STATUS AND ECOLOGY OF BALD EAGLES AND NESTING OF GOLDEN EAGLES IN OKLAHOMA

By

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1973

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1975

Name: James William Lish Date of Degree: December, 1975

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: STATUS AND ECOLOGY OF BALD EAGLES AND NESTING OF GOLDEN EAGLES IN OKLAHOMA

Pages in Study: 99 Candidate for Degree of Master of Science

Major Field: Wildlife Ecology

Scope of Study: Field observations were made of bald and golden eagles in Oklahoma. Intensive studies of bald eagles wintering along the Salt Fork River in Grant and Alfalfa Counties were conducted on the phenology of migration, habitat use, behavior, and food habits. Laboratory studies of pellets provided information on food habits. Taxonomic measurements, analysis of band recovery data, and a comparison of nesting dates of southern bald eagles with the dates that eagles winter in Oklahoma provided information of subspecies. Studies of vegetation at roost sites helped determine roosting habitat requirements. Aerial and ground surveys were used to assess nesting activity and to estimate the statewide population of bald eagles.

Findings and Conclusions: The Salt Plains Area, Grand Lake, Eufaula Reservoir, Osage County, and Texas County were main wintering areas for bald eagles. More than 15 communal roosts may be located in Oklahoma. Cottonwoods were the main species in 57 percent of the roosts. Sixty-four percent of the roosts were in state or federal land ownership.

Aerial and ground surveys indicate a total statewide population of between 550 and 600 bald eagles. No evidence was found of bald eagles nesting in Oklahoma. Band return data and nesting dates of southern bald eagles indicate that the northern bald eagle is the main subspecies and perhaps the only subspecies wintering in Oklahoma. Bald eagles wintering in Oklahoma probably nest in the western Great Lakes Region and south central Canada. Canada geese, cottontail rabbits, and gizzard shad were the main prey items in bald eagle pellets. Bald eagles are more active on clear days, when they soared in large groups, than on overcast days.

A management plan for bald eagles is outlined. This includes suggestions for the protection of roost sites and management of trees within these roosts.

ADVISER'S APPROVAL _____

STATUS AND ECOLOGY OF BALD EAGLES AND NESTING

OF GOLDEN EAGLES IN OKLAHOMA

Thesis Approved:

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Thesis Adviser

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Dean of the Graduate College

PREFACE

I express my sincere gratitude to James C. Lewis, Assistant Leader of the Oklahoma Cooperative Wildlife Research Unit and my major adviser, for his invaluable guidance, suggestions, and patience throughout all phases of this study.

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.

I express my appreciation for the assistance given by the members of my graduate committee, John Barclay, Associate Professor, School of Biological Sciences; and Arthur E. Harriman, Professor, Department of Psychology.

Others who deserve special recognition are: John Snelling, Curator of Birds, Oklahoma City Zoo; Ronald Sullivan, Manager, Salt Plains National Wildlife Refuge; Phil Norton, Manager, Optima National Wildlife Refuge; Roger Johnson, Manager, Wichita Mountains National Wildlife Refuge; Gene Bartnicki, Biologist, Wichita Mountains National Wildlife Refuge; Robert Stratton, Manager, Sequoyah National Wildlife Refuge; Dr. Raymond P. Morgan, Chesapeake Biological Laboratory, Solomons, Maryland; Bud Hammons, Ranger, Oklahoma Department of Wildlife Conservation; the LeForce family, Pond Creek, Oklahoma; Joe Fletcher, Manager,

Cookson Hills State Game Refuge; Ronald Klataski, Regional Representative, National Audubon Society; James Reidy, Tulsa Zoo; and members of the Oklahoma Ornithological Society.

I extend my sincere thanks to fellow students and friends who helped with field work and manuscript preparation. These include Gary Sallee, Steve Platt, John Langford, Raymond Lambert, Patty Worthing, Anne Farrell, Ron Freeman, Jim Gleckler, Kathy Quigley, and Susan Reidy.

Special appreciation is due my wife, Linda, who provided me with encouragement, strength, and patience throughout this study.

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CHAPTER I

INTRODUCTION

Bald eagles (Haliaeetus leucocephalus) are the only eagles restricted to North America (Grossman and Hamlet 1964). There are two subspecies: the southern bald eagle (H. l. leucocephalus), and the slightly larger northern bald eagle (H. l. alascanus) (OESIA 1973).

Although they became our national emblem in 1782, bald eagles received little protection until 1940 when Title 54, Statute 250, was passed (Kalmbach et al. 1964). This law protected eagles in the 48 continguous states. A bounty was paid for bald eagles in Alaska from 1917 to 1952; it was not until 1959 that they were given protection in Alaska. Alaska is the only state where bald eagles are still plentiful.

A serious decrease in the number of bald eagles was noted in Florida by Broley (1958). In 1943 he found an average of one active nest per 0.62 km in a 75 km distance on the west coast of Florida from Tampa to Fort Myers. In 1947, however, he noted that 40 percent of the nests failed to produce young. Today less than 500 active nests remain in Florida; similar declines have occurred in other states (USDI 1969).

In 1960 the National Audubon Society began a project to determine the status of bald eagles. During the winter, eagles are found principally in Florida, the Middle Atlantic states, the Middlewest

including the Mississippi and Missouri River Valleys, and the Northwest. The Middlewest contains more than half the eagles reported in the nation (Sprunt and Ligas 1966).

Increased human populations, shooting, removal of nest trees, and severe weather have been shown to have a negative impact on bald eagle populations. These factors are still inadequate to account for population declines noted in certain areas (OESIA 1973). The primary agents involved in lowered productivity may be persistent chlorinated hydrocarbon residues, particularly DDT and its metabolites. The environmental loads of these chemicals are highest where bald eagle productivity is lowest (Sprunt et al. 1973).

Populations of southern bald eagles have declined so rapidly in recent years that they are now included on the list of rare and endangered wildlife (OESIA 1973).

Recent studies of bald eagles have dealt mainly with the relationship of eagles and pesticides. These studies include comparisons of production among various populations, tests for associations between low productivity and pesticide residues, experiments with captive bald eagles fed controlled amounts of pesticides in an attempt to determine lethal dosages, and feeding controlled dosages of pesticides to captive bald eagles to identify physiological effects, particularly on spermatogenesis.

Studies of bald eagles have been negligible except in the subject areas of natural history, 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 shows that very little research has been conducted on the ecology of wintering eagles.

There are four main areas at which eagles winter in the United States (USDI 1973); the Midwest (Mississippi Valley Area) contains the largest number. This area extends from Minnesota to southern Missouri to northwestern Tennessee and includes parts of the Wisconsin and Illinois Rivers. More than one-third of the United States' population of bald eagles winters in the Mississippi Valley.

The second most important wintering area is the Northwest (Washington, Oregon, Idaho, and Montana) where approximately 20 percent of the population occurs. The Middle Atlantic states, particularly the Chesapeake Bay region, contain 5 percent of the population.

Possibly the highest concentrations of wintering bald eagles in North America are found north of Juneau in the Chilkat Valley, Alaska, where 3,000 to 5,000 eagles may be observed from October to January.

Bald eagles are common winter residents in Oklahoma (Sutton 1967; Sprunt and Ligas 1966) from 1 October to 25 April. A national Audubon Society study indicated that Oklahoma ranked fourth or fifth nationwide with a population of 232 in 1962 (Sprunt and Cunningham 1962). Their populations are underestimates of the actual number of eagles in Oklahoma. For example, Cooksey (1962) counted 183 bald eagles in a roost at Grand Lake in January 1962, a month in which the National Audubon Society census indicated only 232 eagles in the entire state. Roosts along the Salt Fork River have contained as many as 200 eagles in previous years (Bud Hammons, Ranger, Oklahoma Department of Wildlife Conservation).

Large populations of bald eagles have been reported at Salt Plains National Wildlife Refuge (NWR) (Van den Akker 1954), Grand Lake in

northeast Oklahoma (Cooksey 1962; Johnson 1960; Lish 1973), Eufaula and Tenkiller Reservoirs (Sutton, personal communication), Wichita Mountains NWR (Halloran 1960), and other areas in Oklahoma. Despite the large numbers of eagles wintering in Oklahoma they have been studied very little. Cooksey (1962) studied behavior and population dynamics at a winter roost on Grand Lake. Lish (1973) studied food habits, local movements, population dynamics, and the phenology of migration in the same area. Other published reports from Oklahoma have involved only brief observations.

Sutton (1967) reported no recent nesting of blad eagles in Oklahoma although a pair built a nest at Fort Gibson Reservoir in 1950. Bald eagles historically may have nested along the Arkansas River in northeastern Oklahoma (Carter and Trenton 1908) and Cimarron County (Tate 1923) in the Oklahoma Panhandle. Golden eagle nests have been found in Cimarron County as recent as 1965 (Sutton 1967). Green (1927) reported three nests of golden eagles in cliffs near the Cimarron River within a 6 km long area in Woods County. He also reported similar cliffs at 24 and 31 km up the Cimarron River.

Several studies of the ecology of bald eagles wintering in states outside Oklahoma are notable. Perhaps the most important is by Southern (1963, 1964). Southern observed eagles at the Savanna Army Depot in Carroll and Jo Daviess Counties in Illinois, an area extending 8.6 km along the Mississippi River. Southern studied food habits, local movements, and made useful observations on the use of telemetry to study bald eagles.

Another important study was conducted by Edwards (1969) on the winter ecology of the northern bald eagle in three mountain valleys of

Utah in 1966-1969. Edwards studied roosting behavior, population density, food habits, and local movements.

Hancock (1964) studied eagles wintering in the Gulf Islands of British Columbia. He censused eagles twice monthly from an airplane over 129.5 km^2; the bulk of his research dealt with population dynamics and density.

Communal roosting is an important behavioral trait of wintering bald eagles. Communal roosts are important because they enable an investigator to make an accurate census of the eagle population in a particular area. Communal roosting behavior has been described by several investigators. Johnson (1960) stated that bald eagles begin arriving at Grand Lake, Oklahoma in late October or early November, but that communal roosting does not start until late February. Cooksey (1962), studying eagles in this same area provided data that support the time periods Johnson indicated for communal roosting. Cooksey (1962) also noted that eagles at Grand Lake have at least two staging areas where they congregate before entering the roost. Edwards (1969) studied the topography surrounding four winter roosts in Utah and noted that all roost sites had similar exposure and vegetation. He also noted that eagles had an attraction to particular trees and even to favorite limbs in roost trees.

Studies conducted by Edwards (1969), Cooksey (1962), and Ingram (1965) indicate that bald eagles roost on or near their feeding areas. However, Swisher (1964) found that eagles wintering on the Bear River Delta in Utah use roosting areas at altitudes of 2,286 m on mountainsides 24-32 km from the delta. The lack of suitable roosting sites on

the delta, which contains few trees, may force the eagles to roost so far from favored feeding areas (Swisher 1964).

Research needs in Oklahoma included evaluating wintering habitat, determining the location of major winter roosts, censusing wintering bald eagles, determining food habits on wintering grounds, and evaluating future land use trends on existing communal roosts.

This study had the following objectives:

1. To determine peak populations of bald eagles wintering in Oklahoma by using aerial and ground censuses.
2. To locate, map and describe winter roosts used by bald and golden eagles in Oklahoma and to determine the landowner's interest in and future plans for these sites.
3. To describe the habitat use, behavior, and food habits of bald and golden eagles wintering along the Salt Fork River.
4. To determine local movements, migration pathways, taxonomy, and nesting areas of bald eagles that roost along the Salt Fork River by banding and color marking them.
5. To evaluate the effect of the Army Corp of Engineers' Chloride Control Project on the bald eagles wintering on the Salt Fork River.
6. To determine the extent of nesting of both bald and golden eagles in Oklahoma.

The Study Area

Intensive field investigations were conducted in the Salt Plains area of northcentral Oklahoma. This area is referred to as the intensive study area throughout this thesis (Figure 1). Field studies

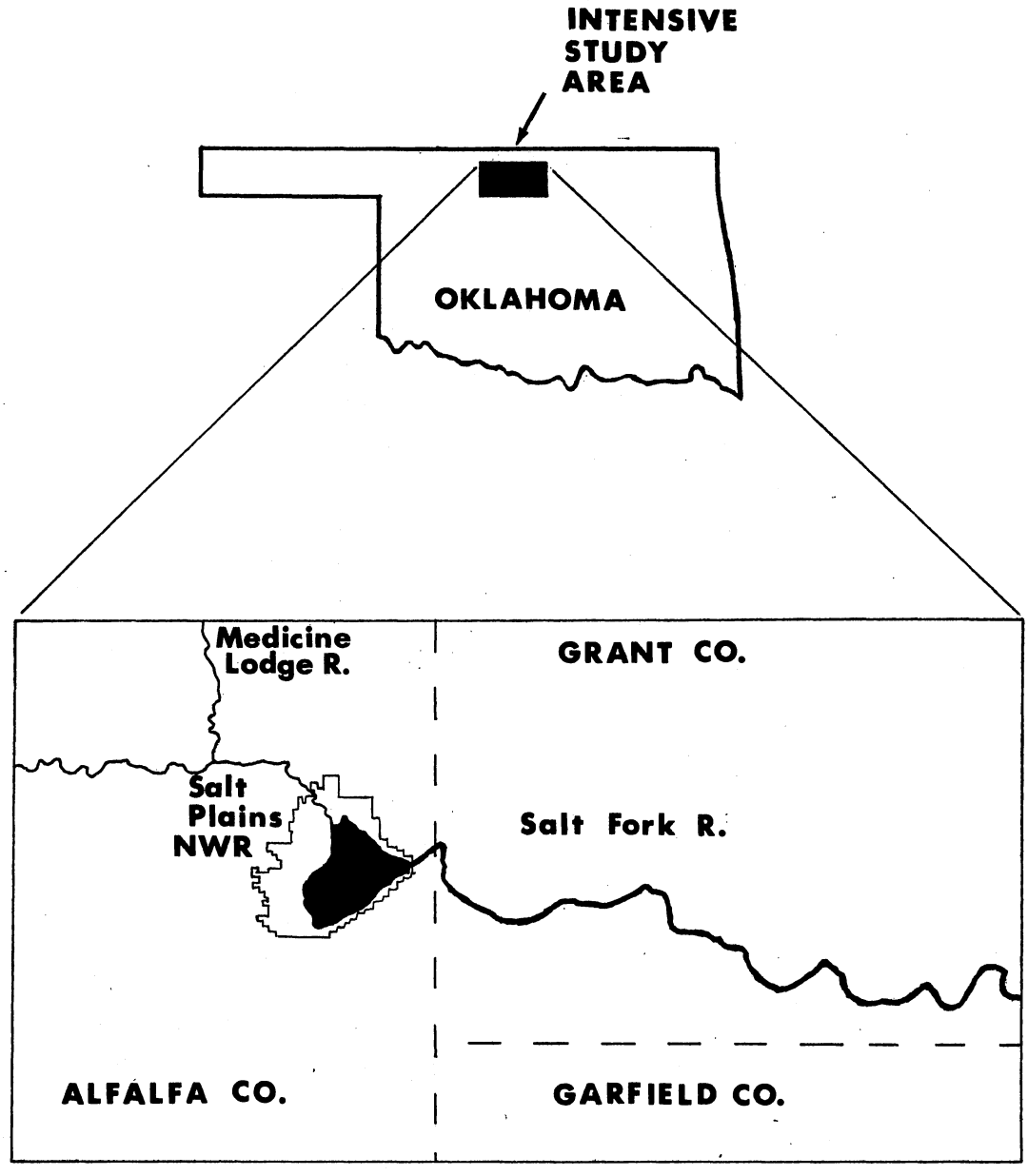


Figure 1. The Salt Fork of the Arkansas River in the Area Where Wintering Eagles Concentrate

were also conducted at other areas where eagles concentrated throughout the rest of the state, and these areas are referred to as secondary study areas. A county map of Oklahoma is included for reference (Figure 2).

The Intensive Study Area

The Salt Fork of the Arkansas River and The Medicine Lodge River flow from southern Kansas to meet just north of Cherokee, Oklahoma before flowing into Salt Plains Reservoir. Below the reservoir the river is called the Salt Fork of the Arkansas and it enters the Arkansas River about 112 km east of Grand Salt Plains Reservoir.

The Salt Fork has a total drainage area of 17,518 km^2, 6451 km^2 of which are in Oklahoma. The stream gradient is gentle and because there is no resistant rock to constrict the valleys, a broad flat floodplain has developed along the Salt Fork (Gray and Galloway 1969). The Salt Fork has a braided channel interspersed with numerous sand bars and sand flats.

The Great Salt Plains Reservoir is located 12 km east of Cherokee, Oklahoma. It was created as a flood storage reservoir in 1941 and contains 3,600 ha contained by 25.4 km of shoreline. The dam is located at the east end of the Great Salt Plains, which is a 103-km^2 basin of alluvial sand saturated with salt water having a surface salt incrustation formed by evaporation. References to this salt source are found in many documents because it was a common source of meat preservative used by Indians, white settlers, and travelers (OWRB 1972).

The Salt Plains National Wildlife Refuge is located in the intensive study area. It originally contained 7,800 ha and was one of

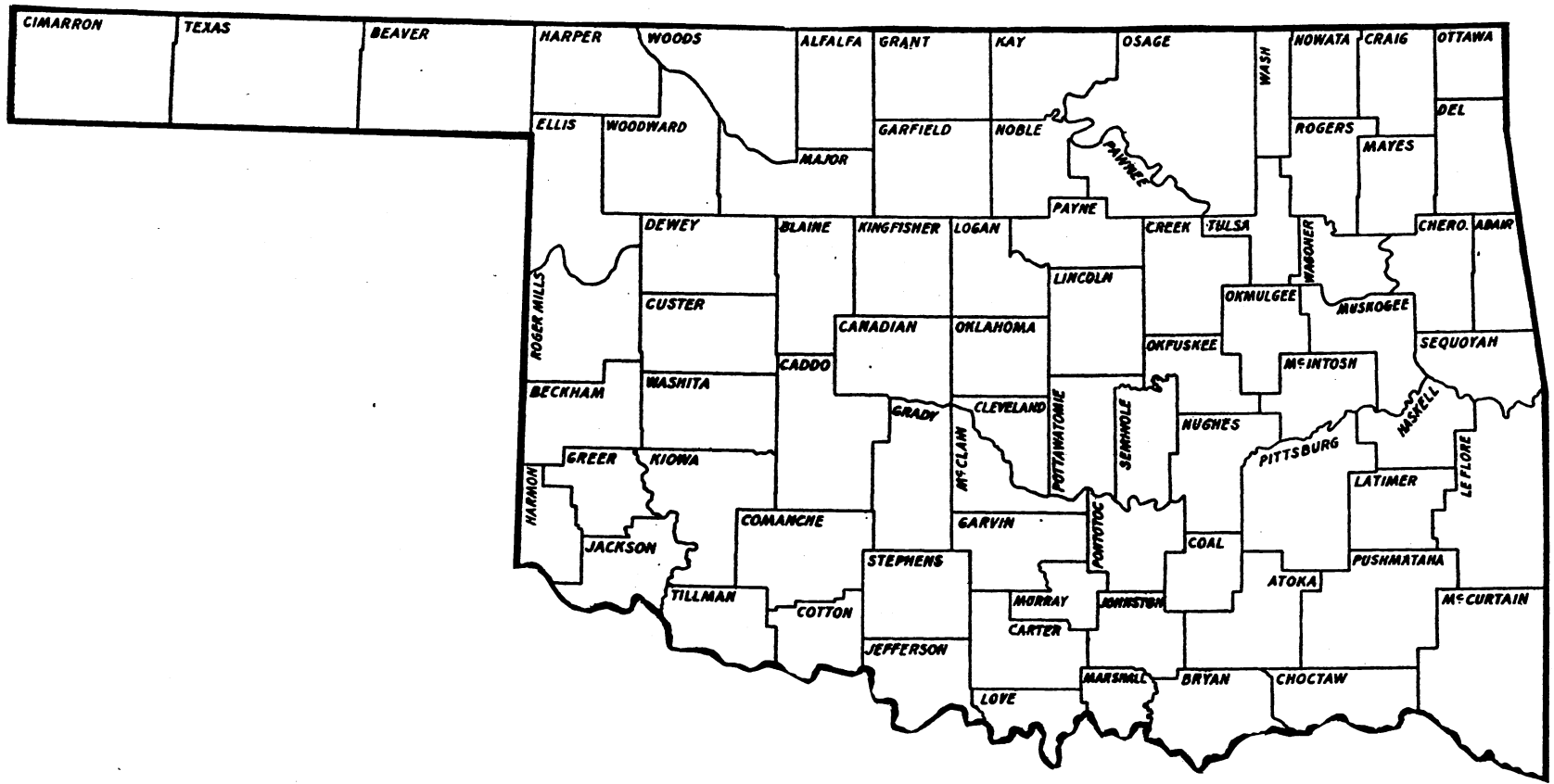


Figure 2. County Map of Oklahoma

the first refuges established under the Migratory Bird Conservation Act. In 1941 when the U. S. Army Corps of Engineers constructed Salt Plains Reservoir the area was enlarged to 13,122 ha. The refuge contains 4,453 ha of saline flats (wetland type 9) and 243 ha of saline marsh (U. S. FWS 1955), 3,600 ha of reservoir, 526 ha of cropland, and 3,644 ha of upland woods and brush (Lewis 1974).

The intensive study area encompasses 1,820 km^2 and is located in the Reddish Prairie Resource Area delineated by the Soil Conservation Service (Gray and Galloway 1969). This is an area of smooth lands that gets its name from the red sedimentary rocks in the area. The topography is relatively flat. Steep areas occur only along the Salt Fork and its tributaries. Elevations vary from 335 to 427 m above sea level. Aeolian deposits of duny sands and silts occur along the north side of the Salt Fork. These dunes are 2 to 20 m high and have resulted from the predominately south wind blowing sand out of the channel and depositing it adjacent to the river on the north side. Local relief is seldom extreme and averages only 30 m.

The soils in this area are chiefly members of the Reddish Prairie (Southern Brunizen) Great Soil Group (Gray and Galloway 1969). The surface soil is loamy and 20 to 30 cm deep. Thin loess layers cover many of the level areas, particularly near the Salt Fork River.

The weather station at Great Salt Plains Dam records an average rainfall of 64.4 cm for the years 1946 to 1970. A maximum of 111.7 cm of precipitation was recorded in 1957. About 20 percent of the annual precipitation occurs during the fall and winter months (September to February) of the growing season. Average winter temperatures vary from

-1 c to 4 c (Kincer 1928) and snowfall averages 25.4 cm to 50.8 cm. Duration of snow cover is usually limited to a few days.

The natural vegetation type in the area is predominately mixed grass. However, species composition has changed because of overgrazing, burning, erosion and cultivation.

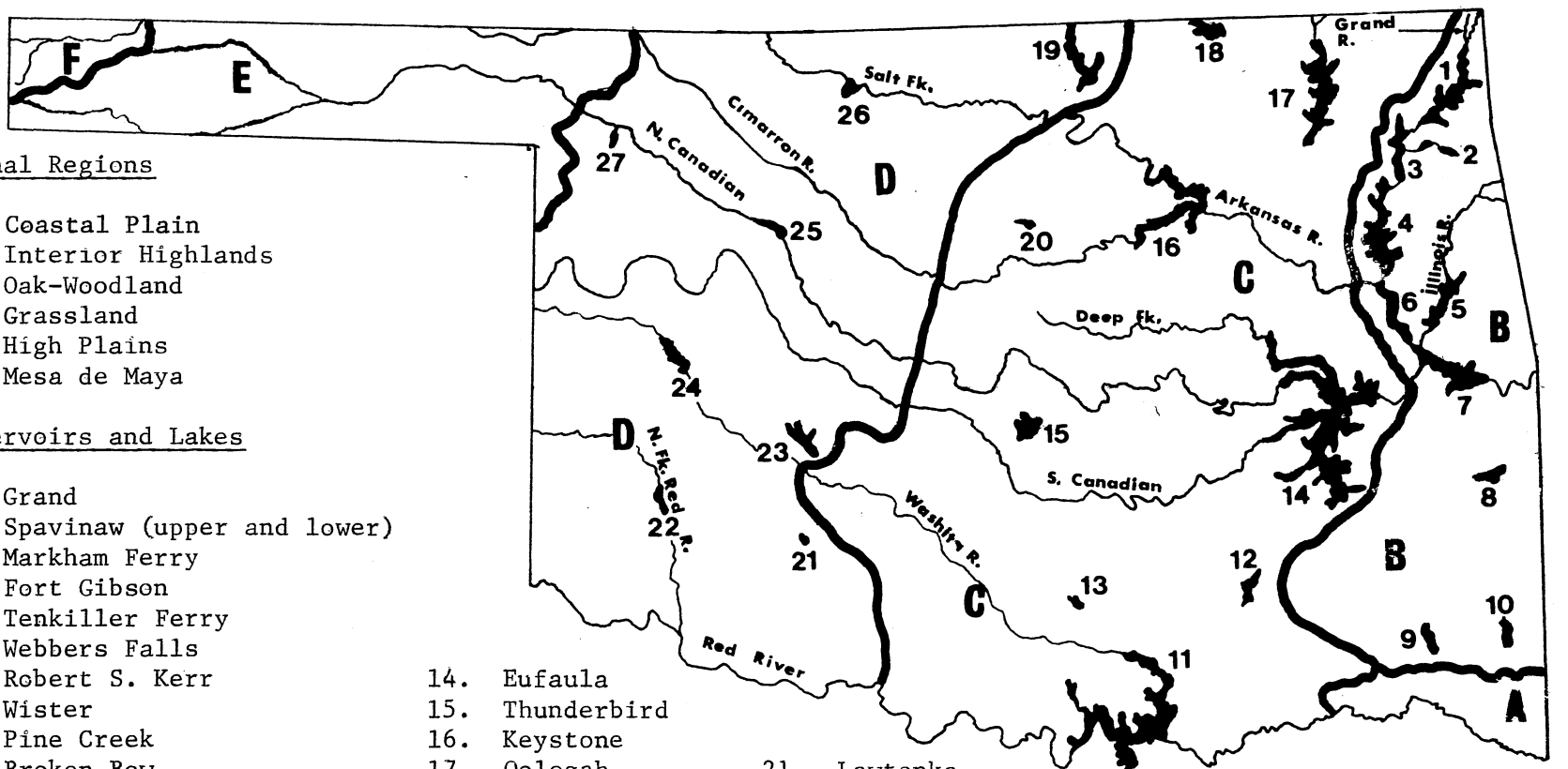
Four game habitat types (Duck and Fletcher 1944) occur within the intensive study area; they are tall grass (70%), mixed grass (20%), sand sage grassland (10%), and bottomland (10%).

The bottomland types were used most often by bald eagles; they are found along the margins of the Great Salt Plains Reservoir and the Salt Fork River and its tributaries. Dominant woody vegetation includes cottonwood (Populus deltoides), American elm (Ulmus americana), willow (Salix sp.), hackberry (Celtus occidentalis), and salt cedar (Tamarix gallica). Cottonwoods and osage orange (Maclura pomifera) were planted in large numbers around houses and field margins by early settlers and are common on all habitat types.

With the exception of the Salt Plains NWR the entire area is devoted almost exclusively to farming and ranching. Some of Oklahoma's most productive croplands occur in this area.

Secondary Study Areas

Field investigations were conducted at the major reservoirs throughout the state (Figure 3). The floral and faunal assemblages of the various biotic districts of Oklahoma are discussed in some detail by Snider (1917) and illustrated by Duck and Fletcher (1943). The dominant floral components of these biotic districts are summarized by Webb (1970).



Faunal Regions

A. Coastal Plain
B. Interior Highlands
C. Oak-Woodland
D. Grassland
E. High Plains
F. Mesa de Maya

Reservoirs and Lakes

1. Grand
2. Spavinaw (upper and lower)
3. Markham Ferry
4. Fort Gibson
5. Tenkiller Ferry
6. Webbers Falls
7. Robert S. Kerr
8. Wister
9. Pine Creek
10. Broken Bow
11. Texhoma
12. Atoka
13. Arbuckle
14. Eufaula
15. Thunderbird
16. Keystone
17. Oologah
18. Hulah
19. Kaw
20. Carl Blackwell
21. Lawtonka
22. Altus
23. Fort Cobb
24. Joe Foss
25. Canton
26. Salt Plains
27. Fort Supply

Figure 3. Major Reservoirs and Faunal Regions in Oklahoma

Lake of the Cherokees (Grand Lake), Markham Ferry Reservoir, Upper and Lower Spavinaw Reservoirs, Fort Gibson Reservoir, Tenkiller Ferry Reservoir, and Robert S. Kerr Reservoir all have notable populations of bald eagles and occur in the Interior Highlands Faunal Region. This is the most wooded and mountainous region and includes parts of the Ozark Plateau in the north and the Ouachita Mountains in the south. The two regions are separated by the Arkansas River Valley.

Most of the trees are deciduous, but shortleaf pine (Pinus echinata) is common in the Ouachita Mountains. The dominant trees are post oak (Quercus stellata), black jack oak (Quercus marilandica), black oak (Quercus velutina), black hickory (Carya texana), and in the south, shortleaf pine (Rice and Penfound 1959). Annual precipitation in the Interior Highlands averages 82.5 to 110 cm, according to Thornwaite (1948) the area is dry and subhumid.

Hulah Lake, Oologah Reservoir, Keystone Reservoir, Lake Carl Blackwell, Eufaula Reservoir, Lake Draper, Lake Arbuckle, Atoka Reservoir, Lake Murray, and Lake Texhoma, are located in the Oak-Hickory Woodland faunal district. Eufaula, Keystone, Hulah, and Oologah have notable populations of bald eagles.

The western limit of this region is a rather arbitrary line bordering the grasslands on the west and extending southwesterly from Osage County to Jefferson County (Webb 1970).

The flat-to-gentle rolling topography in this region has undergone differential erosion and is interrupted by numerous escarpments and outcrops. Average annual precipitation in this area is from 75 to 95 cm, which can be classified as semi-arid (Thornwaite 1969).

Canton Lake, Lake Altus, Lake Lawtonka, Fort Cobb Reservoir, Joe Foss Reservoir, and Fort Supply Reservoir, are of minor importance to wintering eagles. These reservoirs are located in the Grassland Faunal District. The topography is flat to gently rolling plains, developed on Permian Redbeds. The vegetation consists of mixed grasses, which are transitional between the tall grasses on the east and the shortgrass plains on the west. Post oak and blackjack oak grow on scattered outcrops of sandstone.

The Wichita Mountains are the most divergent physiographic feature of the Grasslands. The uplift formed in early Pennsylvanian times consists of a Pre-Cambrian, crystaline, igneous core surrounded by outcrops of sediments, mainly limestone and sandstone. The summits of the surrounding peaks may rise 112 m above the mixedgrass plains. The streams in the Wichita Mountains are relatively clear and cool, and some have been dammed to form lakes. The Wichita Mountains NWR is a main wintering area for both bald and golden eagles. The refuge covers 23,903 ha. Annual precipitation for the grasslands averages 55 to 85 cm and ranges from semi-arid in the west to dry subhumid in the eastern portions (Thornwaite 1948).

The Beaver River (North Canadian) winters notable populations of bald and golden eagles, and is located in the High Plains Faunal Region. This region includes the Oklahoma Panhandle. The elevation is higher than in the mixedgrass prairie. The High Plains are relatively flat, have short grasses, and in sandy areas contain much sand sage brush (Artemisia filifolia) and some tall grasses. Average annual rainfall is from 45 to 55 cm and is semiarid (Gray and Galloway 1969).

The Black Mesa area in northwest Cimarron County is the principal nesting area for golden eagles in Oklahoma. It is located in the Mesa de Maya Faunal Region (Webb 1970). This region is principally an outlying extension of the Rocky Mountains Foothills and consists of several large mesas. It is the highest topographic feature in the state (1,518 m above mean sea level). The underlying sandstone has been eroded to form many deep, rocky canyons between numerous flat-topped buttes and mesas that are capped with black basaltic lava. The largest butte, known as Black Mesa extends for about 8 km in a east west direction. The vegetation is mostly buffalo and grama grasses, western hackberry (Celtis reticulata), pinon pine (Pinus edulis), rocky mountain cedar (Juniperus monosperma) (Webb 1970). Average annual precipitation varies from 25 to 45 cm.

CHAPTER II

MATERIALS AND METHODS

Areas containing large eagle populations and roost sites were found by using several methods. Memoranda were sent to the Oklahoma Department of Wildlife Conservation, the national wildlife refuges in Oklahoma, and the Law Enforcement and Wildlife Services Divisions of the U. S. Fish and Wildlife Service. These memoranda described the project and solicited information concerning bald eagles in Oklahoma.

A questionnaire was published in the Scissortail, the bulletin of the Oklahoma Ornithological Society because it is read by professional ornithologists and serious bird watchers throughout the state. These questionnaires were designed to be a concise as possible, allowing the reader to respond quickly and easily (Figure 4). Information about the project was thereby disseminated through conservation agencies, sportsmen, farmers, and ranchers. The project also received publicity from articles published in newspapers throughout the state.

A review of the scientific literature was helpful in locating historic roost sites and concentration areas. Chronological records of all bald eagle sightings in Oklahoma recorded since 1878 were provided by George M. Sutton, Professor Emeritus, University of Oklahoma. These data were very helpful in establishing priorities for investigation of various areas.

Dear OOS Member:

We in Oklahoma are very fortunate to winter one of the largest populations of bald eagles in the United States. At the Oklahoma Cooperative Wildlife Research Unit we are currently conducting a study of the ecology of this bird in Oklahoma. It is very important to monitor the population of this species and one of the best methods is to locate roosts and census eagles systematically throughout the winter.

If you know (1) the location of any established winter roosts, (2) areas where large numbers of bald eagles concentrate, or (3) where eagles have nested recently, please fill out the questionnaire and return it to me. This information will be very important for assuring future preservation of this species.

James W. Lish
Oklahoma Coop. Wildlife Research Unit
Oklahoma State University
404 Life Science West
Stillwater, Oklahoma 74074

- -

QUESTIONNAIRE

Name _____ Street _____

City _____ Zip Code _____

LOCATION OF WINTER ROOST: County _____; Direction and distance from nearest town _____ or highway intersection: _____

_____

LOCATION OF BALD EAGLE CONCENTRATION AREAS: County _____;

Direction and distance from nearest town _____ or highway intersection: _____

_____

Do you know of any reports of eagles nesting in the last 5 years in Oklahoma?

Yes: _____ No: _____

If yes, please give location and date of the report: _____

_____

Figure 4. Sample Questionnaire

Areas where eagles concentrated on some of the larger eastern reservoirs were located by using a Cessna Cardinal at altitudes of 30 to 500 m. Roosting areas were found by questioning persons living and working on the lakes and rivers. Fishermen, lake patrol personnel, U. S. Army Corps of Engineer personnel, and cabin owners on lakes and rivers often provided valuable information. In the evening, when eagles flew to roost, the general locations of roosts were determined by watching eagles as they left their feeding areas. After identifying such an area I searched under its potential roost trees for droppings, pellets, and feathers. Usually it would take several observations of eagles flying to roost to locate the specific area.

The following information was recorded at each roost site: species of tree, diameter at breast height (dbh), condition, and height. A Duo-Sight height rangefinder was used to measure the height of roost trees; at some roosts tree height and dbh were estimated. 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 ground cover under these roosts has no apparent effect on bald eagle behavior, consequently, understory vegetation was not surveyed. However, dominant plants growing under these roosts were identified.

I censused bald eagle populations in specific areas by counting the number of eagles using a communal roost. To standardize these counts I used a roost count data sheet (Figure 5).

A method used for census in the intensive study area was to count eagles at predetermined points along the Salt Fork River. Although this

date_____ roost_____ sky conditions_____

temp_____ Wind direction_____ wind speed_____

arrival time_____ observers_____ departure time_____

# of birds	arrival time	direction	age(A,I,U)	remarks

Figure 5. Sample Roost Count Data Sheet

method proved unsatisfactory for assessing the entire population in the area, it was useful for studying eagle activity in relation to weather conditions.

An airplane was used to census eagles on large reservoirs where communal roosting did not occur or where the roost sites were unknown.

Population information was also provided by personnel working at state and federal wildlife refuges throughout the state. Managers at Sequoyah, Optima and Salt Plains NWR and at Cookson Hills State Game Refuge provided useful supplemental information on eagles wintering in these areas.

Populations of eagles in certain areas were estimated on the basis of counts made in previous years and from my own experience in observing eagles in the same area.

All of the census methods described previously were used to make a composite estimate of the number of eagles wintering in Oklahoma during the winter of 1974-1975.

There are conflicting reports as to which subspecies of bald eagle winters in Oklahoma. Sutton (1967) states that most are of the southern race with members of the northern race visiting Oklahoma occasionally; this assumption was based on measurements from two museum specimens. Refuge managers and game rangers that I interviewed during this study believed that the eagles wintering in Oklahoma were of the larger northern race, because of the dates during which the eagles occur in Oklahoma.

One method used to determine the taxonomy of bald eagles was to compare behavior and seasonal population trends of eagles in Oklahoma with the peak nesting activities of the southern bald eagles in other

states. Questionnnaires were sent to National Wildlife Refuges, Game Management Areas, and State Conservation Agencies in the nesting range of the southern bald eagle. Respondents were asked about the nesting of southern bald eagles and the dates young eagles leave the nest. A supplemental search of the literature provided some nesting dates for various southern states.

Another method used in identifying subspecies was to band and color mark eagles in Oklahoma in hope of receiving reports of band recoveries or sightings on the nesting ground.

I attempted to trap eagles using: (1) padded steel traps near bait, (2) padded steel traps, bait, and a red-tailed hawk for a decoy, (3) rubber tube snare, (4) Bal-chatri, (5) nylon snares on perches, (6) mist nets, and (7) steel spring powered snares. Early in the study I used No. 1 1/2, single, long-spring steel traps padded with surgical rubber tubing. In the second winter I used No. 4 double-spring steel traps padded with buckskin and electrical tape. The rubber tube snare consisted of a nylon snare powered by a length of surgical rubber tubing. This snare was modified from a type used by John Snelling, ornithologist at the Oklahoma City Zoo, to capture vultures in Africa. I used a Bal-chatri baited with a rock dove (Columba livia) placed near eagle feeding areas. Nooses were constructed from 36 kg test monofilament fishing line attached to a 12.7 x 30.4 cm piece of 1.2-cm mesh hardware cloth. These were placed on favorite bald eagle perches.

Mist nets were placed in trees in flight pathways into roosts. To reduce disturbance in roosts, this method was not used near large roosts, but was used at small peripheral roosts where only one or two eagles roosted.

Patagial markers and experimental back and breast markers, constructed of light-gauge Herculite plastic, were placed on captive golden eagles in the Oklahoma City Zoo to study visibility of the tags and the eagles' reaction to them.

Wild bald eagles were to be marked with 10 x 15 cm wing markers of any color with numerals or symbols painted on them. The marker was to be looped around the wing butt and stapled to itself rather than attached to the patagium of the eagle.

The Office of Migratory Bird Management in Laurel, Maryland provided to me a printout of all reports of banded bald eagles recovered prior to May 1974. These data were analyzed to determine the probable nesting areas of eagles wintering in Oklahoma and adjacent states.

Measurements were taken of live eagles and museum specimens collected in Oklahoma. Memoranda were sent to state and federal wildlife agencies in Oklahoma soliciting reports of any eagles found dead or injured in order that measurements might be made of these birds. Standard ornithological measurements described by Pettingill (1970) were taken. These included wing, total length, tail, beak, and tarsus. Measurements of eagles should not be used as the sole means for determining subspecies. Factors such as sexual dimorphism, method of measurement, and differences in measurements taken by different individuals can influence the validity of the results. However, the taxonomic measurements are useful when used in conjunction with other methods of determining subspecies.

Questionnaires were sent to museums throughout the United States to locate specimens of bald eagles collected in Oklahoma. In an effort

to standardize the measuring technique, instructions for taking measurements were included in the letters to museums.

Methods used to study food habits were: collecting pellets from beneath roosts, collecting prey remains from beneath feeding perches, making field observations of eagles feeding and hunting, and collecting pellets and prey remains at nests of golden eagles.

Pellets were enalyzed using methods described by Errington (1932). Avian prey items in the pellets were identified by comparing them with bird specimens from the Oklahoma State University Museum. Mammalian remains were identified using a hair key (Stains 1958) and by comparing them with slides of guard hairs from various Oklahoma mammals. Feeding eagles were observed by using binoculars or a spotting slope.

Reports of possible nesting by bald eagles in Oklahoma were received from Federal Game Management Agents, employees of the Oklahoma Department of Wildlife Conservation, other state employees, and ranchers. We used aerial and ground surveys to search in areas where evidence of nesting was reported.

A ground search for golden eagle nesting in Cimarron County was conducted from 23 to 25 May and from 5 to 8 June 1974, and 15 to 17 May 1975. Nests were located by driving along the Cimarron River and nearby canyons and scanning the cliffs with a spotting scope. Active nests can easily be seen from distances up to 1.6 km because below the nest there is excremental whitewash that contrasts with the brown sandstone cliffs. Access to the nests was gained by rappelling. The location of each of these nests was recorded along with dimensions of the nest ledge or cavity, size of nest, food remains at the nest,

cliff height, height of nest, type of rock, the direction the cliff faces, and the estimated age of the eaglets.

I attempted to equip eagles with transmitters to monitor local movements. I potted Wildlife Materials Corporation AVM SB-2 transmitters and batteries in plastic resin and attached them with epoxy to a back-pack type of harness designed by Southern (1964).

The fifth objective of this study was to evaluate the effect of the U. S. Army Corps of Engineers Arkansas-Red River Chloride Control Project on the eagles wintering along the Salt Fork River, This was accomplished by interviewing the managers of Salt Plains NWR, state game rangers, personnel of the Reservoir Research Center at Oklahoma State University, and fisheries personnel at Oklahoma State University; by studying Corps of Engineers impact statements about the project; and by studying eagles wintering in the area. The final judgement of the project's impact was my subjective opinion.

The source used for nomenclature of plants in this report is Waterfall (1966).

CHAPTER III

RESULTS AND DISCUSSION

Population Estimates

Previous statewide population estimates by Sprunt (1962) were derived completely from aerial surveys and showed a population of only 232 bald eagles wintering in Oklahoma. The current population estimate (Table I) was based on the aerial and ground surveys, the date of the surveys in relation to the date when the population of wintering eagles reaches a peak, and sightings of eagles or signs left by eagles not censused during the surveys. For example, the maximum number of eagles observed at Grand Lake this winter was 10. Grand Lake has 2252 km of shoreline and covers 17415 ha and I was unable to survey adequately 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. Chronological records provided by George M. Sutton of the University of Oklahoma show that bald eagles have been sighted on almost every reservoir in Oklahoma. The populations of eagles on small reservoirs and the river courses between them that were not censused are listed as "other areas." The estimates for this category are probably not as accurate as the other estimates, therefore, I estimated very conservatively. A figure of 550 to 600 eagles is a minimum population estimate.

TABLE I

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
Other areas:			
(Fort Cobb, Lake Chickasaw, Lake Arbuckle, Pine Creek Reservoir, Ft. Supply Reservoir, Lake Wister,			

TABLE I (Continued)

Location	Actual Counts	Dates	Estimated Population
Other areas (continued):			
Optima Reservoir, Atoka Reservoir, Lake Thunderbird, Lake Hefner, Cimarron River, Neosho River, North Canadian River, South Canadian River)	0		50
Totals	355		565

Habitat Use in Main Concentration Areas

In Oklahoma bald eagles concentrate on the largest rivers and reservoirs in winter. Eagles are seldom observed far from a large body of water. Ninety-six percent of the bald eagles that I sighted during this study were within 1 km of a river or reservoir. The Osage and Texas County areas are exceptions that will be discussed later.

Where large numbers of eagles are found at reservoirs they generally concentrate below the dam and in the areas where the rivers flow into the reservoirs. Eagles probably concentrate below the dams because of the availability of food in these areas. When the turbines are generating power, fish are pulled through, killed, and released into the river below the dam, becoming available as food for eagles. The areas where rivers flow into the reservoirs are generally more productive than the main body of the reservoir. Waterfowl, particularly common mergansers (Mergus merganser) and diving ducks (Aythyinae), concentrate

in these areas. Fish such as carp (Cyprinus carpio) and gizzard shad (Dorosoma cepedianum) are also numerous in the shallow waters. These areas are relatively flat and subject to flooding, particularly in the spring. This has inhibited commercial lakeside development. Consequently, human disturbance in these areas has been kept to a minimum. Commercial lakeside development on the shores of the main body of most Oklahoma reservoirs is another factor that inhibits heavy use in these areas by bald eagles.

Although human disturbance is an important factor inhibiting eagle use in most areas, under certain situations, other factors may compensate for the disturbance. For example, below the dam on Grand Lake and on Keystone, Fort Gibson, and Salt Plains Reservoir, there are areas where human population density is high. The abundance of food for eagles in these areas probably compensates for the human disturbance. Eagles using these areas have adapted to human activities and are generally more tolerant of people than eagles in other areas. Where habitat is favorable, eagles may concentrate in areas other than the mouths of rivers and below the dam.

The Intensive Study Area

The Salt Plains area is the primary wintering area for bald eagles in Oklahoma (Table I). Golden eagles are also common. The main factor causing eagles to use this area intensively is probably food supply. Waterfowl concentrate in this area in large numbers during the winter. In the winter of 1973-74, canada goose (Branta canadensis) populations in this area peaked at over 32,000 and mallard ducks peaked at over 22,000. Jet, Oklahoma, is known as the "goose hunting capital" of

Oklahoma. Heavy hunting pressure along the Salt Fork River and areas adjacent to the Salt Plains NWR result in large numbers of crippled geese available as prey for eagles during the hunting season. Large die-offs of gizzard shad along the Salt Fork in early winter also contribute to the food supply. As the water in the Salt Fork River gradually becomes cooler in the late fall, thousands of gizzard shad ranging in size from 10 to 25 cm die and float to the surface of the water where they are available to bald eagles. During the fall large concentrations of eagles hunt for shad on sandbars along the Salt Fork River.

Another factor contributing to the large concentration of bald eagles in the intensive study area is probably the protection they receive from the Salt Plains NWR, law enforcement personnel, and landowners along the Salt Fork. Unlike some areas in the United States, such as western Texas (Spofford 1964), landowners' attitudes towards eagles in this area are highly favorable. All of the landowners that I interviewed during this study had a very positive attitude toward eagles. Landowners along the Salt Fork River who have a large communal bald eagle roost on their land protect them and keep disturbance of these areas at a minimum. This has allowed five large communal roosts to build up in this area. State game rangers in Grant and Alfalfa Counties are aware of the concentration of wintering eagles there, and accept a high responsibility for their protection. Bud Hammons, State Game Ranger in Alfalfa County, maintains a close watch on the largest eagle roost in Oklahoma. While studying eagles at this roost it was very difficult to ever enter the roost without Mr. Hammons being aware of my activity.

Land use in this area does not conflict with the feeding habits of eagles. Most land use operations involve cattle grazing, wheat farming, and mining of petroleum. Sheep farming is not a major land use. All of these land uses contribute to the large concentration of bald eagles in this area.

The area of heaviest use by eagles at the Salt Plains NWR (Figure 6) is the northeast shore of the reservoir. Eagles were seen consistently along the sandstone bluffs below the spillway. The most heavily used area on the Salt Fork River is between Hixon Bridge and Red Rock Hill Bridge. Eagles sometimes perched near waterfowl feeding areas as much as 3 km from the river. Bald eagles were never sighted at long distances from the river when waterfowl were not present.

Eagles perched primarily on both live and dead cottonwood trees and on sandstone bluffs along the river. When the reservoir was completely frozen, eagles sat on the ice rather than the trees. When eagles were perched around waterfowl concentration areas they used almost any perch that provided good visibility, such as trees from 5 to 50 m in height, fence posts, and knolls in wheat fields. I never saw bald eagles perched on power poles in this area.

Grand Lake

Both this area and Eufaula Reservoir have approximately 50 wintering bald eagles (Table I). Most eagles concentrated at the upper end of Grand Lake near the confluence of the Neosho River and Sycamore Creek, and at the mouth of Spring River. The area includes 38 km^2 of mud flats and shallow water where eagles commonly perched in dead trees, and on

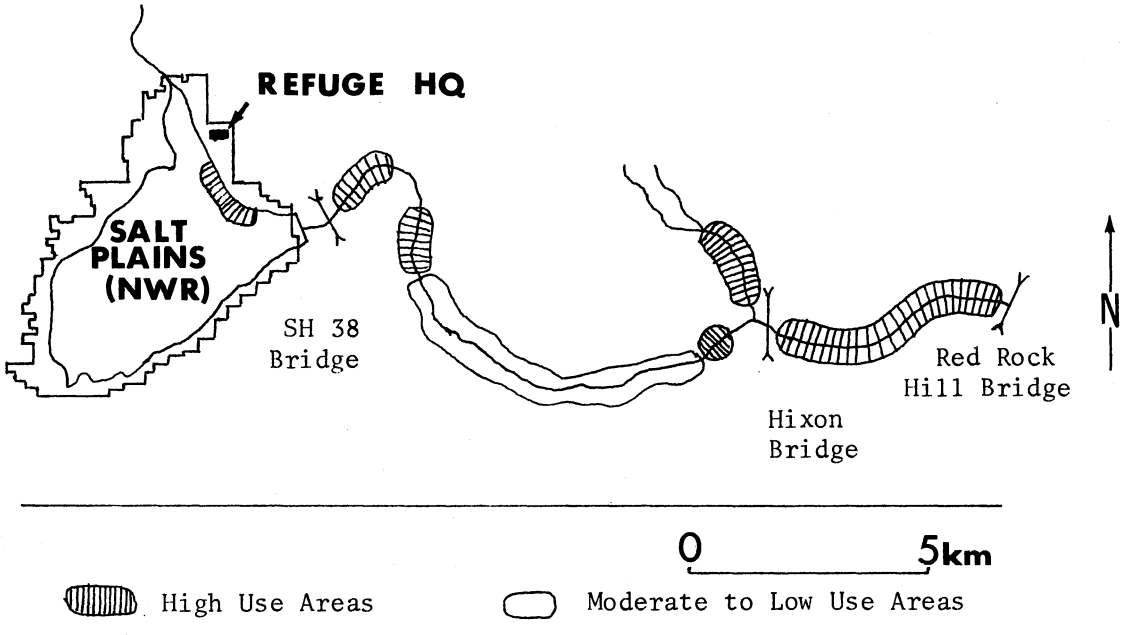


Figure 6. Eagle Concentration Areas and Their Intensity of Use on the Salt Fork River, Oklahoma

steep bluffs near the waters' edge. Thirty-three percent of the eagles in this area perched in live trees, white oak (Quercus alba) and northern red oak (Quercus borealis), near the water's edge and 4 percent were sitting on mudflats or dead stumps in the river. Eagles were never observed more than 0.05 km from the river.

Hundreds of wintering waterfowl, mostly common mergansers and coots (Fulica americana) used the shallow water and mud flats for feeding and loafing (Lish 1973). These waterfowl probably attracted eagles to the area. Human disturbance can be considered minimal. Fishing was the main activity that disturbed eagles in this area. Several lakeshore cabins are present, but they are seldom used in the winter. Historically a large roost containing up to 183 eagles existed on Grand Lake (Cooksey 1962). I found only one small roost containing seven eagles during this study.

Another important concentration area on Grand Lake is 13 km southeast of Fairland, Oklahoma, near Gray's Ranch Resort where eagles occurred consistently.

The area just below the dam is also used by eagles. Eagles perched in large sycamore (Platanus occidentalis) trees just below the western spillway. Eagles frequently sat in large white oaks on steep bluffs approximately 50 m high, 0.05 km south of the eastern spillway.

Eufaula Reservoir

Eagles used two general areas of Eufaula Reservoir: from the dam to approximately 2 km downstream, and among inundated cottonwoods and sycamores where the Deep Fork, North Canadian, and South Canadian Rivers flow into the Reservoir. Most of Eufaula Reservoir is highly

developed for cabins and lakeside homes. However, due to its size, Eufaula is a major wintering area for bald eagles. The only location on Eufaula at which I consistently observed eagles is where I-40 parallels the north end of the lake, approximately 3 km southeast of Hoffman, Oklahoma. This area includes about 2 km^2 of shallow water and inundated cottonwoods. I was unable to locate a roost on Eufaula.

Fort Gibson Reservoir

Most bald eagles on Fort Gibson Reservoir were present directly below the dam. Eagles frequently perched in large sycamore trees adjacent to State Highway 80 and commonly soared over or sat in trees along the wooded bluffs on the west side of Grand River below the dam. Eagles also used the Fort Gibson Migratory Waterfowl Refuge southwest of Wagoner, Oklahoma. One small roost was found in the Fort Gibson area during this study.

Tenkiller Reservoir and Cookson Hills State Game Refuge

My observations and observations made by Jim Gleckler, a forestry student involved in the project, indicate that the majority of bald eagles in the Tenkiller area use the Cookson Hills State Game Refuge located 9.6 km west of the lake. Bald eagles probably roost on the refuge and fly the lake to hunt. The only area of the lake where they consistently occurred was near a campground known as Carter's Landing. This is an area of shallow water and mud flats near the north end of the lake. Eagles perched in trees or soared over the hills on the east side of the Illinois River at Carter's Landing.

Texas County

Evidence collected during this study by James C. Lewis, and Phil Norton, Manger of the Optima NWR, indicates that Texas County is probably a major wintering area for both bald and golden eagles. Two large communal roosts were discovered in this area. Bald eagles in Texas County concentrate along the Beaver River. Golden eagles roost near the river and probably disperse throughout the area during the day. This concentration area was located late in the study, and only cursory observations have been made there.

Osage County

Eagles wintering in Osage County represent an atypical situation. They fed and roosted far from any large rivers or impoundments. The area is primarily tallgrass prairie devoted to grazing. I often saw bald eagles from Grainola north to the Kansas border, 58 percent were perched in cottonwoods and 39 percent on fence posts or on the ground. Eagles frequently fed on cattle carcasses near feed lots or in range land. I made only one trip to Hulah Reservoir in Osage County and noted two immature bald eagles frequenting the west side. Due to the size of Hulah Reservoir and because of human activity in the area, I believe that the number of eagles there is small. Two main factors contribute to heavy utilization of the prairie north of Grainola by bald eagles. Eagles are probably attracted to the cattle carcasses that are common over the area during the winter. The second factor is the light activity by people. Many large tracts of land in Osage County are not divided by county roads. Also, landowners in Osage County usually

own larger tracts of land than do landowners farther east. I observed at least two golden eagles wintering in Osage County.

Wichita Mountains NWR

The Wichita Mountains NWR is an important wintering area for both bald and golden eagles. Most of the eagles roost and feed in Pinchot Pasture, an area closed to public use. Pinchot Pasture is probably attractive to eagles because human activity is limited. The bald eagles frequent the many small lakes on the refuge. Golden eagles perch on the higher summits, and hunt over the entire area.

Keystone Reservoir

Eagles concentrated from the dam to approximately 1 km downstream, and in flooded timber on the Arkansas River just north of Cleveland. Eagles infrequently perched in trees just downstream from the dam. However, due to intensive use by humans in this area, eagles occurred more frequently farther downstream. Ninety-one percent of the activity by bald eagles was observed below the dam. At the mouth of the Arkansas River eagles frequently perched in inundated cottonwoods in the river channel.

Sequoyah NWR and Robert S. Kerr Reservior

Most of the bald eagles wintering on Robert S. Kerr Reservoir stay on the Sequoyah NWR (personal communication, refuge personnel). One large communal roost and one smaller roost are on the refuge. Eagles are probably attracted by the large concentrations of waterfowl wintering there, and by the protection the refuge provides. Only cursory

observations were made at Robert S. Kerr Reservoir during this study.

Other Concentration Areas in Oklahoma

Areas in Oklahoma that consistently contain small populations of bald eagles include: Upper and Lower Spavinaw Lakes, Oologah Reservoir, Tishomingo NWR, and Broken Bow Reservoir. Areas where bald eagles are infrequently sighted 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, Markahm Ferry Reservoir, and Lake Hefner.

Eagles stay infrequently along the major rivers, notably Cimarron River, Neosho River, and the North and South Canadian Rivers.

Communal Roost Sites in Oklahoma

The Intensive Study Area

Bald eagles in large communal roosts are highly vulnerable to human disturbance; consequently, to protect them, specific roost locations will not be described in this thesis. Roost sites in the intensive study area will be designated alphabetically and only general locations will be reported.

There are five large communal roosts in the intensive study area. Roost A (Figure 7) northwest of Pond Creek, Oklahoma, is the largest in the state with respect to the number of eagles using it. Roost B is approximately 0.05 km west of Roost A. Roost C is located north of Nash, Oklahoma. Roost D is located on the Salt Plains NWR, and Roost E is located south of Pond Creek, Oklahoma.

Figure 7. Roost A Viewed as the Observer Faces Northeast

Roosts C and D were discovered after the intensive vegetation studies were conducted (Table II). Only preliminary observations of vegetation have been made at these roosts. The eastern cottonwood is the dominant tree at all roosts. No seedling cottonwoods grow beneath any of these roosts. The condition of Roost B could be termed as critical because 80 percent of the trees are dying. These important roost trees will not be replaced by new cottonwoods; it seems likely, therefore, that eagles roosting in these trees will have to shift to a new roost site within the next 50 yr. The cottonwood trees in Roosts A and B are in excellent condition, less than 8 percent of the trees are dying.

TABLE II

ROOST TREE MEASUREMENTS AND CONDITION OF TREES AT THREE BALD EAGLE ROOSTS ON THE SALT FORK RIVER, OKLAHOMA

Roost	Average Diameter (cm)	Average Height (m)	Percentage of Trees		
			Live	Dead	Dying
A	76.2	19.1	84	12	4
B	73.6	16.9	0	20	80
C	106.6	21.5	92	0	8

At Roost A smaller trees such as chittam wood (Bumelia lanuginosa), catalpa (Catalpa bignonioides), osage orange, and hackberry are prevalent in the understory. At Roost C, mulberry (Morus rubra), hackberry,

and sand plum make up most of the understory. No small trees of any species occur under Roost B.

Dominant species making up the ground cover in all three roosts consist of big and little bluestem, Indian grass, and western ragweed (Ambrosia psylostachia).

Trees at Roost C are larger than Roosts A and B. Because of the total lack of cottonwood seedlings beneath these roosts, the roosting pattern of bald eagles along the Salt Fork River will probably change drastically within the next 50 yr.

Roosts A and B are each surrounded by 64 ha of cattle pasture in which overgrazing has been avoided through proper cattle management. Roost B is 0.5 km from the Salt Fork River. Numerous sand dunes ranging in height from 3 to 10 m surround Roost A. Roost A is in flat topography 0.5 km from the Salt Fork River.

Roosts A and B are in such close proximity (0.05 km) that they can be considered a composite roost. When eagles are disturbed at Roost A, they frequently fly to Roost B. A single cottonwood tree approximately 500 m east of Roost A was used exclusively by four golden eagles. This tree is 30 m in height and appears to be in very good condition.

These two roosts are located 0.5 km from the nearest county road. Both are under the same ownership. Hunting or trespassing is not permitted by the landowner, and disturbance due to livestock management in winter is minimal. These roosts are not threatened by human disturbance or future land use because of the protection they receive by the landowner and the local game ranger. However, biological factors such as the death of roost trees could affect it.

The original owner of Roosts A and B stated that eagles began roosting in the area about 1920. Before that time, most of the area was climax prairie, and there were very few trees. Apparently, the cottonwoods that settlers were required to plant as part of the settlement under the Homestead Act were attractive to bald eagles.

A maximum of 120 bald eagles used Roosts A and B during the winters of 1973-74 and 1974-75. These are the largest roosts in Oklahoma with respect to the numbers of eagles using them.

Roost C is the third largest roost in the intensive study area. A maximum of 70 eagles roosted here in the winter of 1973-1974. Land use in the 64 ha surrounding this roost is devoted to winter wheat (Triticum aestivum). Human disturbance is minimal. The landowner does not allow hunting or trespassing and his attitude toward eagles is very favorable. Roost C is approximately 0.5 km from the Salt Fork River and 1 km from a state highway. The highway has no apparent effect on the eagles using this roost. The topography is flat. The future of this roost can be considered secure.

In January, 1975 I discovered a roost on the Salt Plains NWR (Roost D). An even age stand of cottonwoods 30 to 40 m in height composes the roost. The roost is adjacent to a small impoundment designed for waterfowl management. At least 36 bald eagles used this roost in the winter of 1974-1975.

Bald eagles roosting on the Salt Plains NWR have changed roost sites at least twice in recent years (Ron Sullivan, personal communication). Eagles originally roosted in cottonwoods adjacent to Sand Creek Bay. When Eagle Roost Nature Trail was constructed the eagles moved approximately 1 km south and roosted in a large dead cottonwood. During

a severe storm this tree was blown over, forcing these eagles to roost elsewhere. The new roost is more isolated from human disturbance than the two previous roosts. The trees in the present roost are healthy. With this in mind I believe that Roost D is secure, and the number of eagles utilizing it could increase within the near future.

Roost E is much smaller than the roosts mentioned previously. On 2 January 1975, 11 bald eagles were present in cottonwoods lining a small tributary of the Salt Fork River 200 m north of a county road. The main roost tree is a dead cottonwood approximately 60 m in height. Topography is flat. Winter wheat fields border the roost on two sides. Human disturbance at this roost is probably higher than at the other roosts. Because of the higher human disturbance in this area, the future of this roost can be termed as unsecure.

Communal Roosts in Texas County

Two large eagle roosts were found in Texas County. On 27 January Berkeley Peterson, an employee of the Wildlife Services Division, U. S. Fish and Wildlife Service, reported seeing 18 bald and five golden eagles in Texas County while hunting coyotes from a helicopter. Further investigation of this area by Phil Norton, Manager of Optima NWR, and James Lewis, resulted in the discovery of the roosts.

Roost 1 consists of a group of 75 large cottonwoods measuring from 20 cm to 1 m in dbh and covering approximately 0.4 ha. All of the trees are about 20 m tall. The two cottonwoods showing the most extensive use by eagles are on the north side of this grove. Both trees are healthy, 10 cm dbh, and 15.2 m tall. On 1 February, Phil Norton visited this roost in the evening and saw one adult and five immature

golden eagles and one adult and three immature bald eagles. On 21 February, James Lewis and Phil Norton observed 3 bald eagles and one unidentified eagle at this roost.

Roost 2 is located 0.5 km west of Roost 1. The trees in this roost are larger and more scattered than those in Roost 1. There are about 30 cottonwoods within a 0.4 ha plot. These trees are of 20 cm to 1 m dbh and are about 20 m tall. Available signs indicate that the birds roost at the east end of this grove. On 21 February James Lewis and Phil Norton saw two golden eagles at this roost. The future of these roosts will probably be secure if drastic changes in land use do not occur. Both roosts are on the property of one man.

Wichita Mountains NWR

Gene Bartnicki, Refuge Biologist, FWS, and I located a communal roost in Pinchot Pasture, an area closed to the public. The main roost trees are blackjack oak (Quercus marilandica) of 45 to 60 cm dbh and 10 to 15 m height. These trees are dead and inundated by a small lake. Whitewash and feathers are extensive beneath the roost, indicating that the roost has been used heavily during the winter. The future of this roost can be considered secure.

Sequoyah NWR

Personnel from Sequoyah NWR in Sequoyah County located a roost that contained 11 bald eagles in February 1975. This roost consists of about 50 inundated cottonwoods. These trees will soon die because of inundation. However, some of these trees may stand for 20 to 40 years as they

have at other lakes in Oklahoma. James Lewis and personnel of the Sequoyah NWR found another roost in the vicinity of the refuge and on 11 February James Lewis and I located the exact roost trees. Two bald eagles used a large sycamore tree for a roost site in a large valley. A third eagle also roosted in the vicinity. The topography is hilly. This roost is now threatened by proposed construction of an extension of the Muskogee Turnpike. Because of the protection provided by the refuge, I believe that the populations of eagles using the area could increase in the future.

Cookson Hills State Game Refuge

On 7 March 1975 I located a communal roost on the Cookson Refuge. Three eagles used a single dead oak (Quercus sp.) 20 m tall and with a dbh of 60 cm. The local topography is hilly. Dominant tree species in the area consist of northern red oak, white oak, sugar maple, and short leaf pine. Ground cover beneath the roost consists mostly of buckbrush (Symphoricarpos orbiculatus) and leaf litter.

This refuge is managed for elk (Cervus canadensis) and white-tailed deer (Odocoileus virginanus) that are common in the area. Human activity in the area is slight. Judging from the amount of whitewash beneath the roost, more eagles than I had observed used this roost site during the winter. Jim Gleckler observed eight eagles leaving the vicinity of this roost in December 1974. Joe Fletcher, Refuge Manager, indicated that approximately 10 eagles wintered on the refuge. The future of this roost can be considered fairly secure.

Grand Lake

A large communal roost containing as many as 183 eagles was found in the Broad Hollow area of Grand Lake as late as 1962 (Cooksey 1962). I spent 30 hr during the winter of 1973-74 and during the current winter searching for this roost. Apparently an extensive housing development project in this area has forced the eagles to roost elsewhere. The eagles abandoned the area shortly after Cooksey (1962) terminated his study (J. C. Johnson, Professor of Zoology at Kansas State College, personal communication). This roost should have been protected from human disturbance. It serves as an example of what could happen to several other roost sites in the state unless adequate protection is provided.

On 20 February 1975 I discovered a communal roost containing seven bald eagles in a valley not far from the old roost area. These eagles used three healthy shortleaf pine (Pinus echinata) ranging in size from 45 to 60 cm dbh and 25 to 30 m tall. Ground cover consists mostly of broomsedge, bluestem (Andropogon virginicus) and pine needle litter. The topography is hilly. The roost is 500 m from a dirt road and 1 km from Grand Lake. Because of the extensive housing development in this area, the future of this roost is precarious.

Osage County

On 5 February 1975 I located a small roost in Osage County used by three bald eagles and one golden eagle. The roost consists of a single dead American elm (Ulmus americana) of 60 cm dbh and 15 m height. Ground cover under the roost consists mainly of little bluestem. The dominant land use is cattle grazing, and the topography is flat. This

roost is 1.5 km from a state highway and 0.5 km from a county road. Disturbance is minimal. This roost seems to be used infrequently by only a few eagles. Its future is probably secure. A larger communal roost exists in Osage County, but only the general roosting area has been determined.

Fort Gibson Reservoir

Ronald Freeman, wildlife ecology graduate student, observed eagles at Fort Gibson Reservoir for several days during Christmas and on other dates during late winter. The data he collected indicate the general area where the roost probably occurs. On 13 February 1975, James Lewis and I located a roost containing a single eagle. The roost tree is a blue ash (Fraxinus quadrangulata) 24 m tall and 45 cm in dbh. This tree is in poor health; several of the main branches are dead. Associated tree species in this hilly area, 2 km from the Illinois River, consist of mockernut hickory (Carya tomentosa), northern red oak, post oak, cottonwood, sycamore, American elm, and eastern red cedar. Ground cover consists of leaf litter. Human activity, principally fishing, is intensive in this area.

Everret Grigsby of Tahlequah, Oklahoma, visited this roost in 1973 when the roost was being heavily used by bald eagles (Everret Grigsby, personal communication). The future of this roost is considered precarious.

Keystone Reservoir

A report of a small communal roost on Keystone Reservoir was received in June 1975, from Richard Romero of the Tulsa, Oklahoma

Audubon Society. This roost was censused only once during the winter 1974-1975. It was occupied by five bald eagles. I have not received the exact location of this roost, therefore, no vegetative characteristics of this roost have been assessed.

Summary of Roost Site Charactersitics

Table III is a summary of characteristics of known roost sites in Oklahoma. The future of 78 percent of the roosts in Oklahoma are secure, 7 percent are unsecure, and 14 percent are precarious. Both roosts with a precarious future are on private land.

Sixty-four percent of these roosts are in private ownership, 28 percent are on Federal land, and 7 percent are owned by the state.

Cottonwood trees are the most important tree species; they are the main tree species in 57 percent of the roosts. In 14 percent of the roosts eagles used oak trees. Sycamore, shortleaf pine, American elm, and blue ash are each the main tree species at one roost.

The condition of roost trees is an important factor to consider in assessing future roost management. Fifty-seven percent of the trees are alive and in good condition, 14 percent are dying, and 28 percent are dead. The average height of trees at roost sites is 20.9 m and average dbh is 66.3 cm. Eagles utilize the larger trees in all of these roosts.

Studies of the behavior of eagles in roosts were conducted in the intensive study area from 11 November 1973 to 8 March 1974. I spent a total of 61 hr observing roosting behavior from a blind near Roost A and 15 hr observing eagles at Roost C. Observations on Roost A were made from a distance of approximately 100 m and observations on Roost C were made from a distance of 300 m.

TABLE III

CHARACTERISTICS OF KNOWN ROOSTS IN OKLAHOMA

Roost Designation	Tree Species	Average dbh (cm)	Average height (m)	Condition	Ownership	Future Status
Salt Fork River, A	cottonwood	76.2 cm	19.1 m	live	private	secure
B	cottonwood	73.6 cm	16.9 m	dying	private	secure
C	cottonwood	106.6 cm	21.5 m	live	private	secure
D	cottonwood	70.0 cm	25.0 m	live	federal	secure
E	cottonwood	80.0 cm	30.0 m	dead	private	unsecure
Texas County, 1	cottonwood	60.0 cm	20.0 m	live	private	secure
2	cottonwood	60.0 cm	20.0 m	live	private	secure
Wichita Mountains NWR	blackjack oak	52.5 cm	12.5 m	dead	federal	secure
Sequoyah NWR, 1	cottonwood	105.0 cm	30.0 m	dead	federal	secure
2	sycamore	85.0 cm	25.0 m	live	federal	secure
Cookson Refuge	oak (Quercus sp.)	60.0 cm	20.0 m	dead	state	secure
Grand Lake	shortleaf pine	52.5 cm	27.5 m	live	private	precarious
Osage County	American elm	60.0 cm	15.0 m	dead	private	secure
Fort Gibson	blue ash	45.0 cm	24.0 m	dying	private	precarious

Behavior of Eagles in Roosts

Eagles perched in different parts of the roost trees in response to varying climatic conditions. On calm days eagles consistently perched in the tops of the main roost trees. On windy days they perched on the lower branches.

Eagles came to roost from various directions. At Roost A eagles approached from the east in 35 percent of the observations, and from the south in 27 percent of the observations. Eagles approached from the north, west, northeast, southeast, and southwest in 6, 8, 10, 11, and 2 percent of the observations, respectively. The Salt Fork River is 0.5 km south of Roost A. Approximately 1 km east of the roost, the river turns northeast for approximately 1 km. This section of the river is a main feeding area of eagles. So it is not surprising that in 62 percent of the observations eagles arrived at the roost from the south and the east.

The Salt Fork River is 1 km east of Roost C and flows generally north and south. In 72 percent of the observations eagles approached this roost from the south and southeast suggesting that they fed in a southerly direction from this roost. Eagles approached the roost from the north, east, west, and southwest in 8, 8, 8, and 4 percent of the observations, respectively.

Within the immediate roost area, eagles consistently approached in a perch site from downwind, usually at an altitude above the roost trees. When approximately 100 to 150 m from the perch they dropped below the altitude of a specific perch limb, then swung up and landed on it.

Figure 8 shows the times at which eagles arrived at Roost A in relation to sunset during the winter 1974-1975. Eagles generally arrived at the roost earlier on clear days than on overcast days. The intensity of eagle arrival generally increased as light intensity decreased.

A few eagles could be observed at any of the large roosts in the intensive study area at any time of the day. I never entered Roost A, B, or C without seeing eagles. However, daytime use of the roost was heavier on overcast days than on clear days, when flying conditions were more favorable.

Bald eagles frequently moved from perch to perch and from Roost A to Roost B just prior to dark. They apparently remain sedentary after dark. On the one occasion I entered the roost after dark, I was unable to detect any movement. I was able to observe the eagles sleeping with their heads under their scapulars.

On 8 and 27 January 1974 eagles began leaving Roost A when the light was very dim and all of them flew towards the Salt Fork River. By sunup most of the eagles had left the roost.

I was unable to identify individual eagles in this study, consequently, it was impossible to determine if eagles consistently used specific roosts. Several times I observed what I believed to be the same individual in Roost A. This bird was an immature eagle with several secondary feathers missing. Eagles using Roost A and Roost B probably used these roosts the entire winter.

The maximum distance at which I observed a bald eagle flying to roost was approximately 2 km. In Utah, Swisher (1964) observed bald eagles flying distances of up to 24-32 km to roost. Eagles wintering in

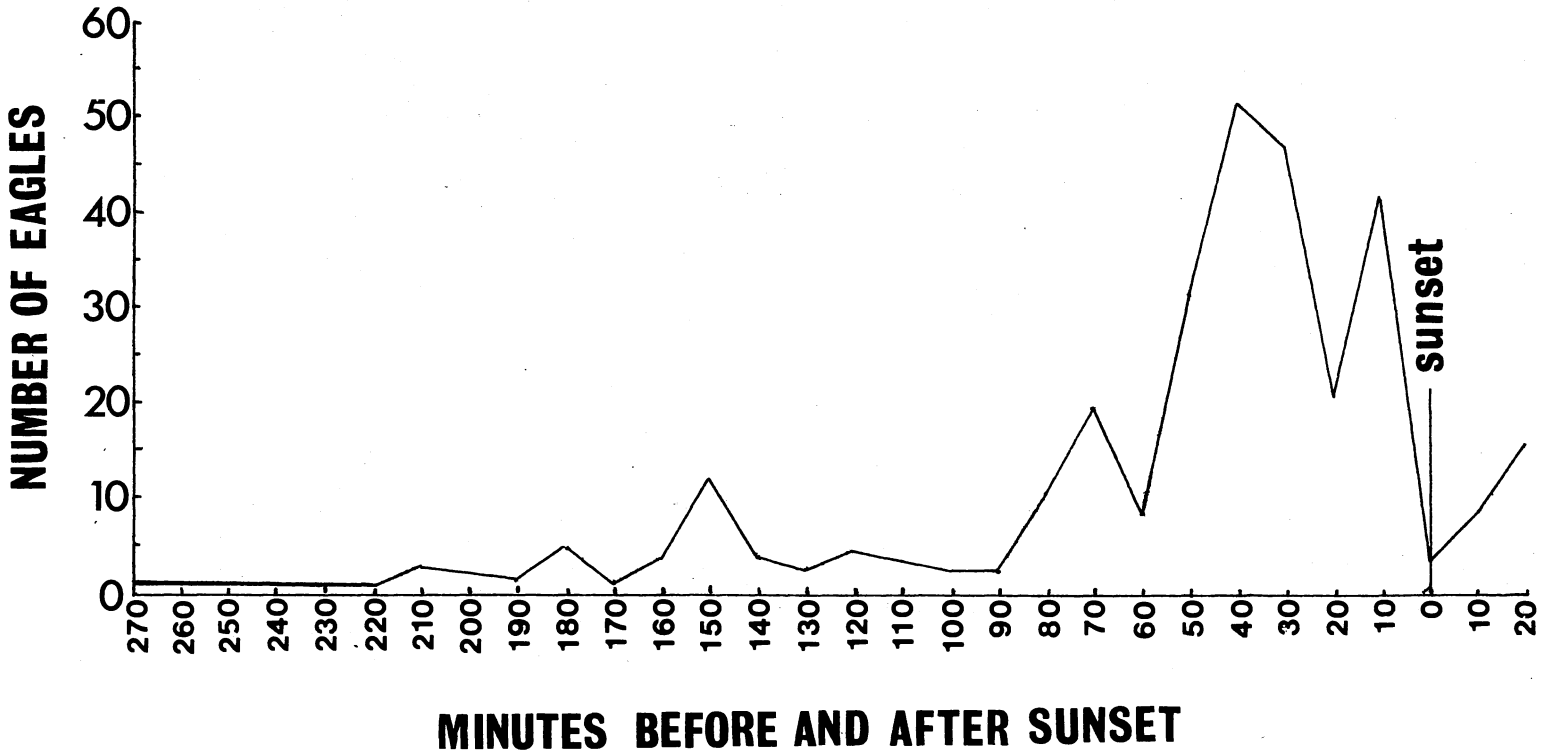


Figure 8. Time of Arrival of Bald Eagles at Roost A in Relation to Sunset

the intensive study area probably fed much closer to the roost than did eagles in Utah, and they seldom flew more than 5 km to feed.

Perch Displacement Behavior

A common behavior observed at roosts was perch displacement. This behavior consists of one eagle landing on a perch site occupied by another eagle causing the roosting bird to fly to another perch. This behavior was difficult to record. Very often, perch displacement by one individual would trigger a displacement by all eagles within the roost. This displacement would sometimes last for several minutes.

I classed perch displacement behavior into categories of: adult displaces adult, adult displaces immature, immature displaces adult, and immature displaces immature. Displacement occurred 47 times (21 percent) during 216 arrivals. Displacement of all the eagles present took place during six arrivals.

An adult displaced an adult in 59 percent of the 47 arrivals that caused displacement, an adult displaced an immature in 22 percent, an immature displaced an adult in only 5 percent, and an immature displaced an immature in 14 percent.

Because adult eagles engaged in perch displacement more than any other age class (80 percent) and because an immature bird displaced an adult in only 4 percent of the observations, perch displacement suggests a social hierarchy exists. Adults generally perched in the favored perch sites as noted previously (Lish 1973).

Vocalization

The sight of an eagle approaching the roost often elicited

vocalizations from eagles already in the roost. As the approaching eagle neared the roost the intensity of vocalizations increased. In the most common posture assumed by eagles during vocalization eagles stood with their bodies horizontal, threw their heads back, and vocalized (Figure 9). This was also the posture most commonly used by eagles just after they arrived at the roost. An eagle that had been on the perch for awhile held its body vertical, threw back its head, and vocalized (Figure 10). Occasionally eagles vocalized in flight when approaching the roost, or when mass displacement occurred.

Vocalization was often associated with displacement. It took place in 70 percent of the displacement activities.

Roost Tree Preference

Eagles showed a definite preference for certain trees within a roost. The preferred tree in Roost A (Figure 11) is dead, and is taller than most trees in the roost. Most displacement activity observed at the roost occurred in this tree. 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 an eagle when landing. Certain trees were preferred over all other trees in each roost in the intensive study area.

Spacing of Eagles in Roost

Spacing refers to the distance between eagles in roost trees. Spacing of eagles within a roost was highly variable. In the preferred roost trees eagles were usually perched closer together than in other trees. Eagles frequently lined upon certain branches in preferred

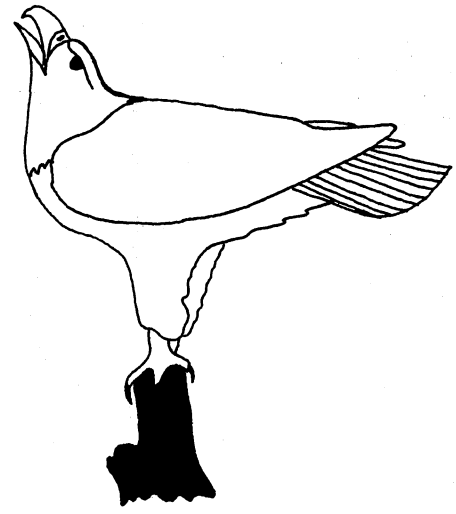


Figure 9. Vocalizing Posture with Body Horizontal

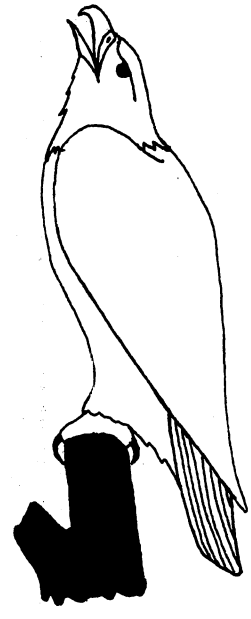


Figure 10. Vocalizing Posture with Body Vertical

Figure 11. Preferred Roost Tree
at Roost A

trees (Figure 12). Spacing distance was hard to determine at the distances from which I observed the roost. Eagles perched in a linear arrangement were usually approximately 50 cm apart. If an eagle moved closer than 50 cm to another eagle, its neighbor sometimes made a threat posture that consisted of raising the feathers on the back of the neck and lowering the head. On several occasions eagles were actually forced off the end of a branch when other eagles came in to perch.

Interactions of Bald and Golden Eagles

Golden eagles using Roost A were observed on four occasions. On three of the occasions the bird involved was an adult.

Bald eagles in the roost became agitated at the presence of the golden and their vocalizations became very intense. Golden eagles displaced both adult and immature bald eagles on 4 occasions. Bald eagles were never observed to displace a golden eagle. Bald eagles reacted in the same manner to both immature and adult golden eagles. A golden eagle roosted overnight at the roost only once. Usually the goldens entered the roost in the evening, stayed only a few minutes, and then flew elsewhere to roost.

Reaction to Observer

Bald eagles utilizing Roosts A and C were seldom alarmed at the presence of an observer. The blind at Roost A was constructed in November 1974 when few eagles were utilizing the roost. When they arrived on their wintering ground the eagles adjusted to the blind and were not disturbed by its presence. I usually entered the blind early in the afternoon before eagles started arriving. If eagles were in the

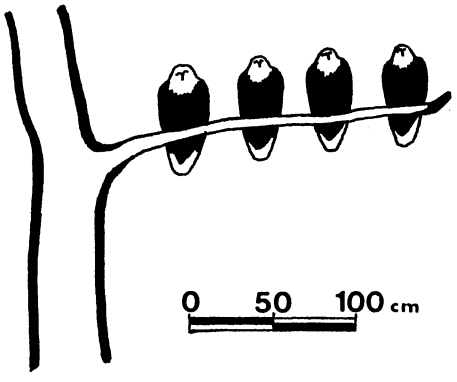


Figure 12. Typical Linear Arrangement of Eagles in Roost Trees

roost when I arrived they usually left the roost and returned after I was inside the blind. Noises and movements in the blind did not appear to disturb the eagles. If I left the blind during daylight when eagles were in the roost they would fly off. However, when I left the blind at dark the eagles were not disturbed.

I occasionally drove a vehicle to a dirt road approximately 30 m west of Roost A to collect pellets in the late mroning when few eagles were present. On several occasions the eagles remained until I left the vehicle.

Interactions of Eagles with Other Animals in the Roost Area

White-tailed deer frequently passed near the roost in the evening. Usually the eagles ignored the deer. However, on one occasion I observed two immature bald eagles diving at a deer. The eagles began by gliding towards the deer and passing approximately 3 m above it. After they had made several passes at the deer the eagles began flying up to a higher altitude and making steep dives at the deer. The eagles' interaction with the deer appeared to be playful rather than one of attack. The deer watched the eagles but did not appear to be alarmed.

An immature bald eagle also chased a fox squirrel (*Sciurus niger*) in the roost trees. It did not appear to be a vigorous attack. The squirrel was very adept at avoiding contact with the eagle. I never saw an adult bald eagle chase other animals in the roost area. Bald eagles showed no reaction to crows (*Corvus brachyrhynchos*), or red-tailed hawks, ferruginous hawks (*Buteo regalis*), marsh hawks, small passerine birds, or livestock near the roost.

Changes in Wintering Populations

Sutton (1967) stated that the bald eagle in Oklahoma is a winter resident seen from 1 October to 25 April. Lish (1973) observed eagles on his study area as early as 17 October and as late as 11 May. Sightings of bald eagles in May in Oklahoma are not common.

In the winters of 1973-1974 and 1974-1975, bald eagles began arriving on the intensive study area in mid November. In 1973 the earliest date on which I observed a bald eagle was 11 November. The numbers of eagles peaked in January and slowly decreased until mid March. Fluctuations in numbers of eagles at Roost A in the winter of 1973-1974 are shown in Figure 13. The large fluctuation in numbers of eagles in January apparently is not due to eagles leaving the intensive study area but rather is a consequence of eagles shifting from Roost A to nearby Roost B. These two roosts were very difficult to census simultaneously.

The trends in numbers of bald eagles wintering at Salt Plains NWR during three consecutive winters (Figure 14) are similar to trends observed elsewhere in Oklahoma (Sutton 1967, Lish 1973).

Food Habits and Hunting Habits of Bald Eagles

Avian parts commonly regurgitated in pellets were: 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: incisors and lower jaw (small rodents), feet, fur, and toe nails. Very few large bones were present. Plant material was probably ingested accidentally when the eagle was feeding on the ground,

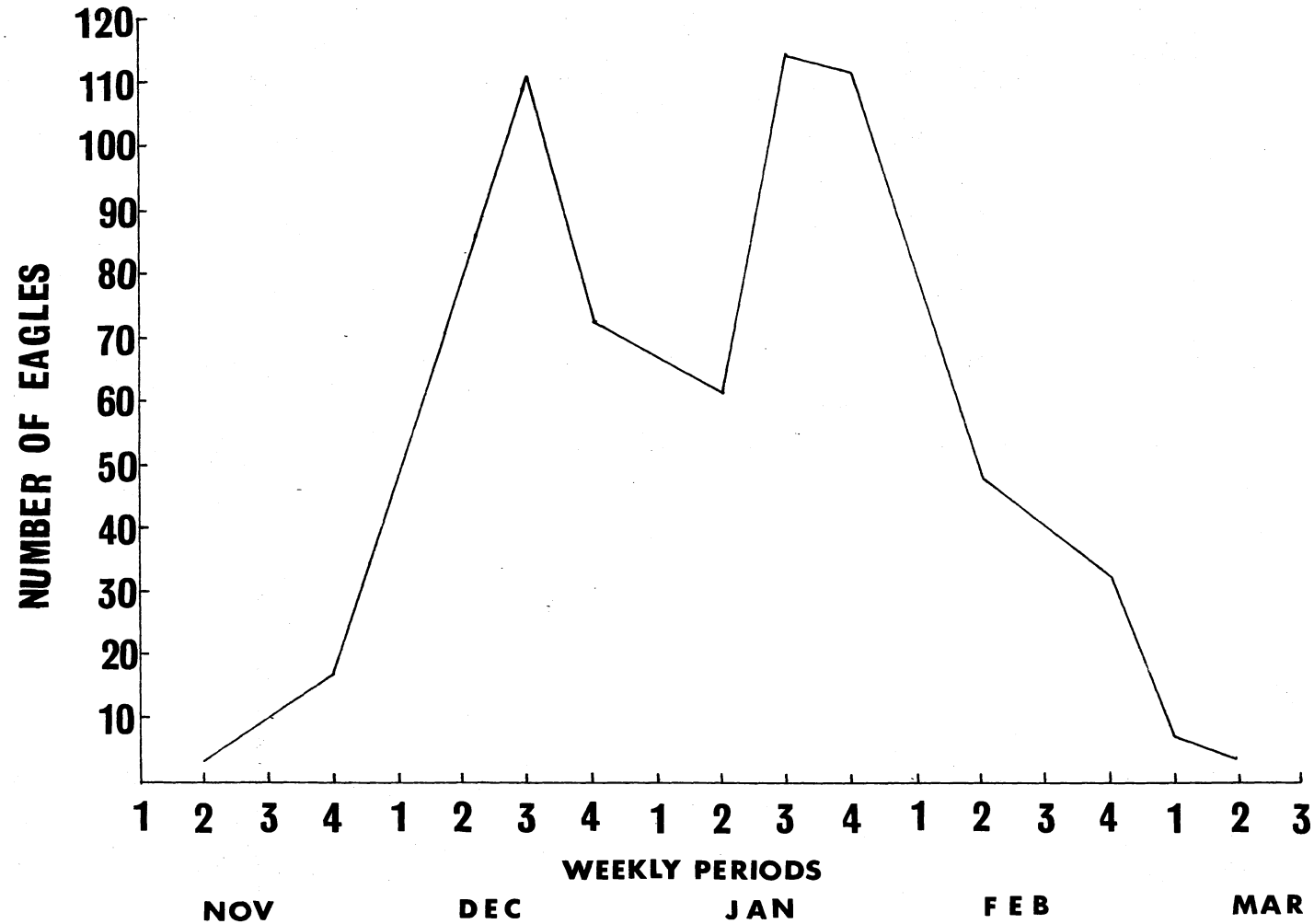


Figure 13. Fluctuations in Numbers of Eagles at Roost A in the Winter of 1973-1974

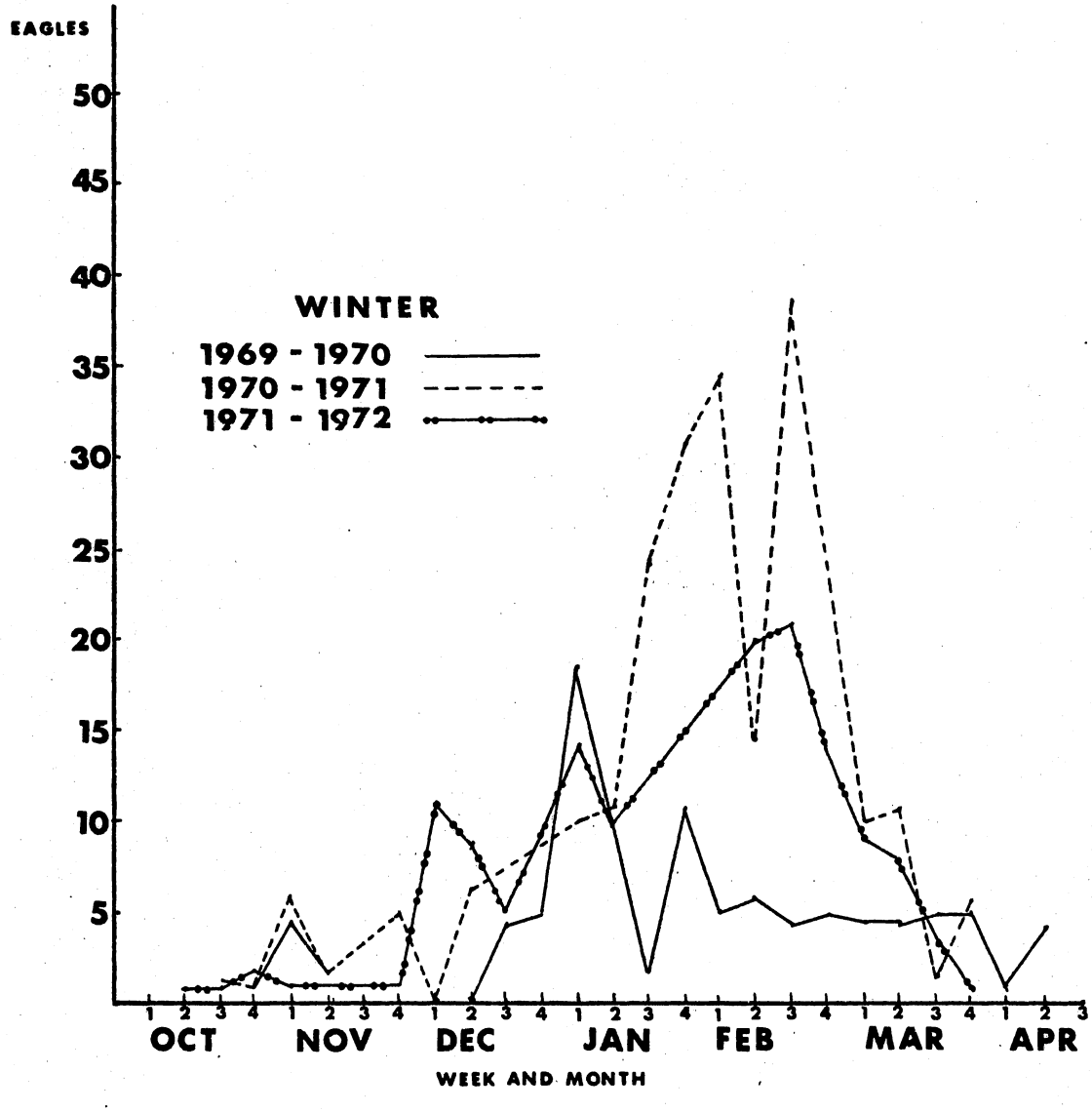


Figure 14. Trends in Bald Eagle Populations in the Winters of 1969-1972 at Salt Plains National Wildlife Refuge (data courtesy of U. S. Fish and Wildlife personnel)

or was ingested by the prey prior to capture. Typical bald eagle pellets are 8 to 15 cm in length and 3 to 6 cm in diameter (Figure 15).

Canada geese and cottontail rabbits (Sylvilagus spp.) constituted 77 percent of the pellets volume (Table IV). This is not surprising considering the abundance of these two species in the intensive study area.

Prey remains were also collected from beneath feeding trees (Table V). Twenty-three whole shad containing talon marks made by eagles were found in brush beneath these trees. Eagles probably dropped fish from the trees shortly after they captured them. Eagles probably were not able to recover them because of the dense ground cover underneath the trees. Sixteen parts of shad consisting mostly of heads and caudal fins were also collected. Waterfowl remains consisted mostly of wings and feet.

On 20 and 27 January and on 20 February 1974 I observed bald eagles feeding on Canada geese in a large winter wheat field south of Roost A. In January 1975 I received a report of bald eagles feeding on the carcass of a cow in the intensive study area. When I visited the site the carcass had been completely consumed. Gene Ivan, owner of a sheep ranch south of Pond Creek, told me that eagles fed there for several days on a lamb carcass during December 1974. He commented that eagles seldom bothered the sheep.

In analyzing the food habits data collected during this study a trend was noted in bald eagle feeding behavior in the intensive study area. In early winter, eagles fed mainly on gizzard shad. Large numbers of shad, parts as well as whole fish weighing up to 6.6 kg, were

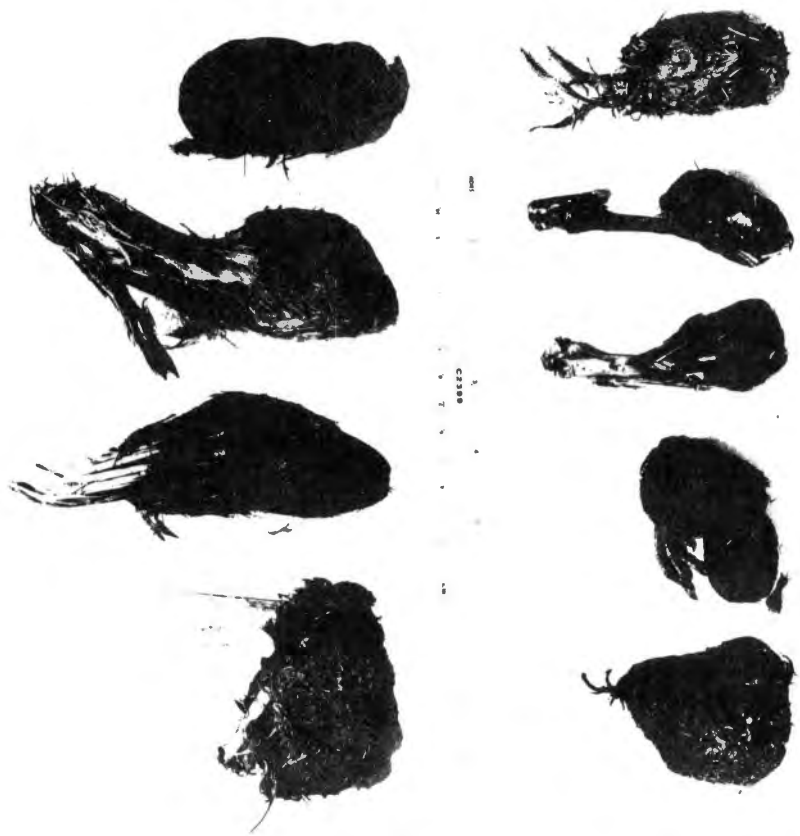


Figure 15. Typical Bald Eagle Pellets

TABLE IV

PREY ITEMS IN 109 BALD EAGLE PELLETS COLLECTED AT ROOST A BETWEEN 23 DECEMBER 1973 AND 2 MARCH 1974

Food Item	Frequency of Occurrence	Percent by Volume
Birds:		
Canada goose (*Branta canadensis*)	55	46.5
Mallard (*Anas platyrhynchos*)	6	3.9
Canvasback (*Aythya valisineria*)	3	3.5
Western meadowlark (*Sturnella magna*)	9	1.8
Pintail (*Anas acuta*)	2	1.7
Common crow (*Corvus brachyrhynchos*)	1	0.5
Unidentified passerine bird	1	0.4
Unidentified bird	2	0.7
Unidentified duck	1	0.4
Red-winged blackbird (*Agelaius phoeniceus*)	2	0.1
Subtotal		59.5
Mammals:		
Cottontail (*Sylvilagus* spp.)	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

TABLE IV (Continued)

Food Item	Frequency of Occurrence	Percent by Volume
Mammals (Continued):		
Kangaroo rat (Dipodomys ordii)	2	0.2
Hair from domestic cow	1	0.1
Deer mouse (Peromyscus maniculatus)	1	0.1
Unidentified rodent	1	0.4
Subtotal		39.8
Plant Material	13	0.7
Total		100.0

TABLE V

PREY ITEMS COLLECTED BENEATH FEEDING TREES ALONG THE SALT FORK RIVER, DECEMBER 1973 TO FEBRUARY 1974

Prey Item	Number Found
Whole gizzard shad	23
Parts of gizzard shad	16
Green-winged teal	1
Canada goose	7
Mallard duck	1

found beneath favorite feeding trees along the river. Pellet castings beneath the roost were very scarce when eagles fed on shad. None of the pellets collected in early winter contained fish remains. This situation apparently arises 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 changed from fish to waterfowl. In January there was an increase in pellet castings collected beneath the roost. These pellets mostly contained remains of waterfowl. A single pellet collected from beneath Roost E contained the hair of a striped skunk (Mephitus mephitus).

Three pellets collected from beneath the roost at Grand Lake on 20 February 1975 contained waterfowl remains. Two of these contained feathers of an American coot, and one contained feathers and feet of a common merganser.

Two pellets were collected beneath the roost at the Cookson Hills State Game Refuge on 7 March 1975; one contained hair from a white-tailed deer and one contained the feathers of an unidentified duck.

Five pellets were collected from beneath the roost at Wichita Mountains NWR; three contained feathers from the American coot, one contained fur from the cottontail rabbit, and one contained the feathers of an unidentified duck.

In Osage County bald eagles fed primarily on cattle carcasses. Nine eagles were observed feeding on a single carcass. A feed lot owner north of Grainola, Oklahoma stated that 10 eagles fed regularly on cattle carcasses in the lot adjacent to his home. Whenever large

concentrations of eagles were seen in Osage County, carcasses of cattle were nearby. In February 1975 the front leg and the tail of a small calf were found beneath a feeding perch in Osage County.

Bald eagles attempted to capture Canada geese on at least five occasions in the winter of 1973-1974. They perched on fence posts or trees around winter wheat fields where geese were feeding. When an eagle attempted to catch geese it flew directly toward the flock. The geese took wing as the eagle approached. On one occasion an adult bald eagle separated a single goose from the flock and pursued it for approximately 30 m. The goose seemed very capable of out-flying the eagle in a level flight. After the eagle made a pass over the goose and returned to its perch, the goose quickly landed. I never observed an eagle capture a Canada goose. I strongly suspect that the eagles carefully watch these large flocks of geese and are able to detect crippled geese. Healthy geese are probably too fast for eagles to catch.

When eagles were feeding on shad along the Salt Fork River they sat in trees along the river or on sand bars in the river.

Food Habits and Hunting Methods of Golden Eagles

On 2 March 1974 I collected three pellets beneath a small roost used exclusively by one immature and two adult eagles. All of these pellets contained hair from cottontail rabbits. On 6 June 1974 two pellets were collected from beneath an active eyrie in Cimarron County. Both of these pellets contained fur from jackrabbits.

Prey remains collected at three active golden eagle eyries in

Cimarron County are shown in Table VI. Cottontail rabbits and black-tailed jackrabbits remains were found at all of the eyries. The 17 ornate box turtle (Terrapene ornata) shells were found at one eyrie where the eagles had become proficient at opening box turtle shells. All 17 turtle shells were broken where the plastron joins the carapace. I was unable to determine if the eagles themselves had broken the shells or if they had dropped the turtles from an altitude to break the shells.

TABLE VI

PREY ITEMS COLLECTED AT THREE GOLDEN EAGLE EYRIES IN THE BLACK MESA AREA IN JUNE 1974

Prey Item	Body Part	Number of Parts Found
Cottontail rabbit	Front and rear legs	5
Black-tailed jackrabbit	Rear legs	3
Ground squirrel (Spermophilos sp.)	Head	1
Turkey (Meleagris gallopavo)	Right wing, femur, synsachrum	1
Ornate box turtle	Plastron carapace	17

On 18 January 1975, an adult golden eagle attempted to catch a Canada goose. The eagle was sitting on a fence post near a flock of approximately 5,000 geese. The eagle suddenly took wing and rlew approximately 50 m downriver away from the geese, then turned and flew

rapidly toward the geese at an altitude of approximately 1 m, apparently using the topography to its advantage. The geese were feeding below a terrace in the field. The eagle flew very fast, and when it neared the terrace it flew over it into the flock of geese. Even though the eagle was flying at a high speed and had managed to surprise the geese, the attempt was unsuccessful.

Nesting in Oklahoma of Bald and Golden Eagles

Bald eagle nesting has previously been reported in the Glass Mountains and along the North Canadian River. Sutton (1967) stated that the golden eagle breeds regularly in small numbers on cliffs in the Black Mesa country. Golden eagles have previously nested along the Cimarron River in Woods and Major Counties (Green 1927) where rock outcrops provide nest sites.

Nests of bald eagles were not discovered during this study. Bald eagle nests are very large and conspicuous and if any bald eagle nesting occurred in Oklahoma it would surely be noticed. Most eagle nesting is reported in northwest Oklahoma and is by golden eagles.

A total of 13 golden eagle eyries were located by using ground surveys and aerial surveys in Oklahoma and portions of New Mexico bordering Cimarron County (Table VII). There were five active golden eagle nests in Oklahoma and adjacent portions of New Mexico in the 1974 breeding season. These nests were checked again in 1975 and none were active. Two nests that were not active in 1974 were active in 1975. Nest site charactersitics such as dimensions and number of young were not determined at some eyries because access was prevented by topography or by the owner.

TABLE VII

CHARACTERISTICS OF GOLDEN EAGLE EYRIES IN OKLAHOMA
AND ADJACENT PORTIONS OF NEW MEXICO

Eyrie Designation	Number of Young		Nest Dimensions (m)			Cliff Height (m)	Type of Rock	Aspect
	1974	1975	Width	Height	Depth			
Black Mesa A	1	0	2.7	1.2	1.2	12	Sandstone	S
Black Mesa B	0	0				20	Sandstone	W
Black Mesa C	0	0				20	Sandstone	NE
Black Mesa D	0	0				15	Sandstone	W
Black Mesa E	1	0				30	Sandstone	E
Black Mesa F	1	0				30	Sandstone	E
Black Mesa G	0	2					Sandstone	E
New Mexico A	2	0	2.1	1.6	1.9	17	Sandstone	N
New Mexico B	0	0				32	Sandstone	W
New Mexico C	1	0	2.1	1.5	2.1	35	Sandstone	SW
Woods County A	0	0	1.8	1.5	2.9	15	Gypsum	S
Woods County B	0	0					Gypsum	S
Wichita Mts. NWR	0	0				15	Sandstone	E

Eyrie C at Black Mesa and Eyries A and B in Woods County were very deteriorated, indicating that they had not been active in several years. The remaining inactive eyries were in good condition, having old whitewash around the nest sites. These all have probably been active within the last 4 yr.

Gene Bartnicki, biologist at Wichita Mountains NWR, said a pair of golden eagles had spent the summer of 1974 on the refuge in an area known as Eagle Mountain. I located an old nest on Eagle Mountain. The lack of old whitewash and prey remains indicated that the nest was used very little. It was probably abandoned due to intensive human activity in the area.

Nests face various directions and there is no apparent preference for a particular aspect. Nest sites varied in height from 12 to 40 m, and had an average height of 26.4 m. All of the eyries in the Black Mesa area and adjacent portions of New Mexico are built on sandstone cliffs. Apparently golden eagles prefer sandstone cliffs to the lava cliffs that also occur in the area.

Five active golden eagle nests produced an average of 1.2 young per nest in 1974. In 1975 two nests were active. One nest contained 2 young and the other nest could not be determined. Golden eagles frequently have more than one nest in their breeding territory (Brown and Amadon 1968). Some of the breeding pairs which had active nests in 1974 probably used alternate nests in an unknown location in 1975. One eaglet banded in June 1974 was found dead approximately 150 k east of its eyrie in December 1974. The cause of death was not determined.

In addition to golden eagles, common ravens (Corvus corax), prairie falcons (Falco mexicanus), red-tailed hawks, rock doves, and american

kestrels (Falco sparvarius), utilize cliffs in the Black Mesa area for nesting.

Young eaglets lay very flat and motionless until they were handled; then they became aggressive and made no further attempt to hide. While one eaglet was being banded, its nestmate still assumed the prone position. Adult golden eagles made no attempt to defend the nest and were very seldom seen in the area.

Although I viewed the Black Mesa area intensively from the air, some golden eagle nests were unobserved because they were not visible from an aircraft. For example, in an attempt to check the status of an eaglet banded earlier, I flew several times over the mesa containing the eaglet's nest that I had previously located from the ground. While flying at 60 km per hour at an altitude of approximately 30-60 m I could not locate the nest. The rock overhangs above some golden eagle nests conceal them from an aerial observer. However, an aerial survey coupled with a ground survey is probably very effective in locating most of the nests.

Taxonomy of Bald Eagles Wintering in Oklahoma

Boundary limits assigned to the breeding ranges of the northern and southern races of the bald eagle are arbitrary. The two races are separated on the basis of size; increasing gradually from the south to north. The largest race is found on the Bering Islands off the coast of southwest Alaska. Throughout the central United States there is an extensive area in which the birds are intermediate in measurements. The taxonomy is further complicated by the northward wandering of the

small southern birds, after the breeding season, into the breeding range assigned to H. l. alascanus, to an extent only partly known (AOU 1957).

The arbitrarily designated breeding range of the southern bald eagle is defined as follows: from northern California south to both coasts of Baja, California, central Arizona, New Mexico (formerly western Nevada and southern Utah), northern Texas, Oklahoma, Missouri, (Nebraska and Iowa), southern Illinois, western Kentucky, and Virginia, and south to the gulf coast and Florida (AOU 1957).

The assumed breeding range of the northern bald eagle is defined as follows: breeds from Bering Island in the Komandorskie group and from the Aleutian islands, northwestern Alaska (Nostak River), MacKenzie (Anderson River, Artillery Lake), Manitoba (Churchill), central Ontario, Labrador (Petitsikapau Lake), southeastern Quebec (Mascanin, Anticosti Island), and coasts of Newfoundland south to Oregon, Idaho, Wyoming, Colorado, South Dakota, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, New Jersey, and Maryland (AOU 1957).

Bald eagles are present in Oklahoma only from October to May; therefore, the northward wandering of southern bald eagles in June, July and August, after breeding, probably does not extend into Oklahoma. Bald eagles along the Gulf Coast are typical representatives of the southern race, and the Gulf area is the only likely source of southern bald eagles that might winter in Oklahoma. Therefore, it seems likely that if the southern race are breeding at the time when populations of bald eagles in Oklahoma peak, we could not possibly have sexually mature southern bald eagles wintering in Oklahoma.

Evidence collected during this study strongly indicates that the subspecies of bald eagle wintering in Oklahoma is the northern race.

Thirty of the 44 questionnaires sent to National Wildlife Refuges and conservation agencies in the Southeastern United States were returned (Table VIII). Nine respondents reported current or former nesting by southern bald eagles in their area. Breeding activity in the southeast United States starts as early as November and ends as late as May.

Eagles arrive in Oklahoma in October, the populations peak in January, and eagles have departed by late April, consequently, the southeastern United States could not be the source of many bald eagles wintering in Oklahoma.

Recoveries of banded bald eagles in Oklahoma and neighboring states, and the resighting of one color-marked eagle from Oklahoma strongly indicate a northern source of eagles that winter in Oklahoma and adjacent states of the central United States.

Robert L. Adams, an employee of the U. S. Army Corps of Engineers, Clarksville, Missouri, observed an adult bald eagle on 1 February 1975 that had a red marker on its right wing, just north of U. S. Highway 54 bridge, near Louisiana, Missouri. Apparently this was the eagle marked and released near Roost A in February 1974 because there are no other authorizations for marking adult bald eagles with red markers. This bird was captured in a steel trap in Texas County, Oklahoma, in December 1973. This bird was either wintering farther east this year or was migrating northward by a route considerably east of its wintering ground.

The Office of Migratory Bird Management, FWS, Laurel, Maryland, provided us with all bald eagle band return data processed up to May 1974. Only one banded bald eagle was recovered in Oklahoma; a bird that was banded as a nestling in Wisconsin and recovered in Adair County. It

TABLE VIII

NESTING DATES AND STATUS OF SOUTHERN BALD EAGLES IN THE SOUTHEASTERN UNITED STATES AS REPORTED BY RESPONDENTS TO A QUESTIONNAIRE

State	Responding Agency or Refuge	Status of Nesting Eagles	Nesting Dates
Louisiana	Wildlife Services Division	Present	Early November to mid-March
Louisiana	Louisiana Coop. Wildl. Res. Unit	Present	December to late March
Louisiana	Catahoula NWR	None present	Formerly December to March
Louisiana	Sabine NWR	Formerly nested	Winter months
Louisiana	Delta and Breton NWR	None present	Unknown
Texas	Brazoria and San Bernard NWR	No nesting	Unknown
Texas	Arkansas NWR	Regular nesting until 1970	January to March
Texas	Laguna Atascosa NWR	None present	Unknown
Texas	Santa Ana NWR	None present	Unknown
Texas	Anahuac NWR	None present	Unknown
Texas	Texas Parks and Wildlife Dept.	None present	Unknown
Mississippi	Mississippi State University	Present on coast	Unknown
Mississippi	Mississippi Game and Fish Dept.	Present	January to May

TABLE VIII (Continued)

State	Responding Agency or Refuge	Status of Nesting Eagles	Nesting Dates
Mississippi	Moxubee NWR	None present	Unknown
Mississippi	Yazoo NWR	None present	Unknown
Mississippi	Mississippi State University	Present	Begins in December
Arkansas	Fish and Wildlife Service, USDI	None since 1951	December to March
Arkansas	White River NWR	None present	Unknown
Arkansas	Big Lake NWR	None present	Unknown
Arkansas	Holla Bend NWR	None present	Unknown
Arkansas	Wapanucca NWR	None present	Unknown
Arkansas	Arkansas Fish and Game Dept.	None present	Unknown
Tennessee	Hatchie NWR	None present	Unknown
Tennessee	Cross Creeks NWR	None present	Unknown
Tennessee	Reelfoot NWR	None present	Unknown
Alabama	Wheeler NWR	None present	Unknown
Alabama	Eufaula NWR	None present	Unknown
Alabama	Choctaw NWR	None present	Unknown

TABLE VIII (Continued)

State	Responding Agency or Refuge	Status of Nesting Eagles	Nesting Dates
Alabama	Department of Conservation and Natural Resources	Formerly nested	December to May
Florida	Saint Vincent NWR	Present	January to March

was apparently the victim of a gunshot wound. There are 14 band returns from states bordering Oklahoma. Three bands recovered in Arkansas were from birds banded in Michigan, Ontario, and Florida. Five band returns from bald eagles in Texas were from birds banded in Saskatchewan and Minnesota. A single immature bird banded in Texas was recovered in South Dakota. Two bands were recovered in Kansas from birds banded in Wisconsin and Saskatchewan, respectively. Two bands recovered in Missouri were from birds banded in Michigan and Wisconsin. One band recovered in Ontario was from a bird banded in Missouri. These data indicate that the bald eagles wintering in Oklahoma probably nest in the western Great Lakes Region and southcentral Canada, well within the breeding range of the northern bald eagle. The single band recovered in Arkansas from a bird banded in Florida is the only evidence of post nesting movement by immature southern bald eagles into this area.

Measurements were taken from three live eagles and two dead eagles illegally shot or trapped in Oklahoma and confiscated by law enforcement officials and from museum specimens collected in Oklahoma (Table IX). Most of the measurements are incomplete because many of the specimens were damaged. To complicate the problem, some researchers did not use standardized measuring techniques and this makes study of old museum specimens difficult. In general the measurements of bald eagles (Table IX) wintering in Oklahoma seem to be intermediate between those of the southern and northern ones.

Local Movements

Attempts to capture bald eagles in the intensive study area were unsuccessful, therefore, observations on local movements were limited.

TABLE IX

TAXONOMIC MEASUREMENTS (mm) OF TEN BALD EAGLES THAT WINTERED IN OKLAHOMA

Source	Age	Sex	Wing	Tail	Total Length	Bill	Tarsus
Grant Co., found dead under roost	Immature	Female	628	323	913	55	90
Texas Co., live trapped	Adult	Unknown	566	295	770	49	85
Tulsa Co., gunshot fatality	Immature	Unknown	640	360	890	53	85
Tulsa Co., injured from gunshot	Immature	Unknown	571	330	836	50	82
Tulsa Co., injured from gunshot	Immature	Unknown	552	304	812	50	88
Texas Co., Museum specimen University of Oklahoma (OU) 2852, 8 February 1957	Sub-adult	Male	577	285	780	51	95
Oklahoma Co., Museum specimen OU 13834, 29 November 1932	Adult	Male	540	290	852	51	91
Atoka Co., Museum specimen National Museum of Natural History (NMNH) USNM-208193, 12 December 1910	Immature	Unknown	634	349		53	96

TABLE IX (Continued)

Source	Age	Sex	Wing	Tail	Total Length	Bill	Tarsus
Osage Co., Museum specimen USNM-531454, 13 February 1964	Sub-adult	Unknown	596	293			
Muskogee Co., Museum specimen USNM-489772, 2 June 1964	Sub-adult	Female	630	328		55	74

Apparently there are at least four groups of bald eagles wintering in the intensive study area. Some interchange of birds between groups probably occurs during winter. However, eagles using any given roost seem to feed in areas along the river adjacent to that roost. Eagles using Roosts A and B probably feed along the Salt Fork River 8 km up or down river from the roost. Eagles using Roost C probably feed from just below the dam on Salt Plains Reservoir to approximately 10 km downstream. Eagles using Roost D probably feed on the refuge and land adjacent to it. Eagles using Roost E probably feed along the river south of Pond Creek, Oklahoma. Under certain conditions eagles using any of these roosts probably disperse a considerable distance from the roost area.

Possible Impact of the U. S. Army Corps of Engineers' Chloride Control Project on Bald Eagles in the Intensive Study Area

Salt Plains National Wildlife Refuge is located in Area I of the U. S. Army Corps of Engineers' Chloride Control Program. Slightly over 20 percent of the natural chloride polluting the Arkansas River comes from the Great Salt Plains. Water in the Salt Fork of the Arkansas and in the Medicine Lodge River above Salt Plains is generally of good quality. Ground water flowing from the higher terrain percolates down to salt bearing strata and becomes a salt solution that is then drawn to the surface by capillary action. During periods of rainfall and surface runoff the salt in the plains is dissolved and carried into the

reservoir. The average daily chloride load from this area is 1,440 tons (USACE 1968).

The Corps of Engineers' plans for reducing the salt load of the Arkansas River includes converting the existing Great Salt Plains Reservoir into a brine storage area (Figure 16). A dike will be constructed upstream to intercept incoming fresh water and divert it to a channel. The channel will empty into the Salt Fork River below Salt Plains Reservoir. Water will no longer be permitted to flow from Salt Plains Reservoir into the Salt Plains River. Maximum pool level of the reservoir will be increased to contain all anticipated ground water inflow and precipitation. With the increased water surface, evaporation will equal the amount of water entering the reservoir. Consequently, the salinity of the reservoir will increase steadily until it is salt water. However, the effect on fisheries above and below the reservoir would not be drastic (Robert Summerfelt, personal communication).

Evidence collected during this study showed that fish and waterfowl are the main foods of eagles wintering along the Salt Fork River. Habitat for waterfowl will be drastically altered.

Croplands on the existing refuge will be flooded, however, mitigation plans include a new refuge site north of the Salt Plains. Waterfowl use could presumably shift to these new refuge croplands and some eagles might also shift their use areas. Roost D on the refuge will be inundated and this may force the eagles to roost on a less protected area closer to their food source. Eagles roosting at Roost C will be affected if waterfowl wintering areas are altered. Eagles occupying Roosts A and B will be least affected.

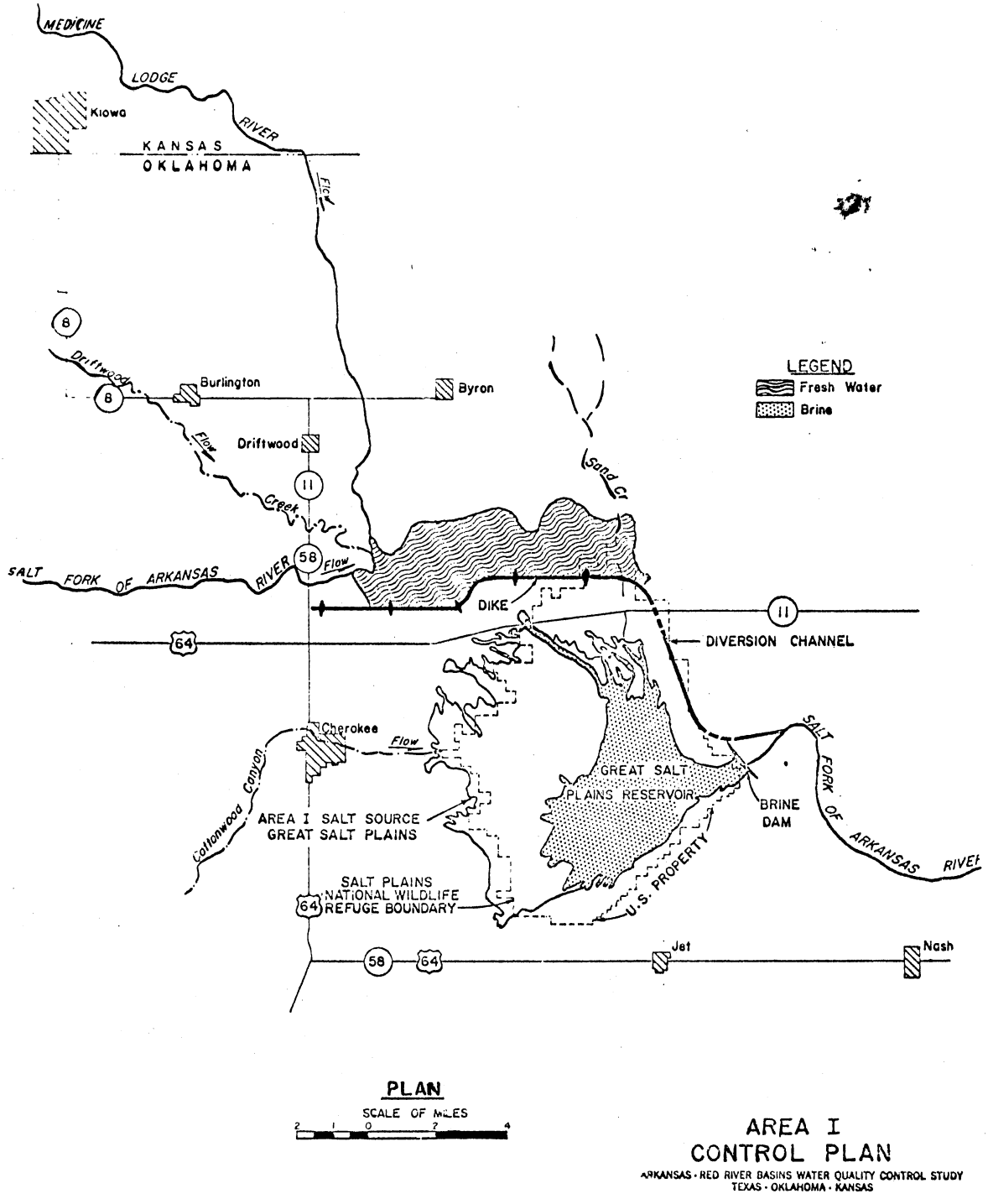


Figure 16. Proposed Modification of the Salt Plains National Wildlife Refuge by the U. S. Army Corps of Engineers' Chloride Control Program (USACE 1968)

Based on present knowledge, I believe that one possible effect of the chloride control project will be a shift of roosting and feeding areas of some of the population.

General Behavior

Bald eagles usually feed in the morning hours. Feeding by eagles I studied was most intense during the first 3 hr of daylight.

Weather conditions had a noticeable effect on bald eagle activities. Eagles were very sedentary on overcast days. Groups of up to 67 eagles perched in cottonwood trees along the Salt Fork River on overcast days. Groups this large never formed on clear days.

Groups of up to 37 eagles soared above the roost area on sunny days. This soaring sometimes lasted for several hours. Soaring never occurred for any extended period on overcast days. I noted two types of behavior that occurred frequently when bald eagles soared. I term these the talon presenting (Figure 17) and tail chasing (Figure 18) behaviors. Both occurred at high altitudes. Talon presenting is similar to bald eagle courtship behavior except that whirling with the talons locked does not occur. The talon presenting consists of one eagle diving at another eagle. When the eagle in the uppermost position nears the other eagle, the lower eagle flips over and presents its talons. Actual contact between the two eagles never occurred. In several instances talon presenting was only partially exhibited. In these cases, the eagle in the uppermost position cut short its dive causing the lowermost eagle to turn over only partially.

The tail chase was also common and consisted of one eagle chasing another, sometimes only 0.5 m apart. While tail chasing, eagles usually

Figure 17. Talon Presenting Behavior

Figure 18. Tail Chasing Behavior

used a fast descending glide. However, when tail chasing was very vigorous, a laboured flapping flight was employed. Some eagles were very aggressive when tail chasing other eagles. Eagles being pursued during a tail chase very often performed evasive manuvers. These consisted of sharp turns, dives, or a dive followed by a steep rise in altitude. Tail chases usually lasted 15-20 sec. However, one tail chase lasted so long that I lost sight of both birds. Physical contact never occurred during tail chasing.

Interactions of different age groups during talon presenting are shown in Table X. Immature eagles were involved in 90.2 percent of the observations of this activity. An immature eagle presented talons to an adult in only 2.4 percent of the observations, and adults presented talons to adults in only 7.3 percent of the observations. Adults were never observed to present talons to immatures.

Tail-chasing activities by different age groups are shown in Table XI. Again, immature eagles exhibited tail chasing more than did any other age class (67.8 percent). Adults chased immatures in 32.1 percent of the observations. I never observed adults chasing adults or immatures chasing adults.

Mortality Factors of Bald Eagles in Oklahoma

Shooting is probably the main cause of mortality among bald eagles wintering in Oklahoma. During this study several eagle shootings were reported. Two immature bald eagles were shot near Keystone Reservoir, one survived but it is unable to fly and it is now in the Tulsa Zoo. A second immature bald eagle at the Tulsa Zoo was shot near Keystone

TABLE X

INTERACTIONS OF DIFFERENT AGE CLASSES
EXHIBITING TALON PRESENTING

Interactions of Age Categories	Number of Observations	Percent of Total
Adult presents talons to adult	3	7.3
Immature presents talons to adult	1	2.4
Immature presents talons to immature	37	90.2
Total observations	41	99.9

TABLE XI

INTERACTIONS OF DIFFERENT AGE CLASSES
EXHIBITING TAIL CHASING

Age Group	Number of Observations	Percent of Total
Adult chasing immature	9	32.1
Immature chasing immature	19	67.8
Total	28	99.9

Reservoir prior to this study. Its wing has healed crooked and it is unable to fly. An adult eagle was shot and killed near Broken Bow Reservoir in 1974.

Ron Freeman, a graduate student in Wildlife Ecology from Oklahoma State University, reported seeing a hunter shoot at a bald eagle near Fort Gibson Reservoir in 1975. This incident was reported to law enforcement officials.

Bud Hammons, State Game Ranger in Grant County, reported apprehending a hunter who killed a bald eagle below the dam on Salt Plains Reservoir. This incident took place prior to this study.

In February 1974 an adult bald eagle was obtained from the Oklahoma City Zoo. This bird was accidentally trapped in Texas County, Oklahoma and transported to the zoo. John Snelling decided that this bird was only slightly injured and should be released in the wild. Handling and transportation of this bird was accomplished by methods described by Robards (1967).

I found a dead immature bald eagle near Roost A on 19 January 1974. The bird was sent to the Migratory Bird Research Laboratory in Patuxent, Maryland, for a postmortem examination. The eagle was an immature female weighing 0.48 kg. It had no external injuries or fractures. The eagle had been in poor health prior to death; it had a marked atrophy of the pectoral muscles and only traces of subcutaneous and abdominal fat. Fat deposits present were apparently being reabsorbed. Internally, there were areas of consolidation along the costal borders of the lungs. Air sacs, bronchii, heart, liver, trachea, esophagus, and kidneys appeared normal. Some coronary fat was present.

Capillarids were not present in the oral cavity or esophagus. Nematodes were not found in the proventriculus or stomach. The stomach contained only about 5 g of what appeared to be blades of grass. Bacteriological cultures of the liver and heart were negative. The brain appeared to have a 4 x 5 mm caseous abcess in the base of the cerebellum. The cause of death was tentatively ascribed to the brain abcess.

Chlorinated hydrocarbon pesticide residues in this specimen are listed in Table XII. These pesticide levels probably had no adverse effect on this bird.

Even though shooting is the main mortality factor for eagles in Oklahoma, I believe that it is not widespread enough to cause a major decrease in bald eagle populations. The overall public attitude towards eagles in Oklahoma is very favorable.

Proposed Management of Bald Eagles in Oklahoma

A general management program for bald eagles in Oklahoma is needed. This program should have three major objectives:

1. To completely protect existing communal roosts from human disturbance.
2. To insure replacement of trees at existing roosts.
3. To conduct a statewide annual census to monitor population trends.

The first of these objectives is the most important. The destruction of the large communal roost on Grand Lake could have been avoided by buying or leasing the land and minimizing human disturbance. Two communal roosts in the state can be considered in precarious condition due to human disturbance. These roosts should be bought or leased to

insure future protection. Roost A in the intensive study area illustrates the populations that can be built up when adequate protection is provided.

TABLE XII

CHLORINATED HYDROCARBON RESIDUES (PPM WET WEIGHT) IN AN IMMATURE BALD EAGLE COLLECTED ON 31 JANUARY 1974 AT ROOST A, SALT FORK RIVER, OKLAHOMA

Compound	Carcass	Brain
p,p' DDE	6.3	2.4
p,p' DDD	0.18	0.05
p,p' DDT	0.0	0.0
Dieldrin	0.3	0.18
Heptachlor epoxide	0.06	0.0
Mirex	0.0	0.0
Oxychlordane	0.05	0.0
Cis-chlordane	0.12	0.0
Cis-nonachlor	0.07	0.0
HCB	0.0	0.0
PCB	2.5	1.1

Communal roosts consisting of dead trees with no young trees to replace them are threatened. This might be avoided by planting young trees or possibly by experimenting with artificial roost structures.

A long-term tree management plan for the larger roosts would be appropriate. The plan should be designed so that a certain percentage of trees in the roost could be girdled periodically. This would insure an adequate number of dead trees for roosting. These dead trees would be replaced by younger trees which could then be girdled. These planting and girdling techniques should be carried out in the summer to avoid disturbing the eagles.

Oklahoma winters one of the largest populations of bald eagles in the United States. If all of their roosts are protected, eagles using the roosts can easily be censused systematically. This would require relatively little effort and the information obtained over a long period of time would be very valuable in detecting population changes.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Research having the following six objectives was conducted in the state of Oklahoma from August 1973 through May 1975 to: (1) determine peak populations of bald eagles wintering in Oklahoma by using aerial and ground censuses, (2) locate, map and describe winter roosts used by eagles in Oklahoma and to determine the landowners' interest in and future plans for these sites, (3) describe the population dynamics, habitat use, behavior, and food habits of eagles wintering along the Salt Fork River, (4) to determine local movements, migration pathways, taxonomy, and nesting areas of eagles that roost along the Salt Fork River, (5) to evaluate the effect of the Army Corps of Engineers' Chloride Control Project on the eagles wintering on the Salt Fork River, and (6) determine the extent of nesting eagles in Oklahoma.

Aerial and ground censuses for bald eagles in Oklahoma indicate a statewide population of between 550 and 600 eagles. The largest concentrations of bald eagles are located at Grand Lake, in Osage and Texas Counties, at the Wichita Mountains and Sequoyah NWR, and at Keystone, Tenkiller, Eufaula and Fort Gibson Reservoirs. Areas wintering small populations of bald eagles are Upper and Lower Spavinaw Lakes, Oologah, Robert S. Kerr, and Broken Bow Reservoirs, and Lake Texhoma. Eagles infrequently occur on many of the smaller reservoirs in the state.

Bald eagles mainly utilized the larger rivers and reservoirs in

winter. On the reservoirs, eagles consistently concentrated below the dams and in the areas where the rivers flowed into the reservoirs. The main concentration areas on all of the major reservoirs were determined.

Eagle concentration areas and the intensity of eagle use in the intensive study area were described. At the Salt Plains NWR eagles primarily used the northeast shore of the reservoir. There were three main concentration areas on the Salt Fork River below the reservoir. Eagles perched primarily in cottonwood trees along the river. Both live and dead cottonwoods were used. Eagles are attracted to the Salt Plains area because of the large food source, and because of the restricted human activity in the area.

Fifteen communal roosts were located across the state. The largest of these is in the intensive study area. Cottonwoods are the main tree species in 57 percent of the roosts. Oaks were the main tree species in 14 percent of the roosts. Sycamore, shortleaf pine, american elm, and blue ash were each main tree species at one roost. Sixty-four percent of these roosts are under private ownership, 28 percent of the roosts are on National Wildlife Refuges, and 7 percent are owned by the state.

The future of 78 percent of the roosts in the state can be considered secure. Fourteen percent of these roosts are threatened by human disturbance and their future status can be considered precarious.

In the intensive study area eagles used different positions in roost trees in response to varying climatic conditions. They approached the roost from the south and the east, the directions of their main feeding areas, in 62 percent of the observations. Eagles consistently approached a particular perch in the roost from downwind; most of the eagles arrived at the roost in the 60 min period before sunset.

A common behavior of roosting eagles was perch displacement. Adult eagles engaged in this activity more than any other age class. Vocalization was associated with perch displacement. Eagles showed a definite preference for dead trees in roosts. Golden eagles were more aggressive and they displaced both adult and immature bald eagles at the roosts.

Eagles generally began arriving in Oklahoma in October, their populations peak in January, and slowly decrease until mid March.

In the intensive study area Canada geese, cottontail rabbits, and gizzard shad were the main food items. Bald eagles fed mainly on shad in the fall, and changed to waterfowl during the winter. Hunting methods of both bald and golden eagles are described.

Both ground and aerial surveys were conducted to determine the extent of bald eagle nesting in Oklahoma. Blad eagle nests were not located. Thirteen golden eagle nests were located. Most of these nests were in Cimarron County and adjacent portions of New Mexico. Three of these nests were active in 1974 and only two were active in 1975. Four of the nests active in 1974 produced an average of 1.2 young per nest.

The taxonomy of bald eagles wintering in Oklahoma was determined by analyzing band return data and by comparing nesting dates of southern bald eagles with the dates when eagles were wintering in Oklahoma. The northern bald eagle is the primary subspecies wintering in Oklahoma.

The impact of the U. S. Army Corps of Engineers' proposed Chloride Control Project at the Salt Plains National Wildlife Refuge was subjectively evaluated.

Observations were made on the general behavior of wintering bald eagles. Climatic conditions had a noticeable effect; eagles were more

active on clear days than on overcast days. Eagles soared in large groups on clear days. Two types of behavior exhibited by soaring eagles, talon presenting and tail chasing, are described. Immature eagles exhibited these activities more than did any other age class.

Shooting was the main mortality factor for bald eagles wintering in Oklahoma, however, loss of eagles due to shooting is not serious.

A management plan was proposed to provide future roosting habitat for eagles in Oklahoma. The plan consists of managing roost trees to insure tree replacement, and protection of roost sites from human disturbance.

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