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

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EXECUTIVE SUMMARY

INTRODUCTION

Ocala National Forest, one of the largest and most important habitats for bears in Florida, is located in a heavily populated and rapidly growing area. The Ocala bear population has accounted for 45% of the states vehicle-caused mortality from 1976 – 2003. Eight of the 15 chronic roadkill problem areas are in this area, and SR-40 had the greatest number of mortalities. Because Ocala National Forest (ONF) is bisected by SR-40 and contains other roads of varying use intensities, it provides an opportunity to assess the impacts of road mortality upon this population and to document bear movements, highway crossing patterns and behaviors associated with a range of traffic levels. This study was designed 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 goals were to: determine habitat use, movement patterns, and home range of bears captured in the vicinity of SR-40; provide abundance estimates of bears within the study area portion of ONF; determine survival rates of adult bears captured in vicinity of SR-40; locate and analyze the characteristics of sites where bears cross SR-40 within the study area; survey the relative abundance and availability of common bear foods in ONF, and synthesize these data to provide recommendations for reducing the impacts of roads on bears in ONF.

Bear Captures. We captured 138 $\geq$ 1 year-old bears (52 females and 86 males). Radiocollars were placed on 95 bears (49 F, 46 M); 13 of these were females trapped in Lynne as part of a biomedical study. Lynne is a small community on SR-40 adjacent to ONF and data from bears in Lynne provided a useful contrast to bears in ONF. We acquired 7,204 locations of collared bears during this study (5,177 from the ground, 2,027 from an airplane).

Home ranges. Annual home range size for males in ONF averaged 94.3 km^2 (range 87.29 km^2 -159.89 km^2) and females averaged 20.48 km^2 (range 17.04 km^2 – 26.25 km^2). Analysis of variance indicated differences among years for both sexes during fall. T-tests indicated that home range estimates for fall 2000 were larger than fall 2002 for females and larger than fall 1999 for males. We documented a failure of most fall foods in ONF in 2000 that occurred after a prolonged drought in Florida.

Habitat use. We analyzed the seasonal habitat used by 57 bears (29F, 28M) during winter, 61 bears (29F, 32M) during summer and 74 bears (28F, 36M) during fall. Bears did not use ONF habitats in proportion to their availability with one exception. Females tended to den in habitat proportional to its availability. Otherwise, our analysis suggests that medium to older aged stands of sand pine/ scrub oaks are preferred black bear habitats in ONF. Although males and females use these habitats somewhat differently, they are important to both groups throughout the year and are used out of proportion to their occurrence in the forest.

Crossings of SR-40 by radio-collared bears. Eighty-six radio-collared bears crossed SR-40 a minimum of 388 times. Logistic regression analysis indicated statistically significant differences in the probability of observing a crossing of SR-40 between consecutive locations of ONF males, ONF females, and Lynne females. The probability of observing a crossing was found to depend significantly on the distance of the previous location from SR-40 and the number of days between two consecutive locations.

However, the observed influence of distance and elapsed time did not differ among groups.

At any given distance and elapsed time between locations, the odds of observing a crossing by an ONF male bear were 4.8 times greater than the odds of observing a crossing by an ONF female bear. The odds of observing a crossing by an ONF male bear was estimated to be 11.3 times greater than the odds of observing a crossing by a Lynne female bear. The estimated odds ratio indicated that a crossing by an ONF female bear was 2.4 times more likely than a crossing by a Lynne female.

In a separate analysis comparing crossing probabilities between bears that were hit by motor vehicles (HBC) during the study period to bears that avoided this fate, logistic regression modeling indicated a marginally significant greater likelihood of observing a crossing by a bear that would go on to get hit by a car. The probability of observing a crossing in these subgroups was again found to depend significantly on the distance of a location from SR-40 and the number of days between two consecutive locations, but again, the influence of distance and elapsed time did not differ among subgroups. The odds of observing a crossing were 3.1 times greater for HBC bears compared to all other bears in the study. When crossing probabilities were compared between ONF (3 M, 1 F) and Lynne (3 F) bears that were later hit by cars, the odds of observing a crossing by an ONF bear were 11.9 times greater than the odds of observing a crossing by a Lynne bear. Lynne bears hit by cars crossed at a significantly lower predicted rate than did ONF bears. Thus SR-40 in Lynne presented a significant obstacle to bears attempting to cross and mortality occurred more frequently per attempt than did crossings in ONF.

Traffic volume on SR-40 in Lynne, at 15,000-16,500 car trips per day, was sufficient to create an obstacle to bears. There was less likelihood for Lynne bears to cross the road and there was an elevated mortality risk associated with attempts. Records of historic bear mortality suggest that the highly disturbed character of the remaining habitat causes crossings to occur at segments that contain natural habitats on both sides of the road. The effects of habitat fragmentation by this highway are compounded by its decreasing the availability of nutritional resources and access to mates while increasing the risks necessary to obtain them. Eventually, habitat patches may be so reduced in size while the hazards to bears so great that Lynne may cease to sustain an indigenous population of bears. Investigations into highway crossing locations in Lynne should be considered as part of mitigation efforts when the highway is improved beyond its current traffic capability.

Survival. We documented mortality of 17 marked bears (5 marked but uncollared bears and 12 radio-collared bears). Humans directly or indirectly caused 15 (88.2 %) of these deaths, the remaining two were collared females killed by another bear. All six documented mortalities in Lynne were anthropogenic. The main source of mortality was vehicular collision (n = 10), especially on SR-40 (n = 6). Illegal killing (n = 5) was the second most frequent source of mortality. Bears appear to have sustained unusually heavy mortality in 2000.

Survivorship curves that illustrate differences among the groups in the probability of survival over time were created. The log-rank test indicated a statistically significant difference in the shapes of the survival curves among the three groups. Cox proportional hazards regression indicated that Lynne females were 10.9 times more likely to die at any time compared to ONF females.

Annual survival rates of 62.4%, 92.9% and 76.5% were calculated for Lynne females, ONF females and ONF males, respectively. The reported survival rate for Lynne females is among the lowest reported for females in North America. All mortality in

Lynne was anthropogenic. If the survival rates we report for female bears in Lynne are representative and the male rate in Lynne is even lower, as is typical in most other bear populations, then the population in Lynne would be in some jeopardy without the adjacent source population of bears in ONF. The mortality rate for ONF bears is low and sustainable under present conditions. The high survivorship of males and females in ONF mimics rates reported in Florida as well as from other unexploited bear populations. Many stable populations of black bears sustain higher rates of mortality.

Track Transect. We utilized a 3 meter wide dirt transect to document bear crossings of SR-40. Mixed effects Poisson regression models found no effects on distribution of bear tracks by highway elevation, presence of intersecting roads and trails, highway curvature, and habitat type the track was entering or leaving.

Bears in search of spatially and temporally isolated nutritional resources fueled the seasonal crossing pattern we documented. The spike of crossings that occurred during summer occurred as bears accessed saw palmetto fiber (early summer) and fruits (late summer) in the understory of slash pine flatwoods. The higher rates of crossings during fall generally occurred in sand pine/ scrub oak habitats as bears focused on acorns as a food source. The focal points along SR-40 where crossings were frequent suggest there were highway segments where bears habitually crossed the roadway. However, many of the crossings of the more intensely used segments occurred within a few weeks in one season of 2000, when bears found “islands” of normal acorn production that otherwise were scarce in a “sea” of mast failure.

The same mixed effects logistic regression models used for bear track distribution analysis indicated that the distribution of historic bear mortalities was influenced by highway factors. The elevation of a road segment was found to have an effect on location of bear mortalities with bears being struck more often at lower elevations. When comparisons were made between a single road intersection category (trail, low use forest road, high use road) and pooled data from other road types, the presence and category of road was significant. The presence of a road versus no road and the presence of a forest road versus all other categories were significant. The effect of road curvature was found to be significant and the relationship was also found to be linear and positive (i.e., the greater the degree of road curvature the higher the mortality rate).

The contrast between where bears cross SR-40 within ONF and where they tend to get struck by vehicles is useful. Bears tended to cross SR-40 in response to food availability and without regard to any attribute of habitat or highway. Low traffic levels during this study and the undisturbed nature of bear habitat along SR-40 within ONF contributed to a lack of crossing patterns attributable to geography. However there were geographic patterns evident in the analysis of historic bear mortality that were attributable to highway features. Bears tended to get struck on curves, at intersections with forest roads and at lower elevations. The effect of elevation and road curvature are merely two measures of the same highway design feature. Curves in SR-40 exist to avoid ONF wetlands. Wetlands along SR-40 in the study area occur at lower elevations. Similarly, there are several forest roads that intersect SR-40 at curves and tended to be the sites of bear mortality.

Results indicate that although highways can impact bears directly through mortality, and indirectly by increasing the frequency of bear-human interactions, highways are semi-permeable barriers. The degree of permeability in this study seemed to be an interaction between gender and traffic volumes.

Population Estimates. We sent samples of bear hair collected from 1999-2003 to a genetics lab and received an identification of the unique genotypes and gender from each successful sample. Of 2,544 samples of bear hair collected, the lab was able to produce viable genotypes from 2,265 samples (89 %). When all available data were considered, there were 229 individual bears identified at least once during 1999-2003. The mean annual survival rate (alive, remaining in study area) for females was calculated as 0.7879 (95% CI: 0.6907-0.8850) and 0.7896 (95% CI: 0.7169-0.8624) for males. Sampled females comprised 41.5% of the total with an estimated abundance of 55 (95% CI: 46-63) individuals, while males made up 58.5% of the dataset and were estimated to number 83 (95% CI: 72 - 94). With an average effective study area over 5 years of 396.7 km^2 for females, the estimated density was 0.14 bears/ km^2 during the study. Males had an average 5-year effective study area of 677.6 km^2 and an estimated density of 0.12 bears per km^2. By summing both results, a 5-year population estimate for the study area yields 138 bears. Results suggest that both population structure and home range sizes are similar to other bear populations in Florida and the Southeast. Our density estimates (0.12 – 0.14 bears/km^2) compared with earlier estimates of bears in ONF suggest the population in Ocala has increased during the last 4 decades. Our estimates were similar to those derived from other mark-recapture studies in Florida but lower than other estimates within the southeast.

Fall Bear Foods. Production of soft and hard mast by the 7 species surveyed (1 gallberry, 2 palmettos and 4 oaks) was highly variable both within and between years. Saw palmetto (*Serenoa repens)*, although more wide spread than the others, was not very productive. The most productive year for saw palmetto was 1999. Scrub palmetto (*Sabal etonia*) was the most consistently productive species we surveyed. Although abundant and productive during our study, it is questionable how significant the scrub palmetto is to bears. Although scrub palmetto was the most reliable food source surveyed, *Q. chapmanii* matched it for average productivity.

There was less mast produced in 2000 than any other year. Only 1 species (*Q. chapmanii*) had moderate to abundant mast along 40% of transects. In 2000, Florida was in the grip of a 2-year La Nina weather pattern that resulted in an extreme drought over much of the state including all of central Florida. It is likely that these conditions caused the nearly complete mast failure we documented. We noted that for the years in which we monitored bears during the complete calendar year (2000, 2001, and 2002) we documented the greatest number of mortalities to tagged bears in 2000 with 8 of 18 mortalities (53% of collared or tagged-but-uncollared bears) occurring in 2000. Foraging bears increased movements in that year, apparently in response to severely restricted mast availability. These bears experienced greater risks by crossing roads more frequently and by making forays into human communities.

Although our survey of bear foods in Ocala National Forest was cursory, we were able to discern patterns of mast availability and bear behavior related to climatological conditions. It was interesting to note that in the fall of 2000, a season in which bears typically possess voracious appetites and store energy reserves in the form of fat, bears were still able to adapt to the severe lack of food resources. Bears increased movements within the study area into localized pockets of mast availability and out of the study area to other, more productive habitat types (*see home range analyses*).

MITIGATION OPTIONS

Currently, SR-40 does not present an obstacle to bears moving across SR-40 in ONF. At current traffic levels bear mortality associated with SR-40 in ONF is sustainable by this population of bears. However, human impacts upon the Florida landscape have seldom remained stable and there is little reason to believe that traffic volumes won't increase significantly during the lifespan of this road.

We found that bears crossed SR-40 without discernable effect of species composition or forest stand age they were entering or leaving or proximity to secondary roads. When current traffic levels (5,100 avg. trips/day) approach 10,000 trips per day, this road would likely present significant risks to individual bears as well as to the population by reducing habitat connectivity and reducing gene flow. Because bears crossed SR-40 along its entirety in the ONF study area bear crossing opportunities will need to be created along its entirety.

Perhaps the only way to completely alleviate the effects of SR-40 on bears as well as all other terrestrial species within the forest would be to elevate the highway through ONF entirely. In effect, this would create a forest-wide wildlife underpass. This scenario would present a tremendous challenge to those who design or finance state highway construction and create conflicts with forest users. Nonetheless, the need to address the bear mortality and genetic isolation created by this highway will become critical in the near future before traffic volume in ONF increases significantly above current levels. The opportunity to address these concerns may never be greater than the present as decisions about the nature and character of this roadway are being made that will impact bears and bear habitat for many decades. This study provides information that can help develop strategies to alleviate bear mortality and genetic isolation caused by a high volume state highway. We believe that substantial improvements to this highway are likely to result in significant increases in traffic volume that will contribute to increased mortality, and genetic isolation of this population. Further, we believe these two issues can be mitigated by highway design.

The construction of 5-6 wildlife underpasses along SR-40 within ONF is recommended to mitigate impacts of road improvement and increased traffic volume. Ideally, a 500-meter length of 2.5-meter high fencing should flank each structure to help funnel wildlife across the highway safely and a 250-500 meter wide strip of forest leading to each structure should remain uncut to provide cover. However, the specifics of each site will need to be considered in order to determine appropriate fencing and vegetative parameters.

Two of these structures should be sited along the 9.3 km segment of SR-40 west of FR-65 to facilitate normal bear movements across SR-40. Although bear mortality on this segment of the highway has been minimal, these structures will promote habitat and genetic connectivity between habitats north and south of SR-40. Given the radius of the average annual male home range in ONF (5.4 km), 2 structures on this segment would provide adequate opportunity for genetic interchange and habitat connectivity regardless of future traffic levels. One of these structures could be incorporated into the Lake-Alachua-Marion (LAM) trail intersection with SR-40 (Site 1). The intended purpose of the LAM trail is for equestrian recreation and the incorporation of a wildlife underpass at this site will have the added benefit of increased human safety. To meet this need the height of the crossing would have to be sufficient to allow the passage of horses.

Two additional sites that should be considered for at least 1 additional western underpass include the intersections of SR-40 with unnumbered low use forest roads. One of these roads intersects SR-40 from the north approximately 200 meters west of FR-588 (Site 2) where we observed at least moderate levels of bear crossings in all seasons and was especially heavily used during fall 2000. The second site is located approximately 1.2 km west of the intersection of FR-65 and SR-40 at the intersection of a low-use forest road (Site 3).

In addition to wildlife crossings needed to mitigate the fragmentation of bear populations and bear habitat, sites of high bear mortality are likely to become more significant with the expected increase in traffic and should be addressed. By overlaying locations of bear mortalities on SR-40 with our track transect data; a few geographic focal points were evident. We note that mortality "hot spots" tended to occur on SR-40 where forest roads intersect the highway on curves where reduced line of sight likely contributes to motorist's inability to avoid bears crossing the road.

Of particular interest we note an apparent north-south bear travel route that crosses SR-40 at a curve east of the entrance to the Juniper Springs Recreation Area (Site 4). A small drainage emerges from wetlands south of SR-40, crosses under the road in a 45.7 cm (18 in.) culvert and exits as a seasonally flowing tributary of Juniper Creek. This drainage crosses under SR-40 approximately 50 meters east of the FR-598 and SR-40 intersection. The streambed leaves the highway at a curved road segment with reduced line of sight. Nine bears have been killed on SR-40 within 400 meters of FR-598 since 1980 including 1 study animal (No. 14). It appears that bears may use FR-598 and the streambed as a north-south travel route into Juniper Springs Wilderness Area, particularly during summer. With only a moderate crossing rate (17 crossings within 400 m of FR-598) the highway surrounding the FR-598 intersection with SR-40 represents a zone of higher than expected bear mortality. In addition to the north-south route created by the northern terminus of FR-598 and southern extant of the streambed, bears may be encouraged to use this route by the traffic and human activity associated with the Juniper Springs Recreation Area, the entrance to which lies 370 meters westward. The track transect segment that included the Juniper Springs entrance was very lightly used by bears. SR-40 at this site would need to be raised above the current level and fitted with an underpass that contained the natural streambed of the creek. In this option, the northern terminus of FR-598 would need to be relocated so that fencing could be installed parallel to SR-40 and to allow bears to continue to use the abandoned northern segment of FR-598 as a travel route.

The intersection of the Florida Trail with SR-40 should be also considered for a wildlife/pedestrian underpass (Site 5). We documented moderate bear crossings at this location in all seasons and it has been the site of 2 bear mortalities. A structure at this site would also improve pedestrian safety.

Additionally, the highway segment with the greatest curvature and most reduced line of sight distance had a corresponding track transect segment with a high bear-crossing rate and should be considered for a structure. The curve occurs approximately 600 m – 900 m west of SR-19 (Site 6). There have been 3 bears killed here since 1982. The roadbed for this curve was cut through a small hill and the incorporation of a wildlife overpass is an option for this site.

If underpasses are erected at some forest road intersections with SR-40, vehicular use of forest roads near SR-40 should be blocked and the intersection relocated. This will benefit bears by providing access routes to underpasses on which the growth of native vegetation would be allowed, thus facilitating bear movement under the highway.

In Lynne, SR-40 is currently an obstacle to normal bear movements. Improvements to the highway in this community that increase the potential for greater traffic volume would contribute significantly to the fragmented nature of the remaining bear habitat. Studies to mitigate the impacts of highway improvements in Lynne should be conducted.

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ACKNOWLEDGEMENTS

A previous report for the first two years (1999-2001) of this study was provided to Florida Department of Transportation (FDOT) (McCown et al. 2001). This final report covers the entire 4-year period beginning May 15, 1999 and ending May 15, 2003 and therefore, in most aspects, we believe, presents a more complete treatment of bears in ONF. The 2001 report contains results of bio-medical examinations of 92 captured animals and 52 post-mortem examinations by Mark Cunningham D.V.M. that are not included here.

A research effort such as this is possible only through the collaboration of many dedicated and talented people. We were fortunate to have the intellect and effort of some exceptional co-workers. We thank Mark Cunningham for allowing us to piggyback onto bear bio-medical investigations he conducted in Lynne. Special thanks to Elina Garrison and Jeremy Dixon who began as field technicians shortly after the project began and completed the study as bear researchers and colleagues. We thank Mark Cunningham, Melissa Moyer, Darrin Masters, Karen Oven, Chris Long, Bill McKinstry, Katherine Isaacs, Bill Bankhead, Andrea Boliek and John Williamson for their efforts with trapping, radio-telemetry, track transect monitoring, hair snaring, mast survey and database management during this study. Stephanie Simek designed the sampling protocol for population estimates in 2001-2003 and provided helpful comments on an earlier version of this report. Jena Perdue managed the genetic sampling database from 2001-2003. The authors thank Gary Evink, David Zeigler, and Vicki Sharpe of Florida Department of Transportation (FDOT) for their foresight and efforts to address wildlife conservation in this booming state. We thank personnel from the United States Forest Service (USFS) especially Jim Thorsen and Carrie Sekerak, for their help, cooperation, and advice during all aspects of this study. We thank Mike Abbott, Mark Aselson, and Joy Hill from the Florida Fish and Wildlife Conservation Commission (FWC) Ocala office for their cooperation and assistance and for helping us with our nearly constant need for field vehicles.

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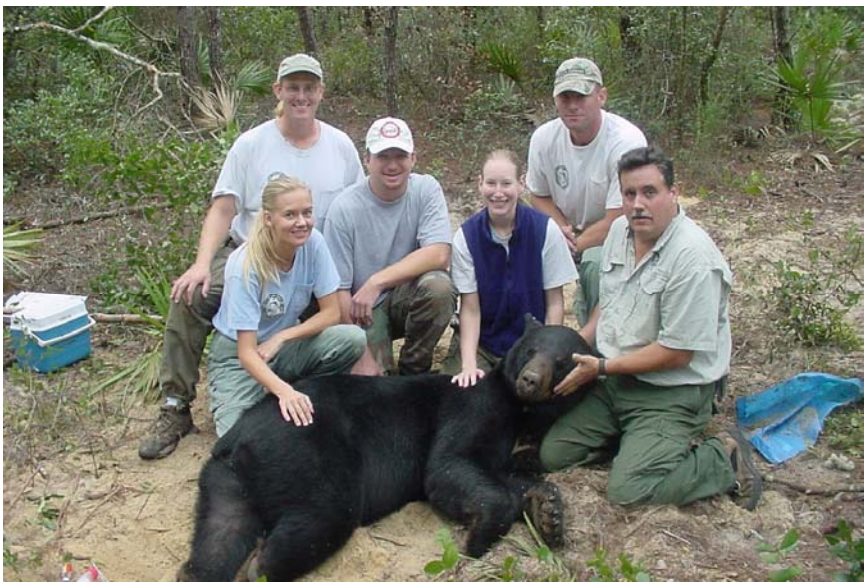


Field crew members from left: Elina Garrison, Darrin Masters, Jeremy Dixon, Melissa Moyer, Chris Long and Walter McCown at third re-capture of bear number 8.

BACKGROUND

At the time of first European contact, there were an estimated 11,500 black bears (Wooding 1993) and 350,000 humans living in what is now Florida (Milanich 1995). The 150,000 natives of the Timucuan culture residing in the central region of the peninsula lived in small communities near the coasts and along inland rivers and streams in small forest openings (Milanich 1995). The Timucuans used fire to create and maintain expansive clearings around their villages that were used for hunting and farming (Stanturf et al. 2002). In effect, humans lived in a patchwork of villages within a landscape dominated by natural habitats. This lifestyle undoubtedly generated frequent interactions and conflicts with bears. In 1527, Spanish explorers recorded frequent observations of bears in the central peninsula region and their use by the natives as a food item. They also noted the complex social and political organization that existed among remote villages and the presence of a rudimentary network of trails and paths that facilitated travel and communication between villages (Cabeza de Vaca 1542). These man-made travel ways through the forest also were likely utilized by foraging bears and may have increased the frequency of human-bear interactions

Many human and bear generations later, Florida exists as a patchwork of shrinking natural habitats amidst an increasingly human dominated landscape. Most of the remaining bear habitat consists of public lands separated by large urban centers, growing suburbs and a well-developed grid of roads. Florida is currently home to over 16 million human residents and the interactions between Floridians and bears along the state's 191,784 km (FDOT 2003) of roads have, in recent years, accounted for more than 100 bear deaths annually. In 2002 and 2003, bears were killed along highways in 31 of Florida's 67 counties (FWC, unpublished data). Recent studies in Florida have found collisions with vehicles to be the primary source of mortality for most bear populations (Wooding and Hardisky 1994, Land et al. 1994, Roof and Wooding 1996).

In addition to directly affecting bears through mortality, highways can cause profound effects upon bear populations in more subtle ways. In addition to the direct loss of approximately 2.6 – 5.6 hectares (ha) (1 ha = 2.47 acres) of habitat per kilometer of highway (Wooding and Maddrey 1994) and the avoidance of habitat adjacent to roads by bears due to noise and human disturbance (Kasworm and Manley 1990, Clark 1991), the habitat fragmentation associated with a high-volume and high-speed roadway can alter home range size and distribution (Brody and Pelton 1989; Proctor et al. 2002), alter movements and prevent bears from utilizing seasonally important nutritional resources (Brandenburg 1996). These effects can be regional and population level in scope. There is recent evidence (Dixon 2004) that habitat fragmentation in Florida has created a formidable obstacle to immigration, migration and genetic interchange among bear populations in Florida.

The impact of highway mortality and habitat fragmentation on bears is potentially significant. Compared to many other mammalian species, bears typically exist at low densities, have low reproductive rates, large home ranges, make extensive movements, and have slow colonization rates. Efforts to address highway mortality and mitigate habitat fragmentation have been successful for panthers (Foster 1993) and bears (Roof and Wooding 1996) when based upon intensive movement and habitat use studies.

Ocala National Forest (ONF) is one of the largest and most important habitats for bears in Florida. However, it is located in the densely populated and rapidly growing area of Central Florida. The Ocala bear population has accounted for 554 of 1,219 (45.4%) of the state's bear highway mortality from 1976-2003. Furthermore, eight of 15 chronic roadkill problem areas in Florida identified in a 2000 review of highway mortality are associated with the Ocala population with State Road 40 (SR-40) accounting for the greatest number of mortalities (Gilbert 2000). Because ONF is bisected by SR-40 and contains other roads of varying use intensities, it provides an opportunity to assess the impacts of road mortality upon this population and to document bear movements, highway crossing patterns and behaviors associated with a range of traffic levels.

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. provide an abundance estimate of bears within the study area portion of ONF,
4. determine survival rates of adult bears captured in the vicinity of SR-40,
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

An early description of the Big Scrub, which today lies within ONF, noted the stark nature of the landscape that seemed to provide little hope for economic exploitation. Simmons (1822; from Myers and Ewel 1990) wrote:

> “Nothing could be more sterile than the soil; and these tracts are, in fact, concealed deserts, as they are too poor to admit of cultivation, and afford nothing that is fit, even for the browsing of cattle. The growth upon these places, from its tough and stunted character, forms a complete live fence which, probably, would never have been penetrated through, but by the Indians, who made the present trail, for the purpose of hunting bear.”

Most of the soil types on ONF are very well drained old dune sands of low fertility (Snedaker and Lugo 1972). The climate is characterized by hot wet summers with abundant rainfall and cool dry winters. Annual precipitation averages 1364 mm (53 in) with 55% of rainfall occurring from June-September of each year. The 174,019 ha-forest (430,000 acres) contains four major plant communities: 1) swamps and marshes along the St. John’s and Ocklawaha rivers that create much of the forest’s east and west boundaries, respectively; 2) pine flatwoods between the rivers and the central ridge; 3) dune-like interior ridges of sand pine (*Pinus clausa*) and several species of scrub oaks (*Quercus sp.*) with numerous ponds and seasonally wet prairies interspersed; and 4) mixed hardwood swamps associated with some of the larger permanent lakes (Ayedelott et al. 1975).

Within ONF, the study area consisted of approximately 60% sand pine/ scrub oak (SPS). This mesic community is managed as a commercial crop on ONF with numerous small cutting compartments ranging from newly harvested clear cuts to very mature stands. Other communities of note within the study area include slash pine (*P. elliotti*) flatwoods (22%), wetland hardwoods (10%) and prairies (5%).

Mature stand of sand pine/scrub oak habitat.

A regenerating stand of sand pine/scrub oaks along SR-40.

A seasonally wet prairie ringed by slash pines.

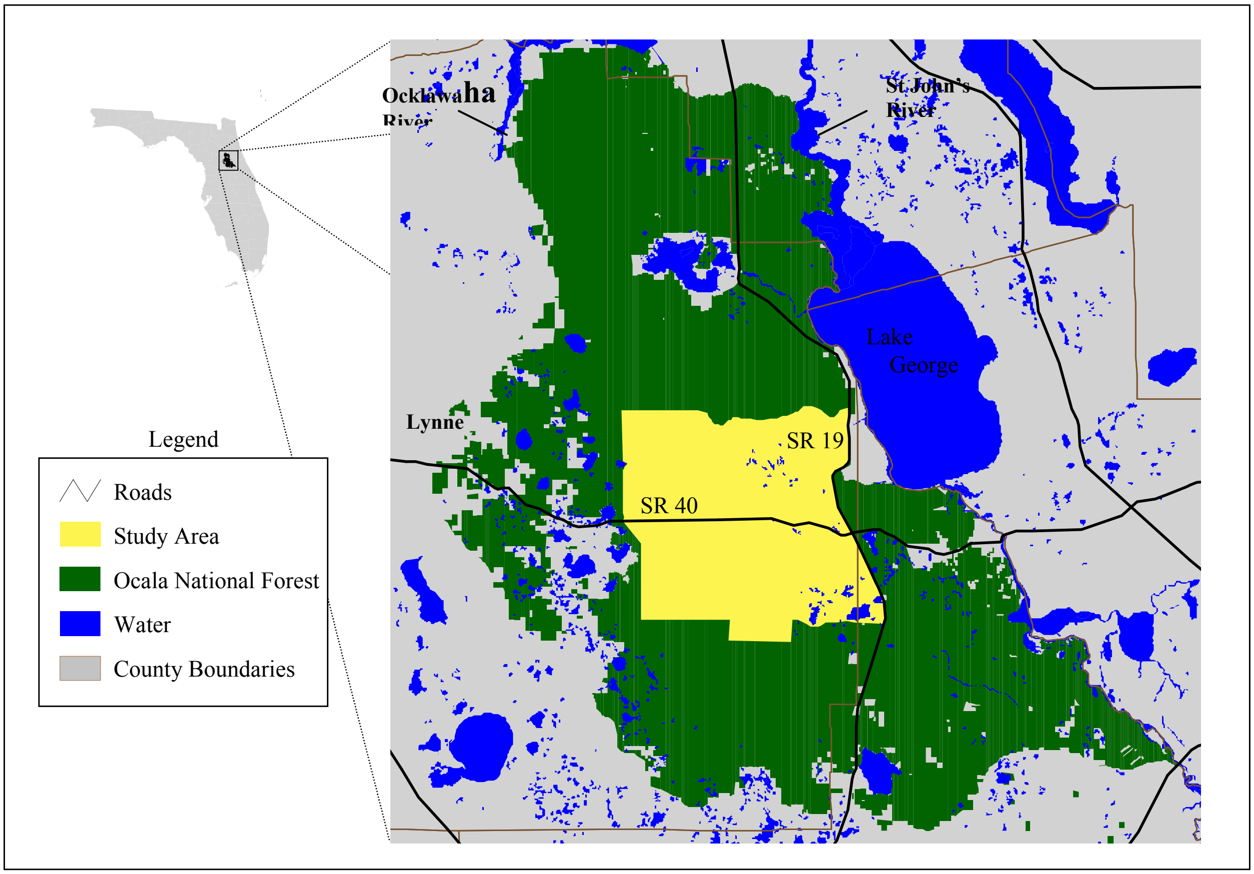


Figure 1. Lynne Florida and black bear study area in Ocala National Forest May 1999 – May 2003.

The study area was centered along an 18-km segment of SR-40 from its intersection with Forest Road (FR) 579 to the intersection with SR-19 (Figure 1). The study area encompassed approximately 335 km^2 (130 mi^2) of nearly contiguous bear habitat and included the central portion of ONF.

Straddling SR-40 approximately 9 km west of the primary study area is the small, unincorporated residential community of Lynne. Bear habitat in Lynne consists of small parcels of slash pine flatwoods that are included within ONF ownership, as well as parcels owned by corporate and private individuals. Lynne bear habitat is fragmented by a network of moderate volume roads and residential, industrial and commercial development.

METHODS

Trapping

We captured bears by modifying standard techniques described by Johnson and Pelton (1980). To reduce the likelihood of bone fractures that can occur when bears torque ensnared limbs around anchor trees, we attached the foot loop to two linked anchor cables that were each looped around anchor trees with adequate distance between them to prevent a trapped bear from reaching either tree. We trapped intermittently from mid-May to mid-December each year and concentrated trapping along the SR-40 corridor. From early July 1999 to the end of the study, we restricted summer trapnights to the hours between 1800 and 2400 to reduce the potential for heat stress and injuries to bears. We utilized an “alarm” radiocollar rigged to activate when bears were trapped. Consequently, the majority of captured bears were immobilized within an hour of their capture. We were able to gather mortality and road crossing data from radio collared female bears in Lynne, Florida, caught and radiocollared by Mark Cunningham D.V.M. that were part of a bio-medical investigation into the demodetic mange organism, *Demodex ursi*. Bears were trapped in Lynne from May 2000-August 2002 and because the demodetic organism is believed to pass from females to offspring, emphasis was placed on trapping in locations that were frequented by females.

Bears were immobilized with an injection of a 1:1 mixture of Tiletamine hydrochloride and Zolazepam hydrochloride (Telazol™). This mixture was administered at 3.0-3.5 mg/kg of estimated bear weight via a remote injection gun or blowpipe. An ophthalmic ointment was administered to moisturize eyes.

Aldrich spring activated snares were modified to use 2 connected anchor cables to reduce trap injuries.

Alarm collars were rigged to activate when a string fastened to the anchor cable was tugged sufficiently to pull the deactivating magnet from the collar.

Vital signs (temperature, pulse and respiration rate) were monitored while bears were immobilized. We weighed, measured, ear-tagged and lip-tattooed all immobilized bears and collected hair and blood samples for genetic analyses and extracted a premolar tooth for aging. We selected individuals to be fitted with radiocollars (Telonics™) based on several criteria including ensuring bears were of adequate size to prevent collar injury due to growth, preferentially collaring all females and those males adjacent to SR-40 and maintaining as balanced a sex ratio as possible. Collars were equipped with a mortality sensor and fitted with a leather connector designed to wear-away after one to two years, to prevent collars from remaining on bears beyond the battery's life expectancy. After work up, bears were released at the capture site, or moved to a nearby area if safety during recovery was a concern.

A bear is fitted with an ear tag and a radio-collar containing a leather breakaway segment to allow the collar to fall off.

Radio Telemetry

We obtained locations from radiocollared bears 1–3 times per week and acquired 7,204 locations of radio-instrumented animals during this study. Ground locations (n = 5,177) were acquired using a Telonics™ model TR-2, TR-4, or TR-5 receiver and a 2-element hand held "H" antennae. Aerial locations (n= 2,027) were collected from a Cessna 172 airplane using a TR-4 or TR-5 receiver. Two-element "H" antennas mounted on each wing strut were used to locate radio signals.

Telemetry locations from the ground were obtained by triangulating and recording compass bearings to the "loudest signal" (Springer 1979) from $\geq$ 3 positions located by a Garmin™ GPS unit. We used program Locate II (Nams 1989) to obtain an estimated position from the bearing and location data. Aerial locations were obtained by flying directly over the loudest signal and plotting that location onto a U.S. Geological Survey topographic map to determine location coordinates. All locations were recorded as Universal Transverse Mercator (UTM) coordinates.

Telemetry Error

We used winter dens and test collars placed in representative habitats to determine telemetry error. We calculated the average ground location error by determining the distance between researchers' estimated den or collar location and the actual location. Average aerial location error was calculated by determining differences between estimated and actual locations of collars that had dropped from bears.

Home Range

We plotted the locations of collared bears to examine movement patterns associated with bear sex, season, and proximity to roads. We used the 95% fixed kernel method (Worton 1989) to estimate seasonal and annual home ranges. Fixed kernel estimates were calculated using the Animal Movement Extension (Hooge and Eichenlaub 1997) in ArcView™ Geographic Information System.

Seasonal home ranges were calculated for all bears with $\geq$ 15 locations within a season. Seasons were defined for this research as summer (1 May-30 September), fall (1 October-31 December) and winter/ (1 January – 30 April). Home range estimates were weighted by the number of locations. Thus, seasonal home ranges of bears with many locations contributed more to the seasonal home range estimate than did the seasonal home ranges of bears with fewer locations available. Mean seasonal home ranges were reported for seasons in which $\geq$ 15 locations were gathered for $\geq$ 3 collared bears. We calculated annual home ranges for animals for which we had $\geq$ 15 locations for summer and fall.

Differences in annual and seasonal home ranges were analyzed by Analysis of Variance (ANOVA) with a log transformation of home range estimate (due to degree of variation). When differences existed, a paired t-test was performed for all possible pairs of means to identify differences.

Habitat Use

We used the compositional analysis method (Aebischer et. al 1993) to compare habitat use with availability. By utilizing this technique individual variation in habitat use is not masked by a high number of locations from a few individuals. Kernel probability density estimation as described by Worton (1989) and implemented through the Animal Movement Analysis extension (Hooge and Eichenlaub 1997) was used to estimate areas utilized by individual bears from radio-telemetry locations for each season. The suggested “ad hoc” smoothing parameter was used for each area calculation and both the 50% and 95% probability regions were estimated. The 50% probability region represents a smaller area with a higher density of telemetry locations and was treated as the "core area" of habitat used by bears while the 95% kernel was treated as habitat area that was locally available for core usage. ONF habitat that was considered to be available for use by bears was defined as USFS lands south of CR-316. Habitat use and available habitat for individual bears were only calculated when at least 15 locations within a season were available for analysis. We plotted bear locations on 2002 USFS GIS coverage of ONF to determine habitat use. Stand ages were corrected from 2002 data. An ONF forest stands classification shape file maintained by the USFS was used to classify sub-areas by habitat type within the estimated habitat use and habitat available areas. We limited habitat use analysis to those bears with $\geq$ 95% of their probability region (kernel) within ONF for a given season. Prior to calculating the composition proportions for habitat, large water body areas and unclassified land areas were subtracted from individual bear areas and the total available ONF habitat area prior to calculating habitat composition proportions.

The estimation and comparison of utilized habitat compositions to available habitat compositions and the comparison of utilized habitat compositions between genders within season and between seasons within gender was carried out according to methods described by Aebischer et al. (1993). Individual bear log-ratio vectors were derived prior to the calculation of mean log-ratio response vectors and test statistics. For analysis of the composition of each individual bear habitat and for the entire ONF habitat available, 1 habitat was chosen as a reference "denominator" and ratios of habitat composition relative to the denominator habitat proportion were calculated and log-transformed. Wilks's Lambda test was then used within the framework of multivariate analysis of variance (MANOVA, Aitchison 1986) to compare the mean log-ratio response vector for a given sample of bear compositions to other log-ratio vectors. The number of locations used to calculate the utilized areas was used to weight individual bear log-ratio vectors. In comparing mean log-ratio response vectors to the available ONF habitat log-ratio vector, differences between individual bear log-ratios in a sample and corresponding available habitat log-ratios were calculated first, and the resulting mean log-ratio difference vector was tested for difference from a vector of zeroes. For comparisons between seasons within gender or between "core" utilized habitat composition (derived from 50% kernel) and locally available ONF habitat compositions (derived from corresponding 95% kernels), within-bear differences in corresponding log-ratios were calculated first, and the resulting mean log-ratio difference vector was again tested for difference from a vector of zeroes. In comparing male and female utilized habitat compositions within each season, a between-groups comparison of mean log-ration response vectors was performed.

In each case where the Wilk's Lambda test indicated a significant difference between the mean compositional pattern of habitat used for a given gender and season and the compositional pattern of total available ONF habitat, a habitat preference-ranking matrix was generated as described by Aebischer et al. (1993). The following steps were repeated for each of the habitats considered in the compositional analysis. Using the observed proportion of a given utilized habitat as the denominator, log-ratios of the proportions (numerators) observed for the remaining 8 utilized habitats were constructed. A similar set of parallel log-ratios was constructed from the entire available ONF habitat composition. Each of the mean log-ratios for utilized habitat was then tested for difference from the corresponding log-ratios for available ONF habitat through the use of a t-statistic within the framework of the MANOVA. Each of these log-ratio differences can be interpreted as the difference between the observed "preference" of a habitat relative to the denominator habitat and the expected preference given that available habitat was selected randomly. The sign of the difference in log-ratios and whether or not the difference was statistically significant at a 0.05 alpha-level were recorded and entered into a matrix for each of the habitats. Similar columns were generated using each of the other habitats as the denominator habitat. Ordering of the log-ratio differences by habitat within a column was done in such a way that each row of the 9 x 9 habitat preference ranking matrix consisted of observed versus expected preference differences of one (numerator) habitat relative to the remaining (denominator) habitats (the diagonal of the matrix is empty). The number of positive log-ratio differences within a row indicates the number of times the preference for a particular habitat relative to each other habitat was greater than would be expected given random habitat selection. The habitat with the greatest number of positive differences within a row was considered the habitat most preferred over all others, while the habitat with the smallest number of positive differences in a row was considered the least preferred. To determine if any of the unique ranks were statistically interchangeable, the habitats were re-ranked according to the number of positive differences in a row that were statistically significant.

Crossings of SR-40 by Radio-Collared Bears

We analyzed crossing rates of bears that were instrumented a minimum of 30 days with no locations > 30 days apart. We documented road crossings by radio-collared bears by connecting consecutive telemetry locations that fell on opposite sides of SR-40. Because animals were not monitored continuously this method provided a minimum frequency of crossings by instrumented individuals.

In order to compare crossing rates between groups of bears defined by gender, locale, season and vehicular interaction, mixed effects logistic regression (Agresti 1990; Littell et al. 1996) was used to model the probability that 2 consecutive bear locations fell on opposite sides of SR-40. Vehicular interaction was defined by whether the bear was struck by a vehicle on SR-40 and locale was defined as being either ONF or Lynne.

For any pair of consecutive bear locations, it was assumed that the perpendicular distance from the earlier location to SR-40 and the number of days elapsed between locations could both influence the likelihood that a crossing of SR-40 would be observed. In particular, it was expected that crossings were less likely to be observed when longer distances from SR-40 occurred in conjunction with shorter time intervals between locations. Therefore, distance of a location from SR-40, days elapsed between consecutive locations, and the interaction between these 2 effects were included in each model as potential predictors. To account for variation between bears and within-bear variation in the outcomes associated with consecutive location pairs, “bear” was modeled as a random effect within the logistic regression framework. To compare bear groups, odds ratios with 95% confidence intervals were estimated for predicted probabilities of observing a crossing and the Wald Chi-square test was used to determine if they differed significantly from 1. The F-test was used to determine the significance of the various model predictors. Logistic regression models that assumed a common association between crossing outcomes and time and distance predictors across all bear subgroups, and models that allowed these associations to vary among subgroups were evaluated in selecting overall best-fitting models. In all cases, models that assumed a common association across all subgroups were found to yield better fitting models.

Survival

We documented mortality events by ground checking all mortality signals from radio-collared bears and performing necropsies on dead bears, whenever possible, to verify their cause of death. In most instances we were able to document the exact date of mortality. When the precise date was unknown, we estimated the post-mortem interval by observing the stage of blowfly (*Chrysomya rufifaces*) development (J.F. Butler pers. comm.) or estimated the interval as the mid-point date between the last location and the first detection of a mortality signal. The maximum possible interval between death and discovery was no more than 4 days in all cases.

Kaplan-Meier (KM) survival curves (Kalbfleisch and Prentice1980) were estimated for each bear in 3 groups (ONF females, ONF males, and Lynne females) in order to compare survival rates. This method assumes that: 1) animals in the population have been randomly sampled, 2) survival times are independent for different animals, 3) time of death is known exactly, 4) survival is not affected by capture, marking or observation, 5) censoring (dropped/defunct collar or other loss of contact with the animal) is random, 6) newly instrumented animals have the same survivorship as previous animals.

In the context of this study, KM survival curves are estimates of the cumulative probability that a bear will survive just beyond a given point in time relative to a defined starting point, for any point along the time interval of the study. We defined the starting point for the survival curves to be the month and day that the first bear was captured and radio-collared (1 June). As more bears were captured and radio-collared in the first year of the study, they entered into the pool of bears that were considered to be at risk of dying (the risk set), but in a staggered manner such that their contribution to calculated survival probabilities only occurred after entry into the study. Staggering the entry of bears into the risk set avoided the potential bias that would be introduced as a result of inflating the size of the risk set with excess "survivors". For each of the 3 remaining years of the study, staggered entry times were defined relative to the day of 1 June in each year. Bears dropped out of the risk set over the course of the study when mortality occurred, when they dropped their radio collar and could not be re-collared, or when the end of the study was reached.

In order to determine if survival rates over the course of the study differed among the 3 groups, the KM survival curves were compared using the log-rank test (Kalbfleisch and Prentice 1980). We estimated annual survival rates from KM survival curves by reporting the survivorship value at the time of the last mortality event for specific years and by treating each year independently (non-cumulative across years).

Track Transect

We monitored a 3-meter-wide dirt transect disked along SR-40 within the study area for bear tracks to document bear crossings. The transect began at SR-19 and terminated approximately 18 km westward at the SR-40 and FR-79/579 intersection. The transect alternated between the north and south sides of SR-40 at roughly 2 km intervals to avoid patches of endangered plant life and discourage use by off road vehicles. Each month we monitored the transect weekly for 3 weeks and then daily for 5 to 7 consecutive days for a total of 8-10 observations each month. We assumed that bear tracks crossing the transect represented a crossing of SR-40. Bear track locations were determined using a Garmin™ handheld GPS. Directional information on the tracks was recorded when determinable. Tracks of obvious family groups were treated as one crossing. Tracks were cleaned from the transect after observation by dragging a 1.3 m wide steel drag behind the observer's All Terrain Vehicle.

Locations of bear tracks were recorded along a dirt transect adjacent to SR-40.

Bear tracks observed on each observation day were used to calculate crossing rates. The observation period for each set of tracks counted on each observation day was considered to be the number of days elapsed between cleansing treatments (dragged by researcher, rain) and the observation day. Thus, the 350 observation days represented 840 cumulative days of observation.

We used ArcView™ GIS to establish meter marks to each meter along the approximately 18 km section of SR-40 in our study area. Locations of bear tracks on the transect were assigned to the nearest corresponding meter mark on SR-40. We designated each of the 35 roads that intersected SR-40 as high use (state highway, forest roads with paved or maintained intersection), forest road (numbered dirt roads), or trails (pedestrian or infrequently used vehicular roads) based upon our observation of level of use, USFS classification and aerial photographs. We measured the width of each intersection using ArcView™ software and Digital Orthoquad aerial photographs and designated buffers around each one equal to 1.5 times its width to assess the effects of levels of road use upon bear crossing behavior. Elevation along SR-40 was determined using ArcView™ grid coverage of a USGS digital elevation model of Florida. Road curvature attributes were determined by considering the point of view of a motorist driving 96 km per hour (60 mph) in an east and a west direction. We chose to measure the angle of the motorists' view at a distance of 100 m because that is the approximate mean stopping distance for a passenger vehicle traveling 100-110 km/hr (62-68 mph) (www.sdt.com.au/STOPPINGDISTANCE.htm). At each meter mark on SR-40, the difference between the bearing of the driver relative to the next meter mark and the bearing relative to the meter mark 100 meters distant was calculated. These meter-by-meter calculations were averaged within 250 m sections to generate a mean relative curvature attribute for each section. Separate curvature attributes were calculated for drivers traveling east and for drivers traveling west.

USFS forest stand boundaries along SR-40, intersecting roads, highway elevation, and relative degree of road curvature were also referenced to meter marks so that stand and road characteristics could be matched to appropriate bear tracks. Meter marks and associated attributes were incorporated into attributes of 250 m segments of SR-40 for analysis of road segments.

Mixed effects Poisson regression (McCullagh and Nelder 1989, Littell et al. 1996) was used to assess the influence of road elevation, road curvature, and presence and type of intersecting roads on crossing rates. The 72- 250 m sections of SR-40 were modeled as a random effect. Spatial correlation among sections within each year and bear season was modeled as a function of the distance between section midpoints along SR-40. Thus, correlation between crossing rates in different 250 m sections was assumed to fall off as the distance between section midpoints increased. Crossing rates in each model were standardized to the number of crossings per 250 m section of road per month (30 d). The association between crossing rates and elevation, curvature and intersecting road type were evaluated while controlling for bear season and year as fixed effects. Restricted maximum likelihood (REML) estimation as implemented in the GLIMMIX macro and PROC MIXED in SAS V8.2™ were used to estimate mean crossing rates and 95% confidence intervals for groups of 250 m highway sections classified by 4 levels of mean elevation, 4 levels of mean curvature, and 4 types of intersecting road. An F-test was used to determine if mean-crossing rates differed significantly among the levels of each attribute of interest. A linear trend test based on the t-statistic was also performed to determine if mean-crossing rates increased or decreased significantly over the ordered levels of elevation, curvature and intersecting road type. Error variances were rescaled prior to the calculation of confidence intervals and test statistics.

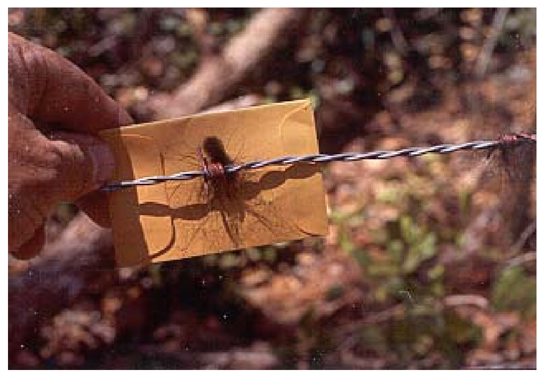
In order to assess the influence of forest type and stand age of forest compartments with boundaries on SR-40, a set of 75 sections of varying length defined by north and south compartment boundaries were generated and categorized by forest type and stand age and aged corrected to each year being considered. Mixed effects Poisson regression was again used to estimate mean crossing rates and compare them among groups of road sections defined by combinations of forest types on opposing sides of SR-40 and by combinations of 4 levels of stand age on opposing sides of SR-40. With the exception of how the road sections were defined, all aspects of the modeling and analysis were identical to what was described for the analysis of 250 m sections.

Since the direction bears were traveling (north or south) was determined for > 98% of tracks, an entering forest type and stand age and a leaving forest type and stand age were defined for each of the sections in which crossing direction was observed. After reconfiguring the data in this manner, mixed effects Poisson regression was again used to estimate and compare mean crossing rates among groups of sections defined by combinations of entering and leaving forest type and stand age level.

In order to determine if the locations of historic vehicle-related bear mortality were associated with specific road characteristics, the locations of 33 bear deaths documented by FWC between December 1982 and December 2002 were referenced to the nearest meter mark on SR-40. Mortality rates for this 20-year period were then calculated for each of the 72- 250 m sections. Because the number of observed mortalities being analyzed was small relative to the number of observed crossings that were analyzed, 250 m sections were classified by 3 levels of road elevation rather than 4, as was the case with track analysis.

Population Estimates

Bear hair was collected from bait sites surrounded by 2 strands of standard 4-prong barbed wire. Barbed wire was affixed to trees at approximately 25 and 50 cm above the ground and encircled an area of 10-30 m^2. We baited the center of the hair snare with approximately 2 quarts of pastries and corn and suspended a small bag of pastries > 2.5 m high from a cable anchored to corner trees of the snare. Hair was removed from the barb and placed into a 5 cm X 7.62 cm manila coin envelope. Grid cells were created based upon the average summer home range of female bears in ONF derived from prior studies. Each cell was 6.25 km^2 in size. Hair snares were placed within good bear habitat within these grid cells. We established 46-50 hair snares in the study area each year. To provide estimates of effective study areas sizes for females and males, each hair snare was buffered by the radius of the average summer home range for that gender in ONF. The mean summer home range sizes used for buffering were calculated from summer telemetry data from this project that met criteria for inclusion into home range calculations. For females, home ranges were an average of 32 summer home ranges and for males mean summer home ranges were calculated from 15 animals. Because snares were moved to new locations each year, the effective study area size varied slightly each year. Lincoln-Peterson estimates from 1999 and 2000 were not calculated separately by gender, so the effective study area was calculated by averaging the summer home ranges of males and females for those years.



A black bear enters a hair snare through 2 strands of barbed-wire and leaves a tuft of hair from which DNA was extracted that resulted in a unique genotype identifying this individual.

We sent samples of bear hair collected from 1999 – 2003 to Wildlife Genetics International for individual identification. The genetic analyses resulted in unique genotypes and gender identification for each successful sample. We used these results to generate population abundance estimates using 3 different mark-recapture models.

The data generated from 1999 and 2000 were obtained from a single capture and a single recapture event from which individual bears were identified. The marking phase began in late May and the recapture phase began in August of each year. Each phase lasted 3-4 weeks and hair snares were shifted within the grid cell between the mark and recapture phases. We collected hair samples from bait sites every 2-3 days and added bait as needed at each visit. 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.

The ratio of marked to unmarked individuals in the recapture session was incorporated into a modified Lincoln-Peterson model (Pollock et al. 1990) to provide population estimates for each year. The relevant assumptions of the Lincoln-Peterson technique are that the population is closed (no births, no deaths, no migration or immigration) and all animals have equal probability of being captured.

The data from 2001-2003 were generated as part of a statewide study of bear abundance that utilized four periods each containing a mark and a recapture session (Eason et al. 2001). Sessions ran from late May through August of each year. There was a week interval between the end of each recapture session and the beginning of the subsequent capture session, in which no bait was utilized, to allow individuals to redistribute themselves within the study area.

We used program CAPTURE (White et al. 1982) to calculate population estimates from these data. CAPTURE computes estimates of population size for a population assumed to be closed. Because it does not require calculations to determine population gain or loss, sources of variation in capture probability are defined to be the result of time, behavioral response of individual bears to the capture process, or the heterogeneity of capture probabilities among individuals in the population. Chi-square goodness-of-fit tests within CAPTURE were used to determine which of these sources of variation best explained the patterns of recapture. Those test results were reviewed to determine which model should be used to estimate abundance.

Program JOLLY (J.E. Hines, Nat. Biol. Surv. PWRC, Laurel MD), developed after methods suggested by Jolly (1965), was used to provide an overall population estimate from estimates of individual years. This modeling of the probability of recapture (re-sampling a bear that was identified previously) was chosen to analyze data from the entire 4-year period because it computes estimates of abundance of an open population where birth, death or permanent emigration is allowed. Although the population can be assumed closed within any given summer of any given year, the same assumption cannot be made when considering an interval of multiple years. For this model, recaptures were tallied from subsequent years, so our 4 periods within each year were pooled to provide a single capture-recapture history for each year, over the entire 5-year period.

The relevant assumptions of JOLLY are that every sampled/marked bear has an equal probability of being recaptured, every sampled individual has the same probability of survival between sampling periods, sampling periods are short, all emigration from the study area is permanent and the fate of each animal is independent of the fate of all other animals.

Two ways in which a previously marked bear can fail to be recaptured in subsequent years are through death or permanent emigration, which are treated the same within JOLLY. Those probabilities are calculated and referred to as survival. The possibility that an animal can fail to be recaptured but remains alive and in the study area population plays an important role in the probability modeling of capture histories. JOLLY contains a number of models from which it can choose to explain recapture probabilities and performs a goodness of fit test to decide which model most nearly fits the data.

Fall Food Abundance

We assessed the availability of common fall bear foods from 68 mast-survey transects in slash pine flatwoods habitat and 60 mast-survey transects in sand pine/scrub oak habitat. 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.

RESULTS

Trapping

Sex Ratio

We captured 138 bears ($\geq$ 1 year-old) a total of 183 times with 592 trapnights of effort (3.2 trapnights per capture). We caught 52 females and 86 males (Appendix A) and placed radiocollars on 95 bears. Thirteen females in Lynne, 36 females in ONF and 46 males in ONF were radio-collared.

Ages and Weights

Lynne females (n= 13) averaged 6.3 years of age and weighed 139.4 lbs. ONF females (n= 40) averaged 4.8 years old and weighed 146.2 lbs. The average male in ONF (n= 86) was 4.4 years old and weighed 224.4 lbs while those in Lynne (n= 6) averaged 3.7 years of age and 264.7 lbs (Appendix A). There were no significant differences in weights between the two areas for females (P = 0.3159) or males (P = 0.1564). However the Lynne males tended to be heavier at a younger age.

Radio Telemetry

We placed radio collars on 95 bears $\geq$ 1 year-old (49 females, 46 males). Nine males and 2 females removed their collars before we were able to acquire > 10 locations and are not included in our analysis. One female was killed by vehicular collision before we acquired 10 locations and is included in highway crossing and mortality analysis only.

Bears wore radio collars for a collective 42,343 days (116 bear years). Females accumulated 26,162 radio days (71.7 bear years) and males 16,210 radio days (44.3 bear years). We obtained 7,204 locations of bears during this study. We estimated the greatest number of locations in 2000 when we obtained 1,956 locations of bears and the fewest number in the 5 months of 2003 that we conducted the study (n=674).

We monitored a maximum of 24 females and 17 males at any one time. We monitored the greatest number of bears in 2001 when we monitored 17 males and 30 females during some portion of the year (Figures 2, 3).

Telemetry Error

We obtained 41 locations of dropped collars (n = 6), test collars (n = 16) and winter dens (n = 19) that were used to test ground telemetry error by observing the difference between the actual and estimated locations. We obtained 25 estimates of aerial telemetry error by comparing locations of dropped collars and winter dens to actual locations. Our estimated errors were 100 m (N = 284; Std = 100.2) for ground locations and 251 m (N = 25; Std. = 270.3 m) for aerial locations.

Home Range

Annual home range size for males in ONF averaged 94.3 km^2 (n = 7, range 87.29 km^2 -159.89 km^2) and females averaged 20.48 km^2 (n = 23, range 17.04 km^2 –

26.25 km^2) (Table 1). The ratio of the average male home range to the average female home range in our study was approximately 4:1 and is about mid-range of male: female home range ratios for Florida black bears (Table 1).

Seasonal home ranges for females ranged from 3.07 km^2 (Winter 2003) to 68.33 km^2 (Fall 2000) (Table 2). The range of male seasonal home range estimates was proportionately smaller. Mean home ranges for males were largest in summer 1999 (151.88 km^2) and smallest in winter 2001 (14.82 km^2) (Table 2).

Analysis of variance indicated differences among years for both sexes during fall. T-tests indicated that home range estimates for fall 2000 (F = 68.33 km^2, M = 119.73 km^2) were larger than fall 2002 for females (20.26 km^2, P = 0.001) and larger than fall 1999 for males (52.50 km^2, P = 0.0182). There were no other differences in the sizes of fall home ranges noted. We also note that estimates of male home ranges in winter 2001 (14.82 km^2) were smaller (P = 0.026) than that of winter 2000 (43.84 km^2). The only other seasonal difference was for females in winter 2002 and 2003. There was a greater proportion of parturient females in 2002 (0.69) than in 2003 (0.47), but estimates of female home ranges in 2002 were larger than those in 2003.

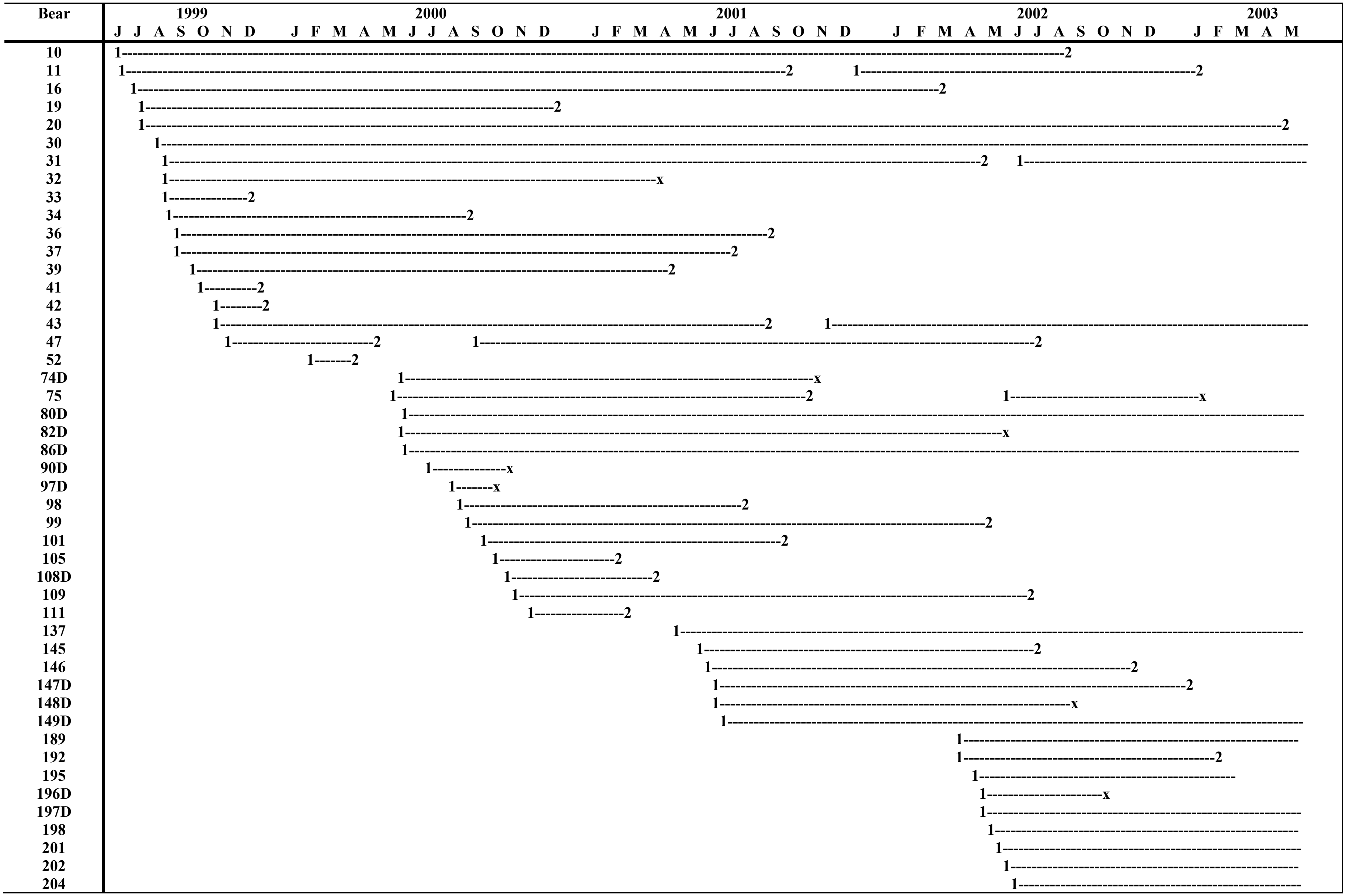


Figure 2. Collar tenure for black bear females with ≥ 10 radiolocations in Ocala National Forest and Lynne (D), Florida June 1999–May 2003. 1= entrance, 2 = exit, x = death.

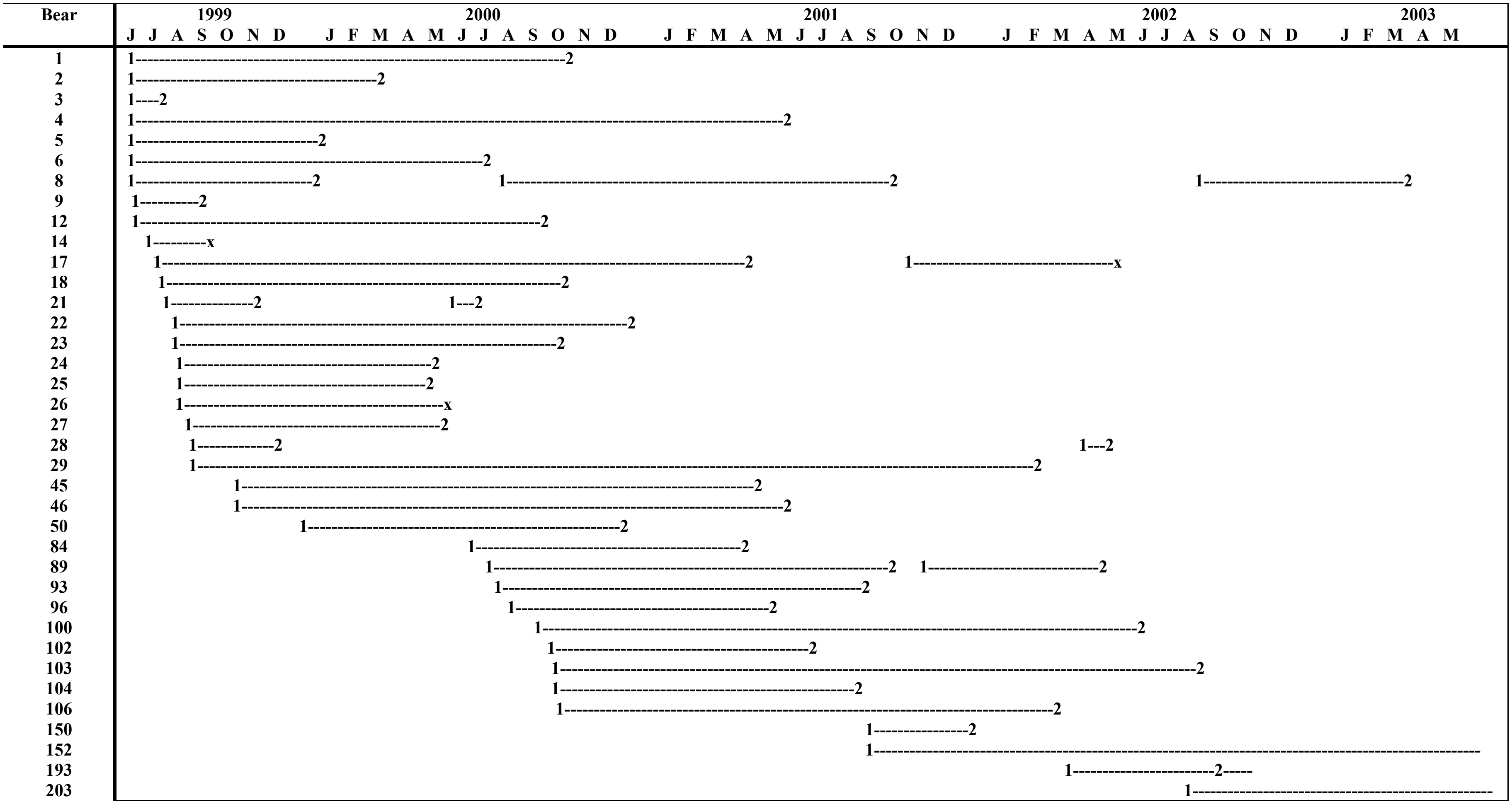


Figure 3. Collar tenure of male black bears with ≥ 10 radiolocations in Ocala National Forest June 1999-May 2003. 1 = entrance, 2 = exit, x = death.

Table 1. Annual home ranges reported for Florida black bears.

Locale	Sex	n	Method	Annual Home Range (km^2)
Ocala National Forest[a]	F	23	95% kernel	20.48
	M	7	95% kernel	94.3
S.W. Alabama[b]	F	10	95% kernel	17.6
	M		95% kernel	114.8
Osceola National Forest[c]	F	53	95% kernel	30.3
Okefenokee N.W.R[c].	F	69	95% kernel	55.9
	M	10	95% kernel	342.8
Wekiva River Basin FL[d]	F	10	MCP[e]	25.0
	M	15	MCP	57.0
Ocala National Forest[f]	F	7	MCP	25.0
	M	7	MCP	135.0
Osceola National Forest[f]	F	1	MCP	52.0
	M	4	MCP	215.0
Big Cypress Nat'l Preserve[g]	F	19	MCP	57.1
	M	32	MCP	303.2

[a] This study
[b] Edwards 2002
[c] Dobey et al. 2002
[d] Roof and Wooding 1996
[e] MCP = Minimum Convex Polygon
[f] Wooding and Hardisky 1994
[g] Land et al. 1994

Table 2. Seasonal home range estimates of black bears in Ocala National Forest, June 1999- May 2003. Home ranges were estimated from the 95% probability region of the fixed kernel estimator. Estimates of home ranges were weighted by the number of locations of individual bears considered. Estimates of seasonal home ranges were not calculated for seasons with < 3 bears.

Sex	Year	Season	№ bears	Mean (km^2)	Stand. Error	Median (km^2)	Min. (km^2)	Max (km^2)
F	1999	Fall	16	52.50	16.32	36.60	4.47	296.42
F	2000	Winter	7	9.36	2.70	5.65	1.67	20.41
F	2000	Summer	8	9.71	17.43	9.49	3.20	16.74
F	2000	Fall	15	68.33	20.60	43.58	8.47	291.23
F	2001	Winterg	15	42.07	20.92	10.40	0.69	286.41
F	2001	Summer	13	29.41	11.58	17.61	4.56	162.83
F	2001	Fall	11	20.26	4.22	15.51	7.15	56.95
F	2002	Winter	4	46.83	21.96	9.87	9.04	89.60
F	2002	Summer	11	30.51	13.45	14.99	1.68	133.43
F	2002	Fall	14	13.18	2.13	12.36	1.25	30.32
F	2003	Winter	8	3.07	0.67	2.24	1.30	6.04
M	1999	Summer	5	151.88	80.96	72.91	38.39	447.16
M	1999	Fall	13	39.93	5.38	45.79	10.33	64.04
M	2000	Winter	15	43.84	11.27	40.22	2.75	146.76
M	2000	Summer	4	44.77	16.16	23.09	20.37	90.93
M	2000	Fall	12	119.73	28.77	71.43	25.58	340.73
M	2001	Summer	6	77.98	14.23	61.34	38.38	126.16
M	2001	Fall	13	14.82	5.76	5.07	1.11	70.30

Habitat Use

We identified bear locations within 9 major habitat types: sand pine stands 0-2 years old, sand pine stands 3-7 years old, sand pine stands 8-24 years old, sand pine stands 25+ years old, upland hardwoods, scrub oak, slash/longleaf pine, cypress/wetland hardwoods, and open/prairie land. We excluded 1 bear whose home range consisted of > 20% unclassified habitat. We analyzed the seasonal habitat used by 57 bears (29F, 28M) during winter, 61 bears (29F, 32M) during summer and 74 bears (28F, 36M) during fall.

P-values provided by Wilk's Lambda for all gender by season comparisons indicated that, with one exception, bears did not use ONF habitats in proportion to their availability (Table 3). Females tended to use habitat in proportion to its availability in winter (Fig 4). Habitat structure (i.e., understory stem density, canopy closure) may play a more important role in den site selection than does species composition (E. Garrison, pers commun.). We detected habitat preferences for all other gender-by-season comparisons (Appendix B).

Stands of sand pine/ scrub oaks that were 8-24 or 25 + years old were used well out of proportion to their occurrence on ONF. They constitute 49% of available habitat in ONF but comprised 72%-98% of seasonal habitat use for males and females (Table 4).

Table 3. Seasonal black bear habitat use versus availability for the 50% kernel density probability region in Ocala National Forest June 1999-June 2003. A P-value $\leq$ 0.05 indicates habitat was not used in proportion to its availability.

Sex	Season	№ Bears	Wilk's Lambda P-value Use vs. Available
F	Summer	25	< 0.0001
F	Fall	27	< 0.0001
F	Winter	22	0.9683
M	Summer	20	0.0030
M	Fall	29	< 0.0001
M	Winter	26	0.0003

Table 4. Relative composition (%) of habitat used by bears within the 50% kernel density probability region in ONF May 1999-May 2003 and available habitat in ONF.

Sex	Season	Sand Pine 0-2	Sand Pine 3-7	Sand Pine 8-24	Sand Pine 25+	Slash Pine	Scrub Oak	Upland Hardwd.	Wet Hardwd.	Open Land
F	Summer	0.36	4.93	26.58	67.57	0.27	0.14	0.01	0.01	0.14
F	Winter	1.24	1.28	27.51	44.98	12.01	3.43	0.79	6.90	1.87
F	Fall	0.12	1.55	50.53	47.39	0.14	0.12	0.00	0.01	0.14
M	Summer	0.85	5.05	46.34	45.91	0.75	0.56	0.02	0.02	0.51
M	Winter	5.53	0.10	59.33	21.24	8.03	2.31	0.03	0.84	2.59
M	Fall	2.96	1.76	54.01	38.69	0.57	1.60	0.01	0.04	0.35
Habitat Available in ONF		4.28	3.81	22.62	26.51	22.22	2.77	2.18	10.72	4.88

Both sexes used the landscape similarly during much of the year however; they tended to segregate during winter (Table 5)(Fig 5). Males tended to use stands of sand pine 8-24 years old while females used older sand pine stands in the winter.

Table 5. Comparison of the relative distribution of habitat used by male and female bears in Ocala National Forest June 1999-May 2003.

Season	Wilk's Lambda P-value Male vs. Female
Summer	0.5644
Fall	0.1713
Winter	0.0806

Our analysis suggests that medium to older aged stands of sand pine/ scrub oaks are preferred black bear habitats in ONF. Although males and females use these habitats somewhat differently, they are important for both sexes throughout the year and are used out of proportion to their occurrence in the forest (Figs 6, 7). Graphs of all habitat use versus availability for gender, and season and gender-by-season comparisons are provided in Appendix B.

A bear walks down the forest road separating two stands of sand pine/ scrub oak habitat.

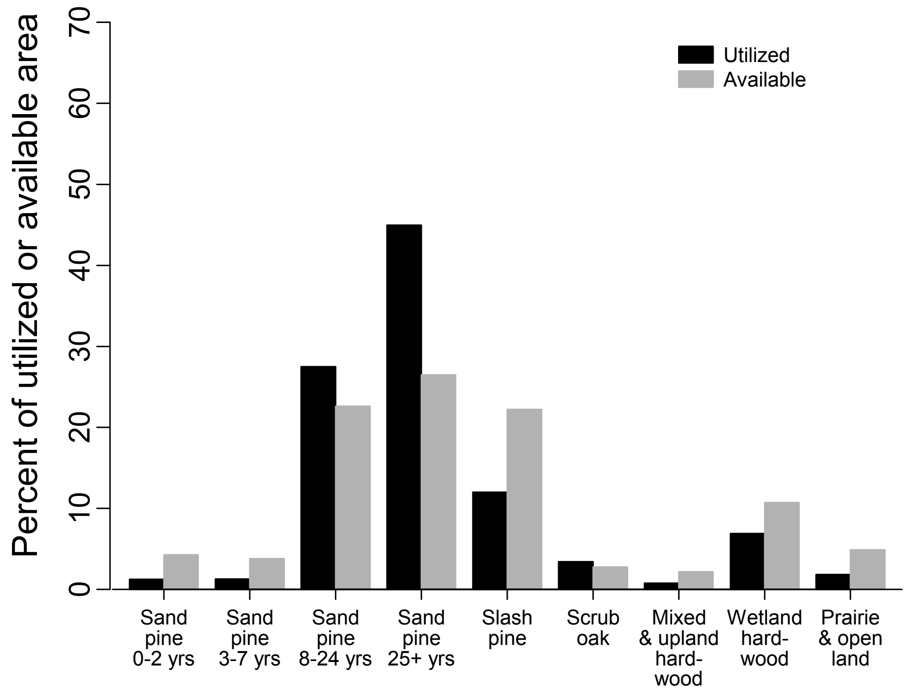
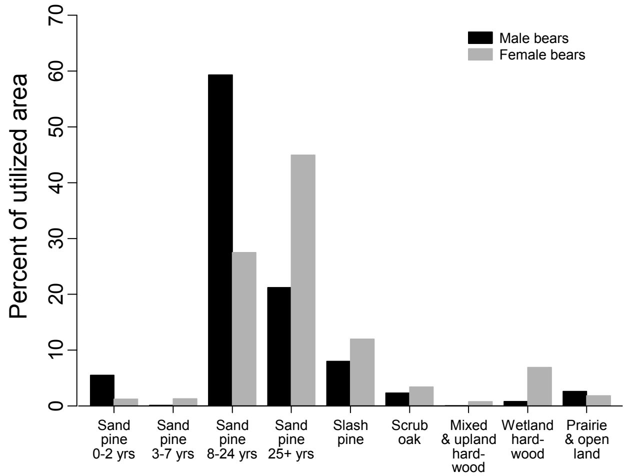
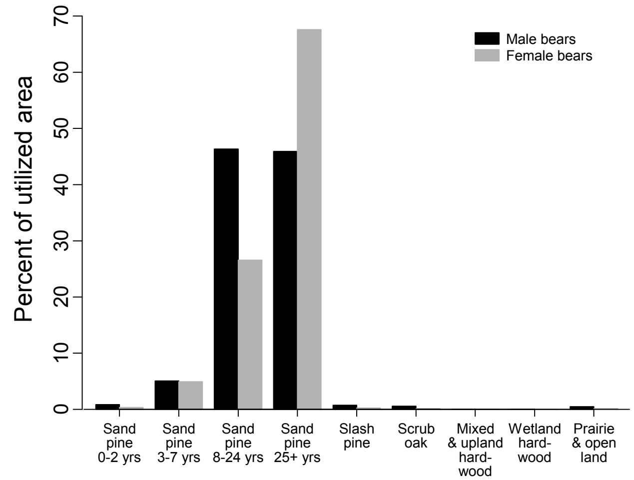


Figure 4. Percent of black bear female winter habitat used versus percent of habitat available in Ocala National Forest 1 Jan – 30 April, 2000 – 2003.

Mature stand of sand pine with scrub oak mid-story and scrub palmetto understory preferred by bears in all seasons.



A.



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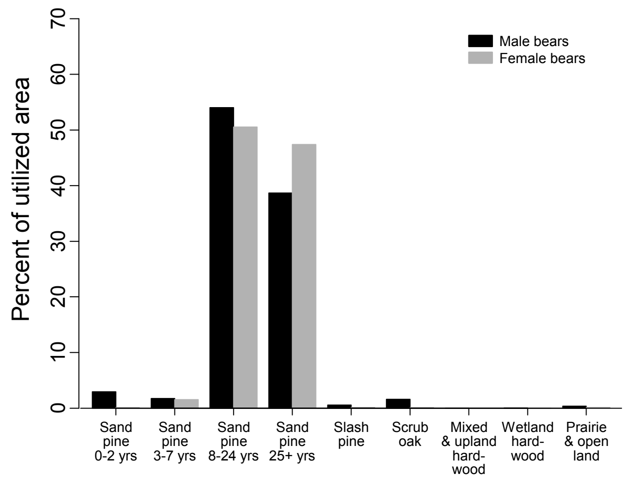

C.

Figure 5. Habitat utilization by male and female black bears during winter (A), summer (B) and fall (C) seasons in Ocala National Forest June 1999-May 2003.

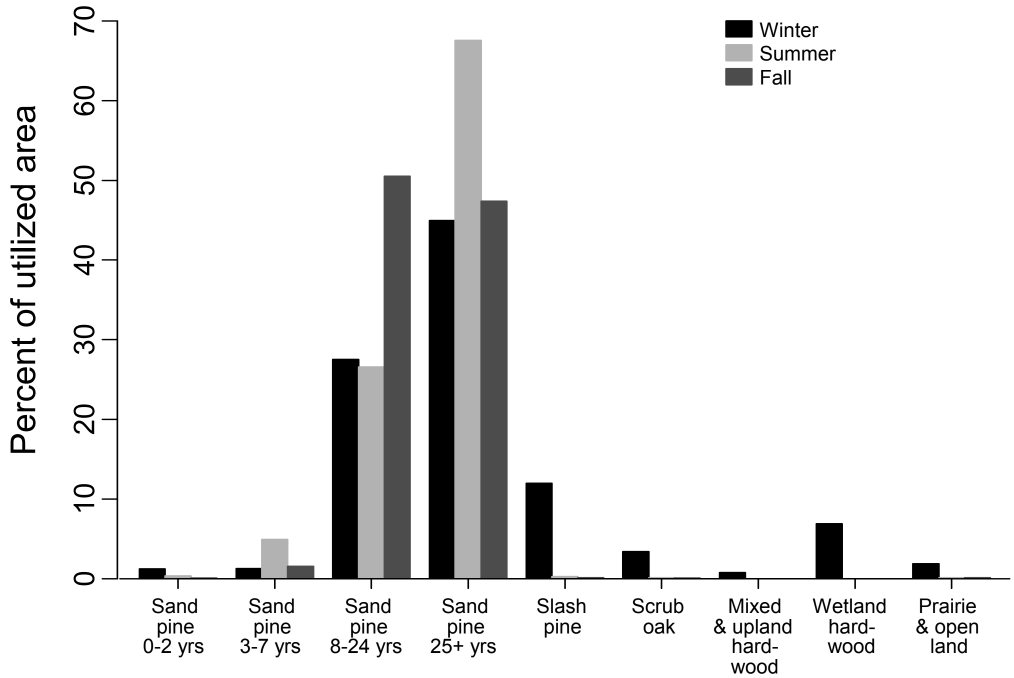

Figure 6. Seasonal habitat utilization by female black bears in Ocala National Forest June 1999-May 2003.

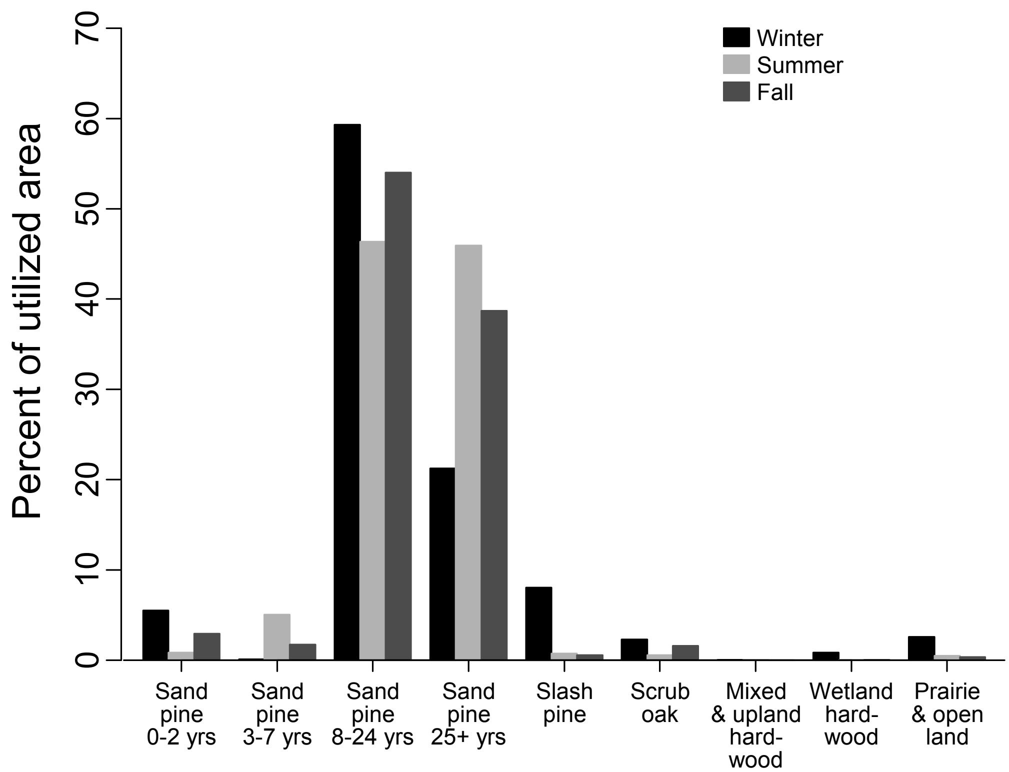

Figure 7. Seasonal habitat utilization by male black bears in Ocala National Forest June 1999-May 2003.

Crossings of SR-40 by Radio-Collared Bears

Analysis of 6,835 locations of 86 bears revealed a minimum of 388 crossings. Bear 17, a male, crossed SR-40 the greatest number of times (n=44) while the female with the most crossings (Bear 19), made 30 trips in the 518 days we monitored her. The bear with the highest crossing rate was bear 41, a female who made 16 crossings of SR-40 in an 82-day period. Bear 41 and her 2 extremely large (≈ 100 lbs at 11 mo) cubs were being fed at a residence located on SR-40 east of SR 19. The family group was captured and removed on 12/15/99 for nuisance behavior at other residences.

Logistic regression analysis indicated statistically significant differences in the probability of observing a crossing of SR-40 between consecutive locations of ONF males, ONF females, and Lynne females. The probability of observing a crossing was found to depend significantly on the distance of the previous location from SR-40 and the number of days between 2 consecutive locations. However, the observed influence of distance and elapsed time did not differ among groups (i.e., the same relative differences among groups were predicted by the model for any specified distance from SR-40 and elapsed time between locations).

Values in Table 6 demonstrate how crossing probabilities change as a function of distance from SR-40 when ONF males and ONF females are observed 7 days after the first location. For comparative purposes the predicted probability of observing a crossing for each group are provided in Table 7 when the previous location was at the selected distance of 2 km. Tables of all predicted probabilities at various distances for each group of bears are in Appendix C.

Because there were no differences in the effects of distance to SR-40 and time interval between locations among the groups, the ratio of the odds of observing a crossing (odds ratio, OR) for the various groups when compared to one another is useful in suggesting behavioral differences. At any given distance and elapsed time between locations, the odds of observing a crossing by an ONF male bear were 4.8 (95% CI: 2.2-10.7, P=0.0002) times greater than the odds of observing a crossing by an ONF female bear. The odds of observing a crossing by an ONF male bear was estimated to be 11.3 times greater than the odds of observing a crossing by a Lynne female bear (OR: 11.3, 95% CI: 3.4 - 37.5, P=0.0001). In comparing ONF females to Lynne females, the estimated odds ratio of 2.4 (95% CI: 0.7 - 8.2, P=0.174) indicated that a crossing by an ONF female bear was more likely to be observed, although this odds ratio did not differ significantly from an odds ratio of 1 (Table 8).

Table 6. Predicted probability that bears at selected distances from SR-40 will cross SR-40 within 7 days in Ocala National Forest and Lynne, Florida June 199-May 2003. ONF male bears (N=40) and ONF female bears (N=33). Comparisons between other bear groups are in Appendix C.

	ONF MALES		ONF FEMALES	
Distance from SR-40 (km)	Prob. crossing SR-40	95% CI	Prob. crossing SR-40	95% CI
0	0.1623	0.0983 - 0.2563	0.0389	0.0194 - 0.0763
1	0.1159	0.0707 - 0.1844	0.0267	0.0136 - 0.0516
2	0.0815	0.0498 - 0.1306	0.0182	0.0094 - 0.0350
3	0.0567	0.0344 - 0.0920	0.0124	0.0064 - 0.0239
4	0.0391	0.0233 - 0.0648	0.0084	0.0043 - 0.0164
5	0.0268	0.0155 - 0.0458	0.0057	0.0029 - 0.0114
6	0.0183	0.0102 - 0.0326	0.0039	0.0019 - 0.0079
7	0.0125	0.0066 - 0.0234	0.0026	0.0012 - 0.0056
8	0.0085	0.0042 - 0.0168	0.0018	0.0008 - 0.0040
9	0.0057	0.0027 - 0.0121	0.0012	0.0005 - 0.0028
10	0.0039	0.0017 - 0.0088	0.0008	0.0003 - 0.0020
11	0.0026	0.0011 - 0.0064	0.0006	0.0002 - 0.0015
12	0.0018	0.0007 - 0.0047	0.0004	0.0001 - 0.0011
13	0.0012	0.0004 - 0.0034	0.0003	0.0001 - 0.0008
14	0.0008	0.0003 - 0.0025	0.0002	0.0001 - 0.0006
15	0.0006	0.0002 - 0.0018	0.0001	0.0000- 0.0004

Table 7. Predicted probability that bears 2 km from SR-40 will cross the highway within 7 days in Ocala National Forest and Lynne, Florida, June 1999-May 2003. Confidence intervals (95%) are provided in tables found in Appendix C.

ONF Males	ONF Females	Lynne Females	Bears HBC[a]	Bears not HBC[a]	ONF HBC[a]	Lynne HBC[a]
0.0815	0.0182	0.0078	0.0736	0.0248	0.1628	0.0160

[a]HBC = hit by car

In a separate analysis comparing crossing probabilities between bears that were hit by motor vehicles (HBC) during the study period to bears that avoided this fate, logistic regression modeling indicated a marginally significant greater likelihood of observing a crossing by a bear that would go on to get hit by a car. The probability of observing a crossing in these subgroups depended significantly on the distance of a location from SR-40 and the number of days between 2 consecutive locations. The influence of distance and elapsed time did not differ among subgroups. The odds of observing a crossing were 3.1 times greater for HBC bears compared to all other bears in the study (OR: 3.1, 95% CI: 0.9 -11.3, P=0.083). When crossing probabilities were compared between ONF (3 M, 1 F) and Lynne (3 F) bears that went on to get hit by cars, the odds of observing a crossing by an ONF bear were 11.9 times greater than the odds of observing a crossing by a Lynne bear (OR: 11.9, 95% CI: 3.6 - 39.6, P=0.0001).

There was a tendency for the predicted probability that a bear will cross SR-40 to increase from winter to summer to fall (Table 9); however, not all of these increases were significant. When the OR for observing a crossing were modeled for bears 2 km distant to the highway, we observed that the odds ratio a crossing would

Table 8. Comparisons among bear groups of the odds ratios of predicted probabilities a crossing of SR-40 will occur within 7-days. Data from radio-collared bears in Ocala National Forest (ONF) and Lynne, Florida, May 1999-May 2003.

Comparison	Odds Ratio	95% CI	P(OR=1)
ONF male vs. ONF female	4.79	2.15 - 10.65	0.0002
ONF male vs. Lynne female	11.29	3.40 - 37.49	0.0001
ONF female vs. Lynne female	2.36	0.68 - 8.18	0.1744
HBC[a] vs. not HBC	3.12	0.86 - 11.31	0.0827
ONF HBC vs. Lynne HBC	11.92	3.59 - 39.56	0.0001

[a] HBC = hit by car/motor vehicle, killed

occur during winter was less than that for summer or fall for ONF females and males. In Lynne there was no difference in the odds ratios of observing a crossing between summer and winter seasons (Table 10).

Table 9. Predicted probabilities by season that a bear 2 km from SR-40 will cross the highway within 7 days in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Sex	Locale	Season	P(x SR-40) 2km ,7 days	95% CI
M	ONF	Winter	0.0490	0.0277 - 0.0855
M	ONF	Summer	0.0943	0.0560 - 0.1546
M	ONF	Fall	0.1000	0.0601 - 0.1619
F	ONF	Winter	0.0064	0.0027 - 0.0150
F	ONF	Summer	0.0164	0.0079 - 0.0341
F	ONF	Fall	0.0282	0.0142 - 0.0550
F	Lynne	Winter	0.0035	0.0007 - 0.0170
F	Lynne	Summer	0.0022	0.0005 - 0.0105
F	Lynne	Fall	0.0173	0.0056 - 0.0522

Table 10. Seasonal comparisons within group of the odds ratios that a bear 2 km from SR-40 will cross the highway within 7 days in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Sex	Locale	Season Comparison	Odds Ratio (OR)	95% CI	P (OR =1)
M	ONF	Summer:Winter	2.02	1.34 - 3.04	0.0010
M	ONF	Fall:Winter	2.15	1.47 - 3.16	0.0001
M	ONF	Fall:Summer	1.07	0.74 - 1.53	0.7207
M	ONF	Season effect	------	------	0.0004
F	ONF	Summer:Winter	2.58	1.31 - 5.10	0.0070
F	ONF	Fall:Winter	4.47	2.39 - 8.37	0.0000
F	ONF	Fall:Summer	1.73	1.07 - 2.82	0.0273
F	ONF	Season effect	-----	-----	< 0.0001
F	Lynne	Summer:Winter	0.62	0.12 - 3.29	0.5698
F	Lynne	Fall:Winter	4.99	1.34 - 18.61	0.0175
F	Lynne	Fall:Summer	8.04	2.19 - 29.46	0.0020
F	Lynne	Season effect	-----	-----	0.0019

The cub of bear 41, an instrumented study animal, crossing SR-40 near Astor Park. This family group was being fed by a local resident and crossed the highway frequently. They were later relocated to Apalachicola National Forest after repeated nuisance behavior.

Road crossing probabilities for each group of bears tended to increase from winter through fall (Figure 8).

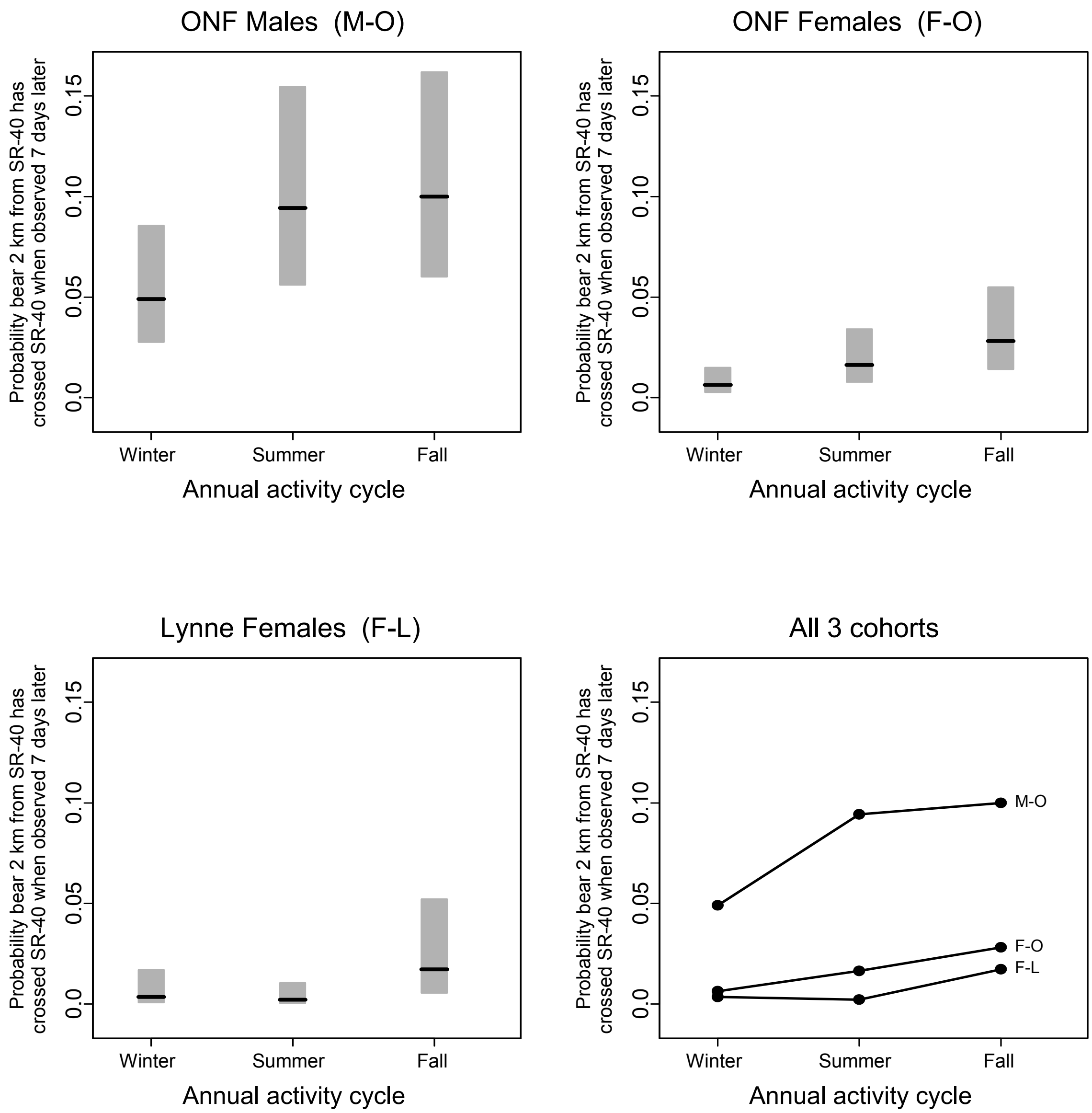

Figure 8. Comparison of the within season probabilities of a bear crossing SR-40 from a distance of 2 km when next observed 7 days later in Ocala National Forest and Lynne Florida June 1999-May 2003.

Survival

We documented 17 mortalities of radio-collared (n=12) and marked but uncollared (n=5) bears. Humans directly or indirectly caused 15 (88.2 %) of these deaths. Ten of the 12 (83.3%) mortalities experienced by collared bears were attributable to humans (Table 11).

Six mortalities of collared bears occurred in ONF. Four (66.7%) of these were caused by vehicular collisions on SR-40 and involved male bears. The other two deaths involved females that were killed and fed upon by collared males. Both instances of predation involved denning females and neonatal cubs. There were mortalities to 5 marked but uncollared bears caught in ONF. Of these, 2 males and one female were struck and killed by vehicles, and 2 males were illegally shot.

All the documented mortalities in Lynne (6) were anthropogenic. Two bears were killed by vehicular collision on SR-40 and one was killed on CR 314. The female killed on CR 314 was accompanied by two dependant cubs that later died from malnutrition (Garrison 2004). One bear was illegally shot by bow and arrow, one was poisoned at an apiary and we assume another was illegally killed after her severed collar was found in an area used by local residents for illegal dumping.

We monitored bears for 3 complete calendar years (2000-2002) and portions of 2 other years (1999 and 2003). Eight of 14 (57.1%) mortalities in the 3-year period occurred in 2000 while only 3 of 14 (21.4.6%) mortalities occurred in 2001 and 2002. These circumstances occurred despite the smaller pool of marked bears (total bears marked minus previous mortalities) in 2000 (94) than in 2001 (110) or 2002 (126). All the documented mortalities that occurred in 2000 were the result of being struck by a vehicle (n= 6) or being illegally killed by humans (n= 2) (Table 11).

Table 11. Sources of mortality for black bears in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Bear	Sex	Age	Capture	Death	Cause	Location
Collared Bears						
Ocala National Forest						
14	M	2	6/22/99	9/07/99	HBC[a]	SR-40, ONF
25	M	4	7/19/99	5/08/00	HBC	SR-40, ONF
26	M	3	7/20/99	5/26/00	HBC	SR-40, ONF
32	F	4	8/20/99	4/09/01	Predation	ONF
17	M	4	6/30/99	6/06/02	HBC	SR-40, ONF
75	F	3	6/08/00	3/21/03	Predation	ONF
Lynne Florida						
97D	F	9	8/26/00	10/13/00	HBC	SR-40, Lynne
90D	F	6	8/08/00	11/04/00	Illegal/shot	Lynne
74D	F	5	5/12/00	10/17/01	HBC	SR-40, Lynne
82D	F	5	7/03/00	6/05/02	HBC	CR 314, Lynne
148D	F	14	8/21/01	11/11/02	Illegal/poison	Lynne
196D	F	2	8/06/02	2/05/03	Illegal/unk.[b]	Lynne
Marked - Uncollared Bears						
33	F	8	8/04/99	5/28/00	HBC	SR-40, ONF
27	M	3	7/22/99	6/27/00	HBC	SR 19, ONF
2	M	2	5/28/99	8/01/00	HBC	SR 16, Clay Co.
53	M	3	2/24/00	10/08/00	Illegal/shot	Umatilla
104	M	2	10/11/00	12/23/01	Illegal/shot	ONF

[a] HBC = Hit By Car
[b] Method unknown, severed collar found

Bear 14, a young male, killed on SR-40 approximately 0.5 km east of the entrance to the Juniper Springs Recreational Area.

Mortality, time of death, and survival probabilities were determined for 12 collared bears during the study. Survivorship curves that illustrate differences among the groups in the probability of survival over time were generated (Figure 9) from Kaplan-Meier (KM) product limit estimates in Table 12.

Table 12. Kaplan-Meier survival probabilities for each group estimated at the time of each mortality.

Months from 1st collaring	Number at risk[a]	Number of deaths	K-M Prob. of survival	95% CI	Std. Error
		Lynne females			
4.4	11	1	0.909	0.754 - 1.000	0.0867
5.2	11	1	0.826	0.635 - 1.000	0.1114
8.2	10	1	0.744	0.532 - 1.000	0.1273
17.4	8	1	0.651	0.425 - 0.996	0.1413
24.2	4	1	0.488	0.240 - 0.991	0.1763
28.6	3	1	0.325	0.112 - 0.947	0.1774
		ONF females			
22.3	14	1	0.929	0.803 - 1.000	0.0688
33.7	8	1	0.812	0.602 - 1.000	0.1242
		ONF males			
3.2	28	1	0.964	0.898 - 1.000	0.0351
11.2	28	1	0.930	0.841 - 1.000	0.0478
11.8	25	1	0.893	0.785 - 1.000	0.0586
36.2	2	1	0.446	0.111 - 1.000	0.3170

[a] Number at risk at time of each mortality; excludes bears that were caught after mortality or that were no longer being monitored due to dropped /defunct collar or other censure.

The log-rank test indicated a statistically significant difference in the shapes of the survival curves among the 3 groups (P= 0.003). To better characterize the manner in which the groups differed from each other, Cox proportional hazards regression (Kalbfleisch and Prentice 1980) was used to estimate the relative risk of dying for individuals in each group. A test to determine if the survival data met the proportional hazards assumption (Grambsch and Therneau 1993) indicated that it was reasonable to assume that the hazard rate (instantaneous or time-specific failure rate) differed among the 3 groups in a proportionate manner at any given time over the course of the study. The ratio of the time-specific failure rates between any 2 of the 3 groups, also known as the hazard ratio was estimated from the fitted Cox regression model. These results indicated that Lynne females were 10.9 times more likely to die at any time compared to ONF females (HR: 10.9, 95% CI: 2.0 to 58.9, P=0.006). There were no other significant differences recorded (Table 13).

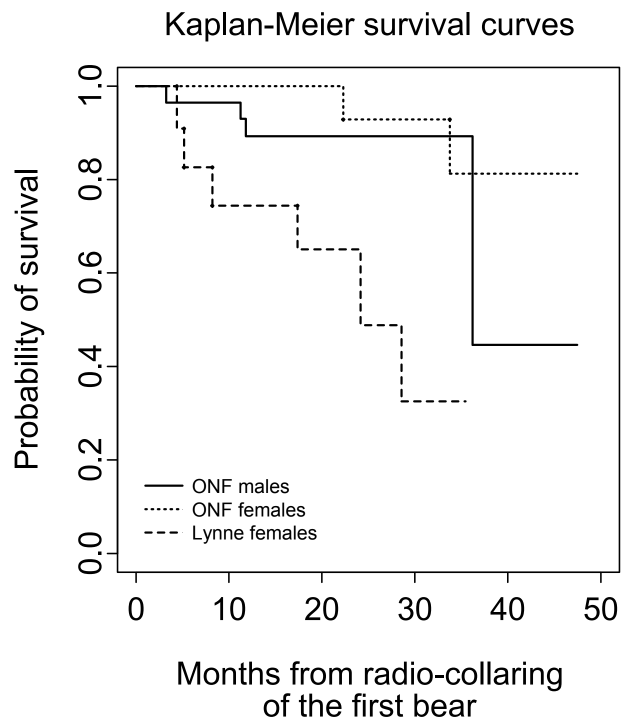

Figure 9. Kaplan-Meier survivorship curves for radio-collared bears in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Table 13. Hazard ratio comparisons between demographic groups of radio-collared bears in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Comparison	Hazard Ratio	95% CI	P (HR =1)
Lynne females vs. ONF females	10.87	2.01 - 58.86	0.0056
Lynne females vs. ONF males	3.41	0.90 - 12.96	0.0718
ONF males vs. ONF females	3.19	0.56 - 18.16	0.1912

Since the age of bears at the time of capture varied widely both within and between groups (Table 14), age was viewed as a potential confounding variable in assessing differences in survival rates among the 3 groups. Therefore, Cox models that included age modeled as an interactive predictor, which could have differential influence on each of the groups, were utilized. No significant interaction was found between age and group (P=0.294), and group hazard ratio estimates remained almost unchanged (P=0.989 for age as a predictor of survival).

Table 14. Age characteristics of radio-collared bears in Ocala National Forest and Lynne Florida, June 1999-May 2003.

Group	№ bears	Mean age 1st radio-collaring	Median age 1st radio-collaring	Range
Lynne females	13	6.3	5	2 –14
ONF females	36	5.0	4	1 –13
ONF males	43	4.6	3	1 -15

Estimates of annual survival tended to be lower for Lynne bears than for either of the other groups (Table 15). Sample sizes used to estimate annual survival were small for females that wore collars through their third years in Lynne and ONF. Likewise the sample size of males that wore collars beyond 2 years was small. Therefore, the effect of each mortality event in these years is exaggerated and survival estimates tended to be low where confidence intervals were broad.

Assuming a constant hazard ratio for each of the 3 groups, the annual survival rate ranged from 92.9% -62.4% during the course of this study (Table 16). The annual survival rates estimated for ONF males and females were generally high and within estimates of most other un-hunted populations. However, the estimate of annual survival for Lynne females (62.4%) was the lowest female rate we found reported for studies involving radio-collared bears from unhunted populations (Table 17).

Table 15. Estimates of annual survival rates for each year bears were radio-collared in Ocala National Forest and Lynne Florida June 1999-May 2003. Estimates were derived from Kaplan-Meier product limit estimates.

Group	YR	№ at Risk	№ Deaths	Bear Yrs per Yr	Prob. Survival.	95% CI
Lynne ♀	1	13	3	8.09	0.7440	0.5320 – 1.0000
Lynne ♀	2	8	1	7.08	0.8750	0.6849 – 1.0000
Lynne ♀	3	4	2	2.30	0.4992*	0.2206 – 1.0000
ONF ♀	1	36	0	24.18	1.0000	0.8390 – 1.0000
ONF ♀	2	22	1	16.91	0.9290	0.8076 – 1.0000
ONF ♀	3	13	1	8.41	0.8741	0.6841 – 1.0000
ONF ♀	4	7	0	4.71	1.0000*	0.7827 – 1.0000
ONF ♂	1	43	3	28.02	0.8930	0.7850 – 1.0000
ONF ♂	2	25	0	14.25	1.0000	0.8814 – 1.0000
ONF ♂	3	6	0	2.16	1.0000*	0.8814 – 1.0000
ONF ♂	4	5	1	1.85	0.4994*	0.1874 – 1.0000

* Note: these estimates are imprecise due to numbers of bears remaining in the group.

Table 16. Estimates of the annual survival rate for bears in Ocala National Forest and Lynne, Florida June 1999-May 2003. Estimates were calculated at the time of the last mortality in each group.

Group	Annual Survival Rate	95% CI
Lynne females	0.624	0.398 – 0.977
ONF females	0.929	0.835 – 1.000
ONF males	0.765	0.483 – 1.000

The annual survival rate we calculate for bears in ONF and Lynne was based upon a radio-telemetry study involving a total of 92 individuals over 4 years. We calculated survival rates using the irregular time intervals between mortalities and not the regular interval (days, weeks, months) approach of Pollock et al. (1989).

Table 17. Estimates of annual survival rates of black bears based on radio instrumented animals.

Population	Sex	n	Ann. Survival Rate	Population Note	Study
Ocala N.F.	F	36	0.929	Not hunted	This Study
	M	43	0.765	Not hunted	
Lynne FL	F	13	0.624	Not hunted	
Osceola and Ocala N.F	F	7	0.890	Not hunted	Wooding and Hardisky 1994
	M	8	1.000	Not hunted	
Osceola N.F.	F	75	0.970	Not hunted	Dobey et al. 2002
Okefenokee NWR	F	129	0.870	Hunted	
Great Dismal Swamp, Virginia	F	24	0.870	Hunted	Hellgren and Vaughn 1989
	M	22	0.510	Hunted	
Oregon	F	98	0.880	Hunted	Akenson et al. 2000
	M	67	0.810	Hunted	
Arkansas	F	31	0.980	Hunted	Clark 1991
NW Montana	F	27	0.790	Hunted	Kasworm and Their 1994
	M	21	0.730	Hunted	

Radio collar of male bear number 8 with damage resulting from an aggressive encounter with another bear.

Track Transect

We observed tracks on a total of 350 days in 2000, 2001 and 2002. Mixed effects Poisson regression models indicated that the distribution of bear tracks was not affected by highway elevation (P > F = 0.4895) and that there was no linear trend relationship (P > F = 0.1959) (Table 18).

Table 18. Mean rates of bear tracks per 250 meters of transect per month at elevations (meters above mean sea level) along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were not different (P ≥ 0.05).

Elevation	Mean Rate	95% CI
8-20 m	0.67	0.53 – 0.85
21-30 m	0.57	0.39 – 0.83
31-40 m	0.78	0.57 – 1.07
41-50	0.77	0.58 – 1.03

Bear tracks along the transect were not affected by intersecting roads (P > F = 0.4895) (Table 19) and there was no linear relationship trend between tracks and type of intersecting road (P > F = 0.1959).

Table 19. Mean rates of bear tracks per 250 meters of transect per month at road buffers along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were not different (P ≥ 0.05).

Road Category	Mean Rate	95% CI
No Road	0.72	0.59 – 0.87
Trail	0.98	0.56 – 1.73
Forest Road	0.64	0.48 – 0.85
High Use Road	0.63	0.44 – 0.90

Regression models indicated that the curvature of the highway had no effect upon the distribution of tracks in either a western (P>F = 0.6159) or eastern (P>F = 0.4447) direction (Tables 20, 21) and that there was no linear relationship between degree of curvature and tracks in a western (P>F = 0.1385) or eastern (P>F = 0.2409) direction.

Table 20. Mean rates of bear tracks per 250 meters of transect per month within categories of road curvature in a western direction along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were not different ($P \geq 0.05$).

Degree Curve	Mean Rate	95% CI
0.0-0.2°	0.69	0.58 – 0.83
0.2-1.0	0.62	0.41 – 0.93
1.0-3.0	0.84	0.50 – 1.40
3.0-6.0	0.87	0.52 – 1.46

Table 21. Mean rates of bear tracks per 250 meters of transect per month within categories of road curvature in an eastern direction along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were not different ($P \geq 0.05$).

Degree Curve	Mean Rate	95% CI
0.0-0.2°	0.70	0.58 – 0.83
0.2-1.0	0.62	0.43 – 0.91
1.0-3.0	0.71	0.44 – 1.12
3.0-6.0	1.05	0.60 – 1.84

Mixed effects Poisson regression models indicated tracks entered the forest without effect of forest habitat type ($P > F = 0.2232$) (Table 22).

Table 22. Mean rates of bear tracks per 250 meters of habitat highway frontage per month found entering specific habitat types along 18 km dirt transect in Ocala National Forest January 2000-December 2002. Mean rates were not different ($P \geq 0.05$).

Habitat Entering	Mean Rate	95% CI
Maple	0.27	0.14 – 0.52
Sand Pine	0.46	0.40 – 0.54
Slash Pine	0.49	0.36 – 0.66
Willow	0.62	0.34 – 1.13

The same models indicated there was also not an effect of habitat type on where bears left the forest to cross SR-40 ($P = 0.0542$) (Table 23) although the effect was significant at the $\alpha = 0.10$ level. The rate of bears leaving maple habitat was higher than other habitat types (Table 23). The mean rate of bear tracks leaving maple and entering slash pine was the highest calculated (Table 24) and when discounting direction, maple was also associated with the highest mean rate (Table 25).

Table 23. Mean rates of bear tracks per 250 meters of habitat highway frontage per month found leaving specific habitat types along 18 km dirt transect in Ocala National Forest January 2000-December 2002. Mean rates were not different ($P \geq 0.05$).

Habitat	Mean Rate	95% CI
Maple	0.99	0.59 - 1.64
Sand Pine	0.45	0.39 – 0.53
Slash Pine	0.49	0.37 – 0.65
Willow	0.38	0.21 – 0.67

Table 24. Mean rates of bear tracks entering and leaving combinations of habitat types per 250 meters of highway frontage along SR-40 in Ocala National Forest January 2000 – December 2002.

Habitat Entering	Habitat Leaving	Mean Rate	95% CI
Maple	Sand Pine	0.28	0.04 - 2.00
Maple	Slash Pine	0.48	0.21 - 1.07
Sand Pine	Maple	0.29	0.04 - 2.11
Sand Pine	Sand Pine	0.45	0.39 - 0.54
Sand Pine	Willow	0.48	0.22 - 1.05
Slash Pine	Maple	1.07	0.52 - 2.21
Slash Pine	Sand Pine	0.38	0.25 - 0.59
Slash Pine	Slash Pine	0.64	0.28 - 1.44
Willow	Sand	0.65	0.31 - 1.37

Table 25. Mean rates of bear tracks located between combinations of habitat types per 250 meters of highway frontage along SR-40 in Ocala National Forest January 2000 – December 2002.

Forest Combination	Mean Rate	95% CI
Maple-Sand Pine	0.43	0.08 - 2.38
Maple-Slash Pine	1.23	0.62 - 2.44
Sand Pine-Sand Pine	0.69	0.58 - 0.83
Sand Pine-Slash Pine	0.64	0.43 - 0.96
Slash Pine-Slash Pine	0.93	0.39 - 2.20
Willow-Sand	0.84	0.41 - 1.70

The focal points along SR-40 where crossings were frequent suggest there are highway segments where bears habitually cross the roadway (Figure 10). However, much of the use of some of the more intensely traversed segments occurred within a few weeks of 1 season of 1 year as bears found food sources that otherwise were scarce (Figure 11).

The same mixed effects logistic regression models used for bear track analysis indicated that the locations of bear mortalities were influenced by highway factors. The elevation of a road segment was found to have an effect on location of bear mortalities (P > F = 0.0072) (Table 26). Bear mortalities were more likely to occur on road segments of lower elevations.

Table 26. Mean rates of bear mortalities per 250 meters of transect per 20 years at elevations (meters above mean sea level) along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates followed by an asterisk were different ($P \geq 0.05$).

Elevation	Mean Rate	95% CI
8-20 m	0.84*	0.54 – 1.30
21–35 m	0.26	0.10 – 0.70
36-50 m	0.13	0.04 – 0.46

There was no apparent effect by presence of road intersection when all categories of road were considered (Table 27). However, when comparisons between a single road category against pooled data from all other road types were made the presence and category of road was significant. The presence of a road versus no road (P>F = 0.0377)(Table 28) and the presence of a forest road versus all other categories were significant (P>F = 0.0407) (Table 29).

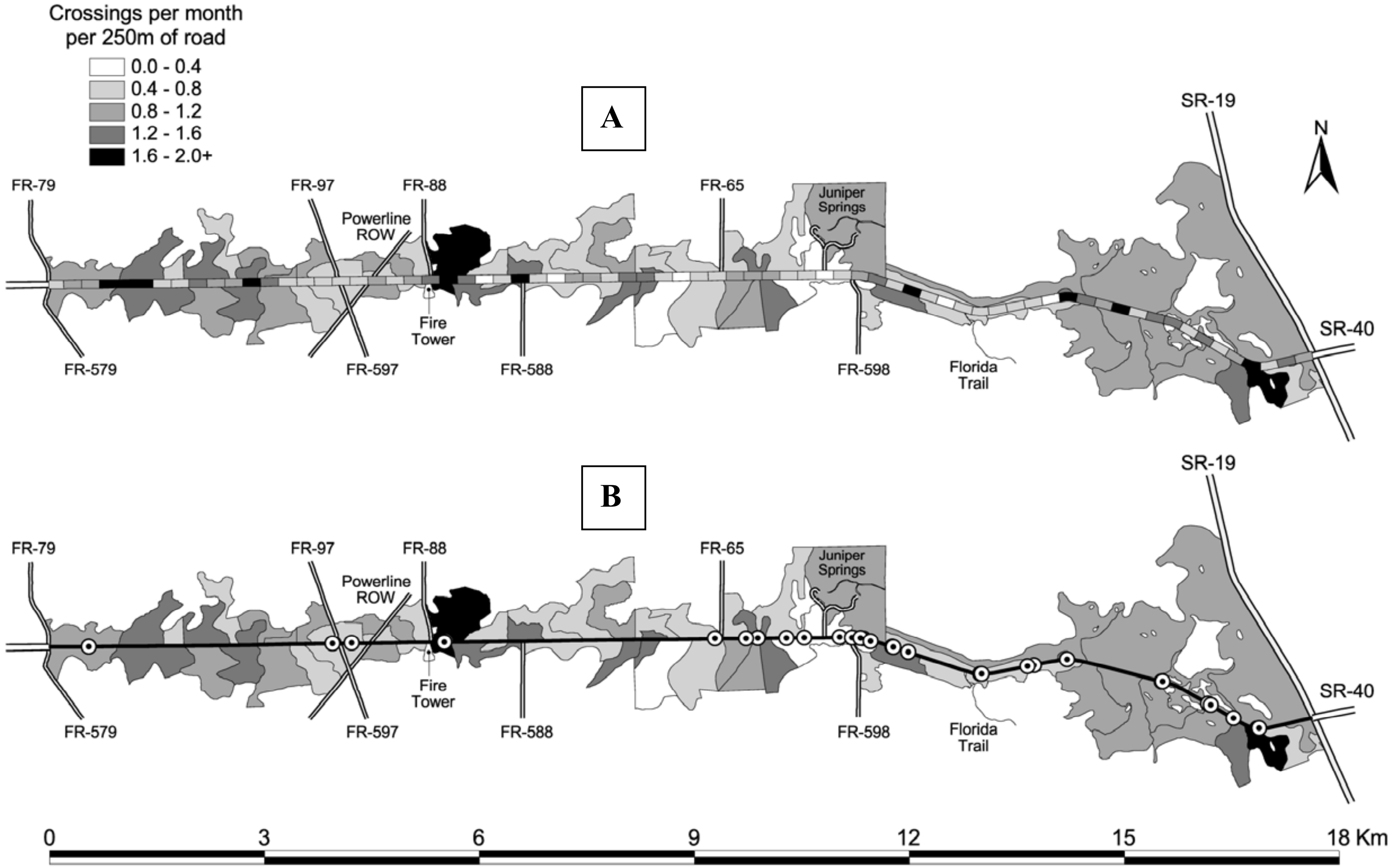

Figure 10. Black bear crossings per month across 250 meter sections of SR-40 through Ocala National Forest January 2000-December 2002 (A) and with locations of black bear mortalities 1982-2002 (B) indicated (dots with circles).

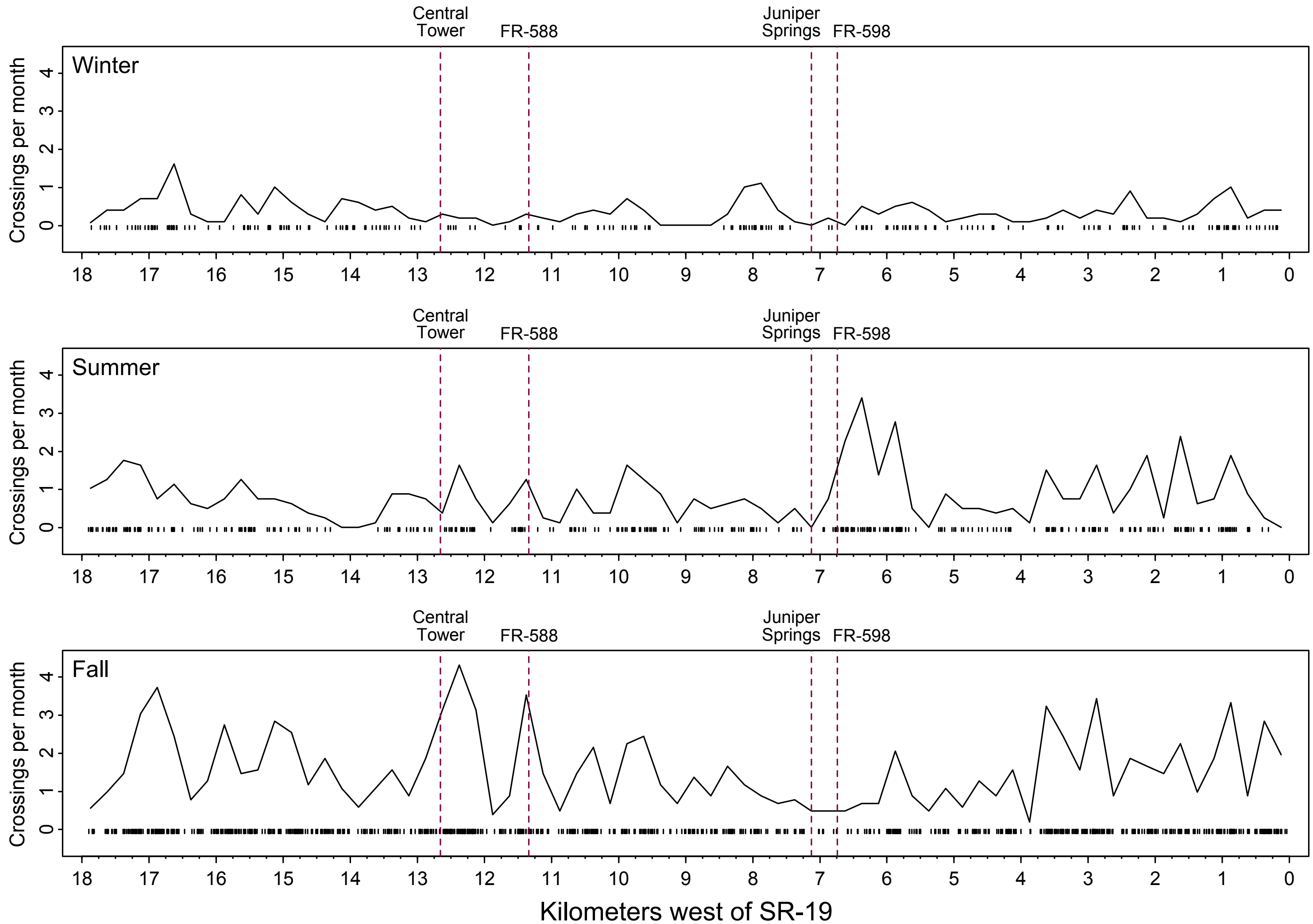

Figure 11. Seasonal pattern of black bear crossings of SR-40 in Ocala National Forest January 2000-December 2002. Crossings, represented by tick marks in the bottom of each plot, were inferred from tracks crossing a 3 meter wide dirt transect adjacent to SR-40.

Table 27. Mean rates of bear mortalities per 250 meters of transect per 20 years at intersecting roads along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were not different ($P \geq 0.05$).

Road Category	Mean Rate	95% CI
No Road	0.29	0.14 – 0.62
Trail	0.69	0.13 – 3.60
Forest Road	0.84	0.43 – 1.65
High Use Road	0.52	0.17 – 1.59

Table 28. Mean rates of bear mortalities per 250 meters of transect per 20 years at intersecting road buffers versus no road along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were different ($P \leq 0.05$).

Road Category	Mean Rate	95% CI
Any Road	0.72	0.41 – 1.25
No Road	0.29	0.14 – 0.60

Table 29. Mean rates of bear mortalities per 250 meters of transect per 20 years at intersecting forest roads versus other roads along an 18 km transect in Ocala National Forest January 2000-December 2002. Mean rates were different ($P \geq 0.05$).

Road Category	Mean Rate	95% CI
Forest Road	0.84	0.43 – 1.63
Not Forest Road	0.35	0.19 – 0.65

The effect of road curvature in each direction was found to be significant (East P>F = 0.0026; West P>F = 0.0169) (Table 30) and the relationship was also found to be linear (i.e., the greater the degree of road curvature the higher the rate of bear mortality).

Table 30. Mean rates (bear mortalities per 250 m of transect) of bear mortalities from 1982-2002 within categories of road curvature along an 18 km transect in Ocala National Forest. Mean rates followed by similar letter were not significantly different ($P \geq 0.05$).

	East to West		West to East	
Degree Curve	Mean Rate	95% C I	Mean Rate	95% C I
0.0° - 0.2°	0.34 a	0.19 – 0.60	0.35 a	0.19 – 0.67
0.2° - 1.0°	0.42 a b	0.11 – 1.63	0.30 a	0.07 – 1.34
1.0° - 3.0°	0.91 a b	0.27 – 3.13	0.66 a b	0.18 – 2.37
3.0°- 6.0°	1.79 b	0.74 – 4.31	2.57 b	1.11 – 5.92

The patterns of bear mortalities as a function of highway segment attributes are presented in Figure 12. The contrast between where bears cross SR-40 within ONF and where they tend to get struck by vehicles is useful. Bears tend to cross SR-40 in response to food availability and without regard to any attribute of habitat or highway. Low traffic levels during this study and the undisturbed nature of bear habitat along SR-40 within ONF contributed to these observations. However, the effects of highway design and landscape features upon bears that crossed this highway were suggested by the relationship between the locations of mortality and highway characteristics. Bears tended to get struck on curves, at intersections with forest roads and at lower elevations. The effect of elevation and road curvature are merely 2 measures of the same highway design feature. Curves in SR-40 exist to avoid ONF wetlands. Wetlands along SR-40 in the study area occur at lower elevations. Similarly, there are several forest roads that intersect SR-40 at curves and tended to be the sites of bear mortality.


A bear track along the track transect near FR-588

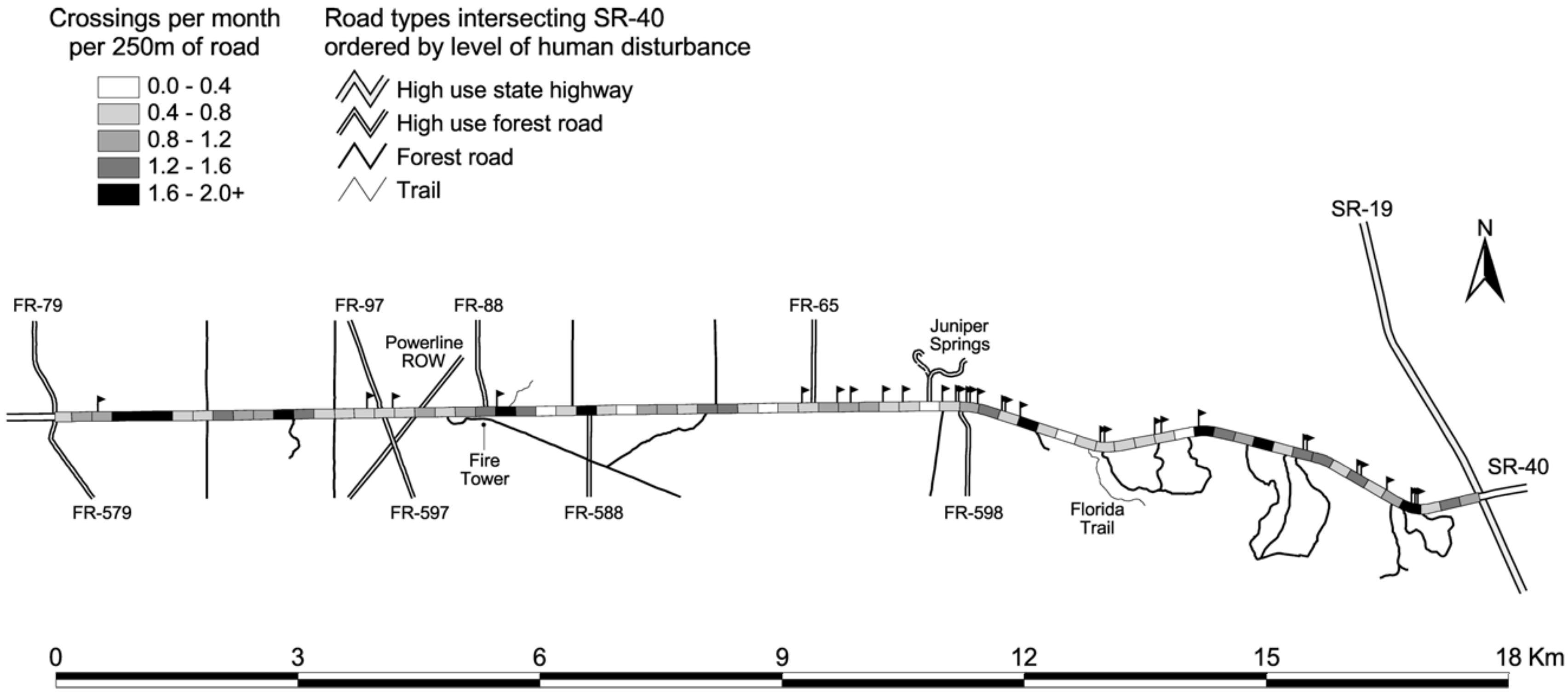

Figure 12. Black bear crossings per month across 250-meter sections of SR-40 through Ocala National Forest, January 2000-December 2002 and locations of bear mortalities from 1982-2002 (flags).

Population Estimates

Wildlife Genetics International was able to produce 2,265 viable genotypes from the 2,544 samples submitted for analysis. Genetic analysis identified 81 bears (51 M, 30F) in 1999. Of these, 38 were identified in 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-Peterson abundance estimate of 131 bears with a 95% confidence interval (CI:) of 95-168 bears within the effective study area (Table 31). In 1999, the effective study area size was 511.6 km^2 corresponding to a density estimate of 0.26 bears per km^2 (0.66 bear/mi^2) (Table 32).

In 2000, 79 bears were identified from the capture period, 70 bears were identified from the recapture period, and 36 bears were sampled in both periods. This yielded a modified Lincoln-Peterson abundance estimate of 153 bears with a 95% CI: of 128-177 bears within the effective study area of 555.1 km^2 (Table 31). This abundance calculation yielded a density estimate of 0.28 bears per km^2 (0.71 bear/mi^2)(Table 32)

Table 31. Numbers of bears identified in sampling periods and resulting Lincoln-Peterson population estimates, Ocala National Forest 1999-2000.

Year	Individuals in 1st Session	Individuals in 2nd Session	Individuals in both sessions	Total Individuals Identified	Study Area population estimate and 95% confidence intervals
1999	38	60	17	81	131 (95 – 168)
2000	79	70	36	113	153 (128 – 177)

Program CAPTURE, used to analyze results from 2001-2003, selected varying models (M(bh) in 2001, M(h) in 2002, and M(o) and M(tb) in 2003). These models, indicated sources of variation, if any, were due to behavioral effects related to encountering the snare the first time (b) heterogeneity (h) in capture probabilities of individuals in the population, or time of capture (t). Therefore, we calculated estimates for the sexes separately to remove a large, known and consistent source of heterogeneity among individuals. Although analysis with separate sexes did not remove all of the heterogeneity (model M(h) was still selected at times), we feel that separation was warranted due to known variation in capture probabilities between males and females. In 2001, capture probability under M(h) was 0.4500 and 0.3161 for females and males, respectively. In 2002, capture probability for females, under model M(bh) was 0.242, 0.417, 0.417, and 0.417; for males capture probability with model (Mh) was 0.2553. In 2003, capture probability for females with model M(o) was 0.4079 and for males with model M(tb) it was 0.324, 0.529, 0.314, and 0.312.

In 2001 there were 41 individual females sampled 100 times. These results produced an estimate of 50 females (95% CI: 45-64) within the study area population during the 4 capture and recapture periods. We sampled 56 males 110 times. Program CAPTURE provided an estimate of 87 males (95% CI: 74-113) within the population from these data. With an effective study area size of 415.1 km^2 for females the calculated density was 0.12 bears per km^2 (0.31 bears/mi^2) (Table 32). The effective study area for males was 705.5 km^2, which provides a density estimate of 0.12 bears per km^2 (0.32 bears/mi^2) (Table 32).

Thirty-nine females were sampled 73 times in 2002. These results produced an estimate of 60 females (95% CI: 44-140) within the study area population during 2002. There were 57 males sampled 97 times in 2002. Program CAPTURE calculated an estimate of 95 males (95% CI: 80-122) within the study area population with these results. With an effective study area of 407.1 km^2 for females the resulting density estimate was 0.15 bears per km^2 (0.38 bear/mi^2). The effective study area for males in 2002 was 674.8 km^2, yielding a density estimate of 0.14 bears per km^2 (0.36 bears/mi^2) (Table 32).

We identified 37 females sampled 68 times in 2003, producing an estimate of 42 females (95% CI: 39-52) within the study area population. There were 45 males sampled 56 times in 2003. Program Capture calculated an estimate of 52 males (95% CI: 46-160) within the study area population. With an effective study area of 385.2 km^2 for females , the resulting density estimate was 0.11 bears per km^2. (0.28 bear/mi^2). The effective study area for males was 650.6 km^2 resulting in a density of 0.08 bears per km^2 (0.21 bear/mi^2) (Table 32).

With program Jolly, the goodness of fit test identified Model A ($P>0.0002$ and $P>0.0399$) as the best model for the capture-recapture data we generated for the female and male datasets, respectively. Model A allows for death and immigration during the time period being considered. The survival rate (alive, remaining in study area) for females was calculated as 0.7879 (95% CI: 0.6907-0.8850) and 0.7896 (95% CI: 0.7169-0.8624) for males.

There were 229 individual bears identified at least once during 1999-2003. Sampled females comprised 41.5% of the total with an estimated abundance of 55 (95% CI: 46-63) individuals. Males made up 58.5% of the dataset and were estimated to number 83 (95% CI: 72-94). With an average effective study area during the 5 years of 396.7 km^2 for females, the estimated density was 0.14-bears/ km^2 (0.36 bear/mi^2) during the study (Table 32). The average effective study area for males during the 5-year study was 677.6 km^2 resulting in an estimated density of 0.12 bears per km^2 (0.32 bear/mi^2). By summing the male and female results, we estimate the total population at 138 bears within the study area (Table 32).

Table 32. Study area estimates of abundance of black bears in Ocala National Forest 1999-2003.

Model	Year	Study Area Population Estimate	95 % C I	Density (bears/km^2)
Lincoln-Peterson	1999	131	95- 168	0.26
Lincoln-Peterson	2000	153	128 - 177	0.28
CAPTURE	2001 female	50	45 - 64	0.12
CAPTURE	2001 male	87	74 - 113	0.12
CAPTURE	2001 Total	137		
CAPTURE	2002 female	60	44 - 140	0.15
CAPTURE	2002 male	95	80 – 122	0.14
CAPTURE	2002 Total	155		
CAPTURE	2003 female	42	39-52	0.11
CAPTURE	2003 male	52	46-160	0.08
CAPTURE	2003 Total	94		
JOLLY	1999-2003 female	55	46-63	0.14
JOLLY	1999-2003 male	83	72-94	0.12
JOLLY	1999-2003 Total	138		

Fall Food Abundance

Production of soft and hard mast by the 7 species surveyed (1 gallberry, 2 palmettos and 4 oaks) was highly variable both within and between years. *Serenoa repens* (saw palmetto) was the only fall mast-producing species to occur in both sand pine/scrub oak and pine flatwoods. This species, although more wide spread than the others, was not very productive; during the 4 years of this study, mast was moderate to abundant along an average of only 7.1% and 9.9% of the transects in the sand pine/scrub oak and pine flatwoods habitats, respectively (Tables 33 and 34).

The most productive year for saw palmetto was 1999, when the fruit was estimated to be moderate to abundant along 23.4% and 35.3% of the transects in the sand pine/scrub oak and pine flatwoods habitats, respectively (Tables 33 and 34). *Sabal etonia* (Scrub palmetto) was the most consistently productive species we surveyed (Table 33). Although Sabal was the most reliable food source surveyed, *Q. chapmanii* matched it for average productivity with an average of 37% moderate or abundant mast (Table 33). *Ilex glabra*, *Sereona repens* and all oak species fluctuated from totally absent to highly available.

Limb of a myrtle oak (*Quercus myrtifolia*), a common scrub oak species, bent by bears to gain access to acorns.

A pair of walking sticks (*Anisomorpha buprestoides),* a frequent summer food item, on a palmetto frond.

Table 33. Percent availability of fall mast for 6 sand pine/ scrub oak species from 60-100 m transects in Ocala National Forest 1999-2002.

Fall Food Item	Estimated Availability			
		1999		
	Absent	Sparse	Moderate	Abundant
Q. chapmanii	95.0%	1.7%	0.0%	3.3%
Q. geminata	46.7%	28.3%	15.0%	10.0%
Q. laevis	5.0%	23.3%	58.3%	13.3%
Q. myrtifolia	80.0%	13.3%	5.0%	1.7%
Sabal etonia	43.3%	33.3%	20.0%	3.3%
Serenoa repens	53.3%	23.3%	21.7%	1.7%
		2000		
	Absent	Sparse	Moderate	Abundant
Q. chapmanii	51.7%	6.7%	26.7%	15.0%
Q. geminata	83.3%	13.3%	1.7%	1.7%
Q. laevis	98.3%	0.0%	1.7%	0.0%
Q. myrtifolia	88.3%	11.7%	0.0%	0.0%
Sabal etonia	68.3%	16.7%	10.0%	5.0%
Serenoa repens	100.0%	0.0%	0.0%	0.0%
		2001		
	Absent	Sparse	Moderate	Abundant
Q. chapmanii	20.0%	13.3%	43.3%	23.3%
Q. geminata	6.7%	25.0%	50.0%	18.3%
Q. laevis	91.7%	1.7%	1.7%	5.0%
Q. myrtifolia	1.7%	31.7%	43.3%	23.3%
Sabal etonia	1.7%	13.3%	53.3%	31.7%
Serenoa repens	91.7%	5.0%	1.7%	1.7%
		2002		
	Absent	Sparse	Moderate	Abundant
Q. chapmanii	35.0%	28.3%	20.0%	16.7%
Q. geminata	55.0%	41.7%	1.7%	1.7%
Q. laevis	60.0%	26.7%	10.0%	3.3%
Q. myrtifolia	28.3%	30.0%	15.0%	26.7%
Sabal etonia	43.3%	31.7%	16.7%	8.3%
Serenoa repens	95.0%	3.3%	0.0%	1.7%

Table 34. Percent availability of fall mast for two pine flatwoods species from 68 100-m survey transects in Ocala National Forest 1999 to 2002.

Species	Estimated Availability			
	1999			
	Absent	Sparse	Moderate	Abundant
Ilex glabra	88.2%	11.8%	0.0%	0.0%
Sereona repens	33.8%	29.4%	23.5%	11.8%
	2000			
	Absent	Sparse	Moderate	Abundant
Ilex glabra	64.7%	8.8%	23.5%	2.9%
Sereona repens	98.5%	0.0%	0.0%	0.0%
	2001			
	Absent	Sparse	Moderate	Abundant
Ilex glabra	33.8%	25.0%	35.3%	5.9%
Sereona repens	91.2%	7.4%	1.5%	0.0%
	2002			
	Absent	Sparse	Moderate	Abundant
Ilex glabra	57.4%	32.4%	7.4%	2.9%
Sereona repens	89.7%	7.4%	2.9%	0.0%

There was less mast produced in 2000 than any other year. Only 1 species (*Q. chapmanii*) had moderate to abundant mast along 40% of transects (Table 33); only 1 other had over 20% (*Ilex glabra*).

The years 1999 and 2002 were fair years for mast production. In 1999, 4 species were moderate to abundant along > 20% of transects, and 1 of these was >70% (Table 33). In 2002, 3 species were moderate to abundant along >20% of transects (all in sand pine/scrub oak), of these 3; one was over 35%, and 1 over 40% (Table 33). The most productive year for mast production was 2001; 5 species had moderate to abundant mast along >20% of transects (Tables 33, 34).

DISCUSSION

Home Ranges

We documented a failure of most fall foods in ONF in 2000 that occurred after a prolonged drought in Florida (see fall bear foods section). The scarcity of fall foods apparently caused bears to become more wide-ranging and to make forays out of normal home ranges in order to obtain the energy reserves necessary for physiologic maintenance over winter. After the mast failure of fall 2000, males exhibited longer denning behavior during winter 2001 than in other years. We theorize this may have been a behavioral adaptation to scarcity of nutritional resources during the previous fall that allowed them to meet energy demands by lowering metabolic rates and energy expenditure in this season.

The reasons females had larger home ranges in 2002 than they did in 2003 are not fully understood. A larger proportion of females were parturient in 2002 (0.69) than in 2003 (0.47) and smaller female home ranges would be expected. Females with neonatal cubs are physiologically lethargic for an average of 113 days (Garrison 2004) while those with yearlings den for shorter periods and exhibit periods of activity.

Habitat Use

Our analysis documented the importance of medium to older age stands of sand pine/ scrub oak. These stands typically include a dense shrub layer of scrub oaks and scrub palmetto that provide ample nutritional resources and adequate cover during much of the year. The presence of dense vegetation is especially important to females as denning habitat and may offer protection from predation by foraging males. Despite the apparent sexual segregation of habitat during winter we documented 3 instances where collared adult males killed and consumed neonatal cubs (Garrison 2004) and two instances where the denning females were also killed and eaten.

Crossings of SR-40 by Radio-Collared Bears

Our data supports the theory that roads are semi-permeable barriers to bears. The degree of permeability in this study seemed to be an interaction between gender and traffic volumes. Beringer et al. (1990) suggested that a traffic level of 10,000 vehicles per day impeded but did not totally restrict road crossings by bears in North Carolina. In our study, females in Lynne were less likely to cross the highway than other bears. Traffic on SR-40 in ONF occurs at an approximate rate of 5,100 vehicle trips per day compared to 14,700-16,700 vehicle trips per day on SR-40 in Lynne (FDOT 2003). The effect that traffic volume had on bears in these 2 locales is suggested by the crossing odds ratios of bears that were hit by cars. Among these bears, Lynne bears hit by cars crossed at a significantly lower rate than did ONF bears hit by cars. If bears are less likely to cross SR-40 at these traffic levels, the effects of habitat fragmentation by this highway are compounded by decreasing the availability of nutritional resources and access to mates while increasing the risks necessary to obtain them. The conflict between the habitat needs of a wide-ranging umbrella species, such as the black bear, and alteration of the natural landscape by humans is a problem facing most bear populations in Florida and is aptly demonstrated in Lynne. If an improved highway increases the urbanization and density of secondary roads in Lynne, habitat patches may become so reduced in size while the hazards to bears so great that this area may cease to sustain an endemic population of bears. Research to document geographic focal points of highway crossings and to determine the impact of SR-40 upon the population of bears in Lynne bears is needed.

The lack of a difference in the likelihood of Lynne bears crossing SR-40 in summer and winter is puzzling. Typically, bears are more active during the summer breeding season than the winter denning season (Wooding and Hardisky 1994, Masters 2002).

Our results may be due to small sample size in Lynne (n=13), fewer years of observation, and from the reduced overall likelihood of Lynne females crossing SR-40 compared to ONF bears. Additionally, we noted several missed reproductive opportunities among some adult Lynne females (Garrison 2004) that may have contributed to higher than normal activity levels during winter

Survival

Our methodology caused limited violations to two assumptions of the KM approach to survival analysis (Pollock et al. 1989). Captures were not random through ONF but were random among those bears we wished to study. We wished to document the effects of SR-40 on bears and therefore focused our trapping efforts to intensively sample bears within 3 km of SR-40. Within this sub-population we believe that we randomly sampled animals. Further, only females in Lynne with active infestations of demodetic mange were collared; however, this ectoparasite has no known effect on survival. The assumption requiring that exact dates of mortality be obtained was violated in a limited manner. While exact dates were not known in some cases, we were able to estimate them with a maximum likelihood of error of only 2-3 days. We believe this degree of imprecision did not measurably affect survivorship estimates of this large sample of long-lived animals.

Although we appropriately confined our survival analysis to collared bears because deaths of marked but uncollared bears are not always documented, consideration of the entire set of mortality events revealed some interesting patterns of mortality. When considering only those years in which bears were monitored for the entire year, bears appear to have sustained unusually heavy mortality in 2000. In 2000, most of central Florida, including Ocala National Forest, was experiencing an exceptional drought that resulted in hard mast (acorn) failure in the study area (see section on fall bear foods).

This resulted in increased bear movements within the forest and into habitats fragmented by human presence and an increased vulnerability as bears moved across roads and through human communities. All 8 mortalities in 2000 were anthropogenic. Greater than normal movements and higher than normal mortality during periods of prolonged nutritional scarcity have been documented in many North American bear populations. The effect that normal fluctuations in food abundance have upon bears in ONF may become especially significant if traffic volume through ONF rises to the level of traffic in Lynne. This would likely result in the reduced likelihood of bears crossing SR-40 to obtain nutrition and an elevated mortality among bears making the attempt.

Survival Analysis

The mortality rate for ONF bears is low and sustainable under present conditions. The high survivorship of males and females in ONF mimics rates reported by Wooding and Hardisky (1994) in Florida as well as rates reported for other unexploited bear populations. Many stable populations of black bears sustain higher rates of mortality.

Our estimate of the annual survival rate for Lynne females was lower than those reported for other populations including those that are subject to hunting mortality. In their review of mortality rates of black bears, Bunnell and Tait (1985) found an average mortality rate of 17.2% among adult females in 13 North American populations subject to hunting mortality. Based upon the survival rates for female bears in Lynne and the general knowledge from other populations that male survival rates are likely even lower, then the population in Lynne might be in jeopardy without the adjacent source population of bears in ONF. In their discussion of population dynamics of North American bears, Bunnell and Tait (1980) concluded that a bear population in which females conceive at age 2.5, reproduce at age 3, produce a litter of 2.0 cubs every 2 years can sustain "*an absolute, maximum rate of mortality of 23% per year.*" Those parameters describe the

Lynne bear population well with one exception. The estimated mortality rate of Lynne females was even higher at 37.6% than the maximum sustainable rate calculated by Bunnell and Tait (1980). While our study involved a small sample of females in Lynne, the results are nonetheless compelling. A study utilizing a larger sample of male and female bears in Lynne is needed, however, to investigate population dynamics of bears in Lynne to more fully document the effects of the urban-forest interface upon bears.

Track Transect

The effect that forest type had upon the occurrence of exiting bear tracks, we believe, was an artifact of other forest factors. A small woods road exited the forest through a small stand of maple (*Acer rubrum*) habitat south of SR-40 across from a compartment of slash pine approximately 2.5 km west of SR-19. The slash pine/ saw palmetto association produces preferred early (blueberry) and late (palmetto fruit) summer bear foods. It is likely that the presence of an "access road" across from slash pine stands was more significant than the species comprising the forest stand. Further, because the analysis standardized crossing rates per 250 meters of habitat type, the crossings that occurred at this single small stand of maple may have been exaggerated.

Much of the crossing intensity indicated in Figure 9 for the road segment and forest compartment immediately east of FR-88 is attributable to a single 4-week period in 2000. Due to an extended drought, most of the acorn production failed in much of the scrub habitat in ONF (see fall foods section). In October 2000 we observed that up to 6-instrumented animals were using a small portion of the forest compartment northeast of the FR-88 and SR-40 intersection simultaneously. Field investigations into possible reasons for this unusual clumping of bears in such close proximity to a popular rifle range revealed that it represented an "island" of normal acorn production in a "sea" of mast failure and that several uncollared bears were also present.

The random locations of highway crossings by bears in ONF suggests that, in its current condition and with current traffic levels, SR-40 is not an impediment to bear movements. Habitat along the road remains virtually intact and bears crossed it along the entire segment within the study area. Because traffic intensity diminishes at night, when bears are most active, current traffic volume did not constitute a barrier to bear movements. However, if population growth or highway improvements cause traffic levels to increase significantly, this road may create a substantial barrier to bears. Projected traffic volume for this highway in its current design is 6,100 vehicle trips per day within the next ten years (FDOT 2003). However, if this highway were to be significantly improved the increase in traffic would likely be much greater. If or when this occurs, this road would, in effect, create two smaller and increasingly isolated populations of bears. To prevent or reduce the likelihood of this happening, highway planners will need to incorporate design features to allow unimpeded bear movements. Because bears crossed SR-40 along its entirety this will entail creating opportunities for bear crossings at sites along its entirety.

Population Estimates

We believe the study area population estimate provided by the JOLLY analysis for the 5 years of the study is an appropriate and conservative statistic to use with this population. It is based upon data gathered over an extended time period and many of the assumptions of the model address the open population dynamics characteristic of a large far-wandering species such as the black bear. It was within the estimates derived from the modified Lincoln-Peterson technique and program CAPTURE, however those estimates may have arisen from a violation of some of the assumptions associated with their models. One key assumption in using both the Lincoln-Peterson and CAPTURE estimators is that the population is closed and no immigration, emigration, births or deaths will occur. However the data from 1999 and 2000 were gathered from late May through August when normal bear movements associated with breeding and foraging likely carried some bears into and out of the study area. Data from 2001-2003 were collected May to September, which similarly included months when large bear movements are possible. This scenario likely depressed the number of recaptures and caused these estimates to be high. In fact, the test for closure available in CAPTURE showed evidence of openness for females in both 2001 and 2002 (Z= 0.00833 and 0.01916, respectively).

Although the exact number and density of bears at any one moment in ONF may be unknowable due to natality, mortality, emigration and immigration, we believe that the estimates we provided for each gender derived from 5 years of data (0.14/km^2 for females, 0.12/km^2 for males) were accurate estimates of the population. This belief is strengthened by the tight array of density estimates that resulted from multiple models over several years. The population abundance and density estimates we report are much higher than that made in 1962 (Harlow) when Marion County (the majority of ONF) was not even listed as supporting a significant bear population and the results from a 1978 survey that suggested bears were restricted to extreme eastern portions of ONF along the St John's River system (Brady and McDaniel 1978). In a 1988 study, Wooding and Hardisky used intensive trapping; radio tracking and sign survey efforts to estimate a density of 0.08 bears/km^2 in a 100-km^2 portion of northeastern ONF. It is reasonable to consider that these increasing estimates represent a real change in bear abundance in ONF over the last several decades.

The density estimate of bears within our study area was similar to estimates derived from other mark-recapture studies in Florida but lower than some other estimates within the southeast. Dobey et al. (2002) estimated a density of bears in the Okefenokee

– Osceola ecosystem of 0.12 - 0.14 bears/km^2 while Eason (2002) estimated mean densities in 2 areas of Great Smokey Mountain National Park over several years to be 0.94 – 1.20 bears/ km^2. Bears are extremely mobile and are able to respond to temporary and localized nutritional abundance or scarcity. While we do not empirically know if bear densities elsewhere in ONF are similar to the 0.12-0.14 bears per km^2 estimated within our study area, our field experience suggests that bears are not spread uniformly within ONF. Evidence of bears is encountered much less frequently within the longleaf pine (*Pinus palustris*) community and might be found with even greater frequency in the riparian forests and wetland hardwood communities outside of our study area during some portions of the year.

Fall Food Abundance

Saw palmetto is an important component of bear diets in ONF. Field sign and gross examination of bear scats suggest that, in addition to fruits consumed in summer, bears pull palmetto stems and eat the fleshy basal portion in winter when few other foods are abundant.

The chronology of our sampling may have contributed to the apparent lack of productivity for saw palmetto (*Serenoa repens)*. Our surveys were done in mid to late fall, when saw palmetto fruit is usually no longer abundant in ONF. In an earlier assessment we observed more moderate fruit production from this species during summer than these results from fall (McCown et al. 2001).

Although abundant and productive during our study, it is questionable how significant the scrub palmetto (*Sabal etonia*) is to bears. Food habits investigations either failed to document its presence in scats from Lower Wekiva River Basin (Roof 1997) or documented it a very low incidence (Maehr and DeFazio 1985) in scats and stomachs from ONF.

In 2000, Florida was in the grip of a 2-year La Nina weather pattern that resulted in an extreme drought over much of the state including all of central Florida (National Weather Service www.srh.noaa.gov). As a result, we documented a nearly complete mast failure in those areas and habitats sampled in our study. However, despite the catastrophic decrease in availability of food, bears were able to adapt by making forays out of their normal home ranges and out of areas normally used by bears. Bears increased movements within the study area into localized pockets of mast availability and out of the forest to other, more productive habitat types (*see home range analyses*). Foraging bears experienced greater risks during this season by crossing roads more frequently and by making forays into human communities. In the years in which we monitored bears during the complete calendar year (2000, 2001, 2002) we documented the greatest number of mortalities to tagged bears in 2000 with 8 of 18 mortalities (53% of collared or tagged but uncollared bears) occurring in 2000. Similarly, there were more bears hit by cars in the Ocala area in 2000 (64) than in 1999 (38) or 2001 (50) and more nuisance bear reports received for the area in 2000 (760) than in 1999 (141) or 2001 (364).

Stems of saw palmetto (*Serenoa repens*) pulled and eaten by bears

CONCLUSIONS AND MITIGATION OPTIONS

- The number of vehicle-bear collisions is increasing in Florida (FWC, unpublished data).
- The bear population in the Ocala area accounts for a disproportionate amount of annual bear mortality in Florida (FWC, unpublished data).
- Many of the vehicle-bear problem spots occur on S.R. 40 (Gilbert 2000).
- Traffic volume on SR-40 will increase in the future and may increase rapidly if the highway is significantly improved (FDOT 2003).
- High volume highways negatively affect bears by fragmenting habitat (Brody and Pelton 1989), by contributing to genetic isolation (Dixon 2004), and through direct mortality.
- Effectiveness of mitigation techniques depends on a strong understanding of animal behavior and proper location of mitigation efforts.

Much of Ocala National Forest exists as a large block of contiguous and protected habitat with a low to moderate density of roads that currently carry a low volume of traffic (5,100 average annual car trips per day on SR-40) through the forest. Traffic volume is greater along some other roads in the forest-urban interface that characterizes much of the forest periphery (FDOT 2003). Because the majority of ONF consists of a large block of contiguous and protected habitat, future traffic volume is more likely to impact bears and bear habitat than is road density in ONF. Beringer et al. (1990) and Brandenburg (1996) reported bears avoided roads when road densities were similar to that of ONF (0.20 km/ km^2) but with much higher traffic volumes. Currently, SR-40 does not present an obstacle to bears moving across SR-40 in ONF. At current traffic levels bear mortality associated with SR-40 is sustainable by this population of bears. However, human impacts upon the Florida landscape have seldom remained stable and there is little reason to believe that traffic volumes won't increase significantly during the lifespan of this road.

Many bears in ONF have home ranges that incorporate SR-40. Movements by these bears and bears dispersing across SR-40 are primarily in response to temporally and spatially isolated sources of nutrition. Because the time, duration and location of food items change within and between years, locating mitigation efforts based solely upon crossing patterns of a season or a year would be inappropriate. Mitigation efforts associated with highways have been successful for large mammals when crossing sites are clearly delineated by landscape features or migration routes. Much of the habitat along SR-40 in ONF is a homogenous expanse of sand pine stands of various ages and without prominent landscape features. We found that bears crossed SR-40 without discernable effect of species composition or forest stand age they were entering or leaving or proximity to secondary roads. This road will likely present significant risks to individual bears as well as to the population by reducing habitat connectivity and reducing gene flow when the current traffic level (5,100 average trips/day) increases to 10,000 trips per day.

Our results indicate that highways can impact bears directly through mortality and indirectly by increasing the frequency of bear-human interactions and by altering normal bear movements. The contrast between bear habitats in Lynne and ONF provided a useful context for interpretation of our results. Bear habitat in Lynne exists as a patchwork of small forest parcels that are highly fragmented by development and roads. The mortality rate of female bears in Lynne was higher than either males or females in ONF. Further, all mortality in Lynne was anthropogenic. Traffic volume on SR-40 in Lynne at 15,000-16,500 car trips per day was sufficient to create an obstacle to bears. There was less likelihood for Lynne bears to cross the road and there was an elevated mortality risk associated with attempts. Improvement of SR-40 through Lynne would increase risk to individual bears and impact the Lynne subpopulation as a result of habitat degradation and fragmentation. Although we did not have a track transect along SR-40 in Lynne, the locations of bear mortalities suggest that, due to the highly disturbed character of the remaining habitat, bear crossings are concentrated within road segments that contain natural habitats on both sides of the road (FWC unpublished data). Investigations into highway crossing locations in Lynne should be considered to facilitate mitigation efforts if the highway is to be improved beyond its current traffic capability.

The need to address the bear mortality and genetic isolation created by this highway will become critical when traffic volume in ONF increases significantly above current levels. The opportunity to address these concerns may never be greater than the present as decisions about the nature and character of this roadway are being made that will impact bears and bear habitat for many decades. Substantial improvements to this highway will result in significant increases in traffic volume capacity. Increased mortality, and genetic isolation of this population will likely result if traffic volume increases signigicantly. Further, we believe these two issues can be addressed through innovative highway design.

Systems to mitigate the effects of highways on wildlife have been developed in recent decades with the majority designed to reduce vehicular collisions with ungulates. Most systems seek to cause changes in driver and/or animal behavior through passive highway design features or by actively warning drivers of an animal's presence or by warning animals of a vehicle's presence.

Systems designed to warn motorists of an animal's presence near or on the highway depend on the reliable detection of animals. Most systems incorporate post-mounted sensors (infra-red, electric eye) that trigger a series of flashing signs to warn motorists. This system depends upon intensively monitoring a clearly defined crossing site and would be a poor choice for SR-40 in ONF. Also, this type of system is not capable of discriminating between such large bodied mammals as bear and white-tailed deer and, as a result, would be frequently activated as bears crossed SR-40 along its entire length in the study area. Driver response to signs warning of an animal's presence is poor even when animated or flashing (Gordon et al. 2001), and signs that are frequently activated would contribute to dampened driver response.

Animal warning systems rely on scaring animals from the roadway through lights or sounds that are triggered by an approaching vehicle. These systems have been used where crossing sites are well defined and limited and, therefore, are not suitable for SR-40 in ONF.

Reflective devices mounted on posts designed to project a moving wall of vehicular headlights into adjacent habitat were evaluated for use along I-75 in south Florida to reduce vehicular mortality of Florida panthers (*Puma concolor coryi*). They did prove efficacious in deterring animals from the highway and were rejected for use. With more than 5,000 car trips per day through ONF, and with a forest wide crossing zone, bears and most other wildlife would likely acclimate to additional sounds and light making them ineffective.

Perhaps the only way to completely alleviate the effects of SR-40 on bears as well as all other terrestrial species within the forest would be to elevate the highway through ONF entirely. In effect, this would create a forest-wide wildlife underpass. This scenario would present a tremendous challenge to those who design or finance state highway construction and create conflicts with forest users. Perhaps the most successful wildlife mitigation technique for highways has been the incorporation of overpasses and underpasses. When properly designed and sited they contribute to habitat connectivity and genetic interchange. Wildlife overpasses are relatively recent and information on these structures is somewhat limited. Overpasses have been used in Canada and

Europe for several species of large mammals. In Banff National Park, Alberta a 52-m wide overpass was readily used by black bears to cross a multilane highway (Clevenger 2001). Wildlife underpasses for large mammals vary from 2-5m high and are typically either a pre-fabricated concrete box or open span bridge. They are often flanked by high fencing to encourage wildlife to locate the underpass. SR-46 in Lake County Florida was retrofitted with high fencing and a "box culvert" style underpass at the site of frequent bear/vehicle collisions. The Florida Department of Environmental Protection documented at least 73 black bear crossings of SR-46 through the underpass during a recent 16-month period (Walker and Baber 2003). There were no documented mortalities of bears within the protected segment defined by the overpass and fencing.   Bears may frequently use this underpass because of the highly disturbed character of most of the property abutting SR-46. There is a high human presence along much of SR-46 and only a handful of crossings with vegetative cover on both sides of potential crossing sites. Therefore, human activity and presence may tend to funnel bears to less disturbed crossing sites.

Underpass on SR-46 constructed at site of chronic bear-vehicle collisions. Underpass is a simple prefabricated concrete box 14.3 m long x 7.3 m wide x 2.4 m high. The dirt floor of the crossing is at ground level and the road was elevated over the structure to allow bears to easily see through the structure. Vegetation was planted to provide entrance and exit cover (Roof and Wooding 1996).

The underpasses constructed to benefit panthers on I-75 in south Florida were successful because long-term research had documented well-defined crossing routes. Our radio telemetry and track transect data in ONF suggest that bears cross SR-40 along its entirety in ONF and that there is little human presence for bears to avoid. Further, geographic focal points where we documented high incidences of bear crossings tended to be a temporary response to abundant sources of food, the locations of which varied within and between years. In effect, our data suggested that the whole length of SR-40 should be considered a bear-crossing site. In order to reduce the effects a significantly higher volume of traffic will have on habitat connectivity and bear mortality it will be necessary to provide bear crossing structures at intervals along the length of the highway within ONF.

One potential solution to mitigate the effects of road improvements and increased traffic volumes would be the construction of 5-6 wildlife underpasses along SR-40 within ONF. At a minimum, a 500-meter length of 2.5-meter high fencing should flank each structure to help funnel wildlife across the highway safely and a 250-500 meter wide strip of forest leading to each structure should remain uncut to provide cover. However, the specifics of each site will need to be considered in order to determine appropriate fencing and vegetative parameters.

Given the radius of the average annual male home range in ONF (5.4 km), two of these structures, could be sited along the 9.3 km segment of SR-40 west of FR-65 (Figures 13 and 14). Although bear mortality on this segment of the highway has been minimal, these structures would provide connectivity between habitats north and south of SR-40 and promote genetic connectivity of bears north and south of the road as traffic levels increase. One of these structures could be incorporated into the Lake-Alachua-Marion (LAM) trail intersection with SR-40 (Figure 13, Site 1). SR-40 in the vicinity of the

LAM trail experienced moderate levels of bear crossings in each season. The intended purpose of the LAM trail is for equestrian recreation and the incorporation of a wildlife underpass at this site would have the added benefit of increased human safety. To meet this need the height of the crossing would have to be sufficient to allow the passage of horses.

Two additional sites that could be considered for at least 1 additional western underpass include the intersections of SR-40 with unnumbered low use forest roads (Figure 14). One of these roads intersects SR-40 from the north approximately 200 meters west of FR-588 (Figure 14, Site 2) where we observed at least moderate levels of bear crossings in all seasons and was especially heavily used during fall 2000. The second site is located approximately 1.2 km west of the intersection of FR-65 and SR-40 at the intersection of a low-use forest road (Figure 14, Site 3).

The locations of chronic bear mortality are likely to become more significant with an increase in traffic and should be addressed. By overlaying locations of bear mortalities on SR-40 with our track transect data; a few geographic focal points were evident. We note that mortality "hot spots" tended to occur on SR-40 where forest roads intersect the highway on curves where reduced line of sight likely contributes to motorist's inability to avoid bears crossing the road. Additionally, though not significant in our analysis, bears may be subtly encouraged to cross at curves because the reduced line of sight at curves reduces auditory and visual stimuli and may make such areas seem less threatening.

Of particular interest we note an apparent north-south bear travel route that crosses SR-40 at a curve east of the entrance to the Juniper Springs Recreation Area (Figure 14, Site 4). A small drainage emerges from wetlands south of SR-40, crosses under the road in a 45.7 cm (18-in.) culvert and exits as a seasonally flowing tributary of

Juniper Creek. This drainage crosses under SR-40 approximately 50 meters east of the FR-598 and SR-40 intersection. The streambed leaves the highway at a curved road segment with reduced line of sight. Nine bears have been killed on SR-40 within 400 meters of FR-598 since 1980 including 1 study animal (No. 14). It appears that bears may use FR-598 and the streambed as a north-south travel route into Juniper Springs Wilderness Area, particularly during summer (Fig 10). With only a moderate crossing rate (17 crossings within 400 m of FR-598) the highway surrounding the FR-598 intersection with SR-40 represents a zone of higher than expected bear mortality. In addition to the north-south route created by the northern terminus of FR-598 and southern extent of the streambed, bears may be encouraged to use this route by the traffic and human activity associated with the Juniper Springs Recreation Area, the entrance to which lies 370 meters westward. The track transect segment that included the Juniper Springs entrance was very lightly used by bears (Figure 12). A mitigation option for SR-40 at this site would raise the road above the current level and construct an underpass that contained the natural streambed of the creek to reduce bear mortalities. In this option, the northern terminus of FR-598 would need to be relocated so that fencing could be installed parallel to SR-40 and to allow bears to continue to use the abandoned northern segment of FR-598 as a travel route.

The intersection of the Florida Trail with SR-40 could also be considered for a wildlife/pedestrian underpass (Figure 15, Site 5). We documented moderate bear crossings at this location in all seasons and it has been the site of 2 bear mortalities. A structure at this site would also improve safety for pedestrians.

Additionally, the highway segment with the greatest curvature and most reduced line of sight distance had a corresponding track transect segment with a high bear-crossing rate and should be considered for a structure. The curve occurs approximately

600 m – 900 m west of SR-19 (Figure 15, Site 6). There have been 3 bears killed here since 1982. The roadbed for this curve was cut through a small hill and the incorporation of a wildlife overpass is an option for this site.

If underpasses are erected at some forest road intersections with SR-40, vehicular use of forest roads near SR-40 should be blocked and the intersection relocated. This will benefit bears by providing access routes to underpasses on which the growth of native vegetation would be allowed, thus facilitating bear movement under the highway.

We believe that many of the impacts of SR-40 on bears documented in this study are likely also occurring on other state roads in the vicinity of ONF. In particular, we note the volume of traffic on SR-19 near ONF is similar to that on SR-40 and that several residential communities similar to Lynne are located along the road. Since 1982, approximately 100 bears have been killed on this roadway in or near ONF. Information is needed to ensure genetic and habitat linkage between ONF and bear populations in Volusia and Flagler counties.

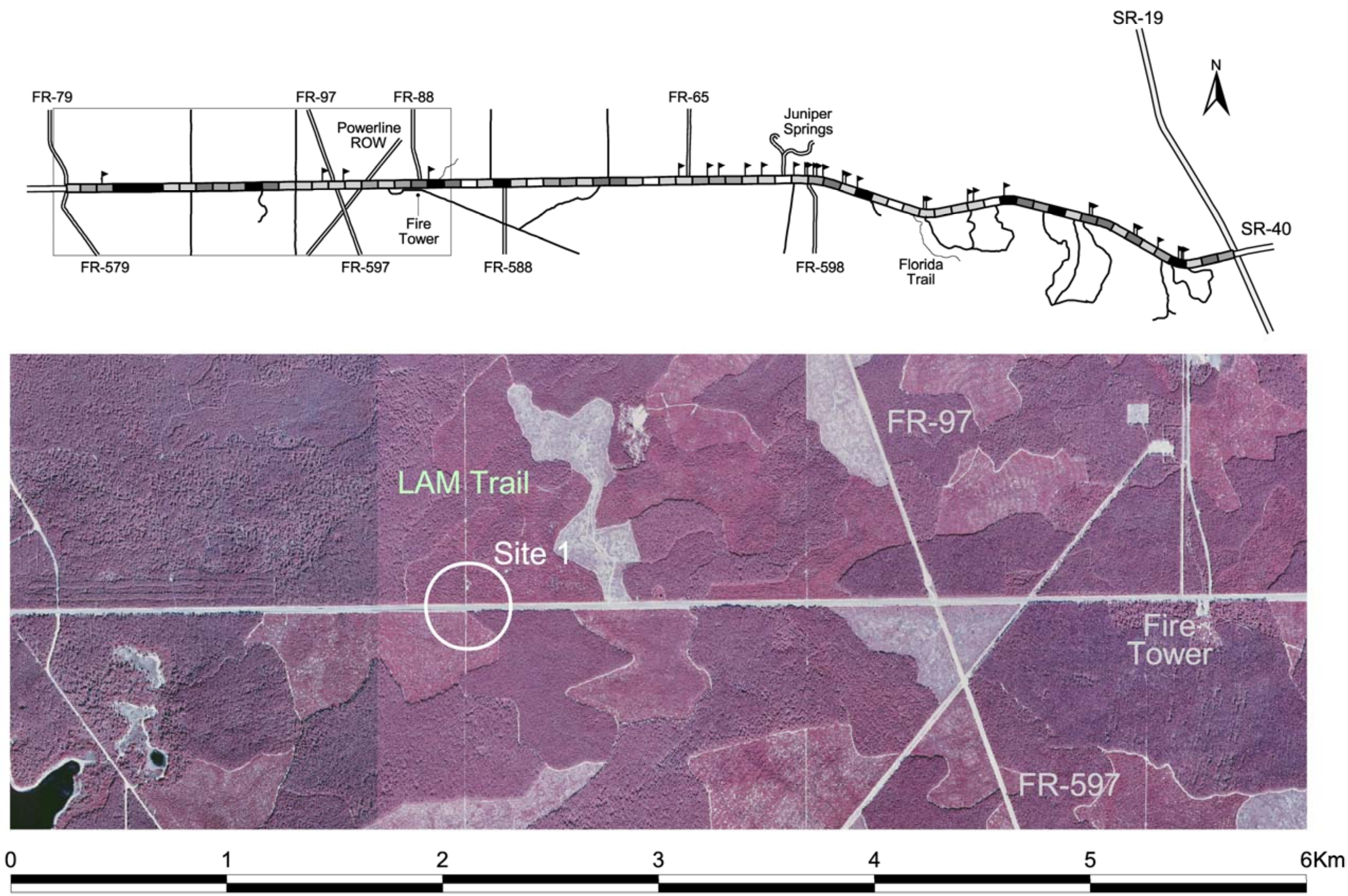

Figure 13. Western segment of SR-40 and site for possible wildlife mitigation. Flags on the map above represent locations of bear mortalities 1982-2002.

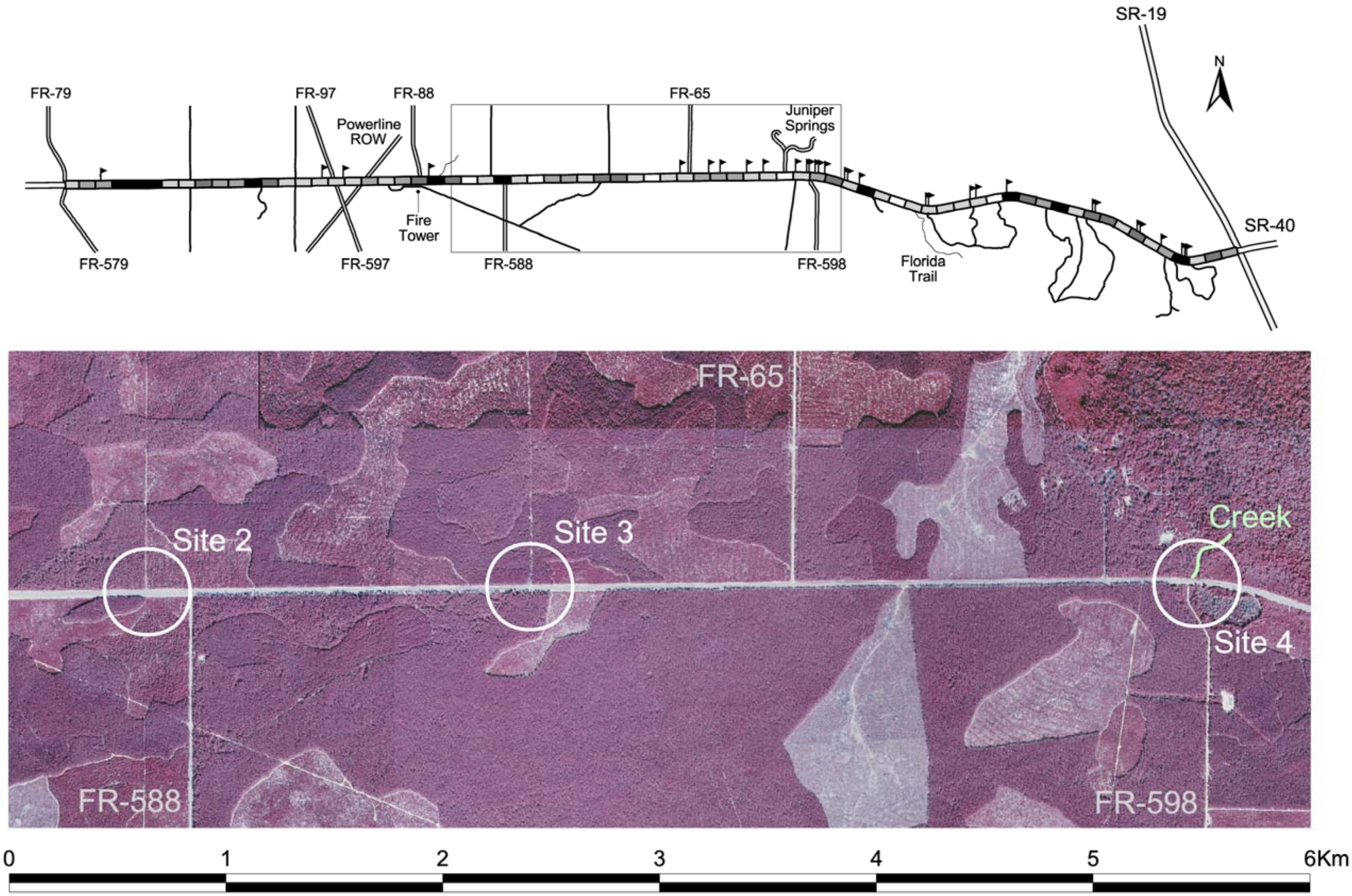

Figure 14. Middle segment of SR-40 and sites for possible wildlife mitigation. Flags on the map above represent locations of bear mortalities 1982-2002.

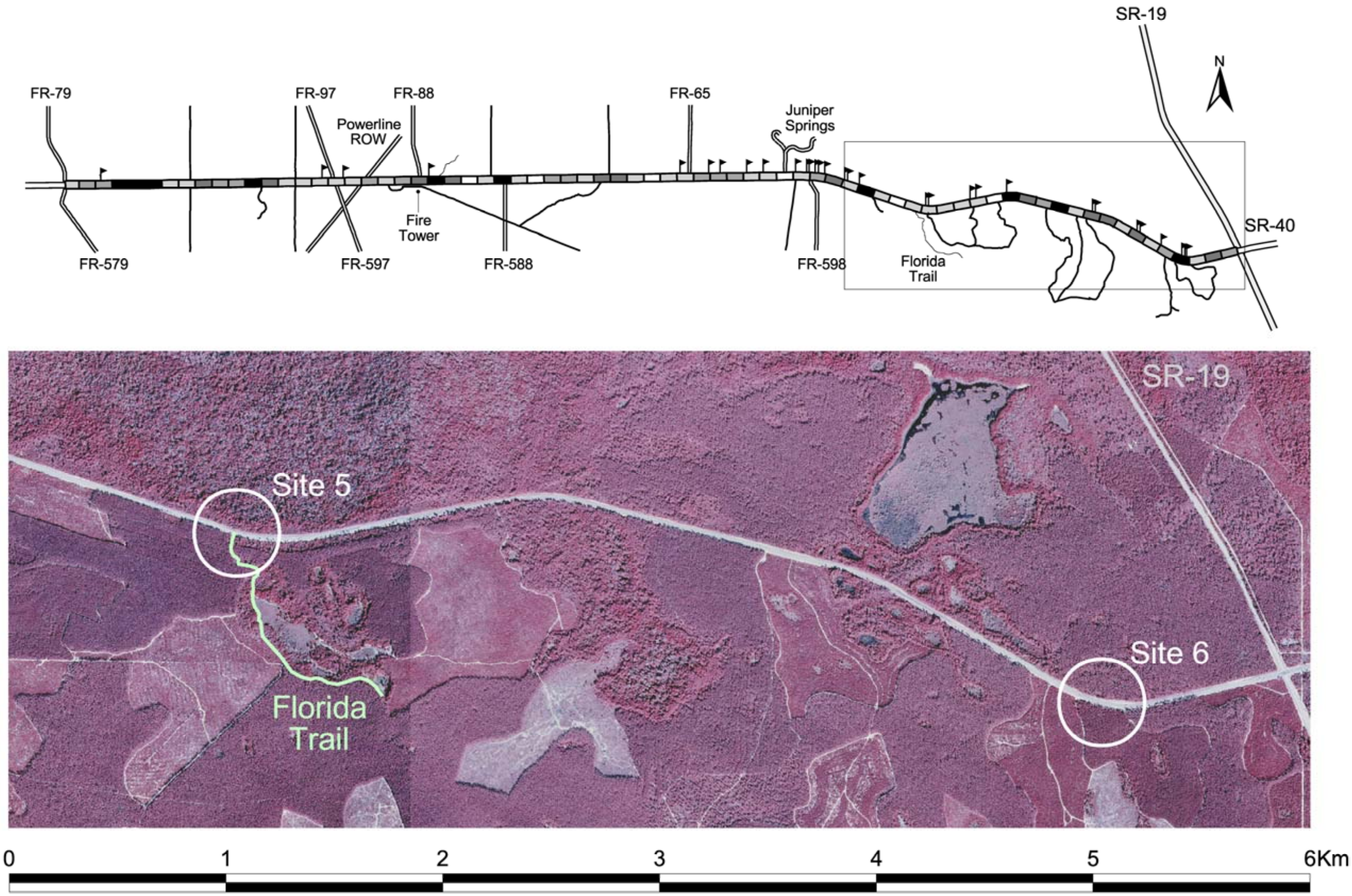

Figure 15. Eastern segment of SR-40 and sites for possible wildlife mitigation. Flags on the map above represent locations of bear mortalities 1982-2002.

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APPENDIX A

Bears Captured in Ocala National Forest and Lynne Florida
May 1999-May 2003

Table A1. Bears ≥ 1-year old captured in Ocala National Forest and Lynne Florida May 1999- May 2003.

Bear ID[a]	Sex	Capture Date	Age	Weight (lbs)	Collar ?	No. Locations	Fate[b]
1	M	5/28/99	3	150	Y	85	Drop
2	M	5/28/99	2	78	Y	73	Drop
3	M	5/29/99	10	420	Y	9	Drop
4	M	5/29/99	3	250	Y	94	Drop
5	M	5/29/99	2	212	Y	35	Drop
6	M	6/02/99	10	210	Y	62	Drop
7	M	6/03/99	4	350	Y	1	Drop
8	M	6/10/99	3	265	Y	40	Drop
8	M	7/20/99	3	--	Y	28	Drop
8	M	8/10/00	4	353	Y	63	Drop
8	M	11/01/02	6	353	Y	26	Drop
9	M	6/10/99	2	305	Y	10	Drop
9	M	8/26/99	2	305	Y	6	Drop
10	F	6/10/99	3	144	Y	161	Defunct
11	F	6/15/99	10	160	Y	50	--
11	F	3/10/00	11	178	Y	83	--
11	F	12/05/01	12	233	Y	86	Drop
12	M	6/15/99	10	300	Y	59	Drop
13	M	6/15/99	3	148	Y	7	Drop
13	M	5/03/00	4	215	N	--	
13	M	10/03/00	4	245	N	--	
14	M	6/22/99	2	120	Y	7	--
14	M	7/20/99	2	--	Y	10	Mortality
15	F	6/26/99	1	80	Y	7	Drop
16	F	6/26/99	7	170	Y	103	Defunct
17	M	6/30/99	4	310	Y	132	Drop
17	M	11/16/01	6	403	Y	27	Mortality
18	M	7/05/99	2	104	Y	89	Drop
19	F	7/05/99	2	77	Y	95	Drop
20	F	7/05/99	2	96	Y	126	--
20	F	8/01/01	4	144	Y	99	Drop
21	M	7/08/99	4	238	Y	24	Drop
21	M	6/26/00	5	261	Y	7	Drop
22	M	7/15/99	2	78	Y	71	Drop
23	M	7/15/99	2	253	Y	48	Drop
24	M	7/19/99	3	98	Y	43	Drop
25	M	7/19/99	4	223	Y	52	Mortality
26	M	7/20/99	3	124	Y	32	Mortality
27	M	7/22/99	3	150	Y	58	Drop
28	M	7/27/99	5	295	Y	18	Drop
28	M	7/17/02	8	327	Y	3	Drop
29	M	7/27/99	3	108	Y	43	--
29	M	6/14/00	4	182	Y	54	--
29	M	7/10/01	5	165	Y	37	Drop
30	F	7/29/99	7	132	Y	131	--
30	F	7/03/01	9	130	Y	136	Study end
31	F	8/02/99	3	107	Y	223	Drop
31	F	6/11/02	6	135	Y	72	Study end
32	F	8/02/99	4	124	Y	87	Mortality
33	F	8/04/99	8	132	Y	23	Drop
34	F	8/04/99	5	140	Y	55	Drop
35	M	8/19/99	3	193	N	--	

[a] Bear ID: D = Bear caught in Lynne, FL as part of investigation into Demodetic mange.

[b] Fate: Drop = dropped collar, defunct = collar ceased, mortality = collared bear died, removed = bear removed- nuisance

Table A1 continued

Bear ID[a]	Sex	Capture Date	Age	Weight (lbs)	Collar ?	No. Locations	Fate[b]
36	F	8/19/99	3	124	Y	108	Drop
37	F	8/19/99	5	164	Y	79	Drop
38	M	9/08/99	5	250	N	--	
39	F	9/22/99	12	173	Y	104	Drop
40	M	9/22/99	8	362	N	--	
41	F	9/25/99	2	112	Y	41	--
41	F	12/15/99	2	160	Y	--	Removed
42	F	10/08/99	2	74	Y	18	Defunct
43	F	10/12/99	5	180	Y	96	Drop
43	F	11/02/01	7	203	Y	109	Study end
44	M	10/14/99	9	268	N	--	
45	M	10/20/99	1	114	Y	42	Drop
45	M	4/19/00	2	193	Y	63	Drop
46	M	10/21/99	7	223	Y	87	Drop
46	M	8/22/02	10	233	Y	37	Study end
47	F	11/02/99	9	238	Y	27	Drop
47	F	9/08/00	10	154	Y	109	Drop
48	F	12/15/99	1	102	N	--	Nuisance
48	F	2/01/00	2	--	N	--	Removed
49	M	12/15/99	1	105	N	--	Removed
50	M	1/17/00	14	468	Y	47	Drop
51	M	2/21/00	12	481	Y	4	Drop
52	F	2/22/00	5	198	Y	12	Drop
53	M	2/24/00	3	208	Y	1	Drop
68D	M	3/17/00	4	383	N	--	
72	M	4/13/00	1	120	N	--	
73D	M	4/14/00	3	155	N	--	
74D	F	5/11/00	5	131	Y	64	Mortality
75	F	6/8/00	3	92	Y	77	Drop
75	F	7/24/02	5	128	Y	63	Mortality
76	M	6/14/00	3	174	Y	2	Drop
77	M	6/14/00	3	198	Y	63	Drop
78	M	6/21/00	14	375	N	--	
78	M	7/06/00	14	--	N	--	
78	M	7/03/01	15	280	N	--	
79D	F	6/22/00	5	204	N	--	
80D	F	6/23/00	4	130	Y	48	Drop
80D	F	8/08/01	5	159	Y	91	Study end
81D	M	6/25/00	4	250	N	--	
82D	F	7/03/00	5	125	Y	62	Mortality
83D	M	7/08/00	6	400	N	--	
84	M	7/11/00	6	325	Y	40	Drop
85	M	7/11/00	4	385	N	--	
86D	F	7/13/00	3	112	Y	149	Study end
87	M	8/2/00	3	373	Y	9	Drop
87	M	9/13/00	3	--	Y	8	
87	M	10/9/00	3	--	Y	--	Removed
88	M	8/2/00	2	183	N	--	
88	M	11/30/01	3	200	N	--	
89	M	8/03/00	2	213	Y	71	Drop
89	M	11/21/01	3	228	Y	28	Drop
90D	F	8/08/00	6	151	Y	11	Mortality
91	M	8/9/00	3	343	Y	42	Drop

[a] Bear ID: D = Bear caught in Lynne, FL as part of investigation into Demodetic mange.
[b] Fate: Drop = dropped collar, defunct = collar ceased, mortality = collared bear died, removed = bear removed- nuisance

Table A1 continued

Bear ID[a]	Sex	Capture Date	Age	Weight (lbs)	Collar ?	No. Locations	Fate[b]
92	M	8/10/00	8	358	Y	3	Defunct
93	M	8/17/00	10	393	Y	49	Defunct
94	M	8/23/00	4	320	N	--	
95	M	8/23/00	6	345	N	--	
96	M	8/25/00	6	228	Y	43	Drop
97D	F	8/26/00	9	114	Y	7	Mortality
98	F	9/02/00	13	170	Y	59	Drop
99	F	9/8/00	3	200	Y	107	Drop
100	M	9/26/00	15	253	Y	94	Drop
101	F	10/03/00	4	200	Y	50	Drop
102	M	10/05/00	4	193	Y	50	Drop
103	M	10/11/00	1	83	Y	80	Drop
104	M	10/11/00	2	148	Y	59	Drop
105	F	10/20/00	4	150	Y	27	Drop
106	M	10/25/00	4	276	Y	49	Drop
107	M	10/27/00	3	190	Y	9	Drop
108D	F	11/02/00	10	230	Y	25	Drop
109	F	11/09/00	3	150	Y	46	Drop
109	F	8/01/01	4	134	Y	62	
110	M	11/09/00	2	98	N	--	
111	F	12/14/00	5	250	Y	21	Drop
135D	M	6/25/01	2	150	N	--	
136	M	6/26/01	1	33	N	--	
137	F	7/11/01	2	77	Y	126	Study end
138D	F	7/13/01	3	100	N	--	
139D	M	7/04/01	3	250	N	--	
139D	M	8/01/02	4	310	N	--	
140	M	7/16/01	2	148	N	--	
140	M	7/17/02	4	200	N	--	
141	M	7/16/01	3	168	N	--	
141	M	11/02/01	3	185	N	--	
142	M	7/17/01	14	245	N	--	
143D	F	7/17/01	7	138	Y		
144	M	7/27/01	4	230	N	--	
144	M	8/17/01	4	--	N	--	
145	F	8/01/01	7	193	Y	66	Drop
146	F	8/10/01	4	128	Y	102	Drop
147D	F	8/21/01	2	101	Y	111	Defunct
148D	F	8/21/01	14	183	Y	72	Mortality
149D	F	8/26/01	5	133	Y	100	Study end
150	M	10/26/01	7	351	Y	3	
150	M	11/09/01	7	358	Y	19	Defunct
150	M	8/28/02	8	360	N	--	
151	M	10/26/01	2	105	N	--	
152	M	10/26/01	2	167	Y	74	Study end
153	M	11/02/01	2	92	N	--	
154	M	11/05/01	9	323	Y	25	Drop
155	M	11/16/01	2	192	N	--	
155	M	8/20/02	3	238	N	--	
156	M	11/16/01	2	188	N	--	
157	M	12/05/01	3	166	N	--	

[a] Bear ID: D = Bear caught in Lynne, FL as part of investigation into Demodetic mange.

[b] Fate: Drop = dropped collar, defunct = collar ceased, mortality = collared bear died, removed = bear removed- nuisance

Table A1 continued.

Bear ID[a]	Sex	Capture Date	Age	Weight (lbs)	Collar ?	No. Locations	Fate[b]
158	M	12/07/01	3	108	N		
159	M	12/18/01	2	145	N		
159	M	7/19/02	3	205	N		
186	M	6/13/02	13	324	N		
187	M	7/01/02	1	98	N		
188	M	7/09/02	2	152	N		
189	F	7/09/02	9	146	Y	66	Study end
190	M	7/10/02	8	335	N		
191	M	7/10/02	1	158	N		
191	M	7/17/02	1	158	N		
192	F	7/10/02	1	142	Y	7	
192	F	7/17/02	2	142	Y	72	Drop
193	M	7/17/02	2	107	Y	18	--
193	M	12/4/02	2	160	Y	--	Removed
194	F	7/31/02	3	157	Y	3	Drop
195	F	8/01/02	4	185	Y	50	Study end
196D	F	8/06/02	3	98	Y	2	--
196D	F	8/22/02	3	98	Y	29	Mortality
197D	F	8/06/02	2	168	Y	30	Study end
198	F	8/14/02	2	98	Y	71	Study end
199	M	8/20/02	9	290	N	--	
200	M	8/20/02	3	225	N	--	
201	F	8/22/02	8	122	Y	77	Study end
202	F	8/28/02	8	144	Y	70	Study end
203	M	11/06/02	5	338	Y	17	Study end
204	F	11/08/02	2	212	Y	32	--
204	F	11/15/02	2	212	Y		Study end

[a] Bear ID: D = Bear caught in Lynne, FL as part of investigation into Demodetic mange.

[b] Fate: Drop = dropped collar, defunct = collar ceased, mortality = collared bear died, removed = bear removed- nuisance

APPENDIX B

Black Bear Seasonal Habitat Use Versus Habitat Availability
Ocala National Forest 1999-2003

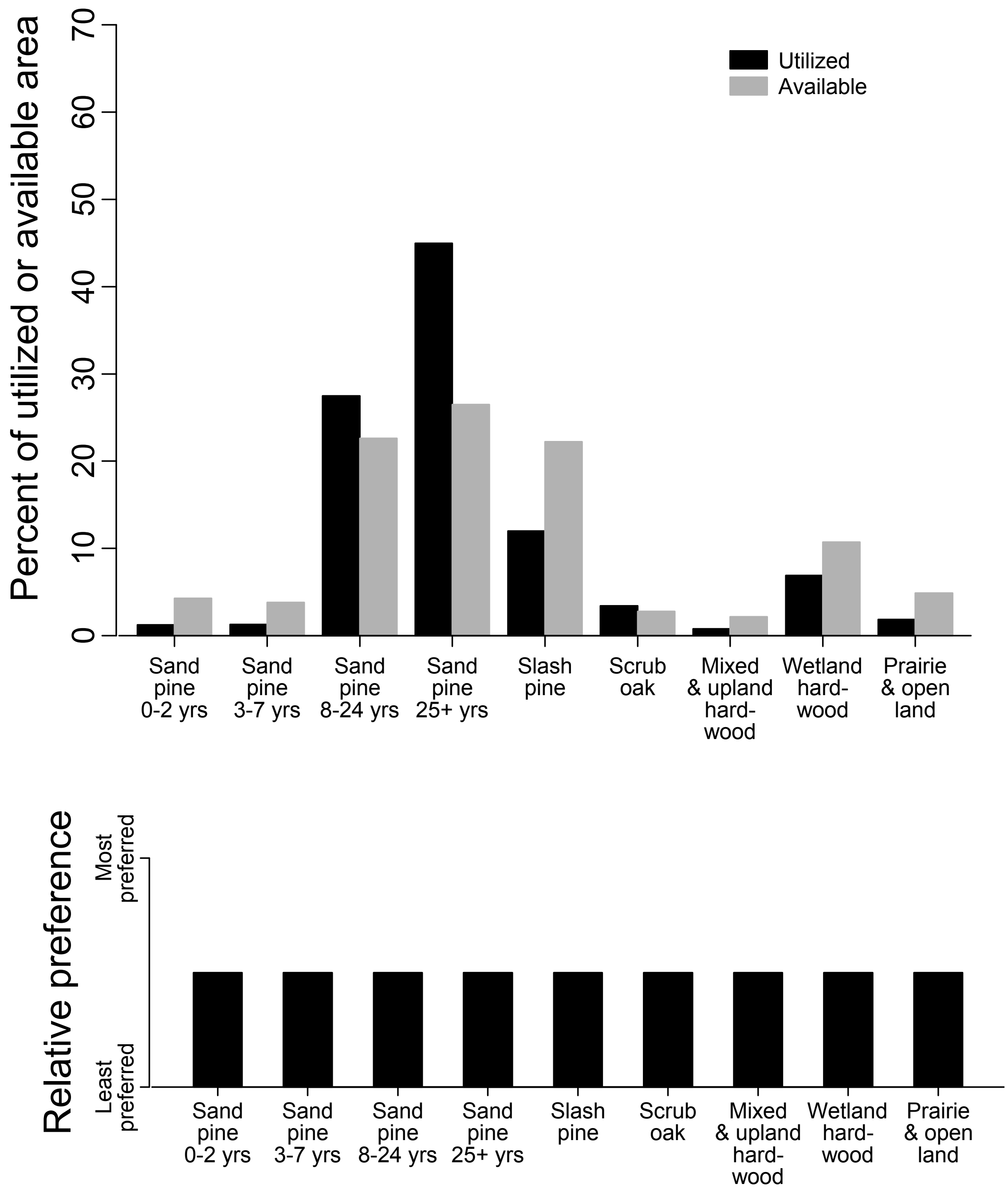


Figure B1. Female black bear habitat used during winter versus habitat available and relative preference of habitats in Ocala National Forest, 1 January - 30 April 2000 - 2003.

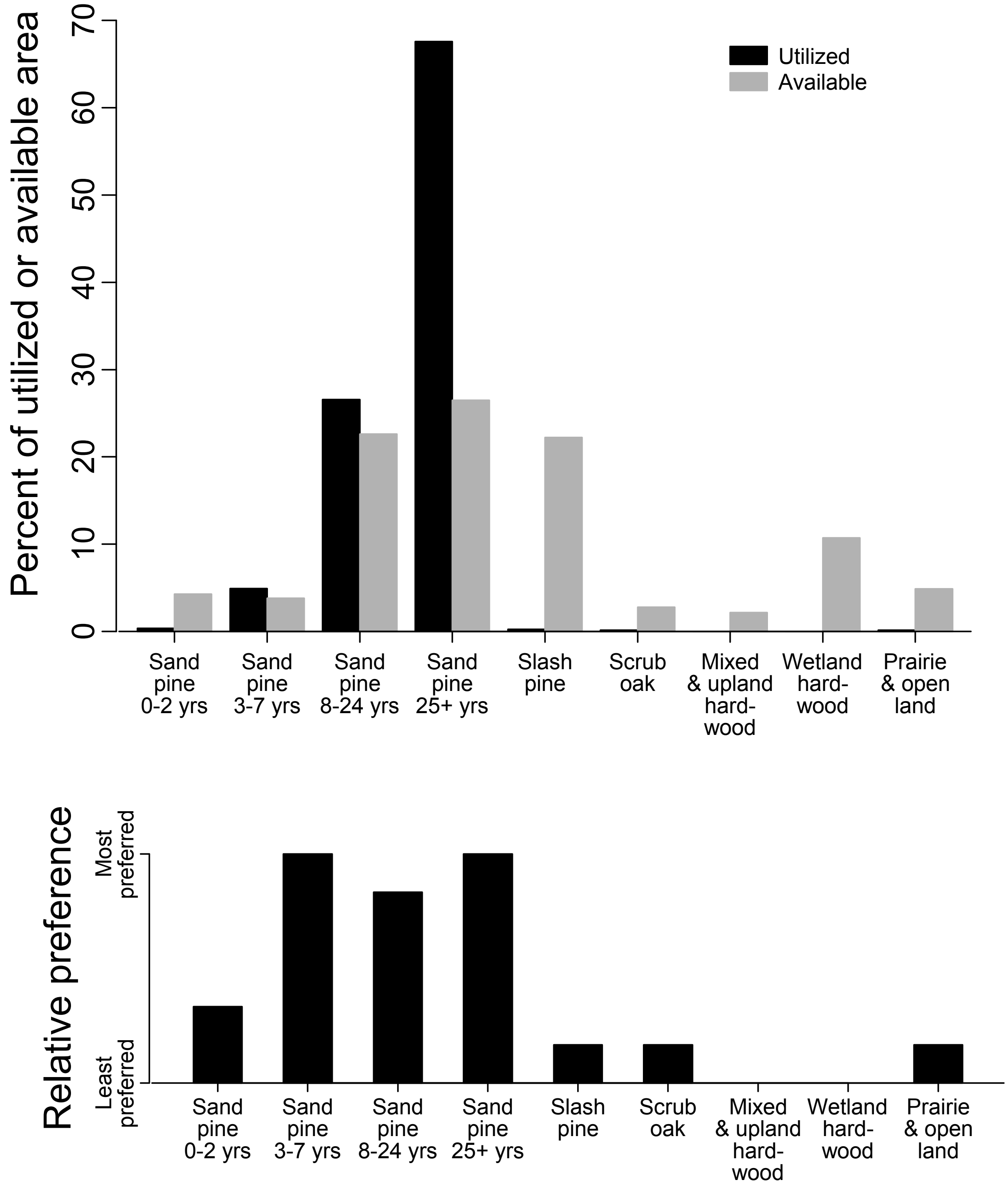


Figure B2. Female black bear habitat used during summer versus habitat available and relative preference of habitats in Ocala National Forest, 1 May-30 September 1999 - 2002.

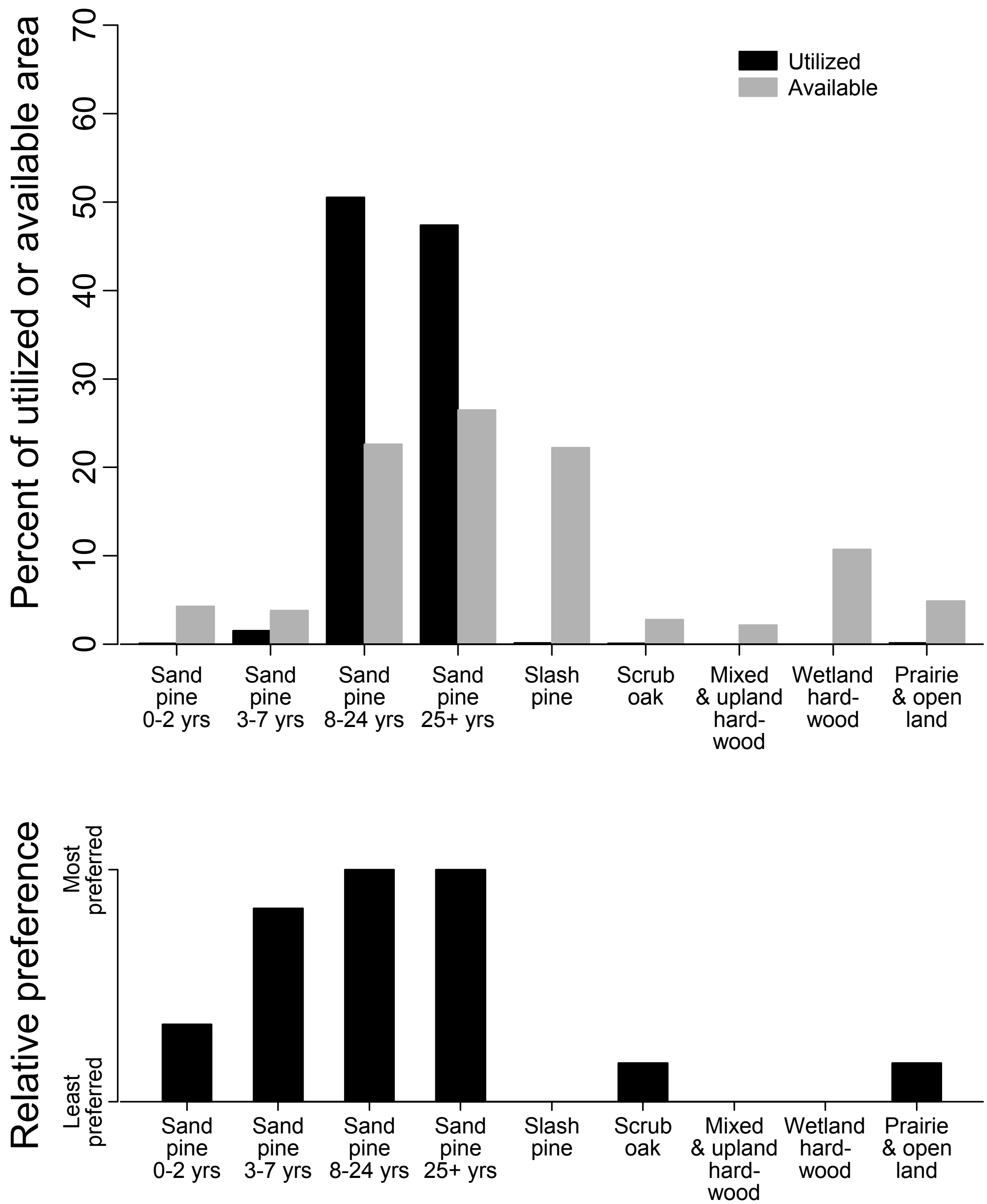


Figure B3. Female black bear fall habitat used versus habitat available and relative preference of habitats in Ocala National Forest, 1 October -31 December 2000. - 2003.

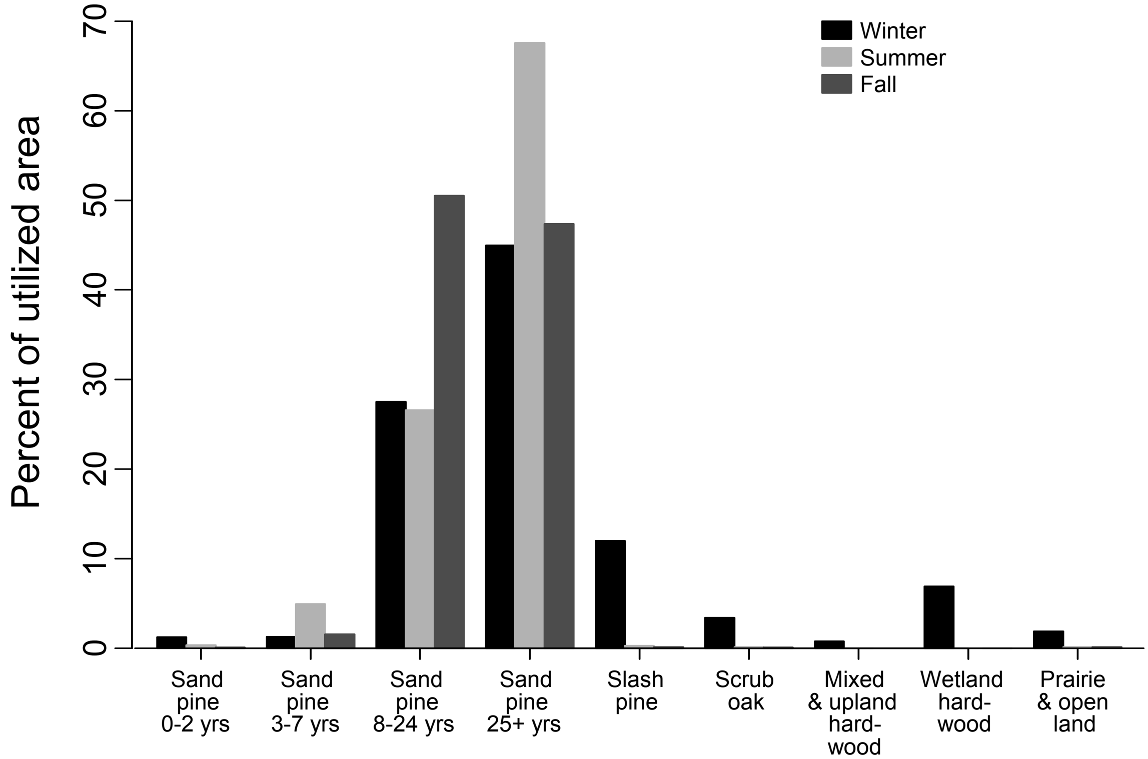


Figure B4. Seasonal habitat used by female black bears in Ocala National Forest 1 June 1999 – 31 May 2003. Seasons were winter (1 Jan. – 30 April), summer (1 May – 30 Sept.) and fall (1 Oct. – 31 Dec.).

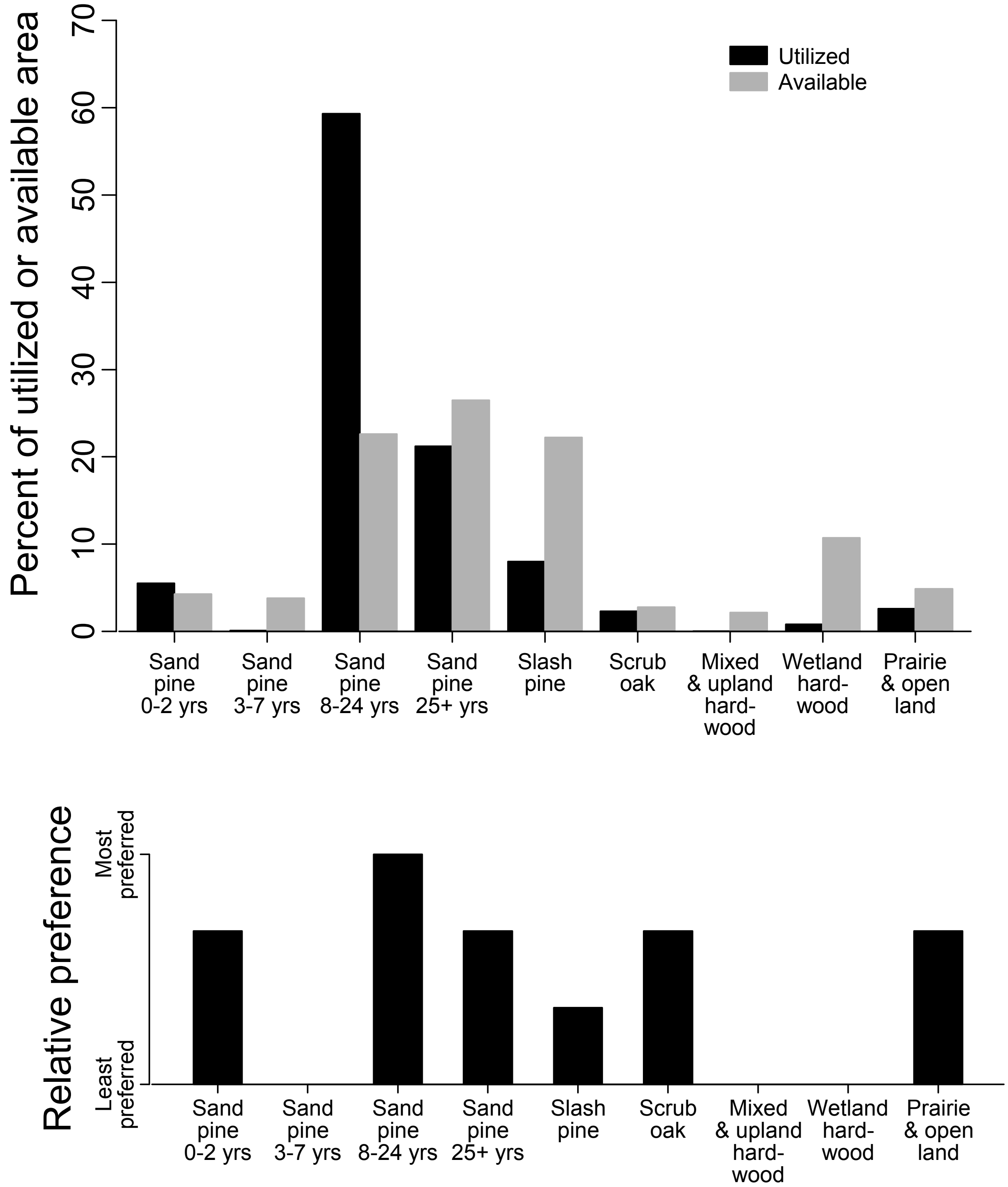


Figure B5. Male black bear habitat used during winter versus habitat available and relative habitat preferences in Ocala National Forest, 1 January-30 April 2000 - 2003.

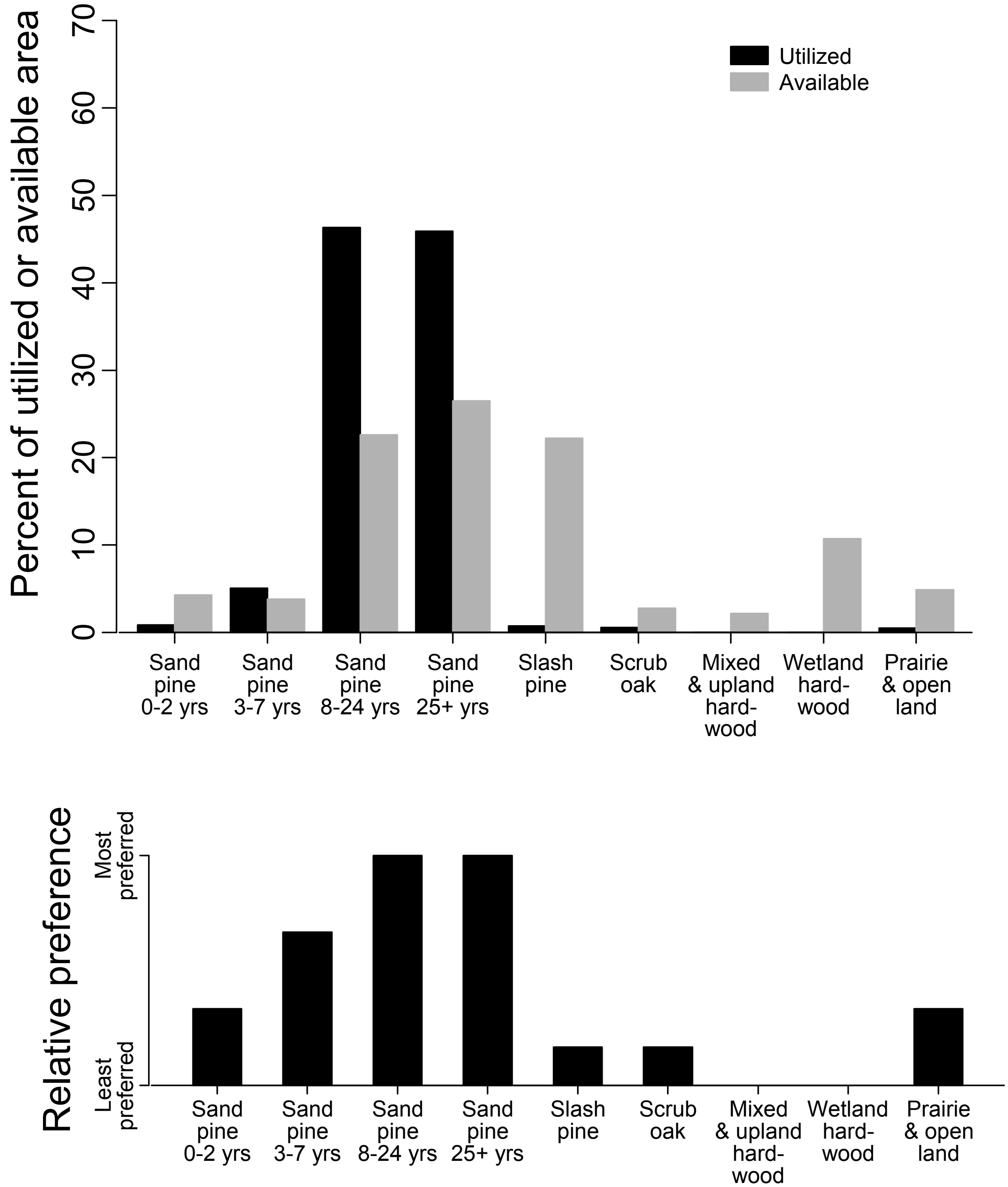


Figure B6. Male black bear habitat used during summer versus habitat available and relative habitat preferences in Ocala National Forest, 1 May-30 September 1999 - 2002.

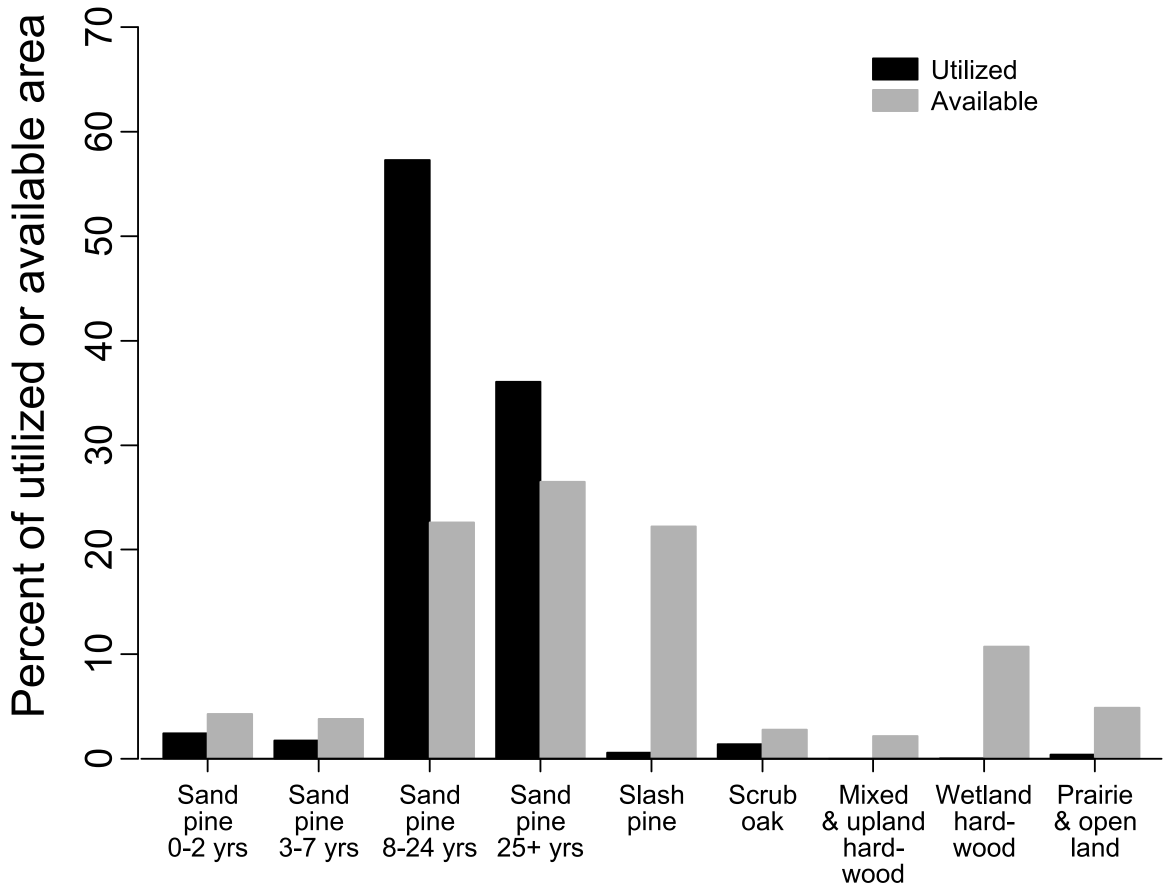


Figure B7. Male black bear habitat used during fall versus habitat available in Ocala National Forest, 1 October -31 December 2000. - 2003. Habitat was not used in proportion to its availability.

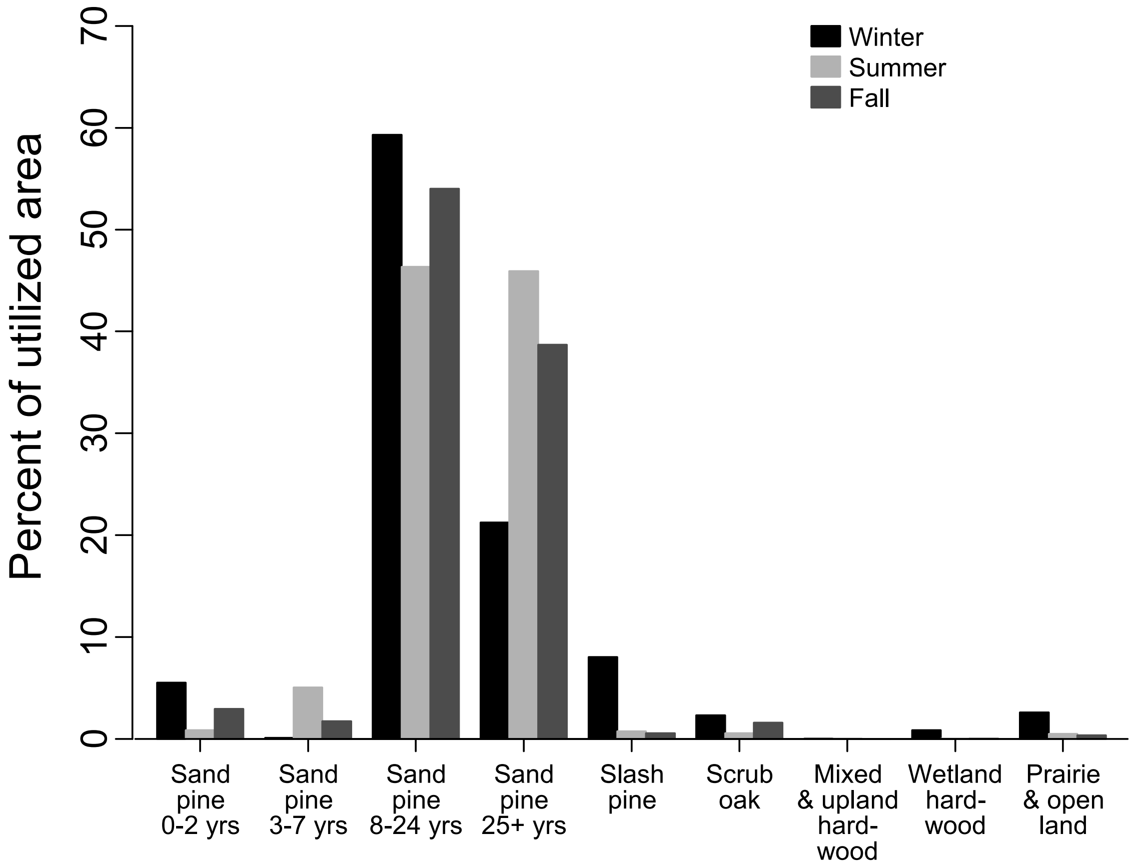


Figure B8. Seasonal habitat used by male black bears in Ocala National Forest 1 June 1999 – 31 May 2003. Seasons were winter (1 Jan. – 30 April), summer (1 May – 30 Sept.) and fall (1 Oct. – 31 Dec.).

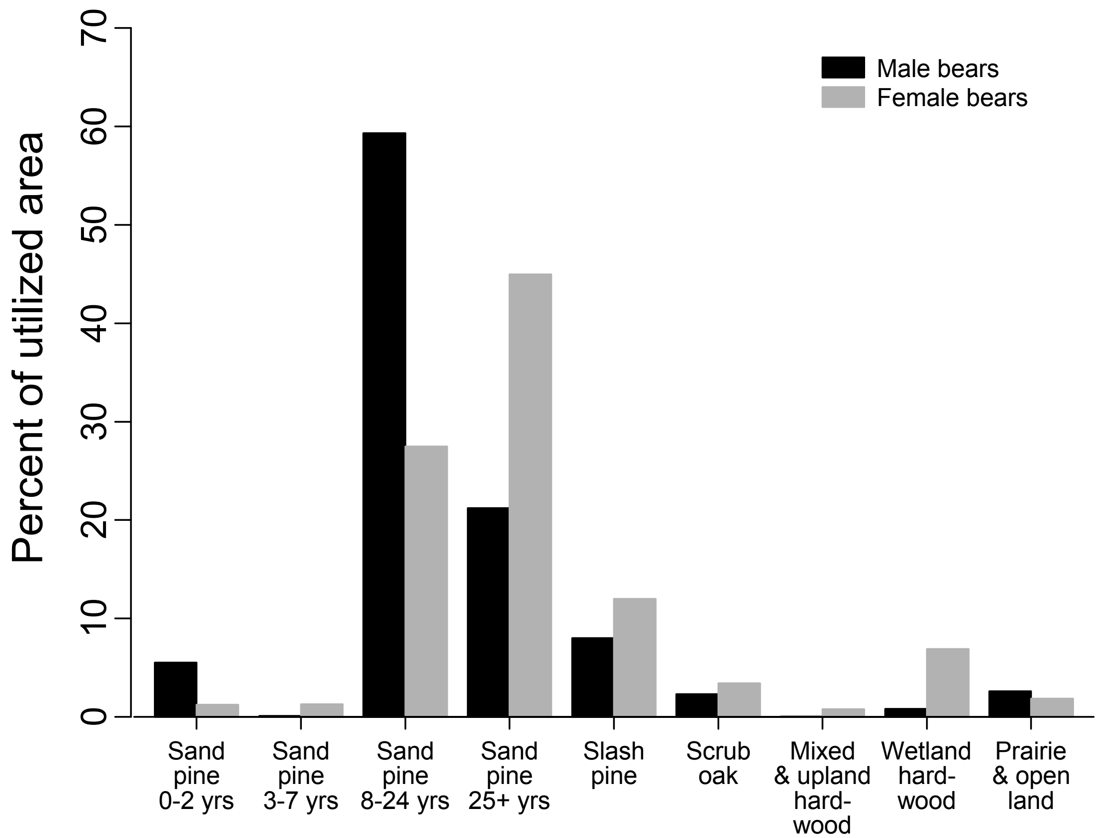


Figure B9. Comparison of male and female habitat used during winter in Ocala National Forest 1January – 30 April, 2000 – 2003. Wilk's Lambda P-value (0.080) indicated a tendency for the sexes to use available habitats differently during this period, but not quite at statistically significant levels (P = 0.05).

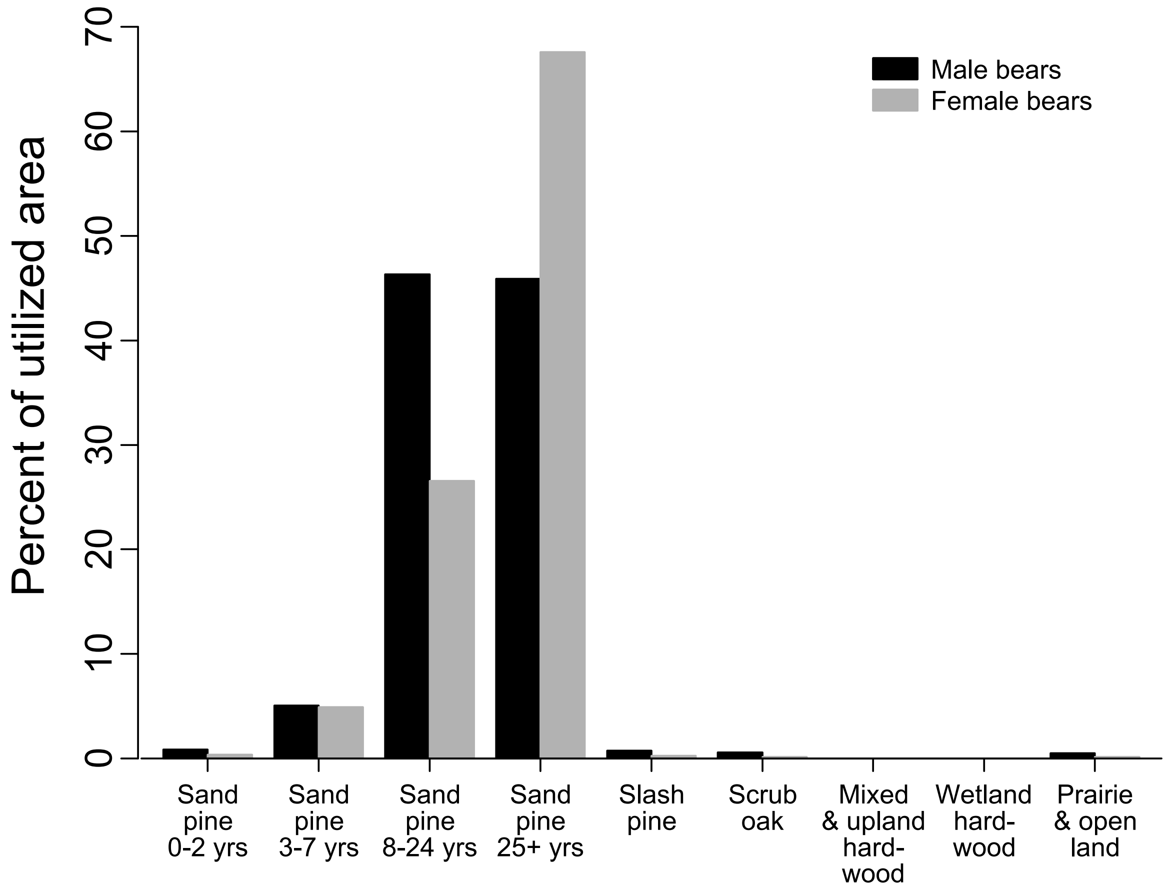


Figure B10. Comparison of habitat used by male and female black bears during summer in Ocala National Forest 1 May – 30 September, 1999 – 2002. Wilk's Lambda P-value (0.5644) indicated no difference in habitat use during this period.

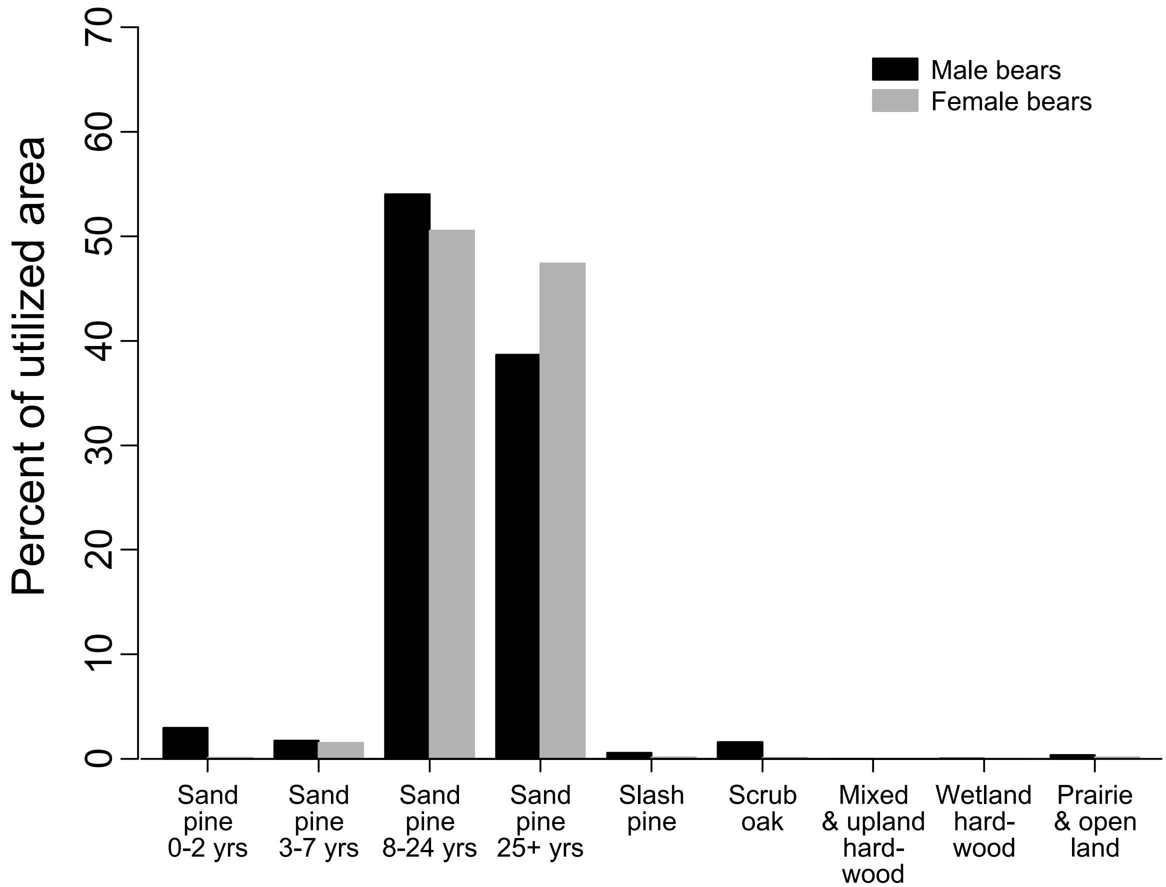


Figure B11. Comparison of habitat used during fall by male and female black bears in Ocala National Forest 1 October – 31 December, 1999 – 2002. Wilk's Lambda P-value (0.1713) indicated no difference in habitat use during this period.

APPENDIX C

Probabilities that a bear will cross SR-40

Table C 1. Predicted probability that a bear observed at selected distances from SR-40 will have crossed SR-40 at least once when it is relocated 7 days later. ONF male bears (N=40) and ONF female bears (N=33).

	ONF MALES			ONF FEMALES		
Distance from SR-40 (km)	Probability crossing SR-40	95% CI Lower	95% CI Upper	Probability crossing SR-40	95% CI Lower	95% CI Upper
0	0.1623	0.0983	0.2563	0.0389	0.0194	0.0763
1	0.1159	0.0707	0.1844	0.0267	0.0136	0.0516
2	0.0815	0.0498	0.1306	0.0182	0.0094	0.0350
3	0.0567	0.0344	0.0920	0.0124	0.0064	0.0239
4	0.0391	0.0233	0.0648	0.0084	0.0043	0.0164
5	0.0268	0.0155	0.0458	0.0057	0.0029	0.0114
6	0.0183	0.0102	0.0326	0.0039	0.0019	0.0079
7	0.0125	0.0066	0.0234	0.0026	0.0012	0.0056
8	0.0085	0.0042	0.0168	0.0018	0.0008	0.0040
9	0.0057	0.0027	0.0121	0.0012	0.0005	0.0028
10	0.0039	0.0017	0.0088	0.0008	0.0003	0.0020
11	0.0026	0.0011	0.0064	0.0006	0.0002	0.0015
12	0.0018	0.0007	0.0047	0.0004	0.0001	0.0011
13	0.0012	0.0004	0.0034	0.0003	0.0001	0.0008
14	0.0008	0.0003	0.0025	0.0002	0.0001	0.0006
15	0.0006	0.0002	0.0018	0.0001	0.0000	0.0004

Table C 2. Predicted probability that a bear observed at selected distances from SR-40 will have crossed SR-40 at least once when it is relocated 7 days later. Comparisons are for ONF female bears (n=33) and Lynne female bears (n=13).

	ONF FEMALES			LYNNE FEMALES		
Distance from SR- 40 (km)	Probability crossing SR-40	95% CI Lower	95% CI Upper	Probability crossing SR-40	95% CI Lower	95% CI Upper
0	0.0389	0.0194	0.0763	0.0169	0.0055	0.0505
1	0.0267	0.0136	0.0516	0.0115	0.0038	0.0344
2	0.0182	0.0094	0.0350	0.0078	0.0026	0.0235
3	0.0124	0.0064	0.0239	0.0053	0.0017	0.0161
4	0.0084	0.0043	0.0164	0.0036	0.0012	0.0111
5	0.0057	0.0029	0.0114	0.0024	0.0008	0.0076
6	0.0039	0.0019	0.0079	0.0016	0.0005	0.0053
7	0.0026	0.0012	0.0056	0.0011	0.0003	0.0037
8	0.0018	0.0008	0.0040	0.0008	0.0002	0.0026
9	0.0012	0.0005	0.0028	0.0005	0.0001	0.0018
10	0.0008	0.0003	0.0020	0.0003	0.0001	0.0013
11	0.0006	0.0002	0.0015	0.0002	0.0001	0.0009
12	0.0004	0.0001	0.0011	0.0002	0.0000	0.0007
13	0.0003	0.0001	0.0008	0.0001	0.0000	0.0005
14	0.0002	0.0001	0.0006	0.0001	0.0000	0.0003
15	0.0001	0.0000	0.0004	0.0000	0.0000	0.0002

Table C 3. Predicted probability that a bear observed at selected distances from SR-40 will have crossed SR40 at least once when it is relocated 7 days later. Comparisons are for bears that were hit by a car during the study (N=10) and bears that were not hit by a car during the study (N=76).

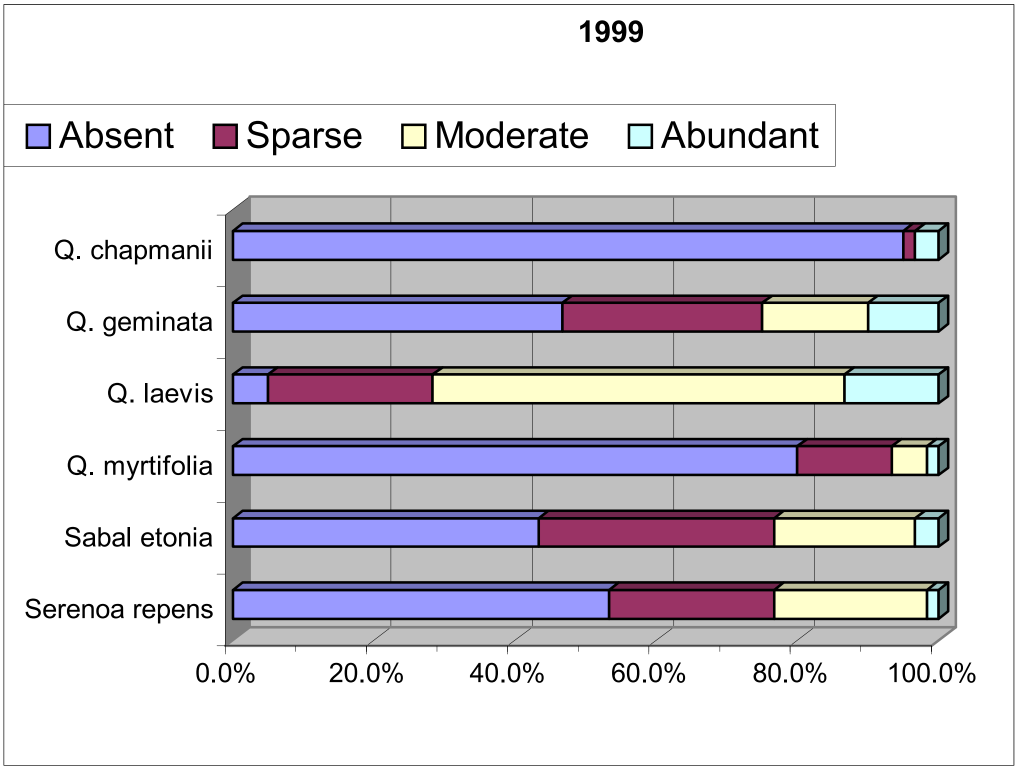
	BEARS HIT BY CAR			BEARS NOT HIT BY CAR		
Distance from SR- 40 (km)	Probability crossing SR-40	95% CI Lower	95% CI Upper	Probability crossing SR-40	95% CI Lower	95% CI Upper
0	0.1416	0.0474	0.3532	0.0502	0.0282	0.0880
1	0.1027	0.0337	0.2730	0.0354	0.0203	0.0610
2	0.0736	0.0237	0.2062	0.0248	0.0144	0.0424
3	0.0523	0.0165	0.1532	0.0174	0.0101	0.0297
4	0.0369	0.0114	0.1126	0.0121	0.0070	0.0210
5	0.0259	0.0078	0.0821	0.0084	0.0047	0.0150
6	0.0181	0.0053	0.0597	0.0059	0.0032	0.0109
7	0.0126	0.0036	0.0433	0.0041	0.0021	0.0079
8	0.0088	0.0024	0.0315	0.0028	0.0014	0.0058
9	0.0061	0.0016	0.0229	0.0020	0.0009	0.0043
10	0.0043	0.0011	0.0167	0.0014	0.0006	0.0032
11	0.0030	0.0007	0.0122	0.0010	0.0004	0.0024
12	0.0021	0.0005	0.0089	0.0007	0.0002	0.0018
13	0.0014	0.0003	0.0066	0.0005	0.0002	0.0013
14	0.0010	0.0002	0.0048	0.003	0.0001	0.0010
15	0.0007	0.0001	0.0036	0.002	0.0001	0.0007

Table C 4. Predicted probability that a bear observed at selected distances from SR-40 will have crossed SR-40 at least once when it is relocated 7 days later. Comparisons are of ONF bears (n=7) and Lynne bears hit by a car (n=3) during the study.

	ONF BEARS HIT BY CAR			LYNNE BEARS HIT BY CAR		
Distance from SR- 40 (km)	Probability crossing SR-40	95% CI Lower	95% CI Upper	Probability crossing SR-40	95% CI Lower	95% CI Upper
0	0.3710	0.2828	0.4687	0.0471	0.0148	0.1401
1	0.2530	0.2008	0.3135	0.0276	0.0088	0.0834
2	0.1628	0.1230	0.2123	0.0160	0.0050	0.0501
3	0.1005	0.0657	0.1507	0.0093	0.0028	0.0308
4	0.0603	0.0327	0.1086	0.0053	0.0015	0.0194
5	0.0355	0.0157	0.0783	0.0031	0.0008	0.0125
6	0.0207	0.0074	0.0563	0.0018	0.0004	0.0082
7	0.0120	0.0035	0.0404	0.0010	0.0002	0.0055
8	0.0069	0.0016	0.0289	0.0006	0.0001	0.0037
9	0.0040	0.0008	0.0206	0.0003	0.0000	0.0025
10	0.0023	0.0004	0.0147	0.0002	0.0000	0.0017
11	0.0013	0.0002	0.0104	0.0001	0.0000	0.0012
12	0.0008	0.0001	0.0074	0.0001	0.0000	0.0008
13	0.0004	0.0000	0.0053	0.0000	0.0000	0.0006
14	0.0002	0.0000	0.0037	0.0000	0.0000	0.0004
15	0.0001	0.0000	0.0027	0.0000	0.0000	0.0003

APPENDIX D:

Estimates of Common Fall Bear Foods



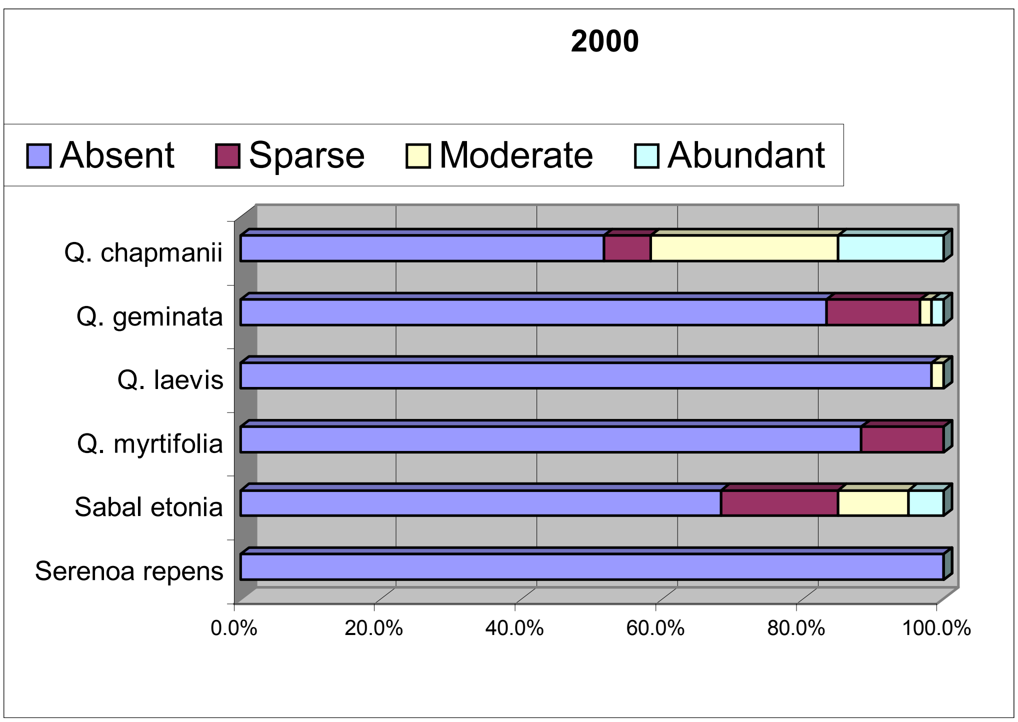
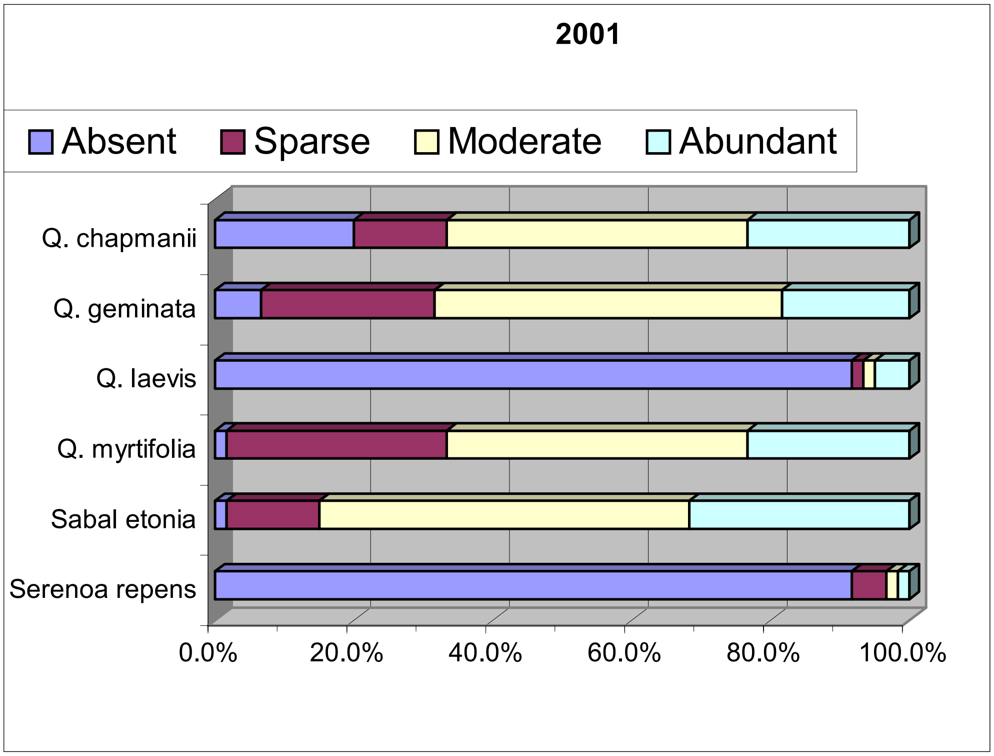


Figure D1. Estimates of abundance of common bear foods along 60, 100-m transects in the sand pine/scrub oak habitat in Ocala National Forest, fall 1999 and fall 2000. Plants containing fruit were estimated to be absent, sparse (1-20%), moderate (21-50%) or abundant (> 50%) along transects.



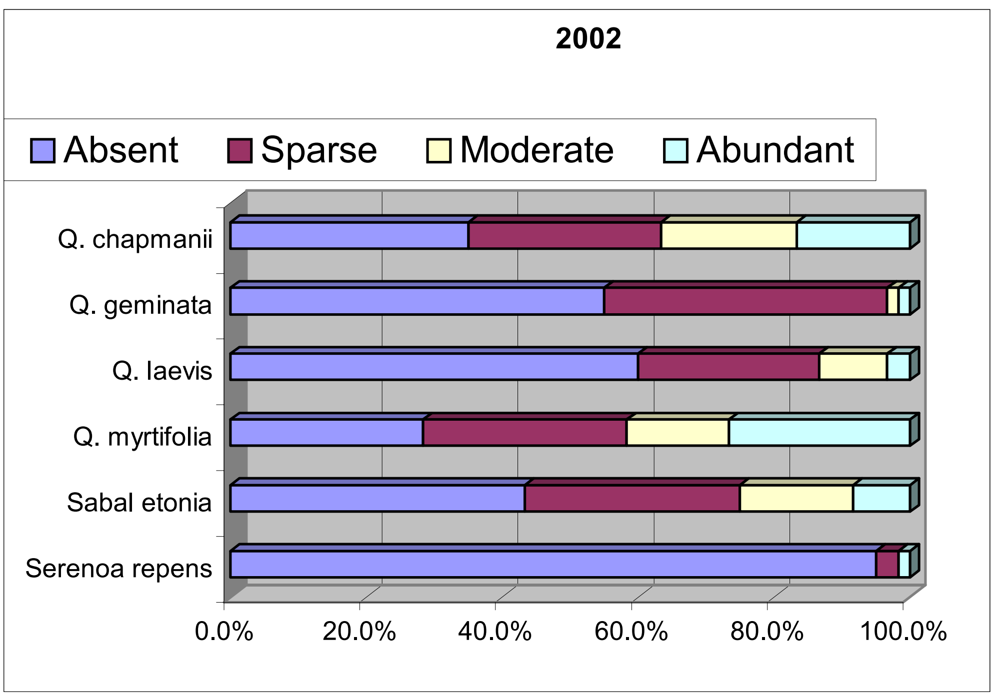
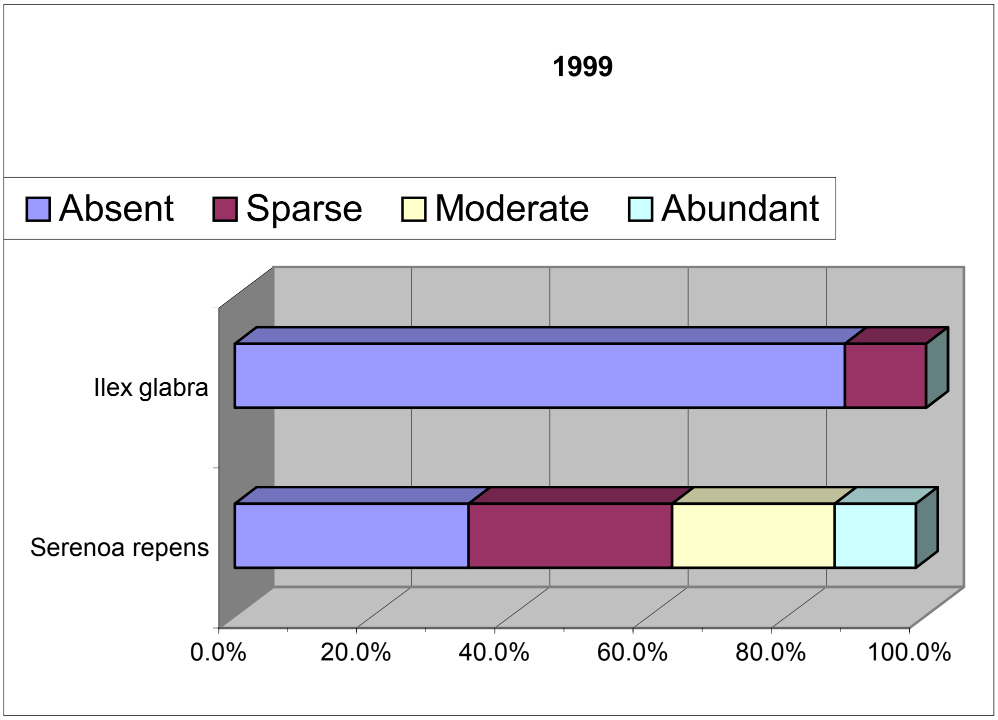


Figure D2. Estimates of abundance of common bear foods along 60, 100-m transects in the sand pine/scrub oak habitat in Ocala National Forest, fall 2001 and fall 2002. Plants containing fruit were estimated to be absent, sparse (1-20%), moderate (21-50%) or abundant (> 50%) along transects.



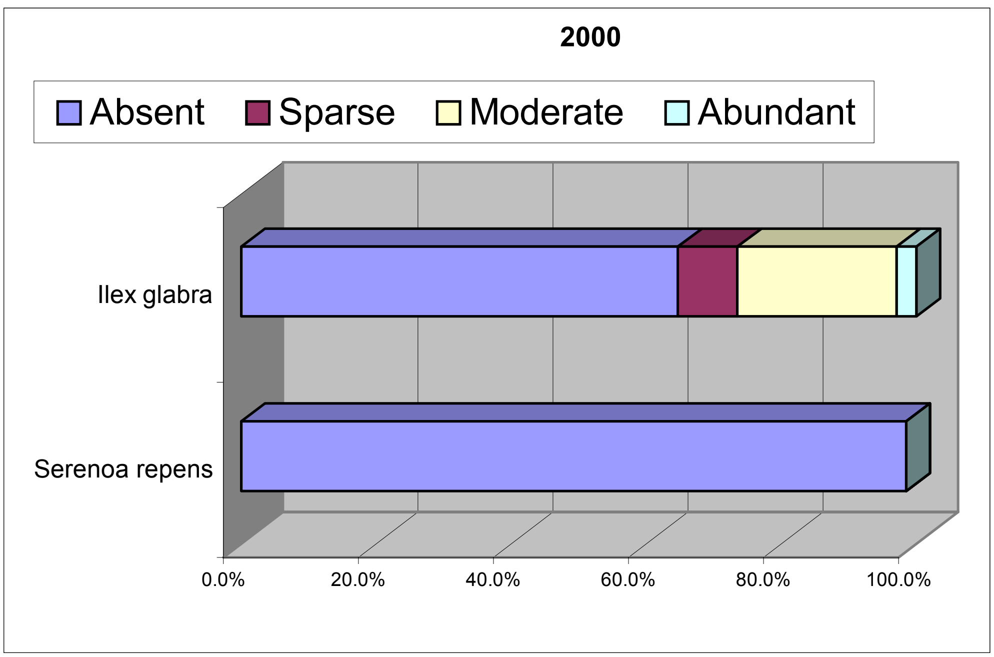
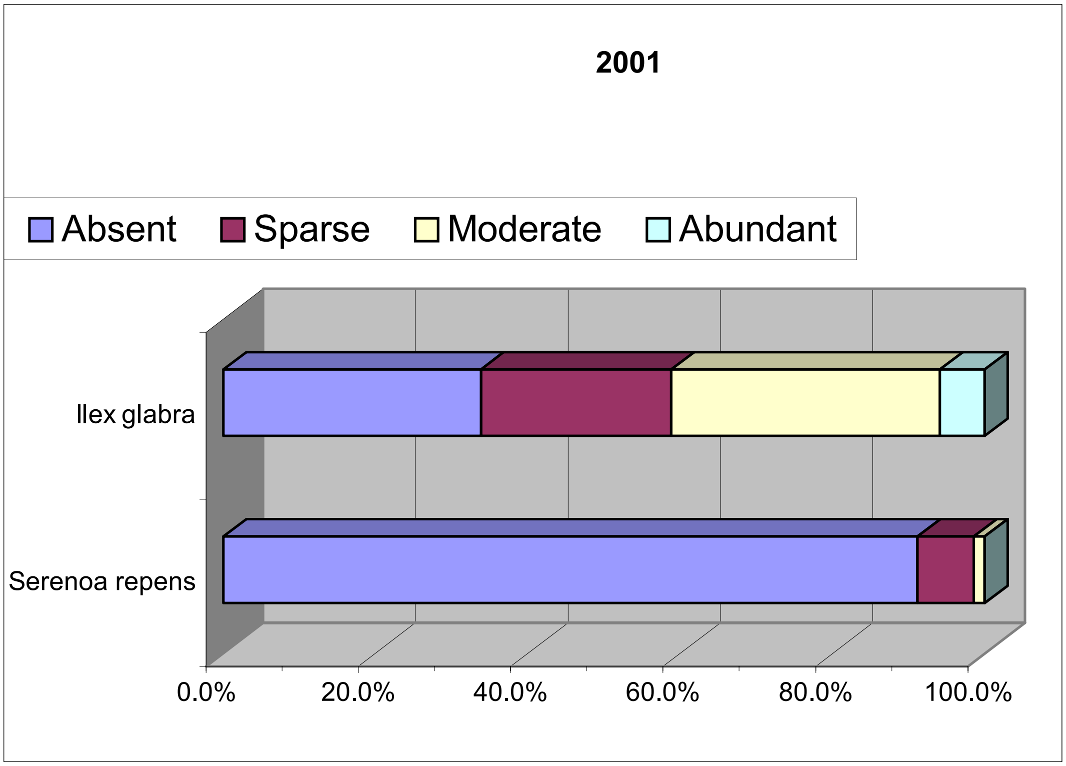


Figure D3. Estimates of abundance of common bear foods along 68, 100-m transects in the pine flatwoods habitat in Ocala National Forest, fall 1999 and fall 2000. Plants containing fruit were estimated to be absent, sparse (1-20%), moderate (21-50%) or abundant (> 50%) along transects.



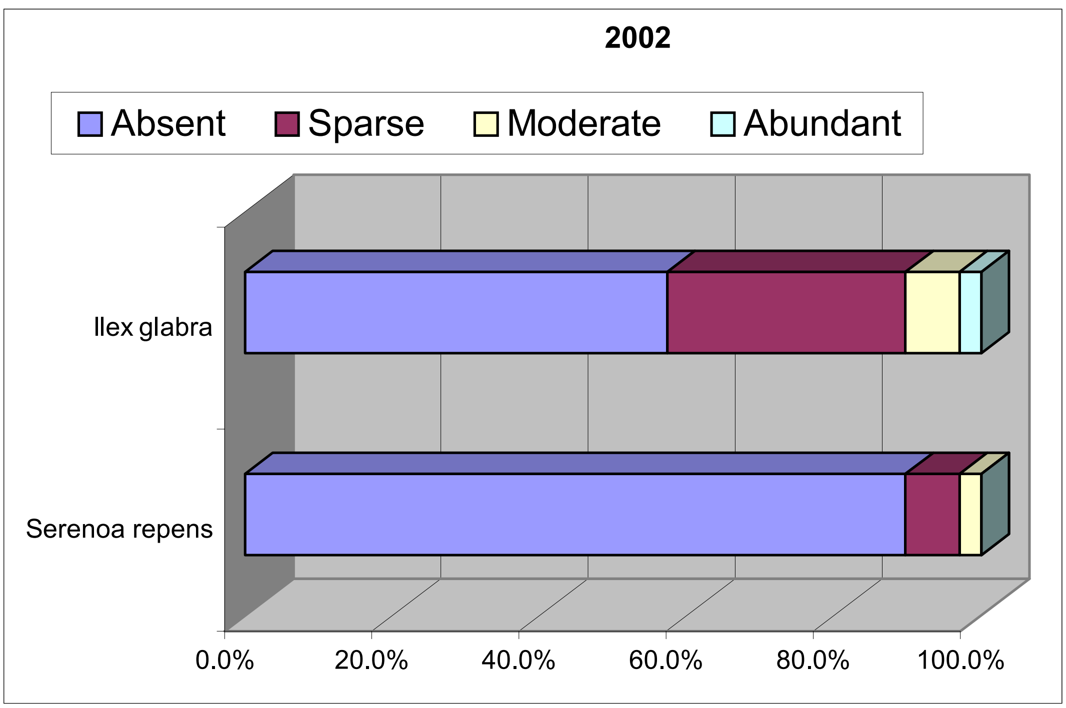


Figure D4. Estimates of abundance of common bear foods along 68, 100-m transects in the pine flatwoods habitat in Ocala National Forest, fall 2001 and fall 2002. Plants containing fruit were estimated to be absent, sparse (1-20%), moderate (21-50%) or abundant (> 50%) along transects.