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STATUS AND ECOLOGY OF BALD EAGLES WINTERING IN OKLAHOMA

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ABSTRACT

Aerial and ground censuses of bald eagles (*Haliaeetus leucocephalus*) wintering in Oklahoma indicate a minimum population in midwinter of almost 600 eagles. The northern bald eagle (*H. l. alascanus*) is the primary subspecies found in Oklahoma. Eagles generally begin arriving in October, their populations peak in January, and most have departed by mid March. The largest concentrations of eagles are located along the Salt Fork River near Salt Plains National Wildlife Refuge (NWR), at Grand Lake, in Osage and Texas Counties, at the Wichita Mountains NWR and Sequoyah NWR, and at Keystone, Tenkiller, Eufaula, and Fort Gibson Reservoirs.

Fourteen communal roosts were found. Cottonwoods (*Populus deltoides*) are the main roost tree species. Sixty-four percent of these roosts are on private property. Fourteen percent of the roosts are threatened by human disturbance and their future is considered precarious. In the intensive study area, Canada geese (*Branta canadensis*), cottontail rabbits (*Sylvilagus floridanus; S. auduboni*), and gizzard shad (*Dorosoma cepedianum*) were the main food items. Shooting was the main mortality factor for these eagles, however, the small numbers presently known shot do not represent a threat to the stability of the entire population. A management plan is presented that recommends managing roost trees to insure tree replacement, protecting roosts from human disturbance, and an annual census.

INTRODUCTION

Studies of bald eagles have been negligible except in the subject areas of natural history, nesting activities, food habits, and effects of pesticides. Bald eagles may spend up to 8 months of the year on their wintering grounds. A review of the literature indicated that very little research had been conducted on the ecology of wintering eagles. Research needs in Oklahoma included evaluating wintering habitat, determining the location of major roosts, evaluating future land use trends at these communal roosts, censusing, determining food habits, and determining the subspecies present.

The Oklahoma Cooperative Wildlife Research Unit; The National Audubon Society; George Hulsey, President, and William Howard, Executive Secretary of the Oklahoma Wildlife Federation; The National Wildlife Federation; George M. Sutton, Professor Emeritus of the University of Oklahoma; and the Oklahoma State University Research Foundation all furnished financial assistance for this study. This report is a portion of the Master's thesis of the senior author. The junior author was major advisor for the study. The authors express their appreciation for the assistance given by graduate committee members John Barclay, Associate Professor, School of Biological Sciences; and Arthur E. Harriman, Professor, Department of Psychology. Numerous other persons provided valuable assistance, but space limitations do not permit us to acknowledge them.

STUDY AREAS

The Salt Plains National Wildlife Refuge (NWR) encompasses Salt Plains Reservoir. The refuge and an area extending 20km downstream on the Salt Fork River was the intensive study area. The Salt Fork of the Arkansas River and the Medicine Lodge River meet in northcentral Oklahoma, before flowing into Salt Plains Reservoir. Below the reservoir the river is called the Salt Fork of the Arkansas. The stream gradient is gentle and a broad flat floodplain has developed. The Salt Fork has a braided channel interspersed with numerous sand bars and flats. Field investigations also were conducted throughout the state at other areas where eagles concentrated.

MATERIALS AND METHODS

Areas containing large eagle populations and roost sites were found by soliciting information from state and federal agencies, from ornithological groups and from the general public, and by using aerial surveys (Lish 1975). Bald eagle populations were determined in specific areas by counting the number of eagles using a communal roost. An airplane was used to census eagles on large reservoirs where communal roosting did not occur or where the roost sites were unknown. These census methods were used to make a composite estimate of the number of eagles wintering in Oklahoma during the winter of 1974-1975.

Several methods were used to determine the subspecies of bald eagles in Oklahoma. One method was to compare behavior and seasonal population trends in Oklahoma with seasonal movement patterns and winter nesting behavior of southern bald eagles in other states. Another method was to leg band and place patagial color markers on eagles in Oklahoma in hope of receiving reports of band recoveries or sightings on the nesting ground. The Office of Migratory Bird Management in Laurel, Maryland also provided reports of all banded bald eagles recovered before May 1974. These data were analyzed to determine the probable nesting areas of eagles wintering in Oklahoma and adjacent states. Measurements were taken of captive eagles, of eagles found dead, and of museum specimens collected in Oklahoma and these were compared with averages reported for the northern and southern races.

The locations of roosts were determined by watching eagles as they left their feeding areas in the evening. After identifying such an area it was searched for droppings, pellets, and feathers to confirm its exact location. The following information was recorded at each roost site: species of tree, diameter at breast height (dbh), condition, and height. Tree condition was assessed subjectively by estimating the number of dead branches on the tree and classifying the trees into categories of live, dead, or dying. The future of each roost was evaluated, based on the condition of the roost trees, the amount of disturbance by humans the roost was subject to, and response of eagles to that disturbance. The future for each roost was then categorized as either secure, insecure or precarious.

Methods used to study food habits included collecting pellets from beneath roosts, collecting prey remains from beneath feeding perches, and making field observations of eagles feeding and hunting. Pellets were analyzed using methods described by Errington (1932).

RESULTS AND DISCUSSION

Population

The bald eagle is a winter resident seen from 1 October to 11 May (Sutton 1967, Lish 1973). Sightings of bald eagles in May are uncommon. In the winters of 1973-1974 and 1974-1975, bald eagles began arriving on the intensive study area in mid November, the population peaked in January and most eagles had departed by mid March. This same pattern appears to exist statewide.

Previous population estimates by Sprunt and Cunningham (1962) were derived completely from aerial surveys and showed only 232 bald eagles wintering in Oklahoma. The current population estimate of 590 (Table 1, Figure 1) was based on the aerial surveys and counts at roosts. Population estimates were adjusted to compensate for differences in survey dates and population peaks. Adjustments were also made for sightings of eagles or signs left by eagles not censused during the aerial surveys and roost counts. For example, the maximum number of eagles observed at Grand Lake in the 1974-1975 winter was 10. Grand Lake has 2252km of shoreline and covers 17415 ha and it was impossible to adequately survey the entire lake. Concentrations of up to 183 eagles have been observed on Grand Lake in previous winters (Cooksey 1962). Lish (1973) observed a maximum of 38 eagles in this area. Because of the large areas of suitable habitat not censused, and because of the high counts in previous winters, the lake's population was estimated to be 50 eagles.

Data provided by George M. Sutton (personal communication) show that bald eagles have been sighted on almost every reservoir in Oklahoma. The populations of eagles on small reservoirs and some rivers are combined in "Other areas" (Table 1). Other areas include Fort Cobb Reservoir, Lake Chickasaw, Lake Arbuckle, Pine Creek Reservoir, Fort Supply Reservoir, Lake Wister, Atoka Reservoir, Lake Thunderbird, Canton Reservoir, Lake Altus, Lake Carl Blackwell, Joe Foss Reservoir, Webber's Falls, Markham Ferry Reservoir, Lake Hefner, and along the Cimarron, Neosho, North Canadian, and South Canadian Rivers (Figure 1). We tried to conservatively estimate the populations of other areas because data for them are incomplete.

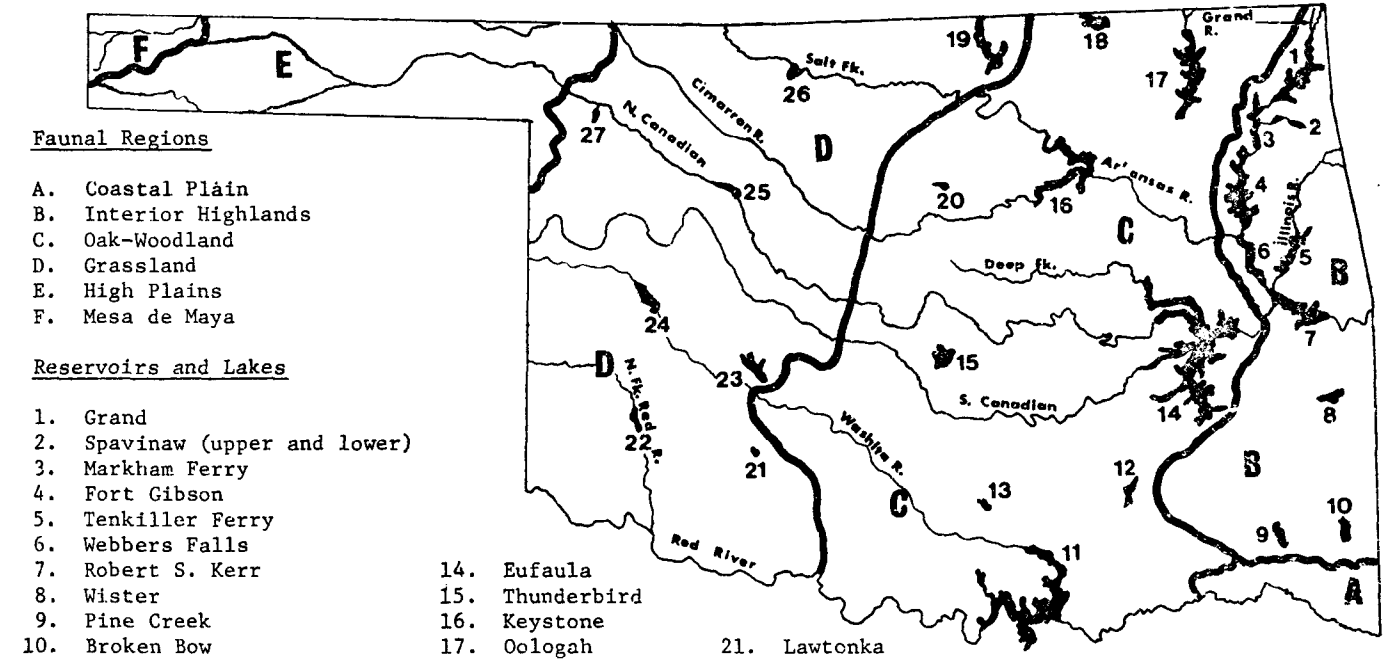

Figure 1. Major Reservoirs and Faunal Regions in Oklahoma.

Table 1. Maximum numbers of bald eagles seen at main concentration areas in Oklahoma during the winter of 1974-1975.

Location	*Actual counts*	*Dates*	*Estimated population*
Salt Plains Area			
Roost A and B (total)	91	12/31/74	120
Roost C	72	1/ 9/75	80
Roost D	36	1/ 1/75	40
Roost E	11	12/31/74	15
Grand Lake	10	2/11/74	50
Eufaula Reservoir	37	2/12/75	50
Texas County (two roosts)	18	1/27/75	30
Sequoyah NWR	16	12/21/74	20
Osage County			
Northwest Osage County	12	2/ 4/74	15
Hulah Reservoir	2	2/27/75	5
Fort Gibson Reservoir	15	11/30/74	15
Keystone Reservoir	12	2/12/75	15
Cookson and Tenkiller Reservoirs	8	12/29/74	15
Wichita Mountains NWR	8	12/21/74	10
Upper and Lower Spavinaw	2	3/ 6/75	10
Robert S. Kerr Reservoir	0		10
Oologah Reservoir	2	2/27/75	5
Broken Bow Reservoir	0		5
Lake Texhoma	3	2/ 1/75	5
Arkansas River above Cleveland	25	2/12/75	25
Other areas	0		50
Totals	380		590

Taxonomy And Source of Wintering Eagles

Knowledge of the subspecies of bald eagles wintering in Oklahoma is of importance because the southern race (*H. l. leucocephalus*) is endangered. Oklahoma is within the nesting range of the southern race (American Ornithologists Union 1957). As noted earlier, eagles have been reported in Oklahoma only from October to early May. Nesting activity of the southern race starts as early as November and ends as late as May (Lish 1975). Sexually mature eagles of the southern race would be nesting at the time when eagles are wintering in Oklahoma. However, bald eagles have not nested in Oklahoma for several decades (Lish 1975). Thus, if any of the southern race spend the winter in Oklahoma they would be immatures or unmated adults.

Measurements were taken from 10 eagles that wintered in Oklahoma. Measurements alone can seldom be used to distinguish subspecies. In general, however, the size of the 10 eagles was intermediate between those of the southern and northern races.

Recoveries of banded eagles indicate those wintering in Oklahoma and bordering states are the northern race. Seven eagles banded as nestlings in Minnesota by L. D. Frenzel and J. J. Burnstein and in Wisconsin by D. W. A. Whitfield were recovered in Oklahoma, Kansas, and Texas during winter. An adult banded in Wisconsin was recovered in Missouri during winter (Hammerstrom 1970). An adult banded at Squaw Creek National Wildlife Refuge in Missouri in winter was recovered in Ontario in April. An immature banded in Texas at Buffalo Lake National Wildlife Refuge in October was recovered in South Dakota in May. Recoveries of four other eagles banded in the Lake states indicate the same pattern. These latter recoveries will be reported in a paper now in preparation entitled Migratory Movements of Bald Eagles in Interior North America (personal communication from J. Grier, S. Postupalsky, and C. R. Sindelar).

Thus, the behavior patterns of eagles wintering in Oklahoma, a small sample of size measurements, and band recovery data all indicate that the northern race is the race wintering in Oklahoma.

Habitat Use

Eagles concentrate on the largest rivers and reservoirs. They were seldom observed far from a large body of water except in rangeland in Osage (northeastern Oklahoma) and Texas (in the Oklahoma Panhandle) Counties. Ninety-six percent of the eagles sighted during this study were within 1km of a river or reservoir. They concentrate below the dams and where rivers enter reservoirs, presumably due to the availability of food in these areas. When the turbines are generating power, some fish are pulled through, killed, and released into the river below the dam, where they become available as food. The areas where rivers flow into the reservoirs also generally produce more eagle food than the main body of the reservoir. Waterfowl, particularly common mergansers *(Mergus merganser)* and diving ducks, carp *(Cyprinus carpio)* and gizzard shad concentrate in these areas.

The areas where rivers enter reservoirs are subject to flooding, particularly in the spring and this has discouraged construction of homes and commercial property along this portion of lakes. Consequently, humans do not reside in these areas and humans are only temporarily present for recreational activities. Human activities at lakeside homes and commercial property may discourage eagle use along the shores of the main body of most Oklahoma reservoirs.

The Salt Plains area is the primary wintering area for bald eagles in Oklahoma (Table 1). The main factor influencing eagle use in this area is probably the food supply. Large die-offs of gizzard shad along the Salt Fork River in early winter provide food. Waterfowl also concentrate there in large numbers during winter. In the winter of 1973-1974, Canada goose populations in this area peaked at over 32,000 and mallard ducks *(Anas platyrhynchos)* peaked at over 22,000 (refuge records). Jet, Oklahoma, is known as the "goose hunting capital" of Oklahoma. Heavy hunting pressure along the Salt Fork River and adjacent to the Salt Plains NWR results in crippled geese which are a major food item during and after the hunting season. Another factor contributing to the large concentration of bald eagles in the intensive study area is probably the protection they receive. Landowners' attitudes towards eagles in this area are highly favorable, unlike some areas such as western Texas (Spofford 1964).

Roost Characteristics And Use

Characteristics of known roost sites in Oklahoma are summarized in Table 2. Nine (64 percent) of these roosts are in private ownership, four (29 percent) are on federal land, and one (7 percent) is owned by the state. Cottonwood trees are the most important tree species; they are the main tree species in eight (57 percent) of the roosts. In two (14 percent) of the roosts eagles used oak *(Quercus* sp.) trees. Sycamore, shortleaf pine *(Pinus echinata)*, American elm *(Ulmus americana)*, and blue ash *(Fraxinus quadrangulata)* are each the main tree species at one roost.

Roosts along the Salt Fork River, in Alfalfa and Grant Counties, and in Texas County and in Osage County, are located on sites with relatively flat topography. Roosts at the Wichita Mountains NWR, Sequoyah NWR, Cookson Hills State Game Refuge, Grand Lake, and Fort Gibson Reservoir are located in hilly topography.

Roosts are usually within 1km of a major river or reservoir. Most of the roosts are in secluded areas where there is infrequent human disturbance. However, the roosts at Grand Lake and Fort Gibson are near areas where there is much human activity and our data suggests declining use of these roosts by eagles.

The condition of roost trees is an important factor to consider in assessing the future of roosts. Fifty-seven percent of the trees are alive and appear to be in good condition, 14 percent are dying, and 29 percent are dead. The average height of trees at roost sites is 20.9m and average dbh is 66.3cm. Eagles utilize the larger trees in all of these roosts.

The future of 11 (79 percent) of the roosts in Oklahoma is rated as secure, one (7 percent) is insecure, and two (14 percent) are precarious. Both roosts with a precarious future are on private land and the primary problem is their location with respect to man's activities. The trees at the roost with an insecure future are old, dying and falling over.

Eagles generally returned to the roost earlier in the evening on clear days than on overcast days. The numbers of eagles arriving usually increased as light intensity decreased. The greatest number of arrivals occurred in the 60 min before sunset and none were observed arriving later than 20 min after sunset.

A few eagles could be observed at any time of the day at the large roosts in the intensive study area. Daytime use of the roost was heavier on overcast days than on clear days.

Eagles frequently moved from perch to perch and from Roost A to Roost B of the intensive study area just before dark. They apparently are inactive after dark. In most cases we were unable to identify individual eagles in this study, consequently, it was impossible to determine if eagles

Table 2. Characteristics of known eagle roosts in Oklahoma.

Roost Designation	Tree species	Maximum number of eagles seen 1973-1975 bald	golden	Average dbh (cm)	height (m)	Tree condition	Land ownership	Probable Future status
Salt Fork River								
A	cottonwood	100	4	76.2	19.1	live	private	secure
B	cottonwood	30		73.6	16.9	dying	private	secure
C	cottonwood	70		106.6	21.5	live	private	secure
D	cottonwood	36		70.0	25.0	live	federal	secure
E	cottonwood	11		80.0	30.0	dead	private	insecure
Texas County								
1	cottonwood	3	6	60.0	20.0	live	private	secure
2	cottonwood	0	2	60.0	20.0	live	private	secure
Wichita Mountains NWR	blackjack oak	10	?	52.5	12.5	dead	federal	secure
Sequoyah NWR								
1	cottonwood	11		105.0	30.0	dead	federal	secure
2	sycamore	3		85.0	25.0	live	federal	secure
Cookson Refuge	oak	8		60.0	20.0	dead	state	secure
Grand Lake	shortleaf pine	7		52.5	27.5	live	private	precarious
Osage County	American elm	3	1	60.0	15.0	dead	private	secure
Fort Gibson	blue ash	1		45.0	24.0	dying	private	precarious

consistently used specific roosts. Several times the senior author observed what appeared to be the same eagle in Roost A; this was an immature with several secondary feathers missing.

In the intensive study area eagles were seldom seen more than 5km from the roost. The maximum distance a bald eagle was followed as it flew from a feeding area to a roost was approximately 2km.

Eagles showed a definite preference for certain trees within a roost. The preferred tree in Roost A is dead and is taller than most trees in the roost. Sixty-one of 111 eagles at Roost A perched in this tree the evening of 22 December 1973. The tree is probably preferred because there are no small branches to obstruct eagles when landing.

Food Habits

Avian parts commonly regurgitated in pellets were the feet, feathers, nail of the bill (waterfowl), inner muscular layer of the gizzard (waterfowl), and nails from the toes. Mammalian parts commonly occurring in pellets were the incisors and lower jaw (small rodents), feet, fur, and toenails. Plant material was probably ingested accidentally when the eagle was feeding on the ground or was ingested by the prey before capture.

Canada geese, desert and eastern cottontail rabbits constituted 77 percent of the pellets' volume (Table 3). This was not surprising considering the numbers of these sepcies in the intensive study area.

Table 3. Prey items in 109 bald eagle pellets collected at Roost A (23 December 1973 to 2 March 1974).

Food item	*Frequency of occurrence*	*Percent of volume*
Birds:		
Canada goose	55	46.5
Mallard	6	3.9
Canvasback *(Aythya valisineria)*	3	3.5
Western meadowlark *(Sturnella magna)*	9	1.8
Pintail *(Anas acuta)*	2	1.7
Unidentified bird	2	0.7
Common crow *(Corvus brachyrhynchos)*	1	0.5
Unidentified passerine bird	1	0.4
Unidentified duck	1	0.4
Red-winged blackbird *(Agelaius phoeniceus)*	2	0.1
Subtotal		59.5
Mammals:		
Cottontail rabbit	41	30.4
Black-tailed jackrabbit *(Lepus californicus)*	3	2.4
Plains pocket gopher *(Geomys bursarius)*	3	2.2
Unidentified mammal	3	1.7
Hair from domestic sheep	1	0.8
Opossum *(Didelphis marsupialis)*	1	0.5
Fox squirrel *(Sciurus niger)*	1	0.5
Eastern wood rat *(Neotoma floridana)*	2	0.5
Unidentified rodent	1	0.4
Kangaroo rat *(Dipodomys ordii)*	2	0.2
Hair from domestic cow	1	0.1
Deer mouse *(Peromyscus maniculatus)*	1	0.1
Subtotal		39.8
Plant Material	13	0.7
Total		100.0

Prey remains were also collected from beneath feeding trees (Table 4). Twenty-three whole shad and 16 parts of shad were found in brush beneath these trees. In early winter, eagles fed mainly on gizzard shad in the intensive study area. None of the pellets collected then contained fish remains, apparently because when fish are the sole source of food bald eagles do not regurgitate a pellet (Donald Spencer, personal communication). As winter progressed, the eagles' diet within the intensive study area changed from fish to waterfowl, resulting in a subsequent increase in pellet castings collected beneath the roost.

Table 4. Prey items collected beneath feeding trees along the Salt Fork River, December 1973 to February 1974.

Prey item	*Number found*	*Percent*
Whole gizzard shad	23	47.9
Parts of gizzard shad	16	33.3
Green-winged teal *(Anas carolinensis)*	1	2.1
Canada goose	7	14.6
Mallard duck	1	2.1
Total	48	100.0

Bald eagles were seen attempting to capture Canada geese in the intensive study area on five occasions in the winter of 1973-1974. Eagles perched on fence posts or trees around winter wheat *(Triticum aestivum)* fields where geese were feeding. When an eagle attempted to catch geese it flew directly toward the flock. The geese took flight as the eagle approached. On one occasion an adult bald eagle separated a goose from the flock and pursued it for approximately 30 min. The goose seemed very capable of out-flying the eagle in level flight. After the eagle made a pass over the goose and returned to its perch, the goose quickly landed. An eagle was never observed capturing a Canada goose although they were seen feeding on geese several times. The eagles apparently watch these large flocks of geese and may be able to detect crippled or sick geese. Healthy geese are probably too difficult for eagles to catch.

In Osage County bald eagles fed primarily on cattle carcasses. Nine eagles were observed feeding on a single carcass. The owner of a feedlot north of Grainola, Oklahoma stated that 10 eagles fed regularly on cattle carcasses near his home. Whenever concentrations of eagles were seen in Osage County, carcasses of cattle were nearby. The front leg and tail of a small calf were found beneath a feeding perch.

Mortality Factors

Shooting is probably the main cause of mortality among bald eagles wintering in Oklahoma. Two immature bald eagles shot near Keystone Reservoir, one in the winter of 1974-1975 and the other before this study was made, are unable to fly and are now confined in the Tulsa Zoo. Another immature eagle was shot and killed near Keystone Reservoir in the winter of 1974-1975. An adult eagle was shot and killed near Broken Bow Reservoir in the winter of 1973-1974. Bud Hammons, State Game Ranger in Grant County, reported apprehending a hunter who killed a bald eagle below the dam of Salt Plains Reservoir before this study. Four bald eagles were shot at a location in Osage County in 1964. These shootings all appear to be the result of indiscriminate shooting at birds of prey rather than attempts at poaching eagles for the illegal traffic in feathers and claws.

A dead immature bald eagle found at Roost A in January 1974 was sent to the Migratory Bird Research Laboratory at Patuxent, Maryland, for a postmortem examination. The cause of death was tentatively ascribed to a brain abcess.

Although shooting is the main mortality factor known for eagles in Oklahoma, it is not widespread enough to cause a major decrease in bald eagle populations. Nevertheless, public education programs in the areas where eagles concentrate might help reduce the amount of shooting. In general, the attitude of the public towards eagles is favorable.

Proposed Management

A general management program for bald eagles in Oklahoma is needed. This program should include three major objectives: To completely protect existing communal roosts from human disturbance, to insure replacement of trees at existing roosts, and to conduct an annual census to monitor population trends. The first of these objectives seems the most important. The loss of a large communal roost, containing as many as 180 eagles, on Grand Lake as a result of a housing development might have been avoided by buying or leasing the land thereby minimizing human disturbance. Two communal roosts in the state can now be considered to have a precarious future due to the activities of man. These roosts and a buffer zone should be purchased or leased to insure their future protection.

Communal roosts consisting of old and dead trees without young trees to replace them also have a questionable future. The loss of such roosts might be avoided by planting young trees or possibly by experimenting with artificial roost structures. A long-term tree management plan would be appropriate. The plan could be designed so that a small percentage of the tallest trees in the roost would be girdled periodically to provide dead trees for roosting. Dead trees would be replaced by planting young trees. Planting and girdling should be done in the summer to avoid disturbing the eagles.

Oklahoma winters one of the largest populations of bald eagles in the United States and the population should be monitored annually. Communal roosts are used annually and when the roost locations are known they provide focal points for census.

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