volunteers from local communities were organized to conduct weekly counts at previously-located roosts so that we could search for unknown roosts.

Trees >30.5 cm diameter at breast height (dbh) in communal roosts were measured during July 1986. The 30.5 cm dbh limit was selected because use of trees that size or smaller for roosting has not been reported for the Pacific Northwest (Anthony *et al.* 1982, Isaacs and Anthony 1987). Species, dbh, and height were recorded for all trees measured. Conifers were also given one of five structure classifications (1 = live top with no large dead lateral limbs, 2 = mostly live top with few large dead lateral limbs, 3 = mostly dead top with several large dead lateral limbs, 4 = dead top with large dead lateral limbs and some live lower limbs, 5 = completely dead with large dead lateral limbs) (Isaacs and Anthony 1987). A tree was considered a roost tree if there was one or more intact castings below the tree. Roost tree characteristics (species, dbh, height, and structure class for conifers) were determined by measuring all roost trees. Roost stand characteristics (species, dbh, height, and structure class for conifers) were determined from a systematic sample of trees >30.5 cm dbh. Castings below all roost trees were counted and categorized by condition (intact or piece) and primary composition (i.e., fur or feathers).

Student's t-test statistic was used to test for differences between mean stand and roost tree characteristics. Chi-square goodness-of-fit tests and Bonferroni confidence intervals (Byers *et al.* 1984) were used to evaluate carcass use and eagle reaction to human activities.

Results and Discussion

Timing and Abundance

In 1986, the number of eagles seen during driving counts increased steadily from 23 during the week of 6 January to 86 during the week of 10 March (Figure 2), then dropped sharply to two eagles in the last week of April. In 1987, numbers of eagles stayed below 20 until the last week of January, when 46 were counted. Counts through February were similar to 1986. The peak count in 1987 occurred one week earlier (week of 2 March) than in 1986, and counts for the remainder of 1987 continued to be one week ahead of the 1986 pattern (Figure 2). Prior to 1986, numbers of bald eagles along the Crooked River increased

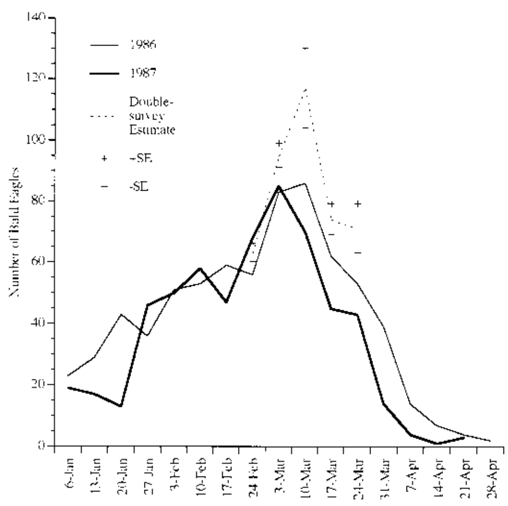

Figure 2. Weekly driving counts and double-survey estimates of bald eagles along the Crooked River, Oregon, 1986-1987.

through January and February, peaked in mid-February (1 year), March (4 years), and early-April (1 year), and declined through April and early-May (U.S. Bur. Land Manage., unpubl. data). Mean date of peak count for 1979-84, 1986 and 1987 was 13 March (n = 8, SD = 17.4 days).

Timing of peak abundance differed among years (U.S. Bur. Land Manage., unpubl. data, This study) and probably resulted from annual variations in and interactions among weather, food abundance, timing of bald eagle migration, and timing of counts. Variations in timing of peak abundance have been related to weather and food abundance in the Harney Basin of southeastern Oregon (Isaacs and Anthony 1987), the Klamath Basin of Oregon and California (Keister *et al.* 1987), and Glacier National Park, Montana (McClelland *et al.* 1982).

We observed a substantial increase in numbers of bald eagles the week after ice broke up on the Crooked River during both years of the study (23 before ice break-up to 43 after in 1986, 13 before to 50 after in 1987). W. Elmore (Bur. Land Manage., pers. comm.) also noted increased numbers during the spring thaw. The spring thaw was probably related to the number of eagles observed along the Crooked River because it coincided with a local increase in food (afterbirth from calving, cows and calves that died during calving, ground squirrels, waterfowl, fish) and to the timing of spring bald eagle migration. We also observed that peak bald eagle counts occurred the third week after ground squirrels emerged in both years and that peak counts for the Crooked River occurred the same week as those in the Harney Basin during both years (Oreg. Depart. Fish and Wildl., unpubl. data). Peak bald eagle counts in the Harney Basin have consistently coincided with the northward movement of migrant waterfowl (Isaacs and Anthony 1987) and the departure of eagles from the Klamath Basin (Keister *et al.* 1987) where waterfowl and bald eagles overwinter. Young (1983) documented movement of a marked bald eagle from the Klamath Basin, where it wintered, northward in March, through central and northeastern Oregon. That bird spent a brief period feeding on ground squirrels in northeastern Oregon. All of these observations provide evidence of a relationship between peak counts on the Crooked River and northward migrating bald eagles.

Our weekly population estimate (Figure 2) was based on driving counts and double-survey estimates, because they were made during a single day. The double-survey estimate was probably the most accurate population estimate, because there were always eagles seen from the air that were not observed from the ground and vice versa. The maximum estimate from the double-survey method was 117 eagles on 12 March 1986 (Figure 2). Subadults and eagles in flight or perched at locations other than on the ground or on fenceposts (in junipers, on rimrock, etc.) were often missed during aerial surveys. The ability of eagles to change locations or move onto or off of the study area during the time between air and ground surveys (as much as 1 h) may have affected the estimate of population size by the double-survey technique. The best and most economical method of censusing the population on the Crooked River was the driving count; it could be conducted during a single day, and fewer eagles were missed than by aerial counts.

Peak eagle abundance observed by driving counts during this study (mean = 86, N = 2, SD = 0.7) was nearly twice that reported for 1979-84 (U.S. Bur. Land Manage., unpubl. data; mean = 44, N = 6, SD = 8.1). Most of the increase was probably due to increased survey effort as a result of our study. The number of individual bald eagles that used the Crooked River during the winter was probably higher than our maximum counts. Young (1983) observed movements of radio-equipped bald eagles at American Falls Reservoir, Idaho, and speculated that as many as five times the maximum daily count of bald eagles may have used that area for periods ranging from one day to all winter. If this pattern of use exists along the Crooked River, as many as 500 individual bald eagles may pass through and use the area annually.

Prior to this study, we suspected that bald eagles in the Crooked River drainage were birds that had moved north from the Harney Basin. However, simultaneous counts in the two areas (Oreg. Depart. Fish and Wildl., unpubl. data, This study) indicate that bald eagles on the Crooked River were different than those in the Harney Basin. Thus, the 100+ bald eagles observed along the Crooked River substantially increased the number of bald eagles known to utilize eastern Oregon in winter.

Food Habits

Large mammal carrion was the most common food item we observed bald eagles eating. During 1986, 90% of feeding observations (n = 73) were at deer (30%), cow (45%), or calf (15%) carcasses; 10% were of eagles feeding on small animals, most of which (5 of 7) were identified as ground squirrels. In 1987, feeding observations were equally divided between large mammal carcasses and small animals (14 each). Two factors contributed to this difference. There were fewer large mammal carcasses available during 1987 (40 in 1987 vs. 130 in 1986) and ground squirrels emerged earlier in 1987 (11 February 1987 vs. 20 February 1986).

The extensive use of mammals for food was substantiated by the composition of intact castings (n = 251) found in communal roosts; 89% were composed primarily of fur. In the Harney Basin, waterfowl were the primary food, and 86% of 1,940 castings were composed primarily of feathers (Isaacs and Anthony 1987).

Most carcasses observed (n = 133) were deer (49%). Deer carcasses were located nearer public roads than cattle carcasses (mean distance for deer = 51 m, n = 65, SD = 61; for calves mean = 134 m, n = 21, SD = 128; for cows mean = 277 m, n = 47, SD = 275), because most deer died due to collisions with motor vehicles. In contrast, cattle died of natural causes where they were pastured.

Use of carcasses by bald eagles was affected by distance to human activity and carcass condition. Use of carcasses increased with distance from roads (Figure 3a) and was significantly less ($P < 0.05$) than expected for carcasses 0-99 m from roads and significantly more ($P < 0.05$) than expected for carcasses >149 m from roads. Della Sala *et al.* (1989) found that most bald eagles (73%, n = 63) foraged >50 m from roads in the Willamette Valley where domestic sheep carrion was the primary food. Flushing responses caused by human activity along roads decreased with distance (Figure 3b) and were significantly more ($P < 0.05$) than expected <50 m from roads and significantly fewer ($P < 0.05$) than expected >249 m from roads. Stalmaster (1980) and Skagen (1980) reported similar responses by wintering bald eagles to boating activities along rivers in northwest Washington where salmon carcasses were the primary food. Bald eagles used carcasses that had flesh and viscera exposed more than expected (Figure 3c); carcass use was significantly less ($P < 0.05$) than expected for apparently intact and stripped (appeared to have little or no meat remaining) carcasses.

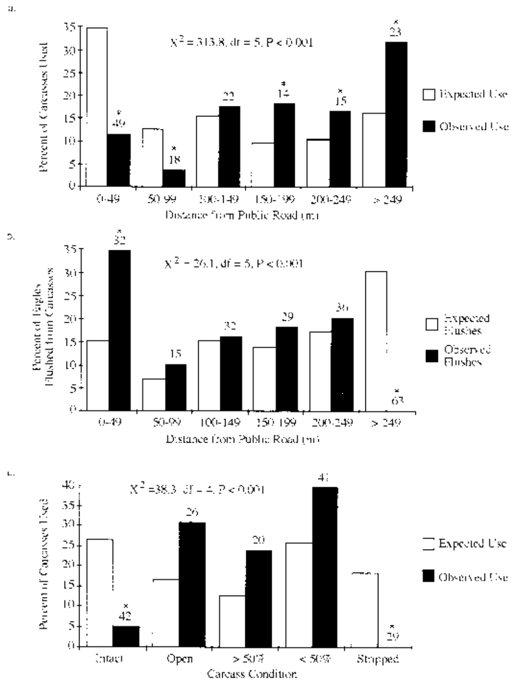

Figure 3. Bald eagle use of large mammal carcasses by distance from public roads and carcass condition along the Crooked River, Oregon, 1986-1987. *Indicates a difference between expected results and observed results ($P < 0.05$) using Chi-square goodness-of-fit tests and Bonferroni confidence intervals (Byers *et al.* 1984). Numbers on top of the black columns are sample sizes.

There was a shift from use of large mammal carrion to small food items in late-February. Only 17 (21%) observations of bald eagles using large mammal carcasses occurred in March and April, even though carcasses were still abundant and the eagle population peaked during that time (Figure 2). Most bald eagle sightings in March and April were near fields with large populations of ground squirrels and near calving areas where stillborn calves and afterbirth were available. Several ranchers allowed the shooting of ground squirrels for target practice, which resulted in high availability of carcasses to scavengers. We saw no evidence that eagles ingested lead when feeding on ground squirrels that had been shot, but believe the potential for lead poisoning exists.

Use of large mammal carcasses by bald eagles could be increased by placing carcasses at least 250 m from areas of human activity. Relocating road-killed deer to isolated areas away from roads would not only enhance feeding opportunities but would prevent vehicle-induced injuries and mortalities of eagles. Ranchers could increase food by leaving or placing dead livestock at least 250 m from human activity and by not placing carcasses in excavated pits where they were not used by eagles.

The increase in eagle numbers after ice breakup on the river suggested that fish may be another important food. Use of fish could have gone undetected during this study, because fish remains generally do not show up in castings (Mersmann *et al.* 1992) and because eagles feeding on fish in the river channel would have been out of view of many of our observation points.

Roosting Habits and Habitat

Twelve communal night roosts were located at 14 suspected roost areas (Figure 1). Most of the roosts were located during the first seven weeks of the study. After that, total weekly roost counts were nearly equal to weekly driving counts, indicating that the major roosts used during 1986 and 1987 were known. The maximum straight-line distance from feeding ground to roost was 21 km.

Roosts were generally located in the largest trees in the vicinity of feeding areas and were isolated from human activities. Four roosts were in single trees and eight were in forest stands. Ponderosa pine was the dominant tree species in roosts; 121 of 125 trees measured were ponderosa pine, 3 were Douglas-fir, and 1 was a cottonwood. Ninety-three percent (n = 1043) of eagles observed roosting used conifers; 7% used the cottonwood.

Roost and stand tree characteristics were compared for five of the main coniferous roosts (Table 1). Roost trees were larger in diameter ($t = 5.24$, $df = 8$, $P \leq 0.0005$), taller ($t = 2.40$, $df = 8$,

TABLE 1. Characteristics of forest stands and roost trees at five communal roosts used by bald eagles along the Crooked River, Oregon. All trees measured were >30.5 cm diameter at breast height (dbh).

	dbh (cm)[a]		Height (m)[a]		Structure[a,b] Classification		% of Trees Dead and Dead-topped	
Roost Name	Stand trees	Roost trees	Stand trees	Roost trees	Stand trees	Roost trees	Stand	Roost
MP 22 Pines	26	2	26	2	26	2		
	68.7	87.6	21.9	28.3	1.7	2.0	8	0
	29.1	19.8	6.6	1.7	1.1	0.0		
Horse Heaven	27	2	27	2	27	2		
	64.6	105.4	20.3	34.0	1.5	2.5	4	0
	22.7	16.2	7.7	5.4	0.9	0.7		
Lower North Fork	37	16	37	16	37	16		
	81.8	94.6	28.2	33.2	1.9	2.9	14	31
	25.4	19.4	6.8	5.7	1.3	1.5		
Upper North Fork	6	2	6	2	6	2		
	68.2	100.3	36.2	40.1	1.7	5.0	0	100
	19.5	12.6	8.9	2.8	0.3	0.0		
Sugar Creek	15	2	15	2	15	2		
	53.7	92.2	26.1	41.0	1.3	2.0	0	0
	16.0	16.1	6.6	2.4	0.4	0.0		
Mean	67.4	96.0[c]	26.5	35.3[c]	1.6	2.9[c]	5	26
Standard Deviation	10.1	7.0	6.3	5.3	0.2	1.2		
t-statistic	$t = 5.24$ $P \leq 0.0005$		$t = 2.40$ $P \leq 0.025$		$t = 2.23$ $P \leq 0.05$			

[a]Values are: Sample Size / Mean / Standard Deviation.

[b]1 = live top with no large dead lateral limbs, 2 = mostly live top with few large dead lateral limbs, 3 = mostly dead top with several large dead lateral limbs, 4 = dead top with large dead lateral limbs and some live lower limbs, 5 = completely dead with large dead lateral limbs (Isaacs and Anthony 1987).

[c]Mean for roost trees was significantly larger than mean for forest stand trees at $P \leq 0.05$.

$0.010 \leq P \leq 0.025$), and had more open structure ($t = 2.23$, $df = 8$, $0.025 \leq P \leq 0.05$) than forest stands. In addition, the percentage of dead and dead-topped trees was higher in the roost tree sample than in the stand sample (Table 1). The dbh of all coniferous roost trees (n = 33; range = 63.5-152.4 cm; mean = 100.4 cm; SD = 22.7) was greater than minimum old-growth specifications for the ponderosa pine forest type (53.3 cm dbh; U.S.D.A. Forest Service 1981). These results are similar to forest stand and roost tree characteristics described for the Harney Basin (Isaacs and Anthony 1987), Klamath Basin (Keister and Anthony 1983), and those summarized by Anthony *et al.* (1982) for communal roosts in the Pacific Northwest.

Management Recommendations

1. Exempt roost stands and a 400-m buffer area from commercial timber production and place those areas under a special management strategy (i.e., eagle management areas) with the goal of maintaining large trees (100.4 cm dbh) and an uneven-aged stand condition (Anthony *et al.* 1982). Buffer areas (zones) have been suggested for forest management and for reducing impacts of line-of-sight (in direct view of bald eagles with no vegetative or topographic screening) human activities on bald eagles for nest and roost sites. Anthony and Isaacs (1989) suggest that 400-m buffer zones be established around nest sites "to maintain the integrity of older aged forests" and that human activities be restricted within 800 m of nests during the breeding season in Oregon. Stalmaster and Newman (1978) found that a 300-m buffer zone would eliminate direct responses (flushing) by wintering bald eagles to human activities on the Nooksack River, Washington. Knight and Knight (1984) also studied flushing responses and found that "restriction zones 350 m wide would protect 99% of the wintering eagles perched in shoreline trees" on the Skagit and Nooksack rivers, Washington. McGarigal *et al.* (1991) quantified the effects of agitation (pre-flushing behavioral changes resulting from human activities) on foraging eagles at nest sites on the lower Columbia River, Oregon and Washington. They concluded that 400 and 800-m buffer zones were required to protect 50 and 95%, respectively, of perched bald eagles from agitation and flushing responses. We recommend a 400-m buffer zone around roosts on the Crooked River because most roosts were shielded from human activity by topographic or vegetative screening within that distance and to eliminate much (50% or more?) of the less obvious, but potentially stressful pre-flushing response to human presence when human activities occur within line-of-sight but outside 400 m. Buffer zone boundaries can be modified during site planning if the specific characteristics of the site (landform, flight paths of eagles to and from feeding areas, screening vegetation, etc.) enable modifications that do not compromise the security of the roost area.

2. Restrict human activities within eagle management areas during the season of use (usually October through April).

3. Prepare site-specific management plans for roosts. Effective planning requires familiarity with the physical characteristics of the site, the way bald eagles use the habitat (flight paths, foraging areas, staging areas, hunting perches, roost trees, etc.), and the landowner's needs.

4. Manage potential roosting areas adjacent to currently-used roosts to provide alternative roosting sites and insure against catastrophic loss of roost stands.

5. Monitor roost use annually and continue searching for new roosts. Roosts are usually associated with feeding areas, so different roosts may be used if changes in food distribution or abundance occur.

6. Maintain large trees in the river valley for both day perching and night roosting. Plant fast-growing deciduous trees with horizontal limb structure (e.g., cottonwood) in or near riparian zones and at least 400 m from areas with concentrated human activity to provide future roosting and perching sites. Protect riparian areas from grazing by livestock to protect plantings and to promote natural revegetation.

7. Conduct driving surveys each winter to determine annual timing and magnitude of peak abundance. Coordinate with similar counts in the Harney and Klamath Basins to monitor the regional population.

8. Use non-poisonous ground squirrel control measures to prevent secondary poisoning of bald eagles feeding on carcasses.

9. Investigate the importance of fish in the diet of bald eagles along the Crooked River prior to initiating projects that could affect the fishery in the Crooked River drainage.

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