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Habitat Use and Effects of Prescribed Fire on Black Bears in Northwestern Florida

Marty R. Stratman
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Marty R. Stratman entitled "Habitat Use and Effects of Prescribed Fire on Black Bears in Northwestern Florida." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Mike Pelton, Major Professor

We have read this thesis and recommend its acceptance:

Joe Clark, Edward R. Buckner

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Edward R. Buckner

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

HABITAT USE AND EFFECTS OF PRESCRIBED FIRE ON BLACK BEARS IN NORTHWESTERN FLORIDA

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Marty R. Stratman
May 1998

DEDICATION

This thesis is dedicated to

the wind,

the water,

and the woods,

and all those who live there too.

ACKNOWLEDGEMENTS

I would like to thank my major professor Dr. Mike Pelton for giving me the opportunity to become a bearguy. I also thank my committee members Drs. Joe Clark, Ed Buckner, and Mel Sunquist for their assistance and review of this manuscript.

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Most of all, I would like to thank my wife Christy and my son Tyler for their love and support throughout this project; you kept me focused on what's important.

ABSTRACT

I determined food habits, habitat use, and the effects of fire on habitat use by Florida black bears (*Ursus americanus floridanus*) on Eglin Air Force Base (Eglin), Florida from November 1994 to October 1996.

I determined the annual and seasonal diet of bears from 259 scats collected on Eglin. Annual diet was dominated by shrub/vine fruit (38%) and tree fruit (34%). Spring diets were dominated by debris, fleshy material (hearts) of saw palmetto (*Serenoa repens*), beetles (Coleoptera), and yellow jackets (Hymenoptera). Blueberries (*Vaccinium* spp.) dominated the early summer diet, whereas sweet gallberry (*Ilex coriacea*) and acorns (*Quercus* spp.) dominated the late summer diet. Acorns and saw palmetto berries dominated the fall diet accounting for 93% of the diet by volume. Winter scats were dominated by saw palmetto and greenbriar berries (*Smilax* spp.). Vegetation, primarily the hearts of saw palmetto and gallberry leaves accounted for 27% by volume. The dominance of saw palmetto berries in the 1994 fall diet indicates that bears selected saw palmetto over acorns as the primary fall food when available.

I used a GIS and compositional analysis to determine annual habitat use from 1,891 location estimates of 9 bears (3F, 6M). To determine seasonal habitat use, 1,049 location estimates of 10 bears (3F, 7M) for summer and 794 location estimates of 10 bears (3F, 7M) for fall were used.

Nonrandom use was detected for annual ($P \leq 0.0027$), summer ($P \leq 0.0002$), and fall ($P \leq 0.0006$) habitat use. Compositional analysis ranked habitats for annual use in the

following order: riparian zones > swamps > pine plantations > sandhills > open areas. There was a difference ($P \leq 0.025$) in annual use between riparian zones and swamps and each showed greater use than the remaining habitat associations. Riparian zones and swamps also ranked highest for summer and fall seasons. Riparian zones provided an abundant food supply, escape cover, and denning habitat. The decrease in vegetation density along the edges of riparian zones allowed bears to travel more efficiently within their home range.

Pine plantations containing slash pine (*Pinus elliottii*) were used more than sandhills during the summer season. The 3-5 year burning cycle in pine habitats allowed many soft mast species to reach maximum production. The lower use of sandhills during the summer was attributed to the higher frequency of fire. Frequent burning in sandhills reduced the amount of soft mast available to bears. The use of sandhills was highest during the fall season, ranking third in use. This coincided with the availability of oak hard mast and saw palmetto berries. Open areas were used significantly less than all other habitat associations during the summer and fall seasons. The low use of open areas was attributed to the lack of sufficient cover.

I used a GIS and compositional analysis to determined the annual and seasonal use of prescribed burns conducted from 1988 to 1996 by black bears on Eglin. Nonrandom use ($P \leq 0.05$) was detected in all years except 1991 and 1995 for annual habitat use. Burned areas ranked highest for years 1989 (6-year-old burns) and 1993 (2-year-old burns), ranking 3rd and 4th, respectively. Burned areas generally ranked higher than open areas but lower than all other habitat types. Seasonal habitat use of burned

areas ranked 1993 (2-year-old burns) and 1995 (<1-year-old burns) burns highest for summer and 1990 (5-year-old burns) and 1993 (2-year-old burns) burns highest for fall.

The most frequently used burned areas were those adjacent to riparian zones and swamps. The strong dependence on these areas for escape cover may have outweighed any deleterious effects burns may have caused. Prescribed burning can be detrimental to bears during the winter denning season. An adult female bear abandoned her den following a prescribed burn. In light of the above results management strategies are discussed that may increase the availability of soft and hard mast and improve habitat quality for black bears on Eglin.

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CHAPTER I

INTRODUCTION

Historically, the Florida black bear (*Ursus americanus floridanus*) occupied all of Florida and the coastal plains of Georgia and Alabama (Hall 1981) (Fig. 1). Habitat fragmentation from agricultural practices and urbanization has reduced the historic range of the species by nearly 83% (Florida Game and Fresh Water Fish Commission [FGC] 1993). The Florida black bear population has been reduced to 8 relatively disjunct populations occupying 2.2 million ha, most of which is public land. Five of these populations are considered to be stable (Cox et al. 1994) (Fig. 2).

The Florida black bear was first described as a species (*U. floridanus*) by Merriam (1896) based on a male specimen from Key Biscayne, Dade County, Florida. Hall and Kelson (1959) later relegated the Florida black bear to subspecies status. Harlow (1961) analyzed 42 black bear skulls from Louisiana (*U. a. luteolus*), Virginia (*U. a. americanus*), and Florida and found no significant differences among skull measurements. In a second report, however, Harlow (1962) indicated he could identify skulls from the Florida subspecies with 70% accuracy. Other researchers also concluded there were morphometric and genetic differences among the 3 subspecies and could not refute the subspecies designation (Eason 1995, Miller 1995).

Because of concern over habitat destruction and illegal killing, the black bear was listed statewide as threatened by the FGC in 1974, except in Baker and Columbia counties and Apalachicola National Forest, where regulated hunting continued. In 1990,

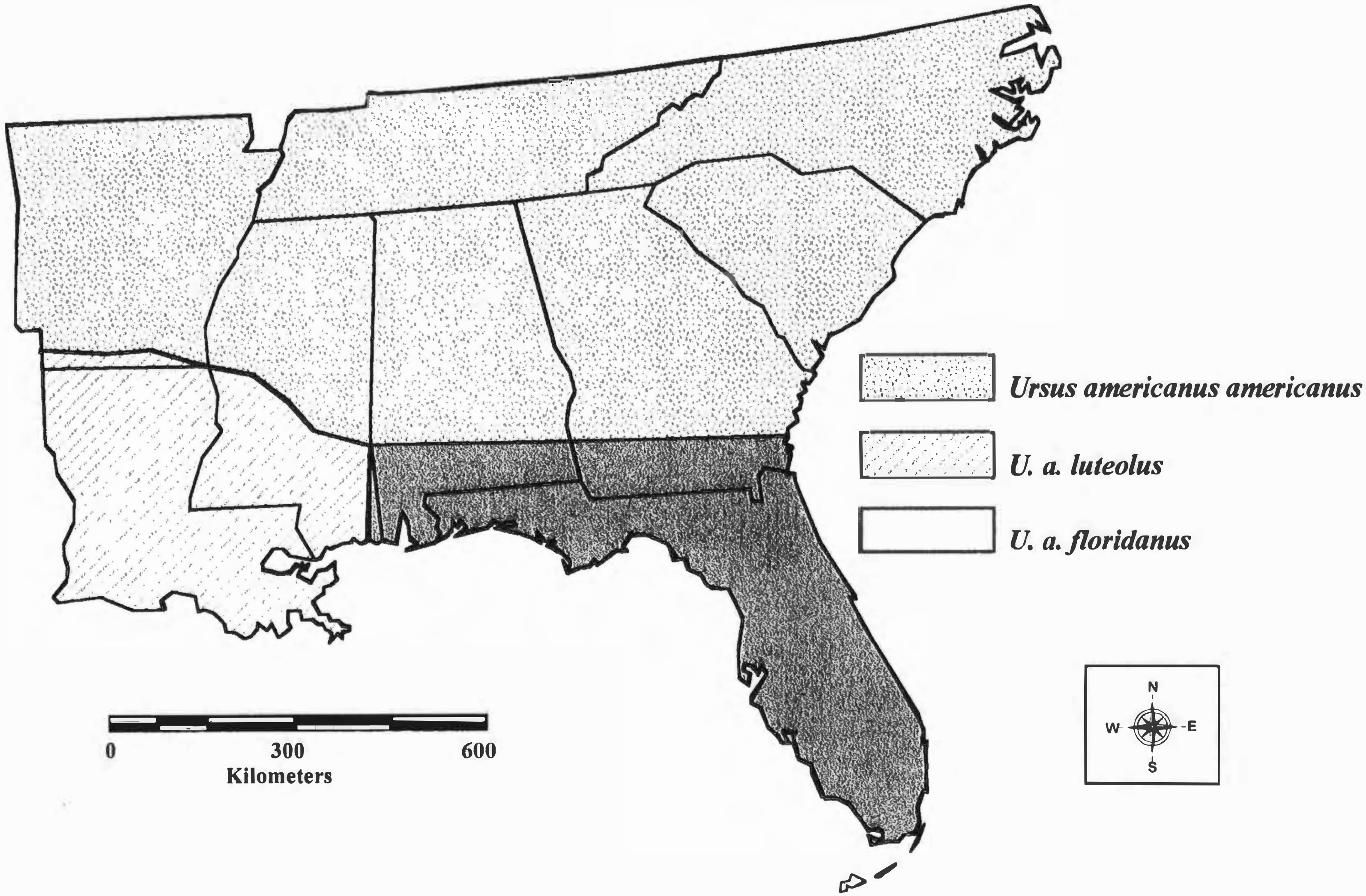

Figure 1. Historical distribution of 3 subspecies of black bears in the southeastern United States (modified from Hall 1981).

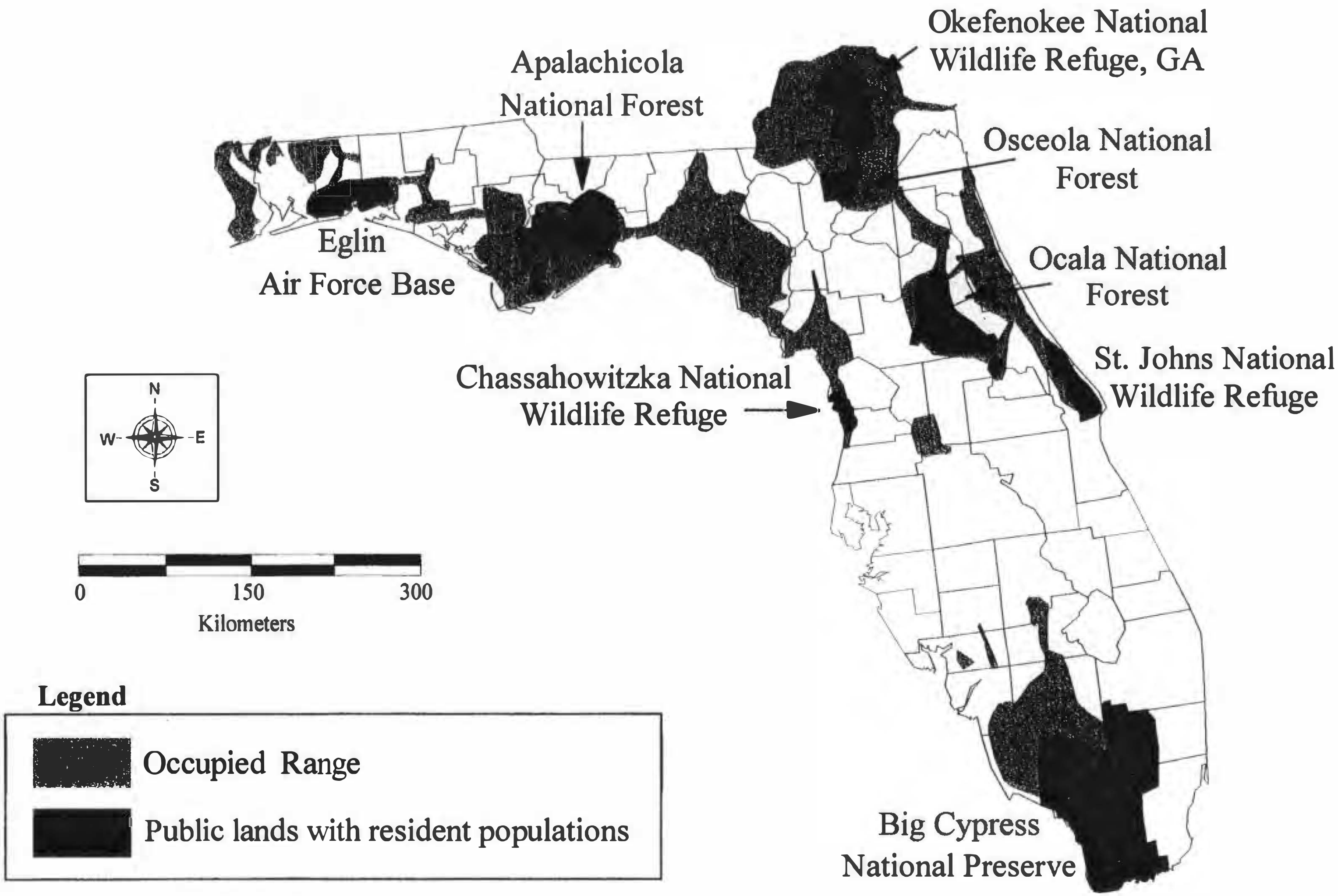

Figure 2. Distribution of black bears in Florida and vicinity (Modified from Pelton and van Manen, in press; and Cox et al. 1994).

the U. S. Fish and Wildlife Service (USFWS) was petitioned to list the Florida black bear as a threatened species under the Endangered Species Act of 1973. The USFWS concluded the Florida black bear warranted listing but was precluded due to the backlog of listing higher priority species (U.S. Dept. of Interior 1991). All black bear hunting seasons in Florida were terminated after the 1993-94 season.

Lack of information prompted research on several areas known to support stable populations: Osceola National Forest (Maehr and Brady 1982, Wooding and Hardisky 1988, Mykytka and Pelton 1989), Ocala National Forest (Maehr and Brady 1984, Wooding and Hardisky 1988), Apalachicola National Forest (Seibert 1993), and south Florida (Land 1994). Currently, research is being conducted on Osceola National Forest and Okefenokee National Wildlife Refuge in Georgia. Eglin Air Force Base (Eglin), located in the panhandle of Florida, contains a population that has not been studied until now.

Historical records from Eglin give little insight about black bears on the base. Before the 1940's, bears primarily were found in the swamps and along the larger river systems (Dept. of Defense [DOD]-Air Force 1962). By the mid-1940's, black bears were considered extirpated from the base. In 1949, 12 black bears were obtained from the Georgia State Game Commission and released on Eglin. By the early 1960's, hunters reported seeing several bears and many tracks where they had crossed sand roads (DOD-Air Force 1962). A survey conducted in the summer of 1964 indicated the presence of bears in several widely scattered areas. The population had reached a point where the stocking venture was considered a success and a limited bear hunt was being considered for 1965 (DOD-Air Force 1964). However, no hunting season was implemented.

Until recently the status of black bears on Eglin had not been monitored since the mid 1960's. An increase in bear sightings and bear/vehicle collisions prompted Eglin's Natural Resources Division to begin collecting baseline data in the early 1990's. All bear sightings were plotted on maps and bear tracks found on deer survey routes also were recorded during the fall season. Increased public awareness, indications of an increasing bear population, and lack of information on the bears prompted research on the population dynamics of black bears on Eglin in 1994. A better understanding of the dynamics of black bears on Eglin is needed for the long term survival of the species.

Because of the diversity of habitats throughout Florida, there may be regional differences in food habits. Food habits of Florida black bears have been studied in several areas of the state (Maehr and Brady 1982, 1984; Maehr and DeFazio 1985; Land 1994). However, little information has been collected from bears in the northwest panhandle of Florida.

In Florida, black bears use a wide variety of forest types, from temperate mixed hardwoods to subtropical plant communities (Maehr and Wooding 1992). Eglin is dominated by sandhills consisting of forests of widely-spaced pine (*Pinus* spp.) trees and sparse understory. Wooding and Hardisky (1994) found bear use of longleaf pine (*P. palustris*) communities was minimal on Ocala National Forest. However, historic management practices on Eglin have altered this community by changing the species composition. Today, many areas contain a dense oak (*Quercus* spp.) midstory and an understory of shrubs, briars, and saw palmetto (*Serenoa repens*). Mast crops produced by hardwood forests are an important food source for black bears in the southern Appalachians and elsewhere (Pelton 1989). Maehr and Brady (1984) found that soft mast crops such as saw palmetto were important components of the fall diet of black bears in other areas of Florida. Saw palmetto and oaks may be important for the survival of black bears on Eglin.

Fire is a natural ecological force in the southeastern coastal plain of the United States (McWhite et al. 1993). Prescribed burning can accomplish a wide range of objectives including habitat management, fuel hazard reduction, and site preparation. Wildfires and prescribed burning are known to improve habitat for deer (Crawford 1984), turkeys (Williams 1992), grizzly bears (Zager et al. 1983, Hamer and Herrero 1987), and black bears (Young and Beecham 1986, Costello and Sage 1994). Wildfires benefit grizzly bears by removing the forest canopy and creating fruit-producing shrub fields. Black bears showed a positive response to 10-70 year old burns due to the increased production of hard and soft mast species. However, little is known about the effects of annual fires on habitat use by black bears.

The time of year and intensity of a prescribed burn could have implications for bear management. Burning during the denning season could impact reproductive success and survival by causing den abandonment or den destruction (Land 1994). The influence of frequent fires on the availability and distribution of important foods may have adverse effects on black bears. It is important to assess the overall influence of fire management on Florida black bears.

This research is part of a 4-year study of the population dynamics of black bears on Eglin Air Force Base, Florida. Objectives of this study were:

(1) to determine the seasonal and annual diet of bears on Eglin,

(2) to determine seasonal and annual habitat use by bears,

and (3) to determine the effects of prescribed burning on habitat use by bears.

CHAPTER II

STUDY AREA

Location

Eglin Air Force Base totals 1,883 km^2 (Fig. 3) and occupies parts of Santa Rosa, Okaloosa, and Walton counties in Florida. It is bounded by the Choctawhatchee Bay and the Gulf of Mexico to the south and west, the Shoal and Yellow rivers and private land to the north, and highway 331 and private land to the east. Approximately 115 km of highways traverse Eglin (Fig. 4). Primary roads include state road 200, highways 20, 87, 123, 287, and 331, and 4-lane highway 85, which bisects Eglin into roughly 2 equal areas. Eglin includes nearly 42 km of rivers and 1,100 km of streams. The major drainages on the base are the East, Shoal, and Yellow Rivers, and Alaqua, Boiling, Rocky, Titi, and Turkey Creeks (Fig. 5).

Topography and Geology

The topography is characteristic of northwest Florida's rolling sandhills with numerous seepage streams. A typical seepage stream within the sandhills has its origin in a steephead, a unique feature found only in the southeastern coastal plain. Steepheads form where deep, unconsolidated sands overlie impermeable clay or limestone layers. Lateral movement of groundwater along the hardpan eventually reaches a slope face and washes away the sandy overburden, creating a natural depression which may expand to 30 m deep and over 300 m wide. At the erosional face of a steephead, the seep that

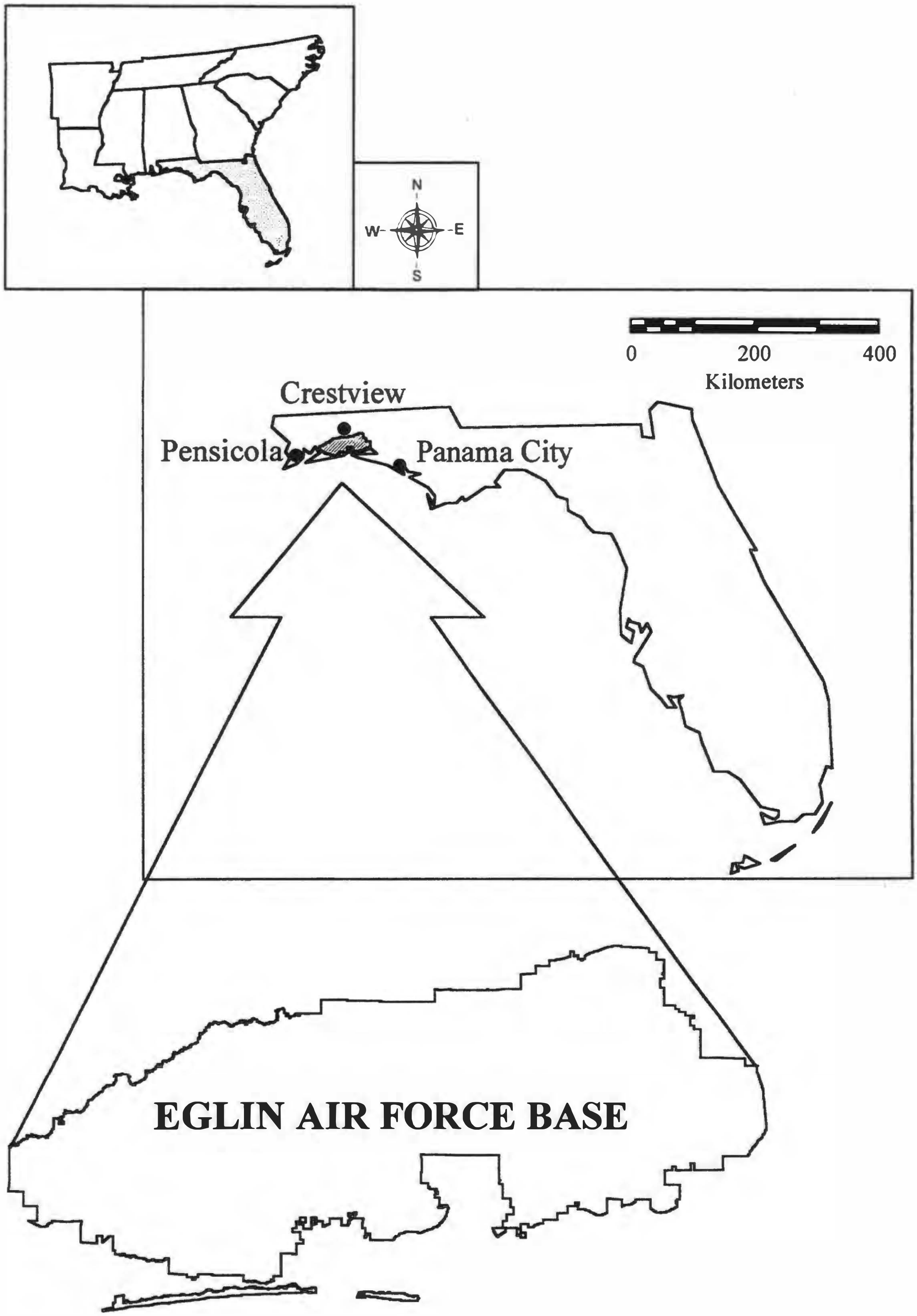

Figure 3. Geographic location of Eglin Air Force Base, Florida.

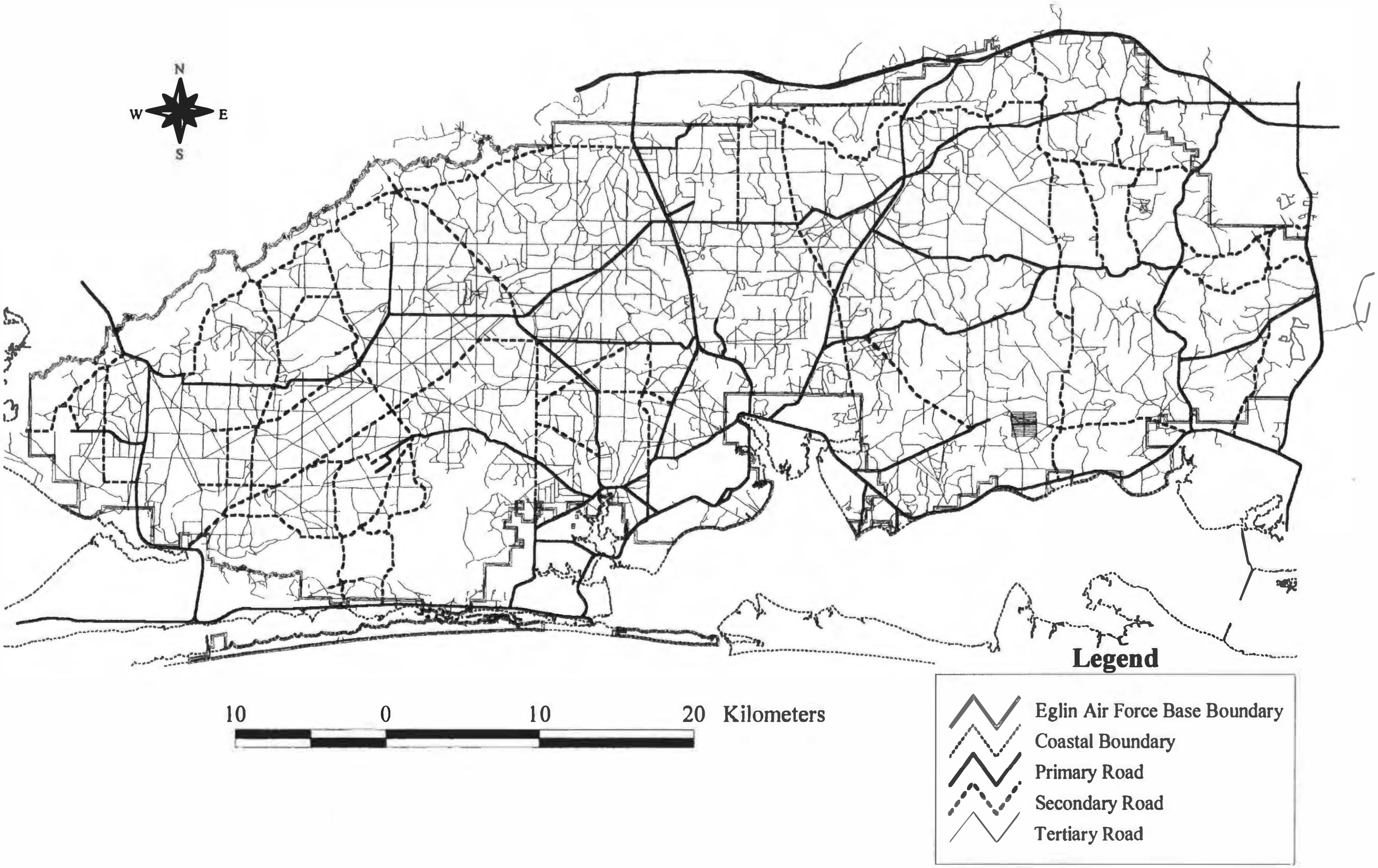

Figure 4. Location of primary, secondary, and tertiary roads on Eglin Air Force Base and vicinity, Florida, 1994-1996.

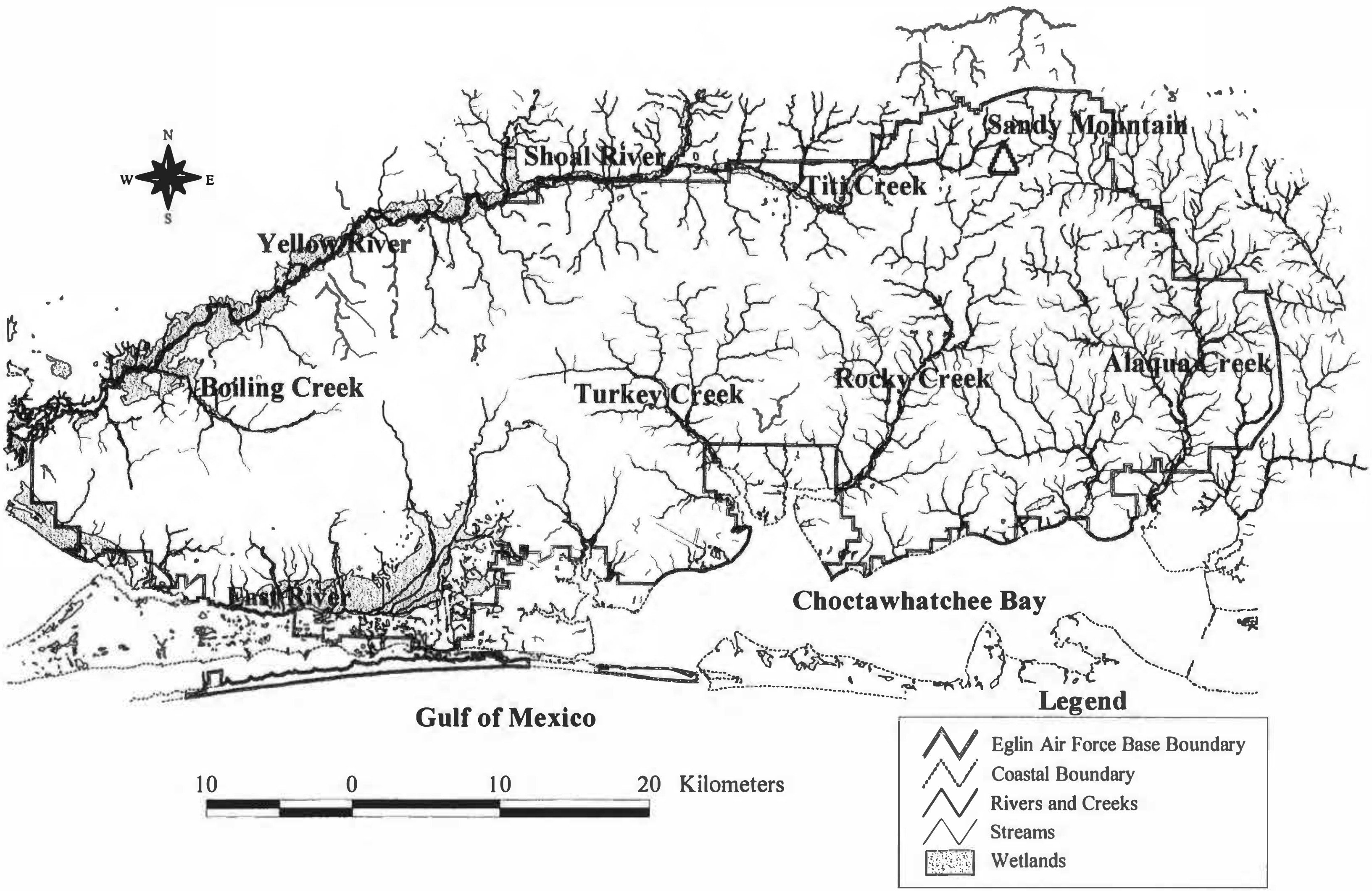

Figure 5. Location of rivers, creeks, streams, and wetlands on Eglin Air Force Base and vicinity, Florida, 1994-1996.

created the geologic feature feeds a seepage stream (The Nature Conservancy [TNC] 1995).

Elevation varies from sea level at Choctawhatchee Bay to 90 m at Sandy Mountain. A long ridge extends from Sandy Mountain, in a southwesterly direction to form a divide. Streams to the north of this divide flow into the Shoal and Yellow rivers and those to the south flow into Choctawhatchee Bay.

The soils are ocean-washed sediments. Most of the colloidal materials have been removed leaving a loose soil composed largely of quartz crystals. Because of the coarse texture of the soils, fertility is inherently poor. Eglin has 5 soil associations composed of 9 different soil series. Seventy-eight percent of the soils are deep sands of the Lakeland soil series, with sandy subsoils more than 2 m deep. Other soil associations include St. Lucie-Paola, Troup-Lakeland, Chipley-Lakeland-Rutledge, and Dorovan-Pamlico series (McWhite et al. 1993).

Climate

Annual temperatures at Eglin range from -13° to 42° C. The mean annual temperature is 19° C with approximately 275 freeze-free days per year. Freezing usually occurs between December and February. Rainfall averages 160 cm per year, increasing inland from the coast. July and August have the greatest amounts of rainfall with October having the least. A large portion of the summer rains are in the afternoon as a result of convection thunderstorms. These storms may be violent with rainfall amounts of 5-10 cm per hour.

The area is subject to frequent tornadoes and periodic hurricanes. The most recent hurricane whose center passed over Eglin was hurricane Opal in October 1995. Prior to this, Eglin had not suffered a direct hit since 1975 (McWhite et al. 1993). In August 1995, hurricane Erin made landfall within 32 km of Eglin. Weather data reveal more than 115 tropical storms have made landfall within 80 km of Eglin between 1871 and 1995, with an average of 1 tropical storm per year.

Fauna

Eglin is home to a diversity of wildlife species. Faunal surveys have identified 52 fish, 115 reptilian and amphibian, 335 avian, and 35 mammalian species (DOD-Air Force 1979). Endangered, threatened, and species of concern include 1 fish, 3 mammalian, 9 avian, and 9 amphibian and reptilian species (McWhite et al. 1993). Some of these species include the Florida black bear, Okaloosa darter (*Ethoestoma okaloosae*), which is endemic to Eglin, and the 3rd largest population of the red-cockaded woodpecker (*Picoides borealis*) in the nation (Provencher et al. 1996).

Principal game species include cottontail rabbit (*Sylvilagus floridanus*), eastern wild turkey (*Meleagris gallopavo*), gray squirrel (*Sciurus carolinensis*), mourning dove (*Zenaida macroura*), northern bobwhite (*Colinus virginianus*), white-tailed deer (*Odocoileus virginianus*), and wild hog (*Sus scrofa*). Bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and red fox (*Vulpes vulpes*) are the common predatory mammals. Raccoon (*Procyon lotor*) and opossum (*Didelphis virginiana*), are among the more common medium-sized mammals.

Flora

Plant communities are diverse and range from sandhills and upland hardwood stands to coastal barrier islands and wetland and riparian habitats. The Florida Natural Areas Inventory (FNAI) has documented 35 natural communities on Eglin (Provencher et al. 1996). The longleaf pine-wiregrass (*Aristida beyrichiana*) sandhills on Eglin represent the largest acreage of this natural community known to occur under a single ownership (TNC 1995). Eglin contains 59 of the 192 vascular plants and lichen taxa designated as rare by FNAI in the Florida Panhandle (TNC 1995). Of these, 1 is federally listed as endangered, 27 are federal candidate species, whereas 9 are listed by the state as endangered and 12 as threatened, and 10 are species of special concern (TNC 1995).

McWhite et al. (1993) described 6 major ecological associations and test ranges/administrative areas. They combined plant communities based on floral, faunal, and geophysical similarities. These areas are sandhills, wetlands/riparian, sand pine (*P. clausa*), flatwoods, pine/mixed hardwoods, barrier islands, and test ranges/administrative areas (Table A-1).

Seventy-eight percent of Eglin is dominated by sandhills, which primarily occur in the central and western portions of the base. Sandhills are characterized by gentle rolling hills dissected by numerous seepage streams. Sand pine covers 3% of Eglin occurring primarily in the southeast portion of the base. The majority of this association was originally part of the sandhills community. Because of the encroachment of sand pine, it has since become a sand pine-dominated forest.

The largest area (4,000 ha) of pine/mixed hardwoods occurs in the northeast portion of Eglin. Flatwoods are characterized by open canopy forests of widely spaced pine trees with little or no midstory. The understory consists of a dense ground cover of herbs and shrubs. Wetland and riparian areas are found throughout the base. The largest wetland areas occur along the Yellow and Shoal rivers on the northern boundary of Eglin and along the East river in the southwest portion of the base. Riparian areas are primarily closed canopy forests of upland hardwoods on steep slopes, bluffs, and ravines.

Eglin's barrier islands are found on 3 land tracts, all of which share the Gulf of Mexico as their southern boundary. Plant life has adapted to and is influenced by the salty environment. Trees and shrubs are often stunted due to strong winds, salt sprays, and fluctuating water tables. Trees are usually found in protected areas behind the dune line. There are 32 land test ranges on Eglin representing 10% of the total land area. Test ranges are maintained in an open grass condition. Large areas of open sand or clay are found where targets are constructed. Administrative areas consist of 4 urban complexes. The largest complex encompasses 4,000 ha, of which, 25% remains forested.

History and Land Use

In 1908, the western two-thirds of what is now Eglin was designated the Choctawhatchee National Forest (CNF) by presidential proclamation. The CNF was estimated to occupy 540 km^2. An aggressive land acquisition program was pursued to consolidate the land base. The production of naval stores was the primary objective until 1927 when the emphasis shifted to timber production. Extraction of gum turpentine also was conducted until the late 1930's. From the earliest day of settlement until 1927, large portions of Eglin's forest were frequently burned to provide palatable forage for livestock and to reduce fuel loads.

By 1940, the CNF had grown to approximately 1,385 km^2 and was transferred to the War Department for development and operation as an air proving ground. An additional 499 km^2 of inholdings were purchased to consolidate lands for military purposes. The majority of forests on this land were over-harvested and used for turpentine extraction. Today, the lack of old-growth longleaf pine on this portion of Eglin is a direct result of those practices.

Eglin is the largest military installation in the free world. Its primary mission is the development and testing of conventional munitions and sensor tracking systems. Numerous other training activities take place, including ground troop maneuvers, flight missions, and special operations. More than 203 km^2 have been cleared for airfields, test ranges, test sites, right-of-ways, and administrative areas. Eglin's Jackson Guard is charged with natural resources management while supporting the Air Force mission. Management decisions are implemented to ensure ecosystem viability and biodiversity while providing compatible uses such as outdoor recreation, watershed protection, and wildlife resources.

CHAPTER III

METHODS

Trapping, Handling, and Marking

I captured black bears from October to December in 1994, May through August in 1995, and April through August in 1996 with Aldrich spring-activated foot snares (Aldrich Animal Trap Co., Clallam Bay, Wash). Trapsites were established primarily in and along creek drainages and swamps, known bear travel routes, and in areas with signs of bear activity and placed 0.8 to 2 km apart. The western portion of Eglin was the primary focus of this study. I was able to cover approximately 70% of the western portion; 30% was cleared test ranges and military restricted areas.

I used trail and modified cubby trapsets to capture bears (Clark 1991; Brandenburg 1996; Jones 1996). Mobile home anchors were used to capture bears in areas with insufficient trees (e.g., roads and trails). Bait consisted of bakery products (e.g., sweet rolls and donuts) and artificial raspberry flavoring (Medallion International Inc., North Haledon, N.J.) to attract bears to trapsites. I usually checked traps by 1100 daily.

I immobilized captured bears with a mixture of Ketaset (200 mg/ml) (Ketamine hydrochloride, Bristol Laboratories, Syracuse, N.Y.), Rompun (100 mg/ml) (Xylazine hydrochloride, Haver-Lockhart, Inc., Shawnee, Ks.), and Carbocaine (20 mg/ml) (Mepivicaine hydrochloride, Winthrop Laboratories, New York, N.Y.) (KRC). KRC was administered with a jab stick or CO_2-powered dart pistol (Capchur, Palmer Chemical and Supply Co., Inc., Douglasville, Ga.) at a dosage of 1 ml per 22.7 kg (50 lbs) of estimated body weight. Liquamycin (Phizer Animal Health, New York, N.Y.) was administered at a dosage of 1ml per 22.7 kg of body weight to bears that had sustained minor injuries. I administered Yohimbine hydrochloride (Sigma Chemical Co., St. Louis, Mo.) intravenously at a dosage of 1 ml per 45.5 kg of body weight as an antagonist to Rompun (Garshelis et al. 1987).

Upon initial capture, I tattooed a permanent identification number to the inside upper lip and inner thigh of each bear. Numbered metal tags, which matched the tattoo identification number, were placed in both ears of each bear. Also, a radio-collar (Telonics, Inc., Mesa, Ariz.) was placed on each bear. Leather spacers were used as a breakaway function on each radio-collar.

I extracted a first premolar tooth and sectioned and stained them for age identification by cementum annuli counts (Willey 1974, Eagle and Pelton 1978). Three separate individuals, myself included, independently aged bear premolars to year class. If we disagreed on age determination for a sample, we reexamined the tooth until we reached a consensus. Bears were weighed with a spring scale and general body measurements recorded including total length, head length and width, shoulder height, zygomatic, neck, chest, and forearm circumference, ear length, length and width of the front and hind foot pads, and teat or baculum length. I monitored body temperature and recorded descriptive information including general bear condition, prominent scars or wounds, parasite load, and anomalies on each bear.

Radio Telemetry

I monitored 19 radio-collared bears from November 1994 to October 1996. I located most bears 2-5 times per week. Bears were located from roads with a TR-2 or TR-4 receiver (Telonics, Inc., Mesa, Ariz.) and a 5-element, vehicular roof-mounted antenna (Wildlife Materials, Carbondale, Ill.), or 2-element "H" antenna (Telonics, Inc., Mesa, Ariz.). Whip antennas and aerial flights from a Cessna 172 were also used to locate animals that could not be found from the ground.

I established telemetry stations at known locations that could be accurately identified on U. S. Geological Survey (USGS) topographic maps. Each telemetry station was plotted and an identification (ID) number and Universal Transverse Mercator (UTM) coordinates were recorded to the nearest 10 m.

I determined bear locations through triangulation with at least 2 azimuths by the loudest signal method (Springer 1979, Mech 1983). Azimuths were selected based on the following criteria: (1) the angle between all azimuths was between 60° and 120°; (2) the time interval between all azimuths was ≤ 20 minutes; (3) signal strength was good; and (4) the distance between the receiver and the animal in question was closest using the selected azimuths. Telemetry data was entered into the software program Telem 88 (Coleman and Jones 1988). Generated output included bear ID, date, time, and UTM coordinates.

I also obtained sequential locations every hour during 24-hour tracking periods (diel locations). One to 4 radio-collared bears were monitored during each 24-hour tracking period and diel locations on radio-collared bears were recorded 1 to 2 times during the early summer, late summer, and fall seasons.

Home Range Estimation

I used the adaptive kernel method (Worton 1989) with the software program CALHOME (Kie et al. 1994) to estimate seasonal and annual home ranges of bears. The adaptive kernel method is a nonparametric method that requires no assumptions about underlying distributions (Worton 1989) and the effect of outliers is small.

Because movements by bears likely depend on past experiences, no 2 telemetry locations are truly independent (Powell 1987, Clark 1991). Garshelis (1978) determined that a bear usually could move between any 2 points in a home range within approximately 6 hours. Observations of bear movements on Eglin revealed that bears could move between any 2 points in their home range within an 8-hr period. Therefore, I used only locations taken ≥ 8 hours apart for home range analysis.

I estimated annual home ranges for 9 black bears (3F, 6M) based on 1,379 location estimates after eliminating locations < 8 hours apart. Seasonal home ranges for summer and fall were calculated for 10 black bears (3F, 7M) based on 785 and 529 location estimates, respectively. Locations from early summer and late summer were combined to attain adequate sample sizes.

I determined home range stability by plotting home range size against the number of location estimates for 95% Adaptive Kernel (AK) and 95% Minimum Convex Polygon (MCP) (van Manen 1994). Home ranges stabilized between 70-80 locations for 95% AK and 95% MCP. Therefore, annual home range perimeters were calculated for bears that had 70 or more locations and were monitored ≥ 9 months.

Food Habits Analysis

Between November 1994 and October 1996, I collected 259 scats to determine the major food items in the annual and seasonal diet of bears on Eglin. Scats were collected at capture sites, daybeds, den sites, and while scouting for new trap sites. Radio telemetry was used to aid in locating scats in foraging areas, bedding areas, and den sites. Because scats were collected in many different locations on Eglin and in all types of habitat throughout the collection period, any bias due to scat location should be minimal. Scats were placed in ziploc bags, labeled with date collected, and frozen until analysis could be conducted.

I thawed and washed scats through a series of sieves with openings of 7, 2, and 0.15 mm to separate food particles of equal size. Individual food items were identified to the lowest possible taxon. Frequency of occurrence and volume percent were determined both seasonally and annually for each food item (Korschgen 1980). Volume percent was visually estimated for individual food items in each scat. Food items were grouped into 5 categories: tree fruit, shrub/vine fruit, animal matter, vegetation, and debris. Seasons were determined by major shifts in bear food habits: winter - 1 February to 31 March; spring - 1 April to 31 May; early summer - 1 June to 31 July; late summer - 1 August to 30 September; and fall - 1 October to 31 January.

Habitat Use Analysis

To determine seasonal and annual habitat use by black bears on Eglin AFB, Florida, I used compositional analysis (Aebischer et al. 1993). This technique is based on the log-ratio analysis of compositions (Aitchison 1986). A composition is a set of components summing to 1.

I chose compositional analysis to evaluate habitat use because it overcomes several problems associated with other methods. When the animal rather than the radio location (e.g., Smith et al. 1982, Byers et al. 1984, Chi-square analysis, log-linear models) is taken as the sampling unit, the problems of non-independence from serial correlation and variations between animals are eliminated. Also, when habitats are analyzed individually, an animal's avoidance of 1 habitat usually leads to an apparent preference for other habitats (e.g., Neu et al. 1974, Quade 1979). Therefore, interpretation of absolute preference or avoidance of habitats is difficult. Compositional analysis determines which habitats are used more or less than expected by chance, taking into account use of other habitats. The Johnson (1980) method takes into account habitat use in relation to other habitats, but cannot test for differential habitat use by groups of animals (e.g., age or sex class). Compositional analysis can test for differential habitat use by sex, age, season, or other factors because it uses a multivariate analysis of variance.

Aebischer et al. (1993) describes an animal's movements as a trajectory through space and time and an animal's habitat use as the proportion of the trajectory contained within each habitat type. Radio-telemetry data can be used to approximate the trajectory by sampling it at discrete intervals. If sampling is representative and sufficiently frequent to record little-used habitats, then the proportion of radio locations in each habitat estimates the proportion of the trajectory in each habitat. Therefore, serial correlation between radio locations becomes irrelevant; more frequent sampling more closely approximates the trajectory, thus providing a more precise estimate of proportional habitat use.

Because habitat use by a population is that of the "average" member, it should be estimated from the trajectories of a random sample of individuals from the population. Therefore, the sample size is the number of tracked animals. The number of radio locations only determines the accuracy of reconstructed trajectories.

There are several assumptions to the compositional analysis of habitat use: (1) each animal provides an independent measure of habitat use within the population; (2) compositions from different animals are equally accurate; (3) residuals maintain a multivariate normal distribution; and (4) each animal uses all available habitat types.

Because the number of radio locations was not consistent for all bears, I weighted each bears habitat composition by the square root of the number of locations to satisfy assumption #2 (Aebischer et al. 1993). Also, all available habitat types were not used by every bear (violation of assumption #4). Aebischer et al. (1993) describes that a zero value implies that use is so low that it is not detected, and this meaning should be preserved in the analysis. Therefore, a replacement value less than the smallest recorded non-zero proportion should be substituted for a zero value.

Aebischer et al. (1993) tested the effects of substituting 1, 0.1 0.01, 0.001, and 0.0001% for 0% use values. Results were robust with respect to the choice of value to replace a 0% use value with no effect on within-home-range comparisons. Therefore, I replaced all 0% use values with 0.001%, which is less than any existing value in either available or utilized compositions to satisfy assumption #4.

I obtained digitized habitat information for the study area from the Natural Resources Division, Jackson Guard, Eglin AFB and converted them into Arc/Info (Environmental Systems Research, Inc., Redlands, CA). Arc/Info is a vector-based Geographic Information System (GIS) with map features stored as points (e.g., bear locations), arcs (e.g., roads), or polygons (e.g., habitat types).

For analysis, I established 5 habitat associations based on the 6 ecological associations described earlier: sandhills, pine production areas, riparian zones, swamps, and open areas (Fig. 6). Because pine production areas are managed strictly for timber and pulp wood production (McWhite et al. 1993), pine production areas were separated from sandhills to determine their use by bears. I created riparian zones for 4 reasons: (1) to separate the habitat associated with seepage streams from sandhills and pine production areas; (2) radio-collared bears were frequently located near streams; (3) plant species found along streams were rarely found in the upland sandhills; and (4) many streams were not identified on the habitat map obtained for analysis. Open areas consisted of cleared airfields, test ranges, right-of-ways, clearcuts, and sewage spray fields.

I classified riparian zones as the habitat within 50 m of a river and 25 m of a stream; these distances were selected because they generally represented where the vegetational composition differed between riparian zones and other habitat associations.

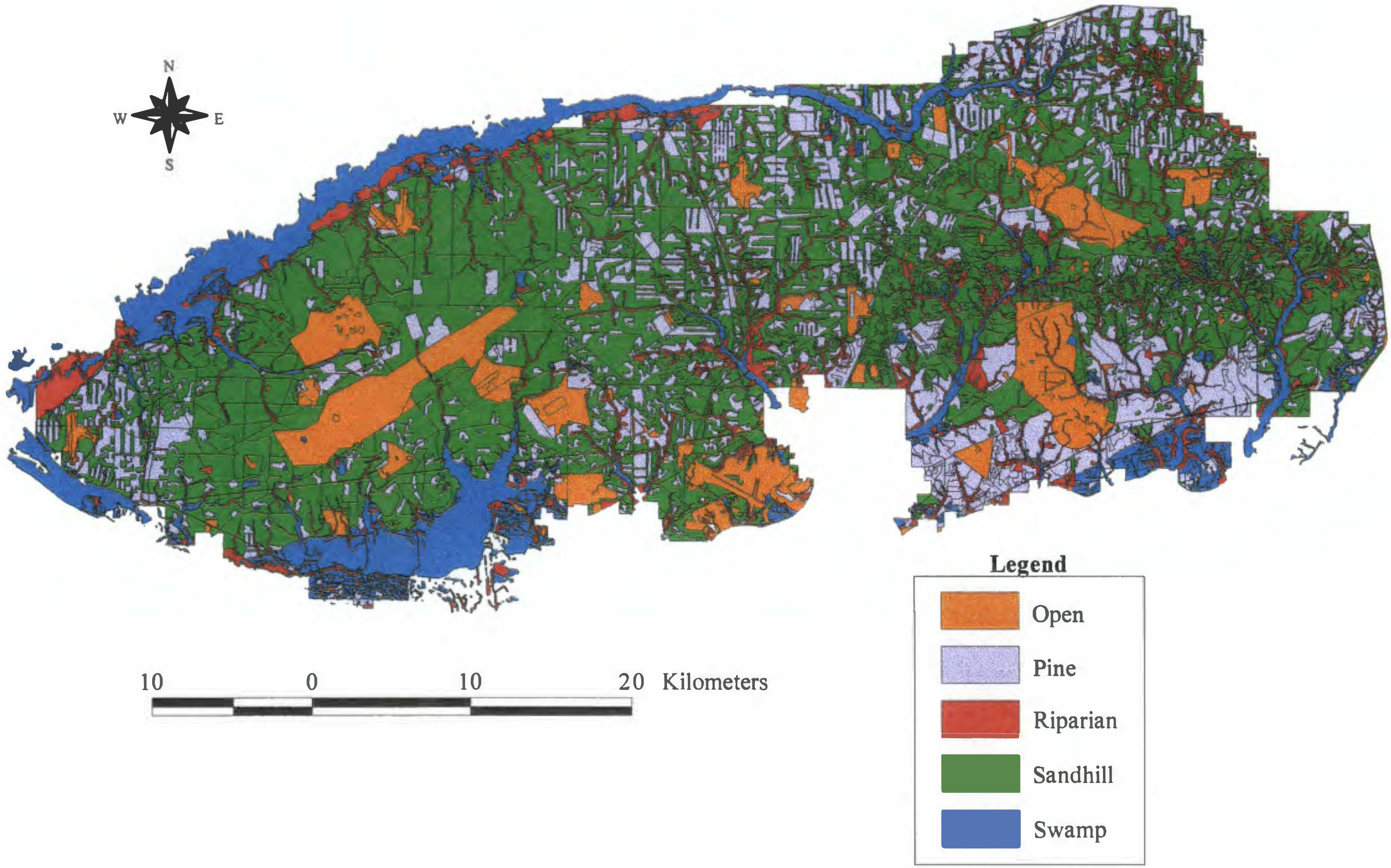

Figure 6. Distribution of habitat associations on Eglin Air Force Base and vicinity, Florida.

A GIS coverage of the riparian zones was created using an overlay procedure (BUFFER in Arc/Info). Home range perimeters of radio-collared bears were used to develop seasonal and annual home range coverages in Arc/Info. The proportion of each habitat association within seasonal and annual home ranges of bears was determined by superimposing home ranges on the habitat coverage with an overlay procedure (CLIP in Arc/Info).

I developed a location coverage for each bear in Arc/Info using the UTM coordinates of bear locations. To determine the seasonal and annual habitat use for radio-collared bears, bear locations were superimposed on the habitat coverage with an overlay procedure (IDENTITY in Arc/Info) to determined the frequency of bear locations within each habitat association.

I applied a log-ratio transformation to each individual bears available (AK home range) and utilized (number of locations) habitat composition. Next, tests for normality of differences in log-ratios were conducted using PROC UNIVARIATE in SAS (SAS 1989). Next, the log-ratios were entered into a multivariate regression to test for differential habitat (PROC GLM) and 999 permutations of the data were conducted to determine if the P-value obtained was valid. If I detected significant nonrandom use with $\alpha = 0.05$, then the pairwise differences between matching log-ratios were compared to determine where use deviated from random. A multivariate analysis of variance was conducted to calculate a covariance matrix of residuals to rank habitat associations in order of increasing relative use. This application of compositional analysis is similar to

Johnson's (1980) rank-based method; the difference is the switch from ranks to logarithms.

Finally, I tested for normality of the ranking matrix data (PROC UNIVARIATE). If the distribution of the ranking matrix data are not normal, Aebischer et al. (1993) suggests using a randomization test. However, the median sign test is designed to test if a population differs from zero when there are normality or equal variance problems. Therefore, a nonparametric median sign test was used to determine P-values of ranking matrix data when the distribution of ranking means were not normal.

Triangulation Error Analysis. I estimated telemetry error during June and July 1995 and 1996 by placing radio-collars in areas where bears were typically located to simulate actual bear locations and signal strength. All observers located test collars using the triangulation methods described earlier. The distance from the estimated location to the true location were determined for each observer to obtain an error distribution (Schmutz and White 1990).

I tested the effect of telemetry error on the habitat analysis by incorporating a weighted telemetry error into a simulated set of locations. Because the number of locations and mean error were different between observers, error distances were weighted by the percent of locations collected by each observer. The weighted distribution was then divided into 10-m error intervals and the number of random locations needed to approximate the weighted distribution was calculated for each 10-m interval. The error distance was applied as the radius around randomly selected radio locations. Within the error distance radius, uniform random locations were created. A GIS coverage was created using the simulated error locations for each bear. Habitat characteristics were recorded for each set of simulated error locations for comparison with the habitat characteristics of the original telemetry locations.

Fire Analysis

I obtained digitized prescribed burning information for the study area from the Natural Resources Division, Jackson Guard, Eglin AFB and converted them into Arc/Info. Fire information was obtained for years 1988 through 1996. To determine the affects of time on bear use of burned areas, each year was analyzed separately. Because 1995 was the first full year of telemetry data collection, it was considered year 0. Therefore, bear use of burned areas was determined for 0 to 7 year-old burns. For 1996, I determined annual and summer preburn and postburn use by bears. The frequency of locations within burned areas before and after the areas were burned was determined. Also, areas that were burned in multiple years were categorized under the most recent year burned.

For each year, the proportion of burned areas was determined within annual and seasonal home ranges of bears by superimposing home range coverages on the yearly burned areas with an overlay procedure (CLIP in Arc/Info). To determined the annual and seasonal use of burned areas for radio-collared bears, bear locations were superimposed on the burn coverages with an overlay procedure (IDENTITY in Arc/Info) to determine the frequency of locations within burned areas for each year.

To determine bear use of burned areas for each year, I categorized burned areas as a separate habitat association. The proportion of each habitat association previously assigned to burned areas that were identified within each bears seasonal and annual home range was determined using an overlay procedure (IDENTITY in Arc/Info). The proportion of each habitat association within seasonal and annual home ranges was recalculated by subtracting the amount each habitat identified in burned areas from the previously assigned habitat proportions.

To determine seasonal and annual use of burned areas for 1988-96 by black bears, I used compositional analysis (Aebischer et al. 1993). This method (described earlier) ranks burned areas for each year in relation to the other habitat associations for annual and seasonal use.

CHAPTER IV

RESULTS

Trapping

Between November 1994 and August 1996, I captured 24 bears (8F, 16M) a total of 38 times. I marked 2 additional male bears during the study; one was hit by a vehicle, and another was captured by FGC and transplanted to Eglin AFB (Table B-1).

In 1994, 328 trap nights produced 5 captures of 4 different bears with a trap success rate of 1 capture per 65 trap nights. In 1995, 963 trap nights produced 20 captures of 15 different bears with a trap success rate of 1 capture per 48 trap nights. In 1996, 1,186 trap nights produced 13 captures of 10 different bears or 1 capture per 91 trap nights. The age of marked bears ranged from 1.5 to 10.5 years (Table B-1).

Radio Telemetry

I collected 2,331 location estimates of 19 radio-collared bears (5F, 14M) during the study (Fig. 7). I obtained 612 of those location estimates during 24-hr diel tracking sessions on 8 bears (3F, 5M).

Home Range

Annual home range size was different for males and females (Table 1, Figs. 8 and 9). The average annual 95% AK home range was 351 km^2 for males (n = 6) and 88 km^2 for females (n = 3). Male 95% AK home ranges were larger in summer (258 km^2) than in

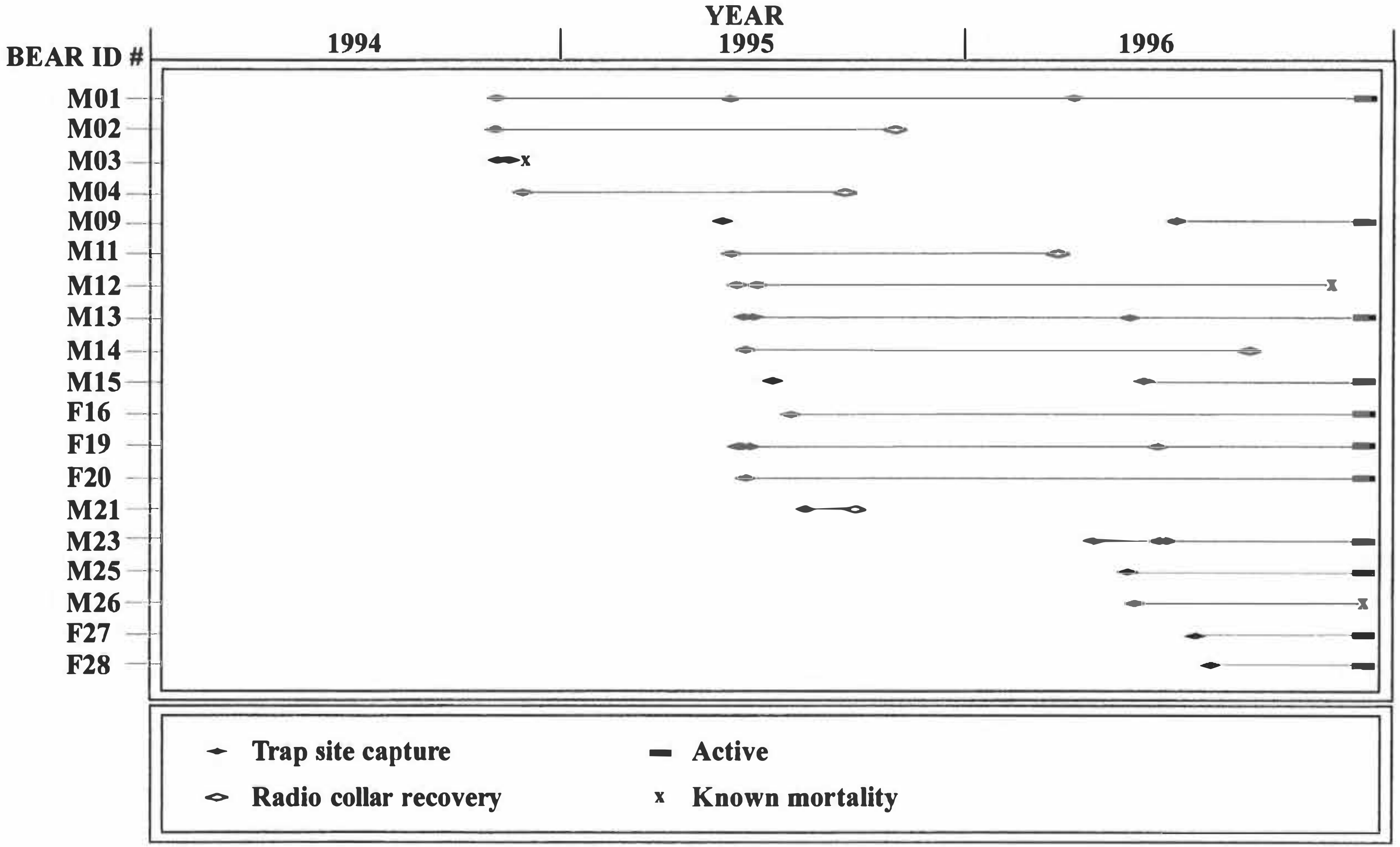

Figure 7. Monitoring history of radio-collared black bears on Eglin Air Force Base, Florida, 1994-1996.

Table 1. Estimates of annual and seasonal adaptive kernel home range sizes (km^2) of black bears on Eglin Air Force Base, Florida, 1994-1996.

	%	Females				Males			
		$\bar{x}$	SD	*n*	Range	$\bar{x}$	SD	*n*	Range
Annual	100%	208.1	84.2	3	110.9-259.4	736.4	344.4	6	360.9-1266.0
	95%	87.5	32.8	3	50.2-111.6	350.7	181.2	6	159.7-631.9
	50%	8.6	0.4	3	8.3-9.1	42.3	33.4	6	17.1-99.8
	%	Females				Males			
		$\bar{x}$	SD	*n*	Range	$\bar{x}$	SD	*n*	Range
Summer	100%	113.2	3.9	3	108.7-115.5	473.0	323.6	7	187.5-927.7
	95%	53.7	5.9	3	49.9-60.5	258.4	168.2	7	69.8-572.4
	50%	8.4	2.2	3	6.7-10.9	47.7	42.1	7	12.0-126.1
	%	Females				Males			
		$\bar{x}$	SD	*n*	Range	$\bar{x}$	SD	*n*	Range
Fall	100%	130.9	69.5	3	61.8-200.9	205.3	167.1	7	24.7-431.6
	95%	73.3	40.5	3	27.1-103.0	115.1	111.6	7	24.0-314.6
	50%	6.8	2.4	3	4.1-8.2	13.6	12.4	7	2.2-37.9

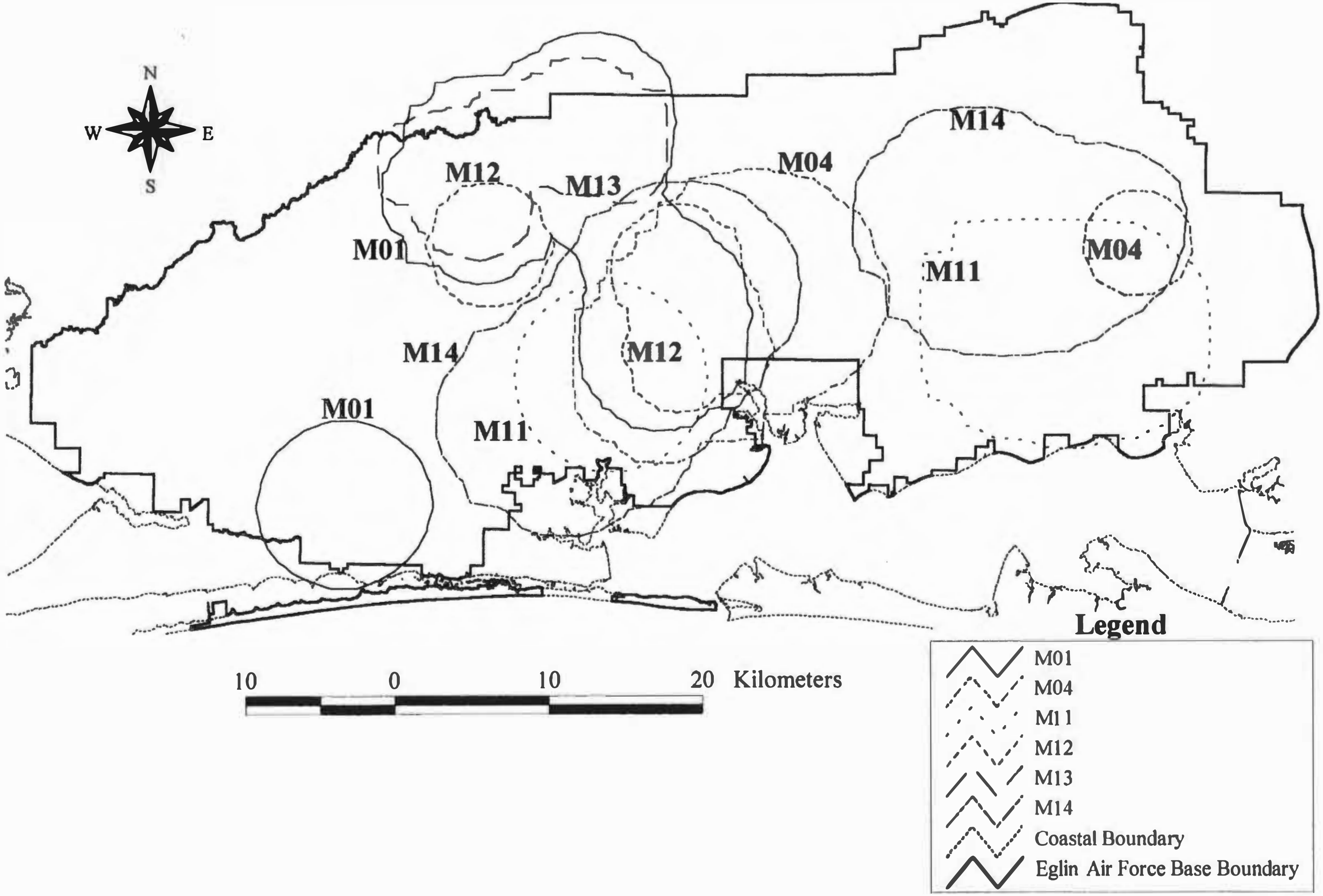

Figure 8. Annual 95% adaptive kernel home ranges of male black bears on Eglin Air Force Base, Florida, 1994-1996.

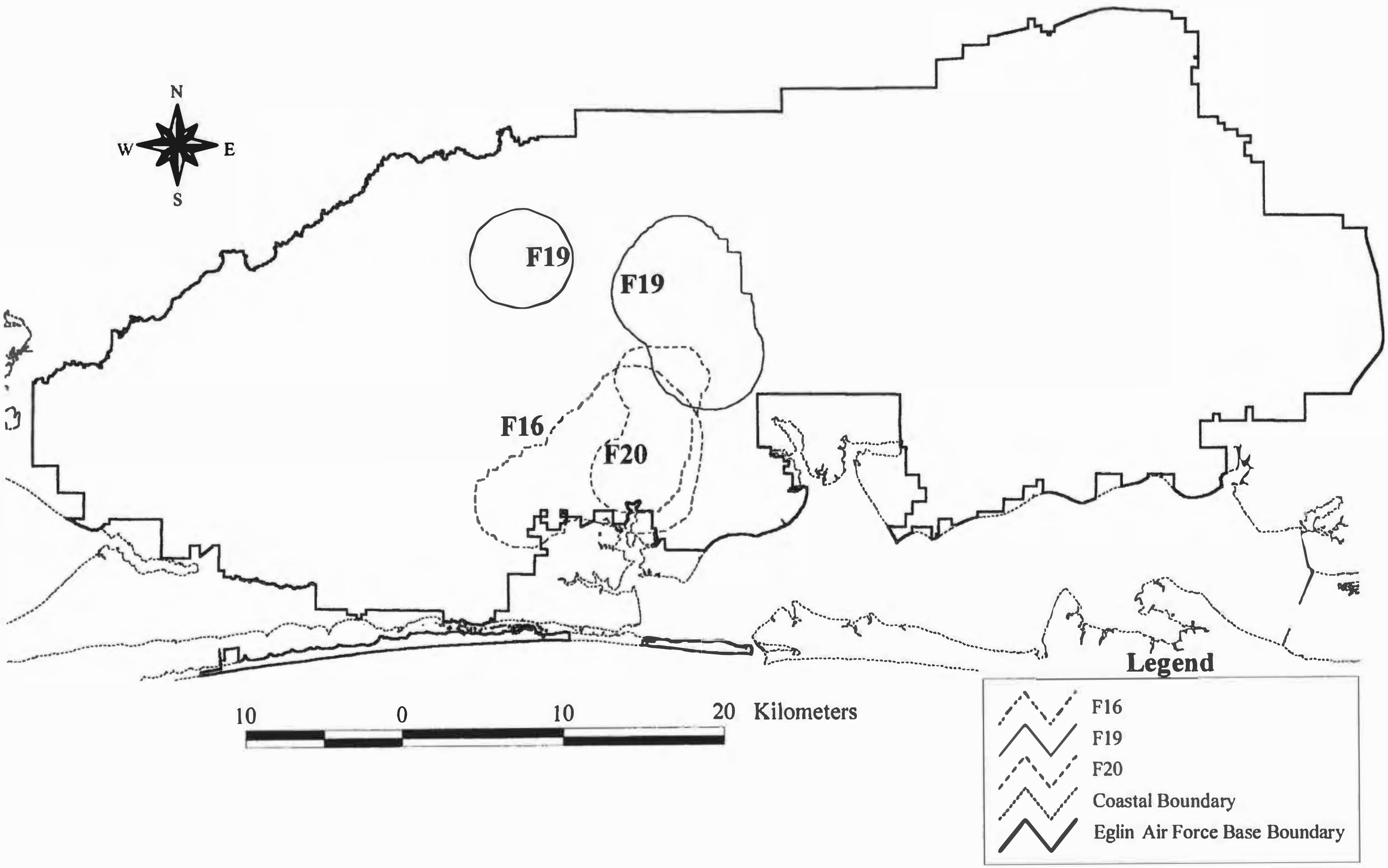

Figure 9. Annual 95% adaptive kernel home ranges of female black bears on Eglin Air Force Base, Florida, 1994-1996.

fall (115 km^2) (Table 1, Fig. 10). Conversely, female 95% AK home ranges were smaller in summer (54 km^2) than in fall (73 km^2) (Table 1, Fig. 11).

Feeding Ecology

Between November 1994 and October 1996, I collected 259 scats to determine the major food items in the diet of bears on Eglin. Thirty separate food items were identified. Eighty-one percent (by volume) of the diet of bears was of plant origin.

Spring diet was dominated by debris (unidentified material, soil, and wood particles) (Table 2, Fig. 12); these were probably ingested while foraging for beetles (Coleoptera) and yellow jackets (Hymenoptera). Beetles and yellow jackets were the primary form of animal matter found in spring scats. The fleshy material (hearts) of saw palmetto occurred in 1/3 of the spring scats and accounted for 23% of the volume. Vertebrate species identified in spring scats were armadillo (*Dasypus novemcinctus*), opossum, and white-tailed deer.

Early summer diet was dominated volumetrically by shrub/vine fruit. Blueberries (*Vaccinium* spp.) and Florida anise (*Illicium floridanum*) accounted for 55% of the early summer scats by volume. The fleshy material of saw palmetto occurred in 18% of scats examined. Animal matter was dominated by beetles occurring in 68% of early summer scats. White-tailed deer was identified in 2 scats collected during early summer.

Late summer diet was dominated by sweet gallberry (*Ilex coriacea*) and acorns (*Quercus* spp.). Sweet gallberry accounted for approximately one-third of the diet by volume. Black bears switched to acorns in mid-September. Acorns represented 25% of

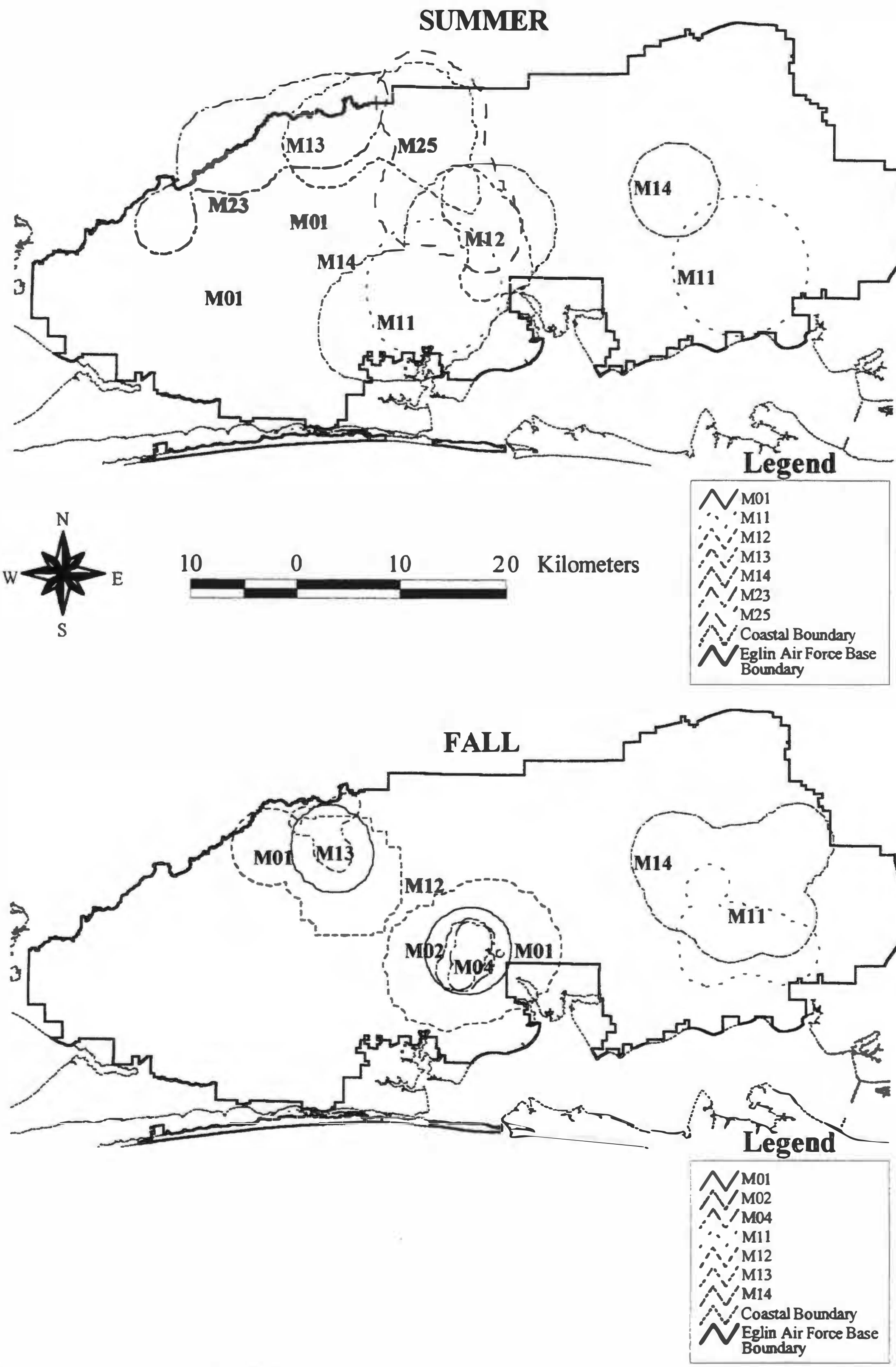

Figure 10. Summer and fall 95% adaptive kernel home ranges of male black bears on Eglin Air Force Base, Florida, 1994-1996.

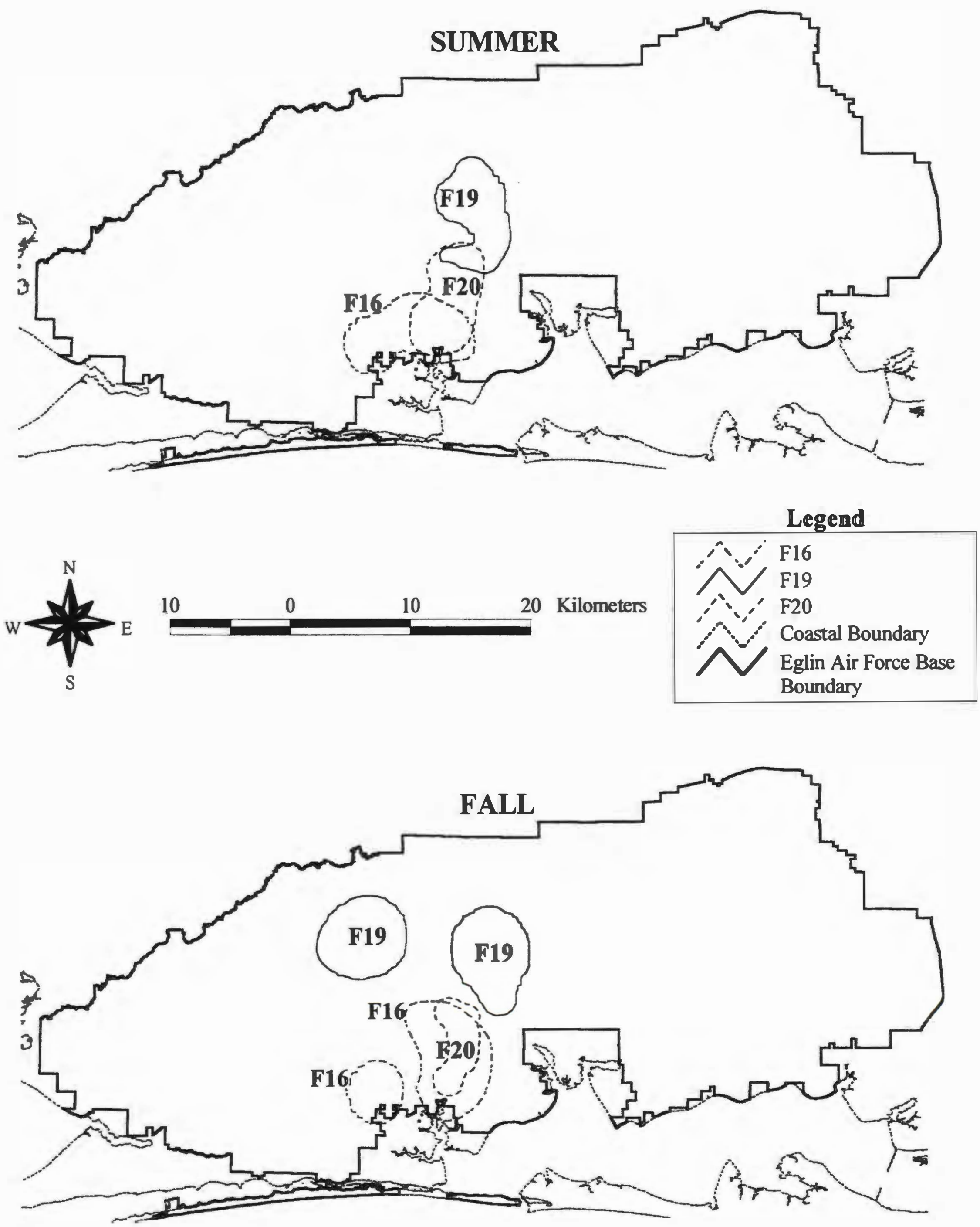

Figure 11. Summer and fall 95% adaptive kernel home ranges of female black bears on Eglin Air Force Base, Florida, 1994-1996.

Table 2. Occurrence (%) and volume percent of items identified in black bear scats collected on Eglin Air Force Base, Florida, 1994-1996.

	% Occurrence / % Volume					
Food Item	**Spring (*n* = 27) O V**	**Early Summer (*n* = 62) O V**	**Late Summer (*n* = 26) O V**	**Fall (*n* = 108) O V**	**Winter (*n* = 36) O V**	**Total (*n* = 259) O V**
Tree Fruit	30 / 13	1 / T	50 / 37	73 / 70	1 / T	37 / 33
Cliftonia monophylla			4 / T		3 / T	1 / T
Diospyros virginiana			8 / T			1 / T
Nyssa spp.			38 / 12	9 / 3		8 / 2
Quercus spp.	30 / 13	1 / T	38 / 25	72 / 67	3 / T	38 / 31
Shrub and Vine Fruit	0 / 0	69 / 60	73 / 54	35 / 27	64 / 39	32 / 37
Galussacia spp.			8 / 4			1 / T
Ilex coriacea		1 / T	46 / 29			5 / 3
Ilex glabra				2 / T	3 / T	1 / T
Ilex spp.		5 / 2			3 / T	2 / 1
Illicium floridanum		15 / 11				3 / 3
Myrica inodora		3 / 3	19 / 12			3 / 2
Rubus spp.		3 / T				1 / T
Serenoa repens				30 / 26	19 / 15	15 / 13
Smilax spp.		6 / T	4 / T	6 / 1	50 / 23	11 / 4
Vaccinium spp.		64 / 44	15 / 1			17 / 11
Vitis rotundifolia		5 / T	19 / 8			3 / 1

Table 2 (Continued).

	% Occurrence / % Volume					
Food Item	**Spring (*n* = 27) O V**	**Early Summer (*n* = 62) O V**	**Late Summer (*n* = 26) O V**	**Fall (*n* = 108) O V**	**Winter (*n* = 36) O V**	**Total (*n* = 259) O V**
Animal Matter	74 / 29	69 / 7	77 / 1	40 / 1	56 / 19	56 / 8
Araneae		1 / T				T / T
Coleoptera	48 / 7	68 / 6	65 / 1	24 / 1	58 / 18	46 / 5
Diptera			4 / T			T / T
Formicidae		1 / T				T / T
Hymenoptera	37 / 16	1 / 1		6 / T		7 / 2
Orthoptera		1 / T			3 / T	1 / T
Phasmatodea		3 / T				1 / T
Dasypus novemcinctus	4 / 4					T / T
Didelphis virginiana	4 / T		4 / T			1 / T
Odocoileus virginianus	4 / T	3 / T			3 / 1	2 / T
Sylvilagus floridanus				1 / T		T / T
Ursus americanus	4 / T	11 / T	11 / T	6 / T	11 / T	8 / T
Mammal - Unknown	4 / 2			1 / T		1 / T
Meleagris gallopavo				1 / T		T / T
Avian - Unknown		3 / T		1 / T		1 / T

Table 2 (Continued).

	% Occurrence / % Volume					
Food Item	**Spring (*n* = 27)** O V	**Early Summer (*n* = 62)** O V	**Late Summer (*n* = 26)** O V	**Fall (*n* = 108)** O V	**Winter (*n* = 36)** O V	**Total (*n* = 259)** O V
Vegetation	63 / 26	21 / 14	8 / T	3 / T	44 / 27	20 / 10
Serenoa repens	33 / 23	18 / 11			19 / 9	11 / 6
Graminae	19 / 3	3 / T	4 / T		3 / T	3 / T
Unknown		11 / 2	4 / T	3 / T	25 / 18	8 / 3
Debris	67 / 32	50 / 19	23 / 8	11 / 2	39 / 15	31 / 12

O = Percent occurrence
V = Volume percent
T = Trace amount (<1.0%)

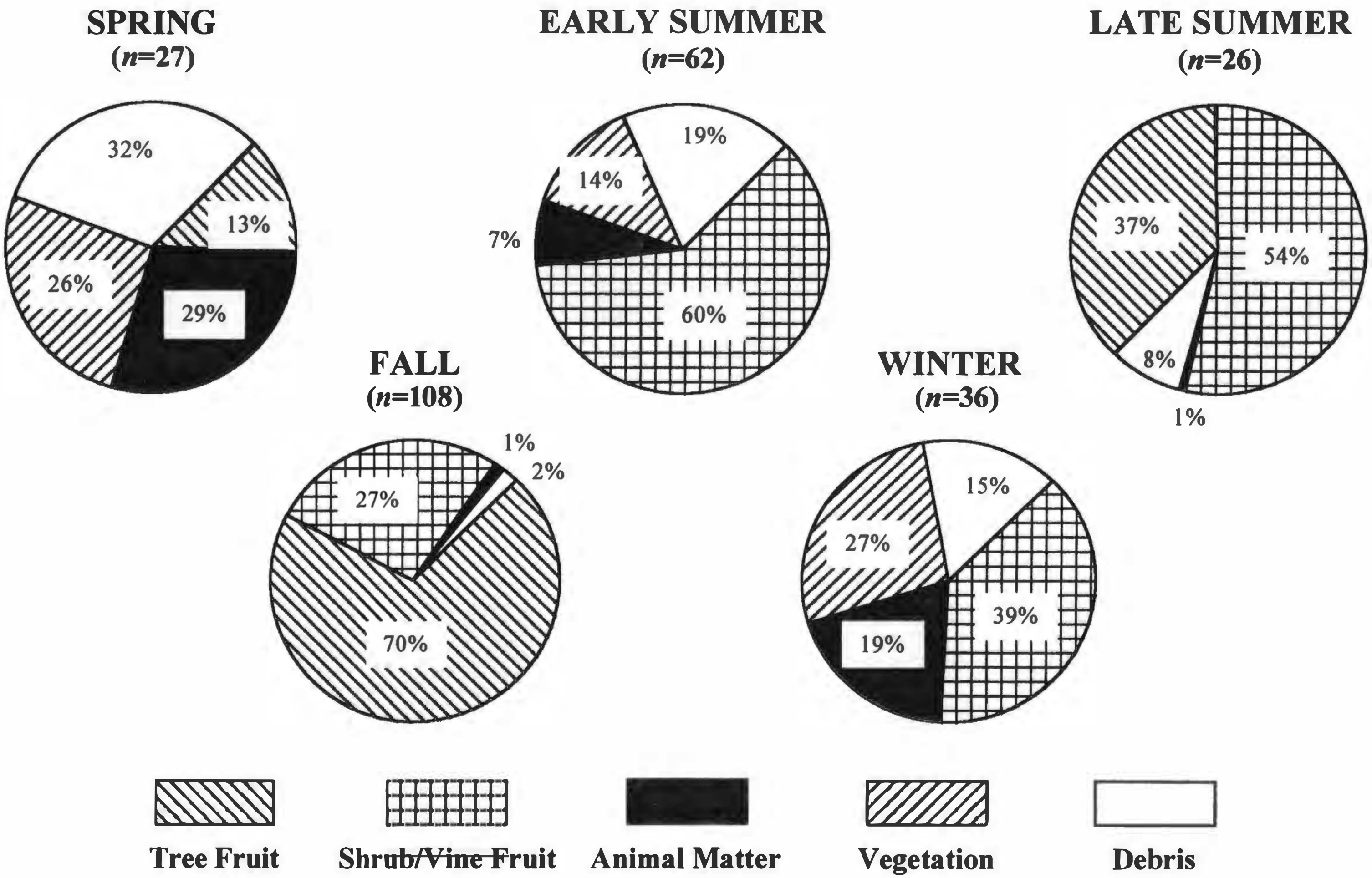

Figure 12. Seasonal comparison of major food components (% volume) in the diet of black bears on Eglin Air Force Base, Florida, 1994-1996.

late summer diet by volume. Animal matter was dominated by beetles. Opossum was the only vertebrate identified in late summer scats, occurring in 1 scat.

Acorns and saw palmetto berries dominated the fall diet accounting for 93% by volume. Animal matter was dominated by beetles and occurred in 24% of fall scats. Cottontail rabbit was the only vertebrate identified in fall scats.

Winter scats were dominated by saw palmetto and greenbriar berries (*Smilax* spp.) and occurred in 69% of winter scats examined; this accounted for 38% by volume. Although ingestion of debris is considered accidental, it represented 15% of winter diet by volume. Vegetation, primarily the hearts of saw palmetto and gallberry leaves, accounted for 27% by volume. One winter scat contained white-tailed deer remains; this was probably ingested as carrion.

The annual diet by volume was dominated by shrub/vine fruit (38%) and tree fruit (34%) (Fig. 13). Debris, vegetation, and animal matter accounted for 12%, 9%, and 7% by volume, respectively.

Habitat Use

I used 1,891 location estimates of 9 bears (3F, 9M) for annual habitat use analysis. To determine seasonal habitat use, I used 1,049 location estimates of 10 bears (3F, 7M) for summer and 794 location estimates of 10 bears (3F, 7M) for fall. Nonrandom use was detected for annual black bear habitat use ($\Lambda = 0.0576$, $F = 20.46$, $P \leq 0.003$). Riparian zones ranked highest annually among the 5 habitat associations (Table 3). There was a difference ($P \leq 0.025$) in use between riparian zones and swamps and

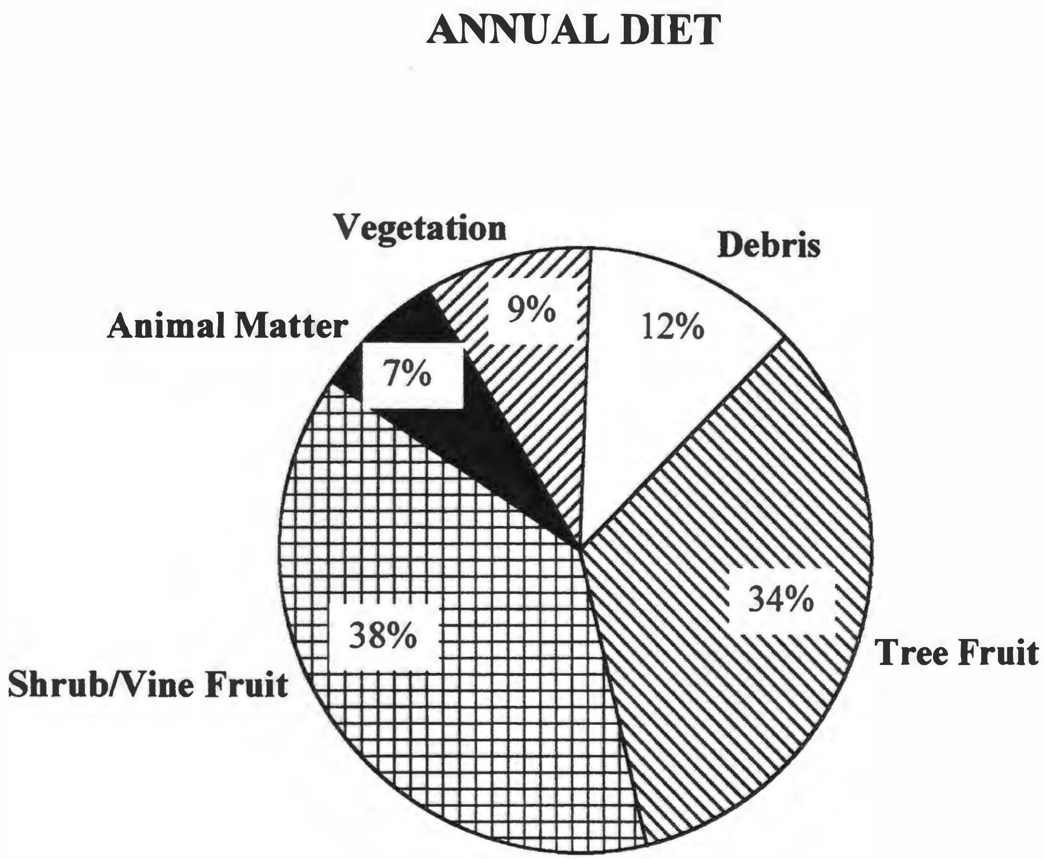

Figure 13. Annual diet (% volume) of black bears analyzed from 259 scats collected on Eglin Air Force Base, Florida, 1994-1996.

Table 3. Ranking matrices for annual and seasonal habitat use by black bears on Eglin Air Force Base, Florida, 1994-1996. Each mean element in the matrix was replaced by its sign; a triple sign represents significant deviation from random at $P \leq 0.05$.

ANNUAL

Habitat Type	Habitat Type					
	Open	**Pine**	**Sandhills**	**Swamp**	**Riparian**	**Rank**
Open		---	---	---	---	5
Pine	+++		+	---	---	3
Sandhills	+++	-		---	---	4
Swamp	+++	+++	+++		---	2
Riparian	+++	+++	+++	+++		1

SUMMER

Habitat Type	Habitat Type					
	Open	**Pine**	**Sandhills**	**Swamp**	**Riparian**	**Rank**
Open		---	---	---	---	5
Pine	+++		+++	---	---	3
Sandhills	+++	---		---	---	4
Swamp	+++	+++	+++		---	2
Riparian	+++	+++	+++	+++		1

FALL

Habitat Type	Habitat Type					
	Open	**Pine**	**Sandhills**	**Swamp**	**Riparian**	**Rank**
Open		---	---	---	---	5
Pine	+++		-	---	---	4
Sandhills	+++	+		---	---	3
Swamp	+++	+++	+++		-	2
Riparian	+++	+++	+++	+		1

each showed greater use than the remaining habitat associations. Although the sandhills association was the most available habitat to bears, it ranked 4th in annual use.

Nonrandom use was detected during summer ($\Lambda = 0.0380$, $F = 37.95$, $P \leq 0.0002$) and fall ($\Lambda = 0.0541$, $F = 26.20$, $P \leq 0.0006$). Riparian zones ranked highest for both seasons, while swamps ranked 2nd (Table 3). There was a difference ($P \leq 0.001$) in use between riparian zones and swamps during summer, but no difference ($P \leq 0.132$) in use was detected for fall season. Sandhills ranked 3rd and 4th in use for fall and summer, respectively. Open areas was used significantly less ($P \leq 0.05$) than all other habitat associations during summer and fall seasons.

Triangulation Error. The mean error and number of bear locations for each observer were: (A) $\bar{x} = 71$ m, 1402 locations; (B) $\bar{x} = 219$ m, 301 locations; (C) $\bar{x} = 216$ m, 92 locations; (D) $\bar{x} = 191$ m, 30 locations; (E) $\bar{x} = 218$ m, 32 locations; and (F) $\bar{x} = 278$ m, 34 locations.

Ninety percent of the estimated locations were within 400 m of the test location and 50% were within 155 m. The mean error area for all observers ranged from 0.02 - 0.24 km^2. Random locations generated from the weighted error distribution produced a 10% misclassification rate for annual habitat use. The misclassification rate was 7.7% and 8.5% for summer and fall seasons, respectively. There was no overall affect of triangulation error on annual ($P \leq 0.7342$), summer ($P \leq 0.2611$), or fall ($P \leq 0.4064$) habitat use. However, when I tested for affects on habitat classification, the ranking of pine production areas and sandhills were reversed during summer (Table 4).

Table 4. Ranking matrices, based on a simulated set of radio locations obtained from a weighted telemetry error distribution for annual and seasonal habitat use by black bears on Eglin Air Force Base, Florida, 1994-1996. Each mean element in the matrix was replaced by its sign; a triple sign represents significant deviation from random at $P \leq 0.05$.

ANNUAL

Habitat	Habitat Type					
Type	Open	Pine	Sandhills	Swamp	Riparian	Rank
Open		-	-	---	---	5
Pine	+		+	---	---	3
Sandhills	+	-		---	---	4
Swamp	+++	+++	+++		---	2
Riparian	+++	+++	+++	+++		1

SUMMER

Habitat	Habitat Type					
Type	Open	Pine	Sandhills	Swamp	Riparian	Rank
Open		---	---	---	---	5
Pine	+++		-	-	---	4
Sandhills	+++	+		---	---	3
Swamp	+++	+	+++		---	2
Riparian	+++	+++	+++	+++		1

FALL

Habitat	Habitat Type					
Type	Open	Pine	Sandhills	Swamp	Riparian	Rank
Open		---	---	---	---	5
Pine	+++		---	---	---	4
Sandhills	+++	+++		-	---	3
Swamp	+++	+++	+		-	2
Riparian	+++	+++	+++	+		1

Effects of Fire on Habitat Use

Nonrandom use ($P \leq 0.05$) was detected in all years except 1991 and 1995 for annual habitat use. Burned areas ranked highest in use for years 1989 (2-year-old burns) and 1993 (6-year-old burns), ranking 3rd and 4th, respectively (Table 5). For 1996, burned areas ranked 3rd before they were burned and 6th after the areas were burned. Burned areas generally ranked higher than open areas but lower than all other habitat associations.

Years 1988 and 1989 were eliminated from the seasonal analysis of burned areas because low sample sizes precluded ranking of these years. Nonrandom use ($P \leq 0.05$) was detected for the remaining years except 1991 and 1994 for summer habitat use. Burned areas ranked highest for years 1995 (<1-year-old burns) and 1993 (2-year-old burns), ranking 3rd and 4th, respectively (Table 5). Generally, burned areas ranked higher than open areas but lower than other habitat associations. For 1996, the ranking of preburn and postburn habitat use did not change. In both cases, burned areas ranked 5th.

Nonrandom use ($P \leq 0.05$) was detected in all years for fall habitat use. Burned areas ranked highest for years 1990 (5-year-old burns) and 1993 (2-year-old burns), ranking 3rd (Table 5). Although the ranking of burned areas in relation to the other habitat associations are given for 1994, low sample size (n = 5) precluded statistical validation of the rankings. Therefore, the ranking of habitat associations for the 1994 (1-year-old burns) fall prescribed burns will not be discussed.

Table 5. Rankings of annual and seasonal black bear use of prescribed burns conducted from 1988-1996 in relation to other habitat associations on Eglin Air Force Base, Florida.

ANNUAL

Habitat	Rank									
Type	1988	1989	1990	1991	1992	1993	1994	1995	1996A[a]	1996B[b]
Open	6	6	6	6	6	6	6	6	5	6
Pine	3	4	3	3	3	3	3	3	3	4
Sandhills	4	5	4	4	4	5	4	4	4	5
Swamp	2	2	2	2	2	2	2	2	2	2
Riparian	1	1	1	1	1	1	1	1	1	1
Fire	5	3	5	5	5	4	5	5	6	3

SUMMER

Habitat	Rank							
Type	1990	1991	1992	1993	1994	1995	1996A	1996B
Open	6	6	6	6	6	6	6	6
Pine	3	3	3	3	3	4	3	3
Sandhills	4	4	4	5	4	5	4	4
Swamp	2	2	2	2	2	2	2	2
Riparian	1	1	1	1	1	1	1	1
Fire	5	5	5	4	5	3	5	5

FALL

Habitat	Rank					
Type	1990	1991	1992	1993	1994[c]	1995
Open	6	6	6	6	6	6
Pine	5	3	4	4	3	3
Sandhills	4	4	3	5	4	4
Swamp	2	2	2	2	2	2
Riparian	1	1	1	1	1	1
Fire	3	5	5	3	5	5

a = Rank of black bear use of burned areas and other habitat associations after the areas were burned.

b = Rank of black bear use of burned areas and other habitat associations before the areas were burned.

c = Low sample size precluded statistical validation of the rankings.

CHAPTER V

DISCUSSION

Feeding Ecology

Seasonal shifts in feeding ecology of black bears on Eglin were similar to other studies (Maehr and Brady 1984, Land 1994, Brandenburg 1996). Bears shifted from mostly herbaceous vegetation in spring to soft mast in summer and hard mast in fall. A spring diet dominated by herbaceous vegetation is common in many parts of the Southeast (Beeman and Pelton 1980, Maehr and Brady 1984). The consumption of saw palmetto hearts by bears in spring has been found in other regions of Florida (Maehr and Brady 1982, 1984).

Starches and sugars are the primary food reserves in saw palmetto plants (Hough 1968), with starches making up over 80% of the total available carbohydrates. Bear use of saw palmetto appears to correspond with the seasonal trends in starch and sugar content in the plants. With the onset of the growing season in early spring, starches are converted to sugars which are used for frond growth and fruit production (Hough 1968). While starch content decreases, sugar production increases through the summer. This reduction in starch content in spring and summer corresponded with the time when bears consumed the largest amounts of the hearts of saw palmetto.

Also, in plants with high moisture content, particularly following burning, sugar content is nearly twice that of starch (Hough 1968). Signs of bears feeding on saw palmetto were frequently found in areas near den sites, along rivers, streams and wetlands during the spring and early summer. Because spring is generally a time of food shortage for bears, the increase in sugars in saw palmetto and high consumption of invertebrates likely provides the nutrients necessary to sustain general metabolic requirements of bears until fruit production begins in early summer.

On Eglin, summer is a period of high soft mast production. Blueberries, huckleberries (*Gaylussacia* spp.), sweet gallberries, blackgum berries (*Nyssa biflora*), and wild grapes (*Vitis rotundifolia*) were the most important plant foods during this period. Because some of these species maintain an abundant fruit supply throughout most of the summer (e.g. blueberries and huckleberries), bears are able to take advantage of a diversity of food items to meet their nutritional requirements.

Blueberries appear to be the most widely distributed and abundant of the summer foods available to bears on Eglin. Patches of blueberries encompassed many hectares and were typically found in areas that have not been subjected to frequent fires (e.g. ≤ 2 year burning cycle). Fruit production by blueberry and huckleberry plants can be delayed up to 3 years following a fire (Johnson and Landers 1978). Because radio-collared bears were located frequently in or near these larger patches throughout the summer, frequent burning should be minimized to maintain these areas for soft mast production.

Although the relative abundance and distribution of oak mast can have a significant impact on bears in terms of natality, mortality, and movements (Pelton 1989), this may not be the case for black bears in some areas in Florida (Maehr and Brady 1982, Maehr and Wooding 1992). Maehr and Brady (1982) reported that saw palmetto berries were the dominant fall food and found only traces of acorns in black bear stomachs collected in Baker and Columbia Counties, Florida.

The importance of saw palmetto berries and their vegetative parts has been identified in other areas of Florida (Maehr and Brady 1982, 1984; Maehr and DeFazio 1985; Land 1994). Saw palmetto, like some oak species, is subject to periodic mast failures (Maehr and Brady 1982, Seibert 1993). In 1994, many areas were scouted for bear sign, including numerous oak stands and palmetto fields. Although many oak stands had abundant acorns available, the fall diet in 1994 was dominated by saw palmetto berries. In 1995, saw palmetto plants apparently suffered a mast failure; no palmetto berries were found during my investigations of areas with saw palmetto plants during the fall of 1995. Subsequently, acorns dominated the 1995 fall diet of bears. In 1996, I observed that the production of palmetto berries was fair compared to 1994. However, the sample size in 1996 (n=6 scats) was too small to make any comparisons with previous years. The 1994 fall diet indicated that bears on Eglin may be selecting saw palmetto over acorns as the primary source of fall food; similar results were found in other areas of the state (Maehr and Brady 1982).

The dominance of acorns in the 1995 fall diet demonstrates their importance as an alternative source of fall food for bears on Eglin. The high occurrence of acorns and saw palmetto in the diet of black bears, illustrates their importance both seasonally and annually. Acorns and saw palmetto likely serve as replacements for each other during years of mast failures or low food availability. However, current prescribed burning practices could have impacts on availability and abundance of these fall foods for bears in the future. Frequent burning in some areas of Eglin has virtually eliminated the oak midstory. Although fire seldom kills saw palmetto plants (Hough 1965, Hilmon 1969), fruit production can be delayed for 6-9 years following a fire (Hilmon 1969). Because of the wide distribution and abundance of these plant species on Eglin, impacts from prescribed burning on their availability may not be revealed for several years.

Habitat Use

Black bears are opportunistic and adaptable mammals; this allows them to exist in a variety of habitats (Pelton 1982). This generalist nature of bear habitat use was found in Apalachicola National Forest, Florida where bears used most habitat types in relation to there availability (Seibert 1993). However, the present study and previous studies (Mykytka and Pelton 1990, Land 1994, Wooding and Hardisky 1994) demonstrated distinct habitat preferences. Bears in Osceola National Forest preferred large swamps (Mykytka and Pelton 1990), in Ocala National Forest they favored flatwoods and sand pine scrub habitats (Wooding and Hardisky 1994), and in southwest Florida they preferred pine/palmetto habitats and agricultural/disturbed areas (Land 1994). In the current study, riparian zones and swamps ranked highest among the habitats available to bears. This diversity of habitat use by bears in Florida exemplifies the adaptability of bears to changes in landscape composition and habitat availability.

This is the first time riparian zones have been shown to be the primary habitat type used by black bears in the Southeast. Because riparian zones ranked 1st both annually and seasonally, I hypothesize that the preference for riparian zones on Eglin was related to their distribution and vegetational structure. There are nearly 0.7 km of streams for every km^2 of land on Eglin. This network of riparian zones allowed bears to travel over large areas while remaining in close proximity to escape cover. Frequent use of riparian zones by bears resulted in 24 of 38 captures $\leq$ 20 m from the edge of riparian zones. Also, radio diel tracking showed that bears traveled extensively along the edge of riparian zones. The decrease in vegetation density along the edges probably allowed bears to travel more efficiently within their home range.

Most of the dense vegetation adjacent to streams ranged from 10 to >100 m wide. The closed canopy and dense understory of fetterbush (*Lyonia lucida*), gallberry (*Ilex* spp.), saw palmetto and briars likely enhanced their attractiveness to bears by providing food, escape cover, and seclusion. The importance of these stream zones as denning habitat was demonstrated in 1995 when an adult female denned in a corridor approximately 120 m wide and subsequently produced 2 cubs. Similar use of riparian zones also was found in fragmented habitat in Louisiana, where bears used drainage ditches as narrow as 10 m for movement through agricultural areas and denned in drainages 140 m wide (Weaver et al. 1992). Although 86% of Eglin is forested, the high use of riparian habitats illustrates the fragmentation of habitat quality within the forests on Eglin.

Bears used riparian zones as an annual source of food as well. I also attributed the significant use of riparian zones to the high edge-to-area ratio. In some cases, high edge-to-area ratio can be detrimental to a bear population, because of the potential increase in vulnerability to human-induced mortality (Hellgren and Vaughan 1994). However, on

Eglin the high edge ratio, coupled with the species composition and moist environment, provided abundant food sources during most of the year. Because bear movements and home range sizes are largely affected by the distribution and abundance of foods (Jonkel and Cowan 1971, Garshelis and Pelton 1981, Rogers 1987, Smith and Pelton 1990), it is important to maintain the plant species diversity, especially primary bear foods, within and adjacent to riparian zones. Wooding and Hardisky (1994) suggested maintaining densely vegetated areas for year-round cover for bears in Florida; this could effectively minimize the area needed to satisfy the nutritional needs of black bears.

Swamps generally rank as 1 of the most important habitats for black bears in the southeastern coastal plain (Hamilton 1978, Mykytka and Pelton 1990, Seibert 1993, Hellgren and Vaughan 1994, Land 1994, Wooding and Hardisky 1994, Brandenburg 1996). On Eglin, bears used swamps throughout the year, with the majority occurring in late fall and winter. In the coastal plain, bear use of swamps for denning is well established and was substantiated by the current study. However, many of the swamps used by bears on Eglin AFB were narrow bands along streams, some were < 5 ha in size. These bands of swamp likely enhanced the attractiveness of the riparian zones to bears because of the dense vegetation and inaccessibility. If the bear population increases, these small patches of swamp may become increasingly important for long term survival of black bears on Eglin.

Pine habitat was used significantly more than sandhills during the summer season. Although pine habitats consist of slash pine (*Pinus elliottii*) and sand pine plantations, the majority of use by bears occurred in slash pine. Most sand pine areas were closed canopy forests with little or no understory; bears probably were not attracted to sand pine because of the lack of food in these areas. Wooding and Hardisky (1994) noted that the use of sand pine scrub corresponded to the availability of hard mast.

The availability of blueberry and huckleberry seemed to be more prevalent in slash pine habitat than in sandhills. The most productive sites did not appear to have been burned for several years. Johnson and Landers (1978) found blueberry production following a prescribed burn was most abundant after 3 years of fire suppression. The lower use of sandhills during the summer may be attributed to the higher frequency of fire, suppressing or eliminating soft mast production in many areas.

Sandhills ranked highest during fall; this was primarily due to the mast failure of saw palmetto in 1995, when bears switched to acorns as the primary fall food. Although sandhills provided abundant oak mast, bears were generally located farther from escape cover (primarily riparian and swamp habitats) than during any other season. Because sandhills are more open habitats than riparian or swamps, bears may be more susceptible to human-induced mortality.

During the hunting seasons on Osceola NF, bears using uplands were more vulnerable to hunting mortality than bears using swamps (Mykytka and Pelton 1990). This was evident in my study. One subadult male was poached, presumably while traveling through an upland habitat. The radio transmitter of another bear failed after a bullet pierced the transmitter casing. I hypothesize that this occurred while the bear was foraging in a frequently used oak stand that was adjacent to a well-used road.

Oak species should be encouraged in sandhill habitats in close proximity to riparian zones and swamps. This would provide foraging areas for bears while minimizing travel to escape cover. Preserving uplands adjacent to swamps was also recommended for bears on Osceola NF (Mykytka and Pelton 1990).

Open areas, primarily consisting of airfields, target ranges, and clearcuts, ranked lowest among the habitat associations, both annually and seasonally. Bears have been shown to avoid nonforested areas (Carr 1983, Garris 1983, Smith and van Daele 1990), roads (Beringer et al. 1990, Kasworm and Manley 1990, van Manen 1994, Brandenburg 1996), urban development (McCutchen 1990), and oil development complexes (Tietje and Ruff 1983) due to human disturbance. Also disturbance by low flying aircraft was documented for grizzly bears (Harding and Nagy 1980) and other wildlife (Côté 1996).

I attributed the low use of open areas to the lack of forested cover and not military flights. Observations of free-ranging and radio-collared bears on Eglin showed no physical response (i.e., sudden movements or visual identification of noise source) to low-level aircraft noise. Because military flights have been conducted on Eglin since the 1940's (McWhite et al. 1993) and occurred on a daily basis, bears appeared to have become acclimated to this activity. This was substantiated by the use of a riparian zone by an adult male bear; this zone extended into the middle of a heavily used target range in the eastern portion of Eglin. The bear was located several times in and near the riparian zone prior to and after bombing missions were conducted. Although monitoring the activity of bears during missions could not be conducted, the bear did not appear to be adversely affected by the flight missions based on estimates of locations before and after missions. However, other responses to the missions may have occurred even though gross movements were not detected. Because limited use of open areas was found, factors other than military flight missions likely had a greater impact on whether or not bears used these areas. Non-use of open areas by black bears also was found in Arkansas even though abundant food was available (Clark 1991).

Most test ranges are maintained in a low vegetative or grassy condition, although some portions of test ranges have received limited maintenance allowing the vegetation to reach heights of 3-5 m. The limited use of these areas was primarily restricted to riparian zones and limited maintenance areas. Although runner oak (*Quercus pumila*) provided adequate hard mast on many of the more open test ranges, the lack of sufficient cover likely discouraged bears from using these areas. Lack of sufficient cover attributed to higher rates of black bear mortality by hunters in North Carolina (Hamilton 1978).

Telemetry error had no affect on annual or fall rankings of habitats, but did affect rankings for summer. However, telemetry error had a greater impact on the significance levels of some habitat relationships. Small patch size of various habitats and locations of bears along habitat edges contributed to most of the misclassification of habitats.

Effects of Fire on Habitat Use

Because most burned areas consisted primarily of sandhill and pine habitats, a low ranking of habitat use was expected. However, for some years use was higher, either annually or seasonally. The high annual use of 1989 (6-year-old burns) burns may be attributed to 2 factors. First, soft mast species may have been at peak production; this likely attracted bears. Johnson and Landers (1978) found peak production of most soft mast species was attained 3-5 years following a prescribed burn. Secondly, the most frequently used burned areas were those adjacent to riparian zones. The combination of abundant food and escape cover within close proximity to each other may have made an ideal setting for bears.

The summer use of 1995 burns also ranked high. In 1995, a substantially higher proportion of swamps and riparian zones were subjected to burns. The strong dependence on these areas for escape cover may have outweighed any deleterious effects the burns may have caused. Also, some sections, particularly swamps, classified as burned were not subjected to fire. Personal investigation of a swamp along the Yellow River classified as burned showed that approximately 50-100 m of the periphery was burned even though the swamp was several hundred meters wide. Therefore, the high use of this area may have been related to the lack of fire.

One adult male bear avoided a particular area after it was aerially burned in spring 1995. Prior to the burn, the bear frequently used 2 narrow riparian zones within the area. After the burn, the bear was never located in the area for the duration of this study. Because other bears were located in this area after the burn, demonstrates the varying effects that prescribed burning can have on individual bears.

During the fall season, 1990 (5-year-old burns) and 1993 (2-year-old burns) burns ranked highest among years. The high use of the 1990 burns is difficult to explain because most of the available burns occurred in pine and sandhills habitats. Because the fall diet primarily consisted of acorns, it is suspected that the high use of these areas is related to the fire intensity of those burns. Because fire is used to reduce the oak midstory in upland forests on Eglin (McWhite et al. 1993), the fires may have been of relatively low intensity allowing high survival of oak species.

Several factors may have contributed to the higher annual and seasonal use of 1993 (2-year-old burns) burns. Similar to the 1989 burns, many areas burned in 1993 were adjacent to or included riparian zones. Much of the use of burned areas can be attributed to these riparian zones. Also, some soft mast species may have been attaining maximum production. This likely contributed to the higher use during summer. Maximum production was achieved by the 3rd year following a burn for some soft mast species (Johnson and Landers 1978). Also, 83% and 95% of the fall locations for 2 subadult male bears were within burned areas. This high use likely had an effect on the fall ranking of 1993 burns.

Prescribed burning can be beneficial for bears by stimulating soft mast production (Zager et al. 1983, Hamer and Herrero 1987). On Eglin, fire every 3-5 years in upland habitats appears to benefit bears by stimulating mast production of several bear foods. On Eglin, bear foods such as huckleberry, dwarf blueberry (*V. myrsinites*), sweet gallberry, bitter gallberry (*Ilex glabra*), and greenbriar appear to proliferate with this type of burning cycle. Other bears foods like highbush blueberry (*V. corymbosum*), sparkleberry (*V. arboreum*), blackgum, and persimmons (*Diospyros virginiana*), as well as, many hard mast species will likely require a burning cycle > 5 years. Because these species are large shrubs and trees, a burning cycle > 5 years would allow many of them to attain mast-producing size (Johnson and Landers 1978).

Fire also can be detrimental to bears especially during the winter denning season. Den abandonment caused by prescribed burning was reported in south Florida (Land 1994) and in this study. Land (1994) reported an adult female suspected to have cubs abandoned her den following a prescribed burn. In this study, a 3-year-old female abandoned her den following a prescribed burn in February 1996. Although the bear was not believed to have cubs, mortality of newborn cubs in the den would have most likely occurred since the den was completely consumed by the burn. Therefore, prescribed burning in and adjacent to potential denning habitat should be avoided during the denning season.

Fire can cause plant scorching and defoliation. If the plant survives, mast production is generally halted for at least one growing season while regrowth and regeneration takes place (Johnson and Landers 1978). Typically, burns < 1 year old exhibit these conditions, which likely explains the low use of burns from 1996 by bears. If a fire is of sufficient intensity to cause many plants to die, important habitats like riparian zones may become unattractive to bears because of the lack of concealment; this may cause bears to look elsewhere for suitable escape cover increasing their exposure and risk to mortality.

CHAPTER VI

MANAGEMENT IMPLICATIONS

Because bears use a variety of foods that are only seasonally available, habitat diversity is necessary to satisfy their dietary needs. A variety of hard and soft mast sources helps buffer irregular fruit production of some species.

If black bear management becomes a high priority for managers on Eglin, then several management strategies are recommended to increase the availability of soft and hard mast and improve habitat quality for black bears on Eglin. Ten Management Emphasis Areas (MEA's) should be established for black bears on Eglin (Fig. 14). These areas are centered around riparian zones and swamps bounded by primary and/or secondary roads. Each MEA should be evaluated and managed to provide adequate food resources, escape cover, and denning habitat to restrict bear movements within management areas on Eglin; this can be accomplished by lengthening the prescribed burning cycle, proper management of forest tracts, and continued management of natural foods.

Five to seven soft mast production zones should be established or maintained within each MEA. I consider current forestry practices (selective thinning and prescribed burns) in upland areas adjacent to riparian zones and wetlands favorable for soft mast production. Burning cycles of 3-5 years should be continued in those zones, which currently contain abundant summer foods, to optimize soft mast production. In addition, some of these zones should be spared from fire for > 5 years to favor late maturing

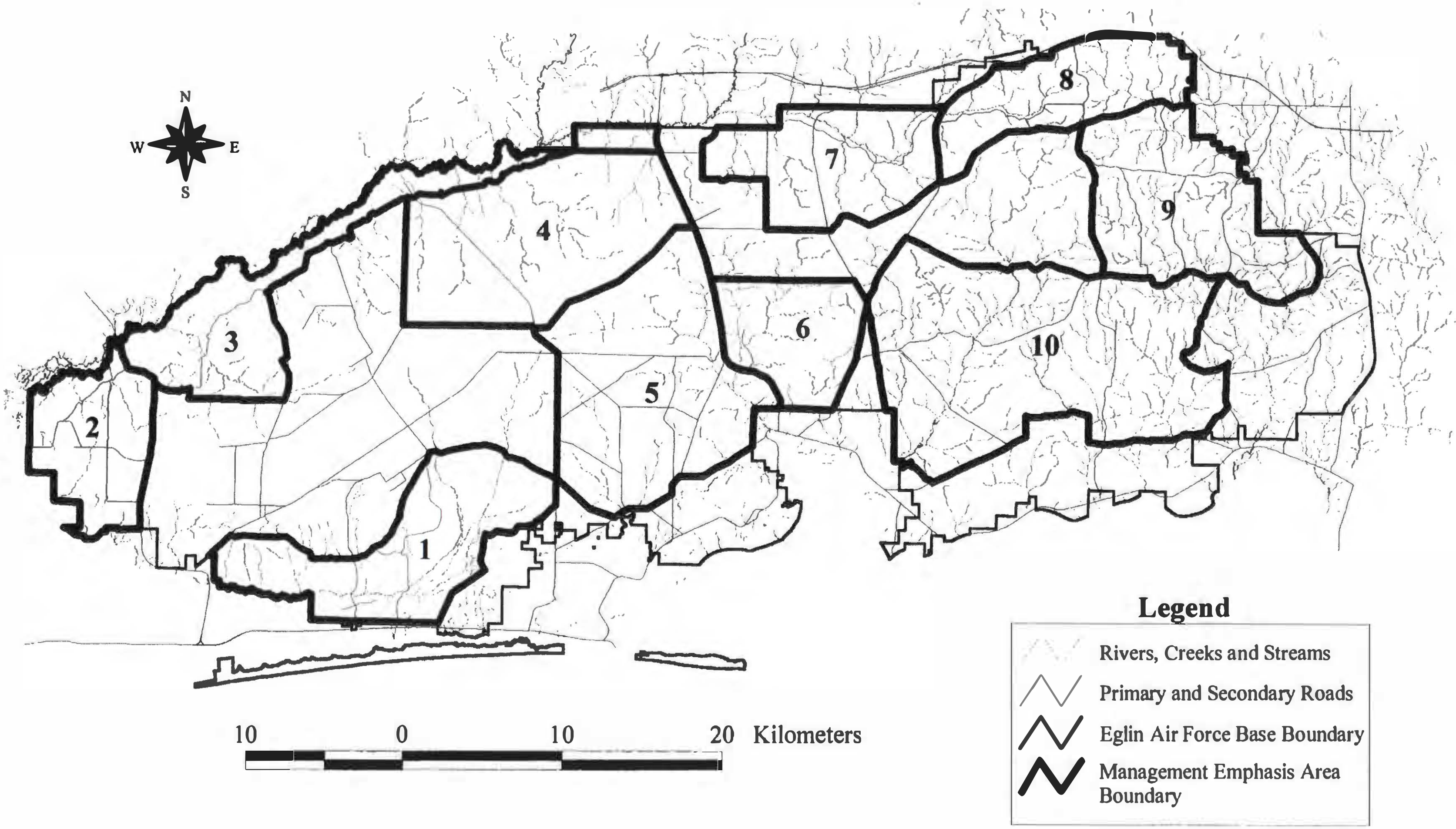

Figure 14. Proposed Management Emphasis Areas (MEA's) for black bears on Eglin Air Force Base, Florida.

species (Johnson and Landers 1978); this would allow species such as highbush blueberry and sparkleberry, to attain the size necessary for maximum fruit production. In MEA's that currently do not contain 5-7 soft mast production zones, fire should be restricted for 5 years in some areas to allow soft mast species to become established and mature. These new soft mast zones should be 1-2 ha in size and juxtaposed to swamps and riparian zones.

Oak mast is an important fall food for most black bear populations in the Southeastern Coastal Plain (Hellgren and Vaughan 1988, Wooding and Hardisky 1994, Brandenburg 1996). Because saw palmetto is subject to mast failures, hardwood stands within upland habitats should be managed to promote production of oak mast while providing a diversity of successional stages. The frequent use of fire (1-3 year cycle) in upland habitats restricts production of oak mast. Within each MEA, fire should be restricted in 5-7 upland zones for 7-10 years to promote oak regeneration and hard mast production. This will ensure that each MEA contains an adequate supply of fall food. These oak stands also should be adjacent to riparian and swamp habitats and be 3-5 ha in size. The current sand pine removal program likely is beneficial to bears. The current practice of leaving mature oaks should be continued to maintain production of oak mast.

This study and others (Maehr and Brady 1982, Seibert 1993, Land 1994) have shown that is a primary fall food. Because mast production of saw palmetto is unpredictable, I recommend fall mast surveys be conducted for saw palmetto and oak mast production; this will provide a means to predict high use areas by bears and potential areas for high human-bear interaction.

Thick vegetative cover for bedding, escape, and denning is of great importance as forests become more fragmented and human encroachment increases (Pelton 1986, Black Bear Conservation Committee 1997). Heavy understories of gallberry, fetterbush, and briars are examples of such natural cover. Because this cover is crucial for bear survival, I have several recommendations. First, an elevational contour map should be integrated into the current GIS system on Eglin. This will ensure accurate identification of all riparian zones on Eglin. Second, riparian zones should be delineated by elevation changes and identified as the area from the top of the slope to the waters edge. Where streams meet the confluence of major water systems and gradient changes are less pronounced, riparian zones should be identified from the waters edge to 25 m beyond the wetland/hardwood boundary. Third, all riparian zones should be exempted from fire and swamps be excluded from prescribed burning during the denning season (January thru April); this would maximize the availability of protective cover and minimize the danger of fire to denning bears, especially females with cubs.

Current management strategies for land areas on Eglin are based on a 4-level, tiered classification (McWhite et al. 1993). This system is based on the status of the existing condition relative to its perceived historic natural state and potential for restoration. Habitats categorized as Type III are areas that have potential for restoration, but would require intensive management over a long period of time (McWhite et al. 1993). Habitats with extensive hardwood encroachment are categorized as Type III. Therefore, 10-15 Type III areas outside the MEA's should be managed for escape cover and mast production for bears. These areas would provide additional habitat for bears, such as adult males and dispersing subadults, whose seasonal movements may extend beyond an individual MEA.

Human demands on the landscape will inevitably cause bear populations to become more fragmented and isolated. If this remnant bear population is to be preserved, then it is necessary to determine the life requisites and develop and implement management strategies. Long-term effects of large-scale land use practices in areas occupied by black bears should be thoroughly evaluated to determine their impacts on survival of the species. Proper management of riparian zones on Eglin could provide valuable information for linking isolated bear populations in the future.

CHAPTER VII

SUMMARY AND CONCLUSIONS

1. I determined the seasonal and annual diet of black bears on Eglin from 259 scats. Spring diets were dominated by debris, hearts of saw palmetto, beetles, and yellow jackets. Blueberries comprised 44% of the early summer diet, while sweet gallberry, acorns, and black gum dominated the late summer diet. Acorns and saw palmetto berries accounted for 93% of the fall diet. My data indicated that bears selected saw palmetto over acorns as the primary fall food when available.

2. This is the first time riparian zones have been shown to be the primary habitat association used by black bears in the Southeast. Riparian zones ranked highest among the habitats available to bears, both seasonally and annually. There was a difference in annual ($P \leq 0.025$) and summer ($P \leq 0.001$) use between riparian zones and swamps.

I hypothesized that the preference for riparian zones was related to their distribution and vegetational structure. The closed canopy and dense understory provided food, escape cover, and denning habitat. The network of riparian zones allowed bears to travel over large areas while remaining in close proximity to escape cover.

The high use of riparian zones also was facilitated by the high edge-to-area ratio. The meandering pattern of riparian zones coupled with the species composition provided abundant food sources during most of the year.

3. Swamps ranked 2nd in use overall with the highest use occurring during the fall season. During the fall season, bears used swamps for denning habitat. Many of the

swamps used by bears on Eglin were narrow bands along streams. These swamps enhanced the attractiveness of riparian zones by the increased inaccessibility.

4. The high use of pine habitat during the summer season corresponded with the availability of blueberry and huckleberry production. The 3-5 year burning cycle allowed most soft mast species to reach maximum production.

5. Bears used sandhills most during the fall season. This study demonstrated the importance of sandhills because they provided abundant acorns for bears on Eglin. Also, bears were generally located farther from escape cover during the fall season, which increased their susceptibility to human-induced mortality. One subadult male bear was poached in sandhills habitat during the fall season.

6. Open areas ranked lowest among the habitat associations, both annually and seasonally. I hypothesized that low use of open areas was attributed to the lack of forested cover and not military flight missions. Because military flight missions have been conducted on Eglin since the 1940's, bears appeared to have become acclimated to flight mission activity. Limited use of open areas was primarily restricted to riparian zones and limited maintenance areas within test ranges. The lack of sufficient cover likely precluded bears from using open areas even though adequate hard mast was available.

7. Areas burned from 1988 to 1996 were used less ($P \leq 0.05$) than most habitat associations available to bears on Eglin. Areas burned in 1989 (6 year-old burns) and 1993 (2 year-old burns) ranked highest for annual habitat use of burned areas. The high use of these burned areas was attributed to their proximity to riparian zones and high soft mast production.

8. Most swamps and riparian zones classified as burned were not completely subjected to fire. The high use of 1995 burns during the summer season was related to the lack of fire in these areas. Increased soft mast production attributed to the higher use of 1993 (2 year-old burns) burns in summer. Eighty-three percent and 95% of the fall locations for 2 subadult male bears were within 1993 burned areas. These high percentages had an effect on the higher ranking of 1993 burns during the fall season.

9. This study showed the adverse effects that prescribed burning can have on bears on Eglin. A female black bear abandoned her den following a burn in 1996. Also, an adult male bear avoided an area after it was burned in 1995.

10. Strategies to increase the availability of soft and hard mast and improve habitat quality for black bears on Eglin are suggested if black bear management becomes a priority. Management strategies included the establishment of management units on Eglin, enhancement of soft and hard mast productions areas adjacent to riparian zones and swamps, and restricting fire in oak stands to allow oaks to mature.

Other strategies included maintaining a 3-5 year burning cycle in upland areas adjacent to riparian zones and swamps to favor soft mast production, eliminating prescribed burning in riparian zones to maximize escape cover, and eliminating prescribed burning during the denning season to protect bears, especially females with cubs. Also, conducting fall mast surveys to determine availability and abundance of primary fall foods and integrating an elevational contour map into the current GIS system on Eglin to accurately identify all riparian zones.

LITERATURE CITED

LITERATURE CITED

Aebischer, N. J., P. A. Robertson, and R. E. Kenward. 1993. Compositional analysis of habitat use from animal radio-tracking data. Ecology 74:1313-1325.

Aitchison, J. 1986. The statistical analysis of compositional data. Chapman and Hall, London, England. 416pp.

Beeman, L. E. and M. R. Pelton. 1980. Seasonal foods and feeding ecology of black bears in the Smoky Mountains. Int. Conf. Bear. Res. and Manage. 4:141-147.

Bentzien, M. M. 1991. Endangered and threatened wildlife and plants; finding on a petition to list the Florida black bear as a threatened species. Fed. Register. 56(4):596-600.

Beringer, J. J., S. G. Seibert, and M. R. Pelton. 1990. Incidence of road crossing by black bears on Pisgah National Forest, North Carolina. Int. Conf. Bear Res. and Manage. 8:85-92.

Black Bear Conservation Committee. 1997. Black bear restoration plan. Black Bear Conservation Committee, Baton Rouge, LA. 133pp.

Brandenburg, D. M. 1996. Effects of roads on behavior and survival of black bears in coastal North Carolina. M.S. Thesis, Univ. Tenn., Knoxville. 131pp.

Byers, C. R., R. K. Steinhorst, and P. R. Krausman. 1984. Clarification of a technique for analysis of utilization-availability data. J. Wildl. Manage. 48:1050-1053.

Carr, P. C. 1983. Habitat utilization and seasonal movements of black bears in the Great Smoky Mountains National Park. M.S. Thesis, Univ. Tenn., Knoxville. 95pp.

Clark, J. D. 1991. Ecology of two black bear (Ursus americanus) populations in the interior highlands of Arkansas. Ph.D. Dissertation. Univ. Ark., Fayetteville. 228pp.

Coleman, J. S. and A. B. Jones III. 1988. User's guide to TELEM88: Computer analysis system for radio-telemetry data. Res. Series No. 1. Dept. Fish and Wildl., Va. Poly. Inst. and St. Univ., Blacksburg. 49pp.

Costello, C. M., and R. W. Sage, Jr.. 1994. Predicting black bear habitat selection from food abundance under 3 forest management systems. Int. Conf. Bear Res. and Manage. 9:375-387.

Côté, S. D. 1996. Mountain goat responses to helicopter disturbance. Wildl. Soc. Bull. 24:681-685.

Cox, J., R. Kautz, M. MacLaughlin, and T. Gilbert. 1994. Closing the gaps in Florida's wildlife habitat conservation system. Office of Environmental Serv., Fla. Game and Fresh Water Fish Comm., Tallahassee. 239pp.

Crawford, H. S. 1984. Habitat management. Pages 629-646 *in* L. K. Halls eds., White-tailed deer:ecology and management. Wildl. Manage. Inst. Stackpole Books, Harrisburg, PA.

DoD-Air Force. 1962. The proving ground for conservation. Nat. Res. Fish Wildl. Conserv. Program., Eglin Air Force Base, FL. 215pp.

_____. 1964. The proving ground for conservation. Nat. Res. Fish Wildl. Conserv. Program., Eglin Air Force Base, FL. 189pp.

_____. 1979. Natural resources conservation report. Dept. Defense., Eglin Air Force Base, FL. 60pp.

Eagle, T. C., and M. R. Pelton. 1978. A tooth sectioning and simplified staining technique for aging black bears in the southeast. Proc. Eastern Workshop on Black Bear Manage. and Res. 4:92-98.

Eason, T. H. 1995. Weights and morphometrics of black bears in the southeastern United States. M.S. Thesis., Univ. Tenn., Knoxville. 132pp.

Florida Game and Fresh Water Fish Commission. 1993. Management of the black bear in Florida: staff report to the commissioners. Fla. Game and Fresh Water Fish Comm., Tallahassee. 79pp.

Garris, R. S. 1983. Habitat utilization and movement ecology of black bears in Cherokee National Forest. M.S. Thesis, Univ. Tenn., Knoxville. 98pp.

Garshelis, D. L. 1978. Movement ecology and activity behavior of black bears in the Great Smoky Mountains National Park. M. S. Thesis, Univ. Tenn., Knoxville. 117pp.

Garshelis, D. L., and M. R. Pelton. 1981. Movements of black bears in the Great Smoky Mountains National Park. J. Wildl. Manage. 45:912-925.

_____, K. V. Noyce, and P. D. Karns. 1987. Yohimbine as an antagonist to ketamine-xylazine immobilization in black bears. Int. Conf. Bear Res. and Manage. 7:323-327.

Hall, E. R. 1981. The mammals of North America. Vol. 2., 2nd ed. John Wiley and Sons., New York. 1181pp.

_____. and K. R. Kelson. 1959. The mammals of North America. Volume II. The Ronald Press., New York. 1161pp.

Hamer, K. and S. Herrero. 1987. Wildfire's influence on grizzly bear feeding ecology in Banff National Park, Alberta. Int. Conf. Bear Res. and Manage. 7:179-186.

Hamilton, R. J. 1978. Ecology of the black bear in southeastern North Carolina. M.S. Thesis, Univ. Georgia, Athens. 214pp.

Harding, L., and J. A. Nagy. 1980. Responses of grizzly bears to hydrocarbon exploration on Richards Island, Northwest Territories, Canada. Int. Conf. Bear Res. and Manage. 4:277-280.

Harlow, R. F. 1961. Characteristics and status of Florida black bear. Trans. N. Amer. Wildl. Conf. 26:481-495.

_____. 1962. Osteometric data for the Florida black bear. Fla. Acad. Sci. 25:257-274.

Hellgren, E. C., and M. R. Vaughan. 1988. Seasonal foods habits of black bears in Great Dismal Swamp, Virginia-North Carolina. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:295-305.

_____, and _____. 1994. Conservation and management of isolated black bear populations in the southeastern coastal plain of the United States. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 48:276-285.

Hilmon, J. F. 1969. Autecology of saw palmetto (Serenoa repens (Bartr.) Small). M.S. Thesis, Duke Univ., Durham, NC. 190pp.

Hough, W. A. 1965. Palmetto and gallberry regrowth following a winter prescribed burn. Ga. For. Res. Pap. No. 31. 5pp.

_____. 1968. Carbohydrate reserves of saw-palmetto: seasonal variation and effects of burning. For. Sci. 14:399-405.

Johnson, A. S. and J. L. Landers. 1978. Fruit production in slash pine plantations in Georgia. J. Wildl. Manage. 42:606-613.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65-71.

Jones, M. D. 1996. Black bear use of forest and agricultural environments in coastal North Carolina. M.S. Thesis, Univ. Tenn., Knoxville. 112pp.

Jonkel, C. J., and I. M. Cowan. 1971. The black bear in the spruce-fir forest. Wildl. Monogr. 27. 57pp.

Kasworm, W. F., and T. L. Manley. 1990. Road and trail influences on grizzly bears and black bears in northwest Montana. Int. Conf. Bear Res. and Manage. 8:79-84.

Kie, J. G., J. A. Baldwin, and C. J. Evans. 1994. CALHOME: Home range analysis program; electronic user's manual. Pacific Southwest Res. Station., U. S. For. Serv., Fresno, CA. 19pp.

Korschgen, L. J. 1980. Procedures for food-habits analyses. Pages 113-127 *in* S. D. Schemnitz eds., Wildlife management techniques manual. The Wildlife Society, Washington, D.C.

Land, E. D. 1994. Southwest Florida black bear habitat use, distribution, movements, and conservation strategy. Final Report No. W-41-32. Fla. Game and Fresh Water Fish Comm. 51pp.

Maehr, D. S., and J. R. Brady. 1982. Fall food habits of black bears in Baker and Columbia Counties, Florida. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 36:565-570.

_____, and _____. 1984. Food habits of Florida black bears. J. Wildl. Manage. 48:230-235.

_____. 1984. Distribution of black bears in eastern North America. Proc. East. Workshop Black Bear Res. and Manage. 7:74.

_____, and J. T. DeFazio. 1985. Foods of black bears in Florida. Fla. Field Nat. 13:8-12.

_____, and J. B. Wooding. 1992. Florida black bear. Pages 265-275 *in* S. R. Humphrey, eds., Rare and endangered biota of Florida. Vol. 1, mammals. Univ. Fla. Press, Gainesville.

McCutchen, H. E. 1990. Cryptic behavior of black bears (*Ursus americanus*) in Rocky Mountain National Park, Colorado. Int. Conf. Bear Res. and Manage. 8:65-72.

McWhite, R. W., D. R. Green, C. J. Petrick, and S. M. Seiber. 1993. Natural resources management plan Eglin Air Force Base, Florida 1993-1997. Dept. Air Force, Eglin Air Force Base, Fl. 235pp.

Mech, L. D. 1983. Handbook of radio-tracking. Univ. Minn. Press, Minneapolis. 108pp.

Merriam, C. H. 1896. Preliminary synopsis of the American bears. Proc. Biol. Soc. Wash. 10:65-83.

Miller, D. A. 1995. Systematic classification of black bears in the southeastern United States. M.S. Thesis., Va. Polytechnic Inst. & St. Univ., Blackburg. 103pp.

Mykytka, J. M., and M. R. Pelton. 1989. Evaluation of four standard home range methods based on movements of Florida black bear. Pages 159-166 *in* C. J. Amlaner, ed., Biotelemetry X: proceedings of the Tenth International Symposium on Biotelemetry. Univ. Ark. Press, Fayetteville. 733pp.

_____, and _____. 1990. Management strategies for Florida black bears based on home range habitat composition. Int. Conf. Bear Res. and Manage. 8:161-167.

Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

Pelton, M. R. 1982. Black bear. Pages 504-514 *in* J. A. Chapman and G. A. Feldhammer, eds., Wild mammals of North America: biology, management, and economics. John Hopkins Univ. Press, Baltimore, MD.

_____. 1986. Habitat needs of black bears in the east. Pages 49-53 *in* D. L. Kulhavy and R. N. Connor, eds., Wilderness and natural areas in the eastern United States: a management challenge. Center for Appl. Studies, Stephen F. Austin St. Univ., Nacogdoches, TX.

_____. 1989. The impacts of oak mast on black bears in the southern Appalachians. Pages 7-11 *in* C. E. McGee eds., Proceedings of the workshop: Southern Appalachian Mast Management. Dept. For. Wildl. and Fish., Univ. Tenn., Knoxville.

Powell, R. A. 1987. Black bear home range overlap in North Carolina and the concept of home range applied to black bears. Int. Conf. Bear Res. and Manage. 7:235-242.

Provencher, L., D. R. Gordon, K. E. M. Galley, J. L. Hardesty, H. L. Rodgers, J. Sheehan, E. Levine, G. W. Tanner, L. A. Brennan, and K. W. Blandford. 1996. Pre-restoration analysis of plants, invertebrates, and birds in sandhills systems at Eglin Air Force Base, Florida: Annual report to natural resources division, Eglin Air Force Base. The Nature Conservancy. Niceville, FL. 155pp.

Quade, D. 1979. Using weighted rankings in the analysis of complete blocks with additive block effects. J. Am. Stat. Assoc. 74:680-683.

Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northwestern Minnesota. Wildl. Monogr. 97. 72pp.

SAS Institute Inc. 1989. SAS/STAT User's Guide, Version 6, 4th ed., Volumes 1 and 2. SAS Institute, Inc., Cary, NC. 1686pp.

Schmutz, J. A., and G. C. White. 1990. Error in telemetry studies: effects of animal movement on triangulation. J. Wildl. Manage. 54:506-510.

Seibert, S. G. 1993. Status and management of black bears in Apalachicola National Forest. Final Report No. W-41-30. Fla. Game and Fresh Water Fish Comm., Tallahassee. 29pp.

Smith, L. M., J. W. Hupp, and J. T. Ratti. 1982. Habitat use and home range of gray partridge in eastern South Dakota. J. Wildl. Manage. 46:580-587.

Smith, T. R., and M. R. Pelton. 1990. Home ranges and movements of black bears in a bottomland hardwood forest in Arkansas. Int. Conf. Bear Res. and Manage. 8:213-218.

Smith, R. B., and L. J. Van Daele. 1990. Impacts of hydroelectic development on brown bears, Kodiak Island, Alaska. Int. Conf. Bear Res. and Manage. 8:93-103.

Springer, J.T. 1979. Some sources of bias and sampling error in radio triangulation. J. Wildl. Manage. 43:926-935.

The Nature Conservancy. 1995. Eglin Air Force Base - a critically important reservoir for biodiversity. Biodiversity Network News, Arlington, Va. 8:1-8.

Tietje, W. D., and R. L. Ruff. 1983. Responses of black bears to oil development in Alberta. Wildl. Soc. Bull. 11:99-112.

van Manen, F. T. 1994. Black bear habitat use in Great Smoky Mountains National Park. Ph.D. Dissertation, Univ. Tenn., Knoxville. 194pp.

Weaver, K. M., D. K. Tabberer, L. U. Moore, Jr. G. A. Chandler, J. C. Posey, and M. R. Pelton. 1992. Bottomland hardwood forest management for black bears in Louisiana. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 44:342-350.

Willey, C. H. 1974. Aging black bears from first premolar tooth sections. J. Wildl. Manage. 38:97-100.

Williams Jr, L. E. 1992. Florida turkey. Pages 214-231 *in* J. G. Dickson eds., The wild turkey:biology and management. S. For. Exp. Stat. Natl. Wild Turkey Fed. and USDA For. Serv., Stackpole books, Harrisburg, PA.

Wooding, J. B., and T. S. Hardisky. 1988. Denning by black bears in northcentral Florida. J. Mamm. 73:895-898.

_____, and _____. 1994. Home range, habitat use, and mortality of black bears in north-central Florida. Int. Conf. Bear Res. and Manage. 9:349-356.

Worton, B. J. 1989. Kernel methods for estimating the utilization distribution in home range studies. Ecology 70:164-168.

Young, D. D., and J. J. Beecham. 1986. Black bear habitat use at Priest Lake, Idaho. Int. Conf. Bear Res. and Manage. 6:73-80.

Zager, P., C. Jonkel, and J. Habeck. 1983. Logging and wildfire influence on grizzly bear habitat in northwestern Montana. Int. Conf. Bear Res. and Manage. 5:124-132.

APPENDICES

APPENDIX A

HABITAT COMPONENTS

Table A-1. Primary overstory and understory plant species of 6 ecological associations and military test ranges on Eglin Air Force Base, Florida.

Habitat Type	Plant Species
Sandhills	Longleaf pine (*Pinus palustris*)
	Turkey oak (*Quercus laevis*)
	Laurel oak (*Q. hemisphaerica*)
	Live oak (*Q. virginiana*)
	Blueberry (*Vaccinium* spp.)
	Huckleberry (*Gaylussacia* spp.)
	Saw palmetto (*Serenoa repens*)
	Greenbriar (*Smilax* spp.)
	Gopher apple (*Licania michauxii*)
	Bracken fern (*Pteridium aquilinum*)
Sand Pine	Sand pine (*P. clausa*)
	Longleaf pine
	Live oak
	Ground lichens
Pine/Mixed Hardwoods	Longleaf pine
	Slash pine (*P. elliottii*)
	Loblolly pine (*P. taeda*)
	American beech (*Fagus grandifolia*)
	Southern magnolia (*Magnolia grandiflora*)
	White oak (*Q. alba*)
	Mockernut Hickory (*Carya tomentosa*)
	American holly (*Ilex opaca*)
	Sweetgum (*Liquidambar styaciflua*)
	Huckleberry
	Needle palm (*Rhapidophyllum hystrix*)
	Wild olive (*Osmanthus americana*)
	Strawberry bush (*Euonymus americanus*)
	Christmas fern (*Polystichum acrostichoides*)
Flatwoods	Slash pine
	Longleaf pine
	Wax myrtle (*Myrica cerifera*)
	Bitter gallberry (*I. glabra*)
	Sweet gallberry (*I. coriacea*)
	Fetterbush (*Lyonia lucida*)
	Saw palmetto
	Wiregrass (*Aristida beyrichiana*)

Table A-1 (Continued).

Habitat Type	**Plant Species**
Wetlands/Riparian	Southern magnolia
	Sweetbay magnolia (*M. virginiana*)
	Slash pine
	Titi (*Cyrilla racemiflora*)
	Black titi (*Cliftonia monophylla*)
	Redbay (*Persea borbonia*)
	Longleaf pine
	Laurel oak
	Bald cypress (*Taxodium distichum*)
	Water oak (*Q. nigra*)
	Atlantic white cedar (*Chamaecyparis thyoides*)
	Blackgum (*Nyssa biflora*)
	Sweetgum
	Flowering Dogwood (*Cornus florida*)
	Florida anise (*Illicium floridanum*)
	Bitter gallberry
	Fetterbush
	Saw palmetto
	Greenbriar
Barrier Islands	Live oak
	American holly
	Marsh elder (*Iva frutescens*)
	Cordgrass (*Spartina* spp.)
	Marsh hay (*Spartina patens*)
	Sea oats (*Uniola paniculata*)
Test Ranges	Turkey oak
	Runner oak (*Q. pumila*)
	Bitter gallberry
	Bluestem (*Andropogon* spp.)
	Broomsedge (*A. virginicus*)
	Woolly panicum (*Panicum* spp.)

APPENDIX B

CAPTURE RESULTS

Table B-1. Black bear captures on Eglin Air Force Base, Florida, 1994-1996.

Date	ID#	Capture Type	Sex	Weight (kg)	Age (yrs)
07 Nov 94	01	Initial	M	72.7	5.5
08 Nov 94	02	Initial	M	45.5	2.5
09 Nov 94	03	Initial	M	47.7	2.5
21 Nov 94	03	Recapture	M	47.7	2.5
03 Dec 94	04	Initial	M	59.1	2.5
18 Mar 95	05[a]	Initial	M	200.0	10.5
05 Jun 95	07	Initial	F	19.5	1.5
08 Jun 95	08	Initial	F	59.1	7.5
08 Jun 95	09	Initial	M	27.3	2.5
10 Jun 95	10	Initial	F	31.8	2.5
10 Jun 95	11	Initial	M	77.3	5.5
12 Jun 95	19	Initial	F	63.6	6.5
13 Jun 95	19	Recapture	F	63.6	6.5
13 Jun 95	12	Initial	M	54.5	5.5
16 Jun 95	19	Recapture	F	63.6	6.5
19 Jun 95	13	Initial	M	50.0	2.5
20 Jun 95	20	Initial	F	43.2	2.5
23 Jun 95	01	Recapture	M	90.9	6.5
24 Jun 95	13	Recapture	M	50.0	2.5
24 Jun 95	14	Initial	M	154.5	10.5
30 Jun 95	12	Recapture	M	54.5	5.5
26 Jul 95	15	Initial	M	47.7	2.5
01 Aug 95	16	Initial	F	54.5	2.5
10 Aug 95	17	Initial	M	20.5	1.5
12 Aug 95	18	Initial	M	36.4	1.5
13 Aug 95	21	Initial	M	100.0	8.5
03 Apr 96	01	Recapture	M	102.3	7.5
27 Apr 96	23	Initial	M	50.0	4.5
24 May 96	13	Recapture	M	63.6	3.5
29 May 96	25	Initial	M	56.8	2.5
04 Jun 96	26[b]	Initial	M	68.2	4.5
14 Jun 96	15	Recapture	M	75.0	3.5

Table B-1 (Continued).

Date	ID#	Capture Type	Sex	Weight (kg)	Age (yrs)
24 Jun 96	19	Recapture	F	47.7	7.5
27 Jun 96	23	Recapture	M	50.0	4.5
30 Jun 96	23	Recapture	M	50.0	4.5
10 Jul 96	25	Recapture	M	56.8	2.5
14 Jul 96	09	Recapture	M	45.5	3.5
22 Jul 96	24	Initial	M	88.6	10.5
27 Jul 96	27	Initial	F	43.2	3.5
12 Aug 96	28	Initial	F	45.5	2.5

[a]Tranquilized and marked after being struck by a motor vehicle.

[b]Captured by FGC and relocated to Eglin AFB.

VITA

Marty R. Stratman was born on March 29, 1966 in Yankton, South Dakota and raised in Nebraska. He attended Wynot Public School in Wynot, Nebraska and graduated in 1984. He then attended Western Nebraska Community College, Scottsbluff and received his Associates of Science degree in Forestry/Wildlife Management in May 1988. That same year he began his studies at Colorado State University, Fort Collins and received his Bachelor of Science degree in Wildlife Biology in December 1991. He began graduate school in 1994 in the Department of Forestry, Wildlife, and Fisheries at the University of Tennessee, Knoxville. He received his Master of Science degree in Wildlife and Fisheries Science in May 1998.