BLACK BEAR MOVEMENTS AND HABITAT USE RELATIVE TO ROADS IN OCALA NATIONAL FOREST

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Final Report

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by

J. Walter McCown, Thomas H. Eason, and Mark W. Cunningham D.V.M.

Florida Fish and Wildlife Conservation Commission, Bear Management Section

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ABSTRACT

We evaluated the movements, habitat use, and population dynamics of black bears relative to State Road 40 in Ocala National Forest. We captured 94 bears and placed radiocollars on 76 of them. Additionally, we monitored an 18-km disk transect along State Road 40 to document bear crossings by tracks left in the sandy substrate. Bears crossed State Road 40 frequently; we documented 749 road crossings along the disk transect and identified 324 crossings from telemetry locations. Bears tended to "avoid" slash pine forest types, particularly the older age classes, as well as younger age classes of sand pine/scrub oak. Bears tended to "prefer" middle aged stands of sand pine/scrub oak, upland hardwoods, and wetland hardwoods. We estimated population size with mark-recapture methodology on genetic analysis of 1,278 hair samples collected from baited enclosures. Incorporation of these data into the modified Lincoln/Petersen model yielded an abundance estimate of 131 bears with a 95% confidence interval of 95 - 168 in 1999 and 153 bears with a 95% confidence interval of 128 - 177 bears in 2000. We estimated food availability from 68 100-meter transects in sand pine/scrub oak and 68 pine flatwoods habitats. These transects indicated a steep decline in the amount of foods available during fall 2000 compared to 1999. We documented the production of 40 cubs from 19 litters. Seventy-nine percent of cubs lived through their first year. We estimated an 8.6% overall annual mortality rate for bears $\geq$ 1.5 years old. Collisions with vehicles accounted for seven of 13 bear mortalities documented over the two years of this study. Roadkill tended to be clustered toward the eastern half of State Road 40 within the forest, although crossings occurred throughout the study area. Hills, curves, and vegetated road margins seem to increase the probability of bear roadkill, whereas long, flat, straight, and open stretches seem to decrease it.

Our findings indicate that roadway design and maintenance could be manipulated to reduce the number of roadkill incurred on two-lane roads.

INTRODUCTION

Currently, Florida is home to over 15 million people, and habitat loss due to the residential, commercial, agricultural, and transportation needs of humans is recognized as the most important cause in the decline of many of the state's wildlife populations (Kautz et al. 1993). The goal of the Florida Fish and Wildlife Conservation Commission (FWC) regarding black bears is to perpetuate the species (*Ursus americanus floridanus*) in Florida. However, management of bears to assure their future in Florida increasingly depends upon accurate biological information.

The Florida black bear once occurred throughout the Florida mainland (Brady and Maehr 1985). Rapid conversion from native range to agricultural and urban landscapes in this century, however, has resulted in several geographically isolated sub-populations of bears and has contributed to its listing as a threatened species by the State of Florida throughout most of its range. Currently, the largest bear populations are concentrated in and around Ocala National Forest (ONF), Osceola National Forest, Apalachicola National Forest, the Big Cypress region, and Eglin Air Force Base.

Because bears in Florida have large home ranges and make extensive movements in response to reproductive activities and nutritional needs (Maehr and Brady 1984, Wooding and Hardisky 1994, Roof and Wooding 1996, Roof 1997), their behavior often puts them in conflict with the state's human population. Wooding and Brady (1987) noted that bear/vehicle collisions had occurred in 27 of Florida's 67 counties. More recent studies have identified collisions with vehicles as the leading cause of mortality among some bear populations in Florida (Wooding and Hardisky 1994, Land et al. 1994, Roof and Wooding 1996) . Efforts to address highway mortality have been successful for panthers (Foster and Humphrey 1993) and bears (Roof and Wooding 1996) when based upon intensive home range, habitat use, and movement studies of the affected populations.

The ONF is one of the largest and most important habitats for bears remaining in the state, but is located near the heavily populated central Florida area, which continues to develop at a rapid pace. Since the FWC began documenting the numbers of bears killed by vehicles in 1976, the Ocala population has had the highest number of roadkills (381 of 880, or 43.3% of the statewide total) of any area in the state. Furthermore, eight of 15 chronic roadkill problem areas in Florida identified in a 2000 study are in Lake and Marion counties (Gilbert 2000). Since ONF is divided by State Road 40 (SR 40) and traversed by other roads of varying intensities of use, it provides an opportunity to assess bear movements relative to a variety of road traffic levels.

This final report covers the 2-year period beginning May 15, 1999 and ending May 15, 2001. During this period, the FWC performed fieldwork for the investigation of black bear movements and habitat use relative to roads in ONF. Thomas Eason managed the project and Walt McCown supervised the fieldwork and data collection. Mark Cunningham, Elina Garrison, Jeremy Dixon, Karen Oven, Darrin Masters, John Williamson, Bill Bankhead, and Andrea Boliek assisted the trapping, radio telemetry, disk transect, winter denwork, hair snaring, mast survey, and database management efforts for this study. Funds were provided by the Florida Department of Transportation, United States Forest Service, and FWC.

OBJECTIVES

The goal of this study was to provide information useful for advancing roadway design, placement, improvement, and maintenance with regard to black bear conservation and management in ONF and other bear populations throughout Florida. Specific objectives for this research were to:

1. determine the habitat use and movement patterns of bears captured in the vicinity of SR 40,
2. determine the home-range dynamics of bears captured in the vicinity of SR 40,
3. determine the productivity and survival of bears captured in the vicinity of SR 40,
4. provide an abundance estimate of the bear population within the study area,
5. locate and analyze the characteristics of sites where bears cross SR 40 in the study area,
6. survey the relative abundance and availability of common bear foods in ONF, and
7. synthesize collected data to provide recommendations for reducing impacts of roads on bears in ONF.

STUDY AREA

The vegetative communities and soils of ONF were described by Snedaker and Lugo (1972). Soil types on ONF were predominately old dune sands. The 169,290 ha forest had four major vegetative types: 1) swamps and marshes along the Oklawaha and St Johns rivers; 2) pine flatwoods between the rivers and the central ridge; 3) mixed hardwood swamps; and 4) dune-like interior ridges of sand pine (*Pinus clausa*) and scrub oaks (*Quercus spp.*) interspersed with numerous lakes and ponds (Ayedelott et al. 1975). Within ONF, the area used for the majority of this study consisted of the sand pine/scrub oak community. This community is managed as a commercial crop within ONF with many cutting compartments ranging from newly harvested clear cuts (0 - 2 years) to mature stands (25+ years). Other communities of note within the study area include slash pine (*P. elliottii*) flatwoods, wetland hardwoods, and prairies. The study area was centered on SR 40 and extended south to Forest Road 595, north to Forest Road 86, east to State Road 19 (SR 19), and west to Forest Road 579 (Figure 1). This area encompassed approximately 335 km^2 (130 mi^2) and covered the central portion of ONF. The effective study area was expanded as necessary to include movements of radio-collared bears and buffering of hair snare sites.

METHODS

Trapping

We captured 94 bears a total of 107 times with 288 trapnights of effort (2.69 trapnights per capture) throughout the designated study area.. We caught 59 males and 35 females (Table 1) and placed radiocollars on 74 bears (41 males and 33 females) a total of 79 times. Forty-seven bears (37 males and 10 females) dropped their collars a total of 48 times during the study; one male dropped two collars. The higher radiocollar drop rate for males as compared to females was due to the large neck girth of adult males. These bears had such thick necks that the only thing holding their radiocollars on was their ears. Consequently, it was easier for them than for females to dislodge the radiocollar. We compensated for this by collaring more males than females.

We trapped intermittently from mid May to mid December each year and concentrated trapping along the SR 40 corridor. We captured bears by use of Aldrich spring-activated foot snares and immobilized them by injection of a 1:1 mixture of Tiletamine hydrochloride and Zolazepam hydrochloride (Telazol®). This mixture was administered at 4.5 mg/kg of estimated bear weight via a remote injection gun. We measured, weighed, ear-tagged and lip-tattooed all immobilized bears. Additionally, we collected hair and blood samples for genetic analyses, extracted a premolar tooth for aging, and fitted selected individuals with radiocollars for remote tracking. Collars were equipped with a mortality sensor and fitted with a leather "break-away" connector that, after one to two years, allowed collars to fall off. After work-up, bears were released at the capture site, or moved to a nearby area if safety during recovery was a concern.

Radio Telemetry

We acquired 3,652 locations (1,213 aerial and 2,439 ground) on radio-collared bears during the study. We collected the most locations (131) on bear R017 and the fewest locations (1) on bears R007, R0053, and R076 (Table 1). These later bears dropped their collars soon after capture.

We selected individuals to be fitted with radiocollars based on several criteria including: 1) ensuring bears were of adequate size (≥45 kg) to prevent collar injuries due to growth, 2) preferentially sampling bears adjacent to SR 40, and 3) maintaining as balanced a sex ratio as possible. Because more males were captured than females, we fitted a higher percentage of captured females with collars than we did males. We attempted to locate each collared bear 2 to 3 times weekly; due to inclement weather and scheduling conflicts, however, we located them less often. Generally, we acquired at least one location per week on most bears. We collected locations through the use of ground triangulation and aerial plotting. We used program Locate II (Pacer 1990) to calculate ground triangulations.

Movements and Home Range. We plotted the locations of collared bears to examine movement patterns associated with bear sex, season, and proximity to roads. We calculated annual and seasonal home range size for each bear that had at least 25 locations within the time frame of interest. We calculated minimum convex polygon home ranges using the Homerange extension in ArcView and compared home range size by sex and season with t-tests. We defined seasons to correspond with important yearly biological events for bears: winter (denning) = January - April, spring (pre-breeding) = May - June, summer (breeding) = July - September, and fall (hyperphagia) = October - December.

Habitat Use. We overlaid bear telemetry locations onto Geographic Information System (GIS) habitat maps of ONF to determine habitat use as compared to availability. We compared actual use of habitat types within individual bear home ranges to estimated use (based on percent available) using chi-square analyses (Neu et al. 1974). We included only those locations that fell within ONF because our habitat type data did not extend outside of the forest boundaries.

Road Crossings

We documented road crossings by bears through the use of two techniques. The first technique consisted of connecting consecutive telemetry locations that fell on opposite sides of SR 40. From this technique we could identify individual bear crossing tendencies and compared crossing rates between individuals, sexes, and seasons. The second technique involved monitoring of a disk transect along S.R. 40. The transect started at Forest Road 579 on the western side of the study area, extended approximately 18 km eastward, and ended at SR 19. The transect alternated from the south to north side of SR 40 at roughly 2-km intervals to discourage use by off-road vehicles and avoid patches of endangered plant life. Each month we monitored the transect once a week for three weeks and further monitored it daily for one week for a total of approximately 10 monitoring trips each month. This schedule allowed us to document daily and weekly use rates for a subset of time as well as overall use rates for the entire period. To facilitate analysis, the transect was broken into 250 meter intervals and tracks were tallied for each of these intervals. We analyzed the frequency of crossings in different forest cover types and compared them to expected frequencies based on percent coverage of each forest type (Neu et al. 1974). Based on the findings of previous studies regarding the extent of road disturbance on bears, we included habitat types within 250 m of SR 40 as available (Wooding and Maddrey 1994).

Because of the overlap of the two techniques whereby crossings by radio-collared bears were potentially counted during track counts, we analyzed and interpreted results from each technique separately. We documented daily, weekly, and seasonal crossing rates and compared crossing rates among individuals, sexes, and seasons. Also, we analyzed the topographic and vegetative characteristics of crossing sites to determine associations and patterns in bear road crossings.

Cub Production and Survival

We completed denwork on radio-collared females during late winter and early spring. Denwork consisted of triangulating on radio-collared bears and creeping in on them to listen for cubs in February. We confirmed the presence of cubs in March by cautiously approaching densites until females moved off and collecting the cubs. We then brought the cubs to nearby work sites and quickly examined them for sex, weight, size, and other characteristics. We returned all cubs to their dens within 45 minutes of pushing the female away.

We estimated cub survival by opportunistically treeing family groups during field work and by revisiting females at den sites in subsequent years. Because we could not identify exact dates of cub mortality, we calculated survival as the proportion of cubs that lived through their first year.

Biomedical Investigations

Carcasses of bears from the ONF and vicinity were necropsied and examined for cause of death and presence of incidental parasites and diseases. Live-captured bears underwent physical examination including auscultation of heart and lungs and inspection of musculoskeletal parts (either thorough or cursory depending on time constraints and field conditions). Musculoskeletal examination included flexion of weight-bearing joints and palpation of long bones (radius, ulna, humerus, femur, tibia, and scapula) for healed fractures and fused joints. Body temperature also was recorded.

All captured and necropsied bears were examined for ectoparasites. Ticks were collected for identification and a subjective assessment of tick infestation was determined for each bear. We determined the presence of chewing lice (*Trichodectes pinguis euarctidos*) by visual examination and/or running a fine-toothed comb through the pelage. When demodicosis (demodectic mange) was suspected, presence of mites *(Demodex spp.)* was confirmed by histological examination of skin biopsies removed from affected areas. Presence of chiggers (*Eutrombicula spp.*) was determined by visual examination.

Whole blood was collected in serum separator, EDTA, and sodium heparin tubes from femoral veins or arteries of captured bears. Complete blood counts (CBC), differential cell counts and serum chemistries were performed at the University of Florida, College of Veterinary Medicine (Gainesville, Florida) or Antech Diagnostics (New York, New York). We determined plasma protein (PP) values and estimated packed cell volume (PCV) for most bears.

Mortality

We documented mortality events for collared bears by ground checking all mortality signals and performed necropsies on dead bears to verify their cause of death. Mortality rates were calculated from radio-collared animals only. We tallied the number of days bears wore radiocollars (radio days) during the two-year period of this study and calculated an annual mortality rate (Heisey and Fuller 1985). If not readily apparent, we calculated the number of days a bear was radiocollared as the number of days between initial collaring and the midpoint between the date of last location and the first date that we detected mortality signals. We further documented the deaths of uncollared, but previously trapped and marked bears, as they were reported to us via vehicular accidents, criminal investigations, or our own field work.

Food Availability

We assessed the seasonal availability of food from 68 mast-survey transects in 17 cutting compartments of slash pine flatwoods habitat and 60 mast-survey transects within 5 age classes of sand pine/scrub oak habitat. Along these 100-m transects, we collected data on species composition, fruit abundance, fruit distribution, and phenology. We used ocular estimates to categorize the occurrence of plants with fruit as absent, sparse (1-20%), moderate (21-50%) or abundant (>50%). We graphed relative abundance of common bear foods through time to examine the potential influence of food availability on bear movements.

Population Estimation

We sent 1,278 hair samples collected during 1999 (n=641) and 2000 (n=637) to Wildlife Genetics International, a genetics laboratory, for identification of individuals. The lab was able to produce viable genotypes from 1,146 of the 1,278 samples (this represents the highest success rate (89%) that they have achieved to date). The genetic analyses resulted in genetic "fingerprints" for each sample as well as identification of sex.

We determined the abundance and density of black bears in the study area through the incorporation of hair samples into mark-recapture models. To collect hair samples, we established bait sites surrounded by barbed wire throughout the study area. Samples were collected during an initial "marking" phase and during a final "recapture" phase. The marking phase began in late May and the recapture phase began in early August of each year. Each phase continued for 3-4 weeks. We collected hair samples from bait sites every 2-3 days and labeled each with the site name, date, and sample number and sent them to a genetics laboratory for identification of individuals. We calculated abundance estimates from the results of the genetic analyses of the hair samples. We considered all bears sampled during the marking phase to be marked for the recapture phase. We considered all new bears in the recapture phase to be unmarked. We calculated abundance estimates using the modified Lincoln-Petersen model (Pollock et al. 1990) for each summer of the project. We converted abundance estimates to density estimates by circumscribing each hair snare site with a radius equal to the average home range size of bears in Ocala National Forest and combining them to form an overall effective study area. This density estimate was then extrapolated from the study area to derive abundance estimates for the entire ONF.

RESULTS AND DISCUSSION

Trapping

The average weight of captured bears was 207 lbs.; males averaged 242 lbs. and females averaged 148 lbs. The average age of captured bears was 4.9 years; males averaged 4.6 years and females averaged 5.4 years. The high capture rate achieved was remarkable in that most bear studies have taken 10 to over 100 trap-nights per capture. Moreover, for this study, we usually activated traps starting at 5:00 pm and deactivated them at midnight, meaning that most bears were captured within a seven-hour window of opportunity. Generally, we ran 2 to 3 traps per night several days a week and routinely captured 1 to 3 individuals each night. While we processed captured bears, it was common for other bears to wander up to and around the capture site. Further, we observed hundreds of bear tracks along the dirt roads of the study area and numerous marked trees. Although the high capture rate was due in part to the willingness of naive bears to enter trapsites, overall it indicates that a dense population of bears resides in ONF.

Radio Telemetry

Movements and Home Range. Movements among individual bears varied greatly. In general, male bears moved greater distances than female bears, and all bears moved greater distances in the fall when they were foraging for food than during other parts of the year. The drought conditions that persisted throughout the 2-year time frame of this study and intensified in 2000-2001 seemed to affect bear movements by causing them to wander out of drier sand pine/scrub oak areas in search of food and suitable denning habitat in more mesic community types. Several females moved out of the study area and raised litters on private property during winter 2000-2001. Home ranges averaged 72.6 km^2; males had larger home ranges (106.8 km^2) than females (38.4 km^2) and 2000 home ranges (80.4 km^2) were larger than 1999 home ranges (62.3 km^2) (Table 2).

The home range sizes, particularly the much larger home ranges we report for 2000, may be overestimates of actual use area. During the drought and generalized mast failure of 2000 many radio-collared bears shifted their home ranges out of the study area into more mesic communities. In most cases these shifts occurred quickly and once they arrived at a satisfactory destination, these bears exhibited normal movements and home ranges sizes. However, the technique we used to determine home range sizes, minimum convex polygon, includes all area within peripheral radio locations into the estimate of home range and thus included large expanses of unused forest into the calculations. Even so, the home range sizes recorded in this study were some of the smallest documented in Florida (T. Eason unpubl. data).

Habitat Use. Telemetry locations occurred at 8-24 year old stands of sand pine, upland hardwoods, and wetland hardwoods at frequencies greater than would be expected by chance. Conversely, telemetry locations occurred at 8+ year old stands of slash pine and 3-7 year old stands of sand pine/scrub oak at frequencies less than would be expected by chance. Telemetry locations fell within other habitat types at frequencies that would be expected by chance, given the amounts available (Table 3).

Black bears are generally described as forest dwellers. Harlow (1961) described bear habitat in Florida as "a mixture of flatwoods, swamps, scrub oak ridges, bayheads, and hammock habitats, throughly interspersed... ." As Harlow suggests, bears are adaptable to a wide variety of habitat types and have been documented using virtually every canopied plant association in the state in search of food, cover or suitable denning environs. In northwest Florida, Stratman (1998) found bears preferred the narrow hardwood riparian zones found along the many drainages on Eglin Air Force Base. We also noted that bears in ONF preferred wetland hardwoods which, in our study area, consisted largely of the riparian forest flanking Juniper Creek. In Osceola National Forest, Scheick (1999) reported finding bears using 8-16 year old stands of slash pine in excess of their availability while we found bears in ONF avoided similar aged stands of slash pine and preferred stands of 8 - 24 year old sand pine (Table 3). It is largely the non-uniform spatial and temporal distribution of food that determines the relative importance of a particular habitat to bears. We noted that when mast was scarce in fall of 2000 many radio-collared bears shifted to riparian zones in and out of the study area.

Road Crossings

Crossings by Radio-collared Bears. Fourty-four of 63 radio-collared bears with more than 10 locations crossed S.R. 40 a total of 324 times (average = 7.4, range = 1 - 40). Sixteen females crossed a total of 108 times (average = 6.8, range = 1 - 30) and 28 males crossed a total of 216 times (average = 7.8, range = 1- 40). Crossing rates of males and females did not vary significantly (p=0.7438). Crossings were lowest in winter and spring, increased in summer and peaked in the fall (Figure 2).

The higher number of radio-collared males that crossed S.R. 40 was explained by their larger home ranges that brought them into contact with the highway more often than females. The fact that many females also crossed frequently indicates that S.R. 40 was not a major barrier to the bear population within our study area in Ocala National Forest.

Bear Track Transect Crossings. We documented a total of 749 bear crossings of S.R. 40 at 707 separate locations (sometimes more than one set of bear tracks were found at a location during a monitoring trip) along the disk transect. The number of bears leaving tracks per location varied from one to four. Weekly crossings averaged 8.1 (range 0 - 67) and daily crossings averaged 2.2 (range 0 - 13). Frequencies of crossings increased in the spring and fall and decreased in the winter and summer (Figure 3).

Locations of historic road mortalities were heavily skewed toward the eastern half of SR 40 within the study area, even though crossings occurred throughout the length of the track transect (Figure 4). Locations of crossings were affected by season. There was a higher incidence of tracks observed along western as opposed to eastern segments of the transect during fall 2000 (Figure 5). When we examined the period of September 15 through October 15, the spike in track numbers was especially apparent. During this 30 day period we tallied 224 bear crossings of SR 40 at 213 locations. More than half of the crossings occurred along the western one-third of the transect (Figure 6).

It is likely that the high frequency of crossings on western segments of the transect during fall months was a response to limited food supplies that became critical during the general mast failure that occurred in fall 2000 in most sand pine/scrub oak habitats within the study area. We noted that clusters (5-8) of radio collared bears tended to clump into a few small patches of sand pine/scrub oak habitat located in western portions of the study area during September and October 2000. Field investigations revealed the oaks in these patches contained a more abundant acorn crop than was available elsewhere within the study area. All scats found at these sites (n = 12) consisted of acorn fragments.

Crossing Habitat Selection. Crossings occurred at 8-24 year old stands of sand pine at frequencies greater than would be expected by chance. Conversely, crossings occurred at 25+ year old stands of sand pine and oak pine scrub at frequencies less than would be expected by chance (Table 4).

Crossing Behavior. We observed or had reported to us the crossing or attempted crossing behavior of 30 bears across major paved roadways. Six of these bears were killed and were described as running full speed across the road into traffic without looking. Three bears actually ran into the sides of vehicles as drivers slowed to avoid them. Of the 24 bears not killed, 11 ran into traffic and narrowly missed being hit and 8 appeared to wait until traffic was light before crossing. We received several reported observations of bears looking up and down the highway before crossing. At least two of these bears were known to have survived a previous collision. Observed successful crossings included those by three family groups (females with cubs) on four occasions. One of these crossings was completed with no traffic around and mother and cubs crossed together. The other three crossings consisted of the sow crossing first (with no traffic) with the cubs following singly, seconds to minutes later (often with traffic present). This behavior (sow crossing first followed by cubs) may be typical and could account for the relatively large number of cubs killed by cars each year.

The two techniques that we used to document black bear road crossings complemented each other well, but revealed slightly different crossing patterns. Both techniques showed frequent crossings that peaked in fall. However, the telemetry data revealed a second, smaller peak in summer, whereas the track data showed an equally large peak in spring. We believe two factors contribute substantially to this result. The first factor was the biased sample of bears that we chose to radiocollar in this study. Because of our study objectives and logistic constraints, we did not radiocollar juveniles and subadults in proportion to their occurrence. Instead, we concentrated on adult males and females. Consequently, our results based on telemetry do not account for the movements of younger bears, which likely increased in spring as these subdominant bears searched for the meager food sources available after denning. The second factor was the increased frequency and amount of rain that fell during summer which obliterated bear tracks along the transect and prevented us from documenting many crossings.

Our analysis indicated that bears tended to cross in habitats with dense canopy and understory cover and tended not to cross in more open habitats. Previous studies have indicated that not only do bears tend to cross roads at low rates, but they also tend to avoid habitat adjacent to highways. The degree of avoidance has been shown to be a function of traffic volume (Carr and Pelton 1984) and roadside cover (Rogers and Allen 1987), with measurable effects up to 500 meters from the highway (Wooding and Maddrey 1994). Our results indicate that the traffic volume was not great enough to prevent bears from crossing SR 40 and suggest that the degree of avoidance of adjacent habitats is minimal at worst.

The ability of bears to cross S.R. 40 in the numbers that we found suggests that the highway, at traffic volumes that existed during this study (6,000 - 10,000 vehicle trips per day; Fl. Dept. of Trans. 1998), was not a barrier. However, Carr and Pelton (1989) found the frequency of bears crossing roads was inversely related to traffic levels with a strong avoidance exhibited by bears to a busy interstate highway. Beringer et al. (1990) found bears avoided roads with more than 10,000 vehicle trips per day. Comparison of unsuccessful crossing locations (roadkill) with successful ones (tracks) suggests that long, straight, stretches of roadway with wide, open right-of-ways reduces the likelihood of vehicle collisions with bears.

Cub Production and Survival

We confirmed the presence of cubs with 19 females, and documented the production of 40 cubs (21 males and 19 females). Average litter size was 2.1 cubs per female; we observed two litters of one, 13 litters of two, and four litters of three (Table 1). The cubs were healthy and averaged 4.53 lbs. (males averaged 4.74 lbs. and females averaged 4.31 lbs.). The 19 females stayed in the immediate area of their dens and returned to their cubs after we left the area. Dens consisted of shallow depressions, or "nest" dens (n = 14), and excavations under root masses and other objects (n = 5). All dens were located in dense understory vegetation.

During 1999-2000, we documented the deaths of three cubs and were able to verify that 12 cubs survived. During 2000-2001, we documented the deaths of three cubs and were able to verify that 10 survived. Consequently, the proportion of cubs that survived their first year averaged 79% (80% in 1999-2000 and 77% in 2000-2001). Compared to other cub survival studies (Kemp 1970, LeCount 1987), these survival rates were high and indicated a healthy population with high yearling recruitment.

Biomedical Investigations

Post-mortem Examination. Necropsies were performed on 52 (38 males, 23 females, 1 unknown) bears from ONF and vicinity. Of these, 47 post-mortem examinations were of intact carcasses and 5 were performed on skeletal or partial remains. Twelve necropsies were performed on bears previously captured during this study. Average age of necropsied animals was 3.5 years with a range of 3 months to 18 years of age. Causes of death included vehicular trauma (n = 41), intraspecific aggression/cannibalism (n = 3), illegal kill (n = 2), cub abandonment (n = 1), capture related (not part of this study) (n = 1), drowning (n = 1) and unknown cause (n = 3).

Extensive abdominal, thoracic, cervical, head, and musculoskeletal trauma were common findings in necropsied bears killed by vehicular trauma (Table 5). Abdominal trauma included splenic and hepatic fractures, stomach rupture, and diaphragmatic hernia. Abdominal organs are asymmetrically situated in the abdominal cavity and injuries to organs varied depending on which side of the animal was impacted. The spleen and most of the stomach are on the left side while the liver has slightly more mass on the right. Severe splenic fractures (a potentially fatal injury) occurred in 4 of 6 bears hit on the left side and none of 7 bears hit on the right side. There was no pattern evident for liver fractures, stomach rupture, and diaphragmatic hernias related to side of impact. The drowning death was secondary to the debilitating effects of bronchogenic carcinoma.

Physical Examination. We examined 92 live adult or juvenile bears (32 female, 60 males) 113 times (87 thorough, 26 cursory) for evidence of healed musculoskeletal injuries. Twelve bears (13%; 10 male, 2 female) had one or more healed skeletal injuries. Seven bears had radius/ulna fractures, 1 had radius/ulna/humerus fractures, 1 had a tibia fracture, 1 had a tibia/femur fracture and luxated stifle (dislocated knee), 1 had a luxated stifle only, and 1 had extensive injuries including a fractured right tibia, fractured left radius/ulna, luxated right coxofemoral (hip) joint, and fusion of the right tibiotarsal (ankle) joint and left stifle. Four bears had no detectable injuries when first captured but had healed injuries evident at recapture between 2 and 13 months later. The proportion of males among injured bears in this study (83%) is higher, but similar to the proportion of males among all roadkilled bears in Florida (68%) since 1991 (FWC unpublished records) and is largely due to their larger home ranges which cause them to cross more roads during their lifetime.

Two of 4 bears that died from causes other than vehicular trauma had healed skeletal fractures. An adult female that died of bronchogenic carcinoma/drowning had extensive healed fractures of both scapulas and an adult male that died from gunshot wounds had healed rib fractures. One necropsied bear killed by vehicular trauma had extensive healed long bone fractures.

Although some injuries may not have been detected during cursory examinations, the injury rate we report (13%) is much higher than that of a similar study in New York where only 2 of 241 (0.8%) bears examined had healed fractures (King et al. 1960). The causes of these injuries were unknown; however, many, if not the majority, were likely due to vehicular trauma. This may be especially true for bears suffering multiple fractures of major long bones. The collar of study animal R021, an adult male that frequently crossed SR 40, was retrieved soon after being dropped. We found the stainless steel mounting posts on the right side of the recovered collar were bent flat against the collar surface. This animal had a healed right radius/ulna fracture when recaptured 230 days later.

An indicator of poor prognosis for bears that survived vehicular collision was the inability of the bear to move from the roadway. This usually indicated severe soft-tissue or musculoskeletal injury. A slightly worse prognosis was indicated for bears hit on the left side due to the likelihood of splenic fracture. A positive prognosis was indicated by bears able to move off the roadway and survive the first few days. We found evidence for this in the large number of bears with healed severe fractures of major bones. Further, all radio-collared bears dying from vehicular trauma were found at the scene (n = 4) while one radio-collared bear was hit, suffered fractures of the right humerus, radius, and ulna, was able to leave the roadway and survived.

Parasitology. Cursory examinations of adult black bear gastrointestinal tracts from the Ocala population revealed a prevalence of *Baylisascaris transfuga* infections of approximately

30% (Table 6). These results may be significant because Conti et al. (1983) failed to find this common parasite of black bears. However, they only looked at two adult bears from the Ocala population. Although roundworms can cause significant clinical disease in domestic dogs (Bowman and Lynn 1995), *B. transfuga* does not appear to have a significant impact on the health of individual adult bears. Indeed, rare individuals have been found to harbor hundreds of these large worms (length approximately 12 cm) without apparent adverse effect.

The presence of helminths in cubs appeared to vary with age. Hookworms (*Ancylostoma caninum*) were found only in cubs ≤7 mo-of-age and all other helminths, including *B. transfuga*, were found in cubs ≥3 mo-of-age. Hookworms can cause anemia in domestic dogs (Bowman and Lynn 1995); however, their significance in bear cubs is unknown.

Ectoparasites were numerous, both with respect to species and numbers, on Florida black bears (Table 6). Ticks were found on every bear examined except one and intensities on some bears numbered in the thousands. Severe local inflammation and secondary bacterial infections were observed at attachment sites of adult ticks. Although a direct impact on the health of bears could not be detected, severe infestations likely had some impact on the health of some individuals. Heavy tick infestations in wild mammals, especially young, can cause anemia (Allan 2001), and black bears from the Ocala population with severe tick infestations had significantly lower PCVs than bears with low to moderate infestations.

Chewing lice (*T. pinguis euarctidos*) were found at a low prevalence (4.8%) and usually low intensity although some bears had large numbers of lice. One infested adult male had a higher intensity when recaptured one year later. Chiggers (*E. splendens*) were seen at a high prevalence (47.6%) during the spring and summer. Neither of these parasites appeared to cause significant morbidity.

Demodicosis (demodectic mange caused by the mite *D. ursi*) was seen in 14 of 133 (10.5%) bears examined. The majority of these cases were concentrated on the western edge of the ONF, centered on the town of Lynne where 10 of 19 bears (52.3%), all females, were positive. The prevalence among females captured in this area (n = 13) was 78% – a prevalence unheard of in almost any mammalian population. Based on capture and remote photography, a 100% transmission rate from mother to cubs is suspected.

Demodicosis in black bears has been reported only one other time. Manville (1978) reported one instance of demodicosis among 113 bears (0.9%) examined in Wisconsin. The cause of demodicosis in domestic animals is unknown although a genetic predisposition is suspected (Scott et al., 1995). The cause of this disease in Ocala black bears also is unknown.

Congenital Anomalies. Congenital anomalies in the Ocala population were rare and included cryptorchidism (less than 2 testes, n = 7), kidney agenesis (absence of a kidney, n = 1), and agnathia (partial absence of lower jaw, n = 1). Of the 7 cryptorchid bears, 3 were cubs and may have had a normal delayed testicular descent; the prevalence among yearlings and adults is comparable to that reported by Dunbar et al. (1996). No heart defects were found although one bear had a grade V/VI systolic heart murmur. The cause(s) of these anomalies were unknown.

Hematology, Serum Chemistry, and Physical Condition Indices. Mean values for selected hematological and serum chemistry parameters for adult and juvenile black bears captured during this study (Table 7) were comparable to values collected from other Florida populations (M. Cunningham unpubl. data). The Ocala population appeared to be healthy.

Body condition indices were comparable to other Florida populations. Further, cub production was better than that seen in the Chassahowitzka (Maehr et al. 1999) and South Florida (Land et al. 1994) populations. Preliminary results of an ongoing genetic assessment of Florida's black bear populations indicate a genetic diversity (based on average expected heterozygosity) for the Ocala population of 61% (M. Cunningham unpubl. data). This level is midway between the 39% seen in Chassahowitzka, a small isolated population, and the approximately 80% seen in large mainland Canadian populations (Paetkau and Strobeck 1994).

Bears in the Ocala population appeared to be relatively resistant to parasites and infectious diseases with the most important causes of mortality directly or indirectly related to humans. Parasites and infectious disease did not appear to be of major concern at the population level (although their effect on cubs is unknown). A possible exception was the high prevalence of demodicosis on the western edge of the population. The expression of this disease may reflect an underlying immunosuppression, although body condition, longevity, and cub production did not appear to be impaired.

Mortality

Six radio-collared bears died during this study. Four bears were struck and killed by vehicles, one died as a result of intraspecific aggression/predation and one died of unknown causes (Table 8) . The documented mortalities during this study constituted an annual mortality rate of 8.6% with a mortality rate of 5.8% attributable to vehicular collision. Adult annual mortality rates for other populations of bears have been reported to range from 12.5% for an unhunted population in Canada (Kemp 1970) to well over 20% in some hunted populations (Jonkel and Cowan 1971, Lindez and Meslow 1980, LeCount 1987). If we include into our mortality calculations a female (R042) with which radio contact was lost and a male (R027) that was killed by vehicular collision 47 days after dropping his collar, the mortality rate would increase to 11.3% and could represent the upper range of adult bear mortality in this unhunted population. The mortality rate we documented among our study animals seems to be sustainable.

Seven other marked but uncollared bears died during the two years of this study. Of these, three died as a result of vehicular collision, two 3 month-old cubs (along with their mother, which was radio-collared and included in the mortality rate calculation) were killed by an adult male, one adult male was shot illegally while reportedly engaged in nuisance behavior, and one 4 month-old cub was abandoned at the den by its mother.

Food Availability

Hard mast (acorns from four species of scrub oaks) was most abundant during fall 1999 and summer 2000, when acorns were sparse to moderate. Hard mast was least abundant in winter 2000, spring 2000, and winter 2001, when acorns were absent. Overall, the drought conditions that persisted throughout the two years of this study resulted in poor hard and soft mast production. We noted, in particular, the general absence of hard mast during fall 2000 (Figure 7). The energy derived from fall foods stored in the form of body fat is of singular importance to bears during the winter denning period. It is largely the nutritional plane of females at this time of year that affects the age at which they first reproduce as well as cub production and survival (Bunnell and Tait 1981). Absence of reproduction was reported for a black bear population in Montana when summertime berry crops failed (Jonkel and Cowan 1971). The nearly complete failure of hard mast in fall 2000 coincided with large-scale movements by many bears and a significant rise in nuisance bear complaints from communities around the periphery of ONF (FWC, unpublished data). We hypothesize that these movements were the direct result of low food availability and the need of bears to find food during the fall in preparation for winter dormancy.

Soft mast (blue, gall, and palmetto berries) availability varied by species, but generally was absent to sparse. Spring 2000 had the highest availability of soft mast, when blue berries and gall berries bore fruit. Telemetry locations and anecdotal evidence indicated that bears moved to wetter areas where, presumably, they were able to find food. The consistent production of cubs and high cub survival, even after the mast failure of fall 2000, further indicated that bears were finding adequate nutrition, albeit from sources sometimes well outside of our study area.

Population Estimation

One hundred thirty-nine individual bears (81 males, 58 females) were identified from the 1,146 viable hair samples; 81 (51 males, 30 females) bears from 1999 and 113 (66 males, 47 females) from 2000. In 1999, 38 bears were identified from the initial capture period and 60 bears were identified from the subsequent recapture period. Seventeen bears were identified from both periods, yielding a modified Lincoln/Petersen abundance estimate of 131 bears with a 95% confidence interval of 95 - 168 bears. In 2000, 79 bears were identified from the initial capture period and 70 bears were identified from the subsequent recapture period. Thirty-six bears were identified from both periods, yielding a modified Lincoln/Petersen abundance estimate of 153 bears with a 95% confidence interval of 128 - 177 bears. Given the effective study area sizes of 608 km^2 (1999) and 652 km^2 (2000), these abundances correspond to densities of 4.6 and 4.0 km^2 per bear. We believe these estimates to be fairly accurate but conservative. With more precise home range estimates the density and abundance estimates would likely go up. However conservative our estimates may be, they represent a significant increase from previous estimates in ONF. Wooding and Hardisky (1992) estimated the minimum bear density at 12.5 km^2 per bear in northeastern ONF where expanses of open, park-like longleaf pine (P. palustris) forests likely contributed to a lower estimate of bear density than in our study area. Conversely, Roof and Wooding (1996) reported an estimate of 1.9 km^2 per bear in the wetland hardwood forests along the Wekiva River in southern Lake County, Florida approximately 20 km south of ONF.

CONCLUSIONS

Based on data gathered in this study, the bear population in Ocala National Forest consisted of healthy individuals that were productive and occurred at one of the densest levels recorded in the state. Home ranges tended to be small compared to other areas of the state, indicating high habitat quality. Movements varied by sex and season, with males traversing much larger areas than females and both sexes moving over greater distances in the fall. These movements subjected bears to greater risk of injury and mortality associated with roads and developed areas.

Collision with vehicles was the leading cause of death for bears on the study area, but did not seem to be limiting the population. Bears crossed SR 40 frequently (over 750 times in two years) and were successful at doing so the vast majority of the time. Roadkill occurred much more often on the eastern half of the study area then on the western half, even though crossing rates were similar. We attributed this phenomenon to road characteristics in each area . The western half of S.R. 40 was straight and flat, whereas the eastern half was curvy and hilly. Additionally, the crossing rate on the western half of SR 40 may have been exaggerated by our observation of travel by bears into a few patches of productive scrub oaks that were located in the western portion of the study area during a period of overall mast failure. Additionally, we noted that bears tended not to cross SR 40 along stretches of road that had open areas (clear cuts) on one or both sides. There is potential for this tendency to be exploited in areas of high roadkill by clearing vegetation back from the roadside to lower crossing rates. Future road projects in the area should address the high crossing rate of bears in Ocala National Forest and the dispersed nature of these crossings. Bears adapted to crossing two lanes of traffic may not be as successful at crossing four lanes, or may be inhibited from crossing at all (Wooding and Maddrey 1994). Results from this study indicated that road design characteristics such as long, flat straight-a-ways and open right-of-ways may facilitate successful crossings by bears. In conjunction with these design features, management efforts could utilize movement patterns of bears to reduce crossing in unwanted areas and increase crossings in designated areas.

Lastly, although we believe that the data presented here are robust and meaningful, we caution against their over-interpretation. The two years of this study fell in the middle of Florida's worst drought in over 50 years. Without doubt, the drought conditions affected bear movements and behavior through food availability and other mechanisms we may not understand. Additionally, bears are long-lived, wide-ranging mammals with complicated life history traits. The two years of study conducted merely provide a snapshot, frozen in time, of bear dynamics in the Ocala National Forest. As time passes and conditions change, so too will the bear population. For these reasons, we have partnered with FDOT and the United States Forest Service on a 2-year (2001-2003) extension of the project. This extension will provide more data and greater context in which to interpret the findings of this study.

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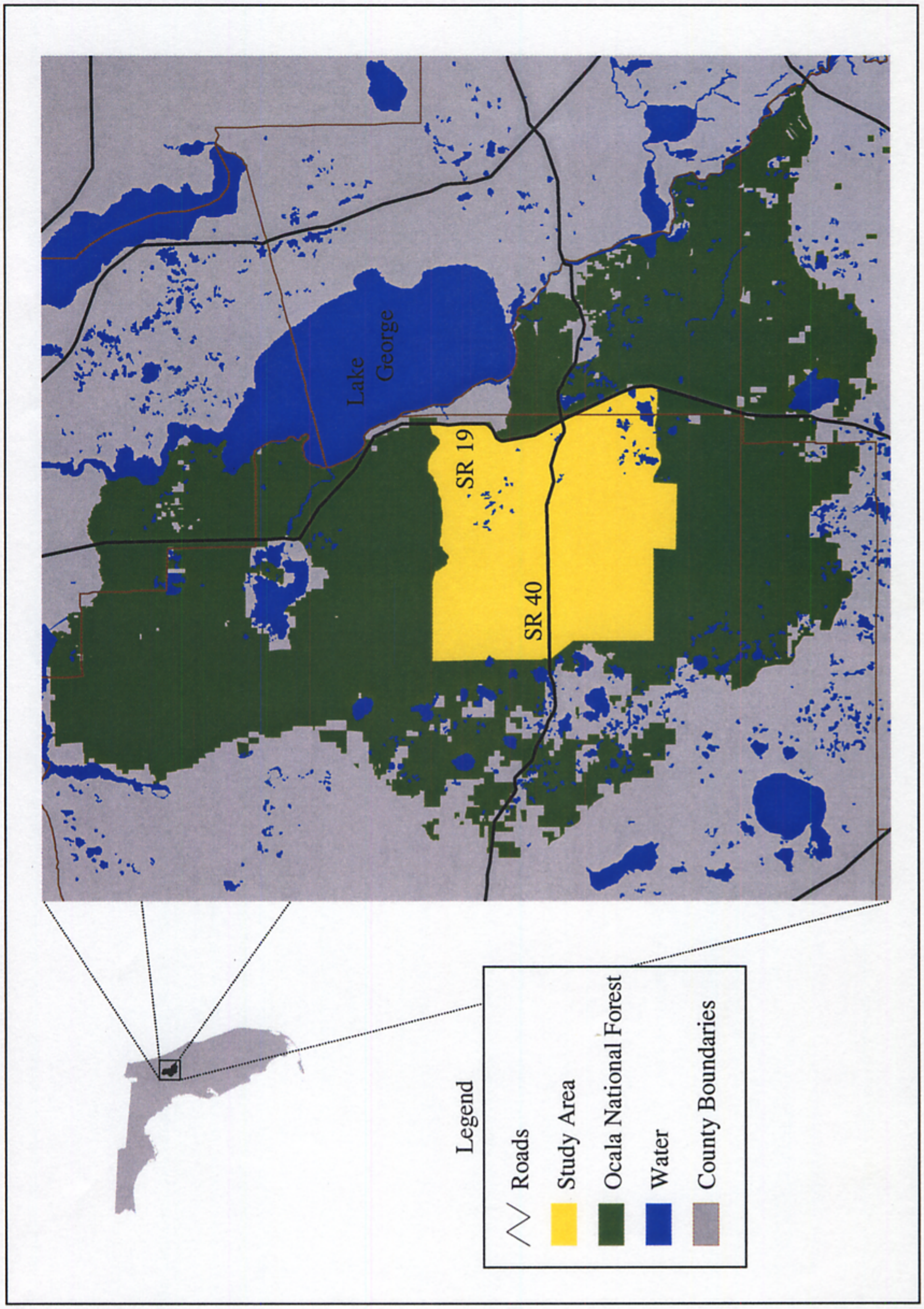

Figure 1. Designated study area for black bear research in Ocala National Forest.

Table 1. Capture and telemetry information for black bears handled in Ocala National Forest, 1999 - 2001.

Bear ID	Date	Sex	Weight (lbs.)	Age	# Locations
R001	05/28/99	Male	150	3	85
R002	05/28/99	Male	78	2	73
R003	05/29/99	Male	420	10	9
R004	05/29/99	Male	250	3	94
R005	05/29/99	Male	212	2	35
R006	06/02/99	Male	210	10	62
R007	06/03/99	Male	350	4	1
R008	06/10/99	Male	265	3	79
R009	06/10/99	Male	305	2	16
R010	06/10/99	Female	144	3	80
R011	06/15/99	Female	160	10	113
R012	06/15/99	Male	300	10	59
R013	06/15/99	Male	148	3	7
R014	06/22/99	Male	120	2	14
R015	06/26/99	Female	80	1	7
R016	06/26/99	Female	170	7	103
R017	06/30/99	Male	310	4	131
R018	07/05/99	Male	104	2	89
R019	07/05/99	Female	77	2	95
R020	07/05/99	Female	96	2	112
R021	07/08/99	Male	238	4	29
R022	07/15/99	Male	78	2	71
R023	07/15/99	Male	253	2	48
R024	07/19/99	Male	98	3	43
R025	07/19/99	Male	223	4	52
R026	07/20/99	Male	124	3	32
R027	07/22/99	Male	150	3	58
R028	07/27/99	Male	295	5	17
R029	07/27/99	Male	108	3	86
R030	07/29/99	Female	132	7	119
R031	08/02/99	Female	107	3	115
R032	08/02/99	Female	124	4	87
R033	08/04/99	Female	132	8	23
R034	08/04/99	Female	140	5	55
R035	08/19/99	Male	193	3	---
R036	08/19/99	Female	124	3	108
R037	08/19/99	Female	164	5	79
R038	09/08/99	Male	250	5	---
R041	09/25/99	Female	112	2	41

Table 1. Continued.

Bear ID	Date	Sex	Weight (lbs.)	Age	# Locations
R039	09/22/99	Female	173	12	---
R040	09/22/99	Male	362	8	---
R042	10/08/99	Female	74	2	18
R043	10/12/99	Female	180	5	96
R044	10/14/99	Male	268	9	---
R045	10/20/99	Male	114	1	104
R046	10/21/99	Male	223	7	83
R047	11/02/99	Female	238	9	65
R048	12/15/99	Female	102	---	--
R049	12/15/99	Male	105	---	---
R050	01/17/00	Male	468	14	47
R051	02/21/00	Male	481	2	4
R052	02/22/00	Female	198	5	12
R053	02/24/00	Male	208	3	1
R054	03/07/00	Female	3.98	0.1	---
R055	03/07/00	Male	3.94	0.1	---
R056	03/08/00	Male	4.07	0.1	---
R057	03/08/00	Female	3.32	0.1	---
R058	03/09/00	Male	4.31	0.1	---
R059	03/09/00	Male	4.64	0.1	---
R060	03/10/00	Male	3.45	0.1	---
R061	03/10/00	Male	3.54	0.1	---
R062	03/11/00	Female	3.85	0.1	---
R063	03/11/00	Female	3.78	0.1	---
R064	03/15/00	Male	5.10	0.1	---
R065	03/16/00	Male	4.92	0.1	---
R066	03/16/00	Female	4.92	0.1	---
R067	03/16/00	Male	4.92	0.1	---
R068	03/17/00	Male	383	4	---
R069	03/21/00	Male	6.02	0.1	---
R070	03/21/00	Female	5.14	0.1	---
R071	03/22/00	Female	2.66	0.1	---
R072	04/13/00	Male	120	1	---
R073	04/14/00	Male	155	3	---
R074	05/11/00	Female	131	5	32
R075	06/08/00	Female	92	3	44
R076	06/14/00	Male	174	2	1
R077	06/14/00	Male	198	3	46
R078	06/21/00	Male	375	14	---
R079	06/22/00	Female	204	5	---
R080	06/23/00	Female	130	4	39

Table 1. Continued.

Bear ID	Date	Sex	Weight (lbs.)	Age	# Locations
R081	06/25/00	Male	250	4	---
R082	07/03/00	Female	125	5	22
R083	07/08/00	Male	400	6	---
R084	07/11/00	Male	325	6	40
R085	07/11/00	Male	385	4	---
R086	07/13/00	Female	112	3	41
R087	08/02/00	Male	373	3	14
R088	08/02/00	Male	183	2	---
R089	08/03/00	Male	213	2	49
R090	08/08/00	Female	151	6	9
R091	08/09/00	Male	343	3	35
R092	08/10/00	Male	358	8	2
R093	08/17/00	Male	398	10	32
R094	08/23/00	Male	320	4	---
R095	08/23/00	Male	345	6	---
R096	08/25/00	Male	228	3	35
R097	08/26/00	Female	114	9	6
R098	09/02/00	Female	170	13	43
R099	09/08/00	Female	200	3	33
R100	09/26/00	Male	253	15	33
R101	10/03/00	Female	200	4	26
R102	10/05/00	Male	193	4	35
R103	10/11/00	Male	83	1	28
R104	10/11/00	Male	148	2	35
R105	10/20/00	Female	150	4	28
R106	10/25/00	Male	276	4	17
R107	10/27/00	Male	190	3	8
R108	11/02/00	Female	230	10	18
R109	11/09/00	Female	150	3	28
R110	11/09/00	Male	98	2	---
R111	12/14/00	Female	250	---	20
R112	03/09/01	Male	2.14	0.1	---
R113	03/09/01	Female	1.17	0.1	---
R114	03/10/01	Female	4.19	0.1	---
R115	03/10/01	Female	4.74	0.1	---
R116	03/10/01	Male	3.85	0.1	---
R117	03/14/01	Female	4.07	0.1	---
R118	03/14/01	Male	4.19	0.1	---
R119	03/14/01	Female	3.41	0.1	---
R120	03/15/01	Male	3.52	0.1	---
R121	03/15/01	Female	3.85	0.1	---

Table 1. Continued.

Bear ID	Date	Sex	Weight (lbs.)	Age	# Locations
R122	03/17/01	Female	4.95	0.1	---
R123	03/17/01	Male	5.40	0.1	---
R124	03/21/01	Male	6.29	0.1	---
R125	03/21/01	Male	6.29	0.1	---
R126	03/22/01	Female	5.17	0.1	---
R127	03/22/01	Female	5.40	0.1	---
R128	03/23/01	Male	5.18	0.1	---
R129	03/23/01	Male	6.06	0.1	---
R130	03/23/01	Male	5.73	0.1	---
R131	03/26/01	Male	5.86	0.1	---
R132	03/26/01	Female	5.73	0.1	---
R133	03/27/01	Female	5.95	0.1	---
R134	03/27/01	Female	5.62	0.1	---

Table 2. Average home range sizes of bears in Ocala National Forest, 1999 - 2001.

	Home Range Size (km^2)			
		Adults (≥3 years old)		
Sex	All Bears	Annual	Winter/Spring	Summer/Fall
Male	106.8	115.1	28.4	71.7
Female	38.4	55.8	20.2	64.4
Combined	72.6	84.1	23.9	67.9

Table 3. Comparison of black bear use versus availability of forest cover types in Ocala National Forest, May 15, 1999 - May 15, 2001. Actual use of habitat was indicated by proportion of telemetry locations within each cover type and compared to expected proportion of locations within each cover type for each bear (Neu et al. 1974).

Cover Type	Observed Proportion	Expected Proportion	Tendency*
Cypress/Pond Pine	0.019	0.018	None
Forest Openings	0.000	0.002	Not Significant
Longleaf/Slash Pine 0-2 years old	0.000	0.002	Not Significant
Longleaf/Slash Pine 3-7 years old	0.001	0.005	Not Significant
Longleaf/Slash Pine 8-24 years old	0.009	0.026	**Avoid**
Longleaf/Slash Pine $\geq$ 25 years old	0.097	0.128	**Avoid**
Mixed Hardwood/Pine	0.012	0.007	Not Significant
Prairie	0.052	0.052	None
Sand Pine 0 - 2 years old	0.012	0.019	Not Significant
Sand Pine 3 - 7 years old	0.027	0.053	**Avoid**
Sand Pine 8 - 24 years old	0.311	0.263	**Prefer**
Sand Pine $\geq$ 25 years old	0.329	0.324	None
Scrub Oak 0 - 7 years old	0.000	0.004	Not Significant
Scrub Oak 8 - 24 years old	0.009	0.007	None
Scrub Oak $\geq$ 25 years old	0.016	0.028	None
Upland Hardwoods	0.028	0.014	**Prefer**
Wetland Hardwoods	0.083	0.057	**Prefer**

*None = expected proportion occurred within 95% confidence interval of observed proportion; Not Significant = expected proportion occurred outside of 95% confidence interval of observed proportion, but difference was not statistically significant; Avoid = expected proportion occurred below 95% confidence interval of observed proportion, and difference was statistically significant ($p<0.05$); Prefer = expected proportion occurred above 95% confidence interval of observed proportion, and difference was statistically significant ($p<0.05$).

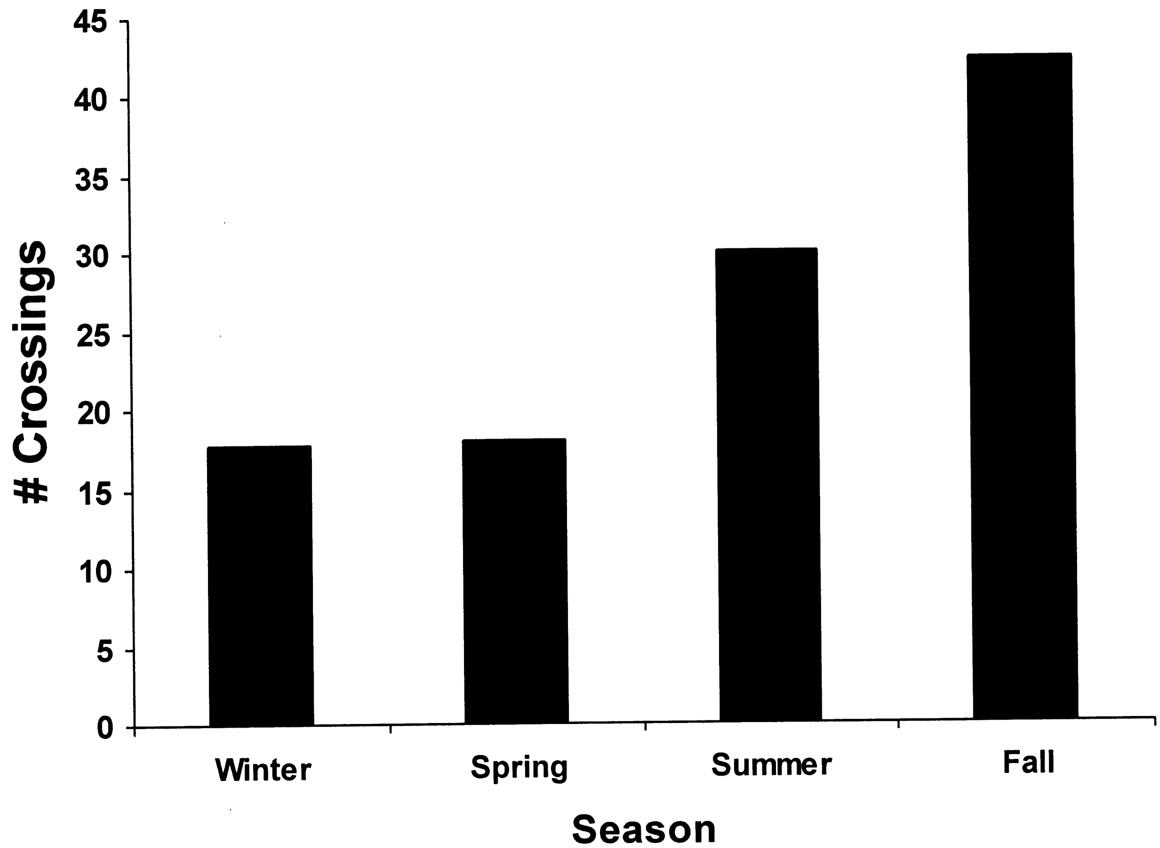

Figure 2. Mean monthly crossings by season [winter (denning) = January - April, spring (pre-breeding) = May - June, summer (breeding) = July - September, and fall (hyperphagia) = October - December] of State Road 40 by radio-collared black bears in Ocala National Forest, May 1999 - May 2001.

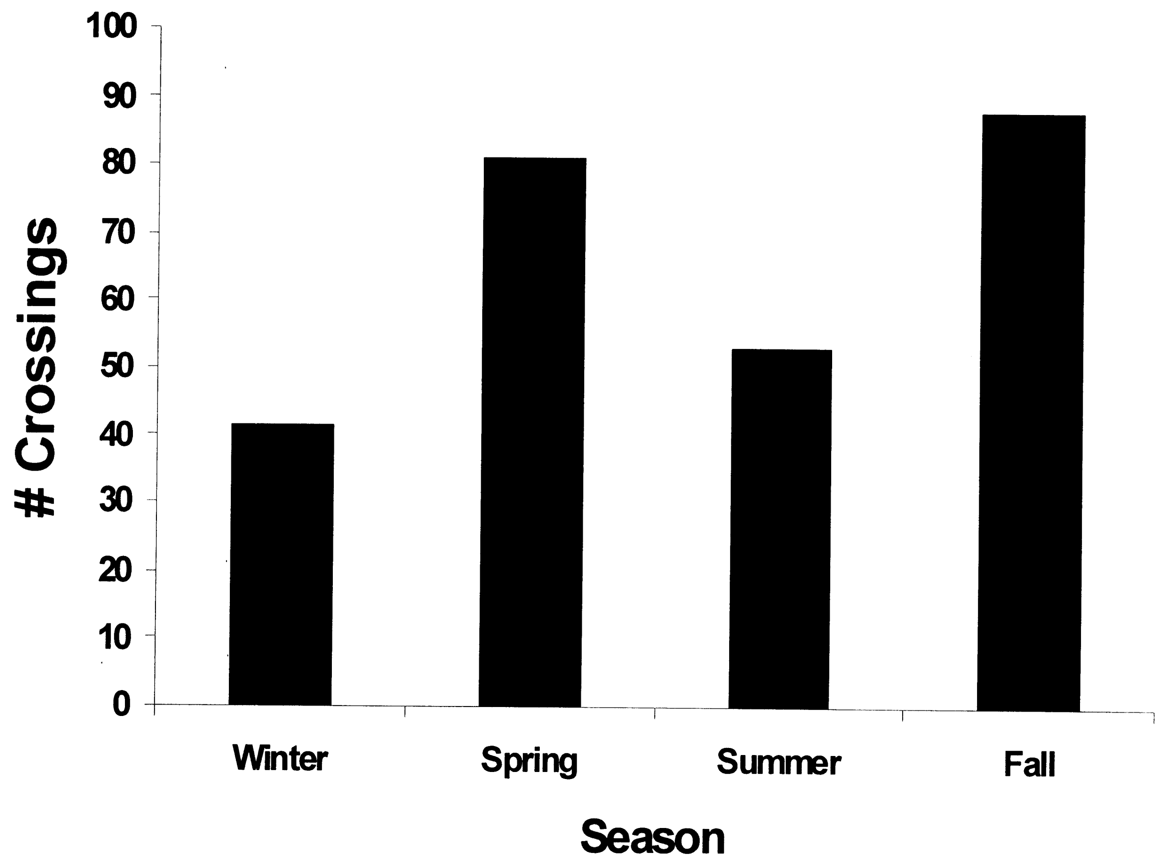

Figure 3. Mean monthly crossings by season [winter (denning) = January - April, spring (pre-breeding) = May - June, summer (breeding) = July - September, and fall (hyperphagia) = October - December] of State Road 40 as documented by black bear track counts in Ocala National Forest, December 1999 -- May 2001.

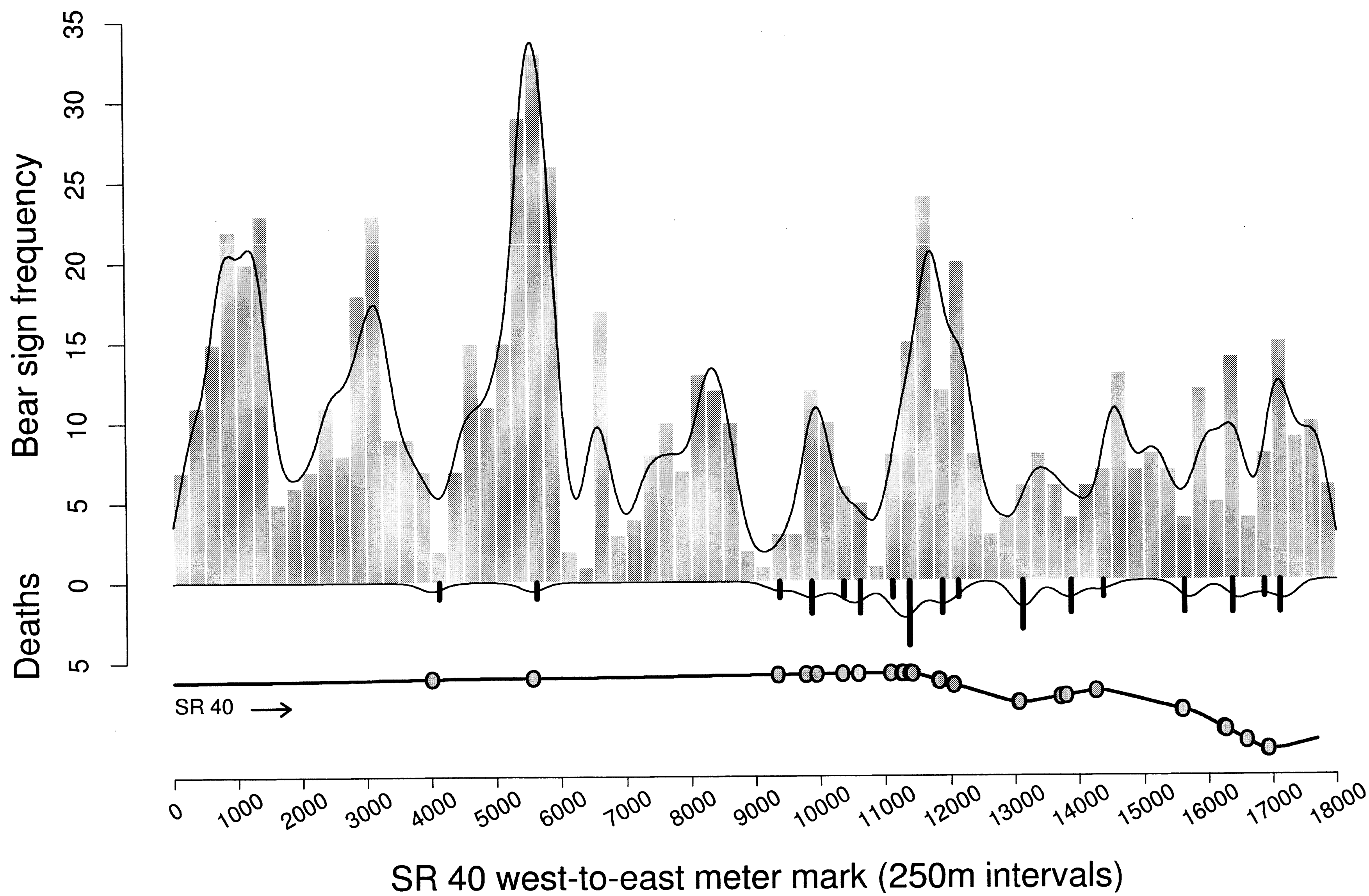

Figure 4. Frequency and locations of bear crossings (n = 749) from December 1999 to May 2001 and bear roadkills (n = 29) from 1982 to 2000 along a portion of State Road 40 in Ocala National Forest.

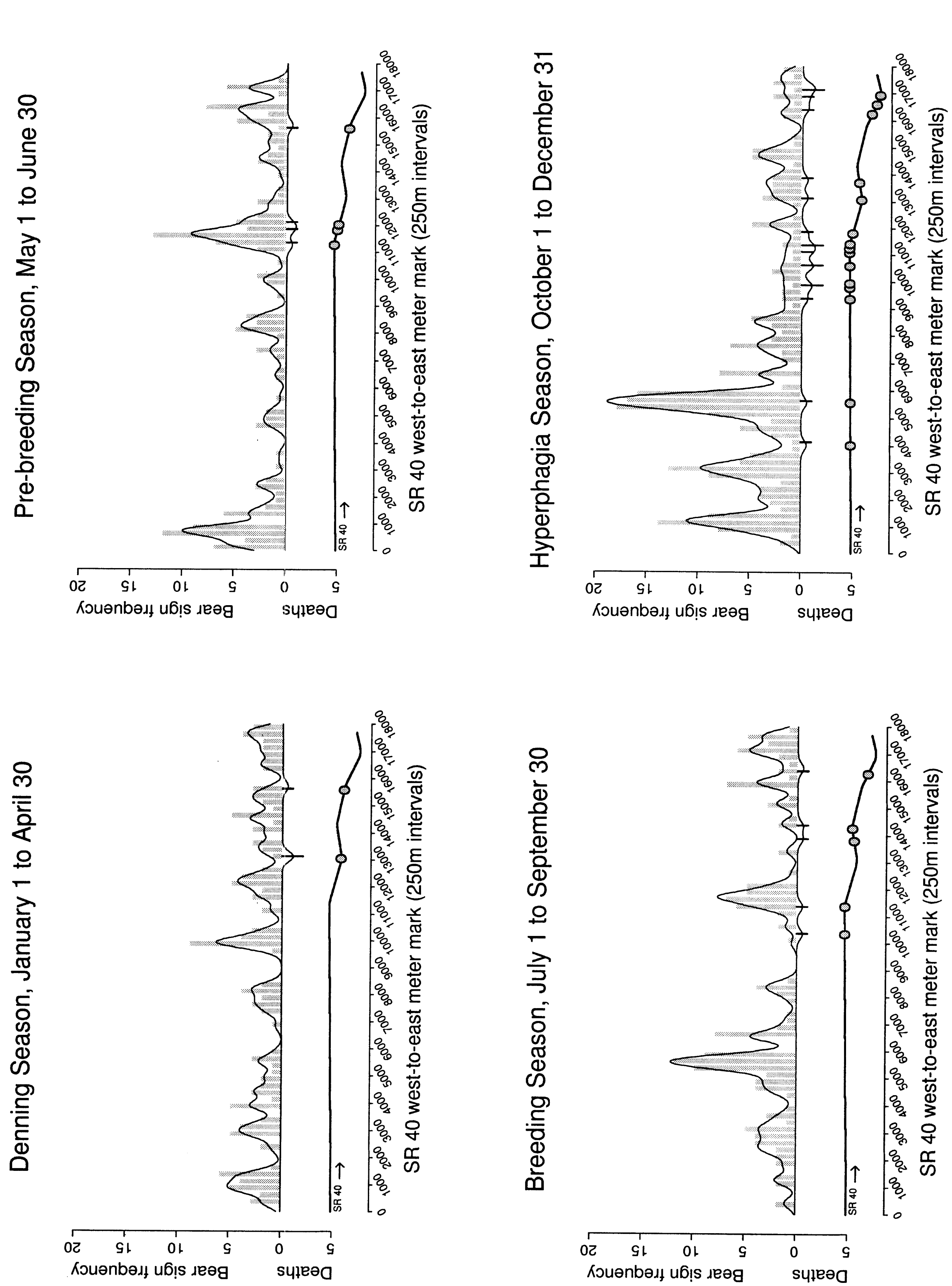

Figure 5. Frequency and locations of bear crossings by season from December 1999 to May 2001 and bear roadkills from 1982 to 2000 along a portion of State Road 40 in Ocala National Forest.

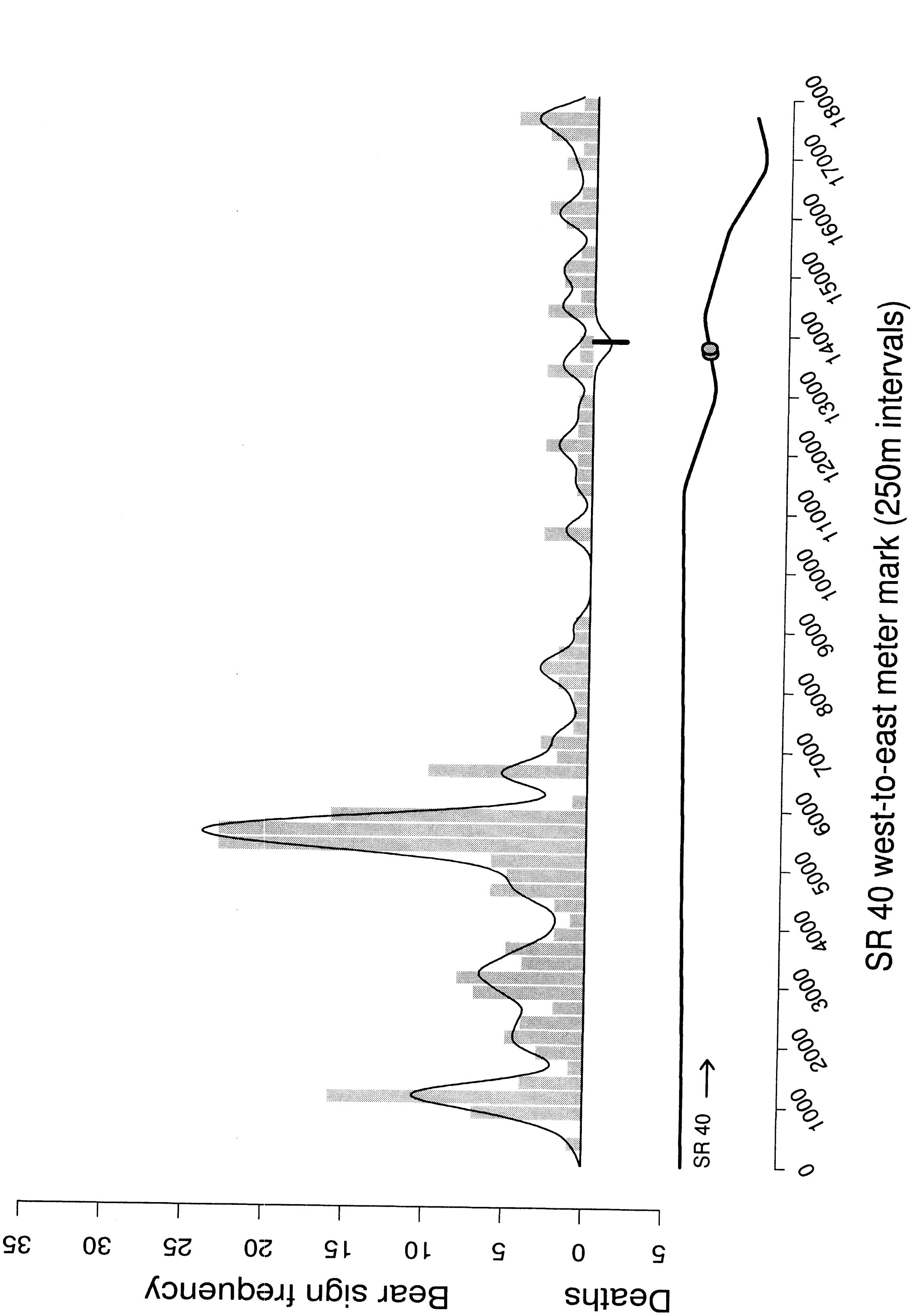

Figure 6. Frequency and locations of bear crossings (n = 224) and bear deaths (n = 2) from September 15, 2000 to October 15, 2000 along a portion of State Road 40 in Ocala National Forest.

Table 4. Comparison of black bear use versus availability of forest cover types at crossing sites along State Road 40 in Ocala National Forest, May 15, 1999 - May 15, 2001. Actual use of habitat was indicated by proportion of telemetry locations within each cover type and compared to expected proportion of locations within each cover type for each bear (Neu et al. 1974).

Cover Type	**Observed Proportion**	**Expected Proportion**	**Tendency***
Mixed Pine	0.064	0.065	Not Significant
Prairie	0.000	0.019	None
Sand Pine 0-2 years	0.052	0.034	Not Significant
Sand Pine 3-7 years	0.048	0.031	Not Significant
Sand Pine 8-24 years	0.413	0.324	**Prefer**
Sand Pine 25+ years	0.407	0.473	**Avoid**
Scrub Oak	0.006	0.016	**Avoid**
Upland Hardwood	0.010	0.015	Not Significant
Wet Hardwood	0.000	0.023	None

*None = expected proportion occurred within 95% confidence interval of observed proportion; Not Significant = expected proportion occurred outside of 95% confidence interval of observed proportion, but difference was not statistically significant; Avoid = expected proportion occurred below 95% confidence interval of observed proportion, and difference was statistically significant ($p<0.05$); Prefer = expected proportion occurred above 95% confidence interval of observed proportion, and difference was statistically significant ($p<0.05$).

Table 5. Black bears necropsied from the Ocala population, February 1999 - May 2001.

BBC[1]	Cause of Death[2]	Month	Day	Year	County[3]	Sex	Age (yr)	Weight (lbs)	Study Animal	Comments
98-006[4]	HBC	4	20	98	PUTN	F		35		Numerous lice, dermatophytosis, localized demodicosis.
99-009	SHT	2	2	99	LAKE	M	11	190		Chronic renal failure, shot while attempting to kill livestock.
99-012	HBC	3	3	99	MARI	F	1	76		Generalized demodicosis, right kidney agenesis.
99-035	HBC	6	8	99	MARI	M	1	65		
99-036	HBC	6	25	99	MARI	F	2	76		Generalized demodicosis.
99-037	HBC	6	22	99	MARI	F	2	132		Probably had 2 cubs
99-038	UNK	6	25	99	MARI	M	2	120 (est)		Found dead in Salt Springs Run, 2 lacerations
99-040	HBC	7	16	99	MARI	M	4	258		
99-041	HBC	7	21	99	MARI	M	0	8.2		Generalized demodicosis.
99-056	HBC?	8	22	99	MARI	M	3	160 (est)		Found dead in Salt Springs Run, broken jaw, frayed claws
99-058	CAP	8	27	99	LAKE	M	7	410		Capture related heatstroke-culvert trap. Not part of Ocala study.
99-059	HBC	8	27	99	MARI	F	0	17.4	cub of R33	Sibling also hit but ok and released, cub of R33.
99-060	HBC	9	2	99	MARI	M	0	34		Testes high in inguinal canal
99-061	HBC	9	7	99	MARI	M		134	R14	
99-069	HBC	10	27	99	LAKE	M	0	52		R testical retained high in inguinal canal
99-070	HBC	10	28	99	MARI	F	1	70 (est)		Carcass mutilated
99-071	HBC	11	2	99	LAKE	F	6	160		Uterus contains white creamy material - pregnant?
99-080	HBC	11	17	99	LAKE	F	1	48		
99-089	HBC	12	17	99	MARI	M	1	110		Generalized demodicosis.
99-090	SHT	12	23	99	MARI	M	6	400 (est)		Skeletonized remains, chronic rib fxs
99-091	HBC	12	24	99	MARI	M	1	116		Left testis high in inguinal canal.
00-001	HBC	1	2	00	MARI	M		90 (est)		Generalized demodicosis, scavengers consumed all hide, bones.
00-002	HBC	1	5	00	LAKE	F	2	114		Numerous tick sores on ventral neck, chin
00-004	HBC	1	15	00	MARI	F	3	173		Necropsied in field
00-005	HBC	1	18	00	LAKE	M	0	80		Scrotum present but testes in inguinal canal
00-010	HBC	3	14	00	MARI	M	4	350		Severely autolyzed.
00-014	HBC	5	5	00	MARI	m	6	427		Euthanized.
00-015	HBC	5	7	00	MARI	f	1	83		
00-016	HBC	5	8	00	MARI	m		250 est	R25	
00-020	DROWNING	5	22	00	MARI	f	18	134		Chronic HBC injuries, neoplasia, emaciated.
00-021	HBC	5	26	00	MARI	m		198	R26	Scar on R shin - previously HBC?
00-022	HBC	5	27	00	MARI	f	4	128		Possibly recovered from demodicosis.
00-023	HBC	5	28	00	MARI	f		155	R33	Euthanized, diaphragmatic hernia.

Table 5. Cont.

BBC[1]	Cause of Death[2]	Month	Day	Year	County[3]	Sex	Age (yr)	Weight (lbs)	Study Animal	Comments
00-029	HBC	6	25	00	MARI	f	3	133		Placental scars but not lactating.
00-039	HBC	6	27	00	MARI	m	3	182	R27	Stomach nodule - no worms.
00-040	HBC	7	7	00	MARI	m	1	86		
00-048	HBC	8	21	00	ALAC	m	3	215		Suspect recovering from demodicosis.
00-050	HBC	7	24	00	MARI	f	9	153		Lactating but no placental scars.
00-056	HBC	9	13	00	LAKE	f	4	150 est		
00-057	HBC	9	1	00	CLAY	m	3	225	R2	HBC 63 miles from capture site.
00-063	HBC	10	3	00	LAKE	f	10	190		Hair thinning, esp. shoulders; discrete 1 cm black discoloration - esophagus.
00-064	HBC	10	4	00	ALAC	m	3	260		
00-067	HBC	10	12	00	MARI	f		115	R97	
00-069	HBC	10	16	00	LAKE	m	6	275		
00-076	UNK	11	6	00	MARI	f	6	nd	R90	Skeleltal remains - suspect illegal kill.
00-076	HBC	11	2	00	MARI	m		182		Healed fracture of right humerus.
01-003	UNK	2	24	01	MARI	unk	1	nd		Cub of BBO-80, died in den, decomposed, partially consumed.
01-005	ABAN	4	18	01	MARI	m		2.77	R123	Abandoned cub of R82, half wt of 1 mo ago, emaciated.
01-007	ISA	4	9	01	MARI	f	0	5.5 (est)	R26	R32 and cubs killed by BBO-17, all but head, pelvis, limbs consumed
01-008	ISA	4	9	01	MARI	f	0	5.5	R127	R32 and cubs killed by BBO-17
01-009	ISA	4	9	01	MARI	f	6	>117	R32	R32 and cubs killed by BBO-17
01-013	HBC	5	6	01	MARI	m	0	7.2		HBC-macerated, in study area but not marked.

[1]Black bear carcass number.

[2]HBC = hit by car, SHT = illegal kill, CAP = capture related, ABAN = abandoned as cub, ISA = intraspecific aggression, UNK = unknown.

[3]MARI = Marion, ALAC = Alachua, PUTN = Putnam.

[4]Killed in 1998, necropsied 1999.

Table 6. Prevalence of morbidity and mortality factors among black bears examined from the Ocala population 15 May 1999 to 15 May 2001.

Factor	No. Exam	No. Pos.	% Pos.	M[1]	Data[2]	Comments
ENDOPARASITES						
Ancylostoma caninum	10	7	70	No	N	Only found in cubs ≤7 mo-of-age. Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
Baylisascaris transfuga	10	4	40	No	N	Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
Gongylonema sp. larvae	10	1	10	No	N	Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
Macracanthorynchus ingens	10	4	40	No	N	Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
Molineus barbatus	10	2	20	No	N	Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
Strongyloides sp.	10	2	20	No	N	Bears examined were between 4 and 12 mo-of-age (Foster and Cunningham, unpubl. data).
ECTOPARASITES						
INSECTA						
Trichodectes pinguis euarctidos	114	5	4.8	No	L/N	Chewing lice - do not cause morbidity but may be secondary to poor condition.
ARACHNIDA						
Ixodidae (Ticks)	129	128	99.2	No	L/N	Almost every bear examined had at least some ticks with some intensities numbering in the thousands. The only exception was one cub killed shortly after emerging from den - had no ticks.
Amblyomma americanum	15	15	100	No	L/N	
Amblyomma maculatum	15	1	6.7	No	L/N	
Dermacentor variablis	15	8	53.3	No	L/N	
Ixodes scapularis	15	5	33.3	No	L/N	
Demodicidae						
Demodex ursi	133	14	10.5	No	L/N	Cases concentrated on the western edge of the ONF (Lynne), predominately affects females.
Trombiculidae (chiggers)						
Eutrombicula splendens	105	39	37.1	No	L	Found only during late spring and summer.

Table 6. Cont.

Factor	No. Exam	No. Pos.	% Pos.	M[1]	Data[2]	Comments
FUNGI						
Dermatophyte (sp. unknown)	159	1	0.6	No	L/N	Ringworm infection with localized demodicosis in a yearling.
TRAUMA						
Illegal Kill	52	2	3.8	Yes	N	One due to depredation on livestock, one found dead from gunshot.
Intraspecific Aggression	52	3	5.8	Yes	N	R32 and her 2 cubs killed by R17.
Vehicular Collision	52	40	76.9	Yes	N	Includes 7 marked bears.
Unknown trauma	52	1	1.9	Yes	N	Found dead in river with fractures and lacerations.
Capture related	52	1	1.9	Yes	N	Not part of Ocala Bear Project. Nuisance bear died of heat exhaustion in a culvert trap.
Healed fractures	92	12	13	No	L	An additional 3 95.7%) had healed fractures at necropsy. Injuries most likely due to vehicular trauma.
CAPTURE RELATED						
Skeletal fractures	139	6	4.3	No	L	Radius and/or ulna fractures associated with snares; femur fracture result of dart.
Self-mutilation	139	4	2.9	No	L	Two injuries were major involving loss of digits, 2 involved minor puncture wounds.

[1]M = mortality due to agent - yes or no; [2]Data = database used - live-capture (L) and/or necropsy (N).

Table 7. Selected hematological and serum biochemical parameters from adult and juvenile Florida black bears captured in the Ocala National Forest 15 May 1999 to 15 May 2001.

Parameter	Units	Mean	STD[1]	Min[2]	Max[3]	*n*
Alkaline phosphatase	U/L	51.85	29.20	12.00	129.00	33
Aspartate aminotransferase	U/L	363.06	382.79	65.00	1779.00	33
Alanine aminotransferase	U/L	63.15	49.18	14.00	204.00	33
Bilirubin	mg/dl	0.07	0.10	0.00	0.30	33
Total Protein	g/dl	7.11	0.99	5.10	10.40	33
Albumin	g/dl	3.42	0.57	2.30	4.20	33
Globulin	g/dl	3.69	0.93	2.30	6.60	33
Calcium	mg/dl	8.15	0.74	6.80	9.80	33
Phosphorus	mg/dl	3.94	1.45	1.90	7.10	33
Creatinine	mg/dl	1.70	0.52	0.80	3.80	33
Blood Urea Nitrogen	mg/dl	8.88	5.48	0.00	23.00	33
Cholesterol	mg/dl	211.27	65.35	136.00	414.00	33
Sodium	mEq/ml	141.97	6.70	131.00	161.00	33
Potassium	mEq/ml	4.48	0.42	3.70	5.50	33
Chloride	mEq/ml	108.39	5.76	94.00	119.00	33
Anion Gap		22.40	5.83	16.00	34.00	33
White Blood Cells	$10^3/\mu l$	13.98	4.42	5.95	24.10	30
Red Blood Cells	$10^6/\mu l$	6.77	0.91	4.49	8.08	30
Hemoglobin	g/dl	13.42	2.35	6.32	17.50	30
Hematocrit	%	39.47	6.39	20.20	49.40	30
Mean Corpuscular Volume	fl	58.13	3.87	45.00	63.00	30
Mean Corpuscular Hemoglobin	pg	19.75	1.74	14.10	21.80	30
Mean Corpuscular Hemoglobin Concentration	%(g/dl)	33.94	1.47	27.50	36.00	30
Band cells	%	0.10	0.40	0.00	2.00	30
Polymorphonuclear Cells	%	79.03	8.53	55.00	91.00	30
Lymphocytes	%	12.27	5.96	4.00	30.00	30
Monocytes	%	4.53	2.45	1.00	10.00	30
Eosinophils	%	3.67	3.68	0.00	18.00	30
Basophils	%	0.97	0.84	0.00	3.00	30
Fibrinogen	mg/dl	260.00	114.31	100.00	600.00	30

[1]Standard deviation; [2]minimum value in range; [3]maximum value in range.

Table 8. Mortality of marked bears, Ocala bear study, May 15 1999 - May 15, 2001.

Bear	Sex	Capture	Death	Cause	Location / collar status
R014	M	6/21/99	9/6/99	Hit by car	SR 40, 0.3 mi E of J. Springs entr. Collared.
R025	M	7/19/99	5/8/00	Hit by car	SR 40, 0.7 mi E of J Springs entr. Collared
R026	M	7/20/99	5/26/00	Hit by car	SR 40, 2.9 mi E of J Springs entr. Collared
R033	F	8/4/99	5/28/00	Hit by car	SR 40, 0.3 mi E of FR 598 Not collared
R027	M	7/22/99	6/27/00	Hit by car	SR 19, 4.1 mi N of SR 40 Not collared
R002	M	5/28/99	8/1/00	Hit by car	SR 16, Clay county Not collared
R053	M	2/24/00	10/8/00	Illegal	Umatilla Not collared
R097D	F	8/26/00	10/13/00	Hit by car	Lynne, SR 40, 0.1 mi E of CR 326 Collared
R090D	F	8/8/00	11/4/00	Unknown	Lynne, off 24th Rd. 3 mi W of 314A Collared
R032	F	8/20/99	4/9/01	Predation	Ocala National Forest Collared
R126	F	3/22/01	4/9/01	Predation	Ocala National Forest Not collared
R127	F	3/22/01	4/9/01	Predation	Ocala National Forest Not collared
R123	F	3/17/01	4/18/01	Abandon at den	Lynne, off CR 314 Not collared

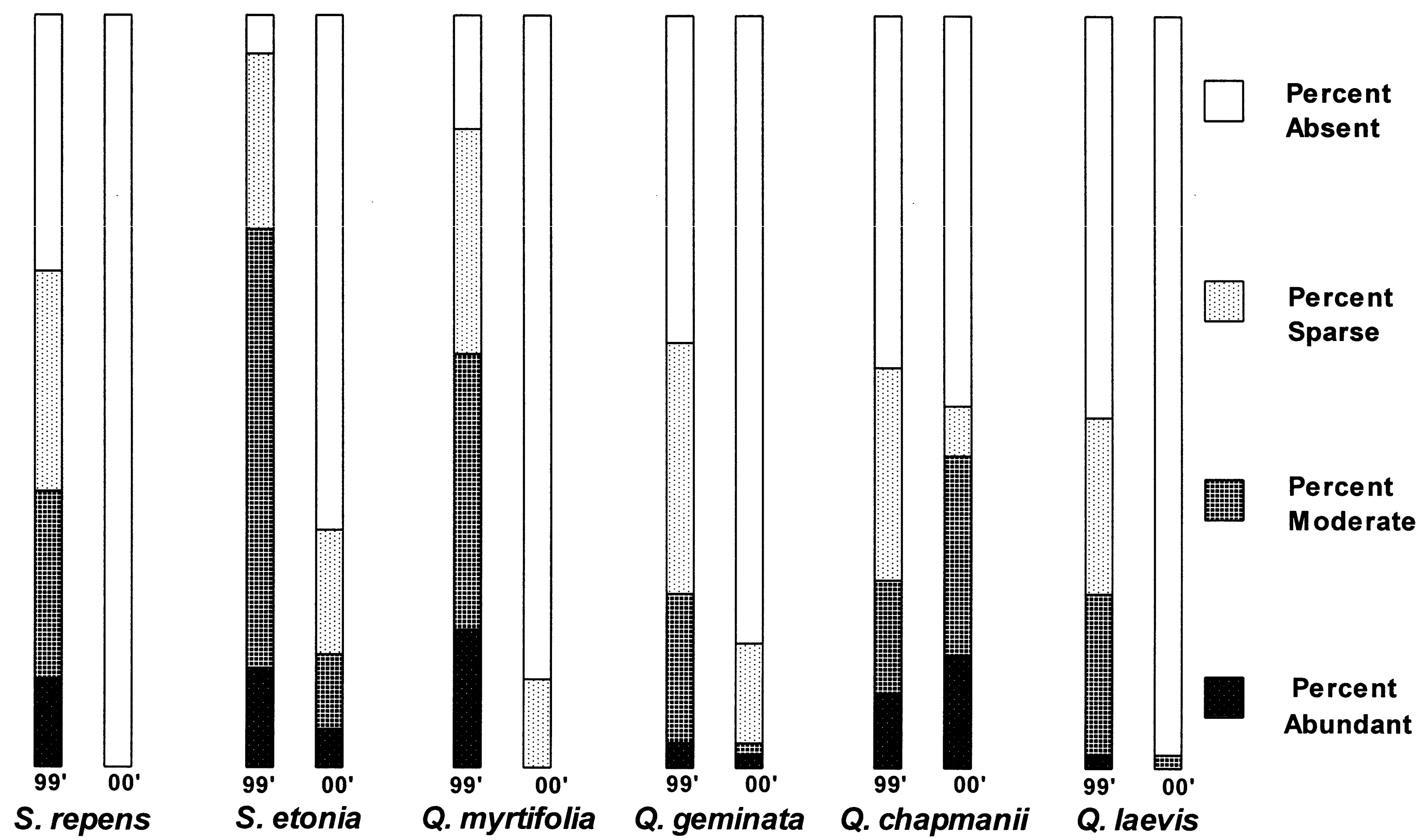

Figure 7. Relative abundance of common fall bear foods in Ocala National Forest. The occurrence of plants in fruit was estimated as absent, sparse (1-20%), moderate (20-50%) or abundant (>50%) along 68 transects in 17 stands in pine flatwoods habitat (*Serenoa repens*) and 60 transects in 5 age classes in sand pine scrub oak habitat (*Sabal etonia, Quercus myrtifolia, Quercus geminata, Quercus chapmanii, Quercus laevis*).