

# SR 200 WILDLIFE IMPACT STUDY

Final Report  
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Written and Prepared by

Daniel J. Smith, Ph.D., Principal Investigator

with assistance from

Maena Voigt, M.Sc., Field Biologist

GeoPlan Center  
Department of Urban and Regional Planning  
University of Florida  
Gainesville, Florida 32611



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## EXECUTIVE SUMMARY

Ross Prairie is a 6,500 ha reserve that serves as an important habitat node in the Marjorie Harris Carr Cross-Florida Greenway. This diverse ecosystem is a mosaic of many habitat types including bottomland hardwood swamps, pine flatwoods, wet prairies and longleaf pine-wiregrass sandhills. Wildlife includes many rare and listed species including the eastern indigo snake, gopher tortoise, Florida scrub jay, Florida mouse and Florida gopher frog.

SR 200 is a major two-lane state highway that bisects the reserve. Average annual daily traffic level is about 11,000 vehicles. Rapid growth and development in Marion County have recently necessitated the need to widen the road to four lanes. A comprehensive approach that employed several methods was used to determine the current and potential impacts of SR 200 on wildlife resources in the Ross Prairie conservation area in Marion County, Florida. These methods included road-kill and track surveys, mark-recapture and telemetry studies, and GIS analysis. Each method was used to evaluate road impacts on different taxa. This multi-species approach was used to determine effects of the road on presence and movement behavior for suites of wildlife (e.g., primarily carnivores, selected herptiles, and small mammals).

Successful and unsuccessful wildlife crossing locations were determined by performing roadkill and track surveys. The project area was surveyed three to five times per week between May 2002 and December 2004. Firebreaks adjacent and parallel to the highway were monitored for animal tracks from September 2002 to April 2004 by dragging a 1 m wide chain-link harrow behind an ATV. Track paths were checked 1-2 times weekly for carnivore, ungulate, snake and turtle tracks. The mark-recapture study was conducted along the road ROW to determine species presence, habitat use, and movement behavior of small mammals and various herptiles. ROW trapping was conducted five days per week from May 2002-December 2004. The radio-telemetry work targeted wide ranging species (bobcat, coyote, and eastern indigo snake) and key indicator species (gray fox, gopher tortoise, and eastern diamondback rattlesnake).

GIS data layers were used in conjunction with results of telemetry, track, mark-recapture and roadkill studies to conduct analyses to predict movement patterns and behavior of individual species (and collective groups of taxa) to the expansion of SR 200.

Results of the road-kill surveys included 759 individual animals from 57 identifiable species. The majority were anurans followed by meso-mammals. Critical locations of significant numbers or rare species of road-kills by taxa were identified. A total of 537 sets of whitetail deer, 481 sets of carnivore, and 474 sets of snake tracks were recorded. Track site hotspots were identified for snakes, white-tail deer and carnivores. In most instances these correspond to the same locations identified as road-kill hotspots.

A total of 1,777 herptiles were captured in right-of-way drift fence traps. Southern leopard frogs and Florida gopher frogs were most abundant. The two sandhill crossings and the wetland basin were important from a population density standpoint as well as for crossing attempts. Individuals of several species of snakes, frogs, and lizards were recorded crossing the road in the two sandhill crossing sections, and moving to/from the Ross Prairie wetland basin. Of 342 small

mammals captured, one cotton mouse was recorded crossing the road. In addition, only six were found as road-kills. Apparently, the road is a significant barrier to small mammal movement.

Fifty gopher tortoises were captured and marked. Average home range of the 18 gopher tortoises monitored in burrow colonies adjacent to the road was 3.14 ha. Only three attempted crossings of SR 200 were recorded, two were successful and one resulted in death. Tortoises used habitat as close as 10-20 m from the pavement. For gopher tortoise, the road is a semi-permeable barrier. Successful crossings are possible; however their poor mobility increases their risk of collisions with vehicles.

We captured a total of 24 eastern indigo snakes over the entire study area, observed 2 others and encountered 5 road-kills. Home range of the 13 eastern indigo snakes monitored averaged 10.3 ha. Considerable overlap of habitat use occurred, except between large adult males. The areas of highest density of eastern indigo snakes coincided with gopher tortoise colonies and sandhill communities. The individuals we tracked seemed to use the road as a home range boundary. Of course, because of road-kills, there is confirmed evidence that road crossings occur.

Only 5 bobcats, 2 coyotes, and 1 gray fox were captured and used in the carnivore telemetry study. Yet observations, track and scat evidence suggest that a significantly higher number of these animals were present in the Ross Prairie area. Known human-related mortality for those captured was high (50%). Average home range size was 13.67 km<sup>2</sup> for bobcats. Based on telemetry and observational data, the size and configuration of the core area (a significant amount of edge habitat and high road density), and the level and sources of mortality the Ross Prairie core area can only sustain a small number of bobcats, perhaps 8-10 animals. Most radio-collared felids avoided SR 200 or used the road as a home range boundary, whereas the radio-collared canids commonly crossed major roads.

To improve habitat connectivity and eliminate road mortality, we propose a system of culverts, bridges and barrier fences that will increase permeability of the road for a diverse assemblage of wildlife in the area. We recommend installing four box culverts in the upland sandhill areas, bridges at each ecotone between the wetland basin and adjacent uplands, a series of five culverts within the basin adjoined by a herptile exclusion wall, and an equestrian underpass across from the trailhead. Between all these structures should be 2 m barrier fencing with herptile excluding mesh at the base of the fence.

## INTRODUCTION

The Florida Department of Transportation (DOT) is currently engaged in the planning and construction of the multi-lane expansion of SR 200 in western Marion County. This 5.75 mi. long widening project bisects the Ross Prairie State Forest (RPSF) – Halpata Tastanaki Preserve (HTP) – Marjorie Harris Carr Cross-Florida Greenway (CFG) State Conservation Area, an area of approximately 12,000 acres (Figure 1). This area serves as an important landscape linkage between the Green Swamp, Ocala National Forest, and Big Bend conservation areas (Figure 2). The road project will potentially increase habitat fragmentation and negative edge effects, and likely preclude the use of normal landscape management practices such as prescribed fire in many areas of these conservation lands.

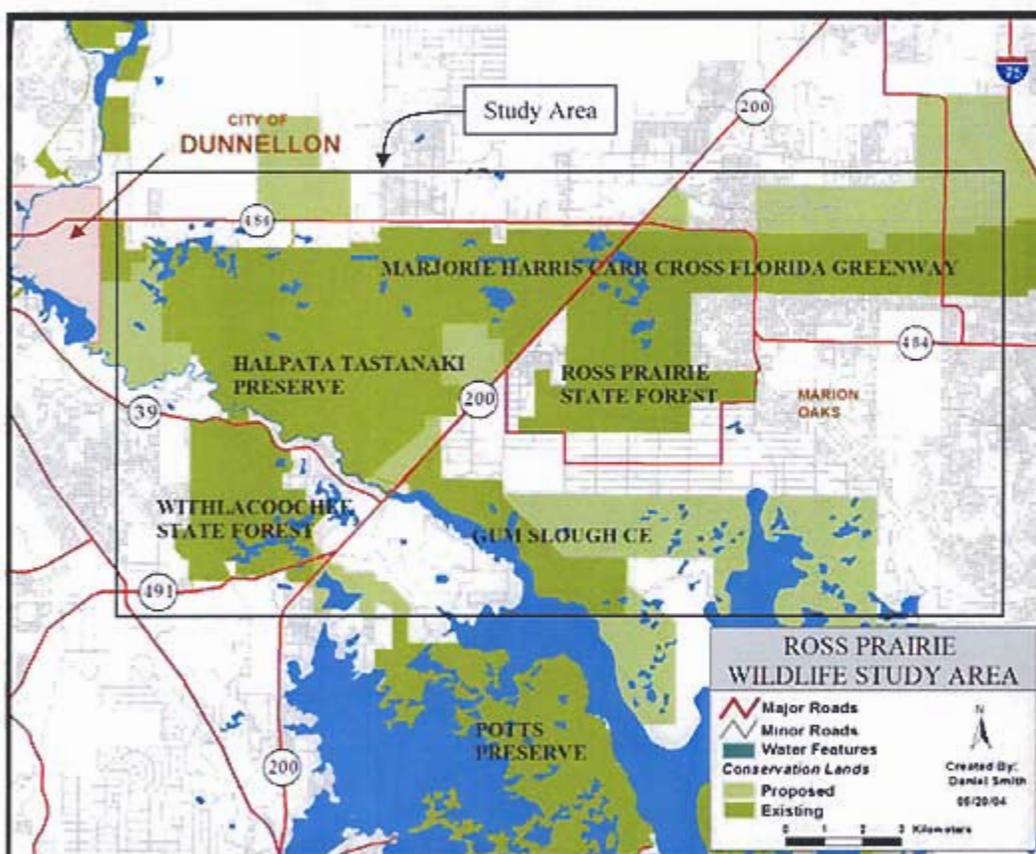


Figure 1. Ross Prairie Study Area Location Map.

The CFG and RPSF properties represent a rapidly vanishing Florida landscape mosaic of xeric upland communities and ephemeral wet prairies. Rare upland ecosystems present at Ross Prairie include longleaf pine sandhill, and sand pine and xeric oak scrub. Xeric upland community types have experienced the highest conversion to human-oriented land uses primarily because of high suitability for urban development, silviculture and the citrus industry. For instance, areal extent of longleaf pine forests and Florida scrub communities has been reduced to approximately 12.5% and 33%, respectively, of that in 1936 (Kautz 1992, WMDs unpublished data 1995).

These are 2 of 21 broad ecosystems/landscapes identified in the U.S. as most endangered (based on extent or area decline, current rarity, number of listed species, and level and urgency of threats) (Noss and Peters 1995). The HTP property contains a significant bottomland hardwood-cypress corridor along the Withlacoochee River at the western extent of the proposed road project that is fed by several ephemeral creeks on the property characterized by hardwood swamps and hammocks and surrounded by pine flatwoods and cypress domes.

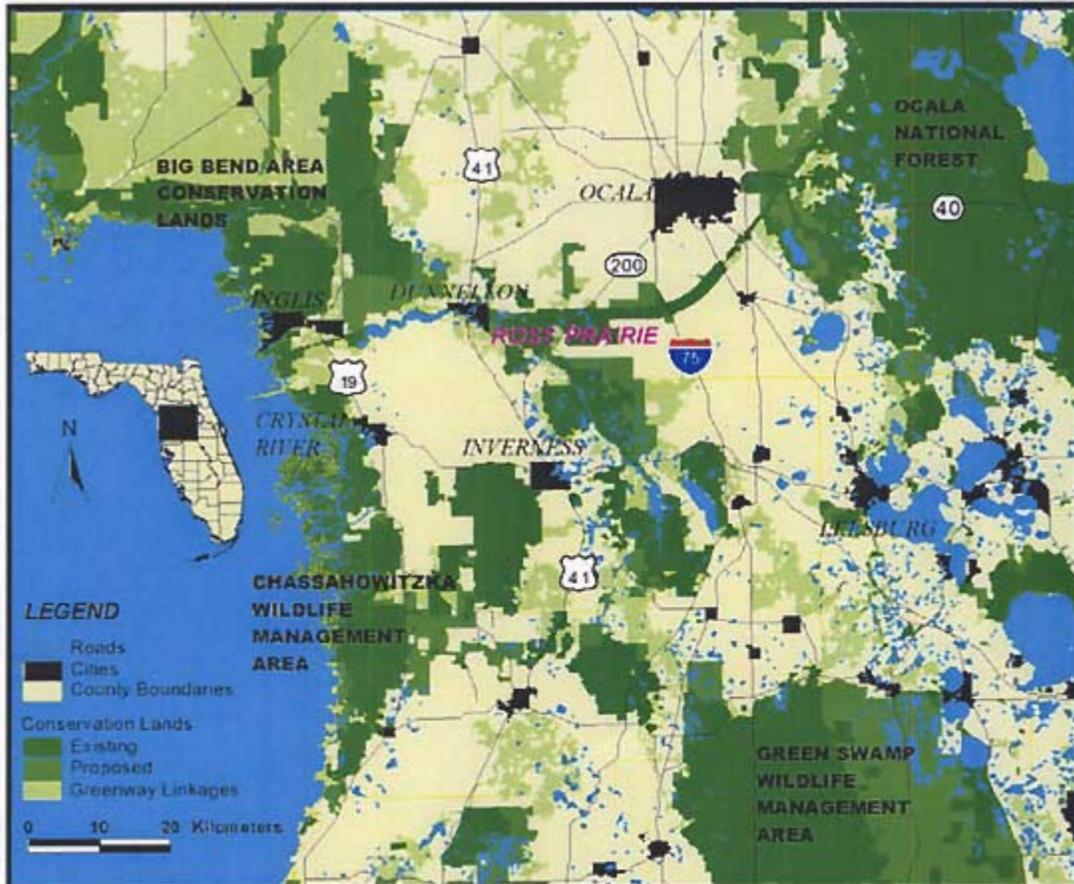


Figure 2. Regional Context for Ross Prairie Conservation Area.

Several management indicator, rare, listed and/or wide-ranging species have been identified in this area, including the Florida Scrub Jay (*Aphelocoma coerulescens*), Great-horned Owl (*Bubo virginianus*), Wood Stork (*Mycteria americana*), Sandhill Crane (*Grus canadensis*), Eastern indigo snake (*Drymarchon corais couperi*), Eastern diamondback rattlesnake (*Crotalus adamanteus*), Florida pine snake (*Pituophis melanoleucus mugitus*), gopher tortoise (*Gopherus polyphemus*), Florida box turtle (*Terrapene Carolina bauri*), snapping turtle (*Chelydra serpentina*), Florida gopher frog (*Rana capito aesopus*), river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and Sherman's fox squirrel (*Sciurus niger shermani*). Several state agencies have identified this area as being especially susceptible to the negative consequences of fragmentation and habitat loss driven by the widening of SR 200.

## **Background Information**

Submitted as a summary of background information and current concerns raised in reference to the road project, the following excerpts were derived from the SR 200 Issue Paper prepared by the SR 200 Working Group, comprised of staff from Southwest Florida Water Management District (SWFWMD), Florida Department of Environmental Protection (DEP), Florida Fish and Wildlife Conservation Commission (FWCC), and Florida Division of Forestry (DOF).

### ***Regarding wetland functions...***

*“The existing two-lane highway was constructed many years ago by filling wetlands that transverse the Ross Prairie, with only a small box culvert to equalize water levels on each side. This has impacted the ecological function of the prairie system for many years. DOT now plans to four-lane this highway, and add an unknown width of median fill, with no mitigation effort to restore continuity to the prairie. Aquatic organisms will still be divided into two fragmented populations by the earth fill. The increasing fragmentation of public lands and isolation of wildlife populations can lead to smaller populations that are more vulnerable to extirpation due to catastrophic events, demographic variability, genetic deterioration, and/or social dysfunction (Wilcove 1987). Currently, six to seven acres of former wetlands are filled; additional projected loss is approximately one acre of wetlands in Ross Prairie.*”

*During extreme high water events, Ross Prairie is connected to other ephemeral wetlands over an extensive area (Federal Emergency Management Agency maps, landuse/landcover maps, pers. observation). SR 200 impacts the connectivity of a much greater area during high water times. By restoring the functional connection of the existing bisected Ross Prairie wetland, an important travel way for both aquatic and terrestrial wildlife would also be restored during normal pool and drought conditions.”*

### ***Regarding impacts to wildlife...***

*“Eastern Indigo Snake: The DOT and US Fish and Wildlife Service (USFWS) procedures for dealing with eastern indigo snakes, a Federally threatened species, entail moving all observed snakes out of the way of construction activities. This approach may protect individual animals during the construction phase of the project, but is ineffective for dealing with populations of this species in landscapes dedicated to conservation. Eastern indigo snakes are wide-ranging animals that typically range from 125 to 250 acres or more (Moler 1992). They are especially susceptible to roadkill because they have large home ranges and are large snakes subject to deliberate persecution.”*

*“Rules for the issuance of Environmental Resource Permits by the SWFWMD, directs the District to consider impacts to wetland species and wetland dependent upland species. Species that fall into this category and have been documented on the RPSF and the HTP Save Our Rivers projects include the following: gopher frog (*Rana capito*), American alligator (*alligator mississippiensis*), Eastern indigo snake (*Drymarchon corais couperi*), bald eagle (*Haliaeetus leucocephala*), Florida sandhill crane (*Grus canadensis pratensis*),*

*limpkin (Aramus quarauna), little blue heron (Egretta caerulea), snowy egret (Egretta thula), white ibis (Eudocimus albus), wood stork (Mycteria americana), and Sherman's fox squirrel (Sciurus niger shermani). All of these species are subject to roadkill, although certain ones are more vulnerable than others. Fox squirrels, American alligators, and eastern indigos cross roads while dispersing to find new territories, and gopher frogs cross roads when migrating to or from their breeding ponds.*

*Conservation lands are the last bastions of hope for many of the State's flora and fauna. One of the primary purposes for placing lands into public ownership is to ensure the maintenance and recovery of wildlife and plant populations. Many species not currently listed are thought to be declining by many scientists or have traits that make them vulnerable to urban sprawl and road expansions. Species that fall into this category that are known to occur in the area include eastern diamondback rattlesnake, river otter, bobcat, eastern coachwhip snake, several species of turtles, and others. Appropriate measures to keep these species "common", including installation of adequate wildlife crossings on roads that span public lands, will have long-term economic benefits by curtailing listing and species recovery efforts in the future."*

#### **Regarding habitat connectivity issues...**

*"SR 200 bisects several significant state lands, including the RPSF, the CFG and the HTP. This greater network extends from the headwaters of the Withlacoochee River in the Green Swamp northward along the river corridor to the Goethe State Forest and ultimately the Gulf Hammock system. Other core areas associated with this system include the coastal conservation lands in Hernando and Citrus counties, the Annuteliga Hammock project and the Citrus tract of the Withlacoochee State Forest.*

*Wildlife management objectives on these public lands include the recovery and maintenance of regional wildlife populations as well as listed species and the landscape level habitat systems that support them. The value of these public lands in terms of the maintenance of connectivity to core habitat areas will become more important as future development occurs within rural areas of Marion and adjacent counties. Therefore, an important statewide objective is to prevent the degradation of habitat from incompatible land use changes such as the barrier effect caused by highways and other associated developments. Four-laning SR 200 will have a significant impact on wildlife movements on these public lands since the high-way bisects the wetlands surrounding uplands and transition habitats associated with Ross Prairie. These meandering edges are important movement corridors and every effort should be made to improve the upland/wetland connection where it intersects the highway. In our opinion, the equestrian and small box culverts planned for the Ross Prairie wetland would be insufficient for an effective upland and wetland habitat connection within this important system of state lands which covers more than 20,000 acres."*

#### **Regarding roadkills...**

*"Many other species of wildlife including both listed and non-listed amphibians, mammals, reptiles, aquatic organisms and birds will suffer roadkill mortality. These include the*

*Florida pine snake, Sherman's fox squirrel, Florida mouse and gopher tortoise, all listed as Species of Special Concern (Wood 1996). Although exclusionary fencing will provide protection for some species, roadkills will still occur. Crossing four-laned roads is particularly problematic for the gopher tortoise, Sherman's fox squirrel and the Indigo snake, protected under state and federal law as a threatened species (Wood 1996). In addition, several herpetologists have expressed the belief that roadkills may be affecting populations of common reptiles and amphibians (Boarman and Sazaki 1996; Nicholson 1978)."*

***Regarding habitat management...***

*"The herbaceous wetlands on the subject lands, most notably Ross Prairie and the numerous herbaceous marshes on the HTP are ecologically valuable and highly productive systems. These wetlands provide nesting sites for birds including the listed sandhill crane and breeding sites for various herpetofauna species including the listed gopher frog. As with the uplands, these herbaceous wetlands require regular fire to maintain their ecological integrity and functionality."*

***Regarding habitat loss and degradation...***

*"Habitat quality will also be degraded due to the reduced management potential. Furthermore, the state is attempting to manage these lands in a way that benefits a wide compliment of species. However, the proposed widened road will serve as a wildlife population sink, through increased roadkills, which may further reduce the types and numbers of some listed species whose population levels are already critically low."*

***Preliminary DOT proposed actions to address adverse road impacts...***

*"To mitigate the project's potential effects, the DOT has proposed to install 1) a 40- x 16-foot high equestrian culvert under SR 200 for trail users of the HTP, RPSF and CFG properties, and 2), two 5- x 10-foot box culverts within the wetland crossing on Ross Prairie. DOT has also agreed to provide exclusionary fencing along public-owned portions of SR 200 to limit roadkills of gopher tortoises."*

***Regarding working group findings in response to Type 2 Categorical Exclusion & Environmental Management Study...***

*"The SR 200 Working Group believes that the Type 2 Categorical Exclusion issued by the Federal Highway Administration (FHWA) was based on inadequate information provided by DOT in the Environmental Management Study submitted on 8, November 1996. Deficiencies identified by the SR 200 Working Group include the following:*

*The proposed box and equestrian culverts and equestrian crossing will not adequately avoid the barrier effect created by the expanded highway, and upland and wetland habitat connectivity will be reduced.*

*No suitable crossing areas for tortoises and other upland species are proposed.”*

In 2001, the SR 200 Task Team, comprised of staff from DOT, FHWA, SWFWMD, DEP, FFWCC, and DOF established final recommendations which include:

- Construction of a 40' x 16' Equestrian Bridge on the north side of Ross Prairie.
- Construction of two 40' slab bridges approximately 6'- 8' high located at the wetland-upland ecotone on the north (Station 186+20) and south (Station 182+90) sides of Ross Prairie.
- Replacement of existing box culvert with a new box culvert in the same location that is approximately 8'-10' high and 10' wide.
- Construction of a 4' concrete herptile wall along the wetland portion of Ross Prairie that is to be placed at the normal water line or higher. Fencing will be placed on top of the wall.
- Fence the boundary of the project along state lands. The fence will be on DOT right-of-way and maintained by DOT.
- Use only native vegetation on right-of-way during roadside stabilization (except for Bahia or Bermuda grass) in accordance with clear zone standards. Resource agencies will do supplemental plantings on state lands where possible to provide vegetated visual and audio buffers.
- Research funded by DOT in an area the Resource agencies propose.

It is per these deliberations and the request for appropriate studies to determine parameters of habitat extent and connectivity in association with the statewide greenways network, evidence of wildlife movement patterns associated with the road right-of-way, and roadkill patterns that the following research project was conducted.

The objectives of this research were:

- To assemble existing information concerning inventories of ecological resources in the study area and to supplement this by gathering new information regarding extent of habitat types and wildlife species present. This data will be used for habitat use and movement analysis.
- To conduct intensive radiotelemetry studies of various species to determine current movement patterns of wildlife in relation to the highway and to assess the road's current and potential impacts to movement and habitat connectivity.

- To assemble data that will help determine potential location of a wildlife crossing near the Withlacoochee River, taking into consideration that land on both sides of the road shall be publicly-owned.

### **Comprehensive Approach to Assess Road Impacts**

This project was funded for 2 yrs by three State agencies, DOT, DEP and SWFWMD. The level of funding and time horizon allowed the research team to employ several methods to conduct a thorough examination of current and potential impacts of the highway on wildlife resources in the Ross Prairie area. Seven primary activities were engaged by the research team:

- coordinate with agencies associated with each management unit to assemble information such as habitat inventories and species surveys
- consult with DOT, other agencies and groups as applicable
- conduct roadkill surveys, and prepare and monitor track paths along SR 200
- conduct trapping and mark-recapture studies along the right-of-way for small mammals and herptiles to determine effects of the existing highway on local movement behavior
- conduct trapping and fit radiotransmitters to management indicator and/or wide-ranging species (candidates: bobcat, gray fox, red fox, coyote, gopher tortoise, Eastern coachwhip, Eastern indigo snake, Eastern diamondback)
- acquire aerial photographs and GIS information; create habitat use and connectivity layers for the area in reference to overall greenways system and potential impacts of SR 200 widening project
- use telemetry and trapping data in coordination with GIS information to conduct species movement analyses

The scientific information obtained from this broad approach enabled the research team to evaluate the ability of the SR 200 Task Team recommended retrofit measures to maintain or improve the ecological integrity of the area. Where appropriate, changes to these recommendations are proposed.

## **METHODOLOGY**

### **Organizational Meetings (Multiagency Coordination)**

Researchers conducted this project as a cooperative effort among all agencies with specific interest in the outcome of this research including SWFWMD, DEP, DOF, FFWCC and DOT. The first step was to assemble all information gathered from various agencies to facilitate the research objectives. This included information gathered for habitat and species inventories, previous data collected on faunal movements and/or species location records, aerial photos, imagery or digital data, local government and state agency land development and management plans, land ownership and descriptions. This information was used to facilitate GIS and field studies.

### **Roadkill Surveys and Right-of-Way (ROW) Track Monitoring**

Successful and unsuccessful wildlife crossing locations were determined by performing roadkill and track surveys. SR 200 within the project area was surveyed three to five times per week to record roadkills found on the road or adjacent verges between May 2002 and May 2004. Roadkill data collected included date, species type, sex, traffic lane, and direction of travel. Firebreaks adjacent and parallel to the highway were monitored for animal tracks from September 2002 to April 2004. The researchers coordinated with the Resource agencies for initial preparation of the firebreaks that required disking to remove established vegetation. Track paths were dragged using a 1 m wide chain-link harrow pulled by ATV. Tracks paths were checked twice weekly for carnivore, ungulate, snake and turtle tracks. Track data collected included date, species type, firebreak, and direction of travel. Track and roadkill locations were recorded in a spatial database.

### **Road ROW Habitat Monitoring for Small Mammals and Herptiles**

A mark-recapture study was conducted along the road ROW to determine species presence, habitat use, and movement behavior. ROW trapping was conducted five days per week from May 2002 to Jan 2004. Traps were checked each morning they were open. Twenty-four drift fence arrays with (metal screen) funnel and (5 gal bucket) pitfall traps were used to capture small mammals and various herptiles (Figure 3a and 3b). Shade covers were placed over each trap and wet sponges were used in each trap to prevent desiccation during hot months. Cotton balls were used to provide insulation in the winter.

Those individuals captured were marked and released and traps replaced. Small mammals (primarily rodents) were marked using uniquely numbered metal ear tags. Frogs and lizards were marked by toe-clipping (Heyer et al. 1994). Snakes were marked by clipping ventral scales (Brown 1976). Morphometrics were recorded for each species, and sex and age when possible. Other data collected included drift fence array number and the trap location with respect to roadside vs. habitat side. Direction of travel was also recorded when it could be determined. Trap pairs were constructed perpendicular to the road surface and diagonally angled directly across from each other at selected sites (Figure 4). Placement intervals varied along a gradient of differing habitat types on each side of the road corridor. Habitat types (n) where drift fence

arrays were placed include longleaf pine-turkey oak sandhill (8), xeric oak scrub (3), wet prairie (7), and hardwood hammock (6). The objective was to detect movement from one roadside to the other through recaptures.

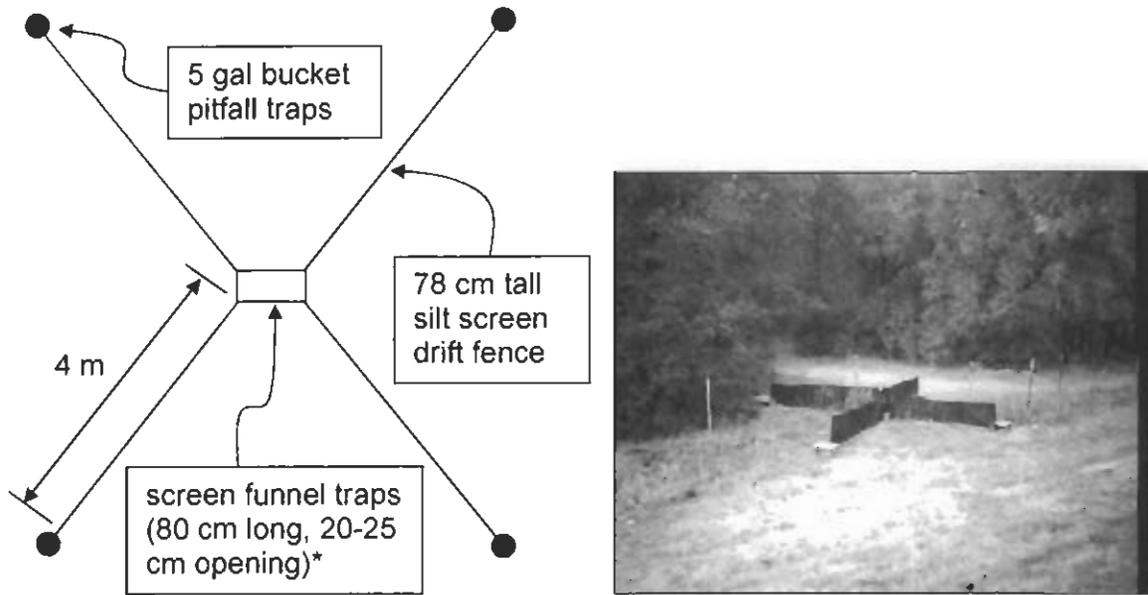


Figure 3a and 3b. Drift Fence Trap Array Design.

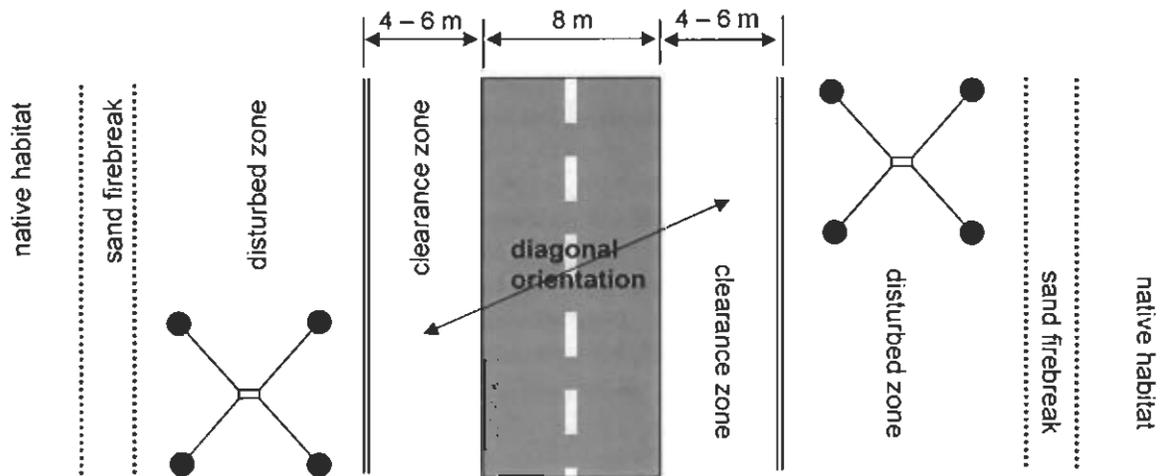


Figure 4. Drift Fence Trap Array Configuration.

Control drift fence arrays were constructed at locations 500 m or more from the road ROW and checked each morning for three months, five days per week, from February to April 2004. Control drift fence arrays were located along habitat ecotones. Each array consisted of a 30 m x 78 cm silt fence fitted with three 5-gal bucket pitfall and two screen funnel traps on each side of the silt fence. Habitat ecotones where traps (n) were located included wet prairie – longleaf pine

forest (2), wet prairie – xeric oak scrub (1), wet prairie - hardwood hammock (1), longleaf pine forest – xeric oak scrub (1), longleaf pine forest – hardwood hammock (1), longleaf pine forest – sand pine scrub (1) and hardwood hammock – palmetto thicket (1). These were used to determine if any differences existed between species presence found in primary habitat and that in disturbed ROW habitat.

Transects were used to estimate habitat quality, plant diversity and extent of edge effects on vegetation along the right-of-way. Each transect was 100 m long by 2 m wide and oriented perpendicular to the paved surface. We recorded ground cover percentage, canopy light penetration, tree dbh, plant species diversity and abundance at eleven transects randomly located within each habitat type present where right-of-way trapping was conducted.

### **Radio-telemetry Studies**

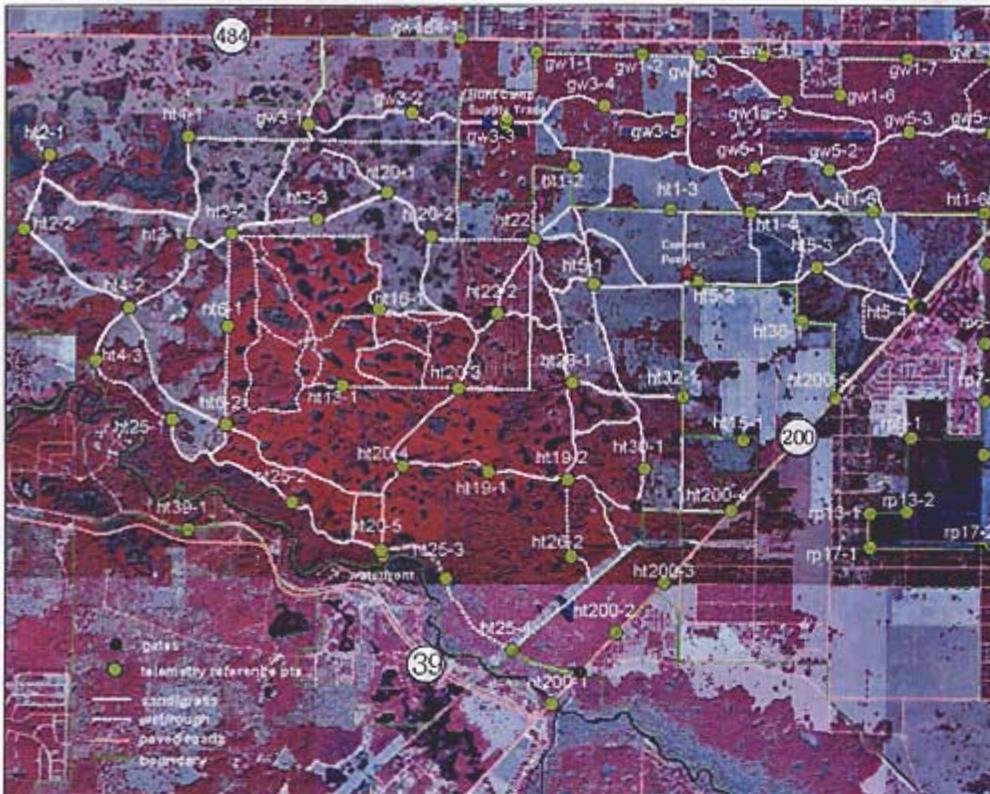
A multi-species approach was used to determine effects of the road on movement behavior for suites of wildlife (e.g., primarily carnivores, selected herptiles, and small mammals as specified previously). The intent of this approach was to target those most representative of species expected to experience the greatest negative impact from increased habitat fragmentation, isolation, and loss and susceptibility to increased road mortality. Consultation with SWFWMD and FFCC staff was conducted prior to selection of the most representative species. Wide ranging target species included bobcat, red fox, coyote, and Eastern indigo snake. Key indicator target species included gray fox, gopher tortoise, Eastern coachwhip, and Eastern diamondback rattlesnake.

A fixed location grid was developed for the area (using GPS) to efficiently record position bearings for triangulation of animal locations. Fixed reference points included service road and firebreak intersections or other permanent landmarks and were arranged so that the maximum distance between reference points was 500 m (Figure 5).

Baited Tomahawk-style wire-box traps (122 × 20 × 20 cm) and Victor soft-catch padded foothold traps were used to capture carnivores. ‘Tomahawk’ box traps contain a separate bait compartment to the rear of the trap where live bait is placed. These were primarily used for capturing bobcats and baited with live chickens (Figure 6). Box traps were placed in various locations and remained for at least two weeks to allow for acclimation and periodic movement cycles of bobcats through their home range. Traps were shaded to reduce hyperthermia for captured animals. Traps were checked every morning on a five day per week cycle. Foothold traps were used to capture canids. Foothold traps were cable anchored to small trees at selected trap sites to prevent trapped animals from escaping. Traps were set at dusk and checked at dawn. Each trap was baited with chicken livers or other meat scraps obtained from local grocery stores.

Captured carnivores selected for radio-transmitters were immobilized using Ketamine HCL at 12-15 mg/kg of body weight hand injected into the hindquarters with a pole syringe. Animals were anesthetized/sedated for 30 – 45 minutes. During this period, eyes were covered to reduce stress, temperature monitored, physical measurements taken (e.g., weight, length), general health observations recorded, and hair samples taken to perform genetic analyses. Water and/or ice were used to prevent overheating from the anesthesia, when necessary. Each individual was

fitted with a 36 month radio-collar and ear-tagged for future identification. Radio-collars weighed less than 10% of subject body weight, approx. 95 g. Each animal was observed for adverse effects while anesthetized, during recovery from anesthesia and prior to release. Positions of those individuals fitted with radio-collars were located on a regular basis at least once per week and on a limited basis, on continuous 8 hour cycles. The majority of mammal locations were recorded at night consistent with the time when the carnivores were active.



**Figure 5. Telemetry Reference Point Grid.** Used as fixed positions to obtain bearings of locations of radio-tagged individuals.

Field surveys were performed to locate gopher tortoise burrows within 200 m of the road ROW for obtaining tortoise subjects to fit with radio-transmitters. A control area was also selected greater than 1,000 m from the road ROW. Gopher tortoises were captured by placing 5 gal bucket pitfall traps at the entrance to active burrows (Figure 7). Each trap was set using aluminum foil covered with sand and shaded either by palm fronds or plywood covers. Traps were checked each morning 5-7 days per week. Data collected on tortoises included morphometrics and general health observations. Radio-transmitters were glued to the front of the carapace using fast-setting epoxy (Figure 8). Transmitter battery life was 20 – 24 months. Also, each tortoise was marked by drilling holes in the rear scutes (reference). Actual locations of radio-tagged tortoises were recorded once or twice weekly.



**Figure 6. Tomahawk Box Trap with Separate Upper/Lower Chambers. The lower chamber is baited with a live Cornish hen.**



**Figure 7. Gopher Tortoise Pitfall Trap with Shade Cover. Set at the entrance to an active burrow.**

Snakes were captured by hand while conducting roadkill, track, trap and telemetry checks and from independent snake hunting activities. Captured snakes suitable for radio-transmitter

implants were taken to the University of Florida, College of Veterinary Medicine, Small Animal Hospital Zoological Medicine Unit for aseptic surgery. Prior to surgery, individuals were measured (e.g., weight, length) and general health observations recorded. Radio-transmitter implants were 10 x 38 mm, weighed 11 g (less than 10% of subject body weights) and had battery lives of 12-18 months. Following recovery, each snake was returned to the original site of capture for release. Locations of radio-tagged snakes were determined in the same manner as specified above for mammals when actual locations could not be accessed.

The objective was to trap animals near the road corridor and intensively detect their movements over the course of approximately one year. The program LOAS (Ecological Software Solutions) was used to triangulate position bearings for each radio-tagged individual. Home range size and habitat analysis was conducted using ESRI Arcview, and the Habitat Analysis and Spatial Movement Analysis extensions.



**Figure 8. A Gopher Tortoise with Glue-on Radio-transmitter.** The transmitter is affixed to the front of the carapace.

### **GIS and Image Analysis**

GIS layers for this analysis included aerial photographs, hydrology, roads, existing land cover data layers, species location information, etc. These data layers were used in conjunction with results of telemetry, track, mark-recapture and roadkill studies to conduct analyses to predict movement patterns and behavior of individual species (and collective groups of taxa) to the expansion of SR 200. ESRI Arcview GIS was used to perform these analyses.

## RESULTS

Results are presented in three major sections: an inventory of species in the study area; an assessment of landscape context, habitat diversity and quality; and an analysis of the targeted monitoring activities (road-kills, mark-recapture, tracks, and telemetry) for each faunal group.

### Species Inventories

#### Focal species

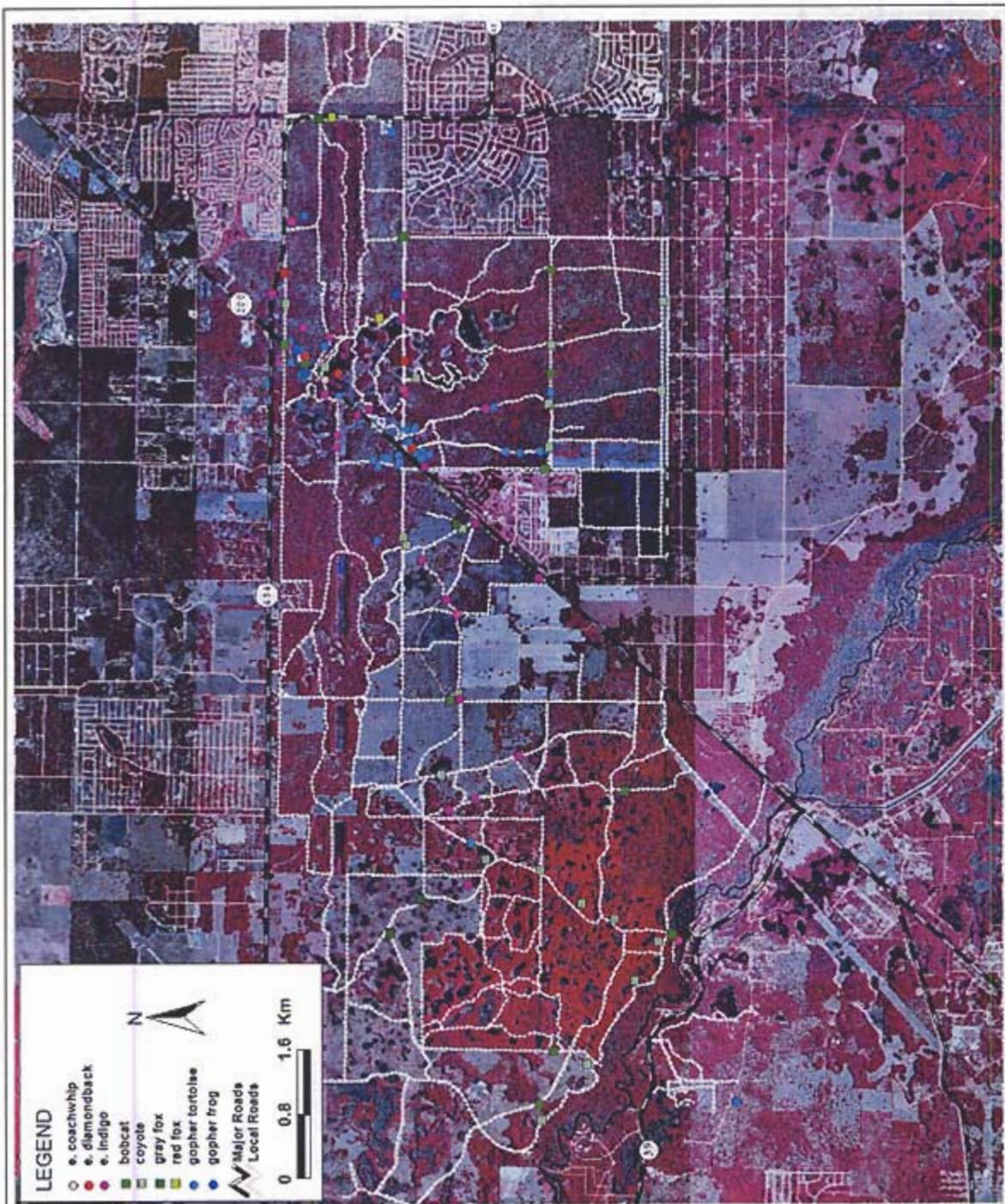
Several focal species were identified within the study area. Focal species selected were those that represented terrestrial wildlife populations in the Ross Prairie Area most susceptible to the negative impacts of roads. Wide-ranging species were significant in this regard. Our focus was restricted primarily to non-volant species, though this does not mean that many birds, specifically Florida scrub jay, may not be negatively impacted by roads. Representatives from three faunal groups were intensively monitored including the bobcat, gray fox/red fox, coyote, Florida mouse, eastern indigo snake, eastern diamondback, eastern coachwhip, gopher tortoise and gopher frog. Table 1 displays a summary of the focal species records obtained from 2001 to 2004 in the Ross Prairie study area. These included captures, sightings, signs, and road-kills. Figure 9 shows the location of focal species recorded.

**Table 1. Focal Species Recorded Between 2001 and 2004.**

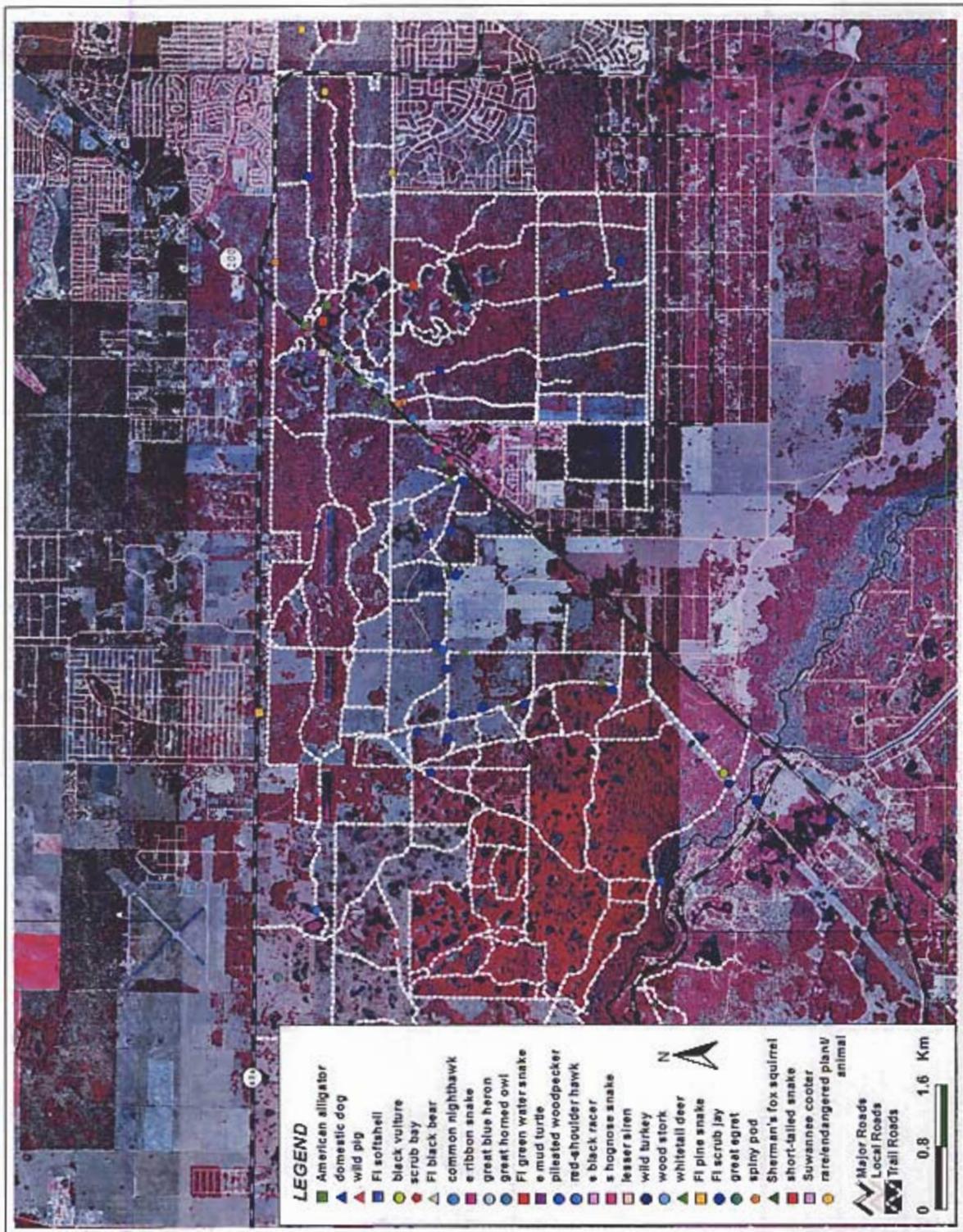
Type	Scientific Name	Common Name	Status	# Recorded
Carnivore	<i>Vulpes vulpes</i>	red fox		2
Carnivore	<i>Urocyon cinereoargenteus</i>	gray fox		15
Carnivore	<i>Felis rufus</i>	bobcat		16
Carnivore	<i>Canis latrans</i>	coyote		16
Herpetofauna	<i>Drymarchon corais couperi</i>	e. indigo	LT	35
Herpetofauna	<i>Masticophis flagellum</i>	e. coachwhip		6
Herpetofauna	<i>Crotalus adamanteus</i>	e. diamondback		6
Herpetofauna	<i>Gopherus polyphemus</i>	gopher tortoise	LS	71
Herpetofauna	<i>Rana capito</i>	Florida gopher frog	LS	609
Small mammal	<i>Podomys floridanus</i>	Florida mouse	LS	131

#### Other species

Comprehensive species inventories were only performed on the focal species; however we also recorded locations of other vertebrates found in the study area. These species are listed in Table 2 and their locations shown in Figure 10. Many other common species were observed but not recorded. Each species record in Table 2 may include more than one individual and more than one method of observation. The method was listed in the following priority: capture, road-kill, sighting and sign. Status refers to level of State protection: LE – endangered, LT – threatened, and LS – species of special concern. Details regarding road-kills and captures are described in later sections.



**Figure 9. Locations of Focal Species.** These locations include recorded captures\*, sightings\*, and signs between 2001 and 2004. \*Excludes road-kills and mark-recaptures that are reported in later sections.



**Figure 10. Locations of Other Species.** These locations include recorded captures\*, sightings\*, and signs between 1950 and 2004\*\*. \*Excludes road-kills and mark-recaptures that are reported in later sections. \*\*Includes Florida Natural Areas Inventory records.

**Table 2. Other Species Recorded Between 2001 and 2004.**

Type	Scientific Name	Common Name	Method*	Status
Avifauna	<i>Fulica americana</i>	American coot	road-kill	
Avifauna	<i>Corvus brachyrhynchos</i>	American crow	road-kill	
Avifauna	<i>Haliaeetus leucocephalus</i>	bald eagle	FNAI <sup>1</sup>	LT
Avifauna	<i>Strix varia</i>	barred owl	road-kill	
Avifauna	<i>Coragyps atratus</i>	black vulture	road-kill	
Avifauna	<i>Quiscalus major</i>	boat-tailed grackle	road-kill	
Avifauna	<i>Thryothorus ludovicianus</i>	Carolina wren	road-kill	
Avifauna	<i>Chordeiles minor</i>	common nighthawk	sighting	
Avifauna	<i>Otus asio</i>	eastern screech-owl	road-kill	
Avifauna	<i>Aphelocoma coerulescens</i>	Florida scrub jay	sighting	LT
Avifauna	<i>Ardea herodias</i>	great blue heron	sighting	
Avifauna	<i>Ardea alba</i>	great egret	sighting	
Avifauna	<i>Bubo virginianus</i>	great-horned owl	capture	
Avifauna	<i>Cardinalis cardinalis</i>	northern cardinal	road-kill	
Avifauna	<i>Dryocopus pileatus</i>	pileated woodpecker	sighting	
Avifauna	<i>Porphyryla martinica</i>	purple gallinule	road-kill	
Avifauna	<i>Buteo lineatus</i>	red-shoulder hawk	capture	
Avifauna	<i>Agelaius phoeniceus</i>	red-wing blackbird	road-kill	
Avifauna	<i>Buteo brachyurus</i>	short-tailed hawk	FNAI <sup>2</sup>	
Avifauna	<i>Parus bicolor</i>	tufted titmouse	road-kill	
Avifauna	<i>Meleagris gallopavo</i>	wild turkey	sighting	
Avifauna	<i>Mycteria americana</i>	wood stork	sighting	LE
Avifauna	<i>Calaptes auratus</i>	yellow-shafted flicker	road-kill	
Carnivore	<i>Felis domesticus</i>	domestic cat	road-kill	
Carnivore	<i>Canis familiaris</i>	domestic dog	sighting	
Carnivore	<i>Ursus americanus floridana</i>	Florida black bear	sign**	LT
Herpetofauna	<i>Cnemidophorus sexlineatus</i>	6-lined racerunner	capture	
Herpetofauna	<i>Hyla gratiosa</i>	barking tree frog	capture	
Herpetofauna	<i>Alligator mississippiensis</i>	American alligator	sighting	LE
Herpetofauna	<i>Anolis sagrei</i>	brown anole	capture	
Herpetofauna	<i>Rana catesbeiana</i>	bullfrog	capture	
Herpetofauna	<i>Thamnophis sirtalis</i>	common garter snake	capture	
Herpetofauna	<i>Elaphe guttata</i>	corn snake	capture	
Herpetofauna	<i>Tantilla relicta</i>	crown snake	capture	
Herpetofauna	<i>Micrurus fulvius</i>	eastern coral snake	capture	
Herpetofauna	<i>Ophisaurus ventralis</i>	eastern glass lizard	capture	
Herpetofauna	<i>Kinostemon subrubrum</i>	eastern mud turtle	road-kill	
Herpetofauna	<i>Gastrophryne carolinensis</i>	eastern narrowmouth toad	capture	
Herpetofauna	<i>Thamnophis sauritus</i>	eastern ribbon snake	sighting	
Herpetofauna	<i>Scaphiopus holbrooki</i>	eastern spadefoot toad	capture	
Herpetofauna	<i>Sceloporus undulatus</i>	fence lizard	capture	
Herpetofauna	<i>Terrapene carolina</i>	Florida box turtle	capture	
Herpetofauna	<i>Derochelys reticularia</i>	Florida chicken turtle	road-kill	
Herpetofauna	<i>Chrysemys floridana floridana</i>	Florida cooter	capture	
Herpetofauna	<i>Nerodia cyclopion floridana</i>	Florida green water snake	road-kill	
Herpetofauna	<i>Kinostemon subrubrum steindachneri</i>	Florida mud turtle	road-kill	
Herpetofauna	<i>Pituophis melanoleucus mugitus</i>	Florida pine snake	road-kill	LS

Table 2. continued.

Type	Scientific Name	Common Name	Method*	Status
Herpetofauna	<i>Trionyx ferox</i>	Florida softshell turtle	road-kill	
Herpetofauna	<i>Anolis carolinensis</i>	green anole	capture	
Herpetofauna	<i>Hyla cinerea</i>	green tree frog	capture	
Herpetofauna	<i>Eleutherodactylus planirostris</i>	greenhouse frog	capture	
Herpetofauna	<i>Scincella lateralis</i>	ground skink	capture	
Herpetofauna	<i>Siren intermedia</i>	lesser siren	sighting	
Herpetofauna	<i>Eumeces egregius</i>	mole skink	capture	
Herpetofauna	<i>Stemotherus odoratus</i>	musk turtle	road-kill	
Herpetofauna	<i>Bufo quercicus</i>	oak toad	capture	
Herpetofauna	<i>Chrysemys floridana peninsularis</i>	peninsula cooter	road-kill	
Herpetofauna	<i>Hyla femoralis</i>	pinewoods tree frog	capture	
Herpetofauna	<i>Diadophis punctatus</i>	ringneck snake	capture	
Herpetofauna	<i>Cemophora coccinea</i>	scarlet snake	capture	
Herpetofauna	<i>Stilosoma extenuatum</i>	short-tailed snake	FNAI3	LT
Herpetofauna	<i>Eumeces inexpectatus</i>	southeastern 5-lined skink	capture	
Herpetofauna	<i>Coluber constrictor</i>	southern black racer	capture	
Herpetofauna	<i>Acris gryllus</i>	southern cricket frog	capture	
Herpetofauna	<i>Heterodon simus</i>	southern hognose snake	capture	
Herpetofauna	<i>Rana sphenocephala</i>	southern leopard frog	capture	
Herpetofauna	<i>Bufo terrestris</i>	southern toad	capture	
Herpetofauna	<i>Pseudemys concinna suwanniensis</i>	Suwannee cooter	road-kill	LS
Herpetofauna	<i>Elaphe obsoleta quadrivittata</i>	yellow rat snake	road-kill	
Meso-mammal	<i>Dasyopus novemcinctus</i>	nine-banded armadillo	road-kill	
Meso-mammal	<i>Procyon lotor</i>	raccoon	capture	
Meso-mammal	<i>Mephitis mephitis</i>	striped skunk	road-kill	
Meso-mammal	<i>Didelphis virginiana</i>	Virginia opossum	capture	
Small mammal	<i>Peromyscus gossypinus</i>	cotton mouse	capture	
Small mammal	<i>Sylvilagus floridanus</i>	eastern cottontail rabbit	road-kill	
Small mammal	<i>Sciurus carolinensis</i>	eastern gray squirrel	road-kill	
Small mammal	<i>Scalopus aquaticus</i>	eastern mole	capture	
Small mammal	<i>Neotoma floridana</i>	eastern wood rat	capture	
Small mammal	<i>Mustela frenata peninsulæ</i>	Florida long-tailed weasel	FNAI <sup>4</sup>	
Small mammal	<i>Ochrotomys nuttalli</i>	golden mouse	capture	
Small mammal	<i>Sigmodon hispidus</i>	hispid cotton rat	capture	
Small mammal	<i>Cryptotis parva</i>	least shrew	capture	
Small mammal	<i>Sylvilagus palustris</i>	marsh rabbit	road-kill	
Small mammal	<i>Peromyscus polionotus</i>	oldfield mouse	capture	
Small mammal	<i>Sciurus niger shermani</i>	Sherman's fox squirrel	road-kill	LS
Small mammal	<i>Geomys pinetis</i>	southeastern pocket gopher	capture	
Small mammal	<i>Sorex longirostris</i>	southeastern shrew	capture	
Small mammal	<i>Blarina carolinensis</i>	southern short-tail shrew	capture	
Ungulate	<i>Odocoileus virginiana</i>	whitetail deer	road-kill	
Ungulate	<i>Sus scrofa</i>	wild pig	road-kill	

\* indicates record from the Florida Natural Areas Inventory (1 – no date, 2 - 1991, 3 - 1991, 4 - 1967)

\*\* scat identified by DOF staff in 2001.

Six faunal groups are found in Tables 1 and 2 including avifauna, carnivores, herpetofauna, mesomammals, small mammals and ungulates. Although not a complete list, we recorded presence of 23 species of birds. From captures, observations and signs, 7 carnivores were found. Herpetofauna was the largest group surveyed and included presence of 48 species. We encountered 16 species of small mammals. Four different mesomammals and 2 ungulates were commonly observed. Five species were recorded previously (FNAI records) in the area, but were not observed during this study. These include the bald eagle *Haliaeetus leucocephalus*, short-tailed hawk *Buteo brachyurus*, Florida long-tailed weasel *Mustela frenata peninsulae*, short-tailed snake *Stilosoma extenuatum*, and Florida black bear *Ursus americanus floridana*.

### **Land Cover, Contextual Analysis and ROW Vegetation Surveys**

Two recent sources of land cover were available for use in analyzing field data. The SWFWMD 1999 land use/land cover and the FFWCC 2003 land cover. The SWFWMD dataset contained elements of land use that were too generic and not appropriate for evaluating wildlife habitat use. The FFWCC dataset contained 43 categories found throughout the state, but does not evaluate habitat quality. To better evaluate habitat use, quality and availability, these datasets were amended, condensed and ground-truthed for this specific conservation area.

#### **Land cover**

Land cover categories used for the analysis are shown in Table 3. A customized set of 21 categories were used for the analysis. These include native plant communities as well as human-influenced land cover types.

**Table 3. Land Cover Classes.**

<b>Category</b>
agriculture
built-environment
dry prairie/grasslands
golf course
hardwood-cypress swamp/forest
marsh-wet prairie-temporary pond
mesic hammock
mixed pine-hardwood
pasture
planted longleaf pine
residential, oak scrub
residential, rural
residential, sandhill
right-of-way
sand pine scrub
sandhill
sandhill, degraded
shrub-brush lands
silviculture
water
xeric oak scrub

Land cover categories are described as follows. Agriculture consists of intensive agricultural uses where the original habitat has been removed and replaced by human-driven activities such as row crop farming, nursery operations, and race horse training facilities. The built-environment includes human-dominated land uses where impervious surfaces and buildings have largely replaced natural land covers. The dry prairie/grasslands category represents native grass prairie systems and former pasture areas controlled by fire to remain open feral, grasslands. The category, hardwood-cypress swamp/forest includes permanent and temporary forested wetlands. Ephemeral wetlands with variable hydroperiods were classified as marsh-wet prairie-temporary pond. Mesic hammocks include areas dominated primarily by large live oaks *Quercus virginiana* near surface water bodies or wetlands where fire has been historically absent or infrequent. Areas classified as mixed pine-hardwood are isolated woodlots where fire has been absent long enough to allow hardwoods to become dominant in the canopy. Pasture represents open grasslands (of mostly nonnative species) currently or recently used for livestock grazing. Some tracts are classified as planted longleaf pine indicating areas being restored by mechanical or hand planting; these trees are 15 yrs old or less. The classification residential (oak scrub) and residential (sandhill) are areas being developed for residential use but are still low density and semi-natural. Significant semi-natural areas will likely be absent once these areas become fully developed. The classification residential (rural) represent large-lot low-density residential use and still contain significant mixed pine-hardwood areas. Rights-of-way include paved roadways with cleared grass strips on either side. Areas designated as sand pine scrub are xeric habitats typically dominated by a dense sand pine *Pinus clausa* overstory. Sandhill habitats are dominated by a longleaf pine overstory regulated by frequent fire (every 2-3 yrs) that maintains an open understory with wiregrass ground cover and only sparse groupings of oaks. The category, sandhill (degraded) indicates sandhill areas where fire management has been absent (4 yrs or more) allowing xeric oaks to become established and dominant in the midstory. These oaks reduce light penetration, promote growth of shrub layers and reduce presence of wiregrass. Shrub-brush lands represent areas that were formerly agriculture or pasture, logged or otherwise cleared and not replanted. Feral regrowth includes early successional annuals and perennials that form a dominant shrub-brush layer. Areas classified as silviculture represent commercial forestry interests and are normally planted in high densities and in narrow rows; the dominant tree is slash pine *Pinus elliotti*. These areas were formerly pine flatwoods and sandhill. Water represents permanent water bodies such as lakes and streams. Xeric oak scrub areas are dominated by a suite of oaks that prefer dry sandy soils. In many cases, these are islands within sandhill communities where frequent fires are rare. When fire does occur it is typically very hot due to high fuel load.

Figure 11 displays the land cover for the conservation areas and surrounding lands (28,526 ac or 11,544 ha). The surrounding area consists of a 300 m minimum buffer from the public lands. This buffer corresponds to the farthest extent of recorded movements of telemetry subjects monitored in the study. Total area and percent of each land cover type is shown in Table 4.

Native plant communities (dry prairie/grasslands, hardwood-cypress swamp/forest, marsh-wet prairie-temporary pond, mesic hammock, sand pine scrub, sandhill, water, xeric oak scrub) account for approximately 11,904 ac (4,817 ha) or 41.7 % of the area. These land cover types are currently being managed to provide the best possible habitat for native wildlife. Disturbed

natural areas (mixed pine-hardwood, planted longleaf pine, residential-rural, sandhill-degraded, shrub-brush lands) make up roughly 8,142 ac (3,295 ha) or 28.6%. Planted longleaf pine and sandhill-degraded are in various stages of restoration. Many shrub-brush land areas are also slated for restoration to longleaf pine forest. Substantially converted lands (golf course, pasture, residential-oak scrub, residential-sandhill, silviculture) compose about 5,653 ac (2,288 ha) or 19.8%. These residential types are being converted to urban systems and will become further degraded and less suitable as native faunal habitat areas. If appropriate management techniques are used, golf courses, silviculture and pasture areas may provide suitable secondary habitat.

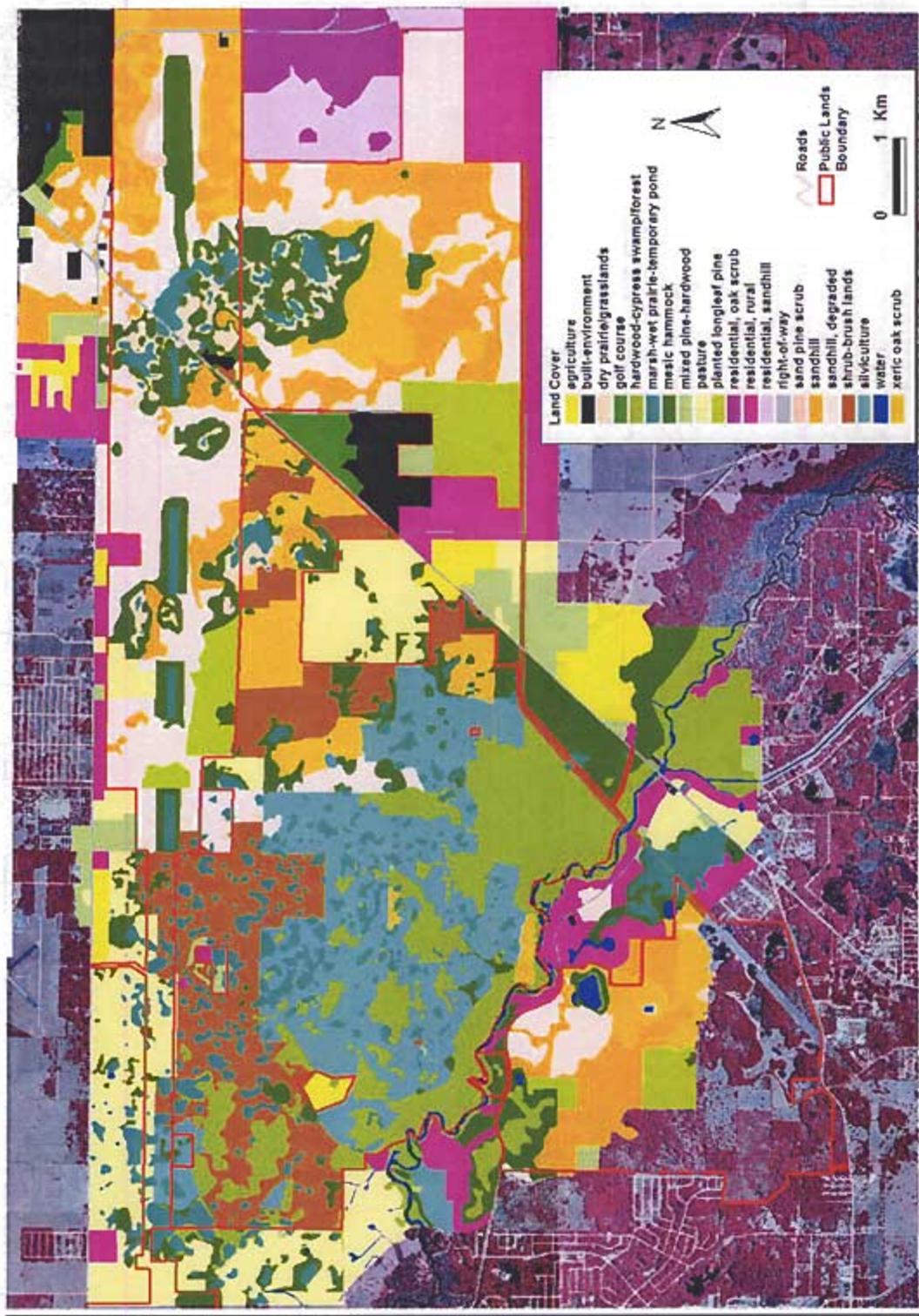
Around 2,825 ac (1,143 ha) or 9.9% are considered human-dominated areas (agriculture, built-environment, right-of-way). Land cover types in this category have already lost most favorable characteristics for native wildlife and serve as habitat sinks.

**Table 4. Total Area and Percent of Land Cover Types in the Ross Prairie Area.**

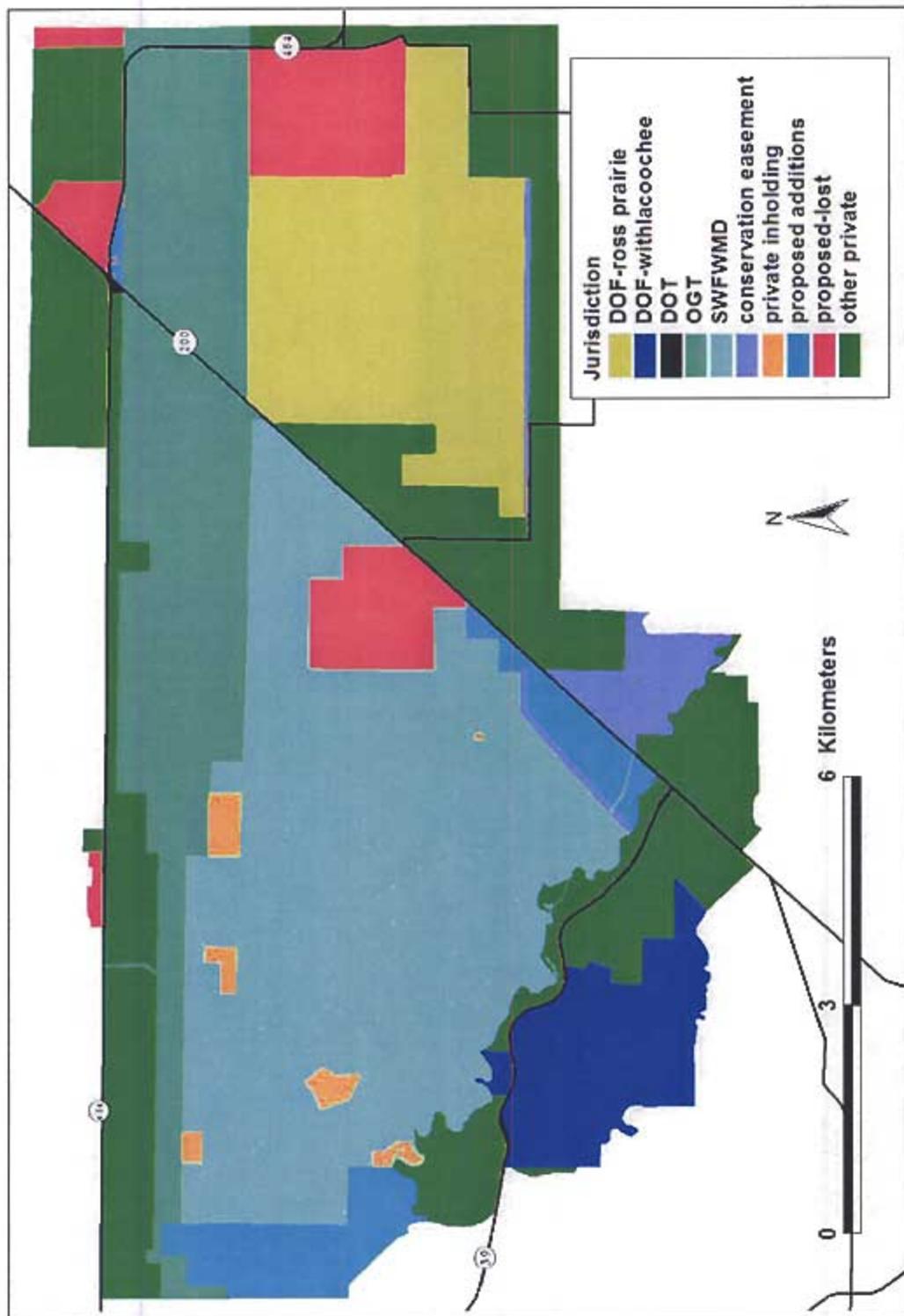
<b>Description</b>	<b>Acres</b>	<b>Hectares</b>	<b>Percent</b>
agriculture	577	234	2.0
built-environment	883	358	3.1
dry prairie/grasslands	329	133	1.2
golf course	185	75	0.6
hardwood-cypress swamp/forest	2,649	1,072	9.3
marsh-wet prairie-temporary pond	1,610	652	5.6
mesic hammock	2,950	1,194	10.3
mixed pine-hardwood	646	261	2.3
pasture	2,295	929	8.0
planted longleaf pine	828	335	2.9
residential, oak scrub	507	205	1.8
residential, rural	2,323	940	8.1
residential, sandhill	508	205	1.8
right-of-way	257	104	0.9
sand pine scrub	52	21	0.2
sandhill	2,479	1,003	8.7
sandhill, degraded	3,241	1,312	11.4
shrub-brush lands	2,132	863	7.5
silviculture	2,235	904	7.8
water	197	80	0.7
xeric oak scrub	1,638	663	5.7

### **Contextual analysis**

Land cover of the area is further described by context. Nine jurisdictional types describe the current level of protection and risk for land development (Figure 12). These include DOF lands, RPSF and Withlacoochee State Forest (WSF); DOT rights-of-way; Office of Greenways and Trails (OGT) lands, CFG; SWFWMD lands, HTP; conservation easements, Gum Slough and adjacent power line rights-of-way; several small private inholdings within the HTP; proposed additions to the HTP; other proposed additions to Ross Prairie conservation area that were subsequently lost to development; other private lands surrounding the conservation area and one existing development (Spruce Creek) separating the HTP and RPSF.



**Figure 11. Land Cover of the Ross Prairie Conservation Area.**



**Figure 12. Jurisdictional Context of the Ross Prairie Conservation Area.** This map displays land ownership of conservation tracts and surrounding lands. Abbreviations: DOF – Division of Forestry, DOT – Department of Transportation, OGT – Office of Greenways and Trails, and SWFWMD – Southwest Florida Water Management District.

The public lands are multiple-use resource areas providing habitat for wildlife and recreation for people. High levels of conversion to urban development are occurring; many proposed additions have already been lost. The remaining linkages that connect the area to other regional conservation areas are the CFG to the east and the two proposed additions to the HTP. The two proposed additions (Figure 12) are needed to establish connections to the larger Goethe State Forest to the west and Pott's Preserve and WSF tracts to the southeast. These proposed additions are critical in minimizing isolation and preserving the area's integrity as a significant habitat node for large carnivores such as black bear and bobcat.

Also of strategic importance is the connection between the HTP and the WSF tract to the south. The WSF tract has approximately 3 km of frontage on CR 39. There is an approximate 0.5 km wide conservation tract between CR 39 and the Withlacoochee River and the HTP that serves as a linkage between the HTP and the WSF tract. Increasing the width of this connector would establish habitat buffers and a more functional connection for carnivores. Parcels on either side of this small tract with an approximate 1 km road frontage each are classified as rural residential and composed of mesic hammock, mixed pine-hardwoods, and two single family residential units. Conservation easements that prohibit additional buildings or land clearing would serve as effective habitat buffers to the centrally protected tract.

Table 5 summarizes land cover types by jurisdictional boundaries. Descriptive measurements include number of patches, percent of total area, mean and median patch size, and total edge and mean patch edge for each land cover type. More complex landscape metrics are presented in Appendix A.

Ross Prairie State Forest, managed by the DOF consists of approximately 3,458 ac (1,404 ha). The Ross Prairie section of the CFG, managed by OGT consists of around 4,691 ac (1,902 ha). The HTP, managed by SWFWMD consists of about 7,988 ac (3,237 ha). Combined, publicly managed lands consist of approximately 16,137 ac (6,543 ha). These three properties form the core conservation area, 57% of the total area examined. A naturally patchy mosaic, the core area contains 804 patches with a mean and median patch size of 8.14 ha and 0.85 ha, respectively. A high degree of variability in patch size is evident ( $P_{var}$  499,  $P_{sd}$  40.58). The most representative class for this patchiness is ephemeral wetlands (335 patches,  $\bar{x}$  = 1.43 ha) followed by mesic hammocks (104 patches,  $\bar{x}$  = 6.95) that frequently surround the temporary ponds. The mean patch edge is notably similar among the tracts of land that comprise the core conservation area (1,264 to 1,502 m). By contrast the mean patch edge for road rights-of-way and the small parcels of inholdings was 8,006 m and 325 m, respectively.

The majority of high and low grade sandhill are located in RPSF and the CFG, 2,004 ac (819 ha) and 2,148 ac (878 ha) respectively. Ephemeral wetlands are scattered throughout the area, yet the majority are found in the HTP and the CFG, 731 ac (296 ha) and 358 ac (145 ha) respectively. The HTP also contains sizable blocks of hardwood swamp/forest, a total of 1,848 ac (748 ha). A large area of the HTP is currently managed as silviculture (2,102 ac, 851 ha). Silvicultural sections are in various stages of restoration. Significant blocks of xeric oak scrub occur in the HTP and the RPSF, 693 ac (283 ha) and 420 ac (170 ha), respectively. Significant areas of mesic hammock are found throughout the core conservation area, 1,788 ac (723 ha). In most cases these hammocks are juxtaposed by wet prairies, either isolated by, adjacent to, or surrounding.

**Table 5. Measurements of Land Cover Types by Jurisdiction.**

<b>Class</b>	<b>Class Area (ha)</b>	<b>% Total Area (ha)</b>	<b># Patches</b>	<b>Mean Patch Size (ha)</b>	<b>Median Patch Size (ha)</b>	<b>Patch Size Coeff. Var.</b>	<b>Patch Size SD</b>	<b>Total Edge (m)</b>	<b>Mean Patch Edge (m)</b>
<b>Core conservation area</b>	<b>6,543</b>		<b>804</b>	<b>8.14</b>	<b>0.65</b>	<b>499</b>	<b>40.58</b>	<b>1,093,687</b>	<b>1,360</b>
mesic hammock	723	11%	104	6.95	1.14	256	17.81	157,072	1,510
marsh-wet prairie-temporary pond	478	7%	335	1.43	0.53	179	2.55	155,820	465
mixed pine-hardwood	27	0%	13	2.07	0.46	220	4.54	8,232	633
residential, rural	6	0%	9	0.63	0.31	93	0.59	8,218	913
sandhill	685	10%	36	19.04	3.41	282	53.74	77,448	2,151
pasture	151	2%	14	10.79	2.95	148	16.00	33,289	2,378
dry prairie/grasslands	123	2%	44	2.80	0.48	195	5.45	58,324	1,326
built-environment	9	0%	5	1.87	1.36	98	1.83	5,722	1,144
shrub-brush lands	778	12%	24	32.40	1.23	298	96.71	108,812	4,534
sandhill, degraded	1,078	16%	59	18.26	0.08	323	59.04	125,743	2,131
xeric oak scrub	546	8%	50	10.92	1.49	243	26.51	75,629	1,513
hardwood-cypress swamp/forest	749	11%	67	11.17	0.50	533	59.50	99,284	1,482
sand pine scrub	21	0%	1	21.18	21.18	0	0.00	3,077	3,077
planted longleaf pine	268	4%	19	14.13	0.00	284	40.18	23,237	1,223
silviculture	866	13%	11	78.70	6.19	225	177.46	119,342	10,849
residential, sandhill	2	0%	2	1.07	0.54	50	0.53	4,247	2,123
residential, oak scrub	1	0%	2	0.31	0.24	22	0.07	1,896	948
water	32	0%	8	4.03	0.08	198	7.96	27,033	3,379
agriculture	1	0%	1	0.82	0.82	0	0.00	1,263	1,263
<b>DOF-Ross prairie</b>	<b>1,404</b>		<b>114</b>	<b>12.32</b>	<b>0.08</b>	<b>334</b>	<b>41.17</b>	<b>171,194</b>	<b>1,502</b>
shrub-brush lands	2	0%	3	0.53	0.02	139	0.74	3,335	1,112
pasture	0	0%	1	0.02	0.02	0	0.00	425	425
mesic hammock	157	11%	5	31.31	7.41	169	52.82	24,331	4,866
xeric oak scrub	170	12%	9	18.89	0.04	261	49.24	13,945	1,549
mixed pine-hardwood	18	1%	2	8.78	0.21	98	8.58	1,868	934
marsh-wet prairie-temporary pond	37	3%	15	2.46	0.62	150	3.69	8,609	574
sandhill	364	26%	13	28.00	0.01	301	84.38	31,284	2,406
sandhill, degraded	455	32%	39	11.68	0.01	238	27.78	45,959	1,178
dry prairie/grasslands	31	2%	6	5.20	0.86	179	9.31	19,072	3,179
residential, sandhill	2	0%	1	1.60	1.60	0	0.00	2,629	2,629
residential, oak scrub	0	0%	1	0.38	0.38	0	0.00	318	318
built-environment	1	0%	1	1.36	1.36	0	0.00	2,363	2,363
residential, rural	1	0%	2	0.68	0.00	100	0.67	2,969	1,484
planted longleaf pine	166	12%	16	10.40	0.00	383	39.84	14,088	880
<b>OGT</b>	<b>1,902</b>		<b>230</b>	<b>8.27</b>	<b>1.04</b>	<b>376</b>	<b>31.05</b>	<b>340,903</b>	<b>1,482</b>
mesic hammock	380	20%	43	8.83	1.25	199	17.60	73,204	1,702
marsh-wet prairie-temporary pond	145	8%	61	2.38	0.69	176	4.17	37,174	609
mixed pine-hardwood	1	0%	4	0.34	0.33	63	0.21	1,728	432
residential, rural	3	0%	3	0.91	1.04	69	0.63	3,489	1,163
sandhill	309	16%	22	14.06	4.32	150	21.07	43,899	1,995
pasture	126	7%	9	13.96	4.61	134	18.66	22,176	2,464
dry prairie/grasslands	78	4%	27	2.87	0.67	168	4.81	33,026	1,223
built-environment	8	0%	4	2.00	0.50	102	2.03	3,359	840
shrub-brush lands	52	3%	8	6.56	0.71	198	12.95	14,299	1,787
sandhill, degraded	568	30%	14	40.60	0.44	268	108.79	66,636	4,760
xeric oak scrub	93	5%	26	3.57	1.32	142	5.08	24,286	934

Table 5. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)
hardwood-cypress swamp/forest	0	0%	3	0.10	0.00	141	0.14	466	155
sand pine scrub	21	1%	1	21.18	21.18	0	0.00	3,077	3,077
planted longleaf pine silviculture	101	5%	2	50.67	17.51	65	33.16	7,225	3,612
residential, sandhill	15	1%	1	14.99	14.99	0	0.00	3,665	3,665
residential, oak scrub	1	0%	1	0.54	0.54	0	0.00	1,617	1,617
residential, oak scrub	0	0%	1	0.24	0.24	0	0.00	1,578	1,578
<b>SWFWMD</b>	<b>3,237</b>		<b>460</b>	<b>7.04</b>	<b>0.62</b>	<b>631</b>	<b>44.39</b>	<b>581,591</b>	<b>1,264</b>
water	32	1%	8	4.03	0.08	198	7.96	27,033	3,379
marsh-wet prairie-temporary pond	296	9%	259	1.14	0.49	156	1.78	110,037	425
hardwood-cypress swamp/forest	748	23%	64	11.69	0.65	520	60.83	98,818	1,544
pasture	25	1%	4	6.37	2.95	102	6.47	10,688	2,672
shrub-brush lands	724	22%	13	55.67	20.75	227	126.40	91,178	7,014
residential, rural	2	0%	4	0.40	0.27	93	0.37	1,760	440
mesic hammock	187	6%	56	3.33	1.06	174	5.81	59,537	1,063
silviculture	851	26%	10	85.07	2.90	217	184.92	115,677	11,568
mixed pine-hardwood	8	0%	7	1.13	0.66	118	1.34	4,637	662
dry prairie/grasslands	14	0%	11	1.31	0.39	233	3.06	6,227	566
sandhill, degraded	54	2%	6	8.96	3.91	120	10.72	13,148	2,191
planted longleaf pine	1	0%	1	0.64	0.64	0	0.00	1,924	1,924
xeric oak scrub	283	9%	15	18.87	3.85	135	25.44	37,399	2,493
sandhill	12	0%	1	11.95	11.95	0	0.00	2,265	2,265
agriculture	1	0%	1	0.82	0.82	0	0.00	1,263	1,263
<b>DOT rights-of-way</b>	<b>109</b>		<b>14</b>	<b>7.80</b>	<b>1.43</b>	<b>226</b>	<b>17.63</b>	<b>112,083</b>	<b>8,006</b>
<b>DOF-Withlacoochee</b>	<b>585</b>		<b>37</b>	<b>15.81</b>	<b>3.00</b>	<b>185</b>	<b>29.28</b>	<b>77,003</b>	<b>2,081</b>
hardwood-cypress swamp/forest	32	5%	5	6.33	2.96	136	8.61	8,109	1,622
residential, rural	1	0%	2	0.56	0.15	74	0.41	1,714	857
mesic hammock	69	12%	7	9.90	8.01	113	11.22	16,151	2,307
water	12	2%	4	2.97	0.85	133	3.96	2,601	650
sandhill, degraded	77	13%	4	19.33	13.10	83	15.95	7,763	1,941
dry prairie/grasslands	6	1%	4	1.47	1.47	35	0.52	2,617	654
sandhill	196	34%	3	65.39	29.03	84	55.19	16,549	5,516
xeric oak scrub	109	19%	3	36.47	2.96	136	49.49	12,728	4,243
planted longleaf pine	67	11%	2	33.30	16.06	52	17.24	5,422	2,711
mixed pine-hardwood	9	2%	1	8.92	8.92	0	0.00	1,196	1,196
marsh-wet prairie-temporary pond	3	1%	1	3.00	3.00	0	0.00	879	879
shrub-brush lands	4	1%	1	3.85	3.85	0	0.00	1,273	1,273
<b>Private inholdings</b>	<b>97</b>		<b>91</b>	<b>1.06</b>	<b>0.00</b>	<b>325</b>	<b>3.44</b>	<b>29,587</b>	<b>325</b>
marsh-wet prairie-temporary pond	12	12%	27	0.44	0.00	241	1.07	4,987	185
hardwood-cypress swamp/forest	11	11%	15	0.72	0.00	258	1.84	4,682	312
mesic hammock	2	2%	13	0.16	0.00	189	0.31	1,799	138
silviculture	9	10%	4	2.33	0.01	153	3.56	2,544	636
residential, rural	8	9%	2	4.11	3.50	15	0.61	1,686	843

Table 5. continued.

<b>Class</b>	<b>Class Area (ha)</b>	<b>% Total Area (ha)</b>	<b># Patches</b>	<b>Mean Patch Size (ha)</b>	<b>Median Patch Size (ha)</b>	<b>Patch Size Coeff. Var.</b>	<b>Patch Size SD</b>	<b>Total Edge (m)</b>	<b>Mean Patch Edge (m)</b>
<b>Private inholdings (continued)</b>									
mixed pine-hardwood	5	5%	8	0.66	0.00	239	1.57	2,435	304
shrub-brush lands	4	4%	14	0.27	0.00	197	0.54	3,965	283
dry prairie/grasslands	3	3%	3	0.83	0.32	115	0.96	1,123	374
sandhill, degraded	26	27%	1	25.65	25.65	0	0.00	4,357	4,357
pasture	0	0%	1	0.00	0.00	0	0.00	20	20
agriculture	17	18%	1	16.93	16.93	0	0.00	1,985	1,985
water	0	0%	2	0.00	0.00	75	0.00	5	2
<b>Proposed additions (all)</b>	<b>470</b>		<b>89</b>	<b>5.28</b>	<b>0.97</b>	<b>392</b>	<b>20.67</b>	<b>109,842</b>	<b>1,234</b>
sandhill	2	0%	2	1.00	0.36	64	0.64	1,044	522
residential, rural	0	0%	2	0.23	0.15	32	0.07	502	251
shrub-brush lands	7	1%	6	1.11	1.14	43	0.48	7,110	1,185
sandhill, degraded	8	2%	2	4.12	1.64	60	2.49	2,782	1,391
marsh-wet prairie-temporary pond	38	8%	23	1.66	0.71	109	1.80	12,319	536
mesic hammock	162	34%	14	11.54	1.37	210	24.22	28,337	2,024
hardwood-cypress swamp/forest	42	9%	18	2.31	0.49	152	3.50	17,886	994
pasture	197	42%	4	49.22	5.42	144	71.09	26,543	6,636
mixed pine-hardwood	2	0%	2	1.14	0.00	100	1.14	1,284	642
water	12	3%	15	0.80	0.25	123	0.99	11,987	799
built-environment	0	0%	1	0.00	0.00	0	0.00	48	48
<b>Proposed add. (west)</b>	<b>310</b>		<b>57</b>	<b>5.44</b>	<b>1.02</b>	<b>414</b>	<b>22.53</b>	<b>81,945</b>	<b>1,438</b>
marsh-wet prairie-temporary pond	35	11%	20	1.73	0.71	107	1.86	11,255	563
mesic hammock	40	13%	10	4.00	1.14	120	4.81	17,459	1,746
hardwood-cypress swamp/forest	26	8%	11	2.33	0.83	137	3.18	13,359	1,214
pasture	197	64%	3	65.62	19.75	115	75.24	26,536	8,845
mixed pine-hardwood	2	1%	2	1.14	0.00	100	1.14	1,284	642
water	9	3%	9	1.02	0.57	106	1.09	9,535	1,059
shrub-brush lands	1	0%	1	1.28	1.28	0	0.00	2,235	2,235
residential, rural	0	0%	1	0.15	0.15	0	0.00	281	281
<b>Proposed add. (east)</b>	<b>148</b>		<b>18</b>	<b>8.23</b>	<b>1.23</b>	<b>266</b>	<b>21.90</b>	<b>22,952</b>	<b>1,275</b>
marsh-wet prairie-temporary pond	4	2%	2	1.77	0.59	67	1.18	1,056	528
hardwood-cypress swamp/forest	16	11%	5	3.20	0.97	137	4.36	4,474	895
shrub-brush lands	4	3%	4	1.06	0.55	55	0.58	4,446	1,112
mesic hammock	122	82%	4	30.40	3.61	127	38.69	10,877	2,719
water	3	2%	3	0.94	0.75	78	0.74	2,099	700
<b>Proposed add. (other)</b>	<b>2</b>		<b>6</b>	<b>1.95</b>	<b>1.14</b>	<b>111</b>	<b>2.15</b>	<b>4,476</b>	<b>746</b>
sandhill	2	17%	2	1.00	0.36	64	0.64	1,044	522
residential, rural	0	3%	1	0.30	0.30	0	0.00	221	221
shrub-brush lands	1	10%	1	1.14	1.14	0	0.00	429	429
sandhill, degraded	8	71%	2	4.12	1.64	60	2.49	2,782	1,391

Table 5. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)
<b>Existing conservation easement</b>	<b>242</b>		<b>30</b>	<b>8.07</b>	<b>1.33</b>	<b>210</b>	<b>16.97</b>	<b>49,750</b>	<b>1,658</b>
mesic hammock	61	25%	2	30.47	0.09	100	30.37	5,274	2,637
shrub-brush lands	52	21%	11	4.71	1.33	154	7.25	22,387	2,035
marsh-wet prairie-temporary pond	2	1%	5	0.33	0.20	100	0.33	1,087	217
mixed pine-hardwood	6	3%	2	3.21	1.87	42	1.34	1,660	830
residential, rural	3	1%	1	2.85	2.85	0	0.00	811	811
agriculture	71	29%	1	70.79	70.79	0	0.00	5,428	5,428
hardwood-cypress swamp/forest	42	17%	4	10.40	2.05	114	11.88	8,336	2,084
water	6	2%	4	1.50	0.14	152	2.29	4,766	1,191
<b>Proposed add. lost (all)</b>	<b>710</b>		<b>40</b>	<b>17.75</b>	<b>2.21</b>	<b>258</b>	<b>45.74</b>	<b>71,014</b>	<b>1,775</b>
pasture	199	28%	2	99.63	1.58	98	98.05	13,573	6,786
mixed pine-hardwood	24	3%	2	12.04	8.14	32	3.90	4,051	2,026
built-environment	36	5%	6	6.05	0.66	193	11.71	5,135	856
sandhill, degraded	26	4%	7	3.76	1.60	132	4.96	7,852	1,122
golf course	4	1%	1	3.78	3.78	0	0.00	925	925
sandhill	38	5%	3	12.69	1.05	133	16.85	6,904	2,301
residential, oak scrub	155	22%	3	51.81	5.79	129	66.80	8,544	2,848
mesic hammock	34	5%	11	3.05	3.03	68	2.07	11,535	1,049
marsh-wet prairie-temporary pond	1	0%	1	1.20	1.20	0	0.00	483	483
residential, sandhill	180	25%	1	180.33	180.33	0	0.00	8,827	8,827
agriculture	10	1%	1	10.38	10.38	0	0.00	1,749	1,749
shrub-brush lands	1	0%	1	1.25	1.25	0	0.00	774	774
silviculture	0	0%	1	0.10	0.10	0	0.00	663	663
<b>Proposed add. lost (pd)</b>	<b>244</b>		<b>16</b>	<b>15.26</b>	<b>2.21</b>	<b>309</b>	<b>47.18</b>	<b>28,255</b>	<b>1,766</b>
mesic hammock	34	14%	11	3.05	3.03	68	2.07	11,535	1,049
marsh-wet prairie-temporary pond	1	0%	1	1.20	1.20	0	0.00	483	483
pasture	198	81%	1	197.68	197.68	0	0.00	13,051	13,051
agriculture	10	4%	1	10.38	10.38	0	0.00	1,749	1,749
shrub-brush lands	1	1%	1	1.25	1.25	0	0.00	774	774
silviculture	0	0%	1	0.10	0.10	0	0.00	663	663
<b>Proposed add. lost (Timberwalk)</b>	<b>337</b>		<b>8</b>	<b>42.17</b>	<b>0.63</b>	<b>167</b>	<b>70.47</b>	<b>20,992</b>	<b>2,624</b>
sandhill, degraded	1	0%	3	0.36	0.30	55	0.20	2,797	932
sandhill	1	0%	1	0.50	0.50	0	0.00	824	824
residential, oak scrub	155	46%	3	51.81	5.79	129	66.80	8,544	2,848
residential, sandhill	180	53%	1	180.33	180.33	0	0.00	8,827	8,827
<b>Proposed add. lost (Wal-Mart, etc)</b>	<b>77</b>		<b>10</b>	<b>7.69</b>	<b>3.78</b>	<b>136</b>	<b>10.48</b>	<b>14,379</b>	<b>1,438</b>
built-environment	2	3%	2	1.10	0.22	80	0.88	1,041	521
mixed pine-hardwood	8	11%	1	8.14	8.14	0	0.00	1,278	1,278
sandhill, degraded	25	33%	4	6.31	4.18	84	5.27	5,055	1,264
golf course	4	5%	1	3.78	3.78	0	0.00	925	925
sandhill	38	49%	2	18.78	1.05	94	17.73	6,080	3,040

Table 5. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)
<b>Proposed add. lost (other)</b>	<b>52</b>		<b>6</b>	<b>8.61</b>	<b>0.76</b>	<b>138</b>	<b>11.90</b>	<b>7,388</b>	<b>1,231</b>
pasture	2	3%	1	1.58	1.58	0	0.00	521	521
mixed pine-hardwood	16	31%	1	15.94	15.94	0	0.00	2,773	2,773
built-environment	34	66%	4	8.53	0.66	160	13.67	4,094	1,024
<b>Private - Spruce Creek</b>	<b>167</b>		<b>11</b>	<b>15.15</b>	<b>0.00</b>	<b>225</b>	<b>34.07</b>	<b>11,579</b>	<b>1,053</b>
built-environment	110	66%	9	12.22	0.00	283	34.56	6,353	706
golf course	57	34%	1	56.57	56.57	0	0.00	4,251	4,251
mixed pine-hardwood	0	0%	1	0.08	0.08	0	0.00	975	975
<b>Private - other</b>	<b>2,621</b>		<b>276</b>	<b>9.50</b>	<b>1.15</b>	<b>250</b>	<b>23.73</b>	<b>357,600</b>	<b>1,296</b>
hardwood-cypress swamp/forest	198	8%	31	6.39	0.08	338	21.58	36,480	1,177
residential, rural	918	35%	42	21.86	6.04	154	33.72	85,243	2,030
water	18	1%	24	0.74	0.11	206	1.53	10,952	456
mixed pine-hardwood	187	7%	18	10.41	2.28	169	17.56	21,707	1,206
built-environment	202	8%	11	18.35	0.67	282	51.69	12,470	1,134
pasture	381	15%	20	19.03	3.47	210	39.95	53,283	2,664
sandhill	80	3%	9	8.84	5.27	135	11.91	12,085	1,343
agriculture	135	5%	6	22.46	24.11	67	15.00	13,812	2,302
golf course	14	1%	1	14.30	14.30	0	0.00	2,629	2,629
marsh-wet prairie-temporary pond	117	4%	35	3.35	0.52	229	7.67	24,572	702
sandhill, degraded	94	4%	12	7.84	1.15	189	14.82	19,731	1,644
mesic hammock	144	5%	42	3.42	1.46	153	5.24	41,347	984
xeric oak scrub	8	0%	3	2.54	0.01	141	3.59	2,311	770
dry prairie/grasslands	2	0%	5	0.35	0.05	127	0.44	1,095	219
shrub-brush lands	23	1%	8	2.86	1.44	126	3.59	9,556	1,195
residential, oak scrub	49	2%	6	8.18	0.00	147	12.04	5,194	866
silviculture	29	1%	1	29.33	29.33	0	0.00	2,682	2,682
residential, sandhill	23	1%	2	11.49	0.00	100	11.49	2,450	1,225

Land cover types for the surrounding area including private inholdings within the HTP are also given in Table 5. Each land cover type is arranged by jurisdiction. A portion of the two-mile prairie addition of WSF, managed by DOF was included in this landscape analysis because one radio-collared bobcat had crossed the river and used the northern extent of the property. The northern portion of the WSF tract (1,446 ac, 585 ha) contains significant patches of mesic hammock (171 ac, 69 ha), planted longleaf (165 ac, 67 ha), sandhill (485 ac, 196 ha) and degraded sandhill (191 ac, 77 ha). Highway rights-of-way account for 270 ac (109 ha) of land in the study area. Local roads are included, by and large, in the built-environment category.

The six inholdings shown in Figure 12 within the HTP account for 239 ac (97 ha). The largest tract of these inholdings is in native land cover types, the smallest is an old church and cemetery of consistent vegetation. The second largest inholding was a former commercial fish farm, now abandoned. The remaining inholdings are primarily used as rural residential. The proposed western addition contains a mosaic of mostly pasture (487 ac, 197 ha), hardwood forests, hammocks and swamps (162 ac, 66 ha) and temporary wetlands (86 ac, 35 ha). Restoration would entail replanting pasture areas in longleaf pine. The proposed addition adjacent to SR 200

would secure a connection with the existing conservation easement that connects to Pott's Preserve. This addition consists mostly of mesic hammock (301 ac, 122 ha) and hardwood swamp (39 ac, 16 ha). The conservation easement has a mix of agriculture (175 ac, 71 ha), hardwood swamp (103 ac, 42 ha), mesic hammock (151 ac, 61 ha) and shrub-brush lands (132 ac, 52 ha). Three other significant proposed additions have been lost to development, a planned development adjacent to HTP (604 ac, 244 ha), the Wal-Mart across CR 484 from the CFG (190 ac, 77 ha), and Timberwalk development (833 ac, 337 ha) contiguous with RPSF. The planned development was primarily pasture, the Wal-Mart and Timberwalk tracts were composed of mostly sandhill and scrub. Other private lands surrounding the Ross Prairie conservation area include 18 land cover classes. Most of the perimeter area consists of rural residential (2,246 ac, 918 ha), agriculture (334 ac, 135 ha), pasture (944 ac, 381 ha), built-environment (504 ac, 202 ha), hardwood swamp/forest (490 ac, 198 ha), mesic hammock (355 ac, 144 ha), temporary wetlands (290 ac, 117 ha) and sandhill (430 ac, 174 ha). A significant area of sandhill adjacent to RPSF was converted to Spruce Creek golf course community (residential – 272 ac or 110 ha; golf course – 140 ac or 57 ha).

Number of patches and linear miles (km) of each land cover type of private lands (includes proposed additions) along the perimeter of the Ross Prairie Conservation Area (Figure 12) are as follows: rural residential (14 – 11.32 km), pasture (15 – 9.11 km), shrub-brush lands (8 – 6.31 km), built-environment (4 – 5.58 km), hardwood-cypress swamp/forest (9 – 4.99 km), mesic hammock (18 – 4.98 km), residential-sandhill (2 – 4.75 km), sandhill-degraded (9 – 3.57 km), golf course (1 – 2.94 km), marsh-wet prairie-temporary pond (15 – 2.69 km), residential-oak scrub (2 – 1.78 km), agriculture (4 – 1.76 km), mixed pine-hardwood (1.74 km), silviculture (1.15 km), sandhill (5 – 0.73 km), and dry prairie/grasslands (1 – 0.14 km).

Landscape metrics are useful to determine extent of fragmentation and isolation of the core conservation area. Landscape metrics used in this analysis are described as follows (from McGarigal and Marks 1994):

Edge Density (ED) is the amount of edge relative to the landscape area. Mean Perimeter-Area Ratio (MPAR) is the sum of each patch's perimeter/area ratio divided by the number of patches. Mean Shape Index (MSI) is the sum of each patch's perimeter divided by the square root of patch area (hectares) for each class (Class Level) or all patches (Landscape Level), adjusted for circular standard (polygons), and divided by the number of patches. MSI is greater than one,  $MSI = 1$  when all patches are circular (polygons). Area weighted mean patch fractal dimension (AWMPFD) is the same as mean patch fractal dimension with the addition of individual patch area weighting applied to each patch. Because larger patches tend to be more complex than smaller patches, this has the effect of determining patch complexity independent of its size. Mean fractal dimension approaches one for shapes with simple perimeters and approaches two when shapes are more complex.

For the purpose of this exercise the core conservation area was defined as the three major protected tracts of land, CFG, HTP and RPSF (Figure 13). All other proposed public lands linked to this core area are considered peripheral. Quantities of area, edge, and fractal dimension provide a measure for core integrity. Edge habitat has been shown to favor generalist or

opportunistic species. Core habitat is required for area-sensitive and forest-interior species. An ideal core conservation area would minimize the negative effects of edge. Low values for these metrics are preferred for core habitat areas. A circle is known to have the lowest perimeter/area ratio. For rectilinear shapes of equal area, a square would have the lowest value.

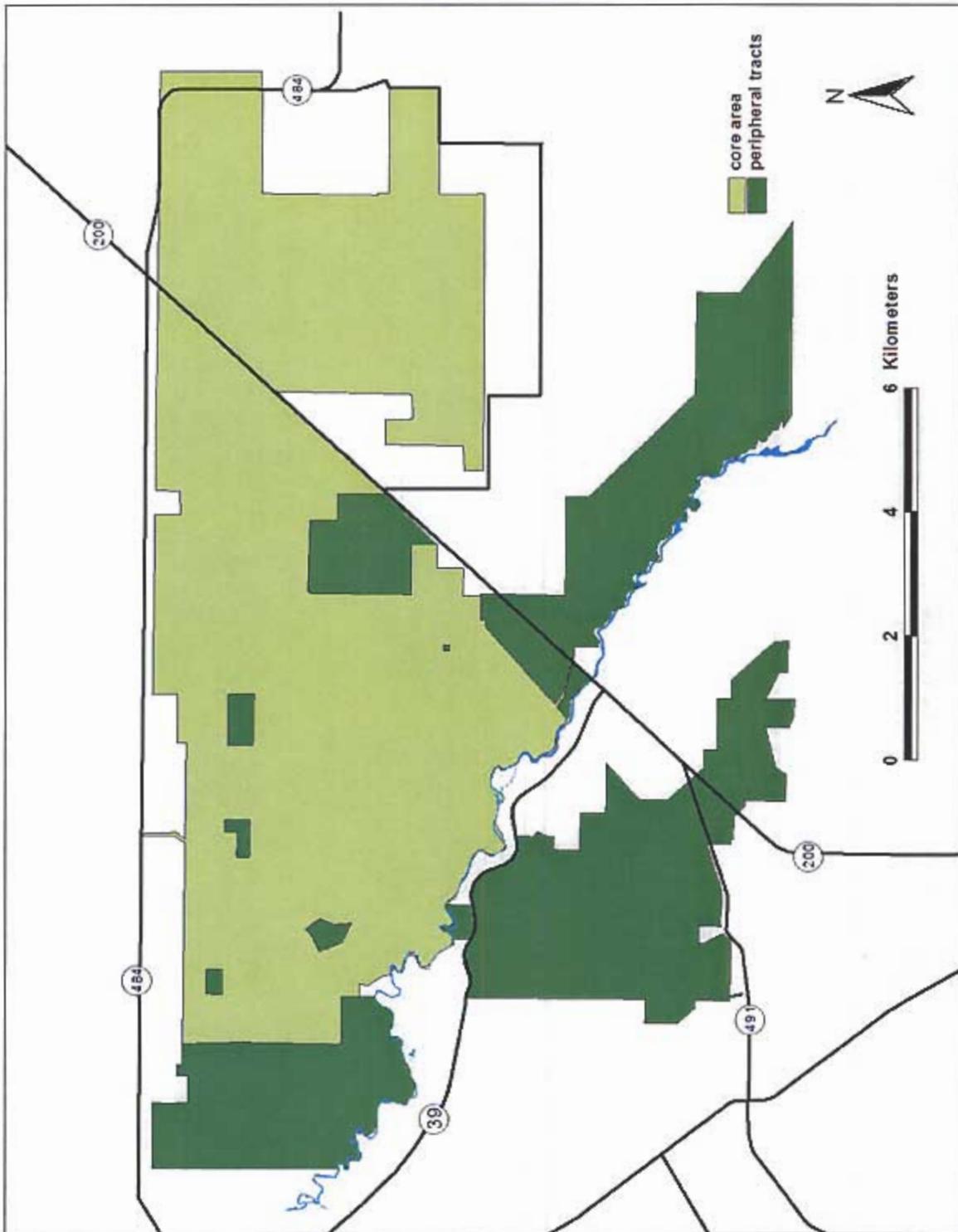
Table 6 displays metrics calculated for the core area and surrounding tracts of land. Different configurations of the core area and surrounding linkages are presented for comparison. A square of the same area as the total landscape in Figure 14 is included in Table 6 for reference. Benchmark metrics for the square are as follows: Area – 10,201 (ha), Edge – 40,400 (m), ED – 3.96 (m/ha), MSI – 1.13, MPAR – 4.0 (m/ha), MPFD – 1.15. A separate reference used was a rectangle formed as an outline for the entire landscape (Figure 14). Benchmark metrics for the rectangle are as follows: Area – 18,158 (ha), Edge – 55,903 (m), ED – 3.08 (m/ha), MSI – 1.17, MPAR – 3.1 (m/ha), MPFD – 1.15.

Total protected tracts in the landscape include OGT, SWFWMD, DOF, and easement (Figure 14, Table 6). Total protected tracts with proposed easements (13 and 14 in Figure 14) and the same total area as the hypothetical square have the following metrics: Area – 10,201 (ha), Edge – 107,525 (m), ED – 10.55 (m/ha), MSI – 3.00, MPAR – 10.5 (m/ha), MPFD – 1.26. Although of the same area, the increased edge of the latter (107,525 m) results in substantially higher values for ED, MSI, MPAR and MPFD (Table 6). Increasing the area in conservation within this defined landscape is the only mechanism to reduce length of edge.

Five alternatives for the core conservation area from available tracts are presented in Table 6. The existing core area (Figure 13) has the following metrics: Area – 6,499 (ha), Edge – 72,402 (m), ED – 11.14 (m/ha), MSI – 2.53, MPAR – 11.1 (m/ha), MPFD – 1.24. The best available configuration given the loss of tract #12 (Table 7) is option five: Area – 7,471 (ha), Edge – 70,002 (m), ED – 9.37 (m/ha), MSI – 2.28, MPAR – 9.4 (m/ha), MPFD – 1.23. Metrics of individual tracts from this landscape are included in Table 6 (Figure 14).

Five proximate linkages are associated with the core conservation area and connect the habitat node to other conservation areas to the south, east and west (Figure 14). Linkage width (m), width to length ratio (WLR – width/length), and width to area ratio (WAR – m/ha) differ. The linkage to the east is protected, but expansion is limited by adjacent development. Linkages to the south and west are partially protected; acquisition of certain tracts is critical to secure functional connections.

The linkage to the west has two parts; the protected section (18) is only 115 m wide x 515 m long at one point (WLR – 0.22, WAR – 16.4), it then widens to 340 m x 410 m long (WLR – 0.83, WAR – 21.25) and then connects with a larger linkage (1,660 m wide) before reaching the City of Dunnellon, around which significant acquisitions are needed. If the proposed addition (11) is added, the linkage becomes wide enough (3,500 m) to include as part of the core conservation area. The south linkage (7 and 9), connecting to an existing conservation easement (10) are a combined 2,025 m wide and 530 m long (WLR – 3.82, WAR – 16.5). The conservation easement is 750 m wide at its narrowest point and 6,200 m long (WLR – 0.12, WAR – 0.80) before connecting with Potts Preserve via the Withlacoochee River. Other acquisitions are needed further south to improve this connection.



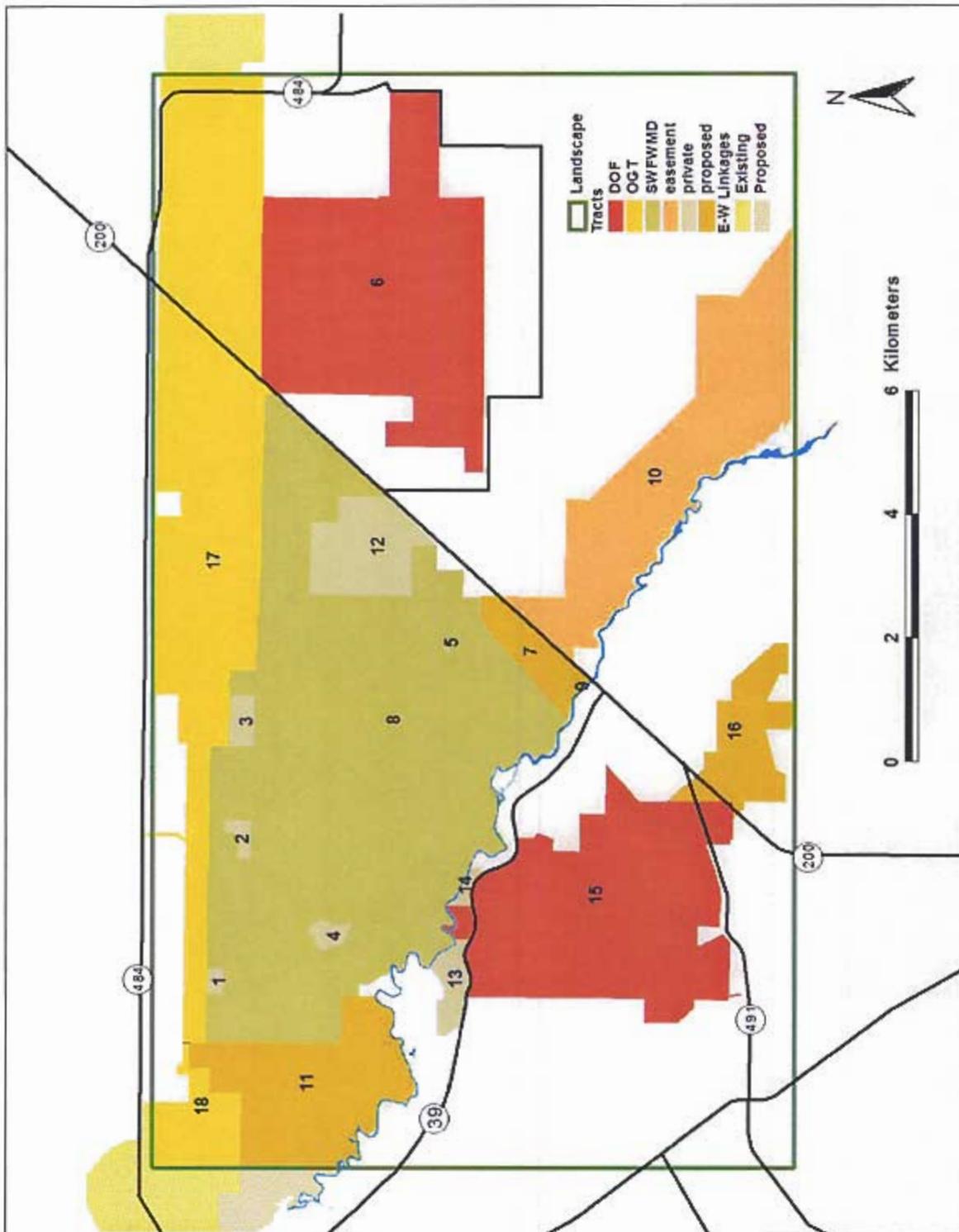
**Figure 13. Ross Prairie – Core Conservation Area.** This map displays the core conservation area and peripheral tracts of land.

**Table 6. Landscape Metrics of Tracts by Jurisdiction in the Study Area.**

No.	Tract	total area (ha)	total edge (m)	edge density (m/ha)	mean shape index	mean perimeter/area ratio (m/ha)	mean patch fractal dimension
	Total	10,122	108,622	10.73	3.05	10.7	1.26
	Total w/ proposed easements	10,201	107,575	10.55	3.00	10.5	1.26
	Square	10,201	40,400	3.96	1.13	4.0	1.15
	Rectangle (of study area)	18,158	55,903	3.08	1.17	3.1	1.15
	Core area	6,499	72,402	11.14	2.53	11.1	1.24
	- w/ inholdings	6,583	64,209	9.75	2.23	9.8	1.23
	- w/ proposed additions	7,387	78,196	10.59	2.57	10.6	1.24
	- w/ proposed additions and inholdings	7,714	65,474	8.49	2.10	8.5	1.22
	- w/ proposed additions and inholdings, excluding #12	7,471	70,002	9.37	2.28	9.4	1.23
1	Inholding 1	11	1,341	0.14	1.15	124.8	1.24
2	Inholding 2	16	2,021	0.21	1.41	123.3	1.27
3	Inholding 3	34	2,475	0.26	1.19	72.5	1.23
4	Inholding 4	22	1,980	0.21	1.19	89.4	1.23
5	Inholding 5	1	375	0.04	1.13	428.4	1.31
6	RPSF	1,401	20,067	14.32	1.51	14.3	1.20
7	HTP proposed addition –east 1	107	4,915	0.52	1.34	46.1	1.22
8	HTP	3,219	42,111	13.08	2.09	13.1	1.23
9	HTP proposed addition –east 2	16	2,197	0.23	1.56	138.5	1.29
10	Existing cons. easement	936	21,184	2.24	1.95	22.6	1.24
11	HTP proposed addition –west	582	12,418	1.31	1.45	21.3	1.21
12	HTP proposed addition –pd	248	6,823	27.46	1.22	27.5	1.20
13	Proposed easement –west	64	4,338	54.90	1.53	67.5	1.25
14	Proposed easement –east	15	1,979	25.04	1.45	134.4	1.28
15	WSF	1,215	19,407	15.97	1.57	16.0	1.21
16	WSF proposed addition –south	256	9,837	38.47	1.74	38.5	1.25
17,18	CFG	2,064	44,556	21.59	2.77	21.6	1.27

Note: numbers in table correspond to labels in Figure 14.

Two linkages connect the WSF with HTP and Potts Preserve. The first linkage, between HTP and WSF (15), is 570 m wide x 300 m long (WLR – 1.9, WAR – 33.5). This small connection can be enhanced by securing conservation easements for tracts 13 and 14. Adding these tracts would increase the connection to 2,125 m wide x 300 m long (WLR – 7.1, WAR – 22.1). The second linkage, a proposed addition between WSF and Potts Preserve, is 410 m wide x 1,700 m long (WLR – 0.24, WAR – 4.88) at its narrowest section near Potts Preserve; it then widens to a minimum 788 m for an additional 1,700 m (WLR – 0.46, WAR – 3.86) before connecting to WSF. A recommended minimum width for linkages in this substantially fragmented area is 750 m.



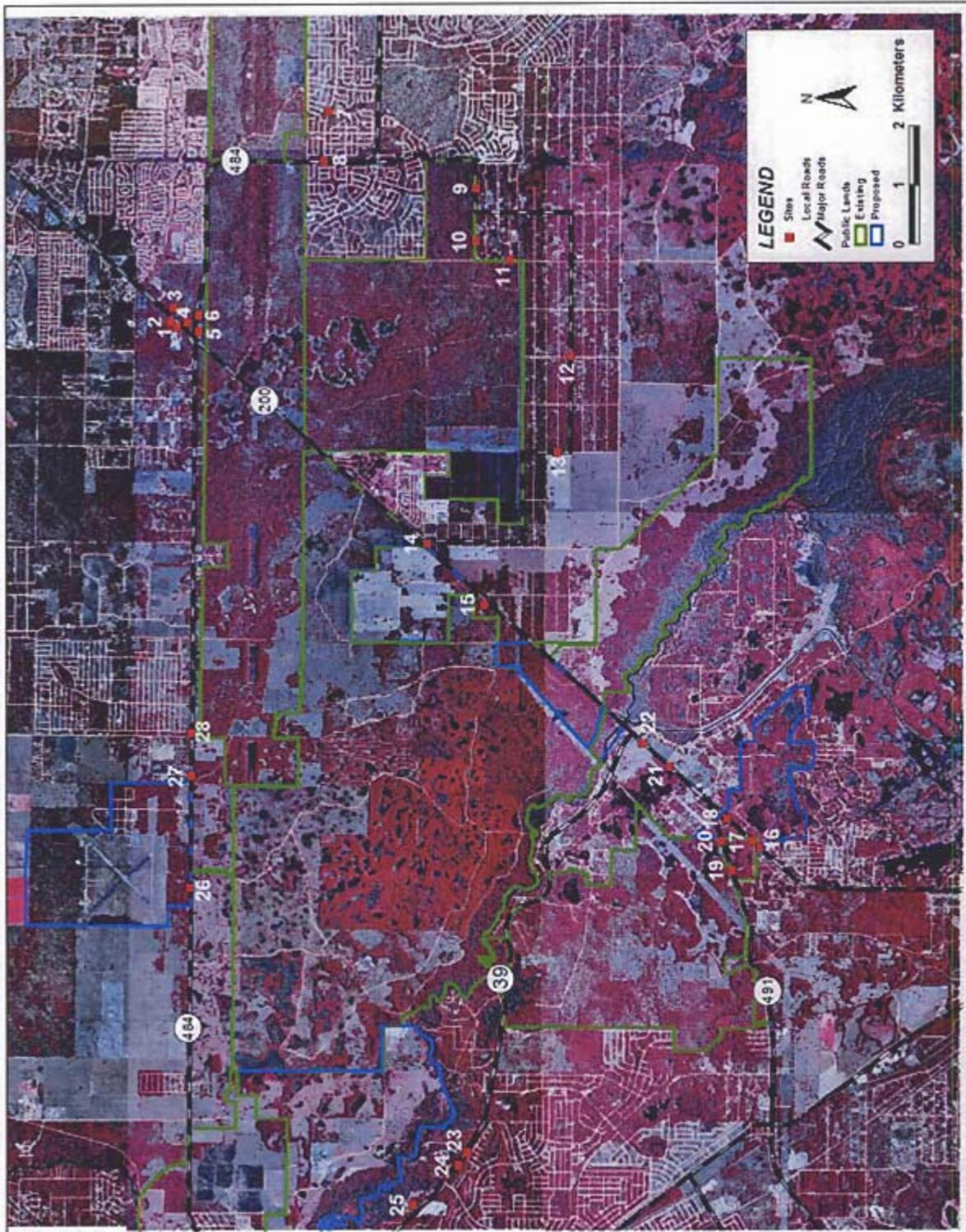
**Figure 14. Ross Prairie – Tracts.** This map displays the core conservation area and peripheral properties by ownership and includes the outline of the analysis landscape. Labels correspond to numbers in Table 6.

A visual survey of the surrounding area was conducted in the winter of 2004 to document the character of specific parcels for sale or vacant and key residential areas bordering the core conservation area. A circuitous route (Figure 15) was followed from SR 200 east on CR 484 to the Timberwalk development, through the Highlands rural residential area back to SR 200, then west past CR 491. From there the route crossed the WSF connection on CR 491 and back east on SR 200 to CR 39. From there the route goes west to Dunnellon and returns east on CR 484. Figure 15 displays specific sites of interest and their respective land cover (e.g., parcels for sale within proposed additions or adjacent to the core conservation area, sites of ecological interest, sites with habitat connectivity attributes). Site numbers in Figure 15 correspond to descriptive records in Table 7 and an array of photographs included as Appendix B.

**Table 7. Survey Sites of Surrounding Land Cover.**

<b>Site No.</b>	<b>Description</b>	<b>Land Cover</b>	<b>Figure Nos.</b>
1	1.75 ac for sale	sandhill, sandhill-degraded	16-1
2	large vacant lot	sandhill, sandhill-degraded	16-2
3	Wal-Mart site	sandhill, sandhill-degraded	16-3a & b
4	110 ac for sale	sandhill, sandhill-degraded	16-4
5	3.25 ac for sale	sandhill, sandhill-degraded	16-5
6	Misty Oaks Realty	sandhill, sandhill-degraded	16-6a & b
7	Marion Oaks	residential-oak scrub	16-7a & b
8	Marion Oaks	residential-oak scrub	16-8a & b
9	The Highlands	residential-rural	16-9
10	The Highlands	residential-rural	16-10
11	The Highlands	residential-rural	16-11
12	The Highlands	residential-rural	16-12
13	The Highlands	residential-rural	16-13
14	The Highlands, 4 ac for sale	residential-rural	16-14
15	12 ac for sale	mesic hammock, wet prairie	16-15
16	stream, double box culvert - 8'x24'x40'	water, mesic hammock, mixed pine-hardwood	16-16a, b & c
17	linear ponds	water, sandhill, xeric oak scrub	16-17a & b
18	linear ponds, box culvert - 2'x2'x54', 6" clearance	water, sandhill, xeric oak scrub	16-18
19	large wet prairie, CR 491	wet prairie, mesic hammock, sandhill	16-19
20	large wet prairie, CR 491	wet prairie, mesic hammock, sandhill	16-20
21	wet prairie, pipe culvert	wet prairie, pasture	16-21
22	32 ac for sale, Stokes ferry rd.	pasture	none
23	waterfront acreage for sale	mixed pine-hardwood, hardwood-cypress swamp/forest	16-22
24	terra research property	mixed pine-hardwood	16-23
25	riverfront acreage for sale	pasture, mesic hammock, hardwood-cypress swamp/forest	16-24
26	Dunnellon airport acreage, auction sale	mixed pine-hardwood	16-25
27	Greenbriar nursery, 42 ac for sale	agriculture, residential-rural	16-26
28	5 ac tracts for sale	residential-rural	16-27

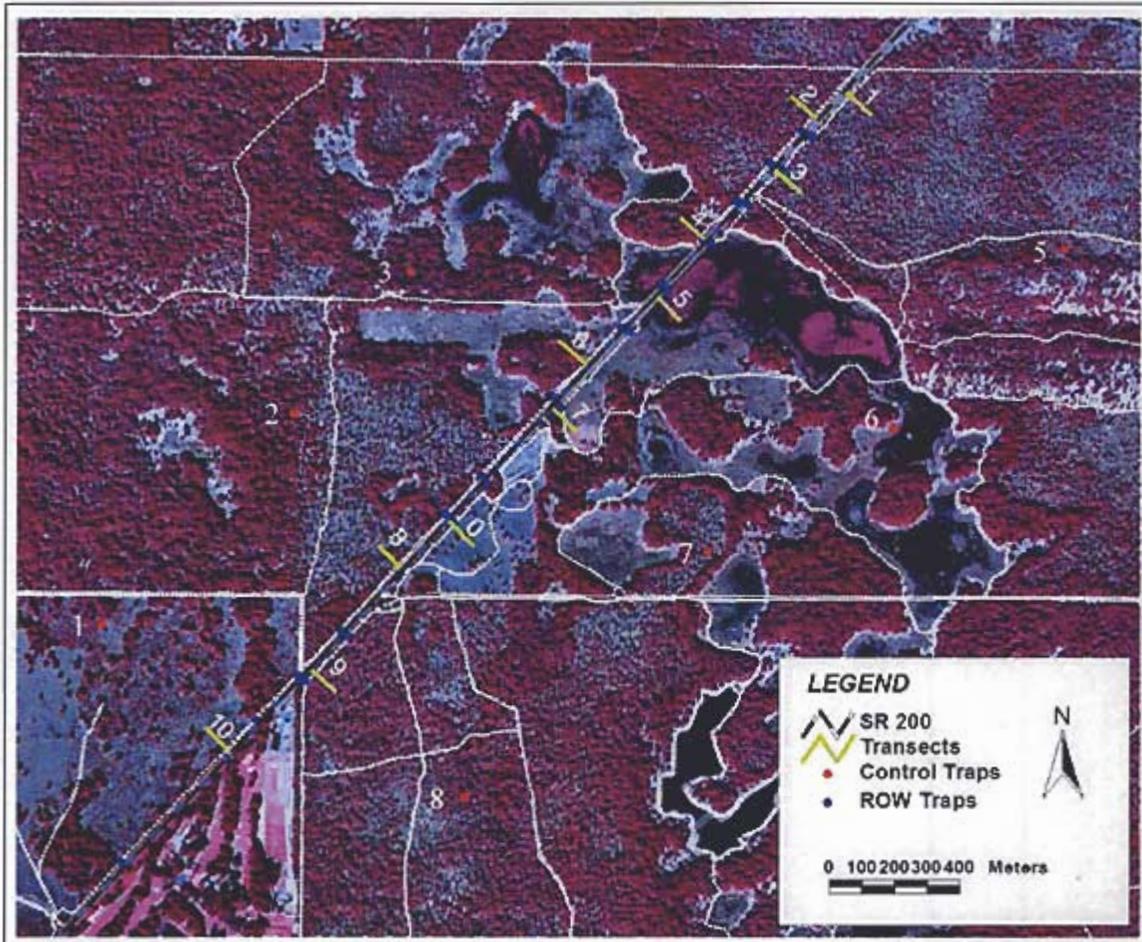
Notable areas include several parcels for sale or being developed on or near CR 484 (Sites 1 – 6 and 26 – 28; Fig. 15, Table 7, App. B), the rural character of the Highlands (Sites 9 – 14, Fig. 15, Table 7, App. B), the water features near SR 200 and CR 491 (Sites 9 – 14, Fig. 15, Table 7, App. B), and misc. property for sale on CR 39 (Sites 23 – 25, Fig. 15, Table 7, App. B).



**Figure 15. Contextual Analysis: Surrounding Land Use Compatibility and Real Estate Availability Survey.** Site numbers shown correspond to information and photographs included in Table 7 and Appendix B.

### ROW vegetation surveys

Eleven 100 m vegetation transects were surveyed in different land cover types along a four mile section of SR 200 (Figure 16). Plant diversity and abundance were recorded to determine extent of edge effects from the road into different habitat types and for comparison of faunal presence and movements along this section of road right-of-way. For reference, the location of right-of-way mark-recapture study trap arrays and control trap arrays are shown in Figure 16. A list of all species recorded including plant form and community type preference is shown in Appendix C.



**Figure 16. Vegetation Transects.** Each transect was 100 m long and perpendicular to the paved surface of the road. Placements were randomly selected within different land cover types.

There were 5 transects in sandhill communities, 2 transects in ruderal/oak scrub areas, 1 transect in mesic hammock, 1 transect in wet prairie and 2 transects along wet prairie/mesic hammock ecotonal areas. Though it was convenient to record plants for each meter along the 100 m transect, this resolution generated an enormous amount of data (over 255,000 records). It was therefore necessary to reduce the dataset for analysis. Each transect was divided into 10 m sections and plant species were grouped according to habitat preferences. Categories included

marshes/wet areas, ruderal/disturbed, pinelands/disturbed, sandhills/pinelands, sandhills/scrub, and upland forests/hammocks.

From all transects, 218 different species were found. Average number of species found in sandhill transects (n=5) was 57. Forty-three species were found, on average at the two ruderal/oak scrub sites. The two wet prairie/mesic hammock sites had an average diversity of 37 plant species. The single mesic hammock transect had 53 species. The single wet prairie transect contained 54 species. Abundance is reported for sandhill transects by community preference for each ten meter interval (Table 8). Presence of disturbance-related species is dominant near the roadside and diminishes significantly after 20 m (Figure 17). The same trend is present with other transect types except the ruderal/oak scrub and wet prairie transects (Figure 18), where disturbance-related species spread further from the roadside. The wet prairies seem more susceptible to the spread of disturbance-related species during dry periods when adjacent to roads.

**Table 8. Number of Individual Plants Recorded by Community Type Preference in Sandhill Transects.**

m	community preference of plant species found	Transect #							mean %	mean %*
		1	2	3	8	9	mean	sd		
10	marshes/wet areas	1	1	0	1	63	13	28	9.9	8.1
	ruderal/disturbed	65	122	24	35	120	73	46	55.0	61.5
	pinelands/disturbed	19	54	4	78	5	32	33	24.1	21.4
	sandhills/pinelands	6	22	0	11	1	8	9	6.0	4.9
	sandhills/scrub	9	5	3	3	0	4	3	3.0	2.5
	upland forests/hammocks	0	12	0	0	1	3	5	2.0	1.6
20	marshes/wet areas	3	0	0	0	0	1	1	0.5	0.5
	ruderal/disturbed	39	22	5	31	1	20	16	15.8	16.6
	pinelands/disturbed	40	107	12	63	43	53	35	42.6	42.2
	sandhills/pinelands	26	45	12	14	6	21	15	16.6	16.4
	sandhills/scrub	2	12	47	7	0	14	19	10.9	10.8
	upland forests/hammocks	1	27	3	28	26	17	14	13.7	13.5
30	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	8	1	1	9	0	4	4	3.2	3.1
	pinelands/disturbed	82	26	29	99	7	49	40	41.2	39.2
	sandhills/pinelands	48	34	58	73	0	43	28	36.1	36.3
	sandhills/scrub	6	5	22	32	4	14	13	11.7	13.0
	upland forests/hammocks	0	19	7	14	6	9	7	7.8	8.4
40	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	6	0	0	0	0	1	3	1.0	0.9
	pinelands/disturbed	84	31	61	35	24	47	25	39.9	36.9
	sandhills/pinelands	72	24	82	22	7	41	33	35.1	39.9
	sandhills/scrub	13	8	13	39	10	17	13	14.1	13.0
	upland forests/hammocks	1	24	8	3	22	12	11	9.8	9.1

**Table 8. continued.**

m	community preference of plant species found	Transect #							mean %	mean %*
		1	2	3	8	9	mean	sd		
<b>50</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	0	2	0	8	0	2	3	1.7	1.3
	pinelands/disturbed	22	40	96	22	0	36	36	30.4	24.1
	sandhills/pinelands	31	29	217	30	1	62	88	52.0	61.9
	sandhills/scrub	2	2	27	35	7	15	15	12.3	9.8
	upland forests/hammocks	2	11	2	0	6	4	4	3.5	2.8
<b>60</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	0	0	2	1	0	1	1	0.7	0.5
	pinelands/disturbed	0	12	117	14	0	29	50	32.2	24.4
	sandhills/pinelands	0	22	119	18	0	32	50	35.8	51.4
	sandhills/scrub	0	3	37	44	48	26	23	29.7	22.5
	upland forests/hammocks	0	5	2	0	0	1	2	1.6	1.2
<b>70</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	0	2	0	22	3	5	9	4.0	3.2
	pinelands/disturbed	0	32	161	19	3	43	67	31.6	25.3
	sandhills/pinelands	0	44	162	41	20	53	63	39.3	51.4
	sandhills/scrub	0	2	46	93	18	32	39	23.4	18.7
	upland forests/hammocks	0	7	3	2	0	2	3	1.8	1.4
<b>80</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	0	0	0	8	8	3	4	2.4	2.0
	pinelands/disturbed	5	73	113	30	1	44	48	33.9	28.1
	sandhills/pinelands	0	120	79	19	1	44	53	33.5	45.0
	sandhills/scrub	5	2	48	29	95	36	38	27.4	22.6
	upland forests/hammocks	6	8	0	4	0	4	4	2.8	2.3
<b>90</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	4	1	0	0	9	3	4	2.1	2.0
	pinelands/disturbed	23	24	81	74	5	41	34	30.4	30.1
	sandhills/pinelands	8	40	103	21	4	35	40	25.8	26.5
	sandhills/scrub	132	7	5	68	54	53	52	39.1	38.7
	upland forests/hammocks	6	2	0	4	6	4	3	2.6	2.6
<b>100</b>	marshes/wet areas	0	0	0	0	0	0	0	0.0	0.0
	ruderal/disturbed	0	5	6	2	0	3	3	2.5	2.4
	pinelands/disturbed	45	30	73	24	4	35	26	34.2	32.0
	sandhills/pinelands	36	46	73	12	9	35	26	34.2	38.5
	sandhills/scrub	94	2	21	10	6	27	38	25.9	24.2
	upland forests/hammocks	0	7	3	2	4	3	3	3.1	2.9

\* Note: This column includes certain ground cover species that could not be counted individually (e.g., rhizomaceous grasses) and therefore were estimated as percent cover. This value represents a calculated proportional value that includes all species, both counted and estimated percent cover.

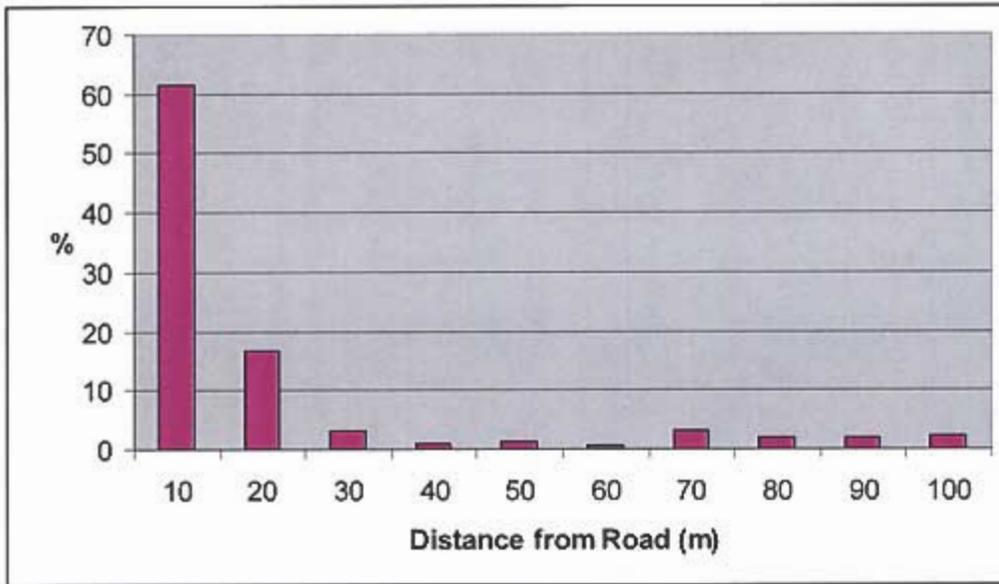


Figure 17. Mean % of Disturbance-related Plant Species in 5 Sandhill Transects.

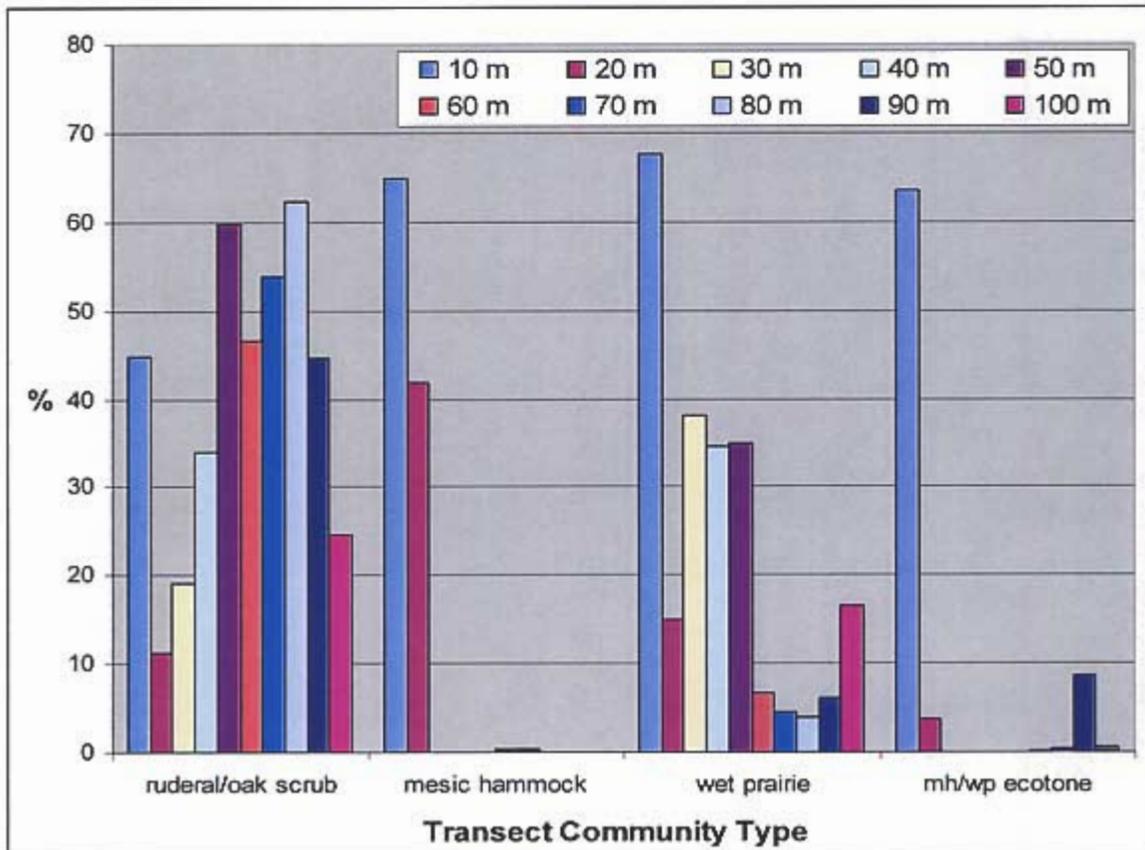


Figure 18. Mean % of Disturbance-related Plant Species in Other Community Type Transects.

Two endangered plants that are tracked by FNAI are present in the CFG and RPSF, Incised Groove-bur (*Agrimonia incise*) and Sandhill Spiny Pod (*Matelea pubiflora*). We found two locations of the endangered Sandhill Spiny Pod; the last sighting of the Incised Groove-bur was in 1975. We did not conduct any specific search for rare plants (Figure 19).

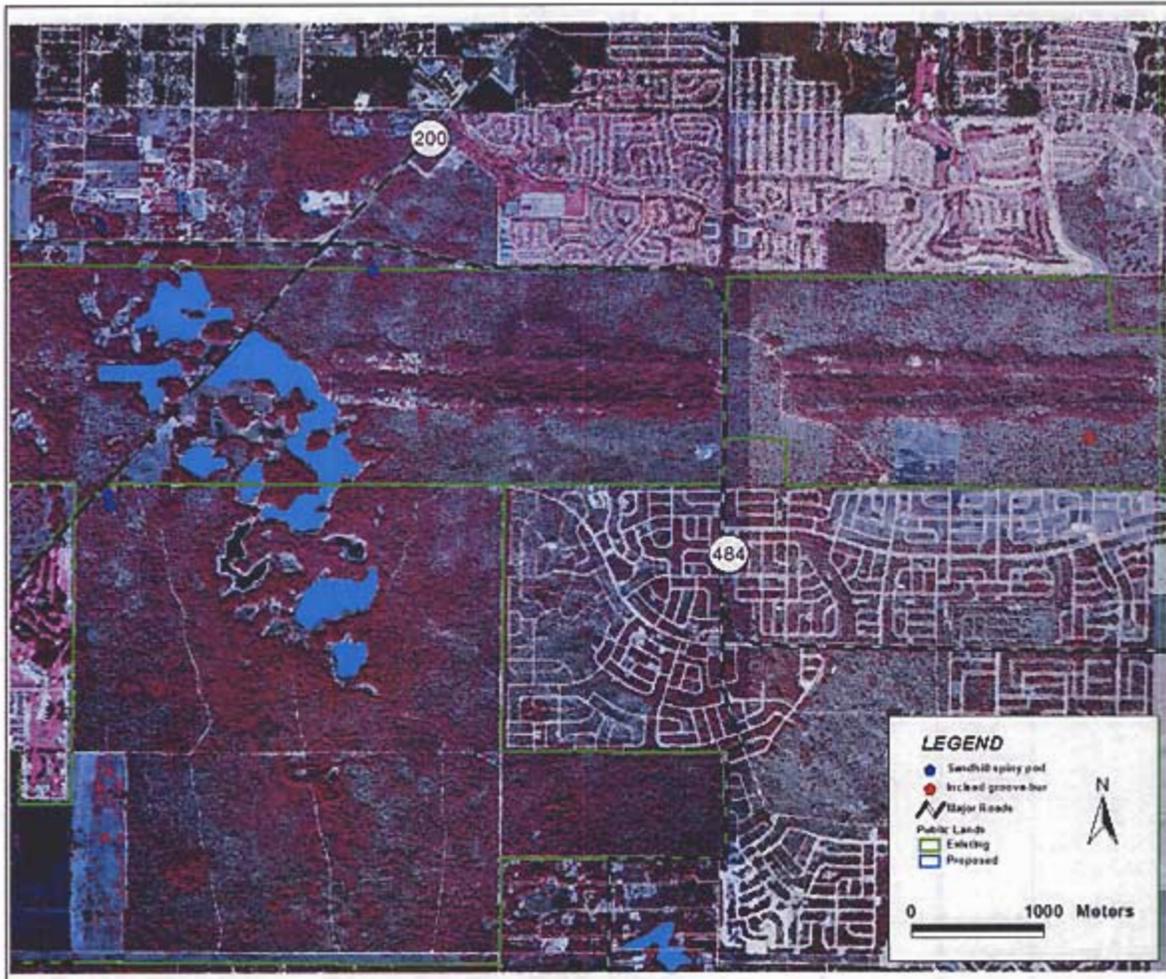


Figure 19. Confirmed Locations of Endangered Plants.

### Highway noise

Eight highway noise transects were surveyed in different land cover types along a four mile section of SR 200. Each transect ran perpendicular from the road surface to each of the control drift fence sites (Figure 16). There were 3 transects in sandhill communities, 1 transect in ruderal/oak scrub, 2 transects in wet prairie/sandhill areas and 2 transects in wet prairie/mesic hammock areas. Readings were taken between 5 pm and 6:30 pm from May 5-12, 2004. Table 9 lists the decibel levels found at various intervals. At the road's edge, noise averaged 90 db, at 100 m noise levels were still greater than 60 db. At 500 m the average was 53 db. Terrain, specifically hills and depressions, in sandhill transects reduced the influence of highway noise. Control sites in the HTP/CFG (3.5 km from SR 200) produced ambient noise levels of 40-50 dbs.

**Table 9. Sound Levels (db) Recorded along Transects perpendicular to SR 200 in the Ross Prairie Area (reference Figure 16), distance intervals in meters.**

<b>Transect/Drift Fence No.</b>	<b>Habitat Type</b>	<b>0</b>	<b>10</b>	<b>25</b>	<b>50</b>	<b>75</b>	<b>100</b>	<b>125</b>	<b>150</b>	<b>175</b>	<b>200</b>	<b>250</b>	<b>300</b>	<b>400</b>	<b>500</b>	<b>Control Drift Fence</b>
1	ruderal/oak scrub	90	82	72	64	62	60	58	56	56	56	56	54	54	54	54
2	sandhill	90	84	70	65	62	58	56	55	54	54	54	52	50	45	45
3	wet prairie/mesic hammock	90	78	71	69	66	65	61	59	58	57	57	56	55	54	54
4	wet prairie/sandhill	88	80	71	68	64	63	61	57	57	56	56	55	55	56	57
5	sandhill	88	76	72	64	62	60	59	58	57	60	59	58	59	58	52
6	wet prairie/mesic hammock	91	82	75	66	63	61	59	58	57	56	56	56	54	54	54
7	wet prairie/sandhill	93	84	76	68	64	62	60	59	58	58	55	54	54	53	53
8	sandhill	88	82	70	64	62	61	60	56	54	55	54	53	53	51	50

## Studies by Faunal Groups

The results of animal studies are presented by separate faunal groups. These include herptiles, carnivores, small- and medium-sized mammals, ungulates and birds. Road-kill monitoring was performed for all groups. Existing culverts were monitored for tracks of all groups. Track monitoring on firebreaks was performed for large herptiles, carnivores and ungulates. Telemetry studies were performed on large snakes, gopher tortoise, and felid and canid carnivores. Mark-recapture studies were performed on herptiles and small mammals.

### Herptiles

Effects of SR 200 on herptiles was determined by three methods: road-kill monitoring, mark-recapture surveys using drift fence arrays on the right-of-way, and track surveys on cleared paths adjacent to the right-of-way. In addition to these methods, telemetry studies were performed on gopher tortoises, eastern indigo snakes and eastern diamondback rattlesnakes.

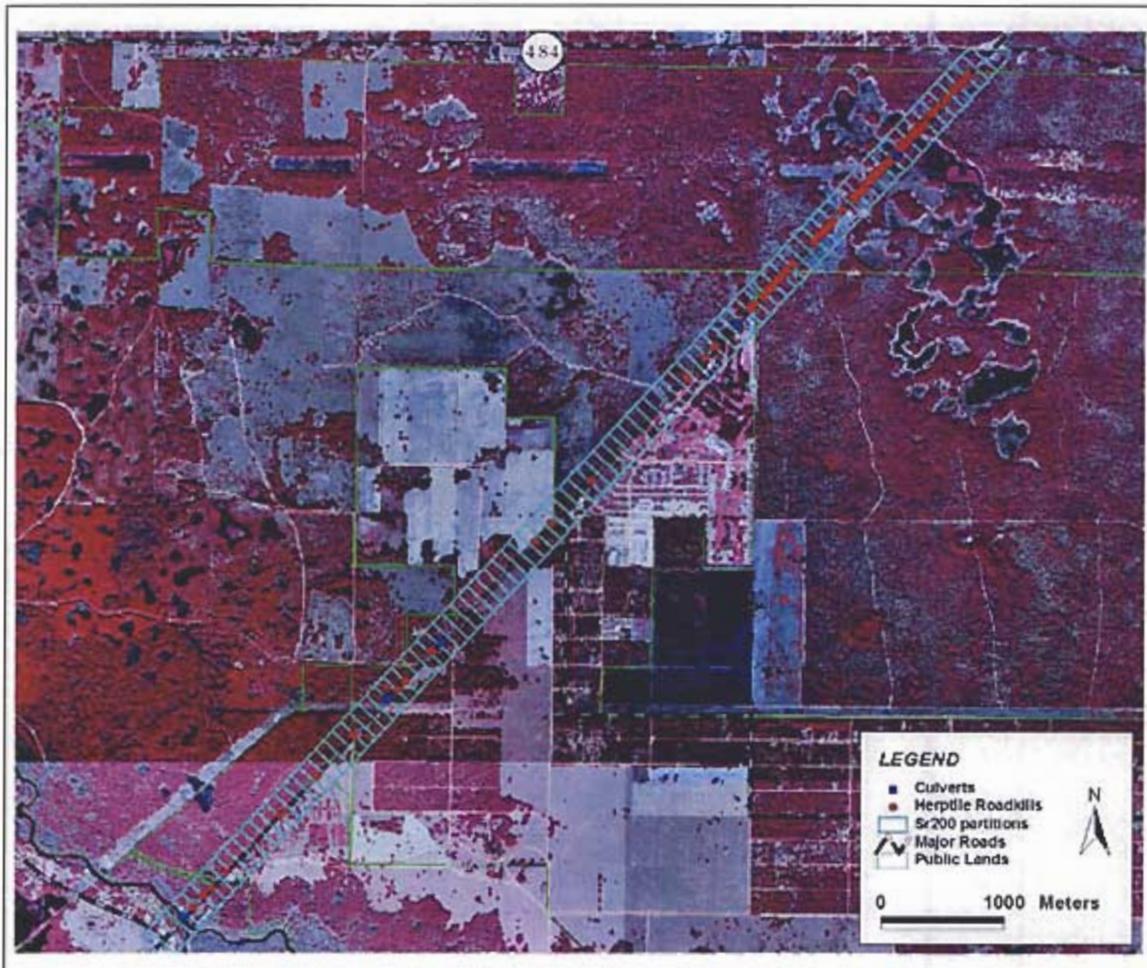
**Road-kill.** Driving surveys were conducted to quantify road-kills on SR 200 from the intersection with CR 484 to the Withlacoochee River Bridge (approx. 6.1 mi. or 9.8 km). Figure 20 shows all road-kills recorded between April 2002 and April 2004. Road-kill surveys were conducted 5 days per week during this period (except mid-December 2002 to mid-January 2003 and April 2003). A total of 573 herptiles were recorded, an average of 1.2 road-kills per day checked (a total of 480 road-kill check days). A list of all road-kills recorded can be found in Appendix D.

Temporal change of recorded herptile road-kills is shown in Figure 21. There were 238 road-kills recorded in 2002-3 and 335 in 2003-4, an increase of 17%. One peak in road-kills occurred in July 2002, 96% of these were frogs. In 2003, two smaller peaks occurred in May-June and September-October. Again, these peaks are attributed to increased numbers of frogs killed on the road. The difference in the annual number of herptile road-kills does not appear to be related to the annual amount of rainfall. The first year rainfall was 62.58 in; the second year rainfall was 47.68 in. Instead, the seasonal timing of rainfall (Figure 22) appears to explain the level of road-killed herptiles by year. From December through March, rainfall prior to the 2002 season was 10.48 in, but prior to the 2003 season it was 22.72.

Herptile road-kills were tested with relation to seasonality (ANOVA) and rainfall (Pearson Correlation Coefficient). Difference of number of road-kills by season was insignificant ( $F=1.21$ ,  $p > 0.3331$ ,  $R^2=.16$ ). Number of road-kills was compared to current and previous monthly rainfall. Number of road-kills was not related to current or same month rain-fall levels ( $R^2=0.16$ ,  $p=0.46$ ); but when compared to rainfall from the previous month a positive correlation was evident ( $R^2=0.72$ ,  $p=0.0001$ ).

Spatially, 96% of herptile road-kills recorded occurred between the north and south boundary of the CFG, a distance of about 1.6 mi or 2.55 km. This equates to about 216 road-kills per km. A Kruskal-Wallis test revealed significant variability of road-kills by land-use jurisdiction (Figure 12) for amphibians ( $\chi^2=68.12$ ,  $p<0.0001$ ) and reptiles ( $\chi^2=13.87$ ,  $p=0.017$ ). Most herptile road-

kills occurred adjacent to public lands near the Ross Prairie basin or adjacent to the Gum Slough conservation easement near the Withlacoochee River.



**Figure 20. Location of all herptile road-kills recorded between 2002 and 2004.**

In addition, variability of road-kills by land cover type (Figure 11) was significant for amphibians ( $\chi^2=82.01$ ,  $p<0.0001$ ) and reptiles ( $\chi^2=32.74$ ,  $p=0.0031$ ). Most herptile road-kills occurred near wet prairie, sandhill or mesic hammock communities.

To establish a finer resolution of the spatial distribution of road-kills, the road was divided into 100 m sections. The three groups of herptiles (frogs, snakes and turtles) are further described by these sections. A total of 511 frogs were recorded from road sections 3 to 29 (Figure 23). Frogs were mostly killed in sections 8 to 14 of the Ross Prairie basin ( $n=420$ , 82%) (Figure 24). Spatial distribution of each anuran is shown in Figures 25a to 25f. These include 24 bullfrogs, 51 Florida gopher frogs, 67 Southern leopard frogs, 10 Southern toads, 3 Eastern spadefoot toads, 2 barking treefrogs, 15 green treefrogs, 4 pinewoods treefrogs, 3 unidentified treefrogs, 301 unidentified frogs, 18 unidentified toads, and 15 unidentified frogs/toads.

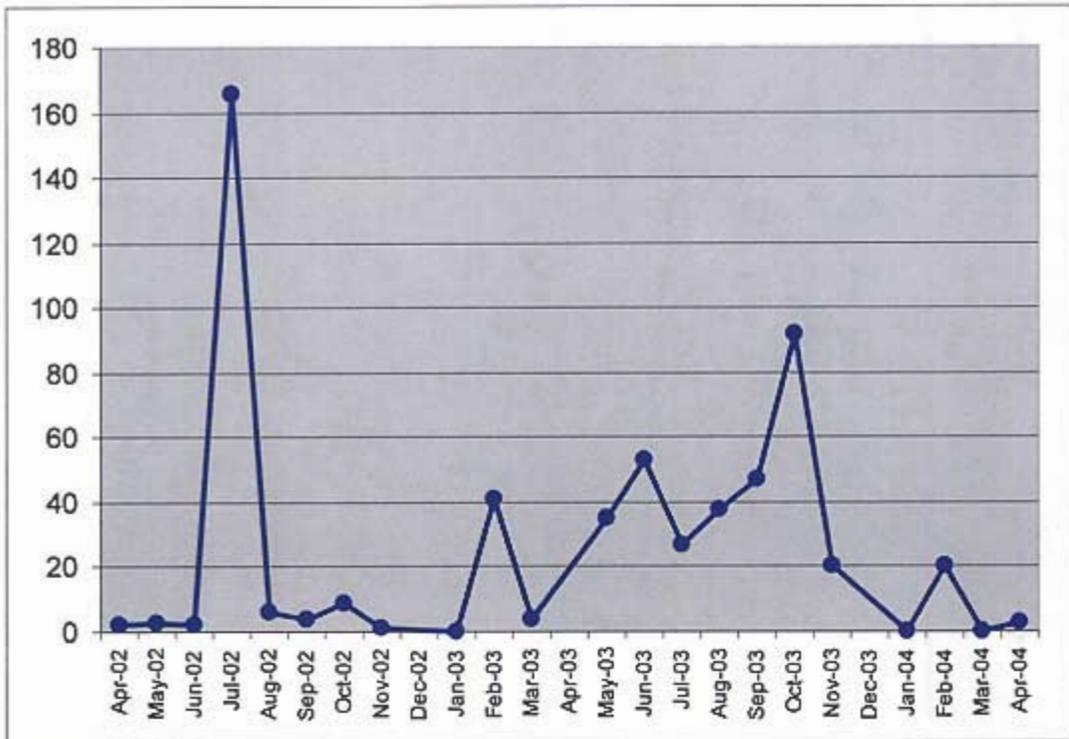


Figure 21. Temporal Patterns of Herpetile Road-kills, 2002-2004.

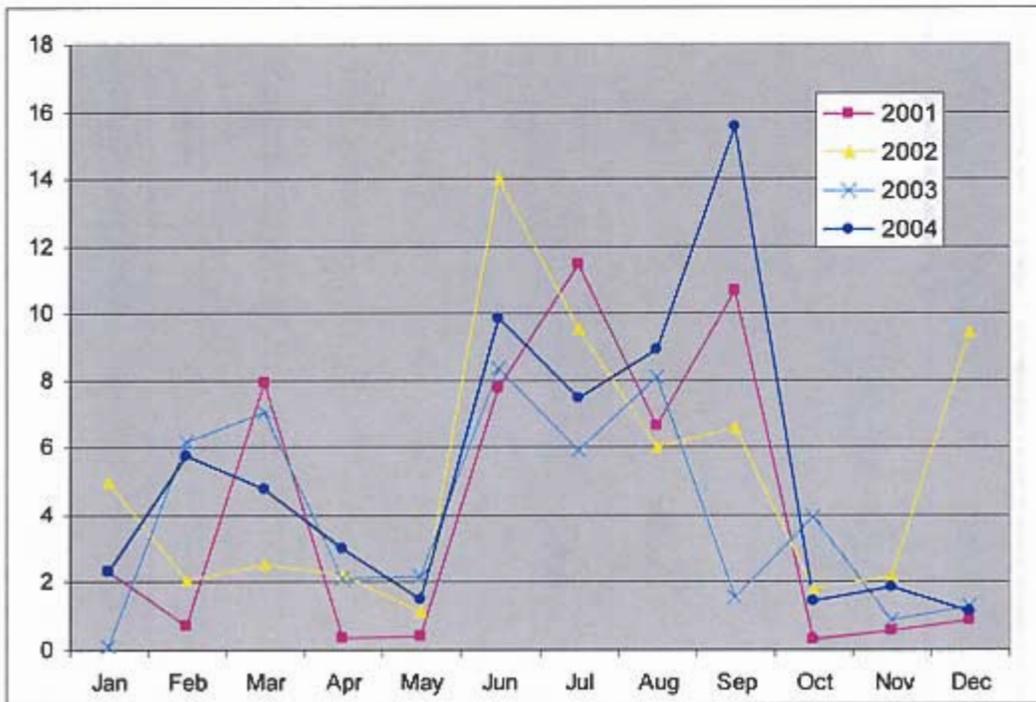


Figure 22. Monthly Precipitation for Ross Prairie, 2001 - 2004. Source: SWFWMD.

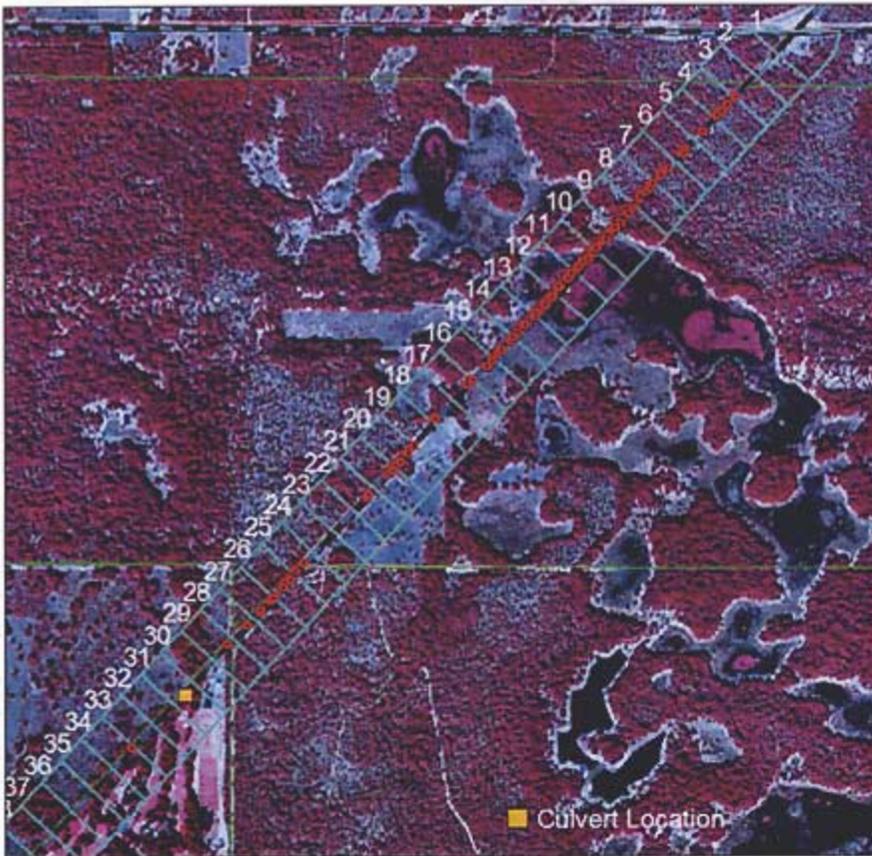


Figure 23. Spatial Distribution of Road-killed Frogs in the CFG Area of SR 200.

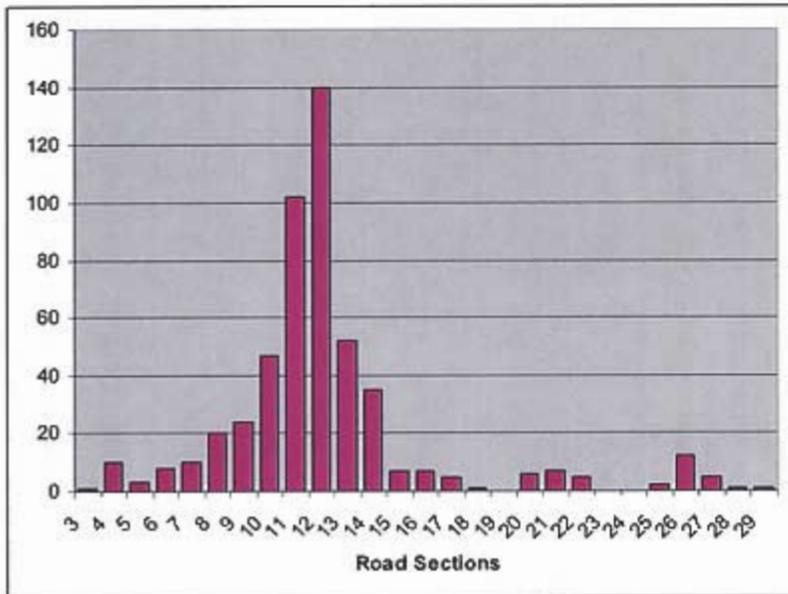


Figure 24. Number of Frogs Killed on SR 200 by Road Section. Sections 10-13 correspond to the Ross Prairie basin.

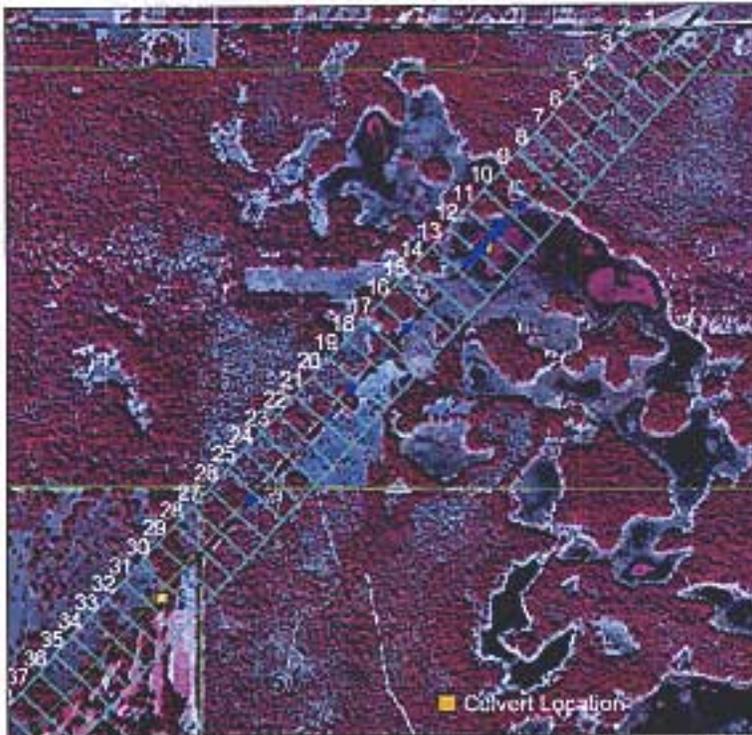


Figure 25a. Spatial Distribution of Road-killed Bullfrogs in the CFG Area of SR 200.

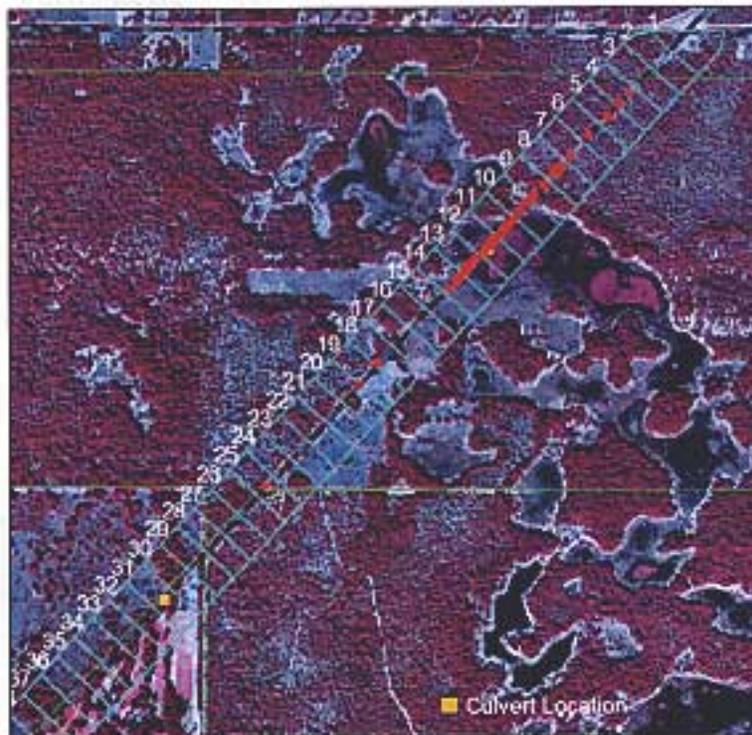


Figure 25b. Spatial Distribution of Road-killed Florida Gopher Frogs in the CFG Area of SR 200.

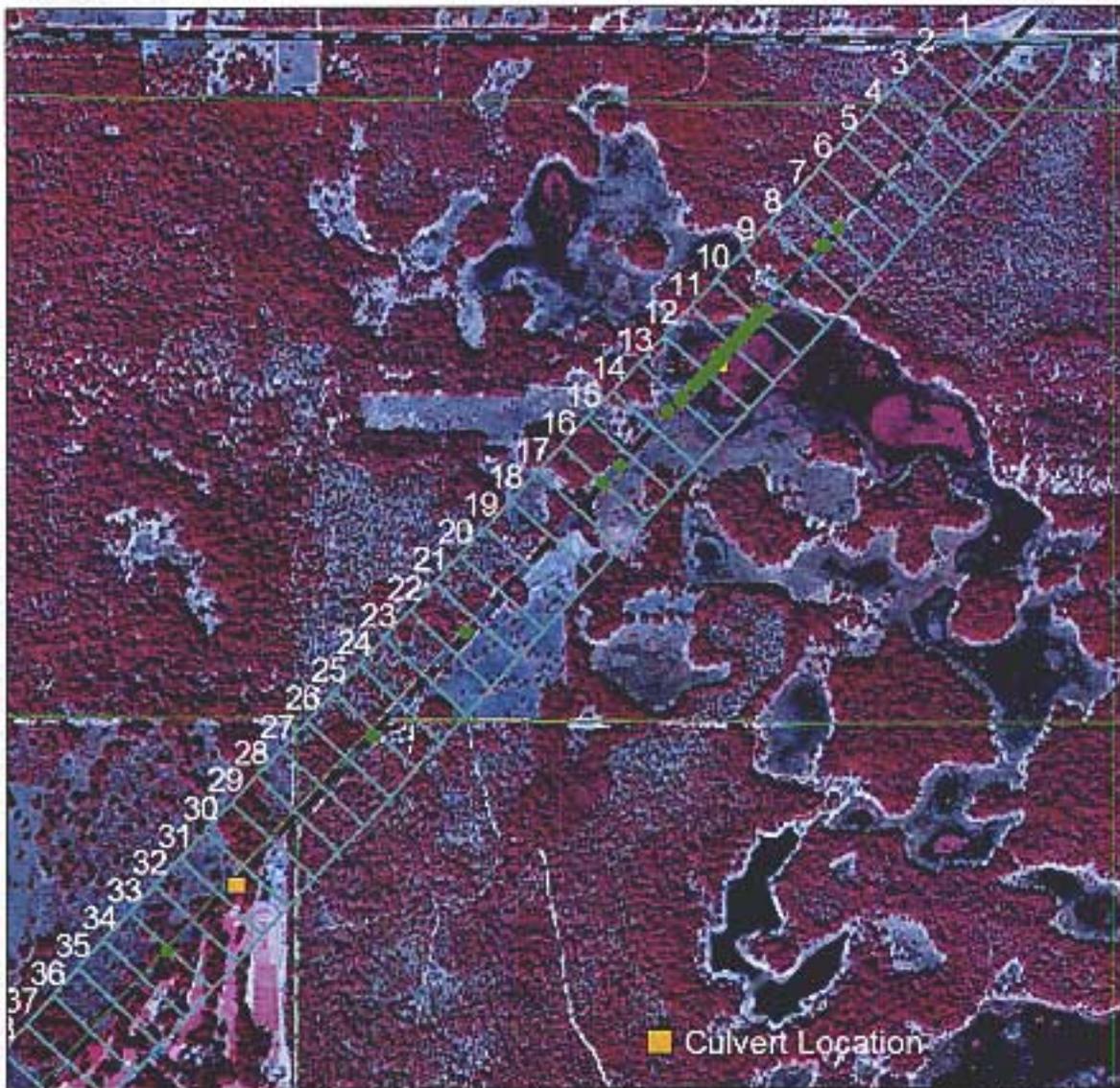


Figure 25c. Spatial Distribution of Road-killed Southern Leopard Frogs in the CFG Area of SR 200.

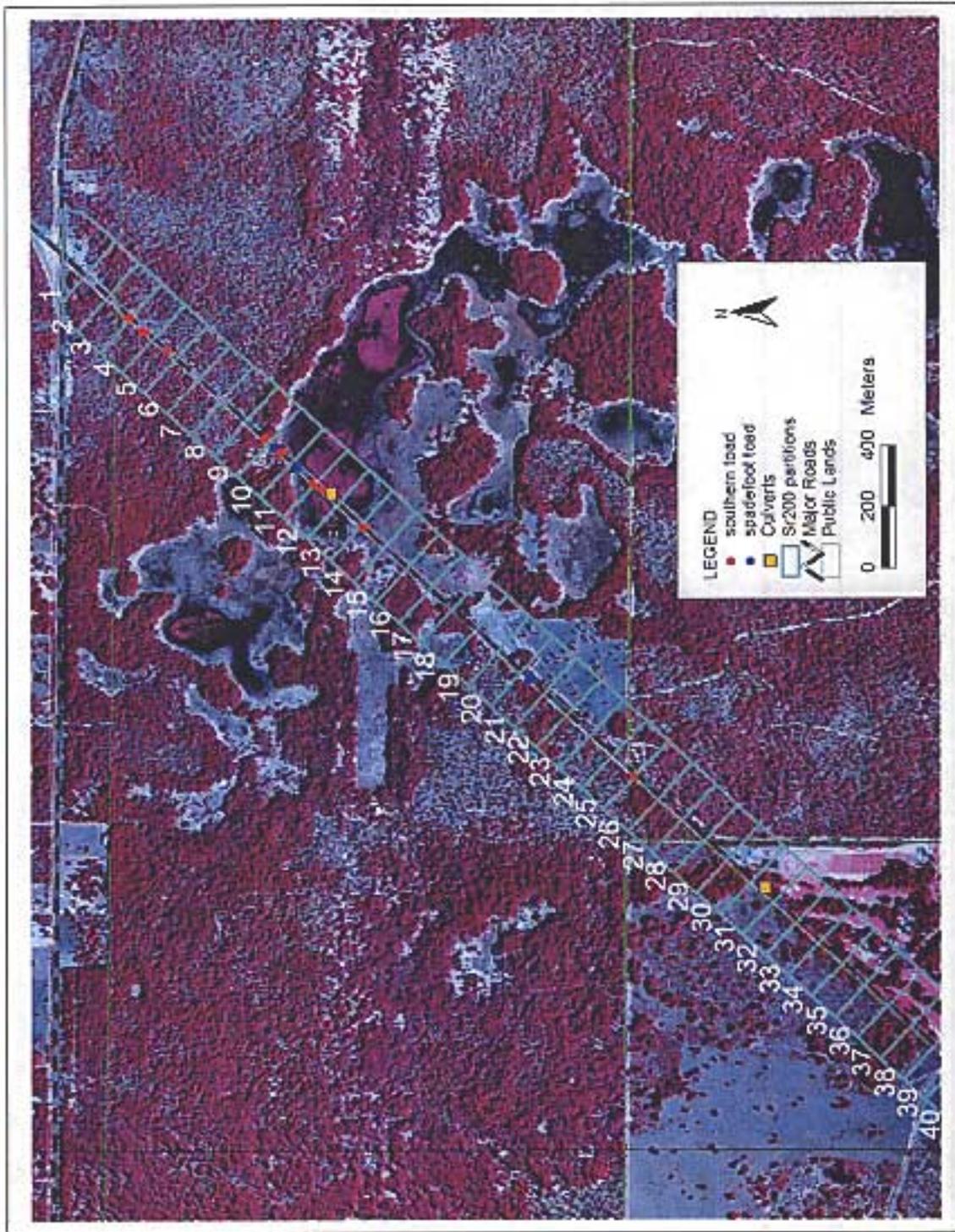


Figure 25d. Spatial Distribution of Road-killed Toads in the CFG Area of SR 200.

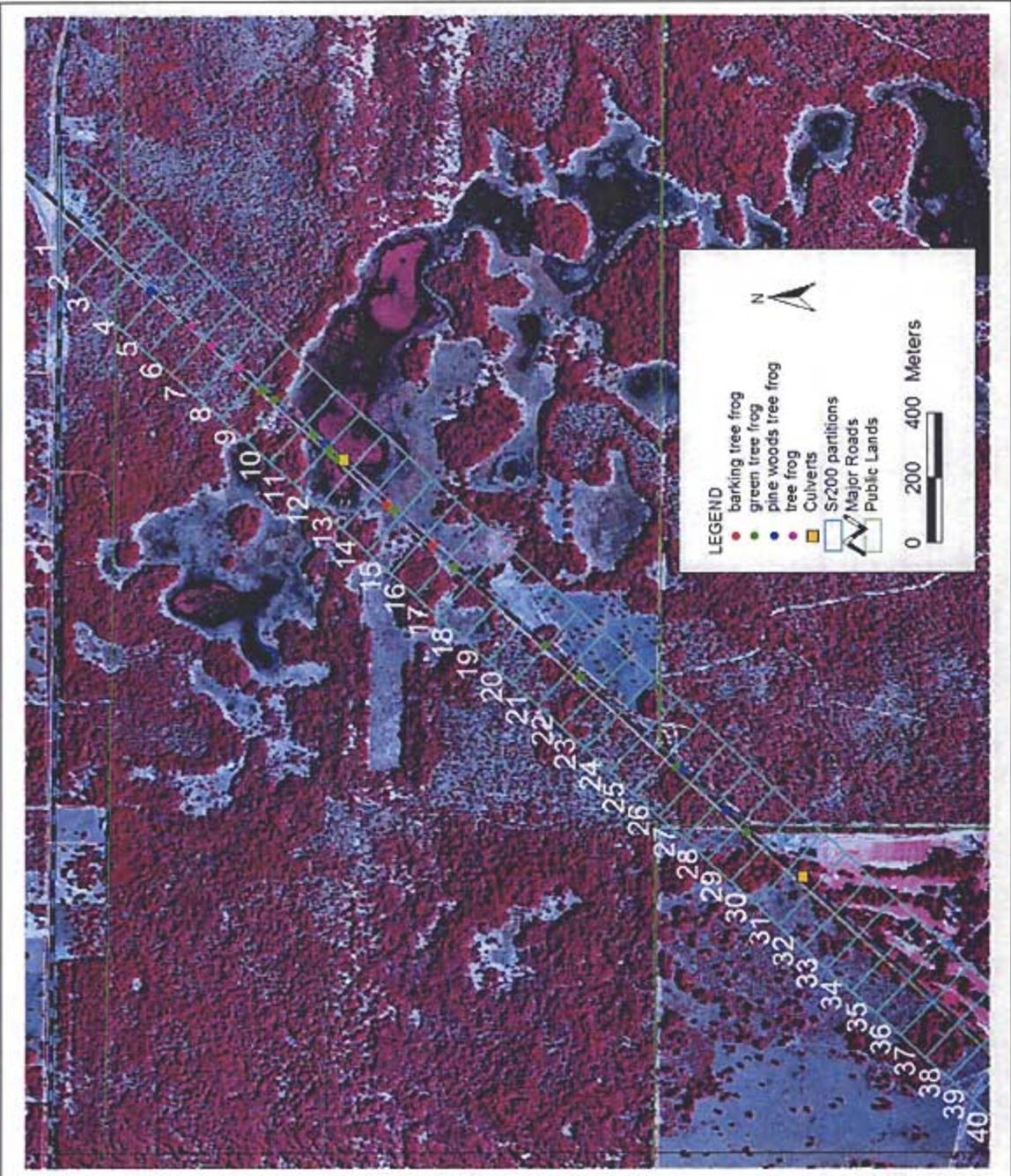


Figure 25e. Spatial Distribution of Road-killed Tree Frogs in the CFG Area of SR 200.

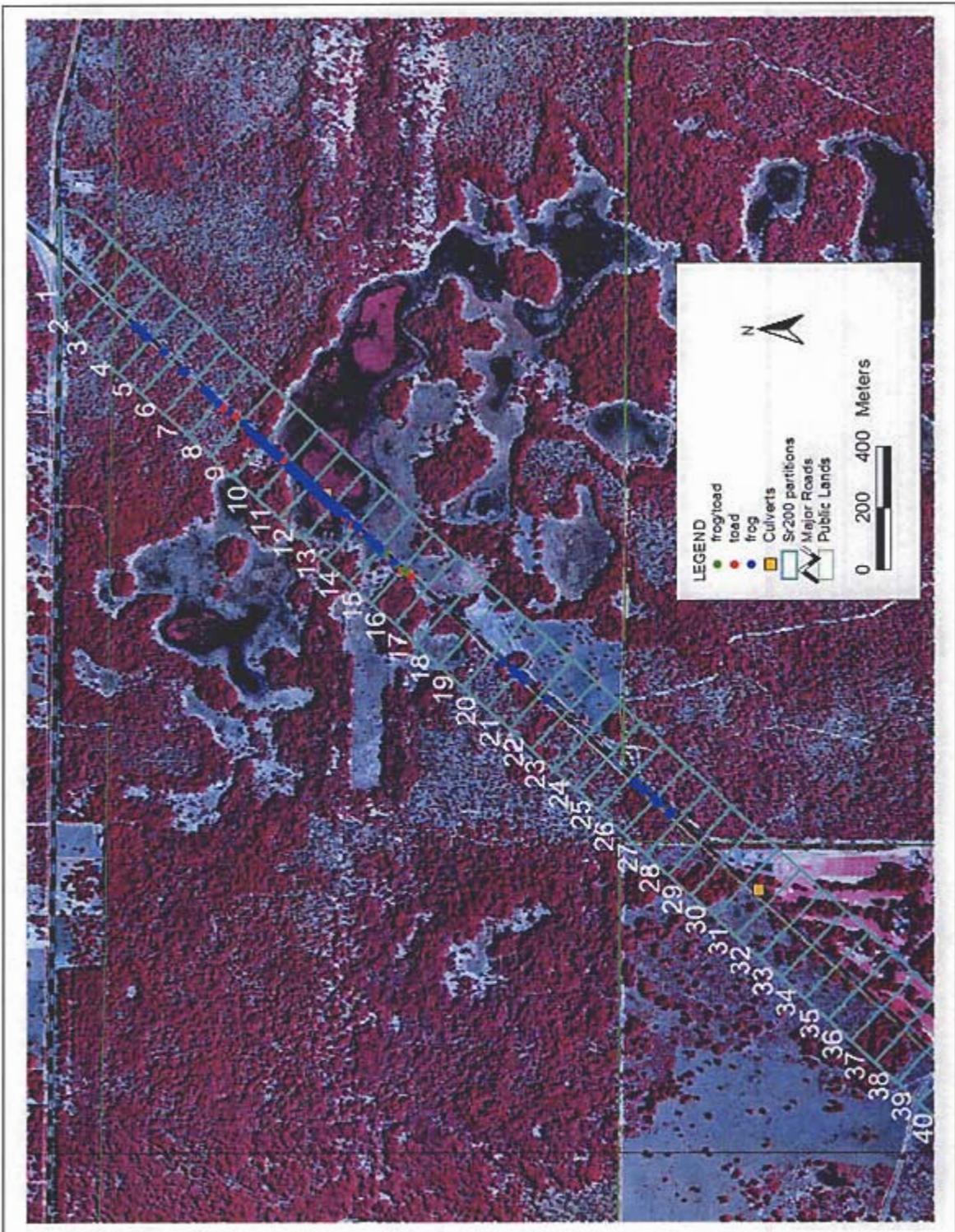


Figure 25f. Spatial Distribution of Unidentified Road-killed Frogs in the CFG Area of SR 200.

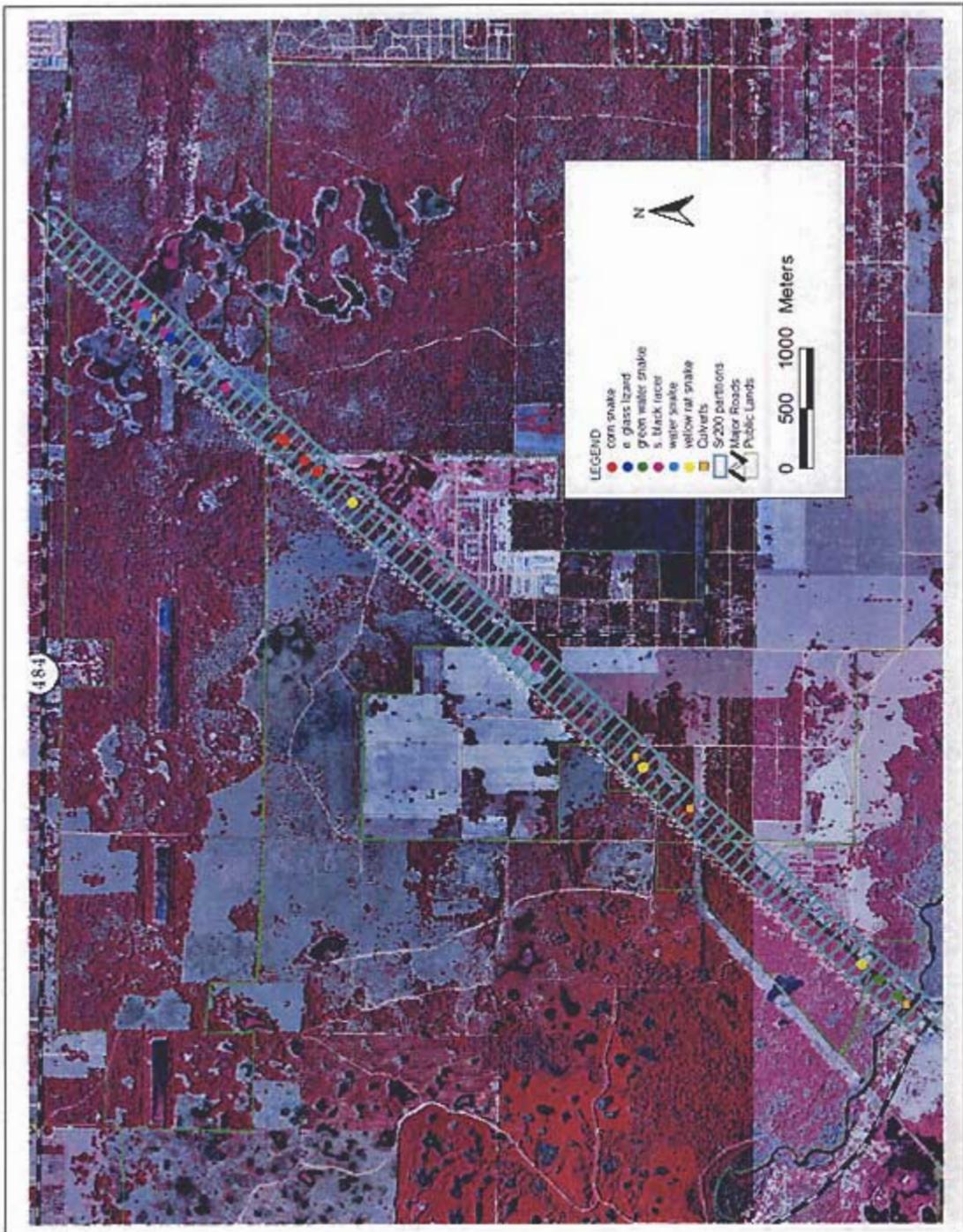
Twenty-five road-killed snakes were recorded on SR 200 from April 2002 to April 2004 (Figure 26). No seasonal patterns were apparent regarding road-killed snakes. Spatial distribution of focal species, Eastern coachwhip (n=1), Eastern diamondback rattlesnake (n=1), and Eastern indigo snake (n=4) killed on the road are shown in Figure 27. Spatial distribution of other snakes, corn snake (n=4), Eastern glass lizard (n=1), green water snake (n=2), Southern black racer (n=6), water snake (n=2), and yellow rat snake (n=3) are shown in Figure 28. Thirteen of 25 snake road-kills occurred in road sections adjacent to the CFG and RPSF. Two of four Eastern indigo snakes were found on road sections adjacent to the HTP and Spruce Creek Golf Course. Two green water snakes and one yellow rat snake were found on road sections adjacent to the Gum Slough conservation easement.



Figure 26. Spatial Distribution of Road-killed Snakes on SR 200 between 2002 and 2004.



Figure 27. Spatial Distribution of Focal Species Snakes on SR 200 between 2002 and 2004.



**Figure 28. Spatial Distribution of Other Road-killed Snakes on SR 200 between 2002 and 2004.**

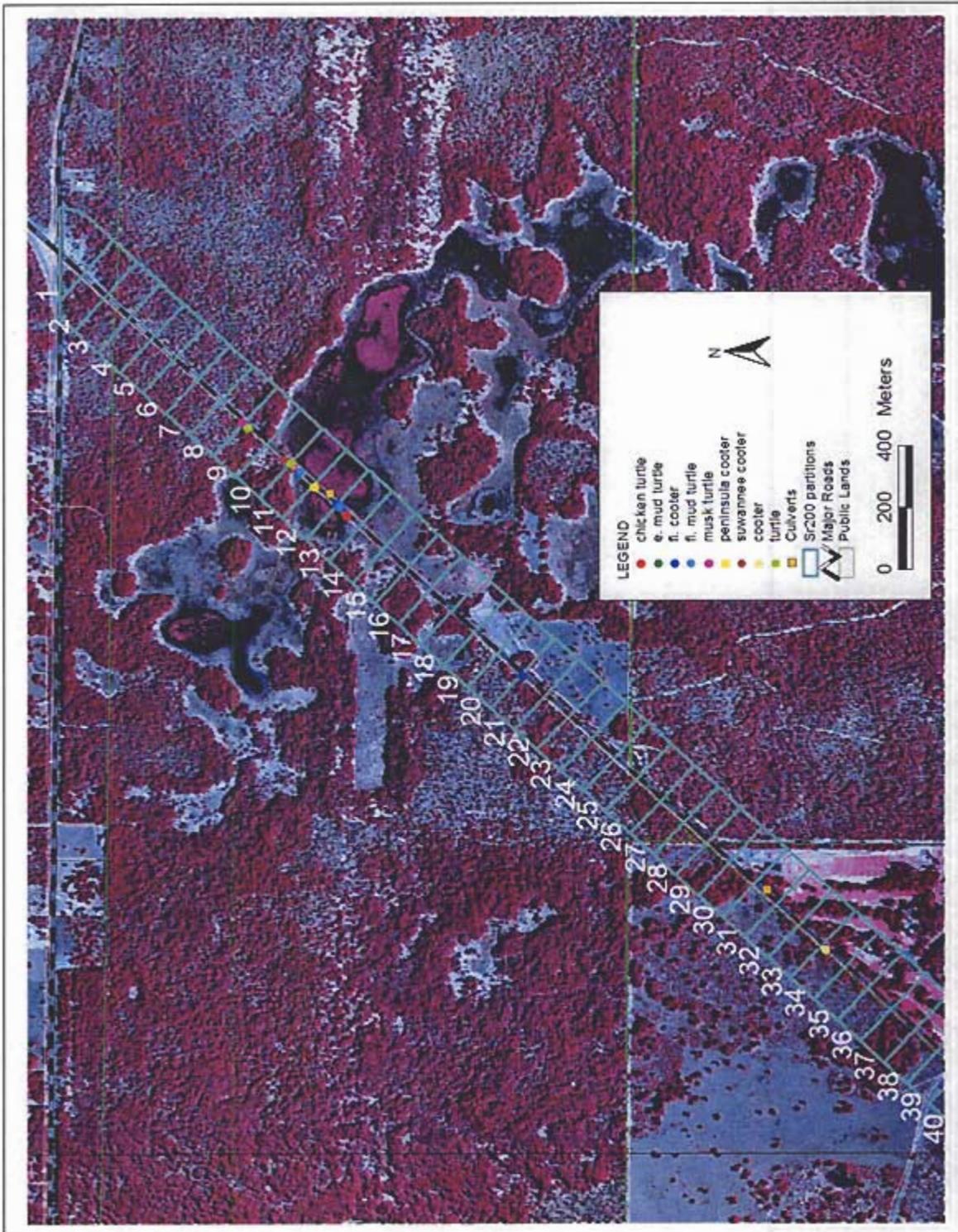
A total of 36 road-killed turtles were recorded on SR 200 from April 2002 to April 2004 (Figure 29). All turtle road-kills occurred between May and October. These included gopher tortoise (n=9), Florida box turtle (n=3), chicken turtle (n=2), Eastern mud turtle (n=2), Florida cooter (n=4), Florida mud turtle (n=2), Florida softshell (n=1), musk turtle (n=2), peninsula cooter (n=2), Suwannee cooter (n=2), unidentified cooter (n=1), and unidentified turtle (n=6). Location of gopher tortoise and Florida box turtle road-kills is shown in Figure 30. All three Florida box turtles and 5 of 9 gopher tortoises were found in road sections adjacent to sandhill communities in the CFG and RPSF, coincident with gopher tortoise colonies included in telemetry studies. Aquatic turtles found in road sections, between the north and south boundary of the CFG, are shown in Figure 31. These included 92% (n=22) of all aquatic turtle road-kills. The road-killed Florida softshell was found adjacent to the Gum Slough conservation easement.



Figure 29. Spatial Distribution of Road-killed Turtles on SR 200 between 2002 and 2004.

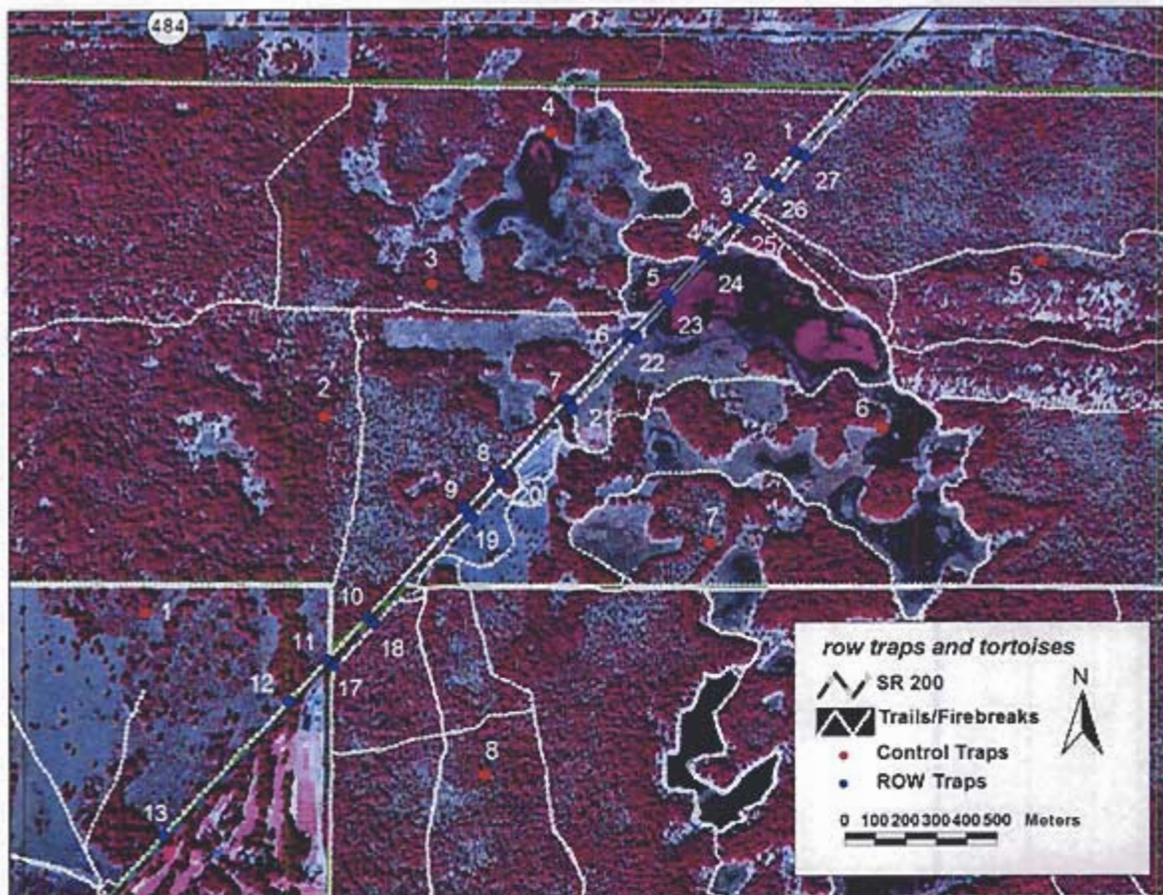


Figure 30. Spatial Distribution of Road-killed gopher tortoises and Florida box turtles on SR 200 between 2002 and 2004.



**Figure 31. Spatial Distribution of Aquatic Road-killed Turtles on SR 200 between 2002 and 2004.**

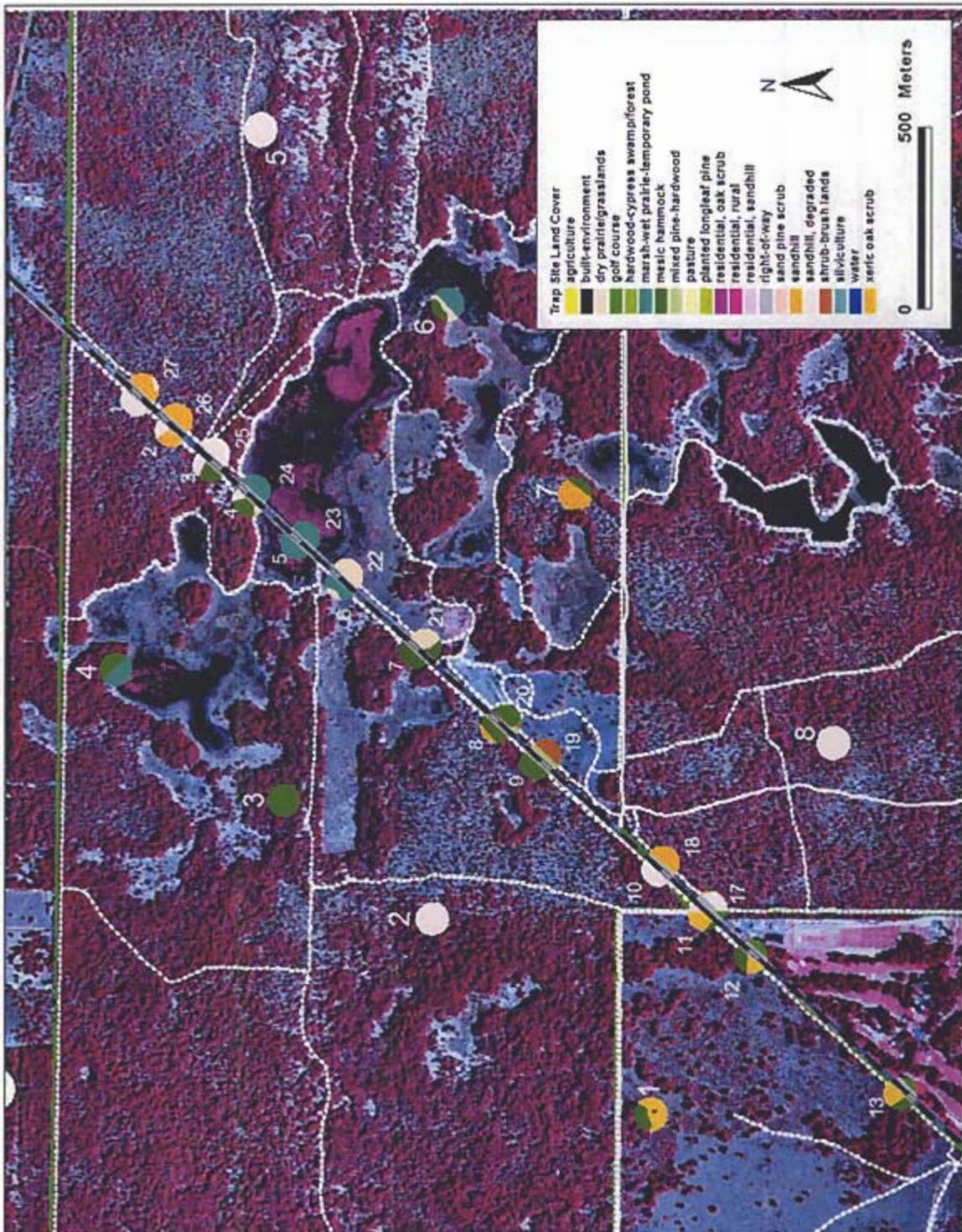
**Mark-recapture.** Twenty-four drift fence arrays were constructed on the road right-of-way (Figure 32). There were also 8 trap arrays set up as controls at distances greater than 500 m from the road. Control drift fences were used for species diversity comparisons.



**Figure 32. Location of ROW and Control Drift Fence Arrays.**

Figure 33 displays the land cover surrounding each trap in a 50 m radius. Number of arrays in each land cover type is as follows: sandhill and sandhill-degraded – 8, mesic hammock – 7, wet prairie – 4, dry prairie – 2, ruderal (shrub-brushlands) – 1, xeric oak scrub – 2. Number of traps in each land cover type is proportional to the amount of each land cover type along the right-of-way gradient. Control trap site land cover included sandhill and sandhill-degraded – 4, mesic hammock – 1, wet prairie and mesic hammock – 2, xeric oak scrub – 1. Differences in diversity and abundance of captures for focal species by trap-site land cover will be compared.

Right-of-way drift fence arrays were checked from June 2002 to January 2004, except for April 2003. Control drift fence arrays were checked from mid-February 2004 to mid-April 2004. During the course of the study certain right-of-way drift fence arrays were closed for extended periods due to several factors: periodic flooding [traps 5 (8 days), 6 (22 days), 22 (15 days), and 23 (28 days)], storm damage [traps 10 (14 days), 11 (9 days), and 12 (14 days)], and right-of-way utility work [20 (28 days), 21 (32 days), 24 (11 days), 25 (33 days)].



**Figure 33. Land Cover at Drift Fence Trap Sites (50 m radius surrounding each array).** Seven different land cover types are represented: sandhill, sandhill-degraded, mesic hammock, wet prairie, dry prairie, ruderal (shrub-brushlands), and xeric oak scrub.

A total 1,777 different individuals from 32 species were captured in the right-of-way traps. The number of each species captured and recaptured is shown in Table 10. Florida gopher frogs (n=544), E. narrowmouth toads (n=411), S. leopard frog (n=109), S. toad (n=109), E. spadefoot toad (n=105), and six-lined racerunner (n=176) were abundant. The fewest individuals captured were scarlet snake (n=1), ringneck snake (n=1), E. glass lizard (n=1) Florida box turtle (n=1), bullfrog (n=1), Florida cooter (n=1), Florida mud turtle (n=1), and green anole (n=1).

**Table 10. Herptiles Caught in ROW Drift Fence Arrays, June 2002 – January 2004.**

Scientific Name	Common Name	# Captures	# Individual Recaptures	Recapture Frequency	Recorded Road Crossings	Crossing Frequency	Sex Ratio (M:F)	Avg. Body Length (SNV - snakes, lizards)	Avg. Tail Length	Avg. Weight
<i>Anolis carolinensis</i>	Green Anole	1	0	0.00	0	0.00	n/a	5.0	n/a	4.0
<i>Anolis sagrei</i>	Brown Anole	6	0	0.00	0	0.00	n/a	4.8	4.9	2.4
<i>Bufo quercicus</i>	Oak Toad	34	3	0.09	0	0.00	n/a	2.5	n/a	3.1
<i>Bufo terrestris</i>	Southern Toad	109	8	0.07	6	0.06	9:31	4.6	n/a	14.2
<i>Cemophora coccinea</i>	Scarlet Snake	1	0	0.00	0	0.00	n/a	11.0	1.5	10.0
<i>Chrysemys floridana floridana</i>	Florida Cooter	1	0	0.00	0	0.00	n/a	9.5	n/a	160.0
<i>Cnemidophorus sexlineatus</i>	6-lined Racerunner	176	50	0.28	14	0.08	61:76	5.9	11.1	5.7
<i>Coluber constrictor</i>	S. Black Racer	27	3	0.11	1	0.04	n/a	65.1	20.7	121.1
<i>Diadophis punctatus</i>	Ringneck Snake	1	0	0.00	0	0.00	n/a	16.0	4.0	4.0
<i>Elaphe guttata</i>	Corn Snake	7	0	0.00	0	0.00	n/a	27.5	7.1	34.3
<i>Eleutherodactylus planirostris</i>	Greenhouse Frog	41	2	0.05	1	0.02	n/a	1.8	n/a	1.5
<i>Eumeces egregius</i>	Mole Skink	3	0	0.00	0	0.00	n/a	4.2	3.1	2.5
<i>Eumeces inexpectatus</i>	SE 5-lined Skink	9	0	0.00	0	0.00	n/a	5.9	8.4	6.1
<i>Gastrophryne carolinensis</i>	E. Narrowmouth Toad	411	4	0.01	0	0.00	81:146	2.2	n/a	2.6
<i>Gopherus polyphemus</i>	Gopher Tortoise	2	0	0.00	0	0.00	n/a	21.3	n/a	268.5
<i>Heterodon simus</i>	S. Hognose Snake	4	1	0.25	1	0.25	n/a	29.0	5.3	64.0
<i>Hyla cinerea</i>	Green Tree Frog	21	3	0.14	1	0.05	n/a	3.0	n/a	3.5
<i>Hyla femoralis</i>	Pinewoods Tree Frog	2	0	0.00	0	0.00	n/a	2.4	n/a	3.0
<i>Hyla gratiosa</i>	Barking Tree Frog	52	5	0.10	3	0.06	25:7	3.8	n/a	5.7
<i>Kinosternon subrubrum steindachneri</i>	FL. Mud Turtle	1	0	0.00	0	0.00	n/a	17.5	n/a	n/a
<i>Micrurus fulvius</i>	E. Coral Snake	7	1	0.14	1	0.14	n/a	48.6	5.7	50.0
<i>Ophisaurus ventralis</i>	E. Glass Lizard	1	0	0.00	0	0.00	n/a	19.0	13.0	33.0
<i>Pituophis melanoleucus mugitus</i>	E. Coachwhip	5	1	0.20	0	0.00	n/a	84.6	19.9	94.3
<i>Rana capito</i>	FL. Gopher Frog	544	32	0.06	8	0.01	n/a	4.1	n/a	8.7
<i>Rana catesbiana</i>	Bullfrog	1	0	0.00	0	0.00	n/a	8.0	n/a	38.0
<i>Rana sphenoccephala</i>	S Leopard Frog	109	6	0.06	1	0.01	n/a	4.4	n/a	8.6
<i>Scaphiopus holbrookii</i>	E. Spadefoot Toad	105	5	0.05	2	0.02	n/a	4.9	n/a	16.3
<i>Sceloporus undulatus</i>	S. Fence Lizard	62	32	0.52	4	0.06	24:20	4.2	5.5	4.6
<i>Scincella lateralis</i>	Ground Skink	19	1	0.05	1	0.05	n/a	3.4	3.6	1.8
<i>Tantilla relicta</i>	Crown Snake	11	0	0.00	0	0.00	n/a	12.5	2.9	2.6
<i>Terrapene carolina</i>	Florida Box Turtle	1	0	0.00	0	0.00	n/a	18.0	n/a	750.0
<i>Thamnophis sirtalis</i>	Common Garter Snake	3	0	0.00	0	0.00	n/a	22.2	4.5	17.7

Seasonal difference in reptile and amphibian captures in right-of-way drift fence traps is shown in Figure 34. One significant peak occurred each year for amphibians, July 2002 (n=219) and May – July 2004 (n=881). As explained previously (road-kill section), the amount of rainfall was greater in months prior to the 2003 trapping period than the 2002 trapping period leading to more amphibians in the second year. Amphibian captures were significantly reduced in cold months. Reptile captures mimicked the temporal peaks and valleys indicated for amphibians, but abundance was much less. The highest number of captures of reptiles was in July 2002 (n=77).

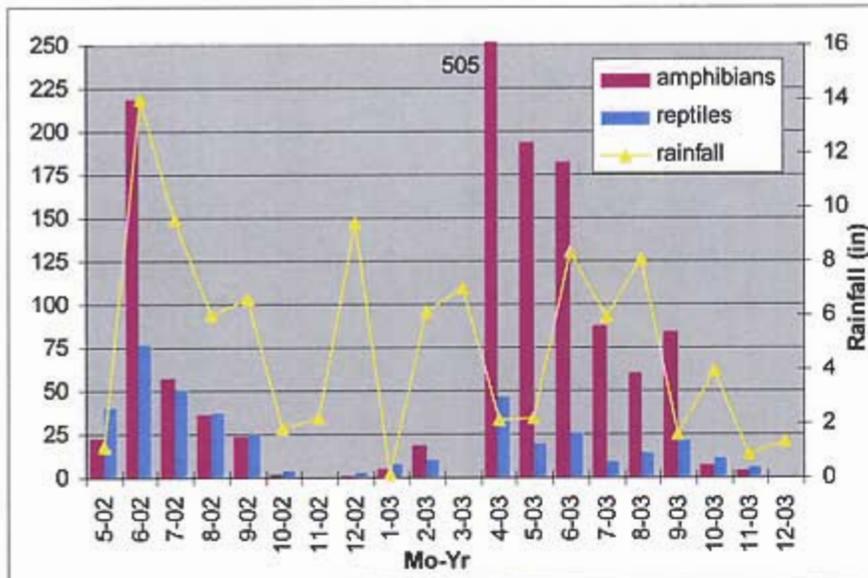


Figure 34. Seasonal Differences in ROW Drift Fence Captures for Reptiles/Amphibians.

A total of 157 individuals from 16 species were recaptured. Six-lined racerunners (n=50), Florida gopher frog (n=32) and S. fence lizard (n=32) were recaptured most frequently. Of those recaptured, few species (n=14) and individuals (n=44) actually were recorded crossing the road. Recorded crossing frequency for each species (at least 10 captures) was less than 10% (Table 10). Only one species with at least 10 captures, crown snake, was not recorded crossing the road.

Two snakes crossed perpendicular to the road between traps 2 and 26 (S. hognose) and 3 and 25 (S. black racer); an E. coral snake traveled parallel to the road for approx. 650 m to cross between traps 2 and 22 (Figure 35a). Six-lined racerunners (n=14) were recorded crossing the road most frequently (Figure 35b). Seven crossings were perpendicular to the road between traps directly across from each other, the other seven were between traps diagonal from each other. The longest recorded travel distance was 350 m. Other lizards recorded crossing the road were the ground skink and S. fence lizard (Figure 35c). One fence lizard was recorded crossing diagonally between traps 6 and 20, a distance of approx. 550 m. Five treefrogs were recorded crossing the road (Figure 35d). The longest travel event was by a barking treefrog, approx. 500 m between traps 10 and 19. Nine ranids (S. leopard frog and Florida gopher frog) and 8 toads (E. spadefoot and S. toad) were recorded crossing the road (Figure 35e and 35f, respectively). Travel distances vary from 50 m to 1,000 m. Fifteen (88%) of these recaptures occurred during breeding season and 13 (76%) occurred traveling in the direction to/from the Ross Prairie basin.

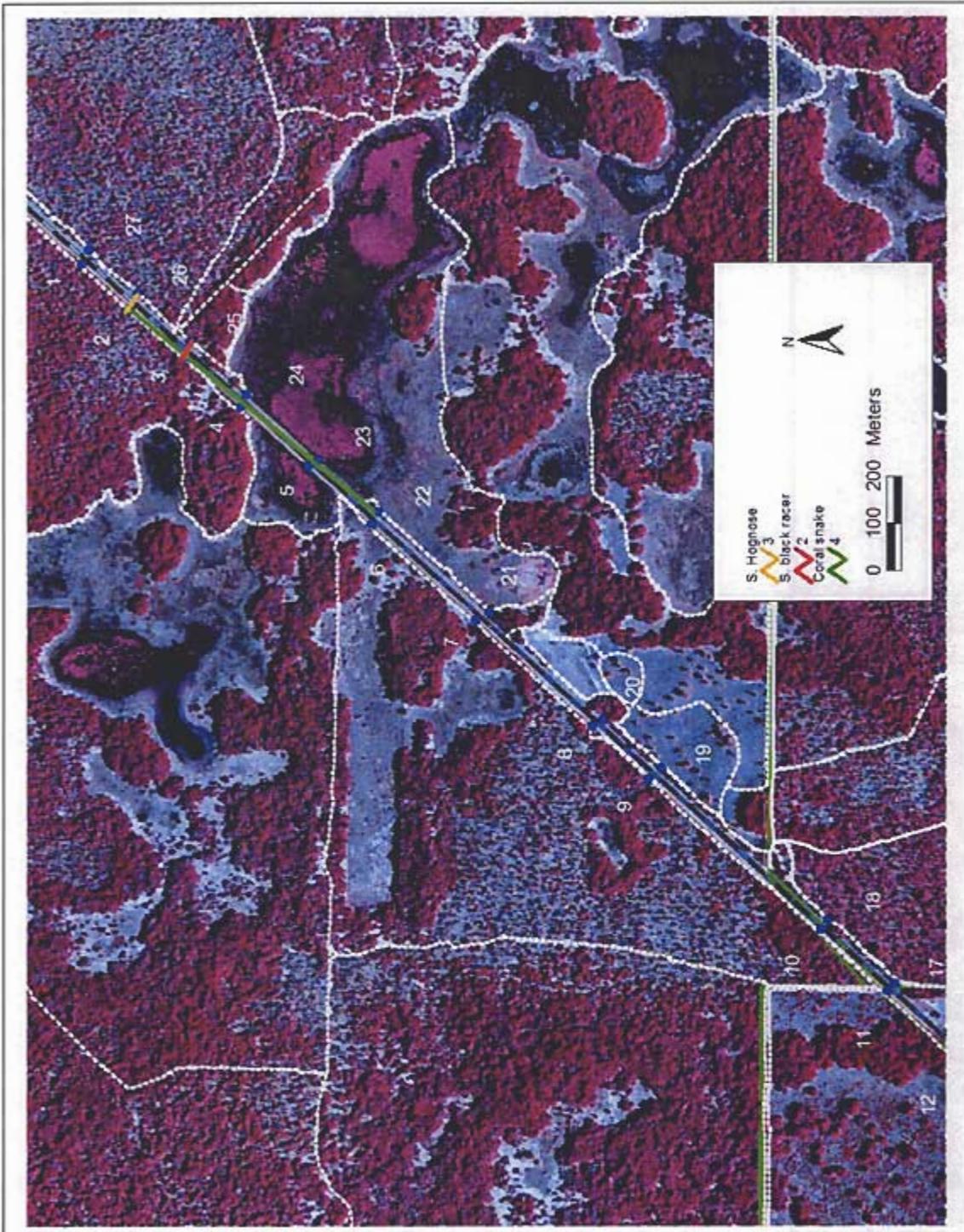


Figure 35a. Location of Recorded Crossings of Individual Snakes on SR 200.

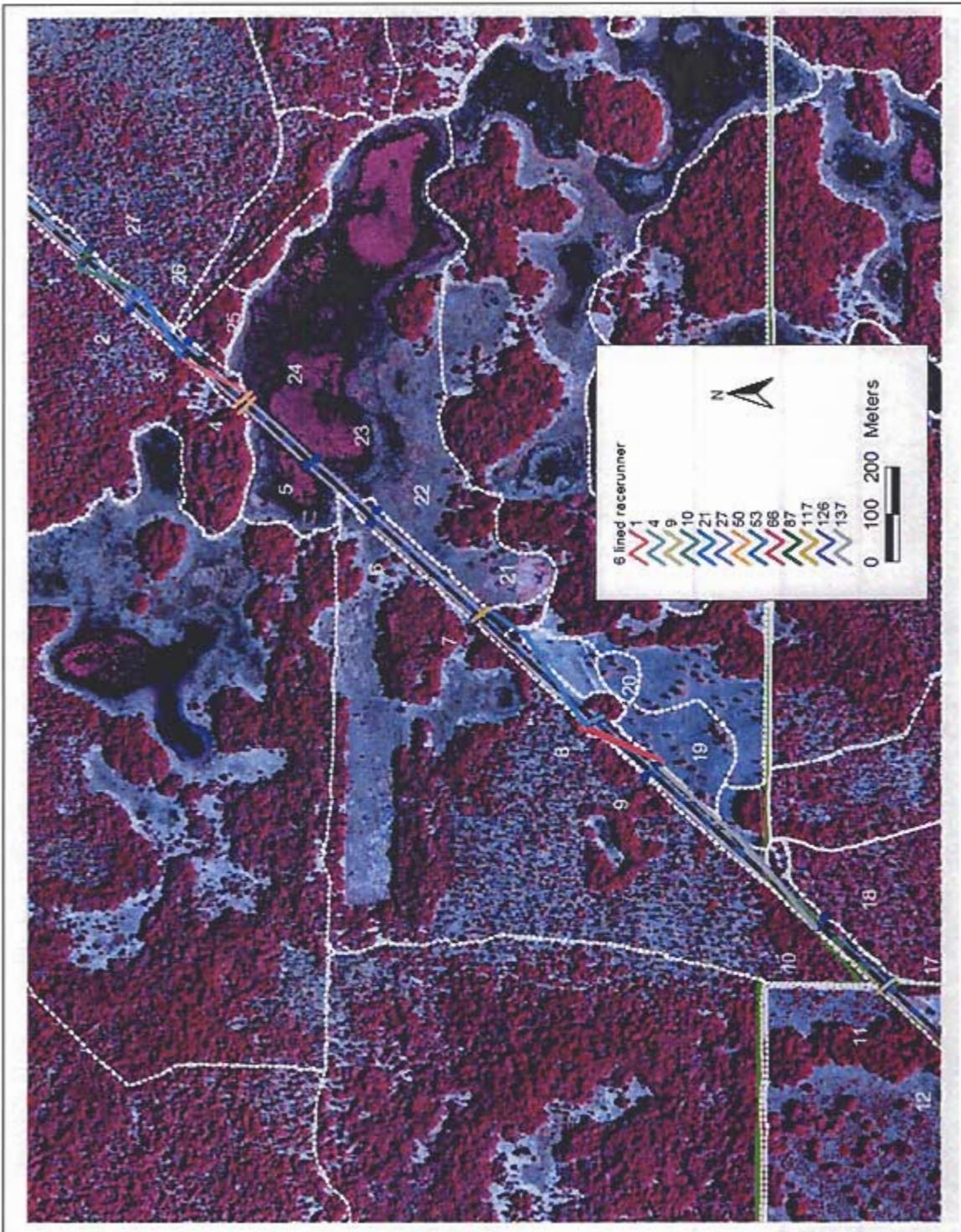


Figure 35b. Location of Recorded Crossings of Individual Six-lined Racerunners on SR 200.

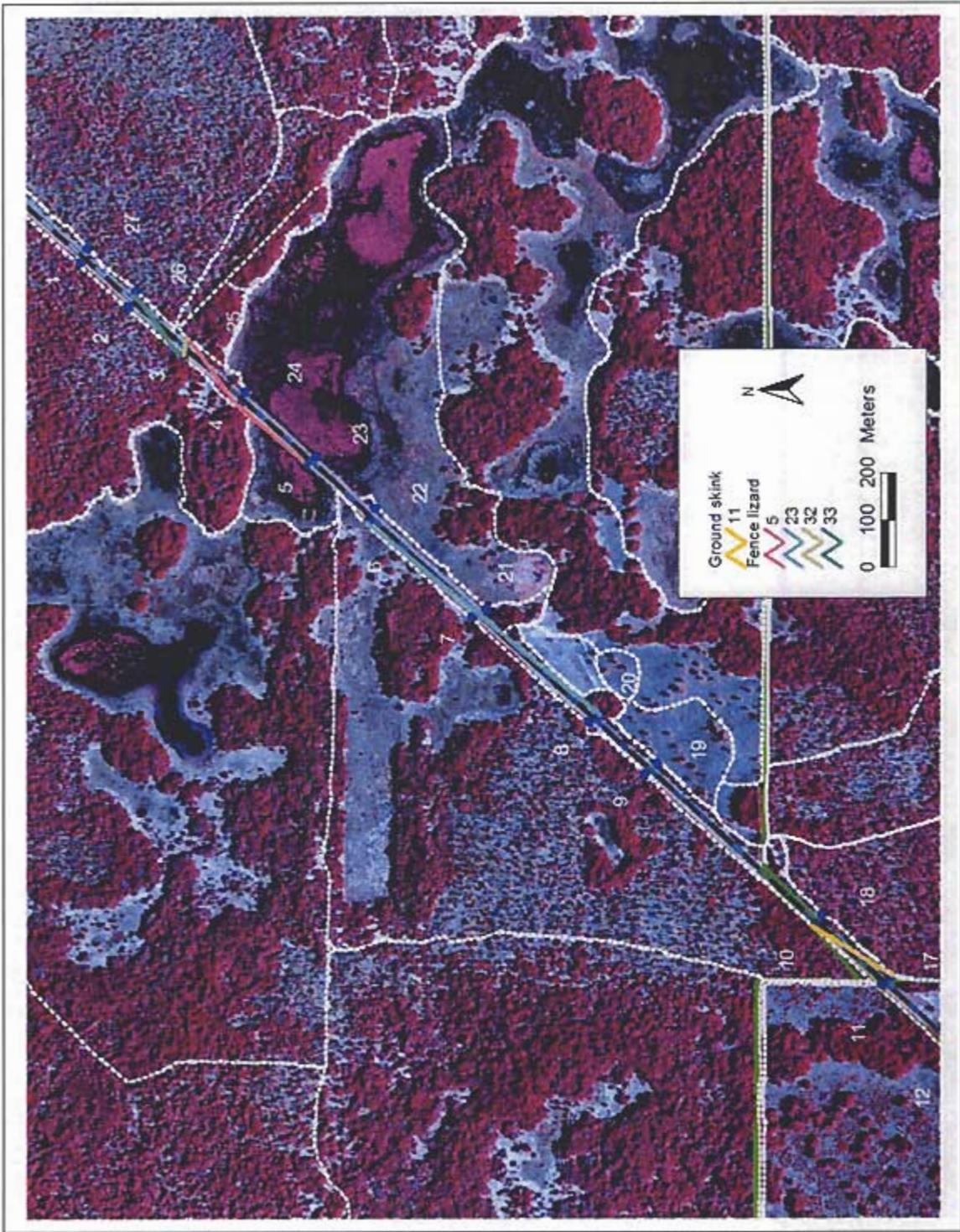


Figure 35c. Location of Recorded Crossings of Other Lizards on SR 200.

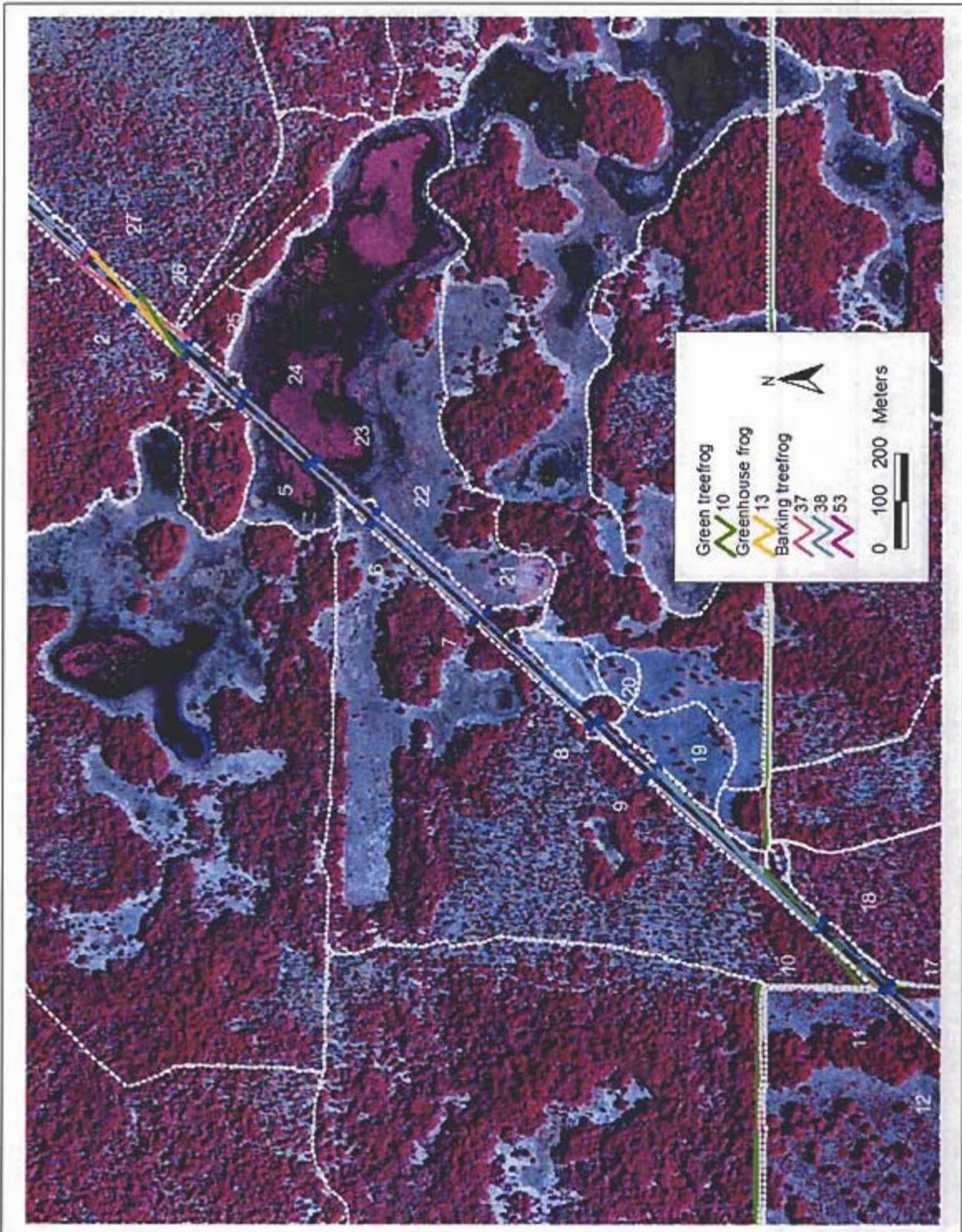


Figure 35d. Location of Recorded Crossings of Individual Treefrogs on SR 200.

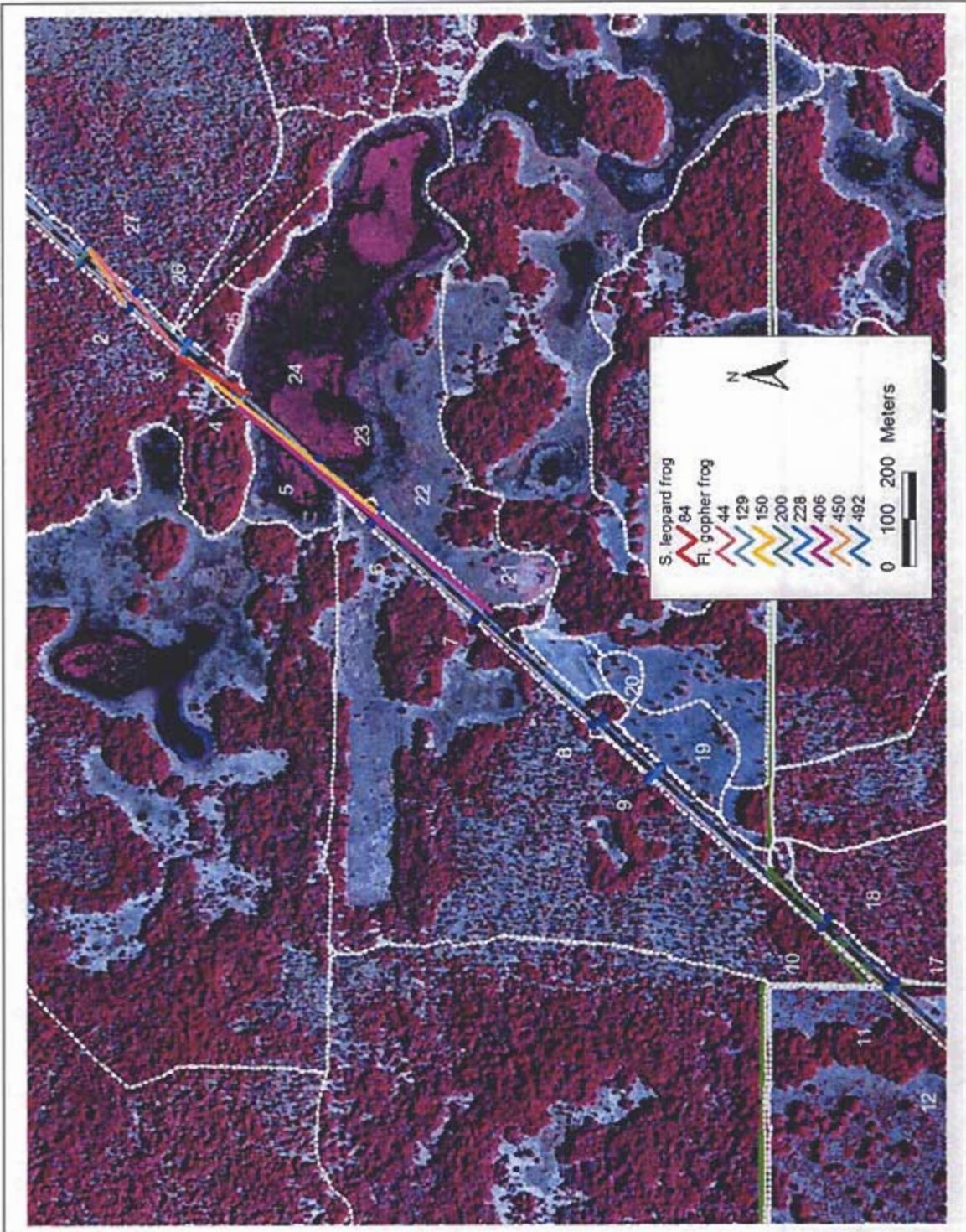


Figure 35e. Location of Recorded Crossings of Individual Ranids on SR 200.

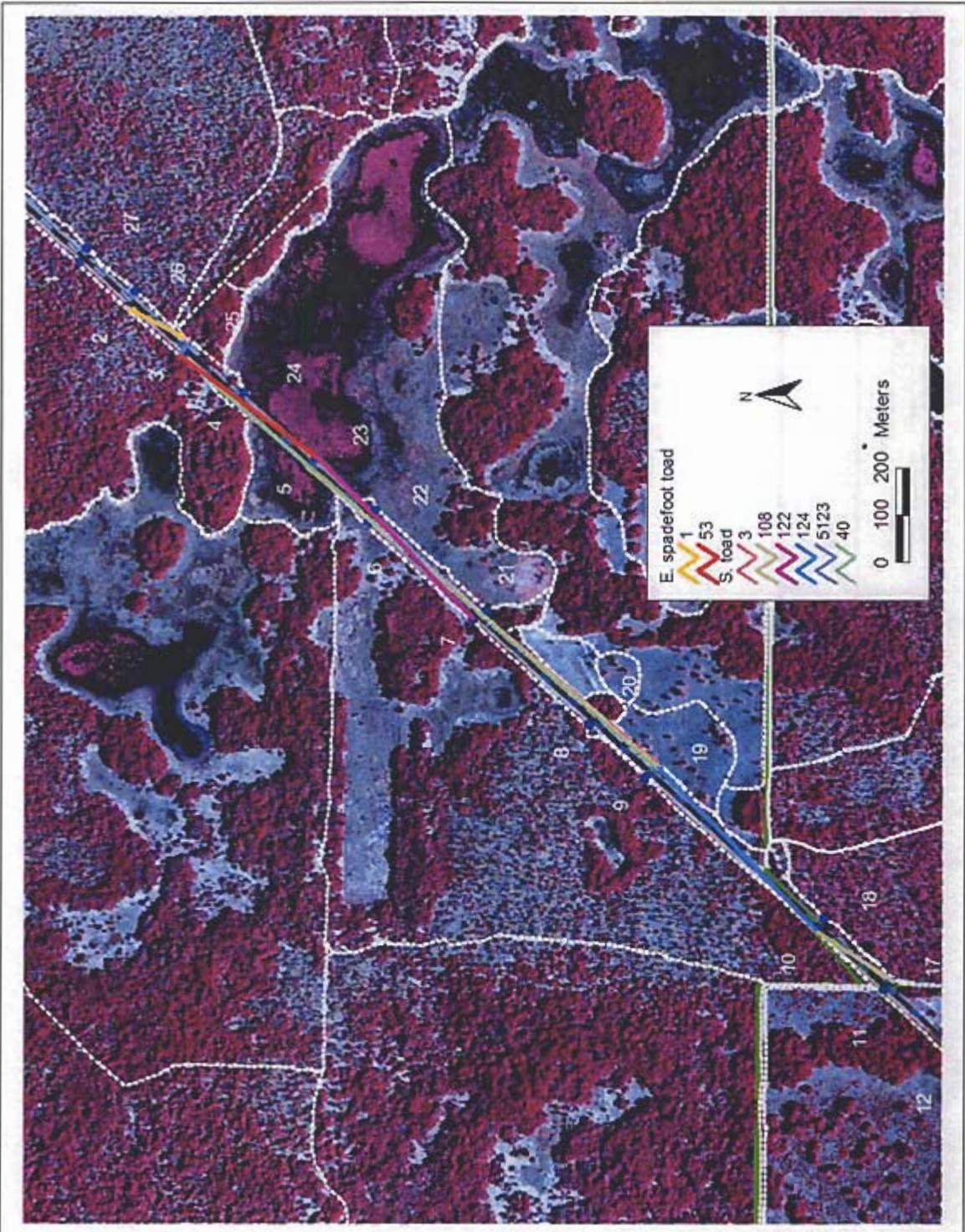
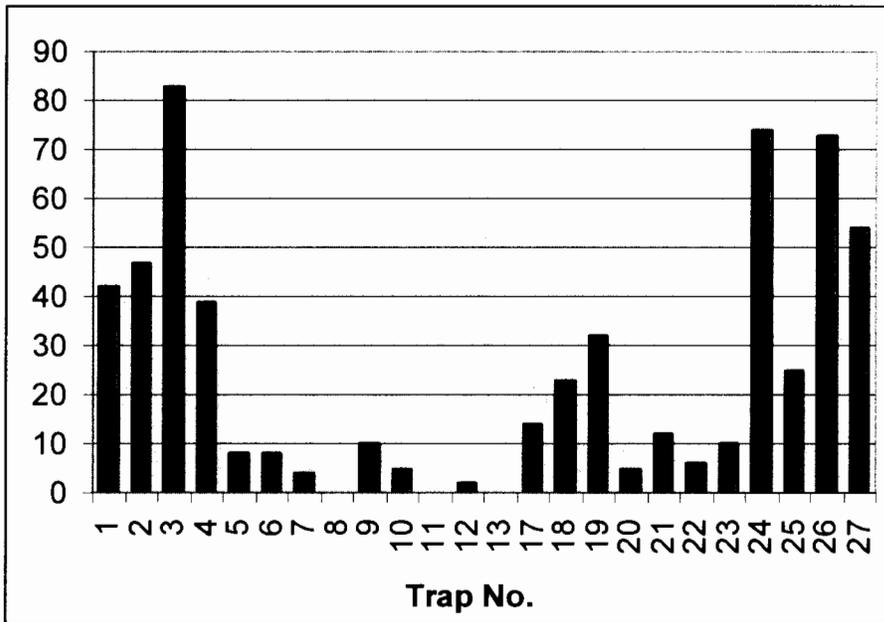


Figure 35f. Location of Recorded Crossings of Individual Toads on SR 200.

Capture locations of focal species (from Table 1) described below correspond to Figure 32. Of 576 captures/recaptures of the Florida gopher frog, 76% were caught in traps 1-4 and 24-27 (Figure 36), coincident with active gopher tortoise colonies in the CFG. Similarly, another 15% were caught in traps 9-10 and 17-19, where active gopher tortoise colonies occur in the CFG and RPSF (Figure 32). Five individual *E. coachwhips* were caught in right-of-way traps. All captures were in separate traps (trap nos. 2, 17, 18, 25, and 27) located adjacent to sandhill communities in the CFG and RPSF (Figure 32). One Florida box turtle and two gopher tortoises were captured in the same area, trap nos. 1 and 25 (Figure 32).



**Figure 36. Number of Florida gopher frogs captured/recaptured by trap number.** For spatial configuration of traps, refer to Figure 32.

Other species of interest that were rarely captured include the bullfrog, *S. hognose* snake, mole skink, *E. ringneck* snake, scarlet snake, *E. glass* lizard, *E. coral* snake, and corn snake (Table 10). A single bullfrog was captured in trap no. 18. The *S. hognose* snake ( $n=4$ ) was captured at trap nos. 2, 24, and 26. Mole skinks ( $n=3$ ) and SE five-lined skinks ( $n=9$ ) were captured at trap locations no. 9 and 27, and 1, 3, 7, 10, 11, 12, 13, 25, and 26, respectively. One *E. glass* lizard, one ringneck snake and one scarlet snake were captured at trap nos. 7, 23 and 26, respectively. Seven coral snakes and 7 corn snakes were captured in right-of-way traps. Trap locations include nos. 2, 7, 10, 22, and 26 (*E. coral* snake) and 1, 3, 7, 9, 11, 12, and 18 (corn snake).

Capture locations of abundant species such as *S. black* racer, barking treefrog, green treefrog, greenhouse frog, oak toad, ground skink, *S. fence* lizard, six-lined racerunner, *E. narrowmouth* frog, *S. leopard* frog, southern toad, and *E. spadefoot* toad are displayed in Figures 37a-37l.

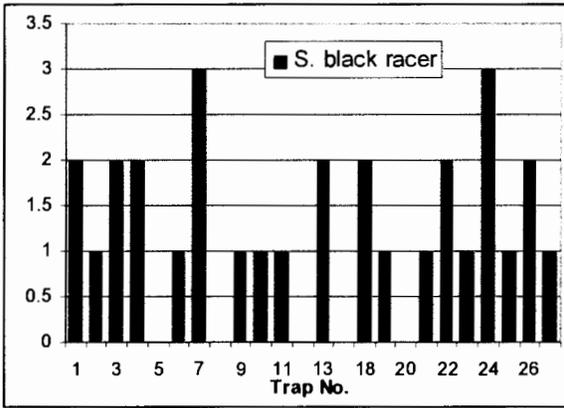


Figure 37a.

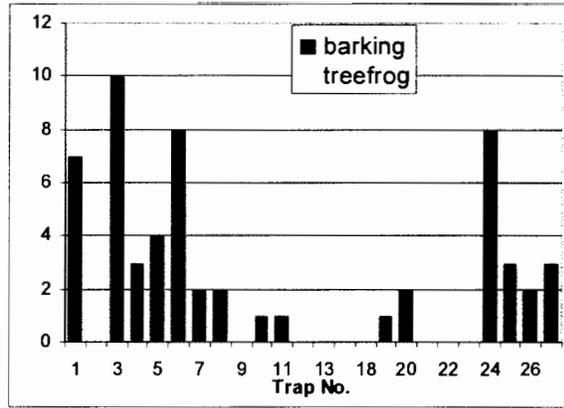


Figure 37b.

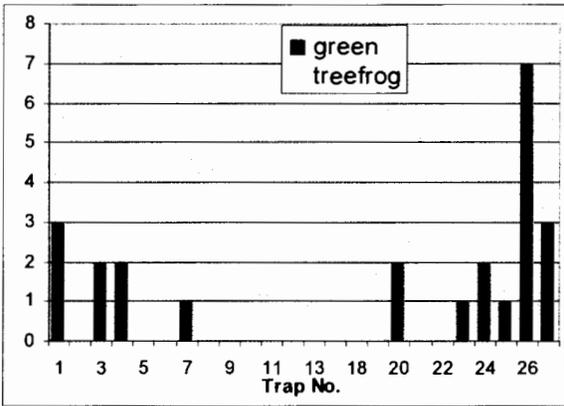


Figure 37c.

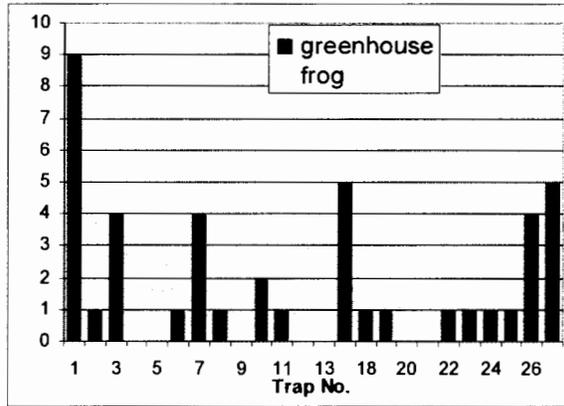


Figure 37d.

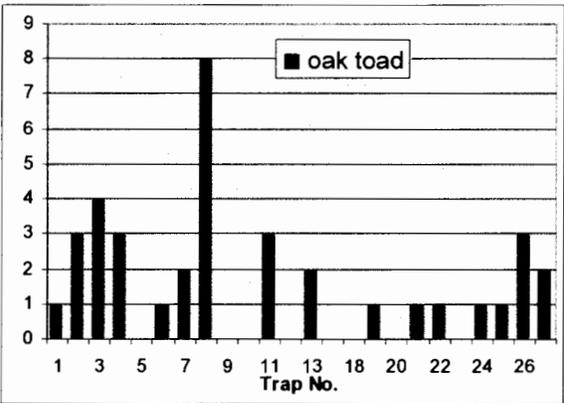


Figure 37e.

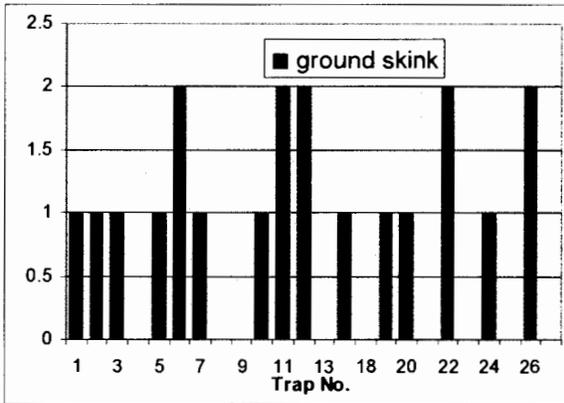


Figure 37f.

Figure 37a - 37f. Number of animals captured/recaptured by trap number. For spatial configuration of traps, refer to Figure 31.

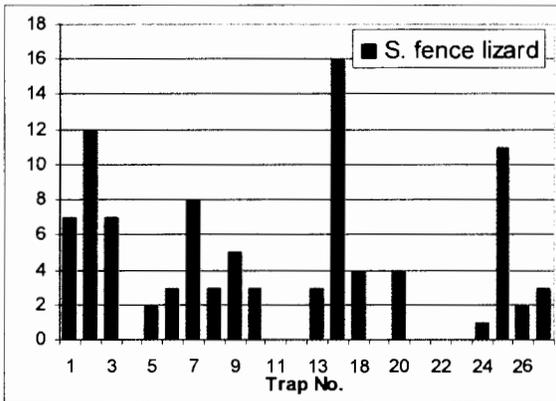


Figure 37g.

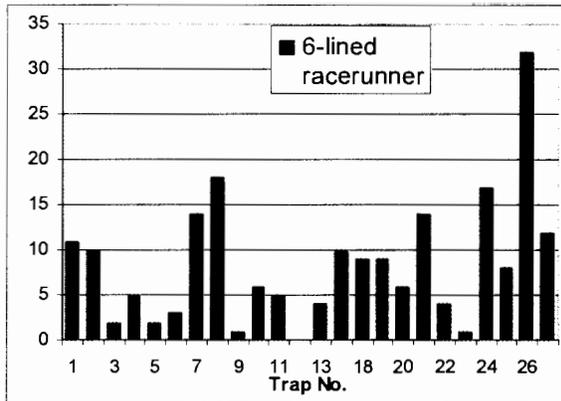


Figure 37h.

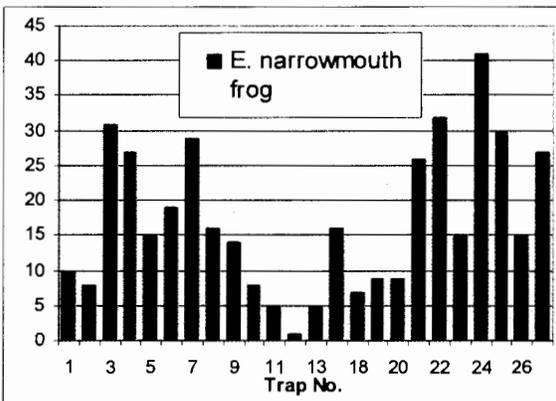


Figure 37i.

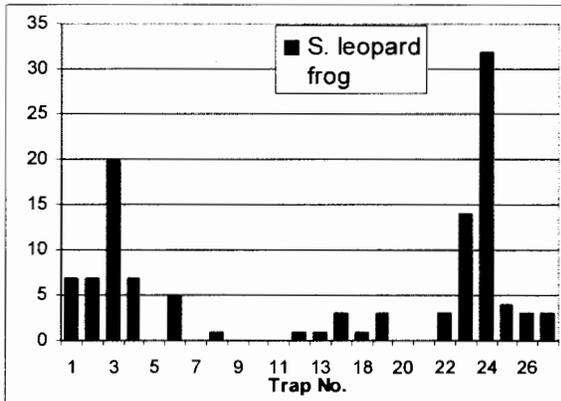


Figure 37j.

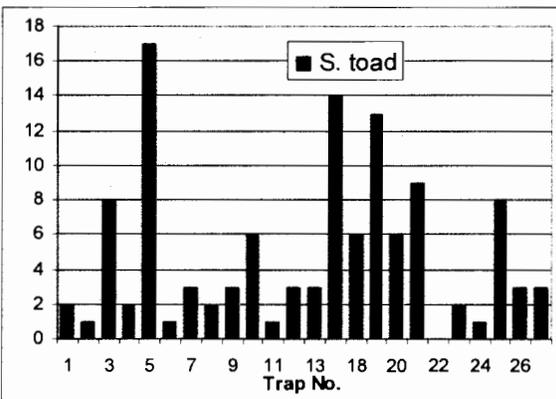


Figure 37k.

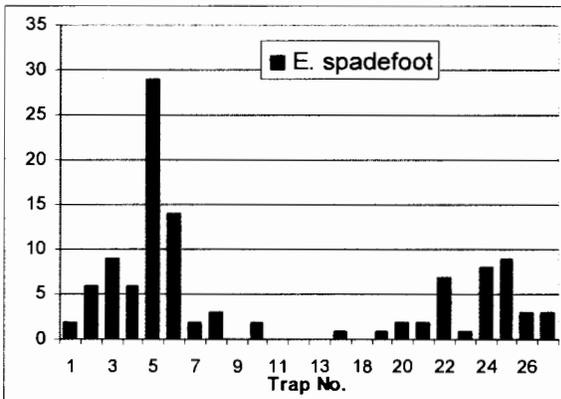


Figure 37l.

Figure 37g - 37l. Number of animals captured/recaptured by trap number. For spatial configuration of traps, refer to Figure 31.

To determine significance of number of captures of each species by plant community type at each trap site, a Kruskal-Wallis Test was performed on all species described in Figures 36 and 37a - 37l. The S. fence lizard was significant showing an increase in mean captures for dry vs. wet habitats ( $\chi^2 = 10.57$ ,  $p = 0.032$ ). None of the other 12 species were significant regarding mean number of captures and capture site plant community type. Student's *t* was used to determine central tendency and Kolmogorov-Smirnov was used to determine departures from normality. Results of these tests showed inconsistency for each species by plant community type. For most species, distributions were not normal and the means within each community type were not central to the distribution. A significant amount of edge habitat exists at all drift fence arrays, due to their close proximity to the road, and likely accounts for the lack of difference. Another limitation is that the resolution of the land cover (30 m cell size) is too coarse to accurately depict habitat type and quality at the scale of the drift fence arrays.

Control drift fences were operated for only two months in the late winter – early spring of 2004 following the collection of right-of-way data. Sufficient resources weren't available to collect data from control sites simultaneous to the collection of the right-of-way data. Therefore, control data was not collected for direct comparisons with right-of-way data, but to simply provide an indication of potential impacts of the road on variation of species in like habitats. The preliminary results given here may lead to future investigations. Herptiles captured in control drift fence arrays are displayed in Table 11. A total of 212 individuals from 20 species were captured. This included 12 species of frogs, 5 species of lizards and 3 species of snakes. Notably absent are representatives from the turtle family.

**Table 11. Herptiles Caught in Control Drift Fence Arrays, February – April 2004.**

Scientific Name	Common Name	# Captures	# Individual Recaptures
<i>Acris gryllis</i>	Southern Cricket Frog	2	
<i>Bufo quercicus</i>	Oak Toad	17	
<i>Bufo terrestris</i>	Southern Toad	34	1
<i>Cnemidophorus sexlineatus</i>	6-lined Racerunner	15	
<i>Coluber constrictor</i>	S. Black Racer	2	
<i>Elaphe guttata</i>	Corn Snake	1	
<i>Eleutherodactylus planirostris</i>	Greenhouse Frog	21	
<i>Eumeces egregius</i>	Mole Skink	2	
<i>Eumeces inexpectatus</i>	SE 5-lined Skink	6	1
<i>Gastrophryne carolinensis</i>	E. Narrowmouth Toad	19	
<i>Hyla cinerea</i>	Green Tree Frog	13	
<i>Hyla femoralis</i>	Pinewoods Tree Frog	4	
<i>Hyla gratiosa</i>	Barking Tree Frog	6	1
<i>Rana capito</i>	FL. Gopher Frog	2	
<i>Rana catesbiana</i>	Bullfrog	7	
<i>Rana sphenoccephala</i>	S Leopard Frog	26	
<i>Scaphiopus holbrookii</i>	E. Spadefoot Toad	26	
<i>Sceloporus undulatus</i>	S. Fence Lizard	4	3
<i>Scincella lateralis</i>	Ground Skink	4	
<i>Tantilla relicta</i>	Crown Snake	1	

Difference in species diversity for control vs. right-of-way traps is shown in Table 12. Nineteen species were common to both trapping areas. All frog species caught in right-of-way traps were

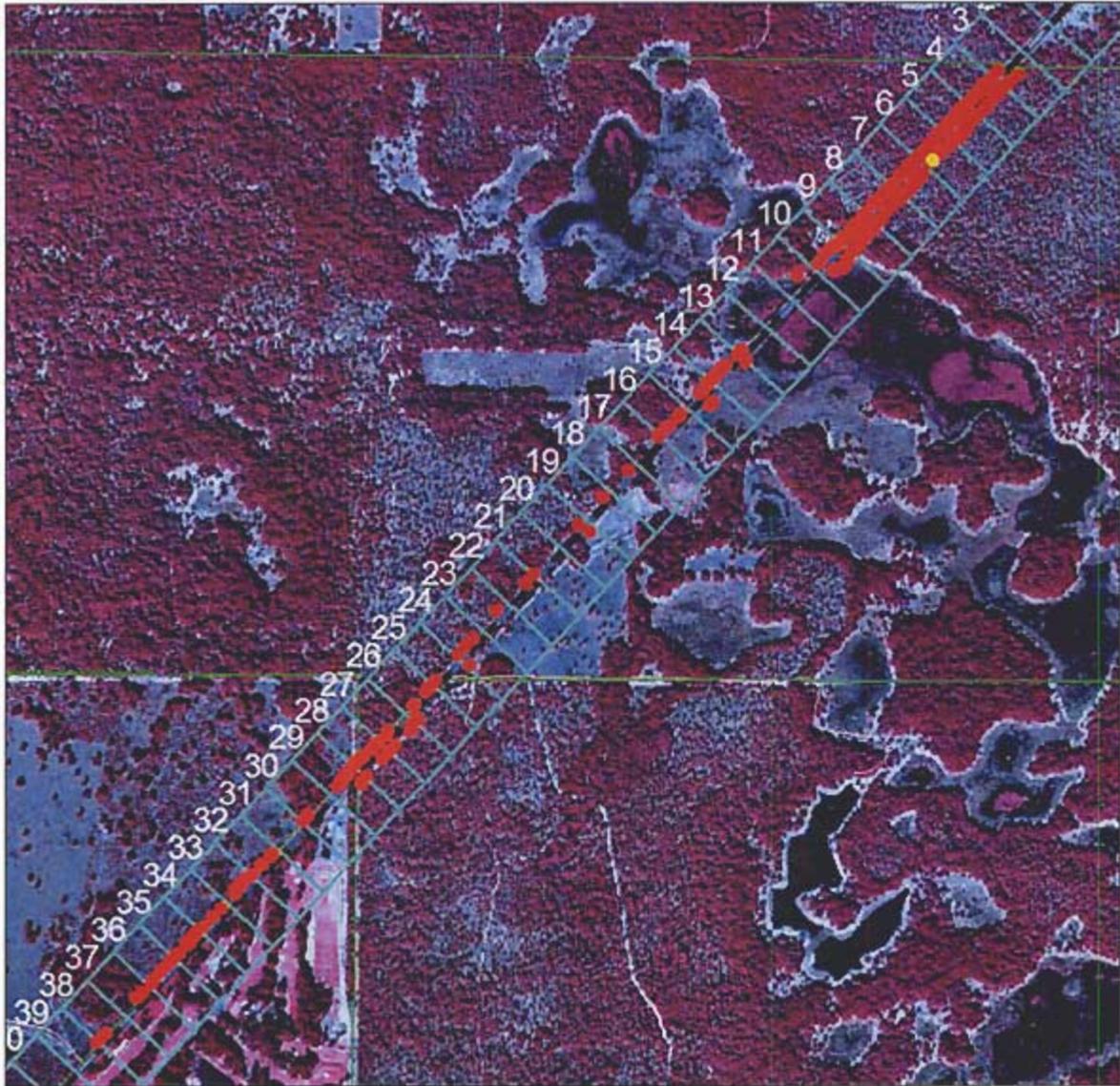
captured in control traps. Five of eight lizards were common to both trapping areas. Yet, thirteen species captured in right-of-way traps were not captured in control areas. This included 4 turtles, 6 snakes and 3 lizards. Even so, these species were rarely captured in right-of-way traps despite the much longer trapping period (18 months). Only the brown anole (n=6) and the E. coral snake (n=7) accounted for more than 5 individuals. One frog was captured in the control area that was not encountered in right-of-way traps, the Southern cricket frog, *Acris gryllis*. Two individuals were captured in the Ross Prairie basin at trap no. 6 (see Figure 32).

As described previously in the section on contextual analysis, this landscape is naturally patchy with a lot of edge habitat. Combined, the attributes of the road surface, non-native vegetation and highway traffic, a road right-of-way creates an abrupt edge to native plant communities. Even so, similarities exist between natural edge and artificial edge. Given more time to conduct control sampling, we suspect that all representatives found in right-of-way traps would have been captured in control areas.

**Table 12. Comparison of Species Captured in ROW and Control Drift Fence Arrays.**

Scientific Name	Common Name
<b>Common to Both (n=19)</b>	
<i>Bufo quercicus</i>	Oak Toad
<i>Bufo terrestris</i>	Southern Toad
<i>Cnemidophorus sexlineatus</i>	6-lined Racerunner
<i>Coluber constrictor</i>	S. Black Racer
<i>Elaphe guttata</i>	Corn Snake
<i>Eleutherodactylus planirostris</i>	Greenhouse Frog
<i>Eumeces egregius</i>	Mole Skink
<i>Eumeces inexpectatus</i>	SE 5-lined Skink
<i>Gastrophryne carolinensis</i>	E. Narrowmouth Toad
<i>Hyla cinerea</i>	Green Tree Frog
<i>Hyla femoralis</i>	Pinewoods Tree Frog
<i>Hyla gratiosa</i>	Barking Tree Frog
<i>Rana capito</i>	FL. Gopher Frog
<i>Rana catesbiana</i>	Bullfrog
<i>Rana sphenoccephala</i>	S Leopard Frog
<i>Scaphiopus holbrookii</i>	E. Spadefoot Toad
<i>Sceloporus undulatus</i>	S. Fence Lizard
<i>Scincella lateralis</i>	Ground Skink
<i>Tantilla relicta</i>	Crown Snake
<b>Right-of-way Only (n=13)</b>	
<i>Anolis carolinensis</i>	Green Anole
<i>Anolis sagrei</i>	Brown Anole
<i>Cemophora coccinea</i>	Scarlet Snake
<i>Chrysemys floridana floridana</i>	Florida Cooter
<i>Diadophis punctatus</i>	E. Ringneck Snake
<i>Gopherus polyphemus</i>	Gopher Tortoise
<i>Heterodon simus</i>	S. Hognose Snake
<i>Kinosternon subrubrum steindachneri</i>	Florida Mud Turtle
<i>Micrurus fulvius</i>	E. Coral Snake
<i>Ophisaurus ventralis</i>	E. Glass Lizard
<i>Pituophis melanoleucus mugitus</i>	E. Coachwhip
<i>Terrapene carolina</i>	Florida Box Turtle
<i>Thamnophis sirtalis</i>	Common Garter Snake
<b>Control Only (n=1)</b>	
<i>Acris gryllis</i>	Southern Cricket Frog

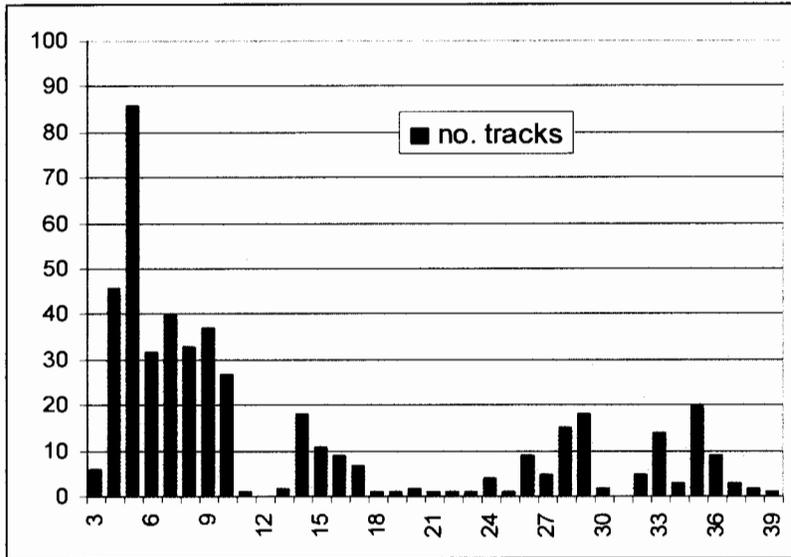
**Tracks.** Track surveys for herptiles were conducted from February 2003 to April 2004 (except 04/03 and 09/03) on firebreaks (along the fenceline) at the edge of the right-of-way. Tracks were checked an average of 6 times per month from an ATV with the focus on larger mammals and reptiles (e.g., snakes and turtles). There were 474 snake tracks recorded and one tortoise. Figure 39 provides an enumeration of the tracks found in each road section shown in Figure 38.



**Figure 38. Location of Snake Tracks Recorded from an ATV on Firebreaks Adjacent to the Road Right-of-Way, February 2003 – April 2004.** The lone yellow dot indicates a tortoise crossing. Highway sections are 100 m wide.

From these figures, it is evident that tracks were concentrated in four areas. The first section (road sections 4 – 10) had by far the greatest snake activity (301 tracks recorded). The other three were significantly smaller but still form notable concentrations of snake activity (road sections

13 – 15 (38 tracks recorded), 25 – 28 (47 tracks recorded), and 32 – 35 (46 tracks recorded). A Kruskal-Wallis test was inconclusive for snake tracks by land-use jurisdiction (Figure 12) for snakes; likely because we only surveyed in two different land-use jurisdictions. Yet, variability of snake tracks by land cover type (Figure 11) was significant for snakes ( $\chi^2=19.14$ ,  $p=0.0142$ ). Most snake tracks occurred near wet prairie, sandhill and scrub communities.

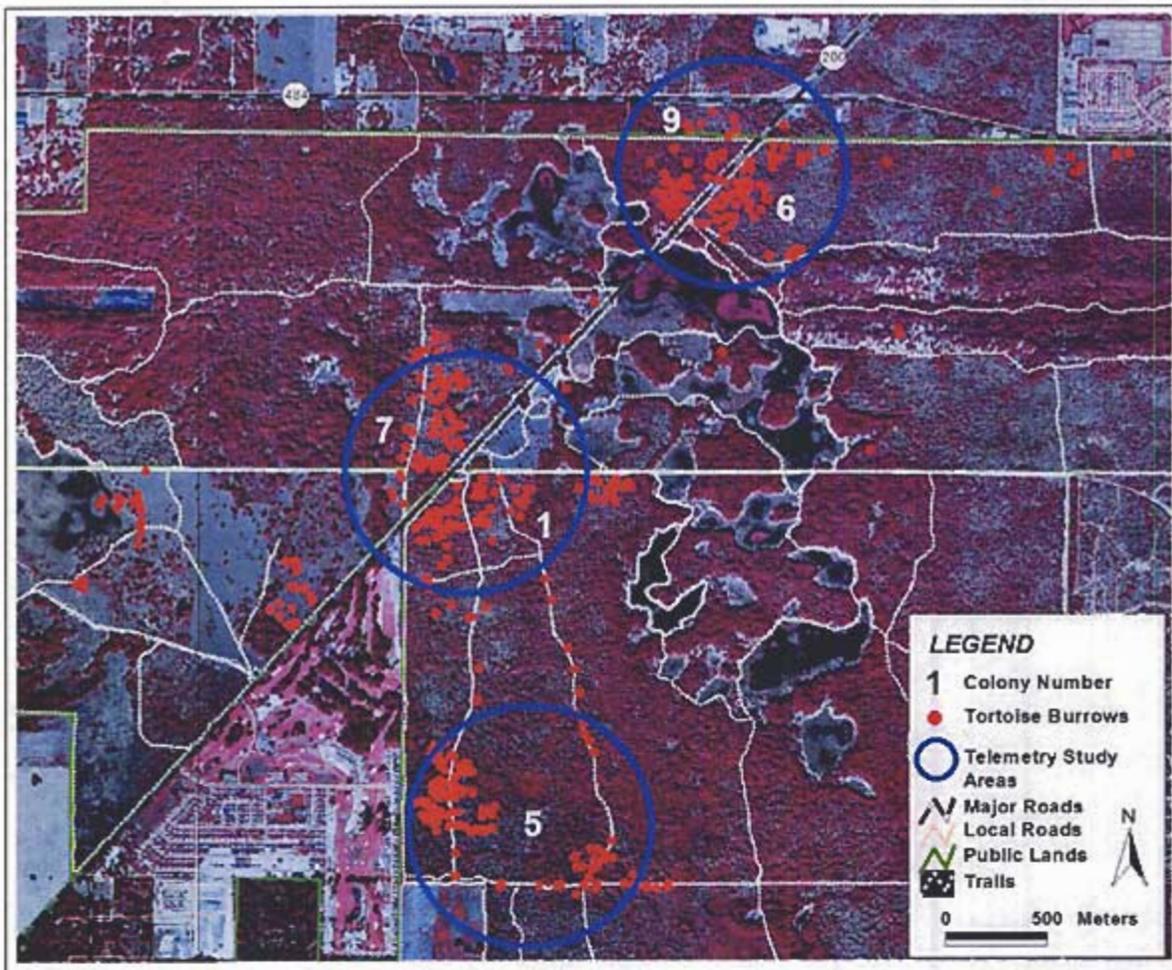


**Figure 39. Number of Snake Tracks Recorded by Road Section.** Sections 10-13 correspond to the Ross Prairie basin.

Notable is the lack of records of tortoise/turtle tracks, despite the significant presence of gopher tortoises at many of the areas where track surveys were conducted. Two factors likely led to the inability to recognize tortoise tracks: 1) the medium was soft “sugar” sand that made it difficult to distinguish some animal track types, and 2) observation from the ATV while slowly moving forward probably limited visibility. Snake tracks are typically a wavy line and were easy to quickly identify from the ATV.

**Culvert Use.** Two existing concrete culverts were present on SR 200 within the right-of-way study area between CR 484 and the main entrance to the HTP (Figure 19). These were monitored for tracks from herptiles and mammals from December 2002 to February 2004. Culverts were checked twice per week. Inconsistent with previous studies of similar structures (Smith 2003), no herptiles were recorded using these culverts over this period. Potential reasons for this outcome are explained in the small mammals section.

**Gopher Tortoise Telemetry.** Figure 40 displays the location of tortoise burrows included in the study area. We chose to study two burrow colonies already affected by the road; essentially split in half creating four sub-colonies. The other burrow colony selected was a control area approximately 900 m from the road in RPSF. A total of 351 burrows were identified in these areas; 55 burrows in area 1, 117 in area 5, 67 each in areas 6 and 7, and 45 in area 9.



**Figure 40. Location of Tortoise Burrows Identified in the Telemetry Study.** Two areas, colonies 1 and 7, and 6 and 9 are split in half by SR 200; the control area, colony 5, is 900 m from the road.

Beginning in late May 2002, we set and maintained approximately 30 bucket traps that were opened and checked five days/week for 3 months. Following a capture, the bucket trap was moved to a different burrow. Over this period we caught 31 tortoises. This led to a capture rate of approximately 1 tortoise / 2 trap days. Twenty-five of these 31 tortoises were affixed with radio-transmitters and used in the telemetry study. Five were captured in colony 1, five in colony 5, six in colony 6, five in colony 7 and 4 in colony nine.

Transmitters used in the study were purchased from AVM Inc. with a battery life of 36 months. However, following initial captures and beginning of telemetry work, the researchers encountered manufacturer defects in the transmitters. Improper antenna attachments led to premature failure of 18 of 24 transmitters: three in colony 1, four in colony 5, four in colony 6, three in colony 7, and four in colony 9. Some of these were recaptured and refitted with new transmitters. Yet, these problems significantly reduced the sample size and number of positions acquired.

To increase the sample size and number of positions, we conducted a second trapping period from mid-March – May 2004. Fifteen new tortoises were captured during this period. Two of these, captured in colony nine, were added to the telemetry study. Additionally, three original subjects, two from colony 1 and one from colony 7 were recaptured and refitted with new transmitters. These five tortoises were tracked for another six months.

Fifty gopher tortoises (29 male, 19 female, 2 juvenile) were captured and marked between May 2002 and May 2004 (Table 13). A total of twenty-eight tortoises were initially included in the telemetry study (Figure 41 shows capture locations); however for home range analyses, a sufficient number of telemetry positions were only recorded from 24 tortoises. We recorded an average of 3 positions per month per tortoise. This resulted in an average of 37 locations recorded per individual for a total of 883 locations for all tortoises (Figure 42). Each of the 24 tortoises was tracked for an average of 12 months.

**Table 13. Tortoise Captures in the Ross Prairie Area, May 2002 – May 2004.**

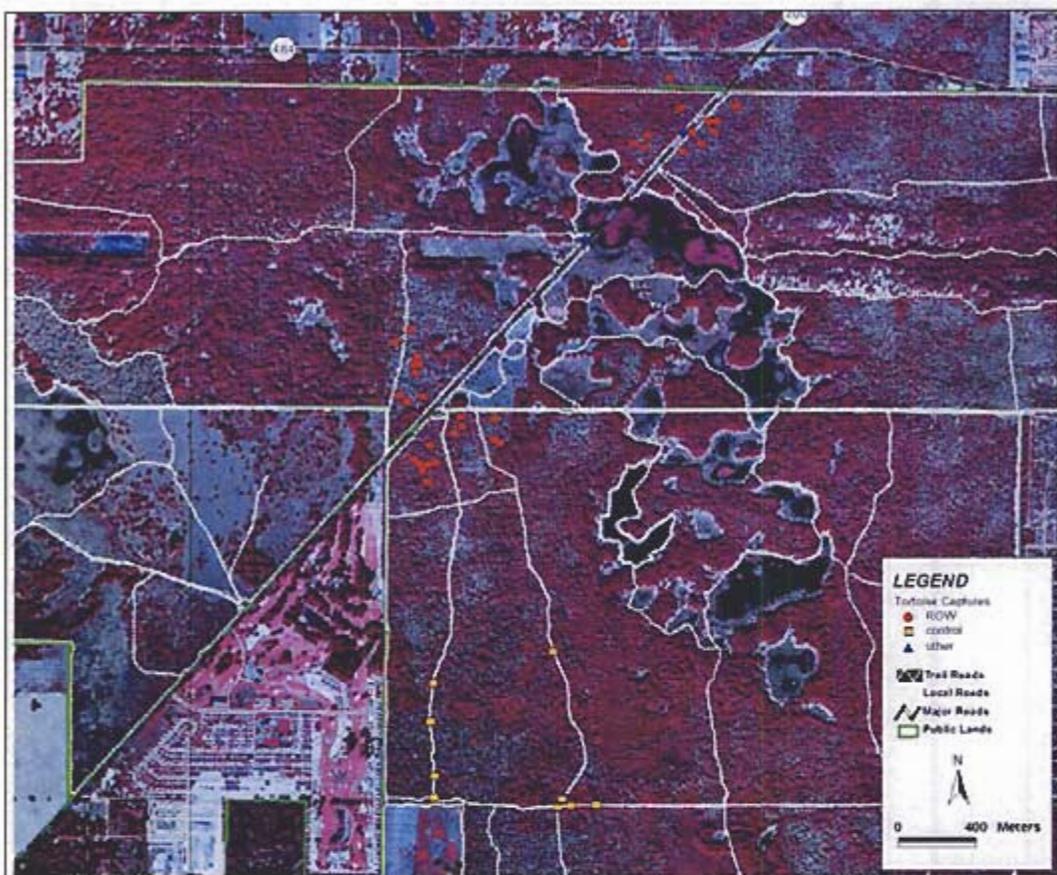
<b>Tortoises</b>	<b>n</b>	<b>AVG Weight (g)</b>	<b>AVG Length (cm)</b>	<b>Average Home Range (FK-95)(ha)</b>	<b>AVG Home Range (mcp)(ha)</b>
<b>all individuals</b>	<b>50</b>	<b>3,237</b>	<b>25.7</b>		
males	29	3,132	25.6		
females	19	3,683	27.2		
juveniles	2	269	11.3		
<b>all telemetry</b>	<b>24</b>	<b>3,125</b>	<b>25.6</b>	<b>2.93</b>	<b>2.09</b>
males	15	2,779	24.6	3.30	2.77
females	9	3,556	27.0	2.32	0.99
roadside	19	2,872	25.1	3.12	2.22
control	5	4,086	27.8	2.00	1.29
<b>all nontelemetry</b>	<b>26</b>	<b>3,596</b>	<b>26.9</b>		
males	14	3,417	26.6		
females	10	3,845	27.4		
juveniles	2	269	11.3		
roadside	16	3,225	25.4		
control	6	3,721	26.8		

Note: For tortoises, the fixed kernel method (FK) was considered more accurate because of the buffering mechanism used in calculations. This is relevant because almost all tortoise positions were recorded while tortoises were in burrows instead of while foraging around the burrows. The MCP method does not include the buffering feature.

The normality of home range size was tested. Student's *t* was used to determine central tendency and Kolmogorov-Smirnov was used to determine departures from normality. For all tortoises, home range size (FK and MCP) was normally distributed ( $t = 5.43$ ,  $p < 0.0001$ ;  $D = 0.27$ ,  $p < 0.01$  and  $t = 2.51$ ,  $p = 0.02$ ;  $D = 0.35$ ,  $p < 0.01$ ).

Average home range size for all tortoises was 2.93 ha (FK method, 95% probability), 2.09 ha (minimum convex polygon method). Home range size was larger for male than female tortoises, 3.30 ha, FK (2.77 ha, mcp) and 2.32 ha, FK (0.99 ha, mcp), respectively. Males were frequently seen moving from burrow to burrow in search of females during breeding season. A breakdown of tortoises by roadside or control areas show an increased home range at roadside areas (3.12

ha, FK; 2.22 ha mcp) vs. control areas (2.00 ha, FK; 1.29 ha, mcp), though this was relatively insignificant (Kruskal-Wallis, FK:  $\chi^2=4.76$ ,  $p=0.09$  and MCP:  $\chi^2=2.15$ ,  $p=0.34$ , respectively). Overlap of home range (FK method, 95% probability) for all tortoises is shown in Figure 43. Also, 50% and 75% probability FK contours were included in diagrams for visual comparison.



**Figure 41. Capture Sites of Gopher Tortoises Used in Telemetry Studies.** Red points = ROW study areas, orange points = control areas, and blue points = ROW drift fence captures.

Six tortoises were monitored in colony one. Tortoise no. 29 was killed on SR 200 the day after it was captured (Figure 44). The transmitter on tortoise no. 7 failed after 2 months and was never relocated. Home range calculations of the remaining four individual tortoises (3 male, 1 female) monitored in colony one in RPSF are shown in Figure 45. Average home range size of tortoises in colony one ( $n=4$ ) was 5.88 ha, FK method (95% probability), 6.58 ha, minimum convex polygon with an average number of telemetry positions of 39. These values were significantly higher than other colony values mainly due to tortoise no. 32 that dispersed across SR 200 into the HTP and greatly increased its home range size (Figure 46). Because we were unable to monitor it for more than a month after the long movement event we were unable to report whether it had dispersed and established a new home range, or if it returned to the RPSF.

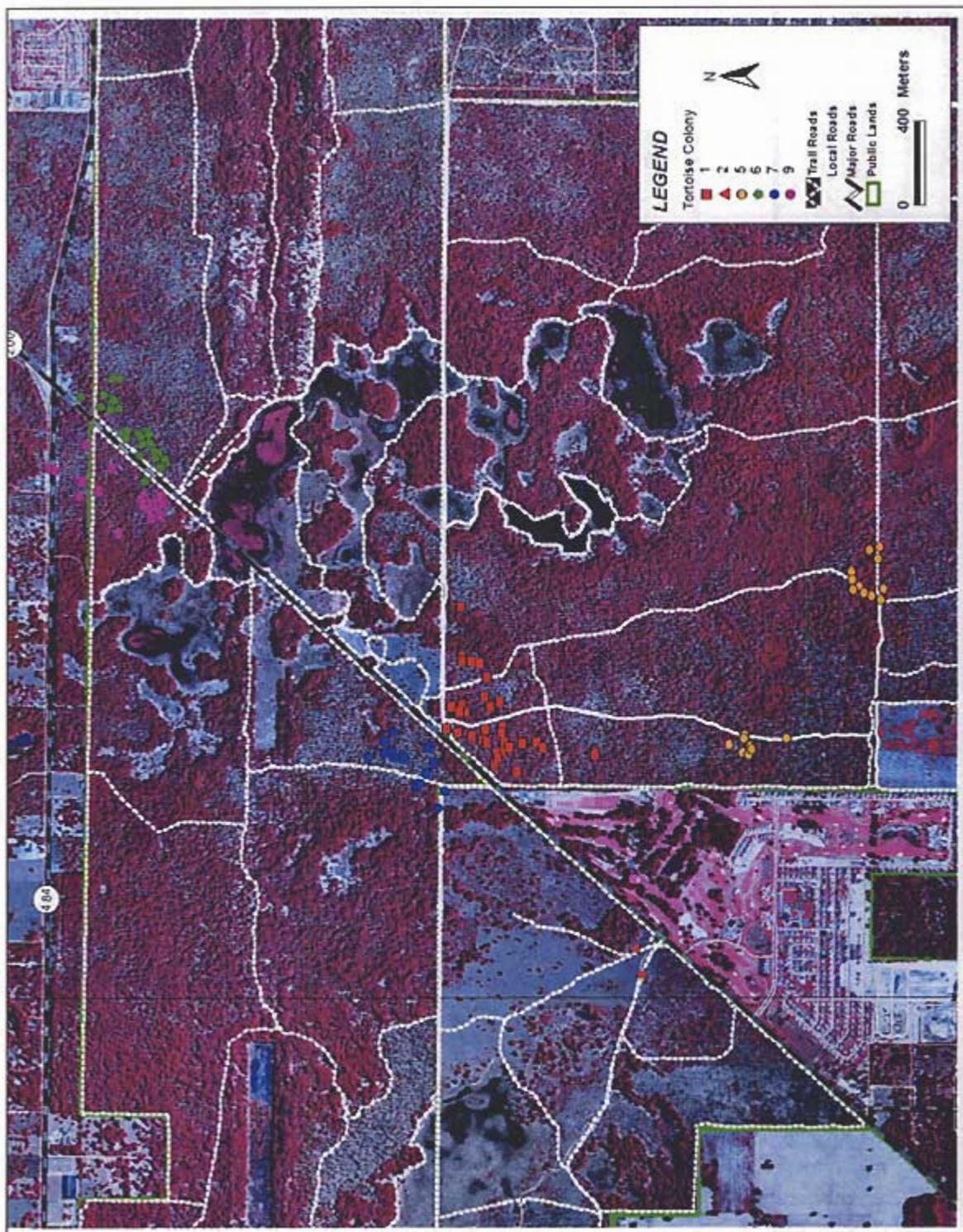
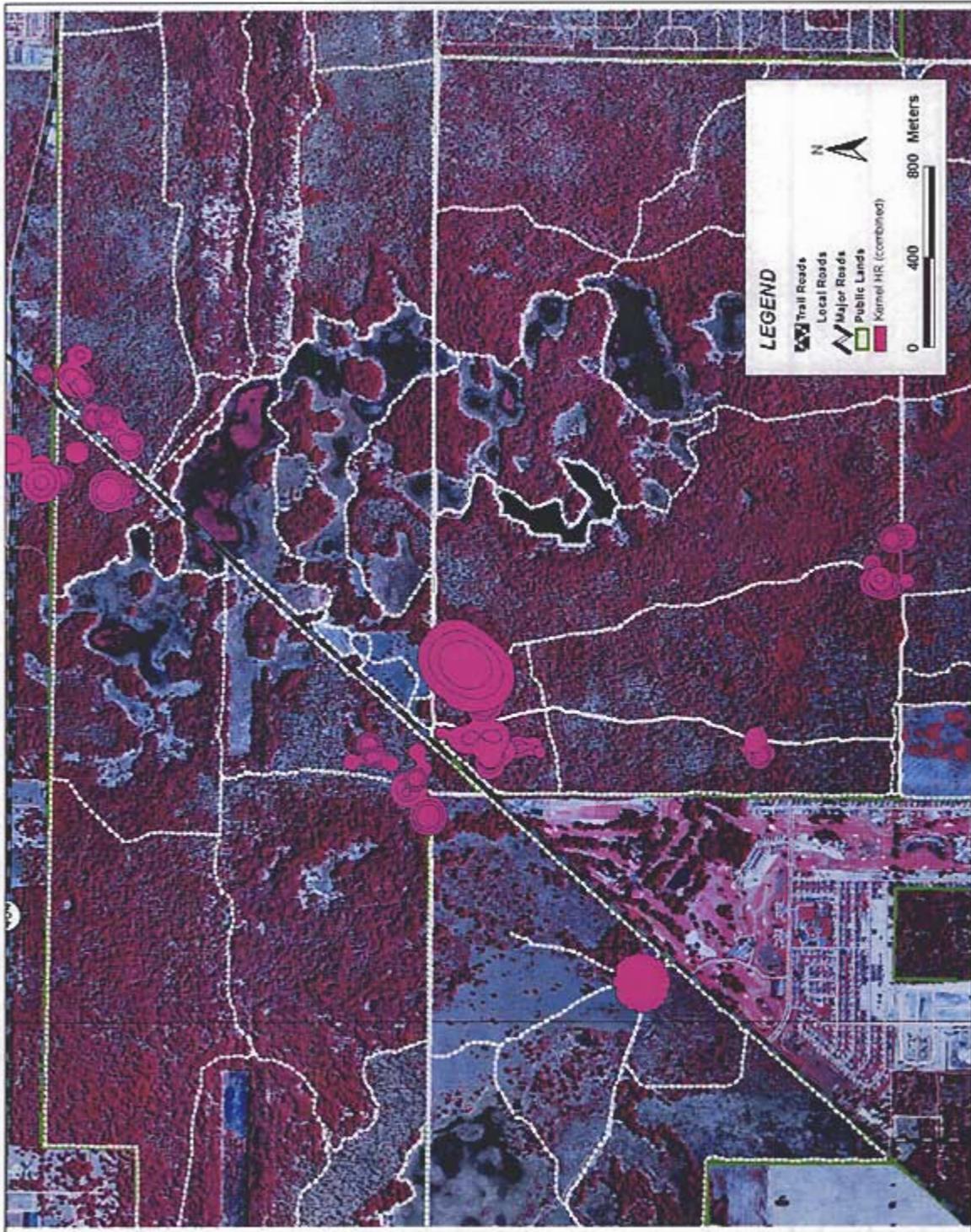
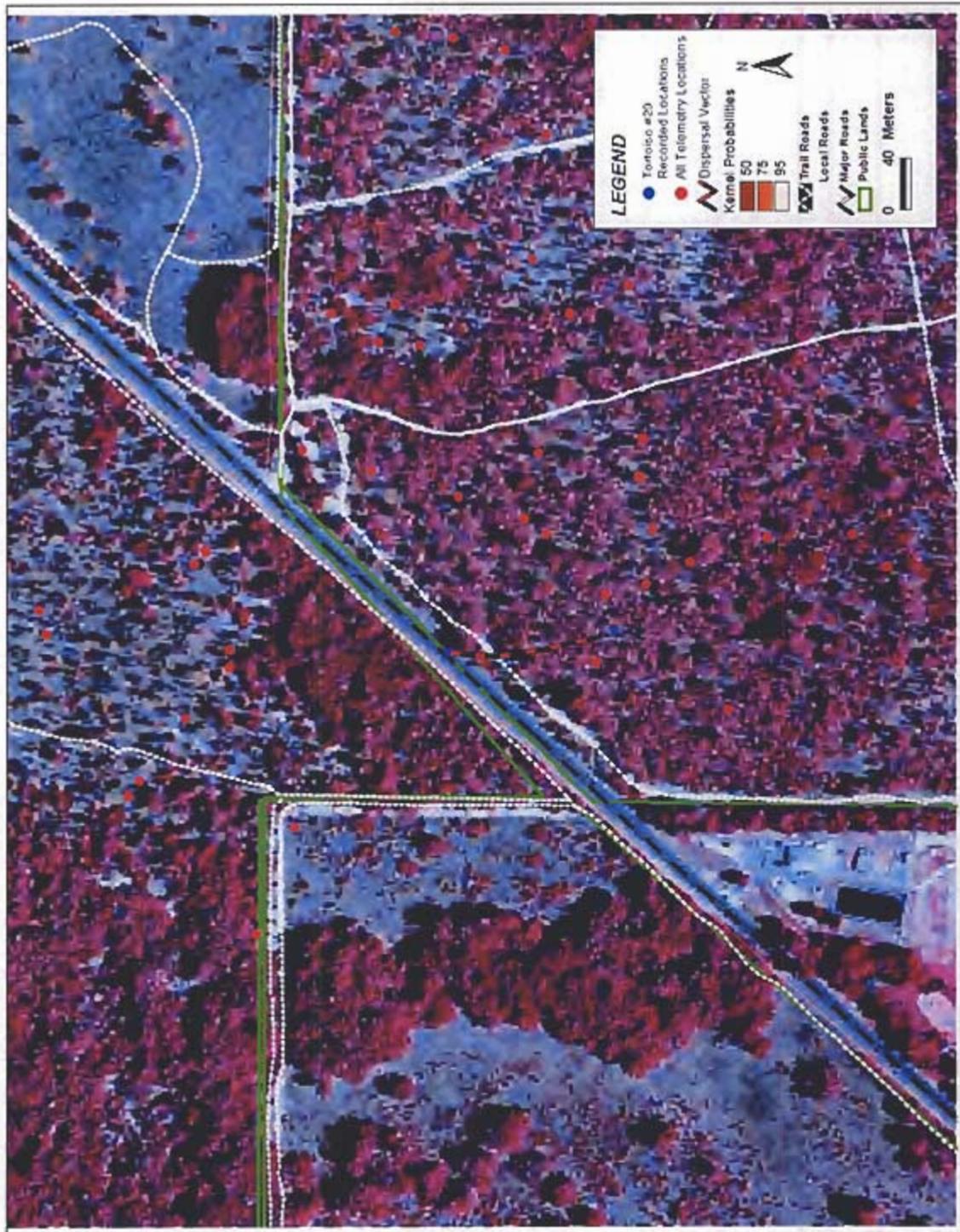


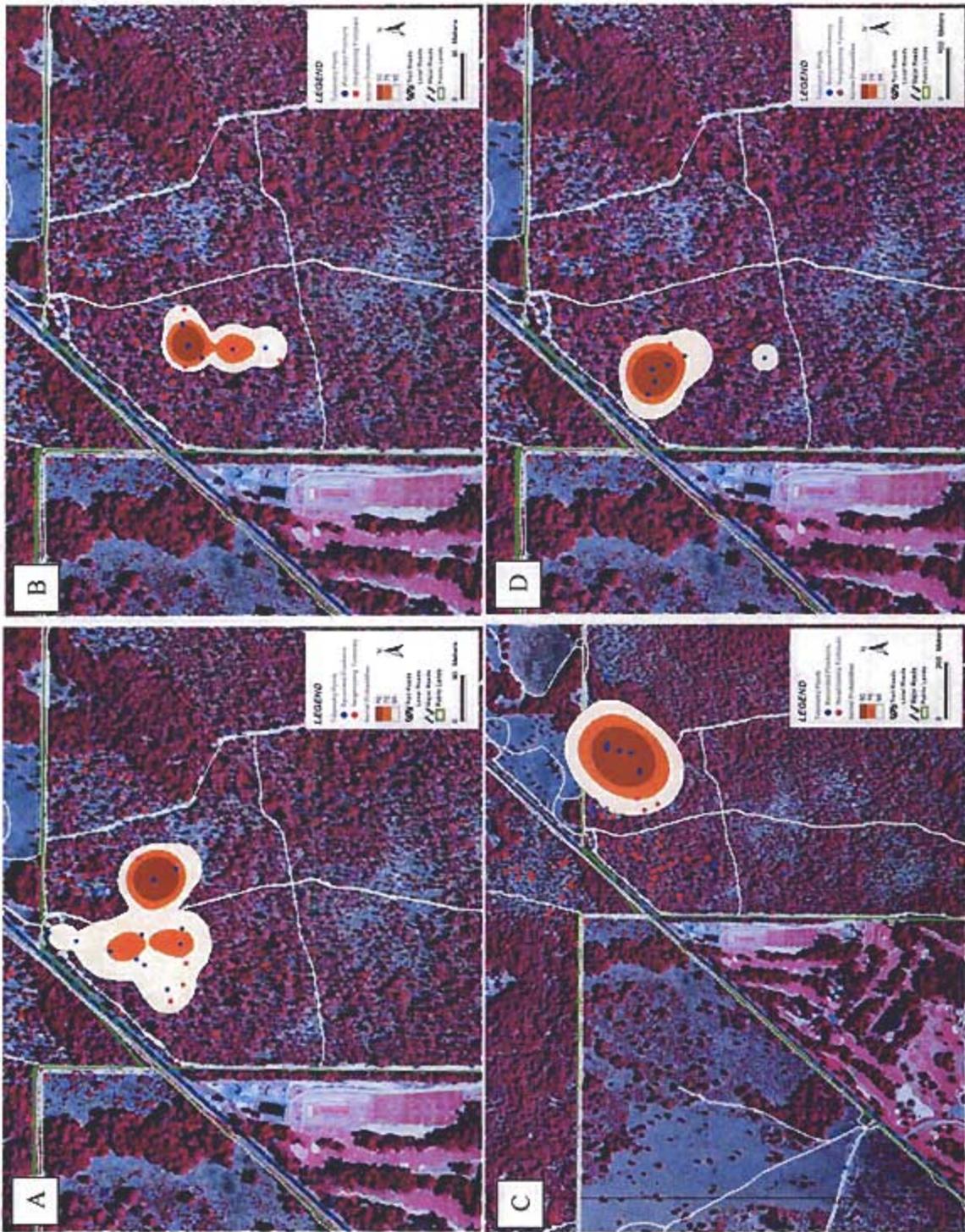
Figure 42. Telemetry Locations for all Gopher Tortoises Used in Telemetry Studies. Colors represent colony numbers where positions were recorded..



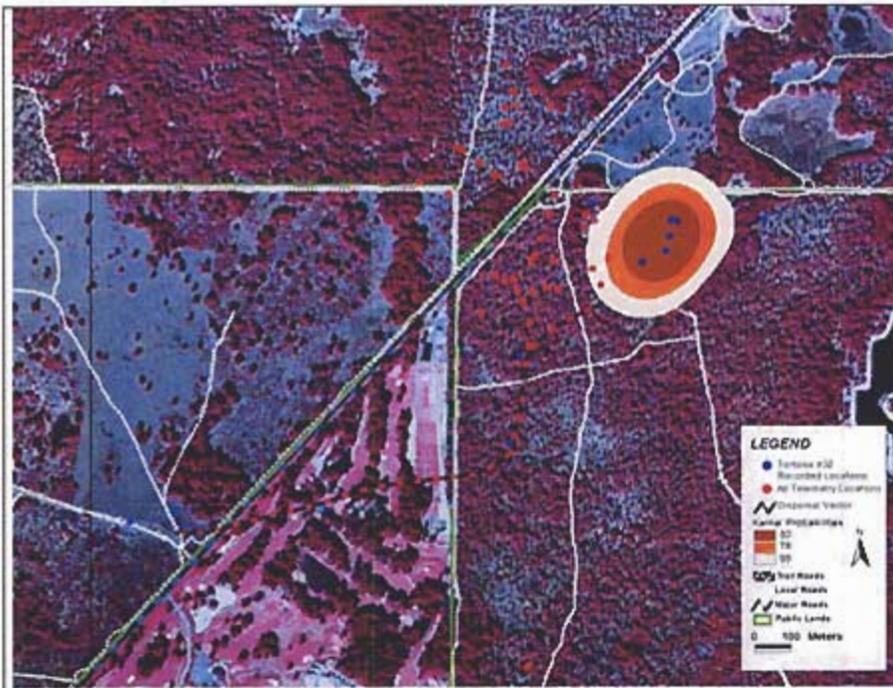
**Figure 43. Combined Home Range (FK) Calculated for all Gopher Tortoises Used in Telemetry Studies.** The outer contour represents 95%, middle contour represents 75% and the inner contour 50% probabilities.



**Figure 44. Dispersal path of Tortoise no. 29.** Tortoise no. 29 left colony one the day after being marked and affixed with a radio-transmitter and was killed on SR 200 attempting to cross.



**Figure 45. Home Range (FK) of Gopher Tortoises in Colony One.** Panels A to D correspond to tortoise nos. 3, 22, 32, and 33, respectively. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise, red dots are neighboring tortoise positions.



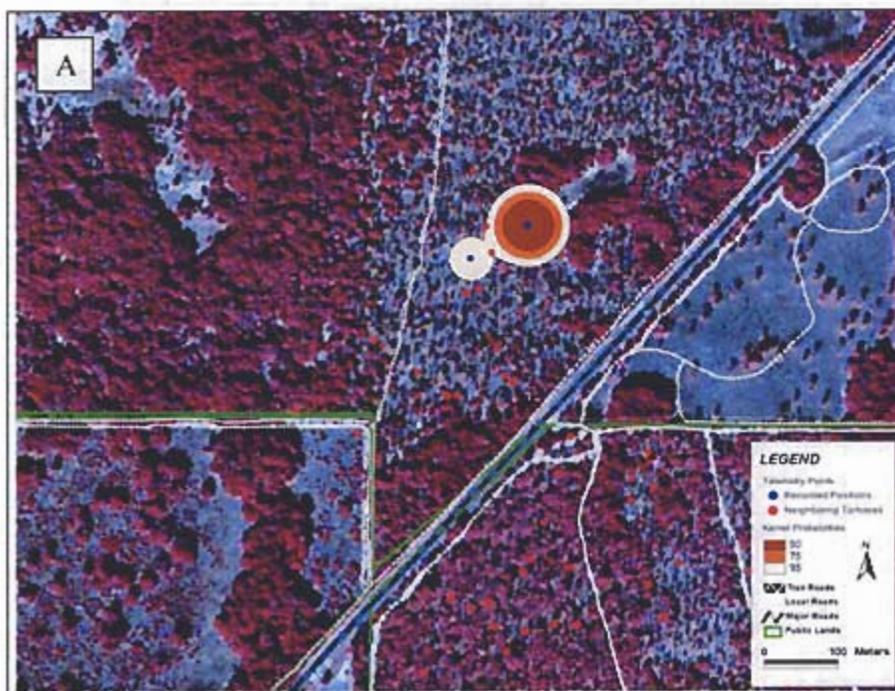
**Figure 46. Dispersal path of Tortoise no. 32.** Tortoise no. 32 left RPSF in July of 2004, traveled through the golf course and successfully crossed SR 200 moving into the HTP.

In colony seven, separated from colony one by SR 200, five tortoises were monitored. Home range calculations of the tortoises (4 male, 1 female) monitored in colony seven in CFG and HTP are shown in Figure 47. Average home range size of tortoises in colony seven ( $n=5$ ) was 2.03 ha, FK method (95% probability), 0.99 ha, minimum convex polygon with an average number of telemetry positions of 48. One item of note, tortoise no. 10 was lost for 17 months following its capture due to transmitter failure. Useful telemetry positions were recorded from June – July 2002 and following its recapture from March – December 2004.

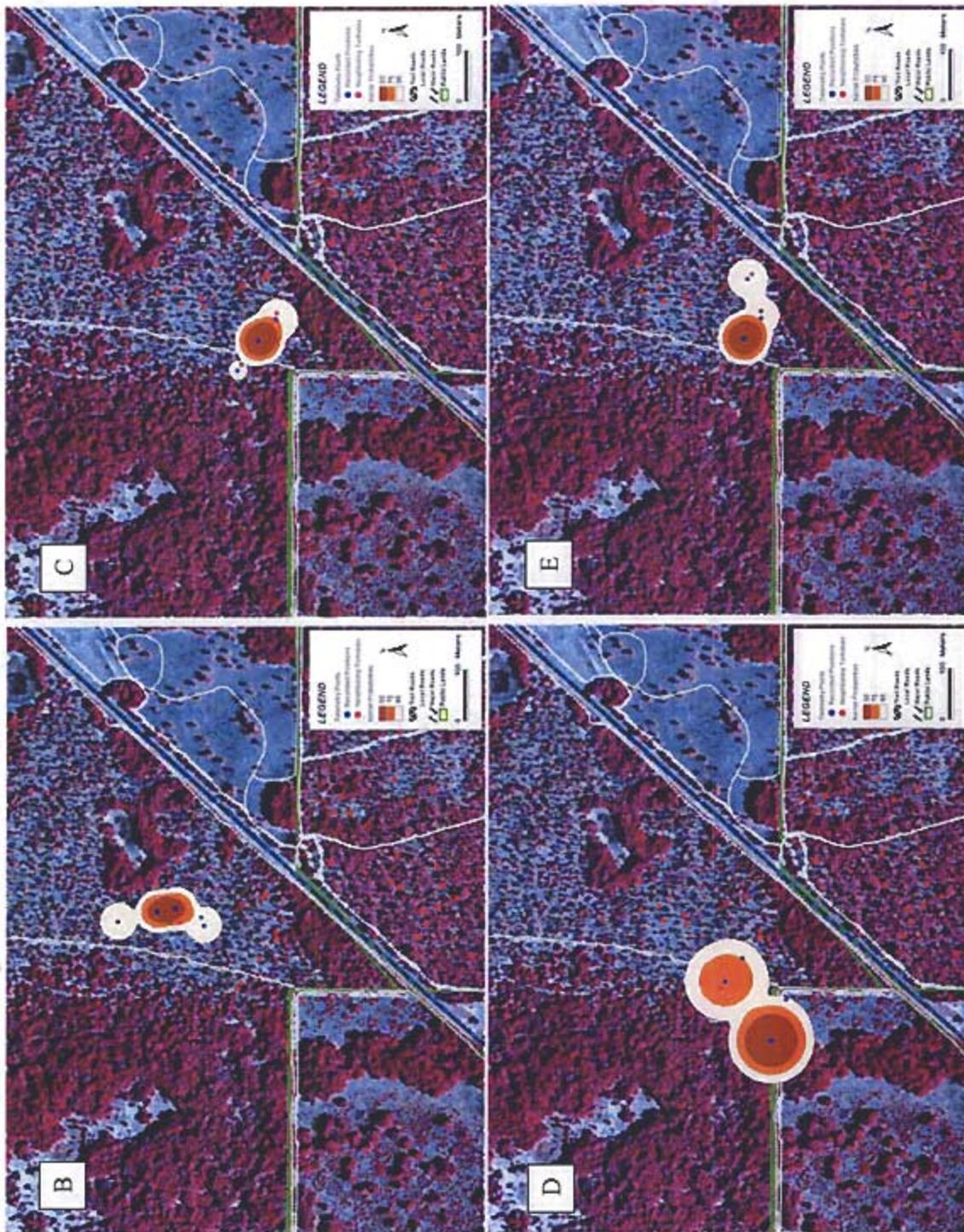
Six tortoises were monitored in colony six. Home range calculations of the tortoises (4 male, 2 female) monitored in colony six in the CFG are shown in Figure 48. Average home range size of tortoises in colony six ( $n=6$ ) was 2.56 ha, FK method (95% probability), 1.21 ha, minimum convex polygon with an average number of telemetry positions of 40. Tortoise no. 11 was lost for 7 months because of transmitter failure before being recaptured and affixed with a new transmitter. It was tracked from June – October 2002 and from May 2003 – January 2004. Tortoise no. 13 was recaptured to replace a failed transmitter in November 2002. It was temporarily held in a container in colony nine across SR 200 from where it was captured and subsequently escaped before the transmitter could be replaced. It was lost for the next seven months before it was again recaptured back in colony six. It had crossed the road successfully and returned to its original home range area (Figure 49). Tortoise no. 13 was tracked from July – November 2002 and August 2003 – April 2004. Tortoise no. 30 had a notable dispersal event (approximately 300 m) to a distant burrow behind a convenience store on the corner of SR 200 and CR 484 (Figure 50). It subsequently returned to its primary home range area after overwintering there from November 2002 – March 2003.

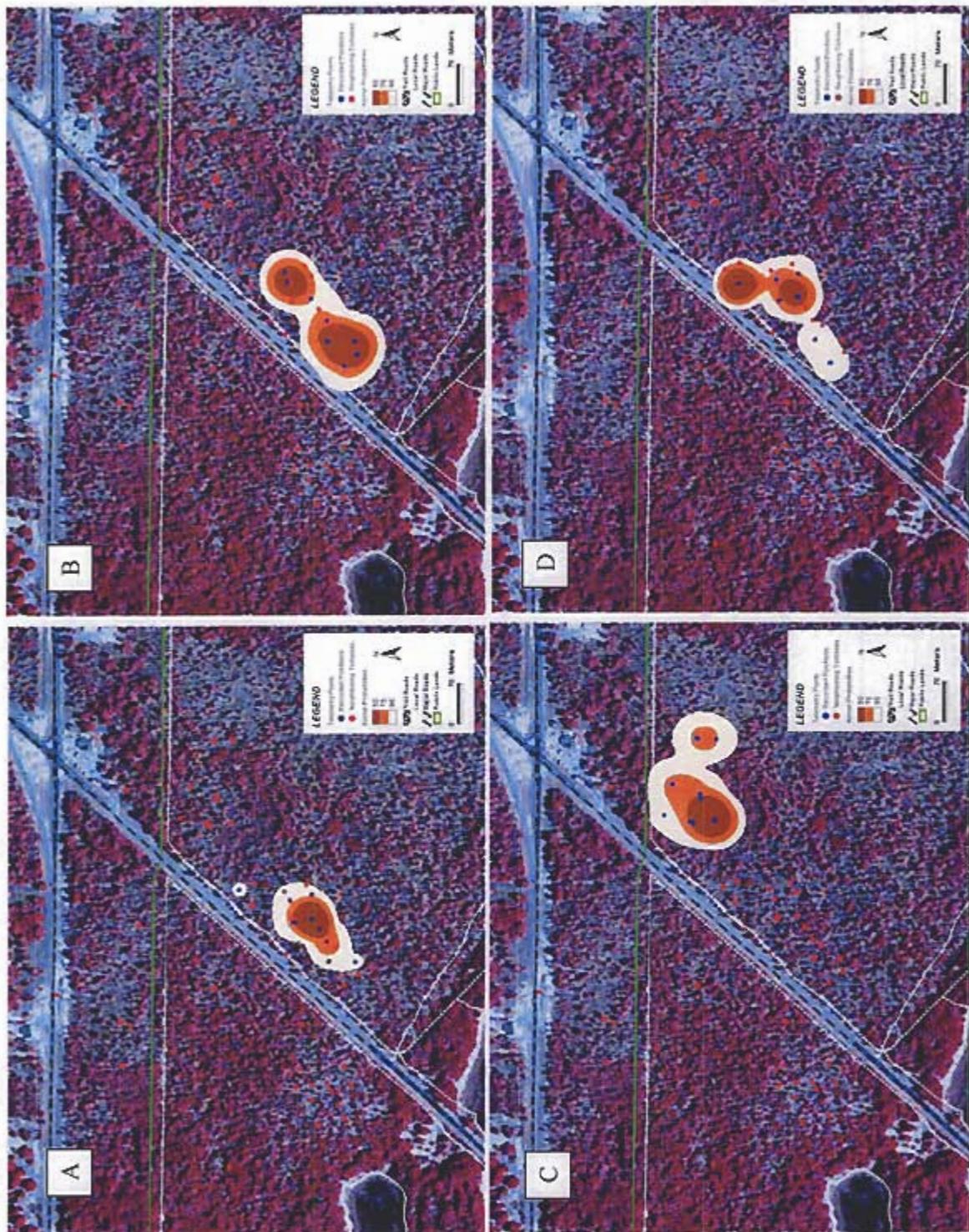
For colony nine of the CFG, separated from colony one by SR 200, four tortoises were originally monitored. The transmitters on tortoise nos. 26 and 27 failed after 1 month and 2 months, respectively. These two were never relocated. The remaining two tortoises (2 small males) were tracked from July 2002 – February 2003 when their signals were lost, most likely from the same transmitter defect. Two additional tortoises (1 male, 1 female) were captured in this area in March 2004 and July 2004. These two were monitored until November 2004. Due to these setbacks, enough positions to calculate reasonably valid home ranges were only acquired for two of the six monitored in colony nine (tortoise nos. 23 and 34). Home range calculations are shown in Figure 51. Average home range size for these tortoises ( $n=2$ ) was 1.80 ha, FK method (95% probability), 0.37 ha, minimum convex polygon with an average number of telemetry positions of 29.

Colony five, located in the RPSF was used as a control area, away from SR 200. Five tortoises were monitored here. Home range calculations of the tortoises (1 male, 4 female) monitored in colony five are shown in Figure 52. Average home range size ( $n=5$ ) was 1.83 ha, FK method (95% probability), 1.16 ha, minimum convex polygon with an average number of telemetry positions of 33. These five tortoises were each monitored for at least 14 months. The split home range of many of these is likely due to tortoise travel patterns to/from available burrows. Tortoise nos. 17, 18 and 19 were seen using firebreaks to move from place to place.

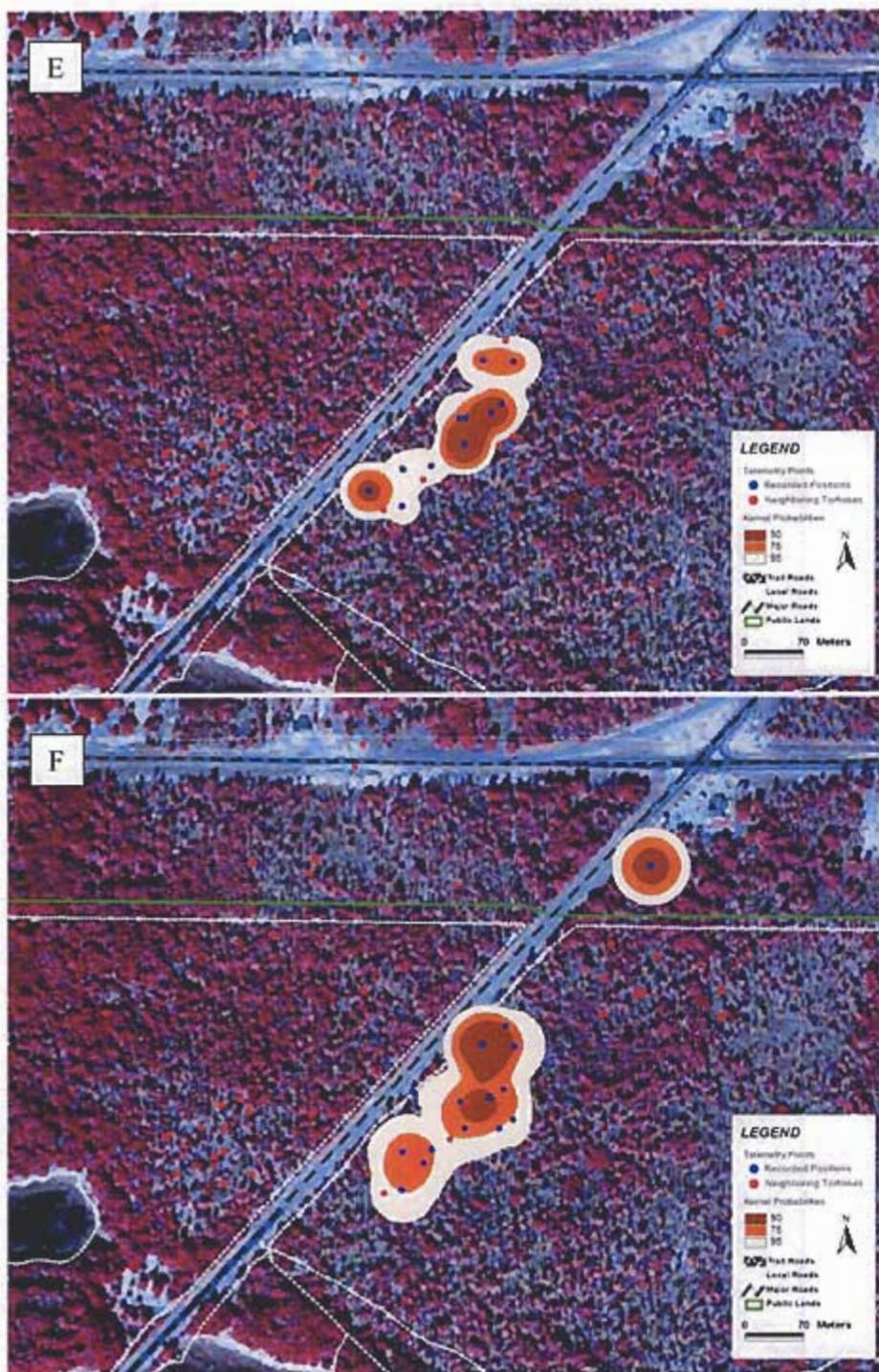


**Figure 47. Home Range (FK) of Gopher Tortoises in Colony Seven.** Panel A shows home range of tortoise 21. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise; red dots are neighboring tortoise positions.

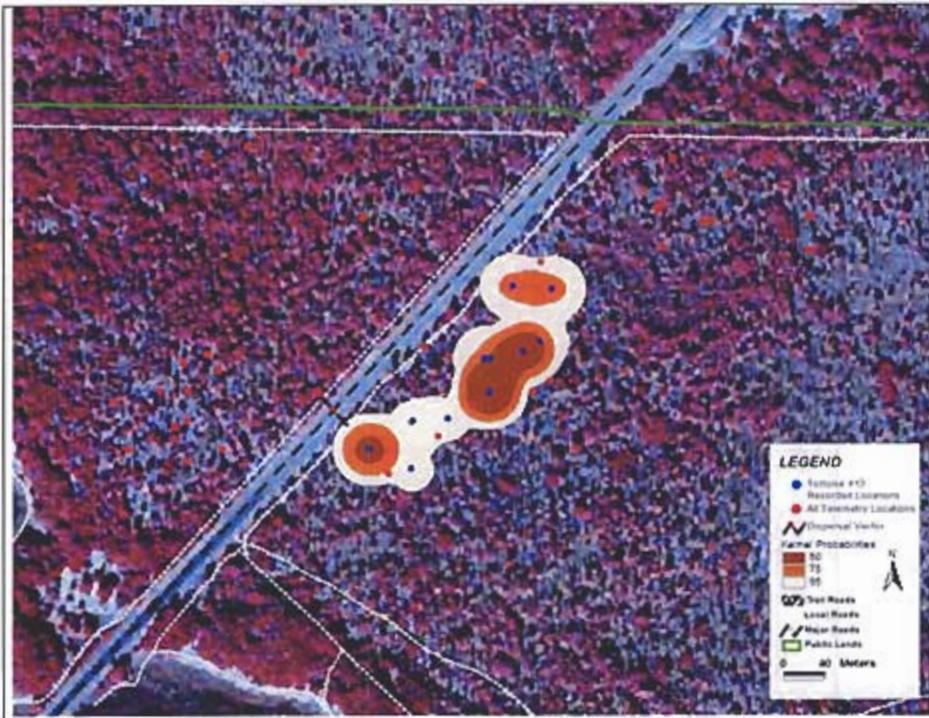




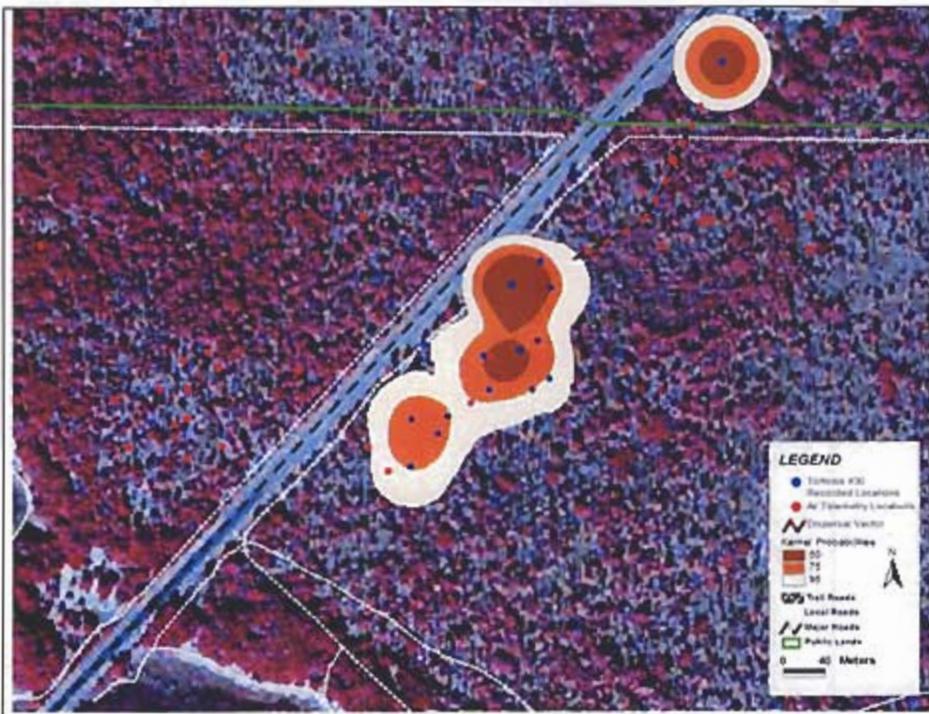
**Figure 48. Home Range (FK) of Gopher Tortoises in Colony Six.** Panels A to D correspond to tortoise nos. 11, 12, 15, and 16, respectively. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise, red dots are neighboring tortoise positions.



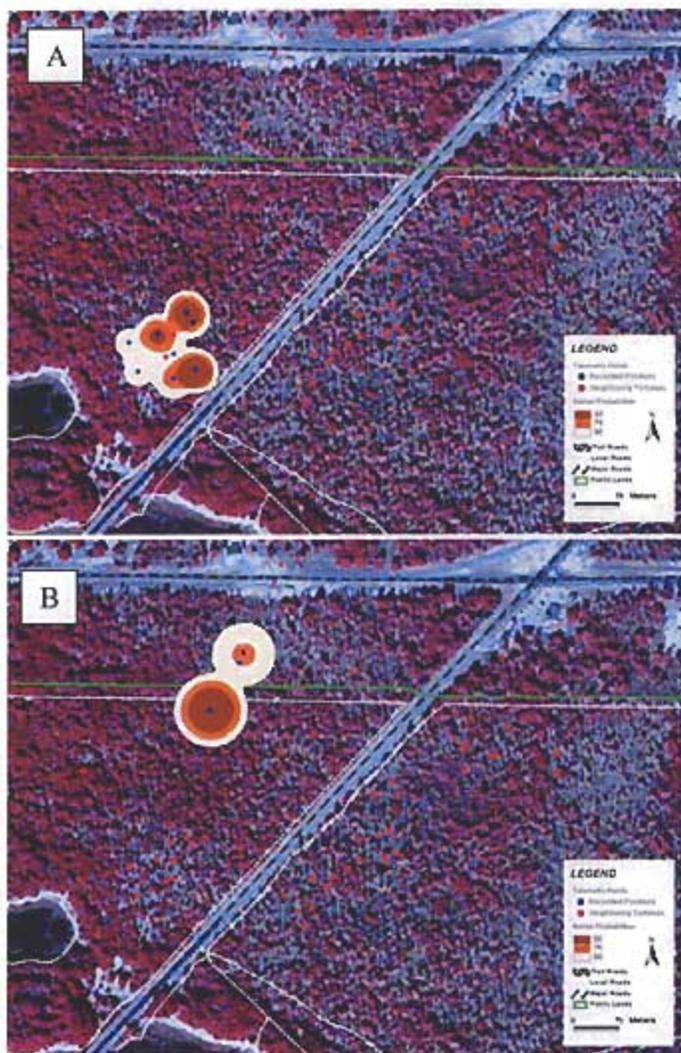
**Figure 48. continued.** Panels E and F correspond to tortoise nos. 13 and 30, respectively. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise; red dots are neighboring tortoise positions.



**Figure 49. Dispersal path of Tortoise no. 13.** Tortoise no. 13, inadvertently translocated when trying to replace a defective transmitter, crossed SR 200 back to its home range territory.

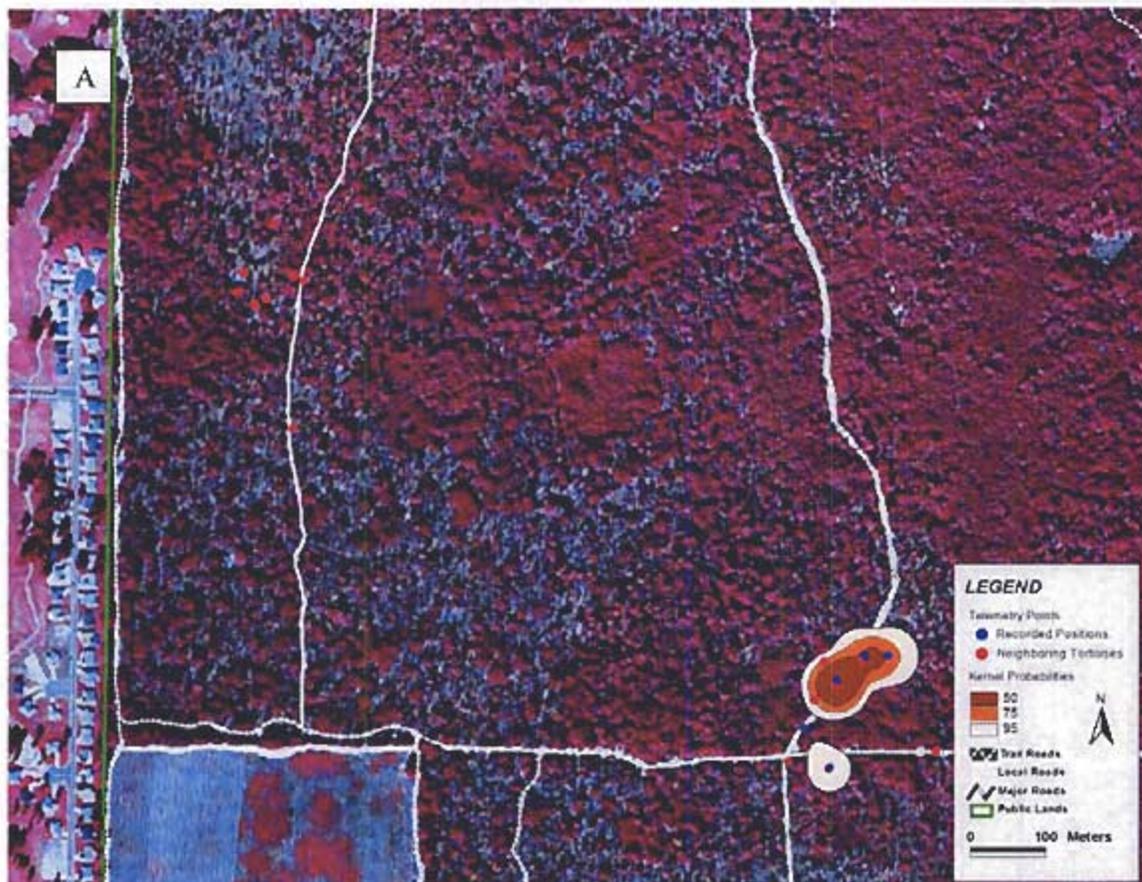


**Figure 50. Dispersal path of Tortoise no. 30.** Tortoise no. 30 traveled over 300 m to overwinter in a burrow near a convenience store in 2002; it returned to the CFG the next season.



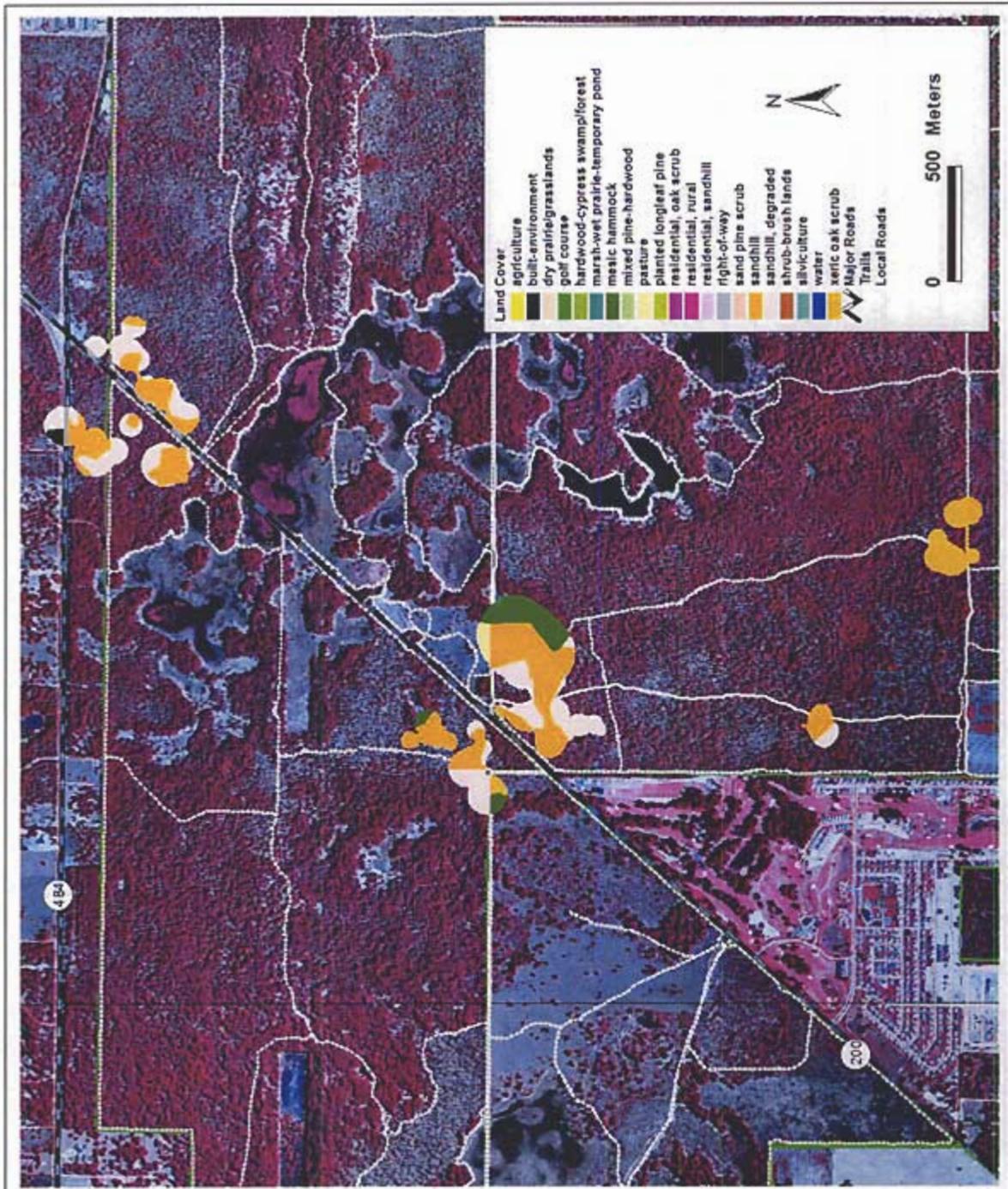
**Figure 51. Home Range (FK) of Gopher Tortoises in Colony Nine.** Panels A and B correspond to tortoise nos. 23 and 34, respectively. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise; red dots are neighboring tortoise positions.

The land cover for all gopher tortoise home range FKs is shown in Figure 53. As with the drift fence analysis, the resolution of the land cover (30 m cell size) is too coarse to accurately determine habitat use at the scale of the tortoise home range and precludes statistical analysis of habitat use. Based on land cover and 899 telemetry positions, tortoises ( $n=24$ ) used habitat in the following proportions: sandhill (64%), sandhill-degraded (25%), and xeric oak scrub (11%). Quadrat sampling of vegetation would be necessary for further analysis of habitat quality and use by tortoises.



**Figure 52. Home Range (FK) of Gopher Tortoises in Colony Five.** Panel A shows the home range of tortoise no. 17. Contour colors represent probabilities of positions – outer 95%, middle 75%, inner 50%. Blue dots are the resident tortoise; red dots are neighboring tortoise positions.





**Figure 53. Land Cover for all Tortoise Home Range (FK).** Seven different land cover types are represented: sandhill, sandhill-degraded, mesic hammock, wet prairie, pasture, xeric oak scrub and urban.

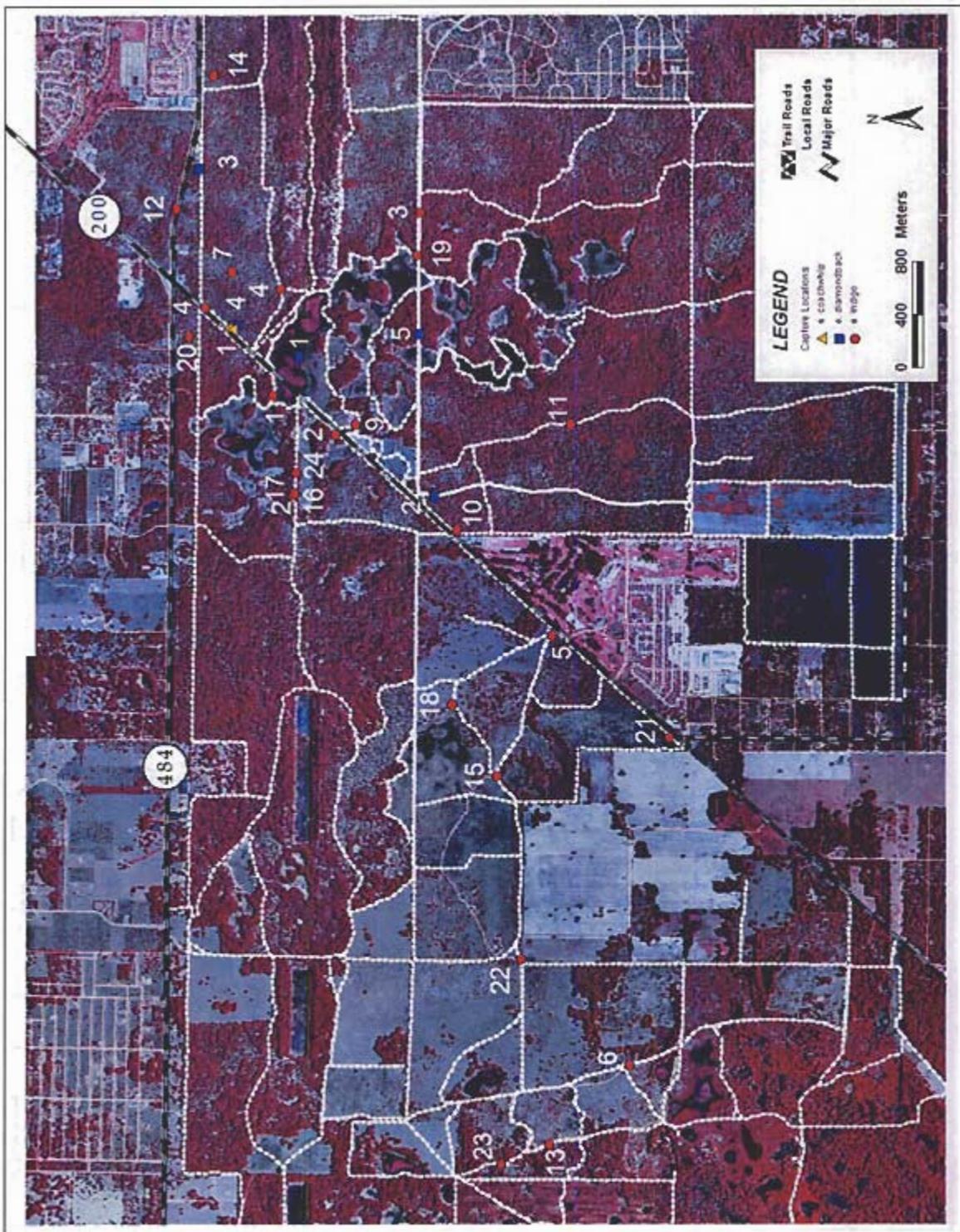
*Snake Telemetry.* Twenty-three Eastern indigo snakes (Table 14), five Eastern diamondbacks and three Eastern coachwhips were captured from May 2002 and July 2004 (Figure 54). Snakes were opportunistically captured near snake refugia and when incidentally crossing firebreaks. Home ranges were calculated using 95% fixed kernel (FK) contours and 50% fixed kernel contours were used to estimate core-area size. Also, 75% fixed kernel contours were included in diagrams for visual comparison. MCP (minimum convex polygon) home ranges were also calculated.

**Table 14. Eastern Indigo Snake Captures: Morphometrics and Home Range Summary.**

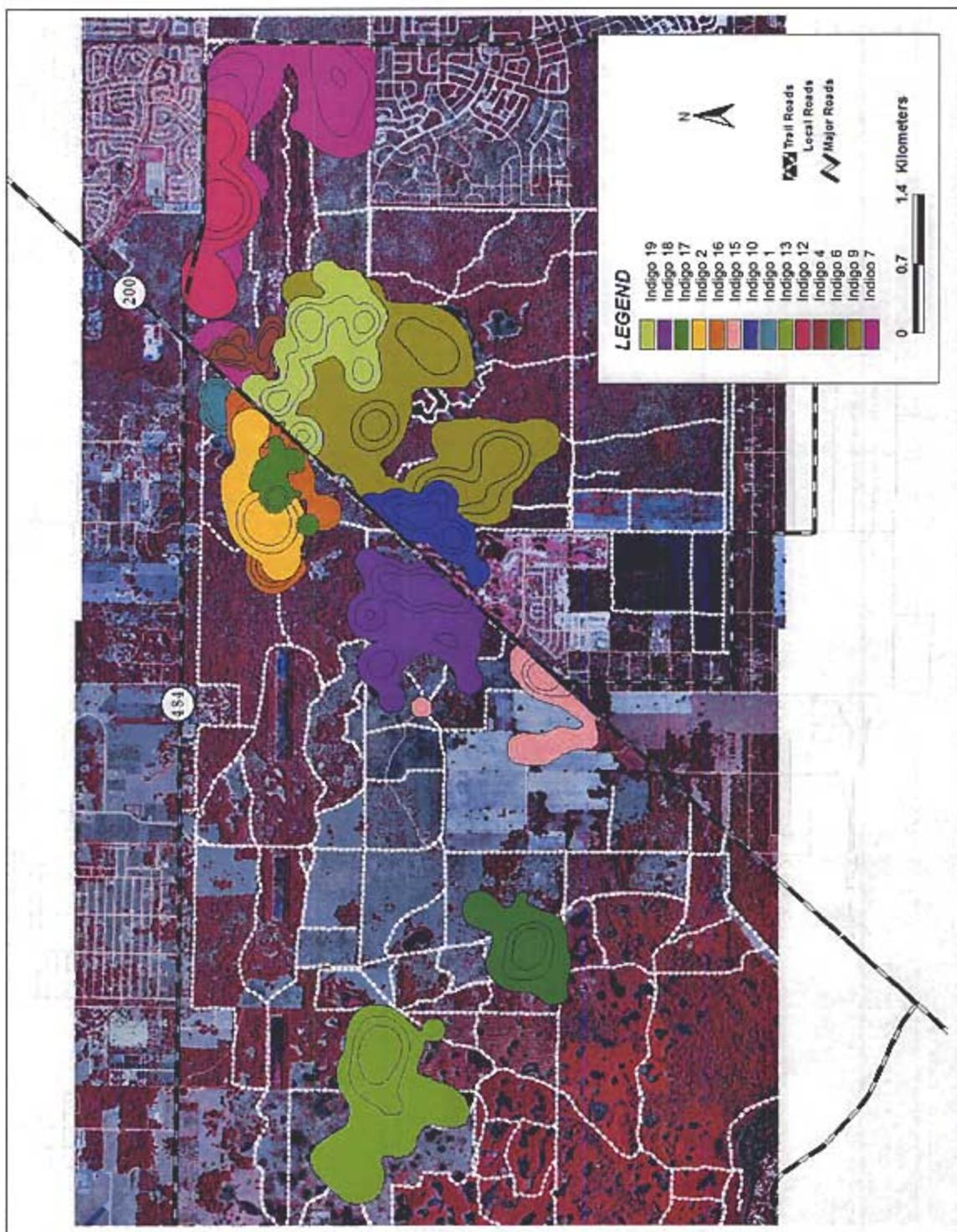
<b>E. Indigo Snake</b>	<b>n</b>	<b>Average Weight (g)</b>	<b>AVG SNV Length (cm)</b>	<b>AVG Tail Length (cm)</b>	<b>AVG Home Range (kernel-95)(ha)</b>	<b>AVG Home Range (mcp)(ha)</b>
<b>all individuals</b>	<b>23</b>	<b>1,251</b>	<b>132.9</b>	<b>25.9</b>		
males	12	1,300	132.4	27.1		
adults	6	1,865	156.4	30.7		
sub-adults	6	735	108.3	23.6		
females	7	1,024	138.8	27.1		
unidentified	4	1,290	130.0	23.4		
<b>telemetry</b>	<b>13</b>	<b>1,356</b>	<b>141.6</b>	<b>28.6</b>	<b>127.6</b>	<b>161.5</b>
males	9	1,460	140.1	28.3	149.8	196.1
adults	5	1,897	158.8	31.0	217.8	269.6
sub-adults	4	913	116.6	24.9	64.8	73.6
females	4	1,124	144.9	29.3	77.5	69.4
<b>nontelemetry</b>	<b>10</b>	<b>1,115</b>	<b>121.8</b>	<b>22.3</b>		
males	3	822	109.2	23.7		
females	3	890	130.7	24.2		
unidentified	4	1,504	124.5	19.9		

Adult E. indigo snake males (n=6) were larger than females (n=7) in 1) snout-vent length (SNV), 156.4 cm versus 138.8 cm, 2) tail length (30.7 cm versus 27.1 cm), and 4) weight (1,865 g versus 1,024 g). Thirteen Eastern indigo snakes were tracked over the course of the study (Table 14). An average of 10 positions per month per individual was recorded. This resulted in an average of 96.8 locations per snake for a total of 1,259 locations for all indigo snakes. Tracking occurred for an average of 9.5 months per subject for all indigo snakes. Males had a larger average 95% FK and MCP home range (149.8 ha and 196.1 ha, respectively) than females (77.5 ha and 69.4, respectively), and adult males averaged much larger home ranges (217.8 ha and 269.6 ha, respectively) than sub-adults males (64.8 ha and 73.6 ha, respectively). Combined home range and home range land cover for all indigo snakes are shown in Figure 55 and 56, respectively.

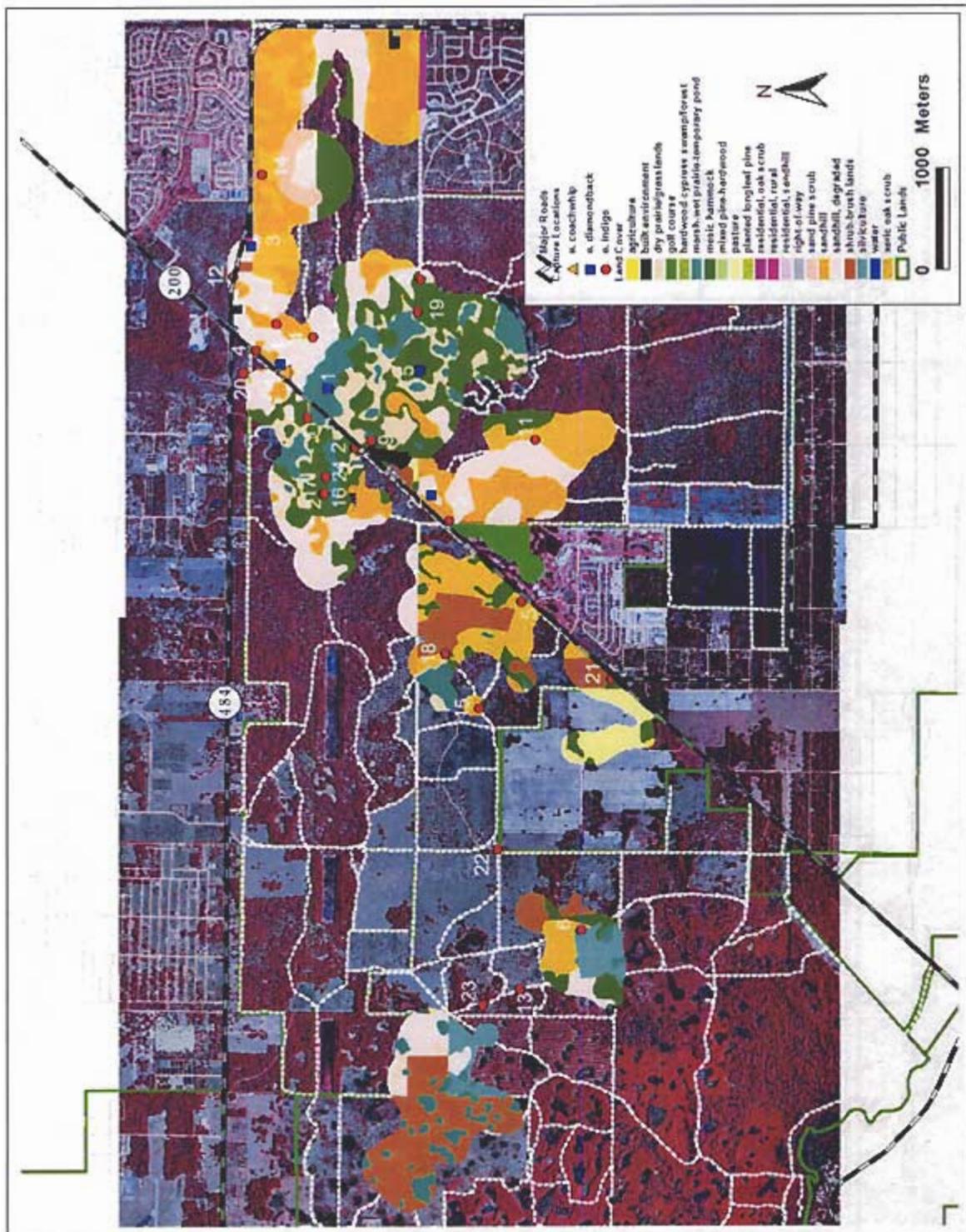
Student's *t* was used to determine central tendency and Kolmogorov-Smirnov was used to determine departures from normality. For all E. indigo snakes, the MCP home range size was normally distributed ( $t = 3.74$ ,  $p < 0.0025$ ;  $D = 0.28$ ,  $p < 0.01$ ); for FK home range size, means were centrally located ( $t = 4.41$ ,  $p < 0.0007$ ), but the distribution did not fit a normal curve ( $D = 0.18$ ,  $p > 0.15$ ).



**Figure 54. Capture Locations of Focal Species Snakes, May 2002 – July 2004.** Red dots indicate *E. indigo* snakes, blue dots indicate *E. diamondback* rattlesnakes, and orange triangles indicate *E. Coachwhip*.



**Figure 55. Combined Home Range (FK) Calculated for all E. Indigo Snakes.** The outer contour represents 95%-, middle contour represents 75%- and the inner contour 50% probabilities. Colors represent different subjects.



**Figure 56. Land Cover for all Snake Home Range Areas (FK). Seventeen different land cover types were used by snakes.**

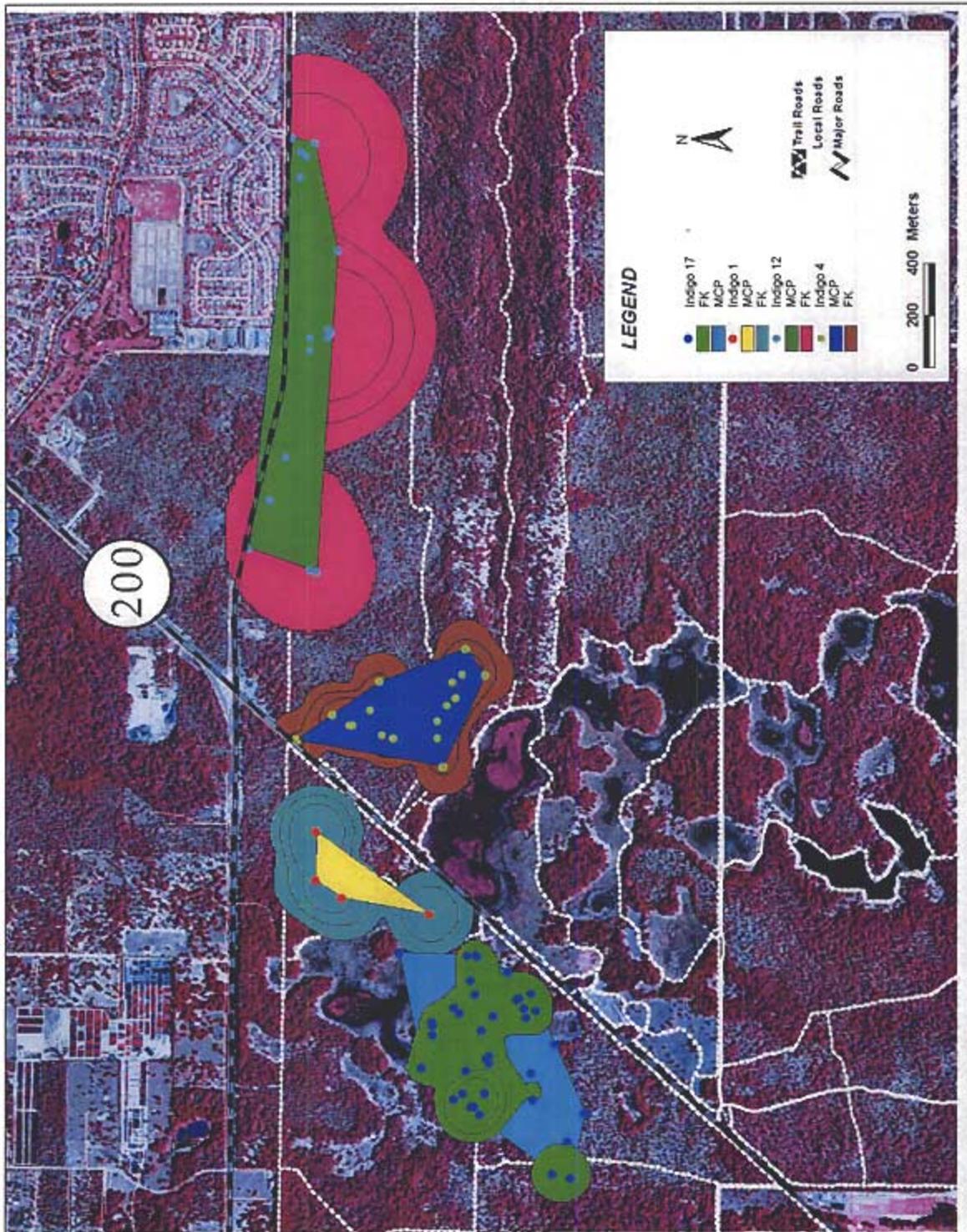
The snake transmitters had the same antenna attachment defect as with tortoises. As a result, E. indigo snakes no. 1, 3 and 5 were lost shortly after release and never recovered. E. indigo snake no. 2 was recaptured 17 months after it was lost and was refitted with a new transmitter. Four E. indigo snakes (nos. 6, 13, 15 and 18) were tracked in the HTP, two (nos. 9 and 10) in the RPSF, three (nos. 2, 16 and 17) in the west CFG, and four (nos. 4, 7, 12 and 19) in the east CFG.

Indigo 1, an adult female captured in May 2002 and released for radio-telemetry in late July 2002 was tracked for about 15 days prior to premature transmitter failure (manufacturer defect), only 5 points were recorded. Though this is certainly not enough positions to base a home range on, for informational purposes these points were plotted to display the potential area used by this snake (Figure 57). A 95% FK calculation of these five points resulted in an area of 27.1 ha. We predict the actual home range to be much larger. Indigo 1 was never recaptured.

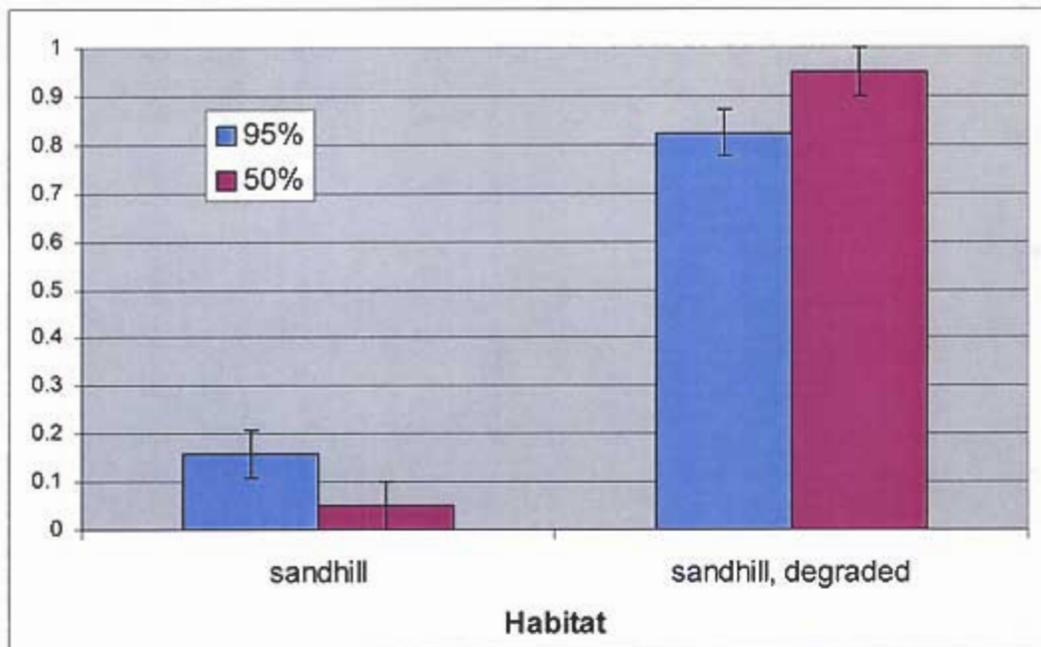
Indigo 4, a sub-adult male captured in November 2002, was monitored 7 months with 18 points taken. This snake had to be removed from the study as it developed an abscess requiring removal of the transmitter. It was rehabilitated and released in June 2003. The 95% FK home range was 30.8 ha, and the MCP was 16.6 ha (Figure 57). Based on only 18 points, the actual home range is probably much larger. Within the 95% FK home range, habitat composition was 82% sandhill-degraded, 16% sandhill, and 1% right-of-way (Figure 58). The 50% FK core area was comprised of 95% sandhill-degraded and 5% sandhill (Figure 58). Actual habitat use (recorded points) in the 50% FK core area was entirely within sandhill-degraded (Figure 59). The small number of points makes clear preferences unknown, other than its use of sandhill habitats.

Another sub-adult male, Indigo 12, was captured in November 2003 and monitored for 8 months, with 98 points taken. It was captured on the shoulder of CR 484 and appeared to have traveled across the road. This movement event occurred during construction of the Wal-Mart. It may have been forced to relocate because of land clearing (This area had been in the proposed conservation lands database). The 95% FK home range was 97 ha and the MCP was 34.6 ha (Figure 57). Habitat composition (Figure 60) within the 95% FK home range was sandhill (41%), xeric oak shrub (22%), sandhill-degraded (20%), sand pine scrub (12%), right-of-way (2%), shrub and brushlands (1%), built-environment (1%), and residential-rural (1%). The 50% FK core area was comprised of 50% sandhill, 32% xeric oak shrub, 15% sand pine scrub, 2% right-of-way, and 1% built-environment (Figure 60). Actual use (documented positions) within the 50% FK core area indicated 73% use of xeric oak shrub, and 27% use of sandhill (Figure 61). This indicates a high selection for xeric oak scrub. The skeleton of Indigo 12 was found in a burrow in June 2004, being dug up after it had not emerged for two months. Cause of death is unknown.

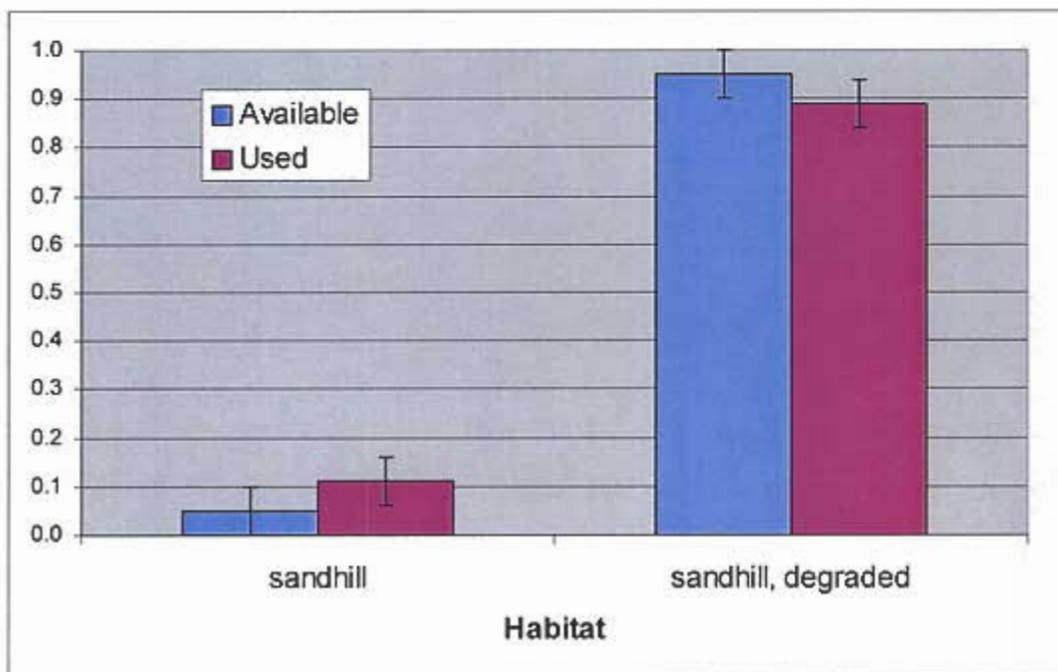
Indigo 17 was an adult female caught in February 2004; it was monitored for 7 months with 185 points taken. The 95% FK home range was 29.5 ha and the MCP was 35 ha (Figure 57). Within the 95% FK home range, 57% of the area was mesic hammock, 22% marsh-wet prairie-temporary pond, 8% dry prairie/grasslands, 7% sandhill-degraded, and 6% sandhill (Figure 62). The 50% FK core area was comprised of 75% mesic hammock and 25% marsh-wet prairie-temporary pond (Figure 62). Actual positions recorded within the 50% FK core area were in mesic hammock (72%) and marsh-wet prairie-temporary pond (28%). Comparison of use vs. availability showed a selection towards sandhill (Figure 63). Indigo 17 died prematurely from unknown causes in November 2004; it appeared malnourished.



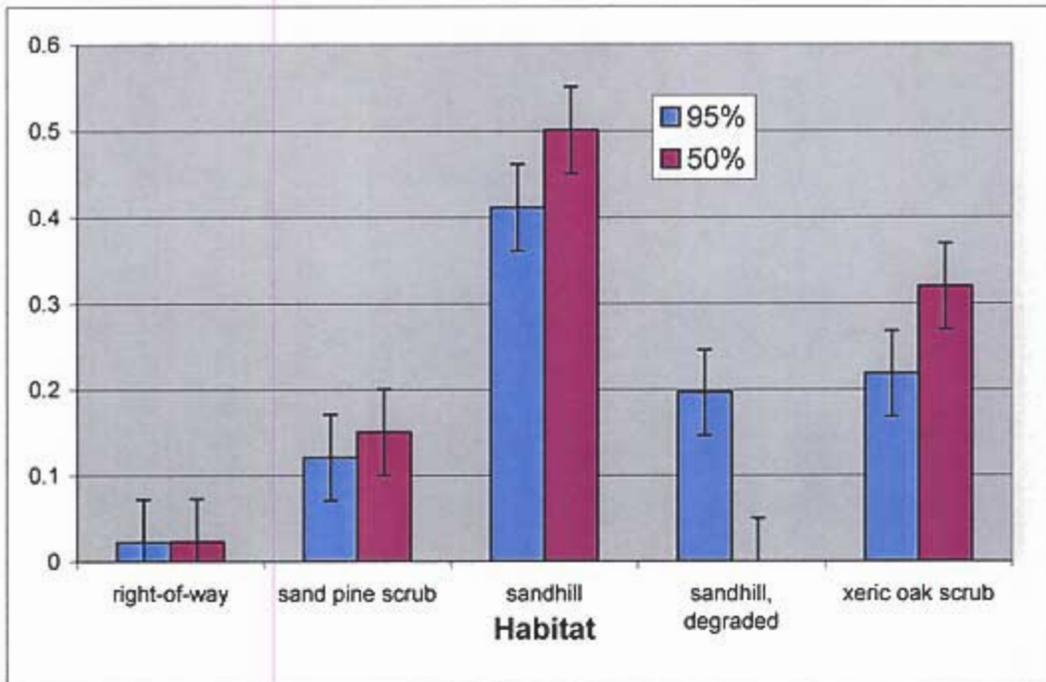
**Figure 57. Home Range (FK and MCP) Polygons (Nos. 1, 4, 12, and 17).** Curvilinear layers are FK and angular-shaped layers are MCP. For the FK, the outer contour represents 95%-, middle contour represents 75%-, and the inner contour 50% probabilities.



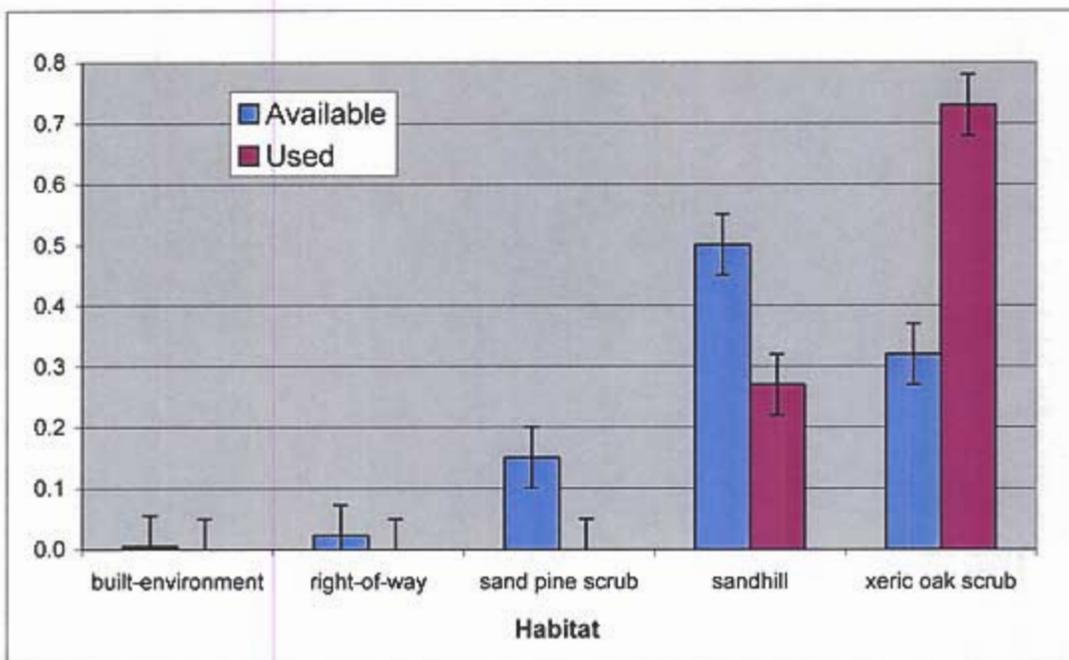
**Figure 58. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 4.** Not included in this chart were minimal amounts of the following habitat types (1% or less): marsh-wet prairie-temporary pond, mesic hammock, and right-of-way.



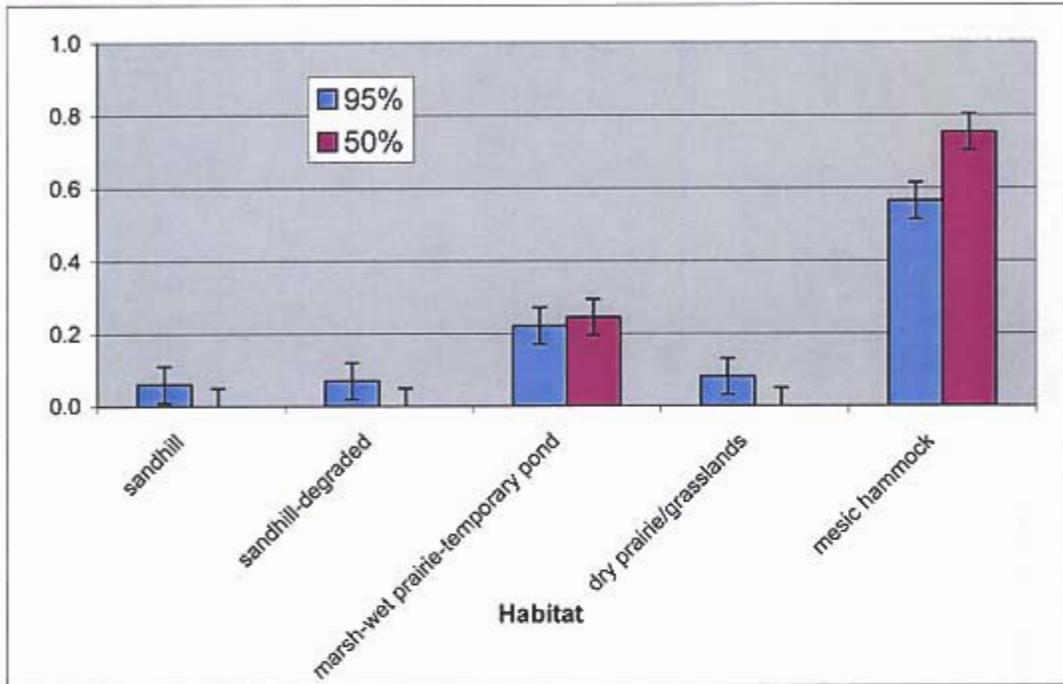
**Figure 59. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 4.**



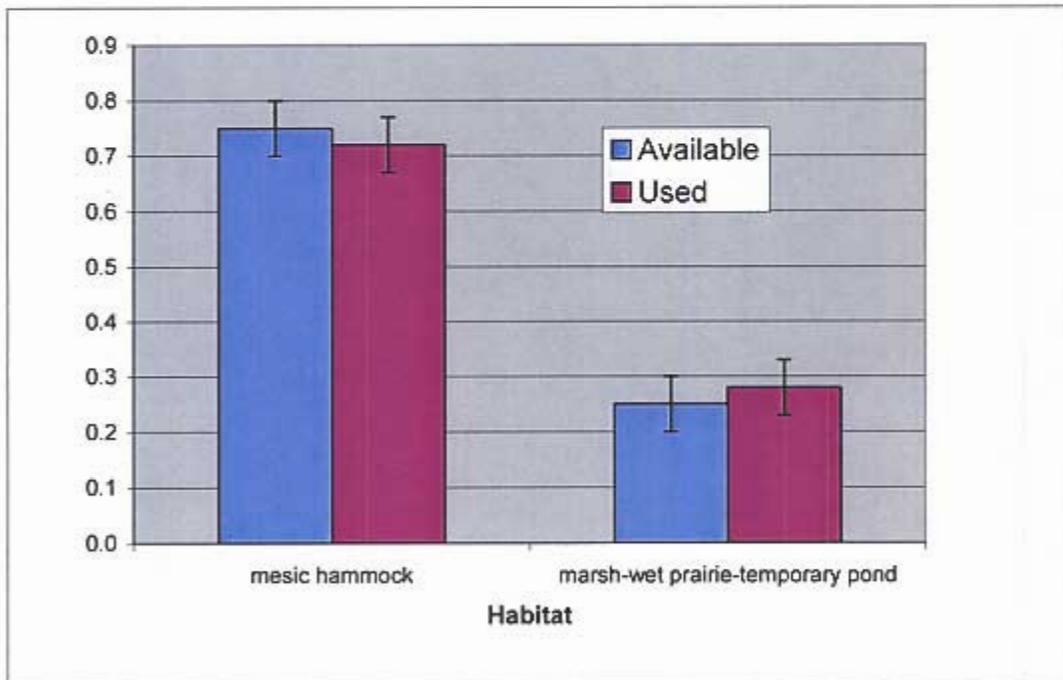
**Figure 60. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 12.** Not included in this chart were minimal amounts of the following habitat types (1% or less): shrub-brush lands, built-environment, and residential-rural.



**Figure 61. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 12.**



**Figure 62. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 17.**



**Figure 63. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 17.**

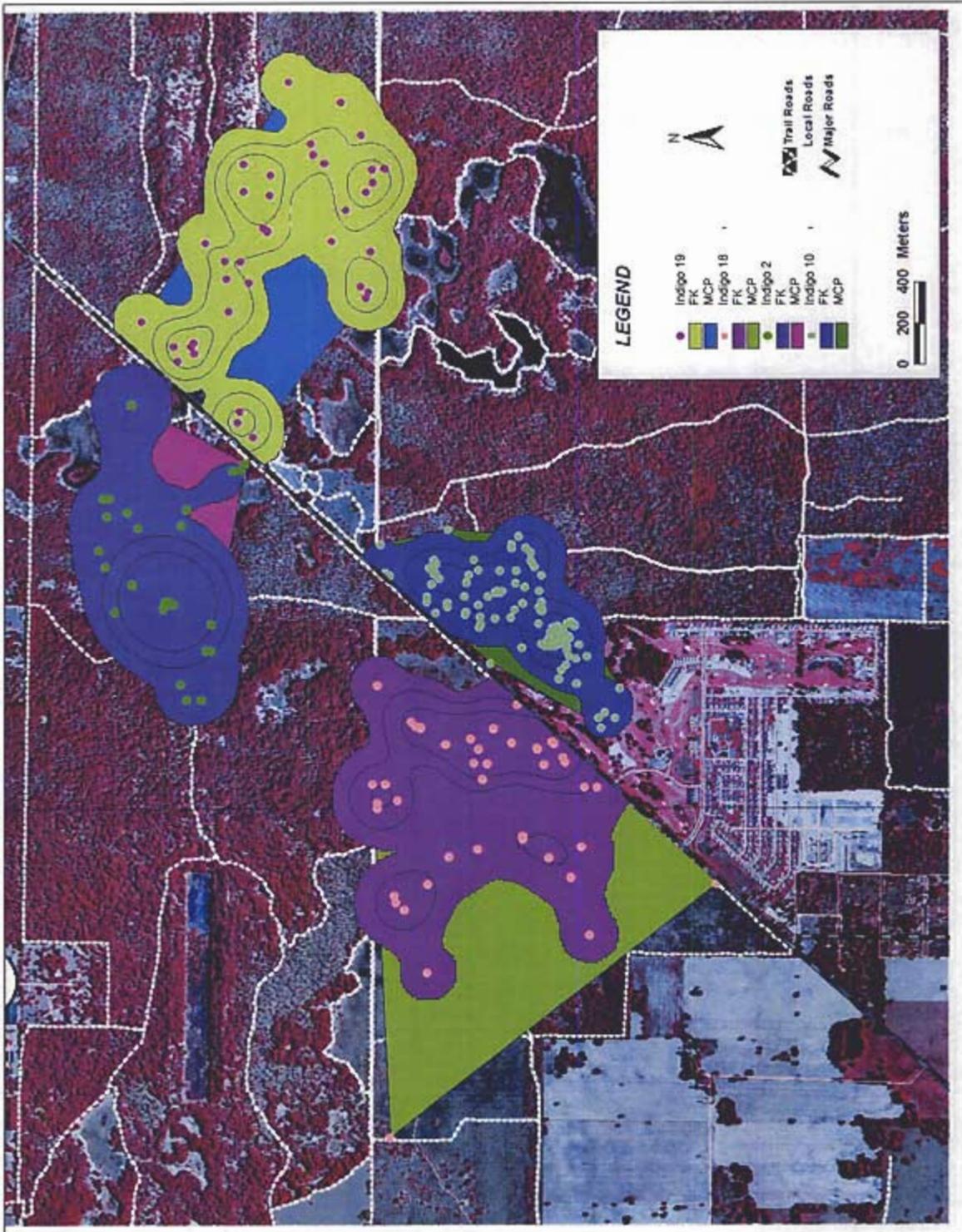
Indigo 2 was an adult female captured in July 2002, subsequently lost in August 2004 because of transmitter failure, recaptured and refitted with a new transmitter in February 2004 and then monitored for 4.5 months, with a total of 78 points taken. The 95% FK home range was 91.8 ha, and the MCP was 63.1 ha. Home range contours (FK and MCP) are shown in Figure 64.

In the 95% FK home range of Indigo 2, the habitat was comprised of 38% mesic hammock, 28% sandhill-degraded, 14% marsh-wet prairie-temporary pond, 14% dry prairie/grasslands, and 6% sandhill (Figure 65). Within the 50% FK core area, 47% was mesic hammock, 29% was dry prairie/grasslands, 10% was sandhill, 10% was marsh-wet prairie-temporary pond, and 4% was sandhill-degraded (Figure 65). Actual use (documented locations) within the 50% FK core area was 88% sandhill, 6% sandhill-degraded, and 6% dry prairie/grasslands. Indigo 2 exhibited a strong preference for sandhill habitat (Figure 66). Comparing use to availability shows that sandhill was used disproportionately to its availability (Figure 66). Indigo 2 was found dead in mid-July 2004 with a neck injury, possibly predation related.

Indigo 10 was an adult female caught in July 2003 and monitored for 15.5 months, with 198 telemetry positions recorded. The 95% FK home range was 59.1 ha and the MCP was 51.4 ha. Home range contours (FK and MCP) are shown in Figure 64. Habitat types within the 95% FK home range include 38% golf course, 31% sandhill, 27% sandhill-degraded, 2% shrub-brush lands, 1% mixed pine-hardwoods, and 1% right-of-way (Figure 67). In the 50% FK core area, 41% was sandhill, 32% sandhill-degraded, 25% golf course, and 2% shrub-brush lands (Figure 67). Recorded points within the 50% FK core area were found in sandhill (39%), golf course (32%), and sandhill-degraded (29%). It used the golf course more than expected. Figure 68 compares actual positions to available habitat.

Indigo 18 was an adult male captured in February 2004 and monitored for 7 months, with a total of 54 points logged. The 95% FK home range was 148.5 ha, and the MCP was 200.2 ha (Figure 64). Within the 95% FK home range, 40% was xeric oak scrub, 26% shrub-brush lands, 13% mesic hammock, 8% marsh-wet prairie-temporary pond, 8% sandhill-degraded, 2% sandhill, 2% dry prairie/grasslands, and 1% right-of-way (Figure 69). The 50% FK core area was primarily comprised of 68% xeric oak scrub, 25% mesic hammock, 6% shrub-brush lands, and 1% right-of-way (Figure 69). Actual use (recorded positions) within the 50% FK core area indicated 69% presence in xeric oak scrub and 31% presence in mesic hammock. This indicates a selection towards mesic hammock and against shrub-brush lands in the core area (Figure 70).

Indigo 19 was an adult female captured in February 2004 and monitored for 6.5 months with a total of 51 recorded positions. The 95% FK home range was 129.7 ha, and the MCP was 110.2 ha (Figure 64). The habitat composition of the 95% FK home range was 39% mesic hammock, 26% marsh-wet prairie-temporary pond, 15% sandhill-degraded, 13% dry prairie/grasslands, 4% sandhill, and 3% xeric oak scrub (Figure 71). Within the 50% FK core area, 39% was mesic hammock, 32% marsh-wet prairie-temporary pond, 15% dry prairie/grasslands, and 14% sandhill-degraded (Figure 71). Actual use (recorded positions) in the core area was 36% mesic hammock, 24% marsh-wet prairie-temporary pond, 24% sandhill-degraded, and 16% dry prairie/grasslands. Comparing documented use to availability shows a selection towards sandhill-degraded (Figure 72).



**Figure 64. Home Range (FK and MCP) Polygons (Nos. 2, 10, 18, and 19).** Upper layers are FK and underlying layers are MCP. For the FK, the outer contour represents 95%-, middle contour represents 75%- and the inner contour 50% probabilities.

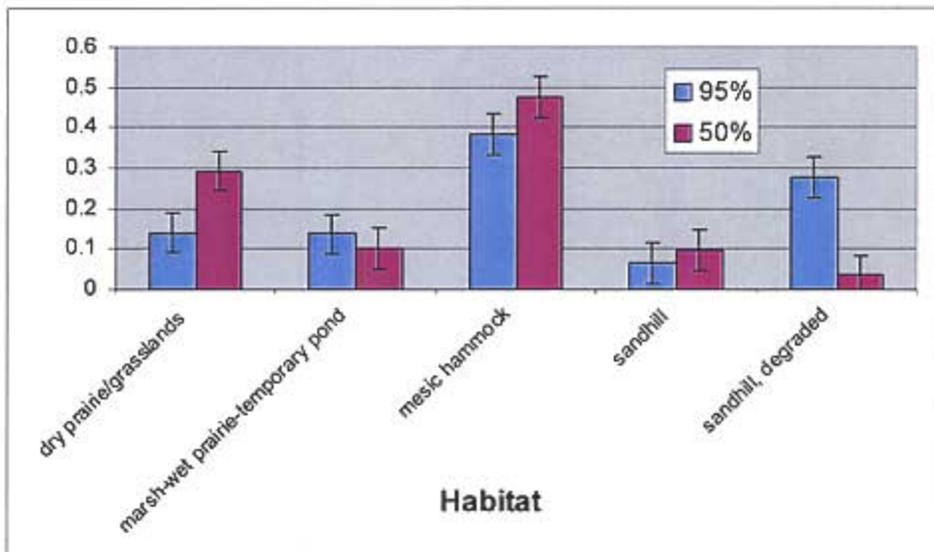


Figure 65. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 2.

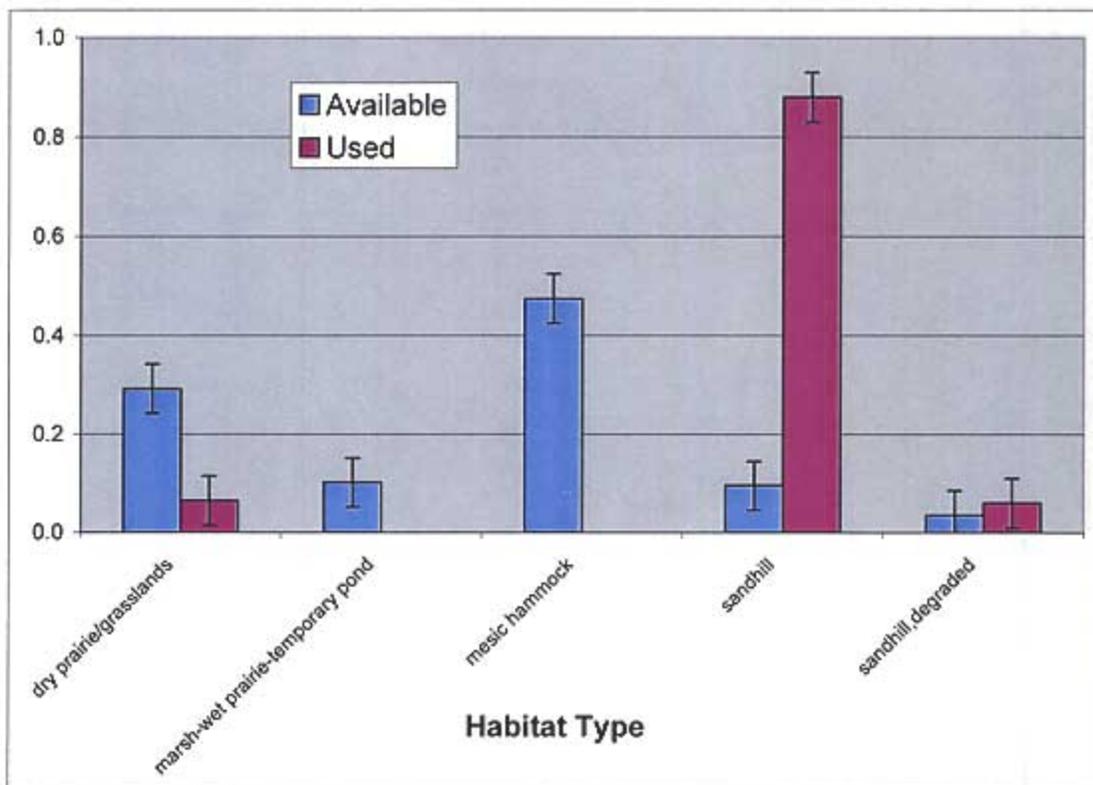
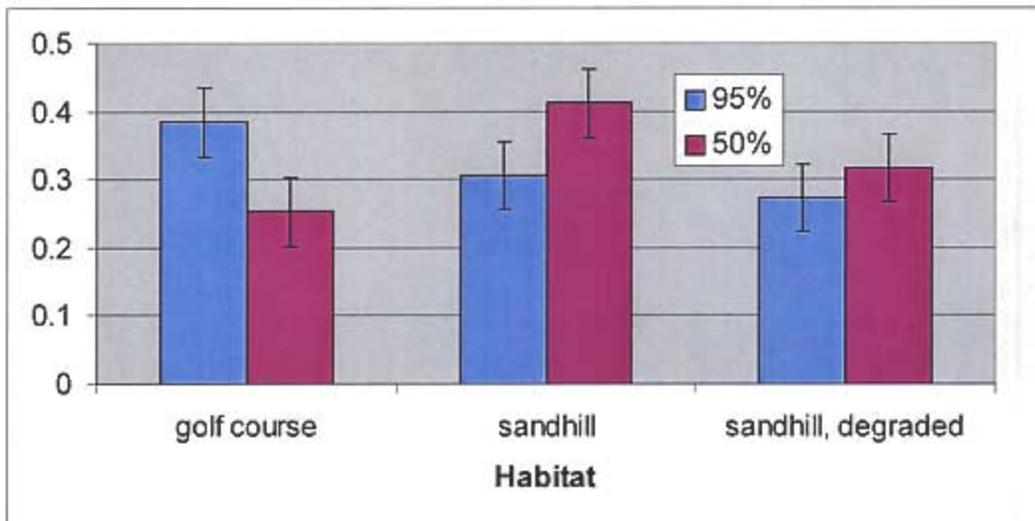
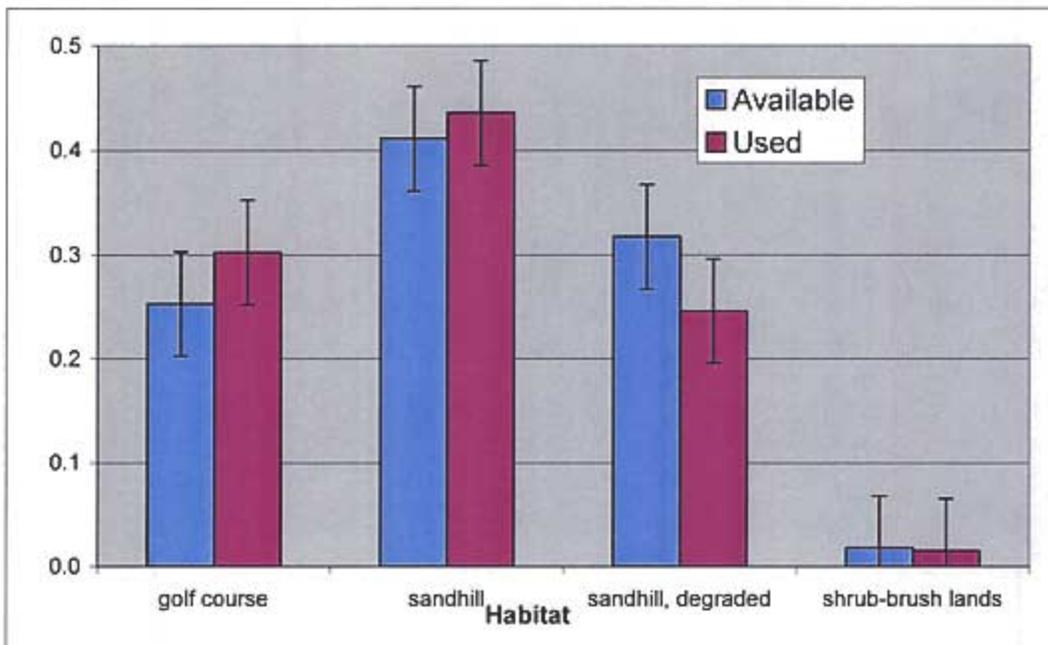


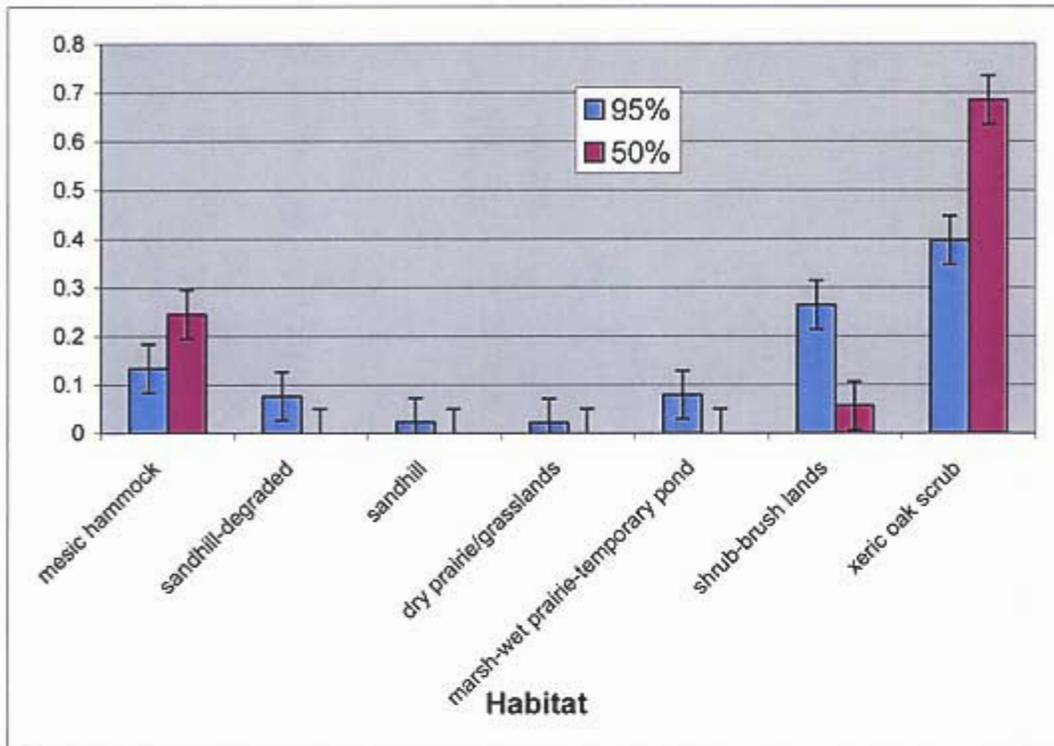
Figure 66. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 2.



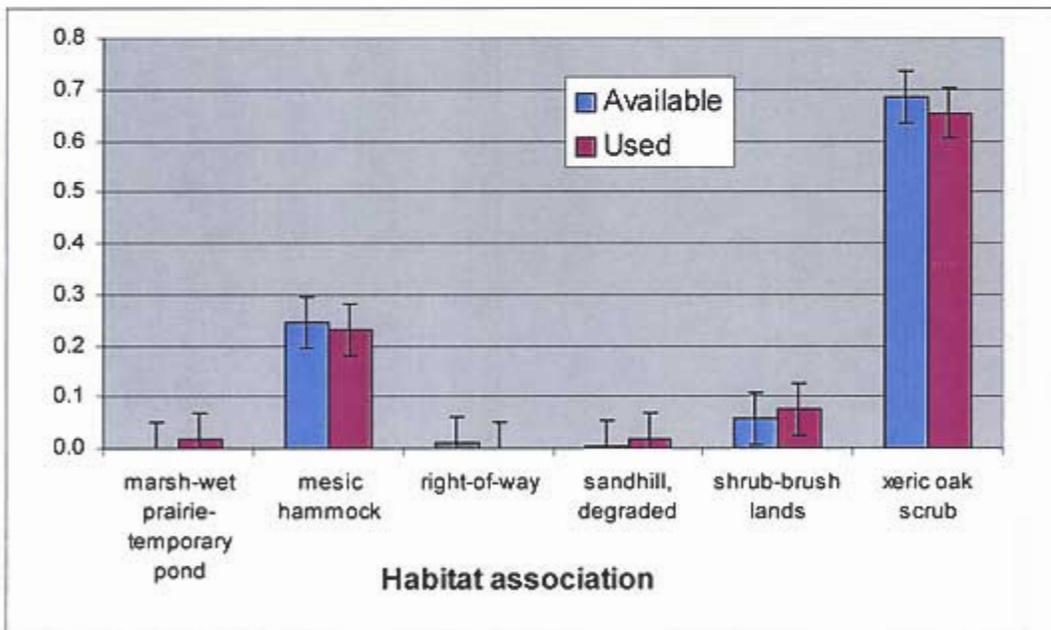
**Figure 67. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 10.** Not included in this chart were minimal amounts of the following habitat types (2% or less): shrub-brush lands, mixed pine-hardwoods, and right-of-way.



**Figure 68. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 10.**



**Figure 69. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 18.** Not included in this chart were minimal amounts of the following habitat types (1% or less): right-of-way.



**Figure 70. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 18.**

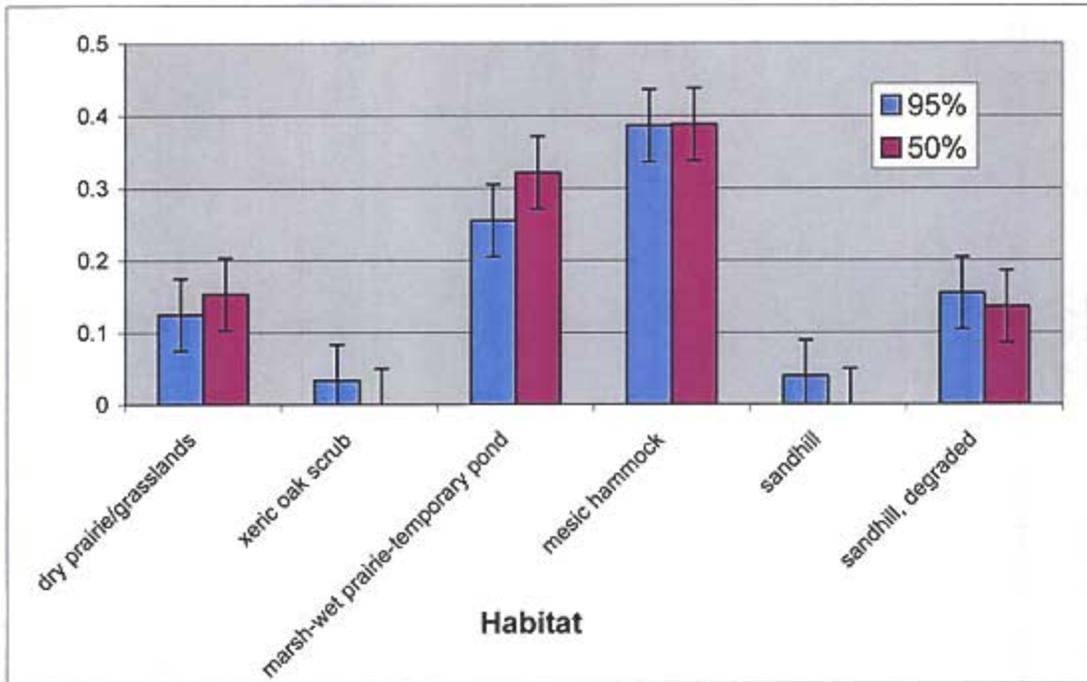


Figure 71. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 19.

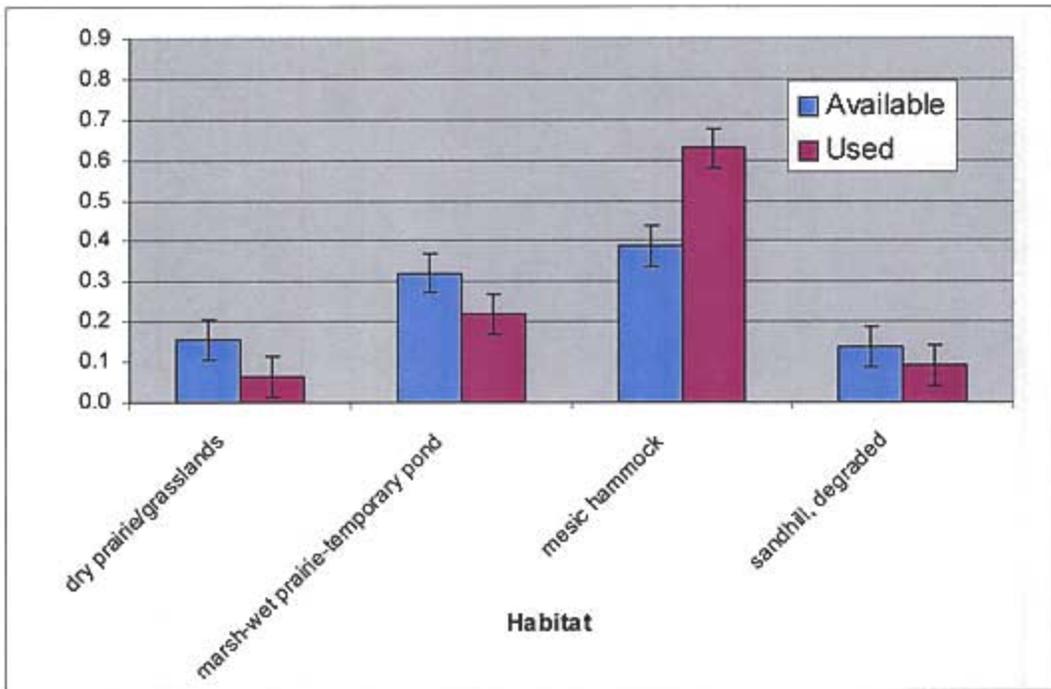


Figure 72. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 19.

Indigo 6, a sub-adult male captured in December 2002 was monitored for 12 months with 121 points recorded. The 95% FK home range was 79.1 ha, and the MCP was 97.4 ha (Figure 73). Habitat composition within the 95% FK home range was 26% silviculture, 22% mesic hammock, 21% xeric oak scrub, 17% shrub-brush lands, 8% sandhill-degraded, and 4% marsh-wet prairie-temporary pond (Figure 74). The 50% FK core area was comprised of 75% silviculture, and 21% xeric oak scrub, 2% sandhill-degraded, 2% xeric oak scrub (Figure 74). Actual use within the 50% FK core area indicated 90% use of silviculture, 3% use of marsh-wet prairie-temporary pond, 3% use of mesic hammock, and 3% use of xeric oak scrub (Figure 75). The percent use of silvicultural areas was surprising, though the area was well developed and had significant palmetto understory. Indigo 6 was found dead, signs of trampling by an ungulate were evident.

Indigo 13 was an adult male captured in November 2003. It was monitored for 12 months, with 106 points taken. The 95% FK home range was 168.1 ha, and the MCP was 224.8 ha (Figure 76). Habitat composition within the 95% FK home range was 56% shrub-brushlands, 16% marsh-wet prairie-temporary pond, 14% sandhill-degraded, 11% silviculture, and 2% dry prairie/grasslands (Figure 77). The 50% FK core area was comprised of 52% shrub-brush lands, 37% sandhill-degraded, 5% dry prairie/grasslands, 4% silviculture, and 3% marsh-wet prairie-temporary pond (Figure 77). Actual use (recorded positions) within the 50% FK core area indicated 62% shrub-brush lands, 35% sandhill-degraded, 2% dry prairie/grasslands, and 2% marsh-wet prairie-temporary pond (Figure 78). The core area for Indigo 13 was mostly within a private inholding in the HTP.

Another sub-adult male, Indigo 15 was captured in January 2004 and monitored for 9 months. Eighty-three points were documented. The 95% FK home range was 52.3 ha, and the MCP was 106.8 ha (Figure 73). Within the 95% FK home range, habitat composition (Figure 79) was pasture (54%), shrub-brushlands (20%), mesic hammock (14%), xeric oak scrub (8%), and sandhill (3%). The 50% FK core area was comprised of 90% shrub-brushlands and 9% mesic hammock (Figure 79). Habitat preference (from documented positions) within the 50% FK core area was toward shrub-brushlands (97%) and mesic hammock (3%) (Figure 80). Indigo 15 crawled inside a pipe at a farm adjacent to the HTP where it was found dead in November 2004. The body was partially decayed and covered with ants. Cause of mortality is unknown.

Indigo 16 was an adult male captured in February 2004. Eighty-five positions were recorded over 8.5 months. The 95% FK home range was 118 ha, and the MCP was 100.8 ha (Figure 73). Habitat within the 95% FK home range included 38% mesic hammock, 22% sandhill-degraded, 14% marsh-wet prairie-temporary pond, 13% sandhill, and 12% dry prairie/grasslands (Figure 81). The 50% FK core area was comprised of 43% sandhill-degraded, 28% mesic hammock, 15% marsh-wet prairie-temporary pond, 8% dry prairie/grasslands, and 7% sandhill (Figure 81). Actual use (based on recorded points) within the 50% FK core area indicated preference for sandhill-degraded (49%), marsh-wet prairie-temporary pond (24%), mesic hammock (22%), and right-of-way (4%) (Figure 82).

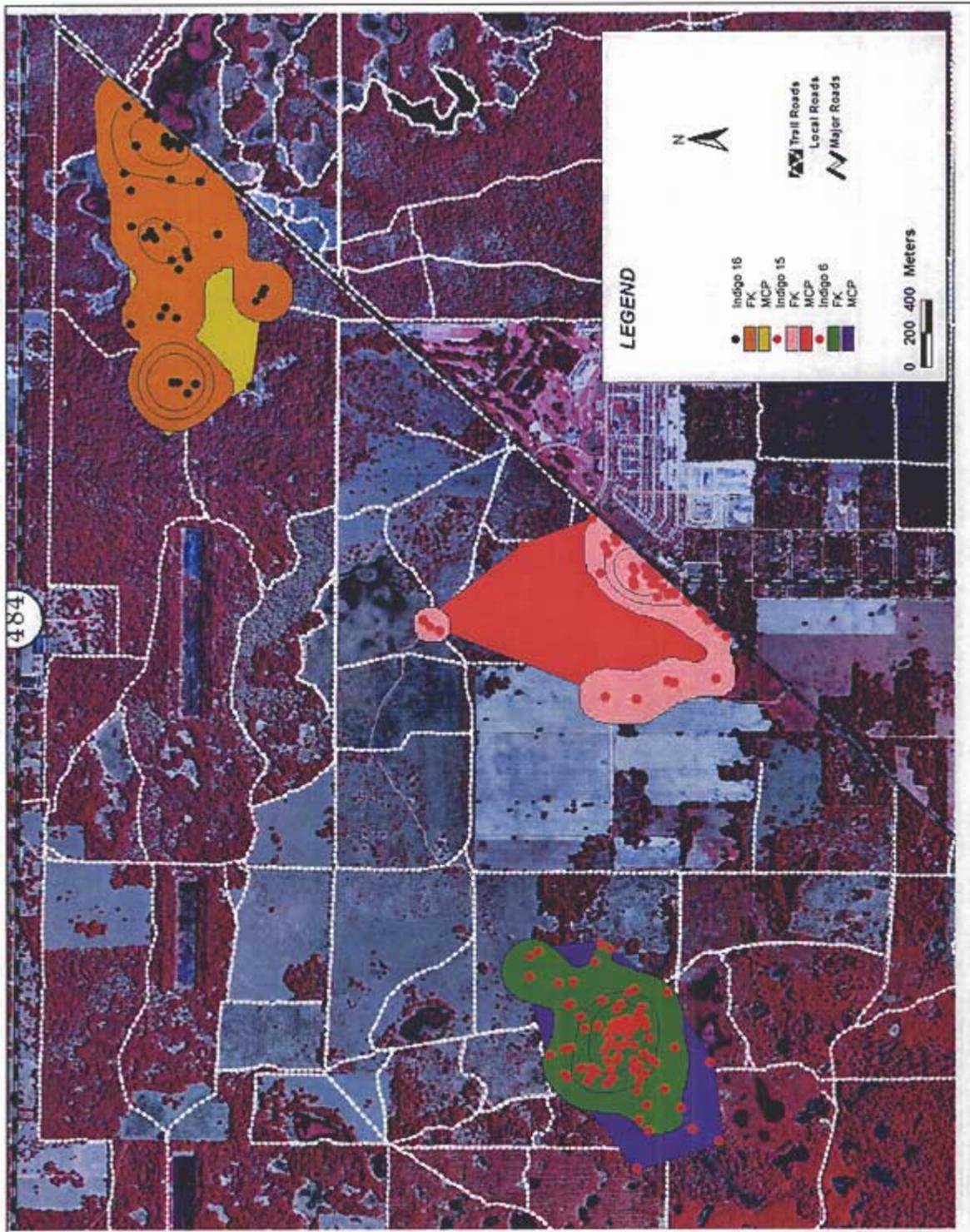
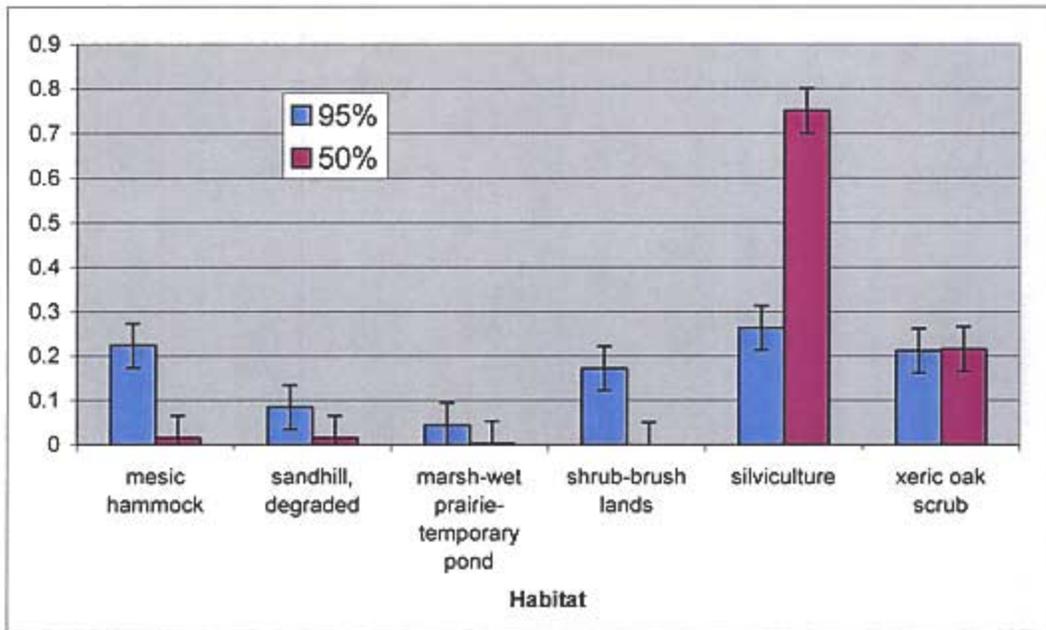
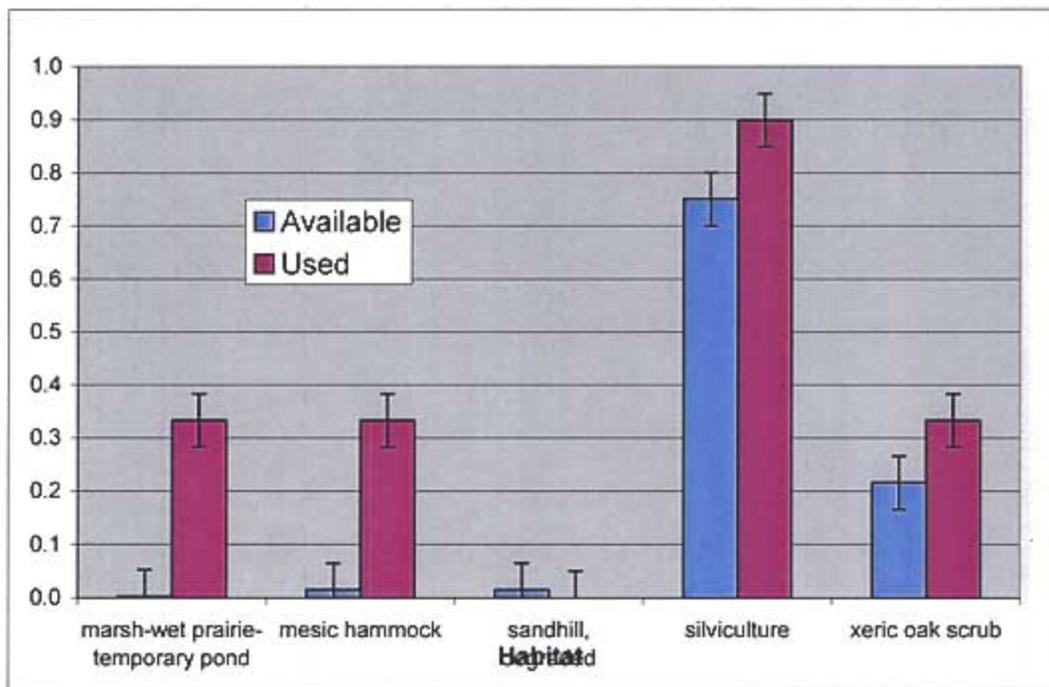


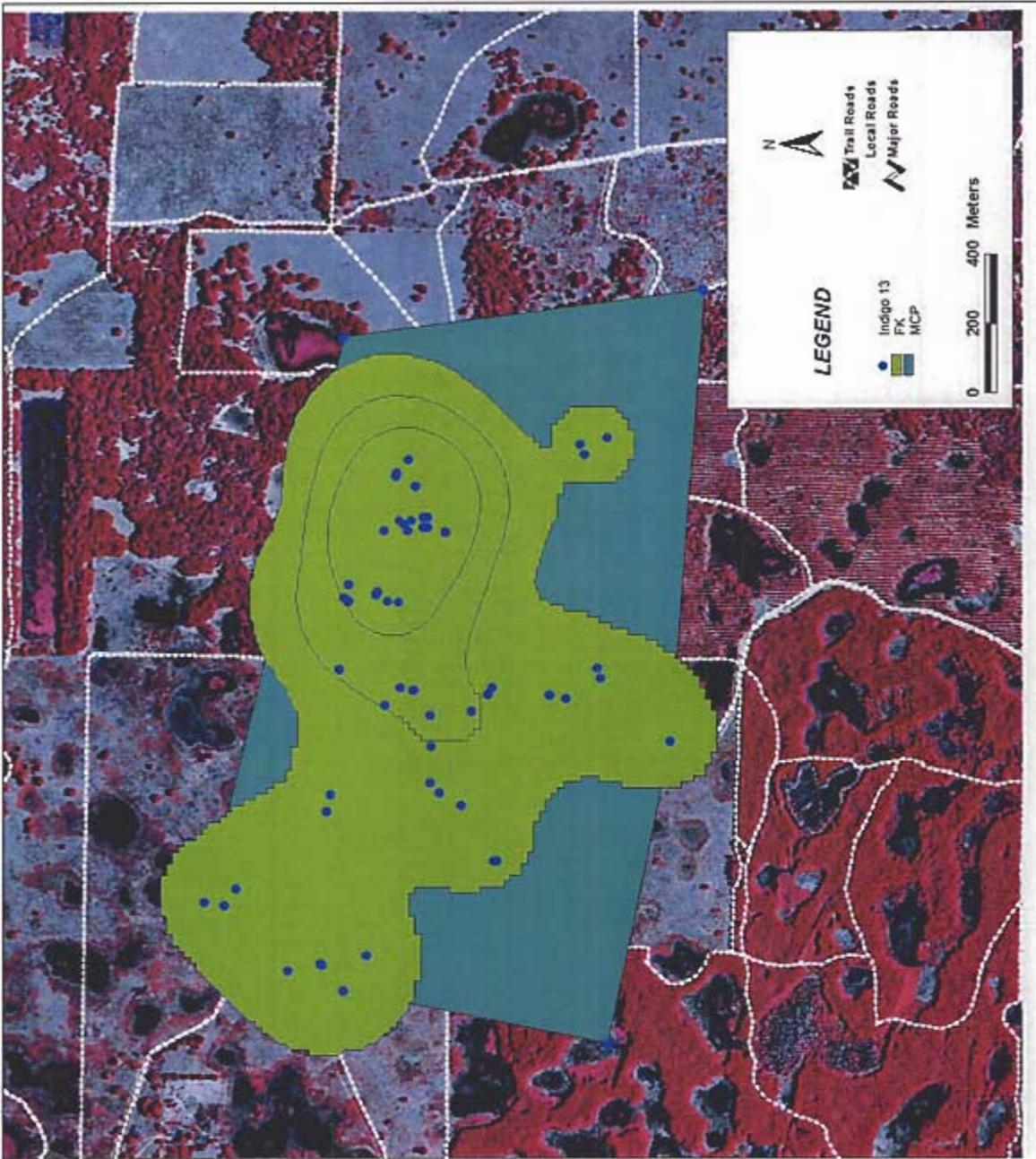
Figure 73. Home Range (FK and MCP) Polygons (Nos. 6, 15, and 16). Upper layers are FK and underlying layers are MCP. For the FK, the outer contour represents 95%-, middle contour represents 75%-, and the inner contour 50% probabilities.



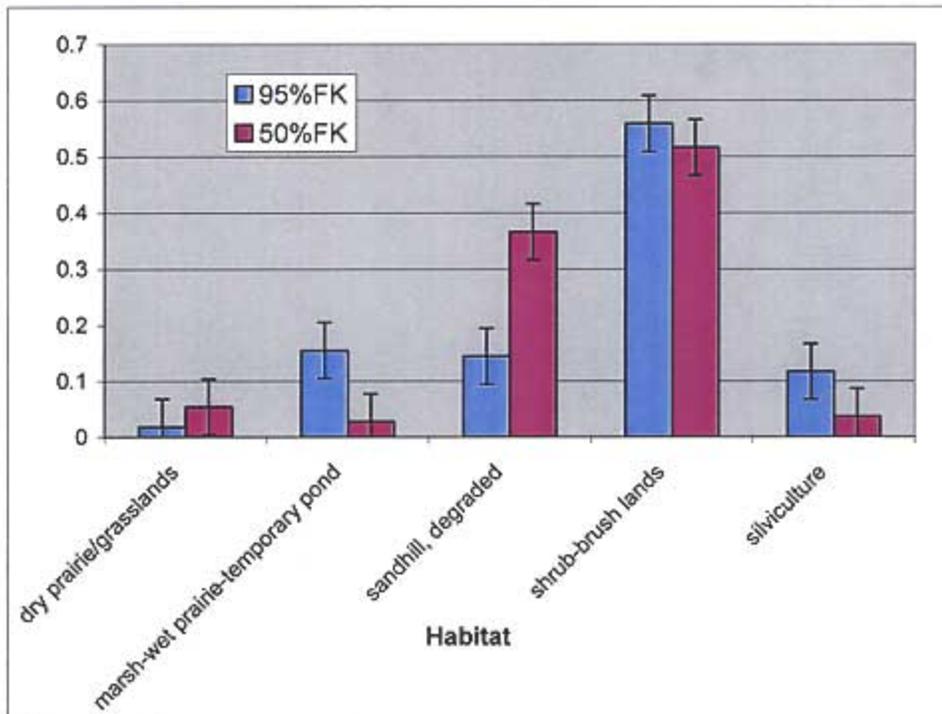
**Figure 74. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 6.** Not included in this chart were minimal amounts of the following habitat types (2% or less): silviculture.



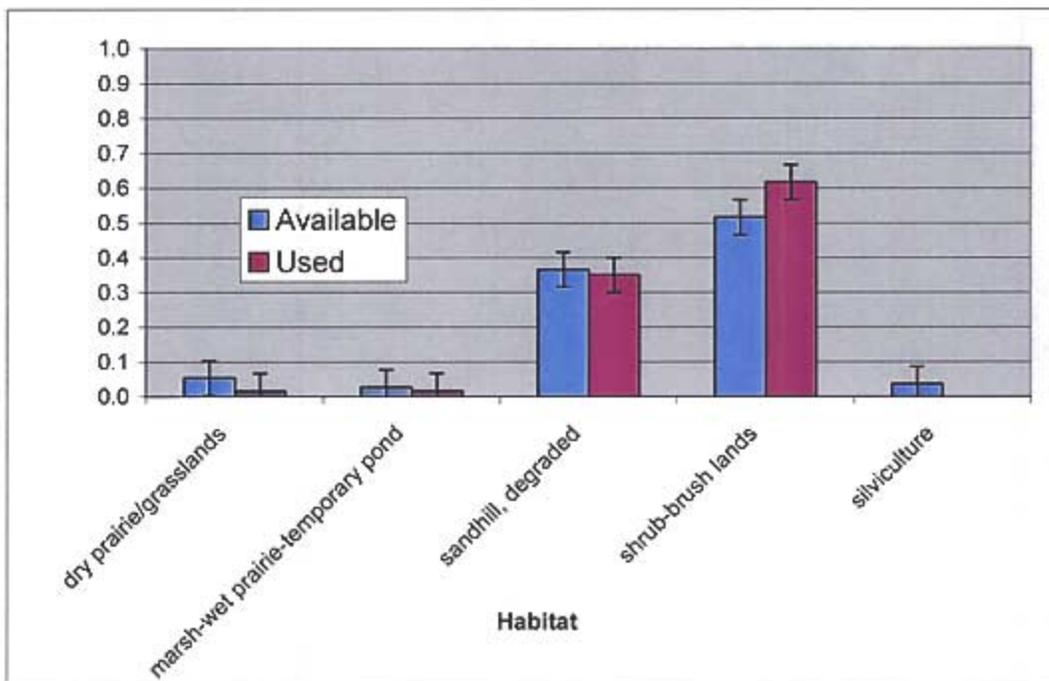
**Figure 75. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 6.**



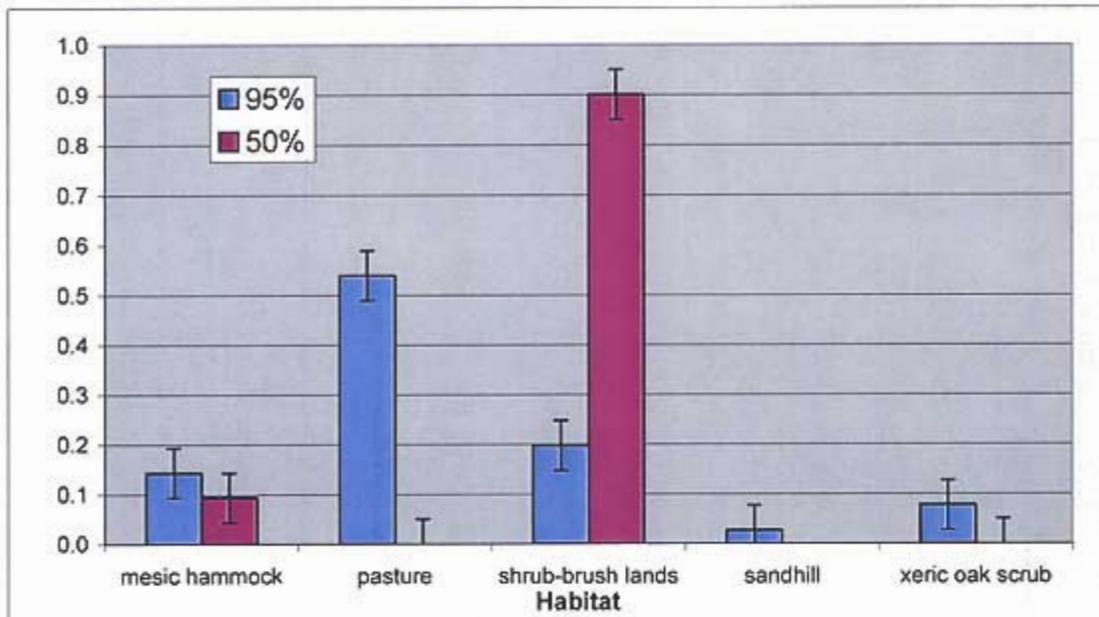
**Figure 76. Home Range (FK and MCP) Polygons (No. 13).** Upper layers are FK and underlying layers are MCP. For the FK, the outer contour represents 95%-, middle contour represents 75%-, and the inner contour 50% probabilities.



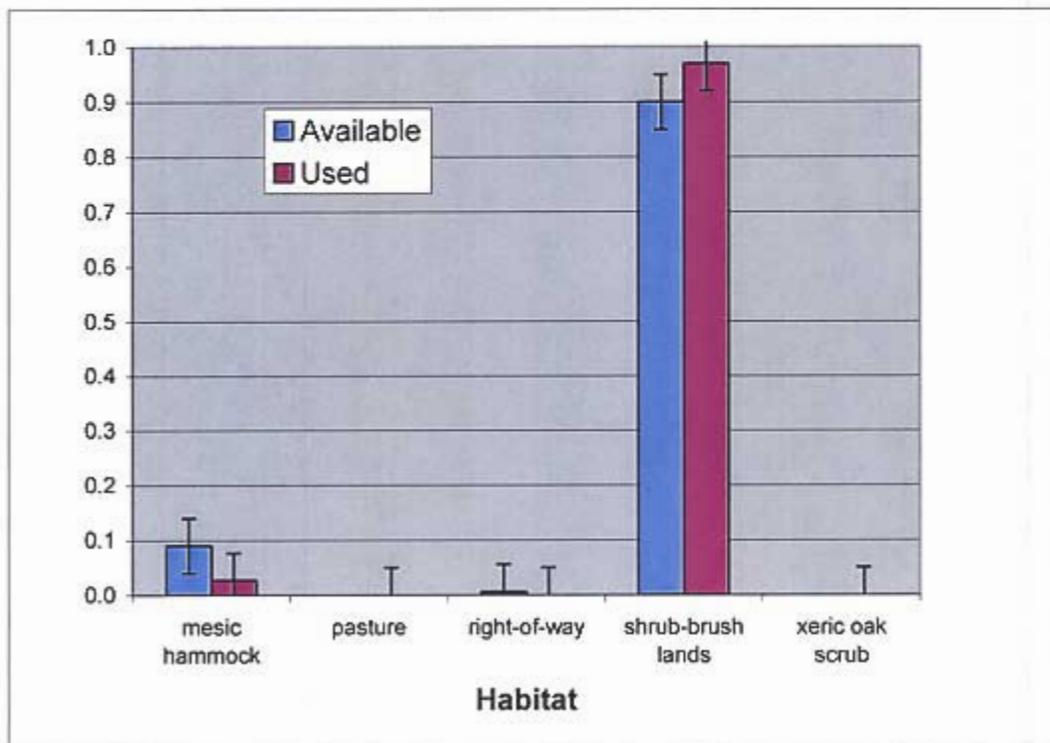
**Figure 77. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 13.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): mesic hammock and pasture.



**Figure 78. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 13.**



**Figure 79. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 15.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): dry prairie-grasslands, agriculture, and right-of-way.



**Figure 80. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 15.**

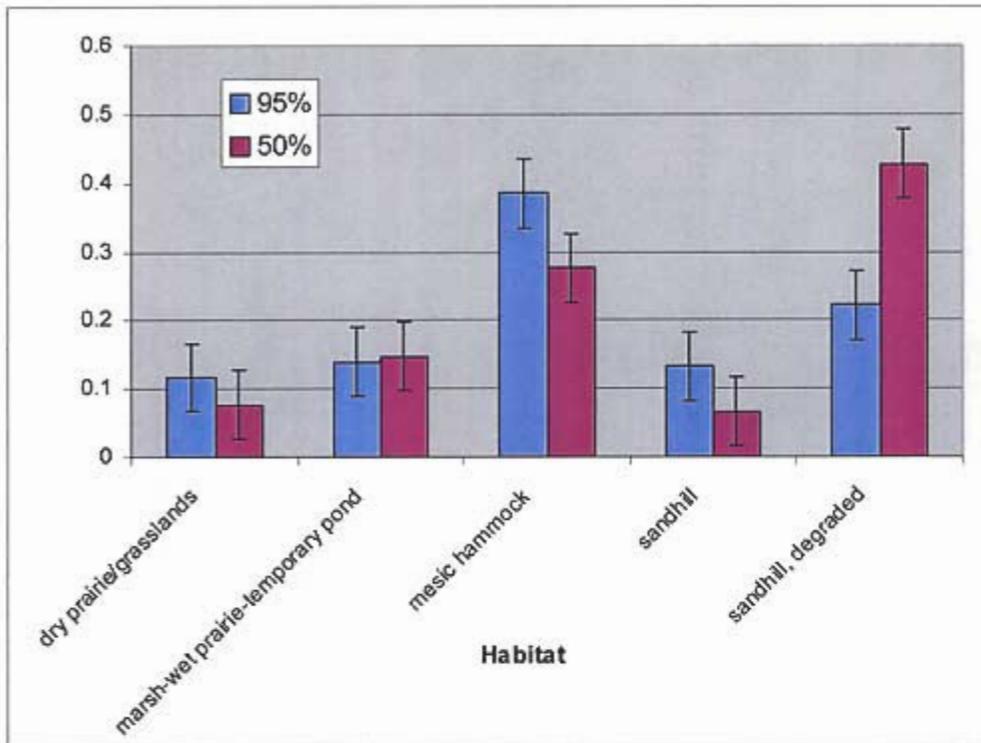


Figure 81. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 16. Not included in this chart were minimal amounts of the following habitat types (less than 1%): right-of-way.

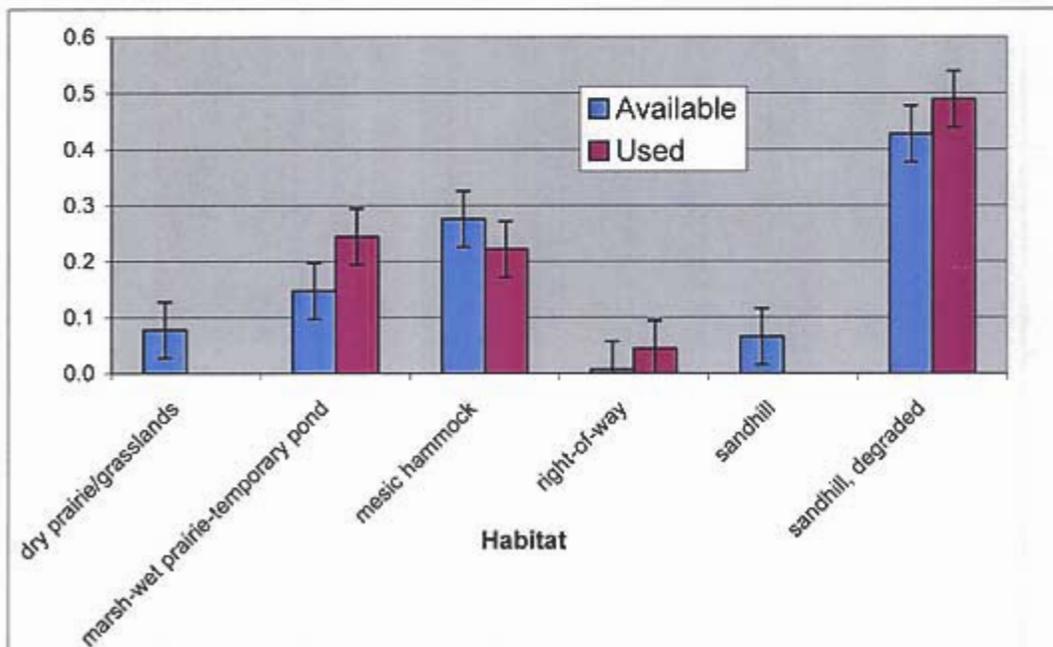


Figure 82. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 16.

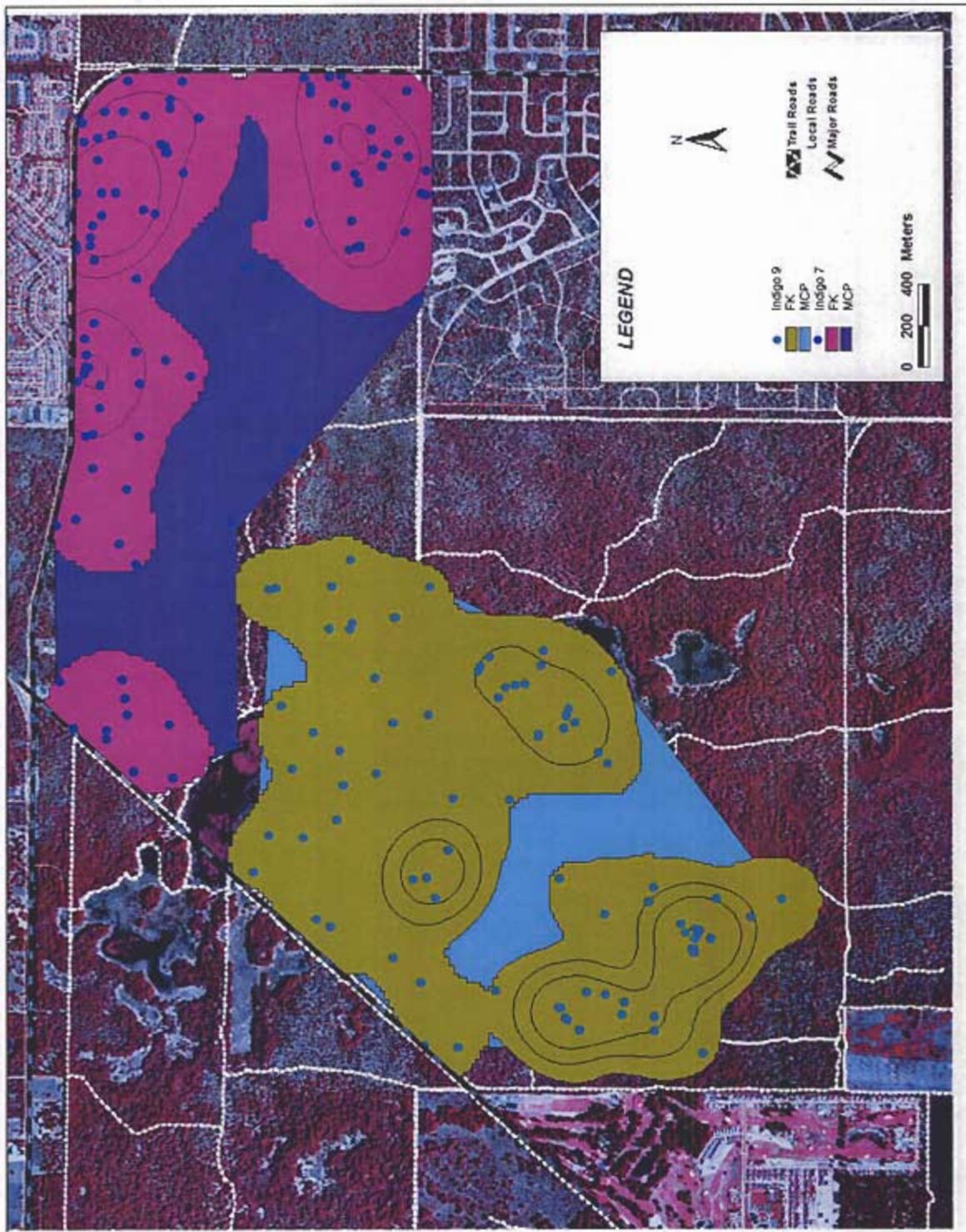
Indigo 7 was an adult male captured January 2003. It was monitored for 14 months with 151 points recorded. The 95% FK home range was 253.1 ha, and the MCP was 408.7 ha (Figure 83). Within the 95% FK home range, 46% was sandhill, 22% sandhill-degraded, 18% xeric oak shrub, 4% sand pine scrub, 3% mesic hammock, and 2% mixed pine-hardwood (Figure 84). The 50% FK core area was comprised of 62% sandhill and 38% xeric oak scrub (Figure 84). Actual use (recorded locations) indicated within the 50% FK core area was 92% sandhill and 8% xeric oak scrub (Figure 85). The transmitter of Indigo 7 failed prior to recapture (battery was rated for 18 months); it was not relocated.

Indigo 9 was an adult male captured in July 2003 and monitored for 12 months with 131 positions taken. The 95% FK home range was 401.4 ha, and the MCP was 413.2 ha (Figure 83). Habitat composition within the 95% FK home range was 34% mesic hammock, 17% sandhill-degraded, 14% sandhill, 12% dry prairie/grasslands, 10% marsh-wet prairie-temporary pond, and 10% xeric oak hammock (Figure 86). The 50% FK core area contained 46% sandhill, 27% sandhill-degraded, 21% xeric oak scrub, and 6% mesic hammock (Figure 86). Percentage of actual points recorded (observed habitat use) within the 50% FK core area was 62% sandhill, 22% xeric oak scrub, 9% sandhill-degraded, and 8% mesic hammock (Figure 87).

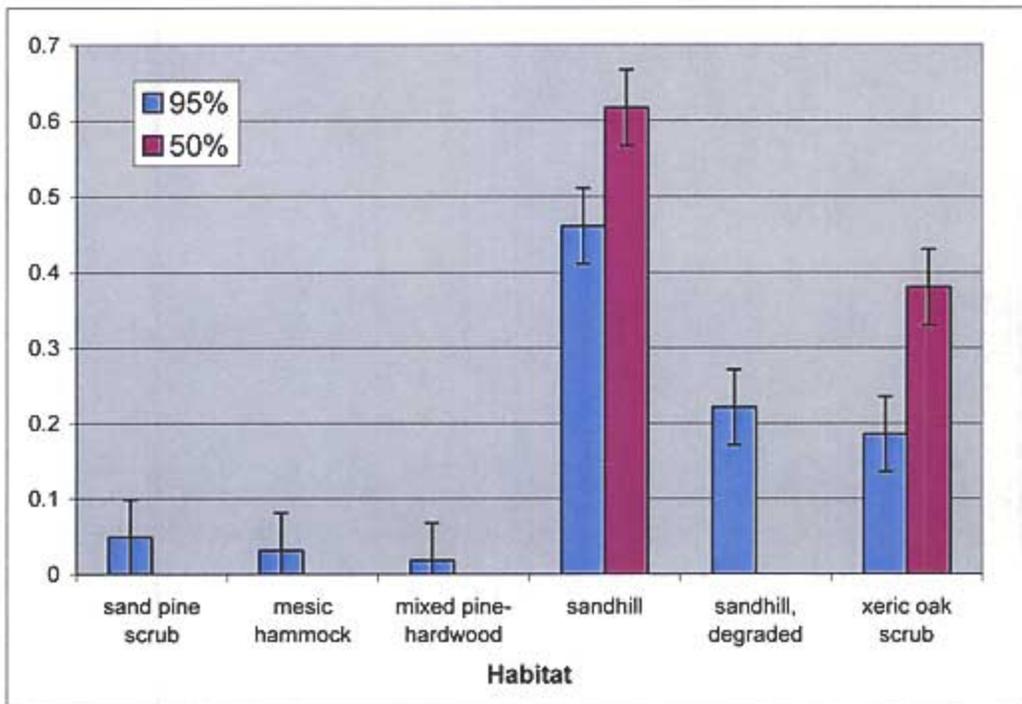
One adult Eastern coachwhip (sex undetermined) was caught in June 2002 in a right-of-way drift fence trap in the CFG. It had a snout-vent length of 116 cm and a tail length of 38 cm. The E. coachwhip was followed for 9.5 months, with a total of 15 points. The 95% FK contour was 15.1 hectares and the MCP was 8.5 hectares (Figure 88). Based on only 15 points, the actual home range is probably larger. In the 95% and 50% (in parentheses) FK contours, the habitat composition was 65% (64%) sandhill-degraded, 33% (35%) sandhill, and 2% (1%) right of way. Actual use (selection based on location of recorded points) in the 50% FK contour was 42% sandhill and 58% sandhill-degraded (Figure 89). The small number of points makes clear preferences unknown, other than its use of sandhill habitats. Telemetry ended in May 2003 when the transmitter was found on the ground; no evidence of the snake was found.

Five Eastern diamondback rattlesnakes were caught – two adult males, two females (one adult, one subadult), and one adult of undetermined sex. Morphometric averages include: weight (1,657 g), SNV length (116.1 cm), and tail length (9.3 cm). Home ranges of all rattlesnakes are shown in Figure 90.

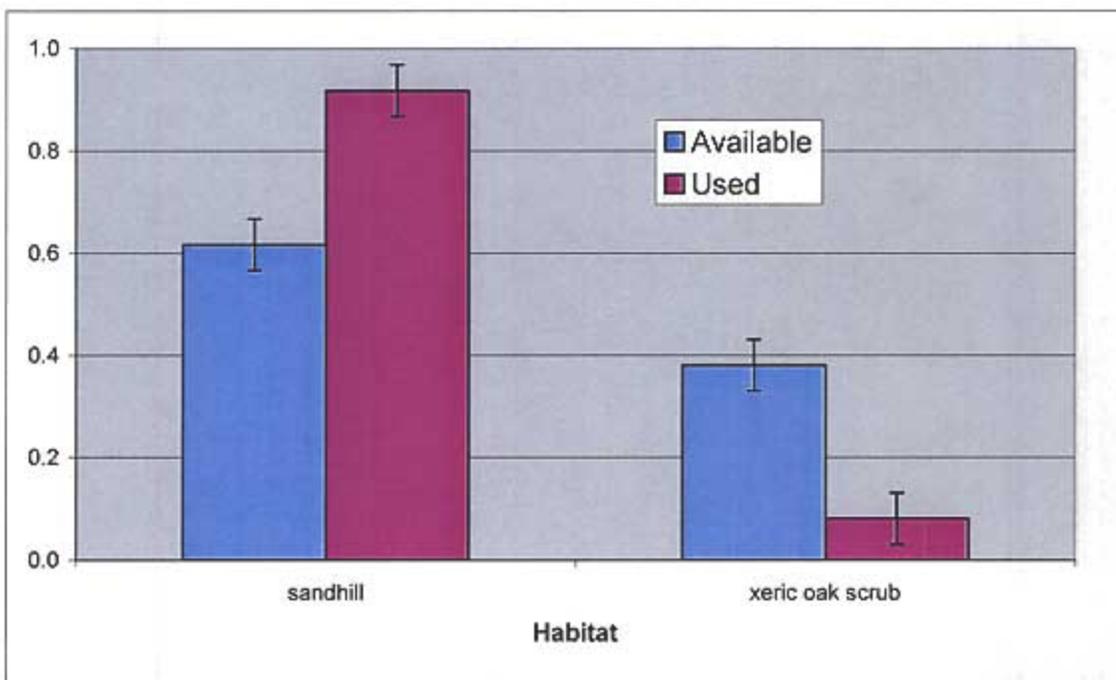
Rattlesnake 1 was captured in November 2002. It was monitored for four months, but signal strength was weak and a total of 8 points were recorded before the signal was lost entirely in March 2003. We suspect the same manufacturer defect as the cause. Rattlesnake 1 was never relocated. A home range contour was calculated simply to denote habitat use during the period it was tracked. The 95% FK contour was 7.6 ha, and MCP was 2.2 ha (Figure 90). In the 95% FK contour, the habitat consisted of 62% marsh/wet prairie-temporary pond, 31% dry prairie grasslands, 6% mesic hammock, and 1% right-of-way (Figure 91). In the 50% FK contour, marsh-wet prairie-temporary pond was the only habitat available (Figure 91). Rattlesnake 1 used dry prairie/grasslands 67% of the time and marsh-wet prairie-temporary pond 33% of the time (based on recorded locations).



**Figure 83. Home Range (FK and MCP) Polygons (Nos. 7 and 9).** Upper layers are FK and underlying layers are MCP. For the FK, the outer contour represents 95%, middle contour represents 75% and the inner contour 50% probabilities.



**Figure 84. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 7.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): built-environment and right-of-way.



**Figure 85. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 7.**

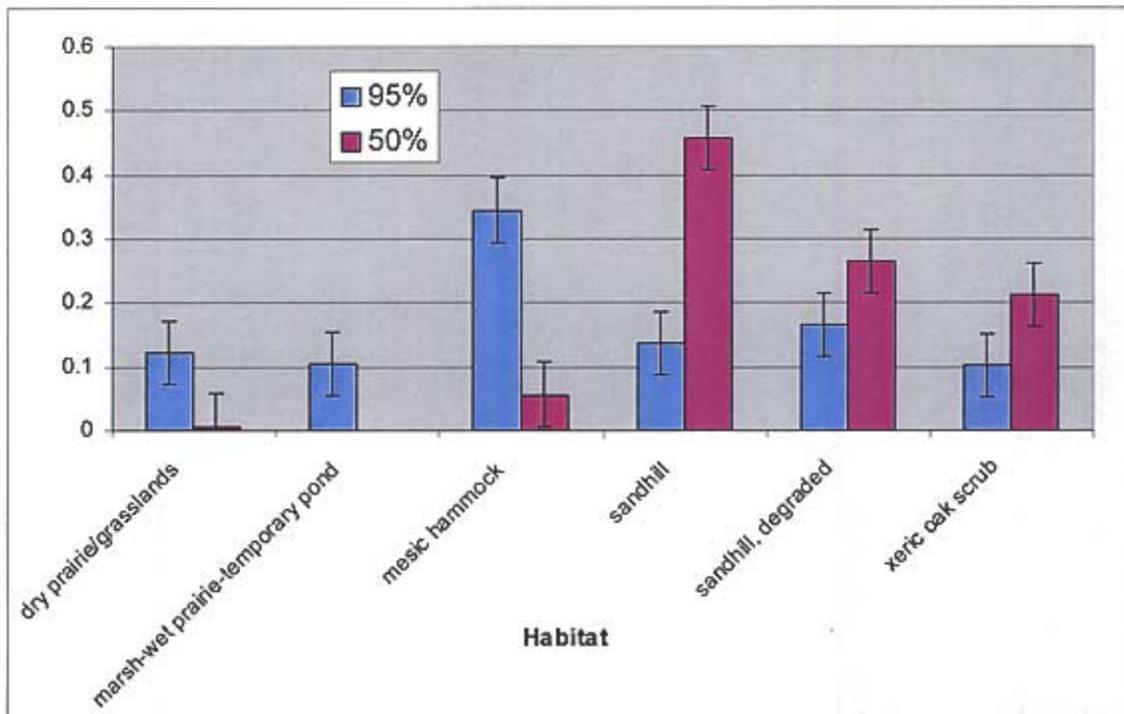


Figure 86. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Indigo 9.

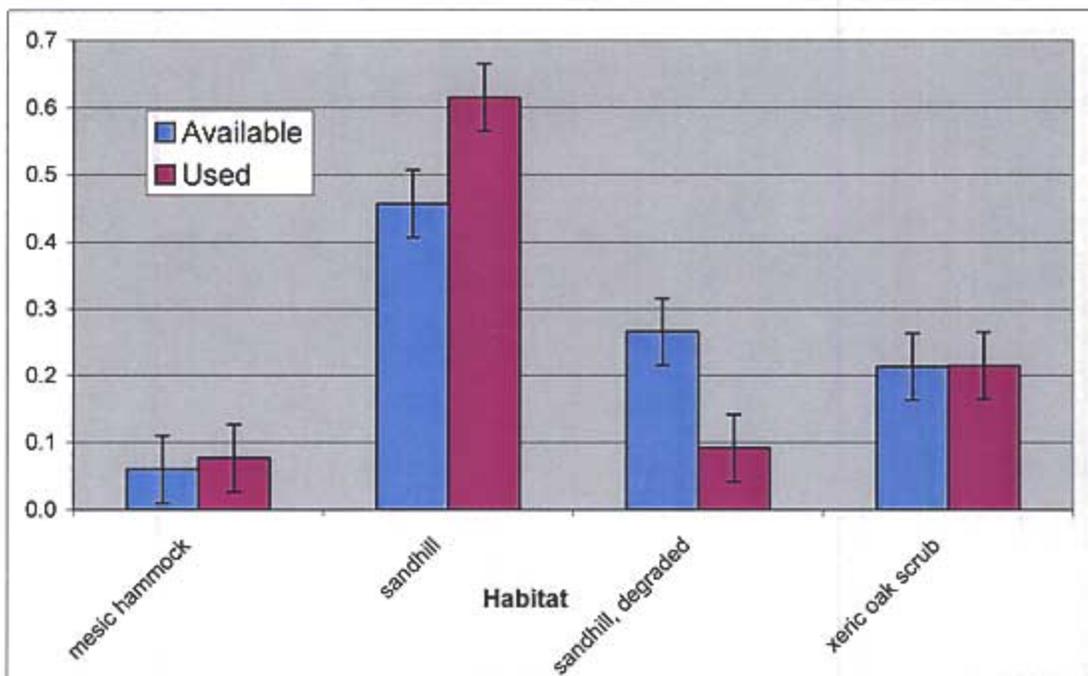
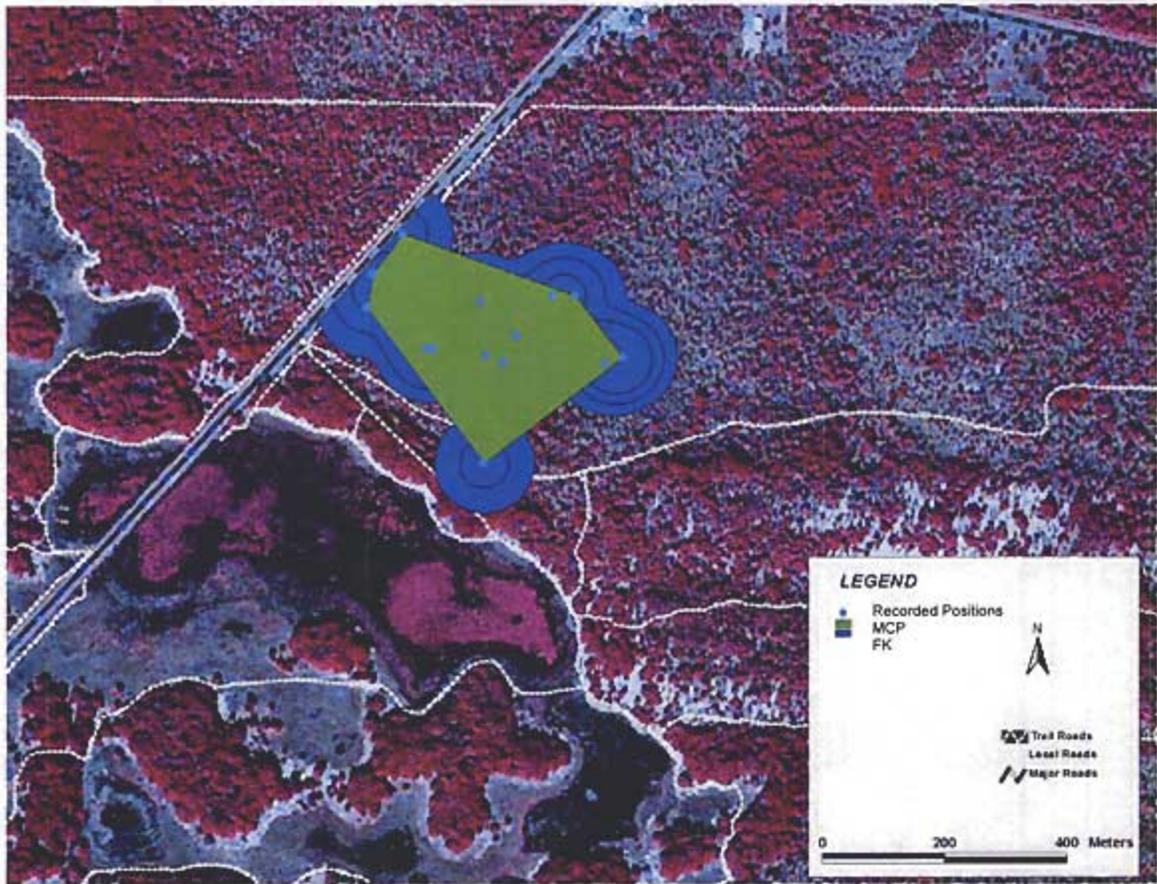
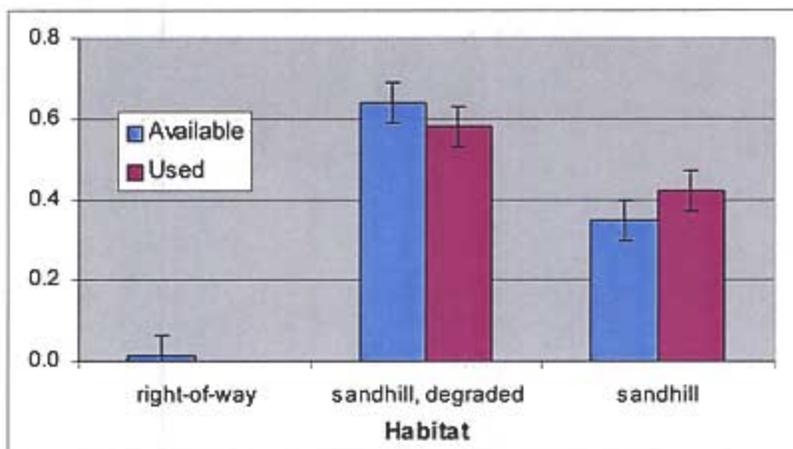


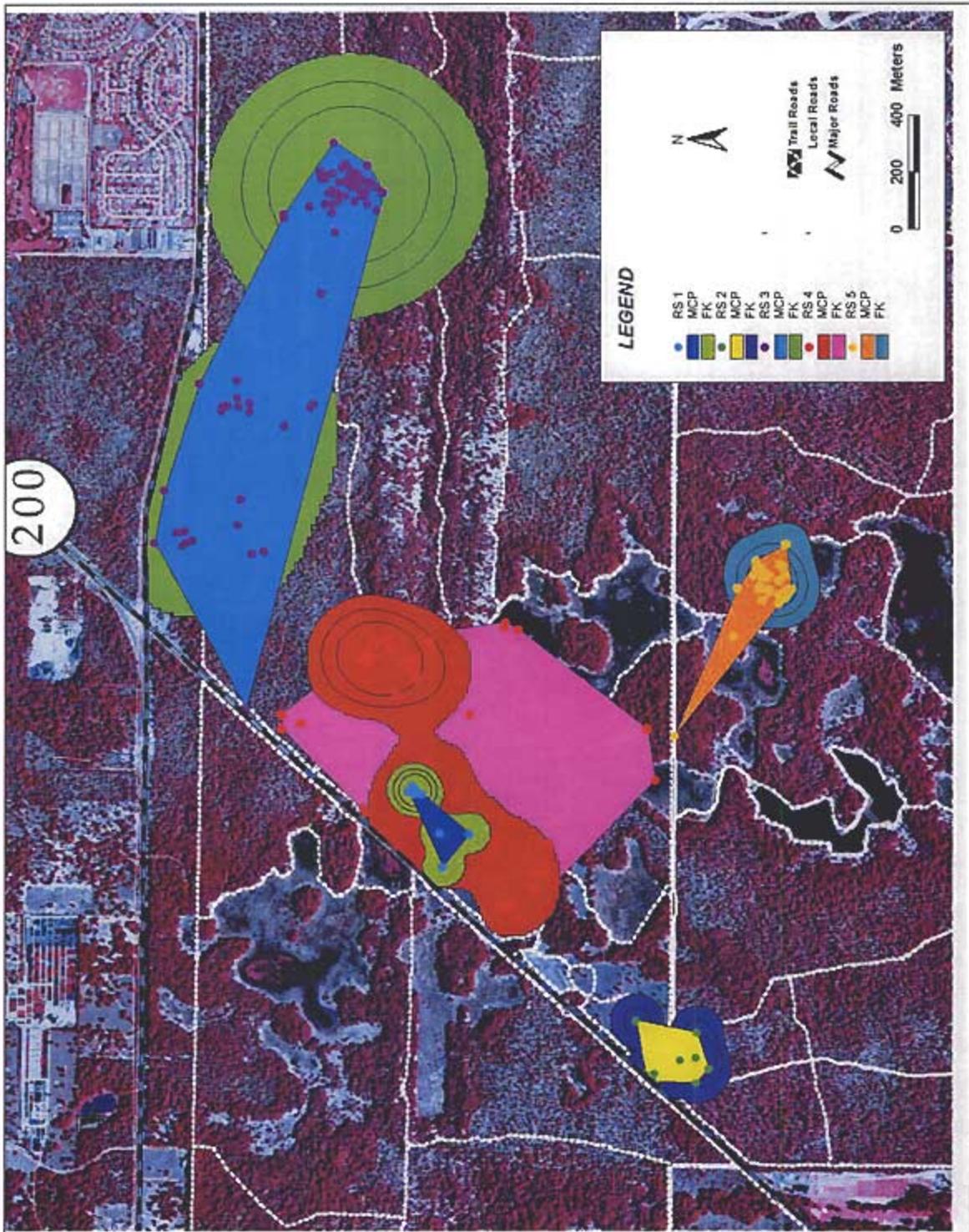
Figure 87. Percent Composition of Actual Habitat Used vs. Available Habitat for Indigo 9.



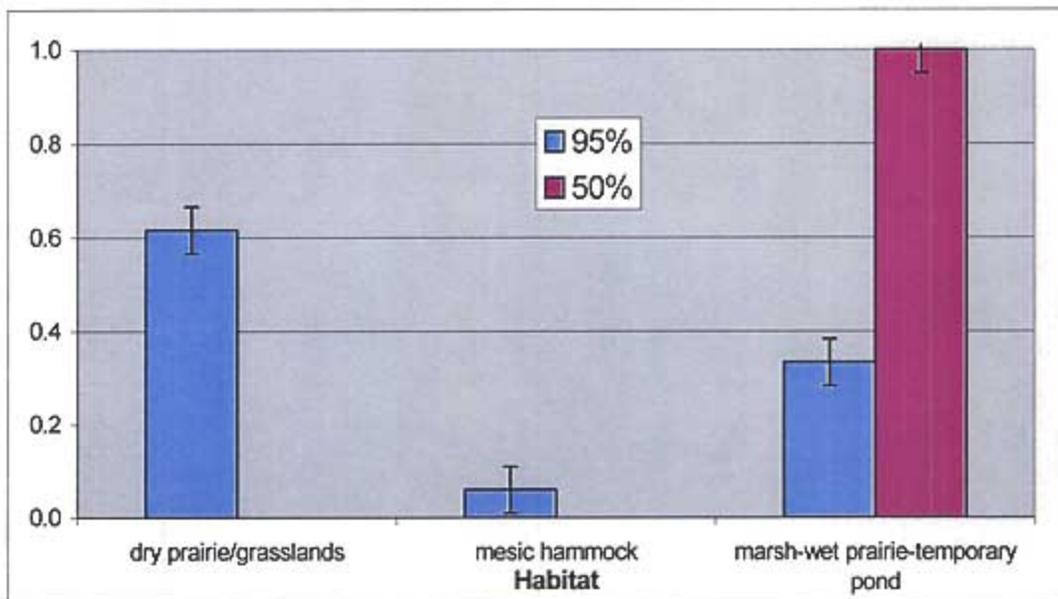
**Figure 88. Eastern Coachwhip Potential Home Range (FK and MCP) Polygons.** Upper layer is MCP and underlying layer is FK. For the FK, the outer contour represents 95%, middle contour represents 75% and the inner contour 50% probabilities.



**Figure 89. Percent Composition of Actual Habitat Used vs. Available Habitat for E. Coachwhip.**



**Figure 90. Eastern Diamondback Rattlesnake Home Range (FK and MCP) Polygons.** Upper layers are MCP and underlying layers are FK. For the FK, the outer contour represents 95%, middle contour represents 75% and the inner contour 50% probabilities.



**Figure 91. Percent Habitat Composition in 95% and 50% FK Contours for Rattlesnake 1.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): right-of-way.

Rattlesnake 2 was a sub-adult female caught in June 2003 and monitored for slightly over one month, with a total of fifteen points taken. Rattlesnake 2 was found dead in July 2003; its head was missing, most likely cut off by right-of-way utility workers in the area. The 95% FK contour was 15 ha and the MCP was 4 ha (Figure 90). Within the 95% FK contour, the habitat consisted of 34% sandhill-degraded, 24% shrub-brush lands, 23% sandhill, 6% mesic hammock, 5% pasture, 4% mixed pine-hardwood, 3% built-environment, and 1% right-of-way (Figure 92). The habitat composition in the 50% FK contour was 78% sandhill-degraded, 8% shrub-brush lands, 8% mesic hammock, 4% mixed pine-hardwood, and 1% right-of-way (Figure 92). Recorded locations (documented habitat use) within the 50% FK contour were in sandhill-degraded (50%), shrub-brush lands (33%), and mixed pine-hardwood (8%). Shrub-brush lands and mixed pine-hardwood were used more extensively than available therefore some preference for that habitat occurred.

Rattlesnake 3, an adult male caught in August 2003, was monitored for 14 months with a total of 168 points taken. The 95% FK home range was 124.7 ha, and the MCP was 68.8 ha (Figure 90). Within the 95% FK home range the habitat was a mixture of sandhill-degraded (25%), sandhill (22%), xeric oak shrub (19%), mesic hammock (18%), and sand pine scrub (13%) (Figure 93). The 50% FK core area was comprised of 44% sand pine scrub, 33% sandhill-degraded, 21% mesic hammock, 2% xeric oak scrub, and 1% sandhill (Figure 93). Actual use within the 50% core area was 91% sandhill-degraded, and 9% sand pine scrub, showing a preference for sandhill-degraded. Last contact date was 10/22/04.

Rattlesnake 4 was an adult male captured in September 2003, and monitored for 12 months with a total of 138 points recorded. The 95% FK home range was 47.9 ha and the MCP was 81.1 ha (Figure 90). The 95% FK home range consisted of 36% marsh-wet prairie-temporary pond, 26% sandhill-degraded, 16% dry prairie/grasslands, 15% mesic hammock, 6% sandhill, and 1% right-of-way (Figure 94). Within the 50% FK core area, 85% was sandhill-degraded, 11% sandhill, and 4% marsh-wet prairie-temporary pond (Figure 94). Actual points recorded within the 50% FK core area were found in sandhill-degraded (94%) and marsh-wet prairie-temporary pond (6%), consistent with available habitat.

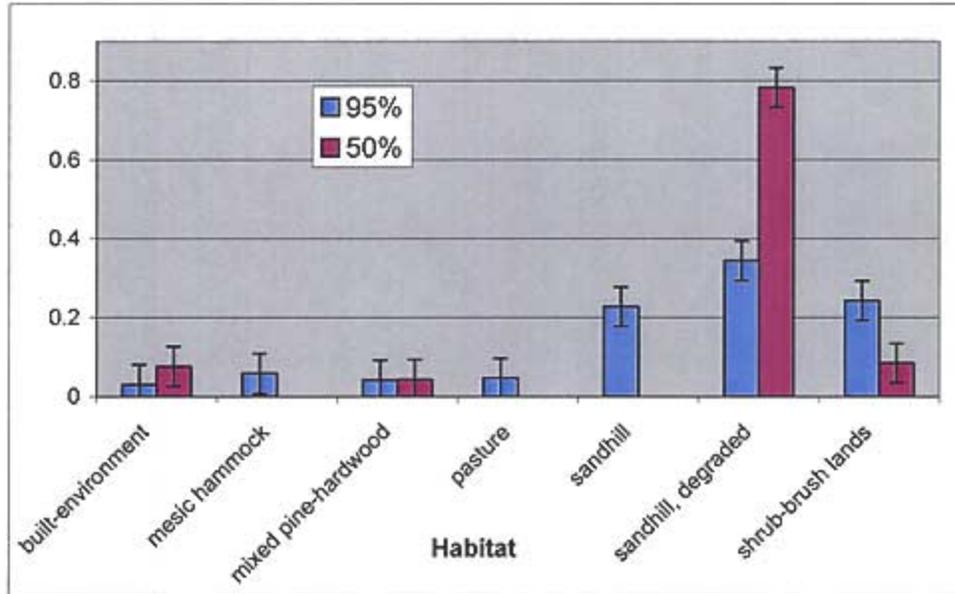


Figure 92. Percent Habitat Composition in 95% and 50% FK Contours for Rattlesnake 2.

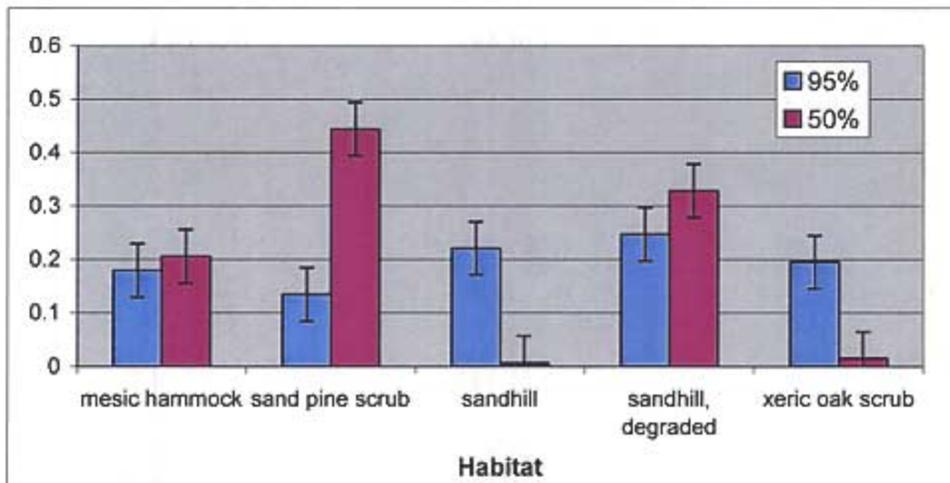
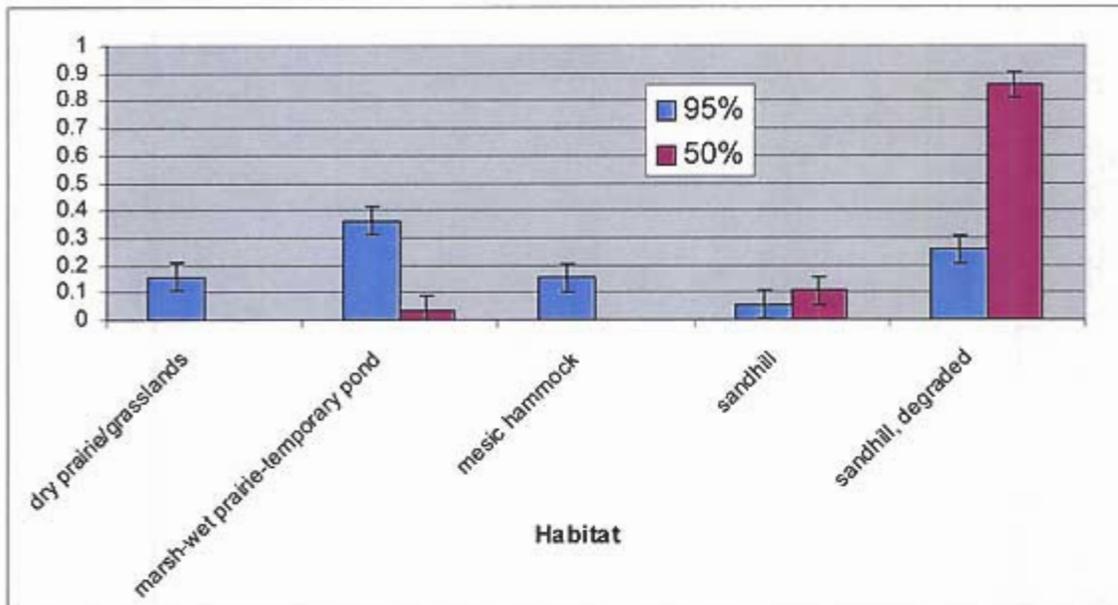
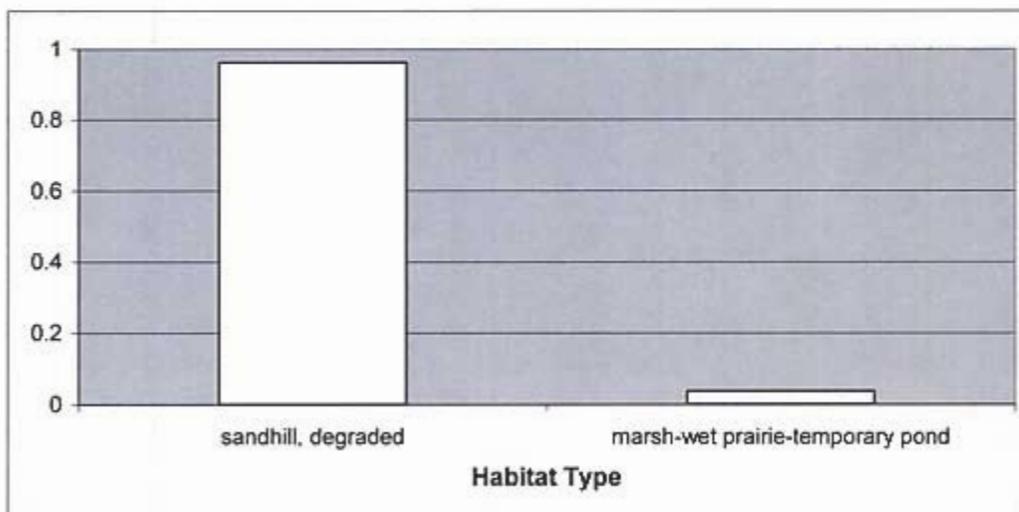


Figure 93. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Rattlesnake 3. Not included in this chart were minimal amounts of the following habitat types (less than 1%): residential-rural, xeric oak scrub, and right of way.

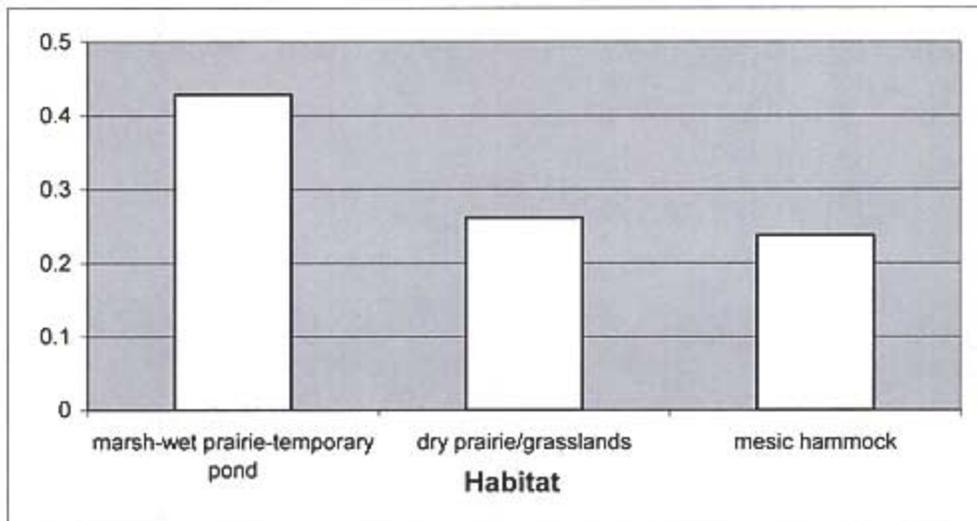


**Figure 94. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Rattlesnake 4.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): right of way.

Rattlesnake 4 had two separate home ranges based on the season. Dividing the seasons into two (warm season = June 1 to Oct 31 and cool season = Nov 1 to March 31) rattlesnake 4 used 96% sandhill-degraded and 4% marsh-wet prairie-temporary pond habitats during the warm season (Figure 95). In the cool season (Figure 96), it used marsh-wet prairie-temporary pond (43%), mesic hammock (24%), dry prairie/grasslands (26%), and sandhill-degraded (5%). Rainfall was considerably higher in the warm (46.29 in) vs. cool season (19.94) corresponding to flooding in the marshes.

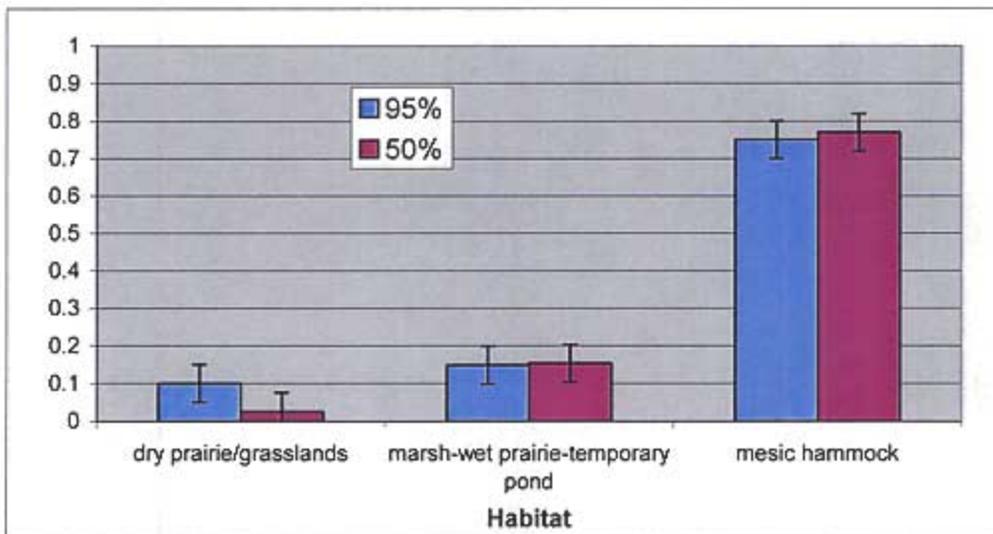


**Figure 95. Habitat Selection by Rattlesnake 4 in Warm Seasons, 2003.**



**Figure 96. Habitat Selection by Rattlesnake 4 in Cool Seasons, 2003.**

Rattlesnake 5 was a female caught in October 2003. A total of 46 points were recorded over three months. The 95% FK home range was 10.5 ha and the MCH was 6.6 ha (Figure 90). The 95% FK home range area consisted of 75% mesic hammock, 15% marsh-wet-prairie-temporary pond, and 10% dry prairie/grasslands (Figure 97). Habitat occurring in the 50% FK core area included 77% mesic hammock, 14% marsh-wet prairie-temporary pond, and 9% dry prairie/grasslands (Figure 97). Actual locations recorded within the 50% core area occurred in mesic hammock (82%), marsh-wet prairie-temporary pond (15%), and dry prairie/grasslands (3%). Rattlesnake 5 was found dead in January 2004. Though the cause was not determined, it appeared to have been trampled by an ungulate.



**Figure 97. Percent Habitat Composition in 95% and 50% FK Contours for Rattlesnake 5.**

## Carnivores

Certain focal (or representative) species were chosen from each taxon to perform intensive monitoring studies to determine abundance or density, habitat use and preference, and movement patterns. Through these factors, direct and indirect impacts of the road could be estimated. For carnivores, the focal species chosen were bobcat and gray fox; coyote was added once their high densities became apparent through trapping and survey efforts. Besides general observations, specific tasks performed included road-kill, track, culvert and radio-telemetry monitoring. Results of culvert monitoring are presented in that section, the other activities are presented below.

**Road-kill.** Surveys were conducted five days per week on SR 200 from April 2002 to April 2004 (except mid-December 2002 to mid-January 2003 and April 2003). Specific cruising schedules were not followed for CR 484; if a road-kill was sighted while driving on CR 484 it was recorded. Eighteen carnivores were found killed by collisions with motor vehicles, not quite one per month (0.82) for the 22 months checked (Figure 98). This included 5 bobcats: 2 male, 2 female, and 1 of unknown sex. Five coyotes were killed, 2 females, one lactating and another post-lactating female, and 3 of unknown gender. Eight gray foxes were killed, 1 male and 7 of unknown sex. No red foxes were found. All road-kills recorded can be found in Appendix D.

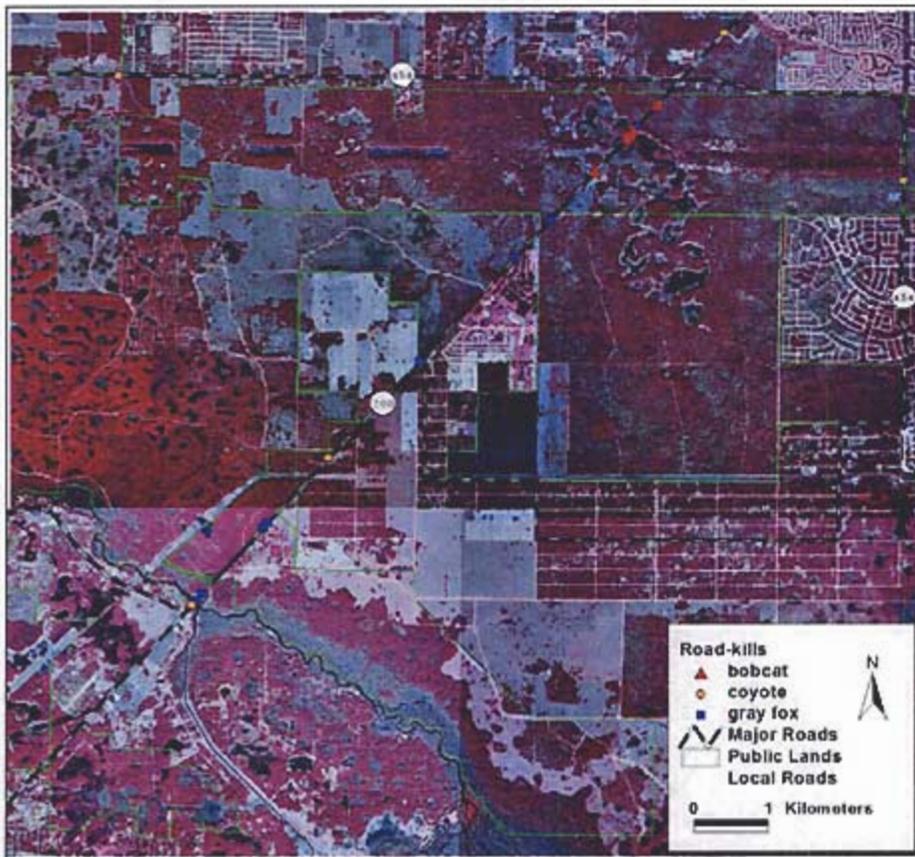


Figure 98. Location of Carnivore Road-kills Documented from August 2001 to April 2004.

Fifteen of these were found on SR 200 between CR 484 and the Withlacoochee River. Two coyotes were found on CR 484 along the perimeter of the CFG. Another coyote was killed just northeast of the SR 200 and CR 484 intersection. Four gray foxes and one coyote were found just northeast of the Withlacoochee River adjacent to the Gum Slough conservation easement and proposed connection to the HTP. Figure 99 shows an inset of the HTP, CFG and RPSF where most carnivores were killed. All bobcat road-kills were recorded in SR 200 (100 m) partition nos. 5-17, in the contiguous section of the CFG bisected by SR 200. Three of these were within the basin. Two of the five road-killed bobcats were subjects in the radio-telemetry study. Four gray fox road-kills are also shown in Figure 99. Two of these were found adjacent to the HTP and golf course community, the other two adjacent to the CFG and RPSF.



**Figure 99. Inset of Carnivore Road-kills in the Partitioned Portion of the SR 200 Study Area.** Road partitions are 100 m wide sections.

Large carnivore road-kills were combined with ungulate road-kills to perform a Kruskal-Wallis test for location preference for large mammals by land-use jurisdiction and land cover. Both variables were significant in determining the location of large mammal road-kills (land-use:  $\chi^2 = 11.19$ ,  $p = 0.05$ ; land cover:  $\chi^2 = 24.92$ ,  $p = 0.04$ ). Fifteen of 18 carnivores were found adjacent to public lands. Of 21 land cover types, all but two carnivore road-kills were found adjacent to one of four types: sandhill, oak scrub, mesic hammock, or wet prairie.

Figure 100 displays the months when each carnivore road-kill was found. Bobcats were found only in cooler months. Canids were killed on roads throughout all seasons. Three of the gray foxes were recorded prior to our continuous monitoring of the road for road-kills. Two of the gray foxes were recorded during our first visit to the field site in November 2001; another gray fox was recorded by DOF staff in August 2001.

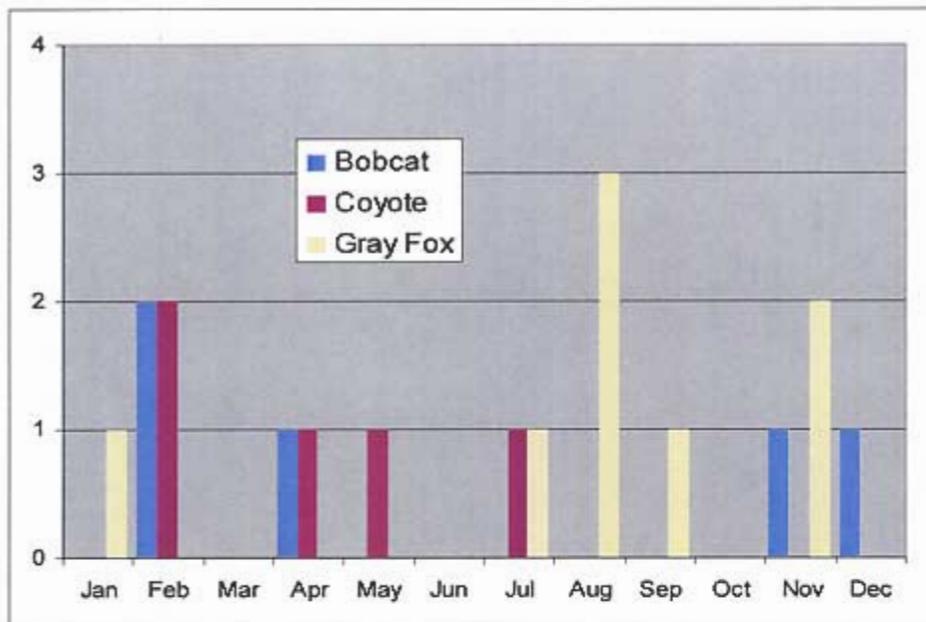


Figure 100. Road Mortality by Month of Carnivores, August 2001 to April 2004 (n=18).

**Tracks.** Tracks were monitored on firebreaks on both sides of SR 200 from CR 484 to the main entrance to the HTP. This task was executed once or twice weekly from September 2002 to April 2004 (except November 2002 – February 2003, and April and September 2003). We recorded 481 sets of tracks from bobcats, coyotes and foxes. This included 12 sets of bobcat tracks, 20 sets of fox tracks, 431 sets of coyote tracks, and 18 sets of coyote or fox tracks.

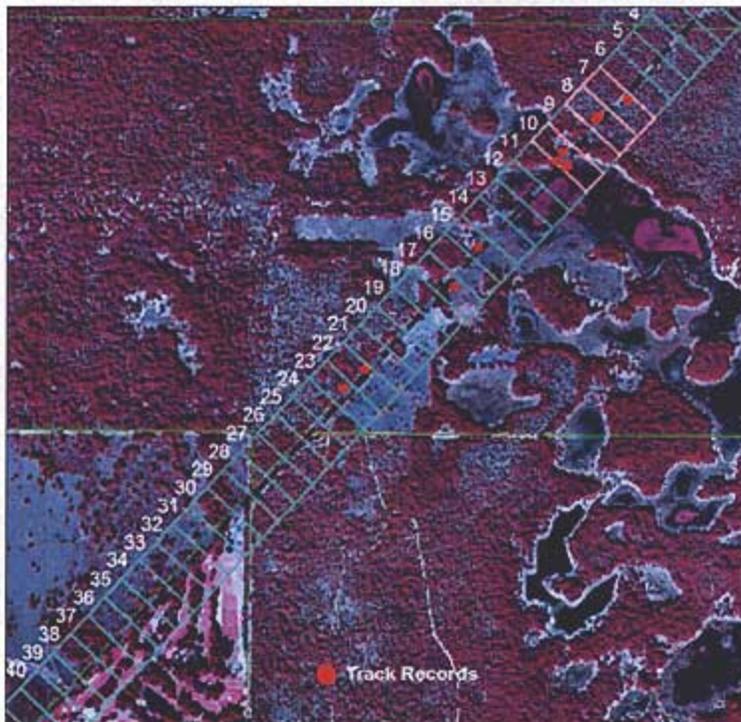
Kruskal-Wallis was used to test significance of land-use jurisdiction and land cover type. Both variables were significant in determining the location of carnivore tracks (land-use:  $\chi^2 = 10.78$ ,  $p = 0.001$ ; land cover:  $\chi^2 = 23.52$ ,  $p = 0.003$ ). Ninety-five percent of tracks were found adjacent to public lands. Of 21 land cover types, all but eighteen sets of carnivore tracks were found adjacent to one of three types: sandhill, mesic hammock, or wet prairie.

From 481 sets of tracks, we were only able to confirm 65 animal crossing events. Several factors contributed to this lack of ability even though direction of travel was perpendicular to the road. First, track paths should be positioned adjacent to the pavement; only animals that intend to cross the road would approach that closely. Worker safety dictated the use of firebreaks along the outer edge of the right-of-way. Second, wildlife do not consistently move in straight lines, travel direction is random; therefore if an animal turns or crosses at an angle the tracks would not be directly across from each other. Third, consistency of the substrate was such that some sections

were unreadable. This included shaded sections where a significant amount of leaves persist (e.g., under hardwood hammocks) and flooded sections (e.g., within the Ross Prairie wetland) not suitable for tracks. Fourth, a small section was fenced near the campground such that we could no longer access the area. Fifth, we were unable to discern aborted crossing attempts; those instances when animals crossed the firebreak only to return without crossing the road. Because of these reasons the track data provides spatial information on activity levels of each species. From this data, the likelihood of crossing events at a given location can be predicted.

Location of bobcat tracks is shown in Figure 101. Two actual crossings were detected from tracks and one crossing was witnessed; these are denoted in Figure 101 by the highlighted partitions (nos. 7, 8, and 10). All tracks were found in and around the Ross Prairie basin. These tracks are similarly found in the same locations as the bobcat road-kills shown in Figure 99. This would indicate that these are common travel paths for bobcats moving through this area. Again, as was found with the road-kills, tracks were found in cool weather months. All but one set of tracks occurred between October and February.

Fox track locations are displayed in Figure 102. We were unable to distinguish between those tracks left by red or gray foxes. Both species were present in the area as we captured individuals of each as part of the telemetry study. All but three sets of tracks were recorded between road partitions 3 and 10. Based on this data, the northern section of the CFG, above the basin, is a preferred crossing site to those areas south of the basin. Seasonally, six sets of tracks were recorded between June and August; fourteen sets were recorded between October and February.



**Figure 101. Bobcat Track Locations, September 2002 to April 2004.** Road partitions are 100 m wide sections. Crossings were recorded in partition nos. 7, 8, and 10.

Some coyote and fox tracks were indistinguishable because of size. We captured one juvenile coyote and observed many others so there were small individuals that left a similar track to that of a fox. Of this type we recorded 18 sets; with one documented crossing. Location of these is shown in Figure 103. Significant clusters are apparent at the northern section of the CFG (road partitions 4-9) and where the CFG and RPSF are contiguous at SR 200 (road partitions 27 and 28). All of these tracks were recorded in the months of January and October to December.

The majority of carnivore tracks recorded were of coyotes. Coyotes commonly were observed using the firebreaks as travel paths. Therefore, the number of tracks is not surprising. Spatial arrangement of coyote tracks along SR 200 is shown in Figure 104. Crossings were recorded in partition nos. 3 (n=4), 4 (n=9), 5 (n=5), 6 (n=5), 7 (n=11), 8 (n=5), 9 (n=2), 10 (n=2), 14 (n=1), 15 (n=4), 16 (n=1), 17 (n=1), 18 (n=1), 19 (n=1), 20 (n=1), 23 (n=1), 24 (n=1), 27 (n=1), 28 (n=4), 29 (n=2), and 30 (n=1). Coyotes are strongly represented in all road partitions between the north and south boundary of the CFG except those where tracks could not be read (Partition nos. 12, 13, 18, east side 21 and 22, west side 27 and 28). Tracks are sparser in the HTP across from the golf course. Monthly distribution of coyote tracks is shown in Figure 105. Despite the months when track monitoring was not conducted, there still appears to be more movement in the cooler months.

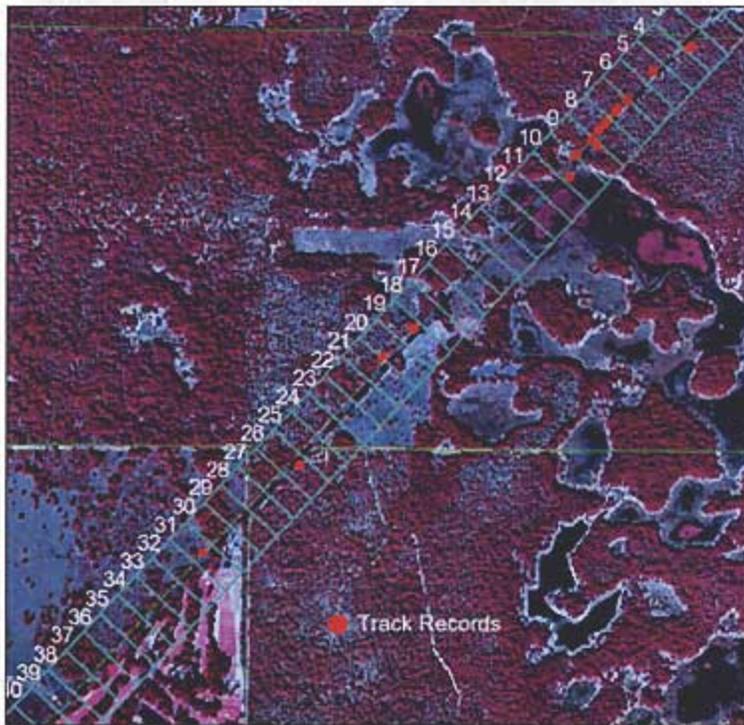
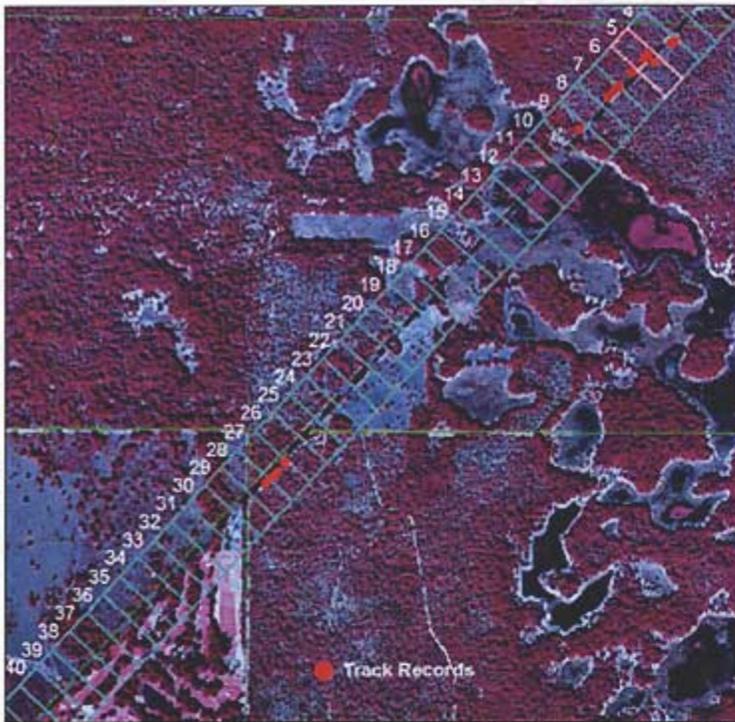


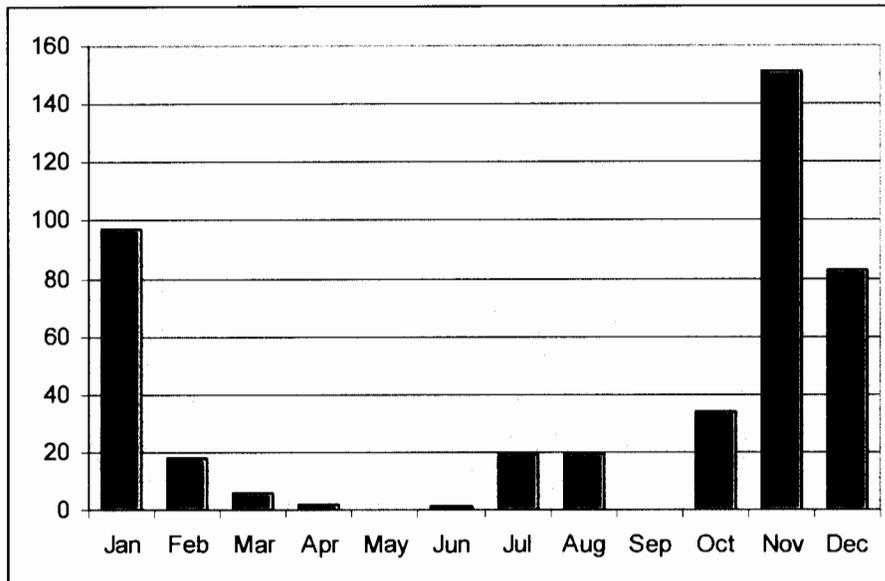
Figure 102. Fox Track Locations, September 2002 to April 2004. Road Partitions are 100 m wide.



**Figure 103. Coyote/Fox Track Locations, September 2002 to April 2004.** Road Partitions are 100 m wide. One crossing was recorded in partition no. 5.



**Figure 104. Coyote Track Locations, September 2002 to April 2004.** Road Partitions are 100 m wide. Crossings were recorded in partition nos. 3-10, 14-20, 23-24, and 27-30.



**Figure 105. Coyote Track Records by Month, September 2002 to April 2004 (n=431).** Tracks were not monitored in November-December 2002 and January-February, April, and September 2003.

**Culvert Use.** The two existing structures monitored for tracks included a concrete box culvert and a concrete pipe culvert. The first culvert, located in the center of the Ross Prairie wetland basin was 1.2 m wide x 1.7 m high x 24 m long; the second culvert, located between the Spruce Creek Golf Club and the HTP was 0.77 m in diameter and 24.9 m long. These were checked twice weekly from December 2002 to February 2004. The prairie culvert was flooded out from March 2003 to February 2004. The golf course site was only flooded on six occasions, whereas the prairie site was flooded for 94 of 110 visits (85%), preventing our ability to read tracks and precluding use by many terrestrial-based organisms. Bobcats and coyotes were recorded using both culverts (one individual of each species at each site).

**Telemetry.** We captured coyotes and bobcats in traps placed along trails and roadsides. Once immobilized, each individual captured was outfitted with a radio collar, ear-tagged, weighed, sexed and measured. Trapping efforts resulted in the capture of 5 bobcats (2 males and 3 females), 3 coyotes (2 females and 1 male), 1 red fox (male) and 1 gray fox (female). Capture locations are shown in Figure 106. One of the male coyotes (a juvenile) was released without a collar due to its small size. One female bobcat was struck and killed by a car the next night after its release.

Trapping was conducted from June 2002 to January 2003; 7 box traps were set each night, and generally left in the same location for 2-3 weeks unless a target animal was captured or if nontarget animals were frequently captured. The number (usually 2-4) of leghold traps set each week varied depending on weather. These were usually left open for a maximum of 2-3 three days straight or until a capture occurred. When an animal (target or nontarget) was captured the traps normally would be moved to a different site because of return visits by the same animal.

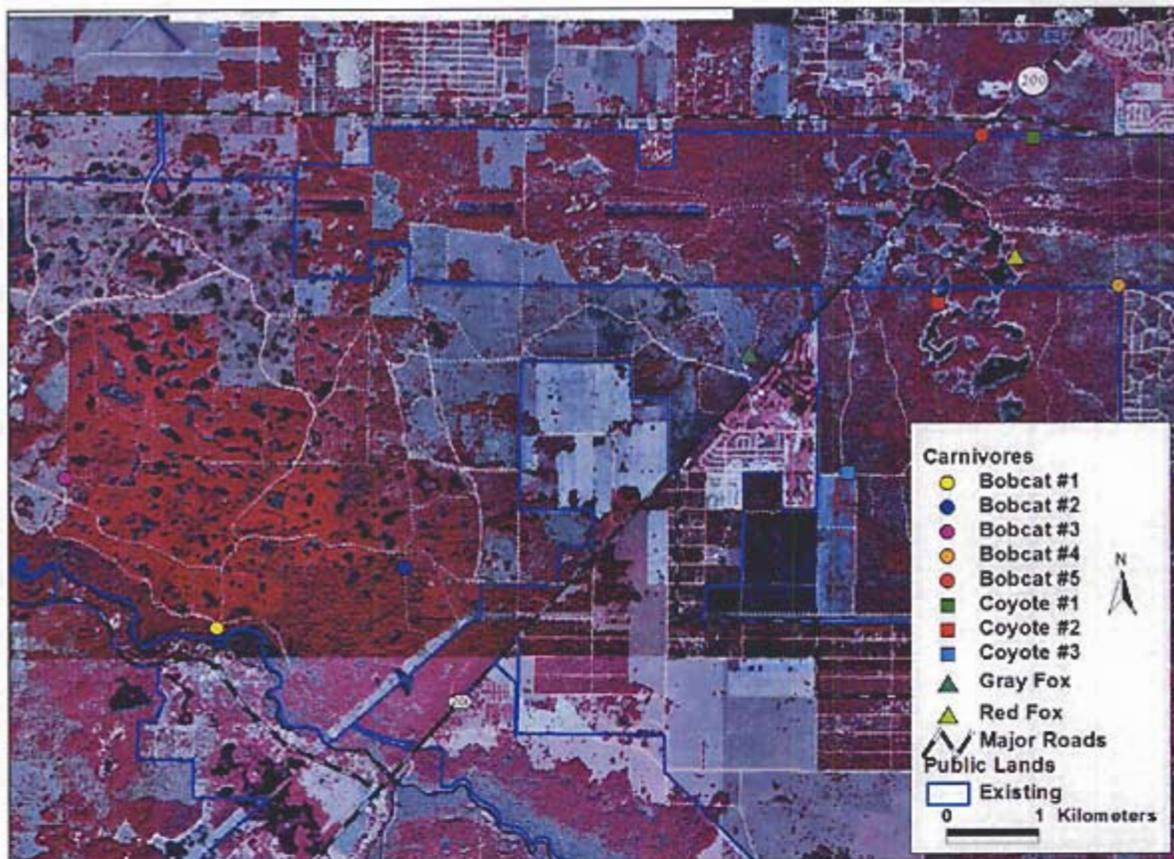


Figure 106. Capture Sites of Targeted Carnivores, June 2002 through January 2003.

Given the number of box traps used we estimated a total of 775 trapping nights. Of these the box traps were tripped and empty 33 times; another 84 times another animal was trapped. Table 14 lists the various nontarget species captured. As a result of nontarget captures in box traps, 15% of capture opportunities were not afforded to target species. Therefore we conclude only 650 trap nights with 6 target captures (4 bobcats, 1 gray fox and 1 red fox); a per night capture rate of 0.92%. We estimate 349 leghold trap nights (59 times they were tripped without capture, 7 nontarget animals were trapped). This leaves a net available to target animals of 283 trap nights. In the leghold traps, 3 coyotes were captured (a per night capture rate of 1.1%).

The adult male and female coyotes weighed 13.15 kg and 12.24 kg, respectively. The female bobcats weighed 8.61 kg, 7.27 kg and 6.53 kg, while the adult male bobcats weighed 12.47 kg and 11.79 kg. The gray fox weighed 4.09 kg; weight of the red fox was not recorded. These weights are within the range reported elsewhere in central Florida (Thornton et al. 2004).

Two of the bobcats died after being hit by motor vehicles, one was shot by a hunter, one died of unknown causes, and one was still alive in the HTP at the end of the study. The gray fox was shot and killed by a neighboring farmer 1.5 months after being collared. The two collared coyotes and the red fox were rarely found within range of our telemetry receivers. Their home range extended beyond the public lands. Since we did not have access to aerial tracking, our

frequency reception was limited to the immediate study area. Some nuisance trapping for coyotes was being conducted in one neighborhood adjacent to a wooded area frequented by Coyote 1 and 3; if they were captured we were not notified. Their disposition is unknown. This accounts for the limited data on these animals.

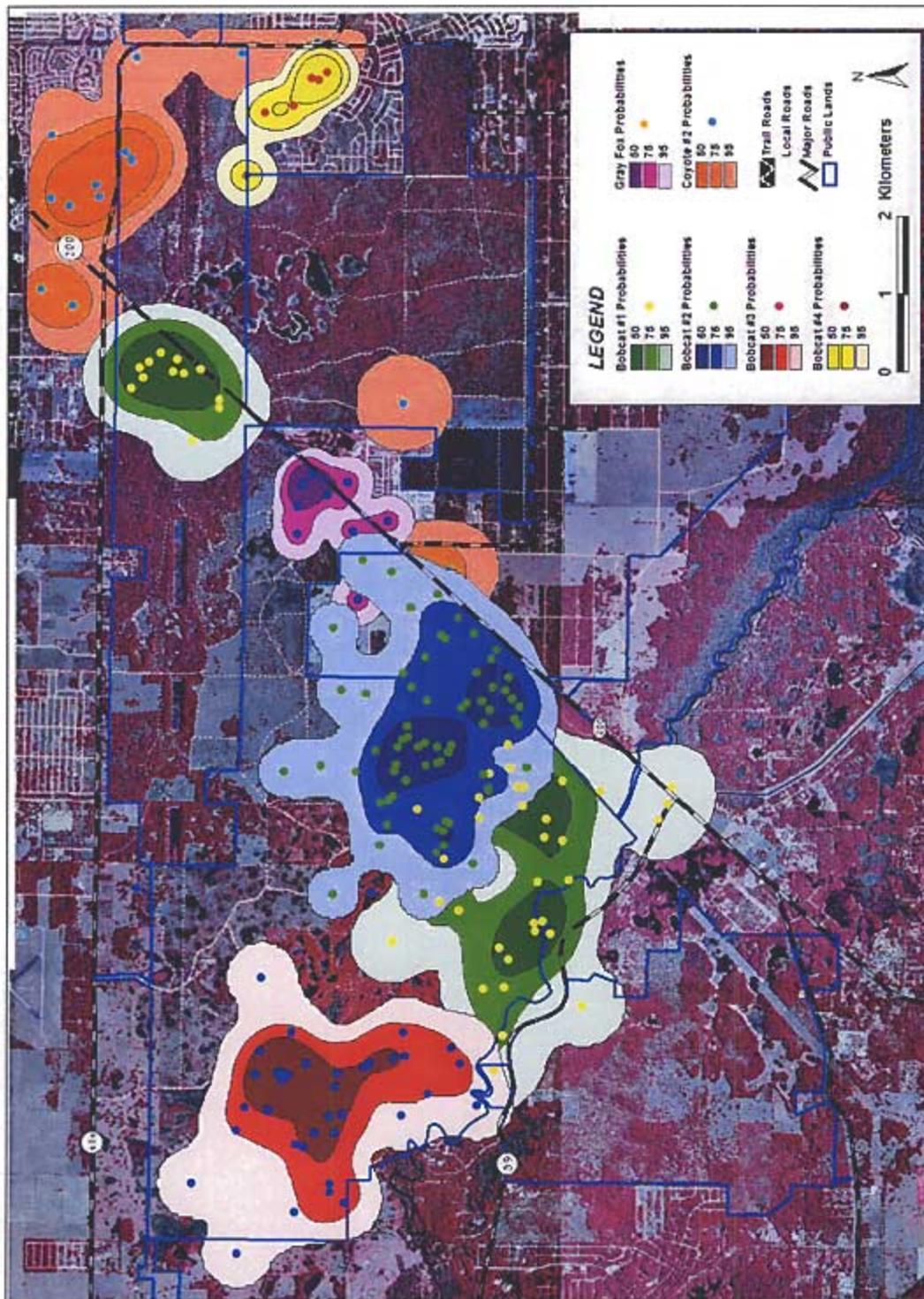
**Table 14. Various Nontarget Species Caught in Traps, June 2002 to January 2003.**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Box Traps</b>	<b>Leghold Traps</b>
<i>Accipiter cooperi</i>	Coopers hawk	1	
<i>Alligator mississippiensis</i>	American alligator	1	
<i>Bubo virginianus</i>	Great-horned owl	2	
<i>Buteo lineatus</i>	Red-shouldered hawk	9	
<i>Canis familiaris</i>	Domestic dog	1	
<i>Cathartes aura</i>	Turkey vulture	6	1
<i>Corvus brachyrhynchus</i>	American crow		1
<i>Didelphis virginiana</i>	Virginia opossum	23	3
<i>Mephitis mephitis</i>	Striped skunk	2	1
<i>Procyon lotor</i>	Raccoon	39	1

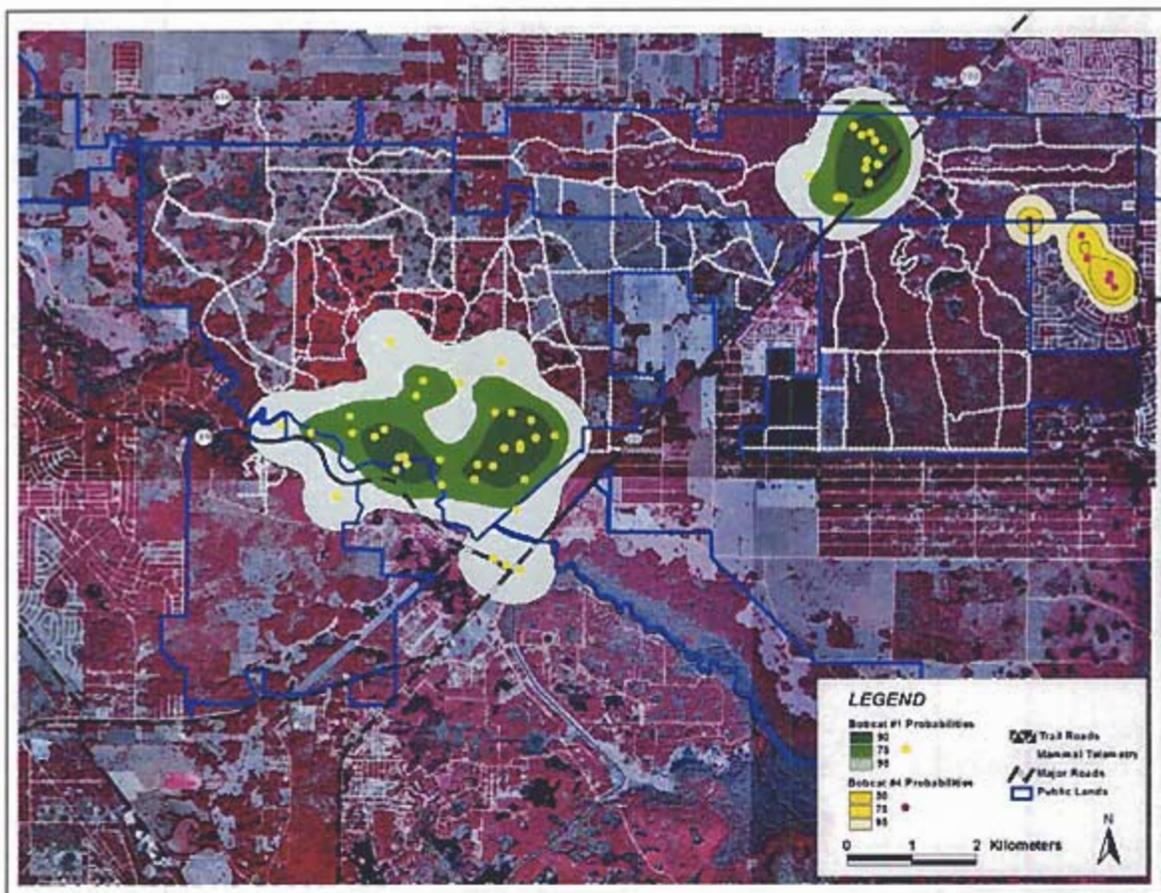
We also came across difficulties with radio-collars acquired from ATS, Inc. The manufacturer lot of radio-collar devices included the use of inferior crystals that had the effect of reducing the transmitter range. This wasn't determined until we already had 6 animals collared and encountered difficulties obtaining radio frequency signals. We did not possess the equipment required for recapture (e.g., tranquilizing dart gun) or the funding to hire a professional trapper. As a result, on many occasions we were unable to obtain signals depending on the distance from access roads, vegetation type and density, and terrain.

Home ranges were calculated using 95% fixed kernel (FK) contours; 50% fixed kernel contours were used to estimate core-area size. Also, 75% FK contours were included in diagrams for visual comparison. Telemetry was conducted on average twice per week. Combined home range for all carnivores is shown in Figure 107; all points were recorded from June 2002 to April 2004.

Bobcat no. 1 (an adult female) was tracked from mid-June 2002 through February 2004, when she was found dead on SR 200. Forty-six positions were recorded; all but 9 were acquired at night. Bobcat 1 had a 95% FK home range of 17.7 km<sup>2</sup> and a 50% FK core area of 2.9 km<sup>2</sup> (Figure 108). There was a shift in the core area of Bobcat no. 1 resulting in two 50% FK core areas. The timing of this shift, summer 2003 coincides with significant logging activity within the 50% FK core area. Land ownership in the 95% FK home range includes public lands (77%), private lands (22%), and highway rights-of-way (1%).

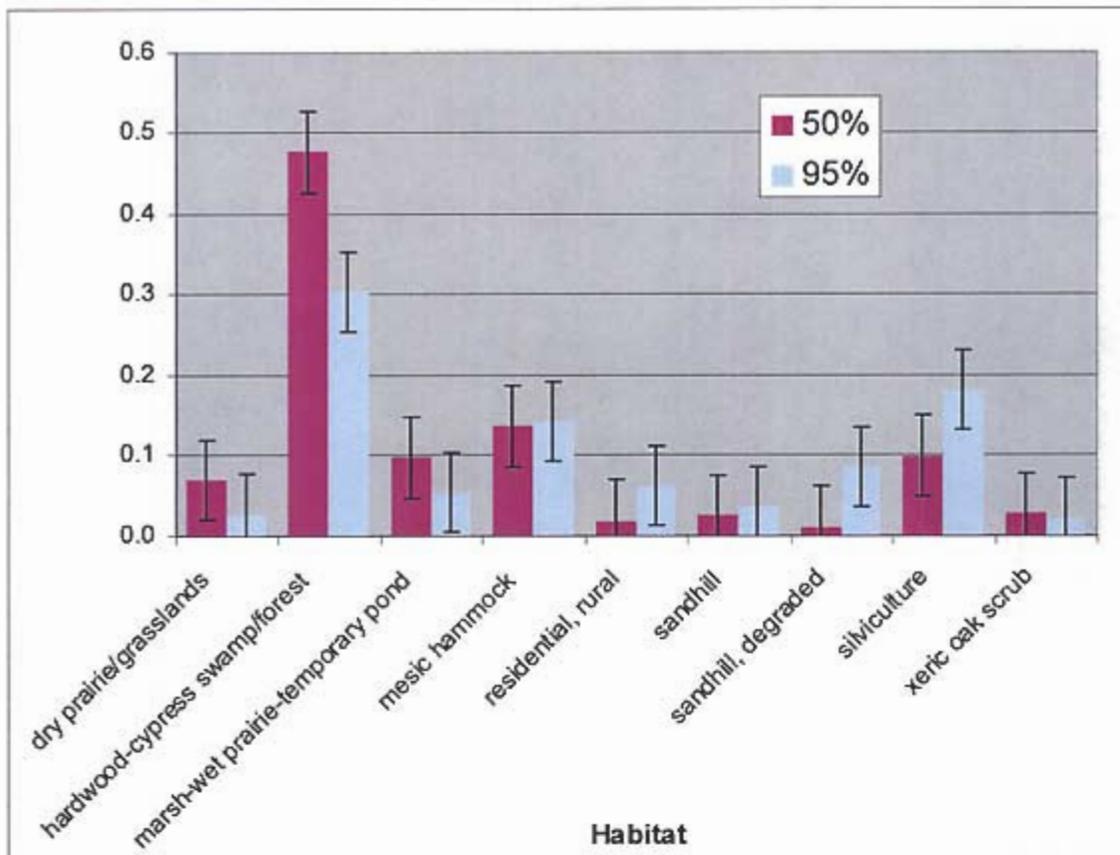


**Figure 107. Combined Home Range (FK) Calculated for all Carnivores.** The outer contour represents 95%, middle contour 75% and the inner contour 50% probabilities. Colors represent different subjects.



**Figure 108. Home Range (FK) Polygons, Bobcat nos. 1 (green) and 4 (yellow).** The outer contour represents 95%-, middle contour 75%- and the inner contour 50% probabilities.

Within the 95% FK home range, habitat composition was 30% hardwood-cypress swamp/forest, 18% silviculture, 14% mesic hammock, 9% sandhill-degraded, 6% residential-rural, 5% marsh-wet prairie-temporary pond, 4% sandhill, 3% dry prairie/grassland, 2% each of shrub-brushlands, water and pasture, and 1% each of built-environment, mixed pine-hardwood, planted longleaf pine, and right-of-way (Figure 109). For the 50% FK core area, 48% was hardwood-cypress swamp/forest 14% was mesic hammock, 10% each of marsh-wet prairie-temporary pond and silviculture, 7% dry prairie, 3% each of sandhill and xeric oak scrub, and 1% or less each of built-environment, mixed pine-hardwood, pasture, planted longleaf pine, residential-rural, sandhill-degraded, shrub-brushlands, water, and right-of-way (Figure 109). An overlay of land cover on bobcat home range is shown in Figure 110.



**Figure 109. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Bobcat no. 1.** Not included in this chart were minimal amounts of the following habitat types (less than 2%): built-environment, mixed pine-hardwood, pasture, planted longleaf pine, shrub-brushlands, water, and right-of-way.

Of actual habitat use in the 50% FK core area, 43% of the recorded locations for this bobcat were in hardwood-cypress swamp/forest (Figure 111); right-of-way, sandhill-degraded, water and xeric oak scrub were used in greater proportion than the amount available. Recorded locations also indicate that the bobcat shifted from a core area in the HTP dominated by hardwood-cypress swamp/forest and silviculture to a separate core area in the CFG consisting of mesic hammock, sandhill-degraded, marsh-wet prairie-temporary pond and dry prairie/grasslands.

River crossings were recorded on two occasions by bobcat no. 1. It crossed the Withlacoochee River and entered the neighborhood along the west side of the river in December 2002; it was witnessed around houses on CR 39 before returning to the HTP. On a second occasion in February 2003 it crossed the Withlacoochee River and CR 39 to enter the Withlacoochee SF (Figure 108). Actual site where the river was crossed is unknown. Its home range bordered SR 200 and CR 39 for several km (Figure 108).

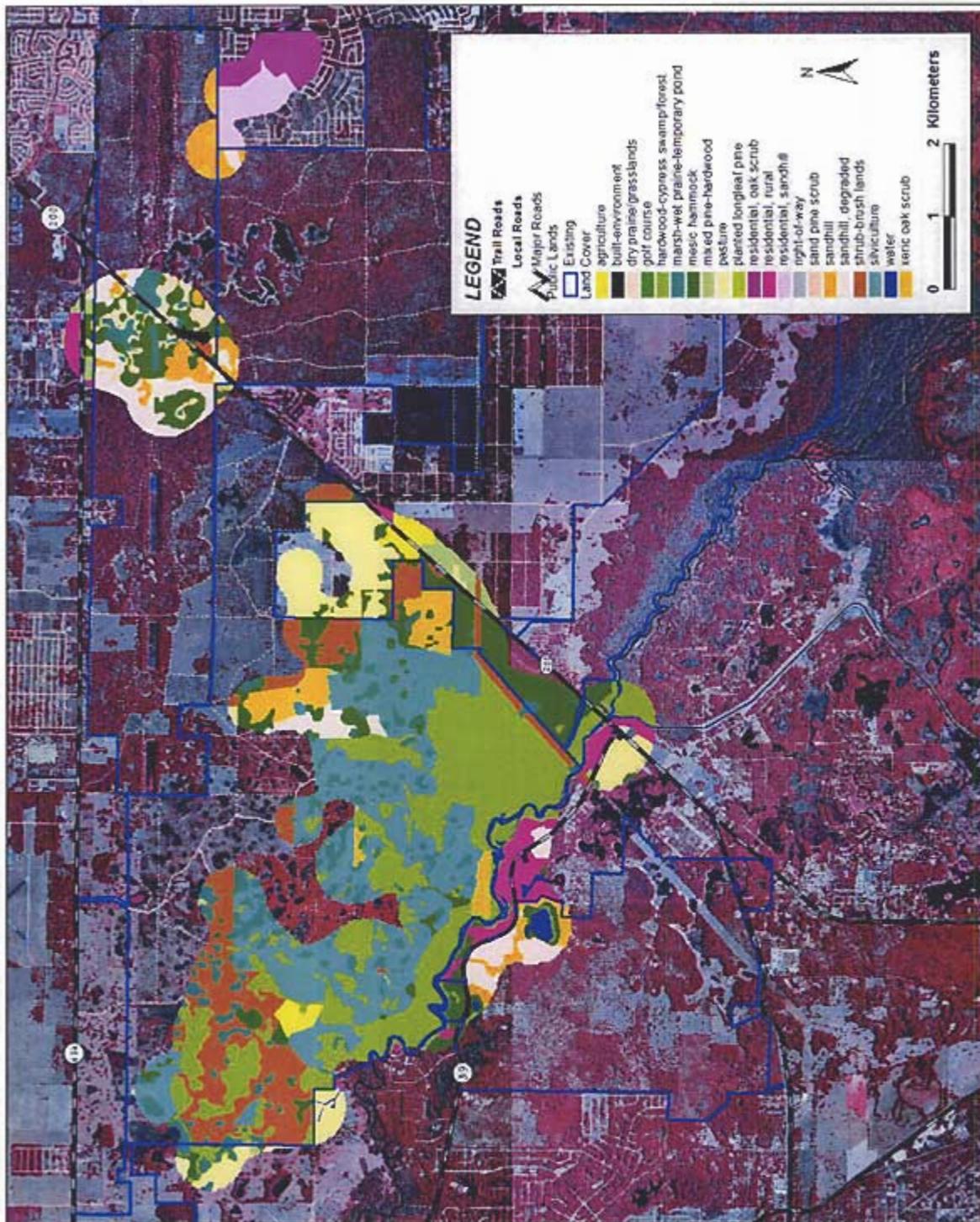
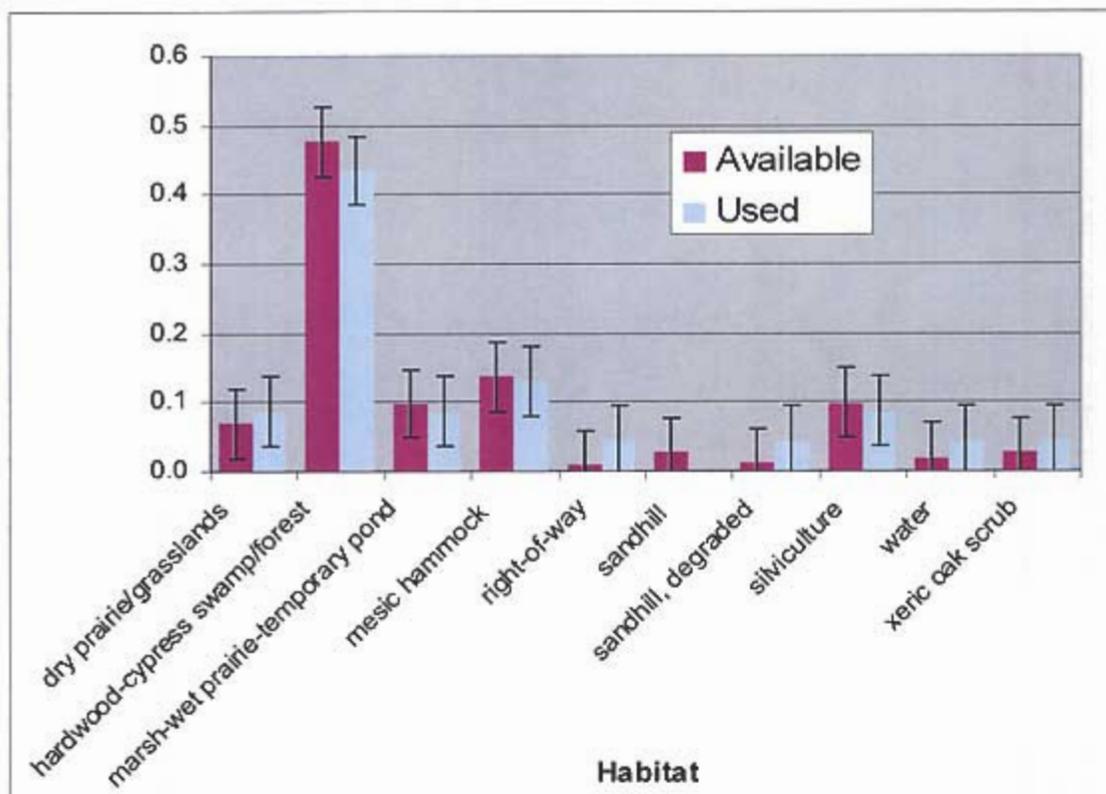


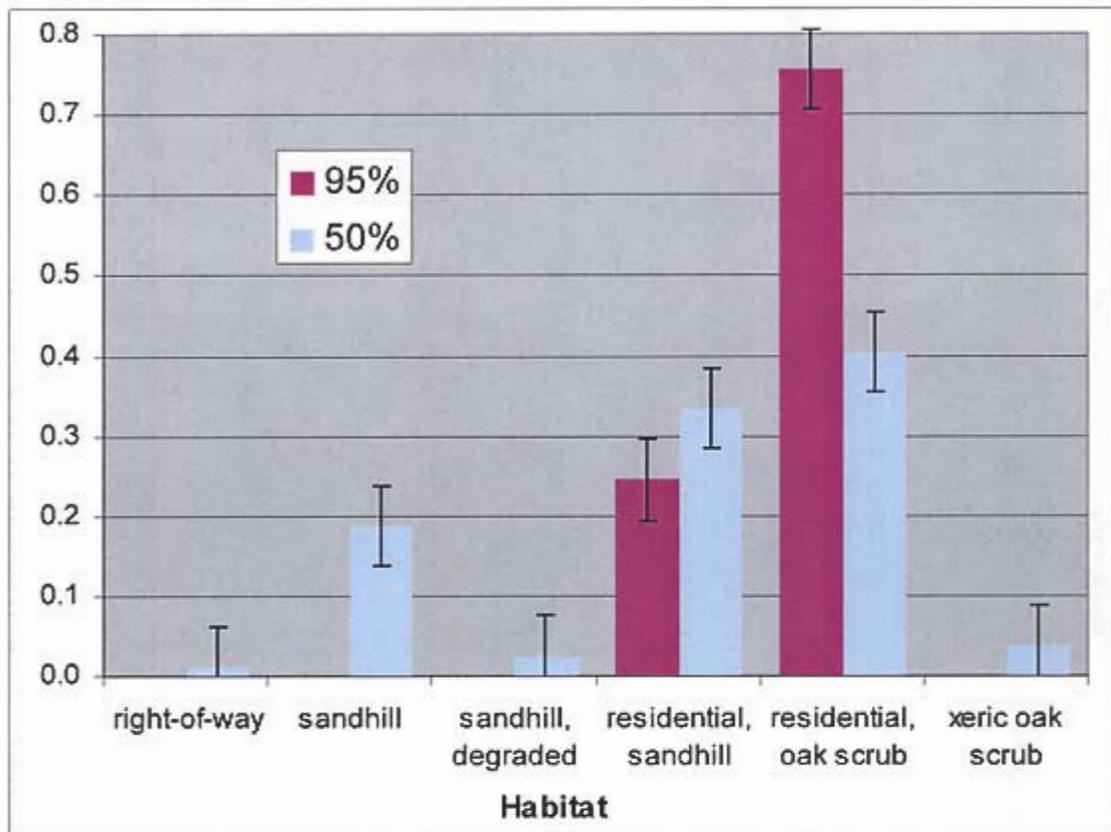
Figure 110. Land Cover for all Bobcat Home Range Areas (95% FK).



**Figure 111. Percent Composition of Actual Habitat Used vs. Available Habitat for Bobcat no. 1 in the 50% FK Core Area.** Not included in this chart were minimal amounts of the following habitat types (less than 2%): built-environment, mixed pine-hardwood, pasture, planted longleaf pine, shrub-brushlands, residential-rural, and right-of-way.

Bobcat no. 4 (a young female) was monitored from September 2002 to December 2002. Only six points were recorded before this animal was shot by a hunter in the back of the Timberwalk Development. Despite the limited number of points, a preliminary home range was plotted to assess the type habitat it was using while we tracked it. Interpretation of these results should reflect this limitation. Bobcat no. 4 had a 95% FK contour of 2.2 km<sup>2</sup> and a 50% contour of 0.33 km<sup>2</sup> (Figure 108). Private lands constituted 74% of the 95% FK contour area, while 25% was publicly owned and 1% was road right-of-way.

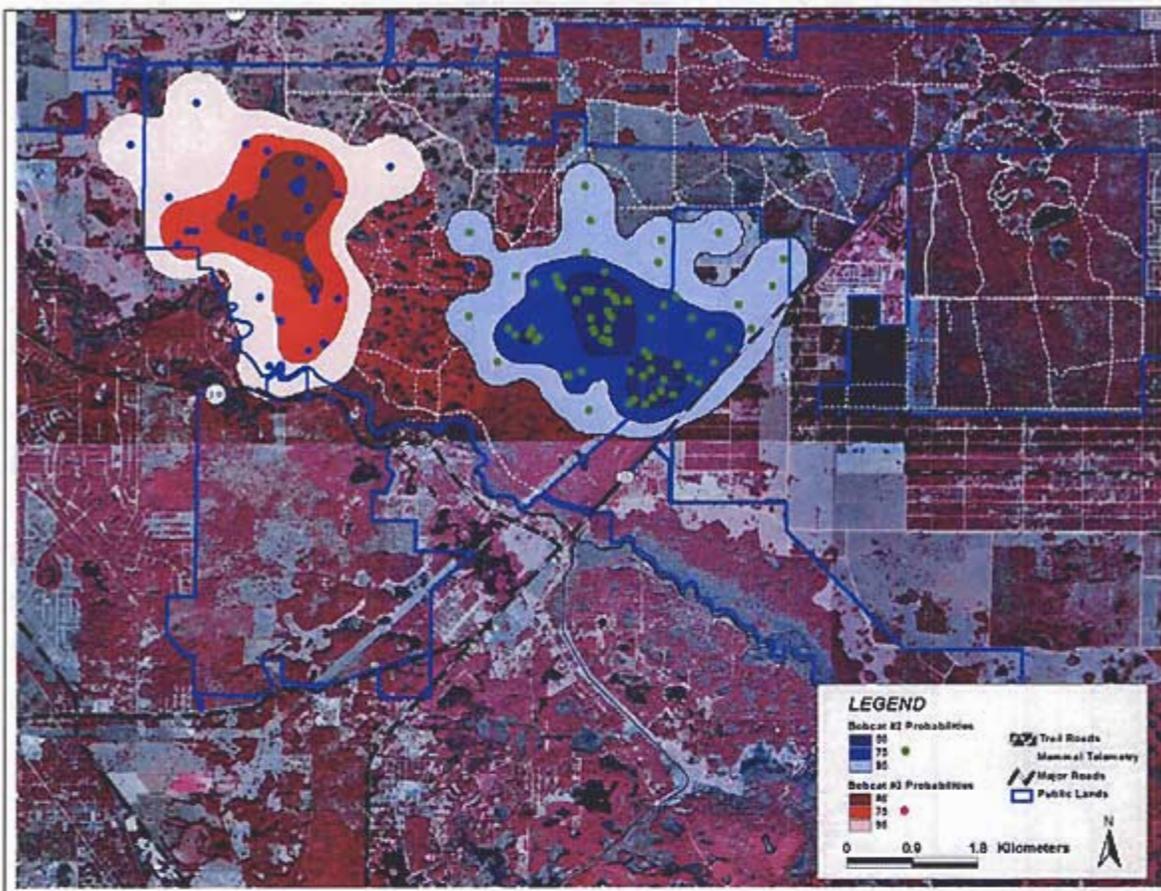
Within the 95% FK contour, 40% was residential-oak scrub, 33% was residential-sandhill, 19% was sandhill, 4% was xeric oak scrub, 2% was sandhill-degraded, and 1% was right-of-way (Figure 112). For the 50% FK contour, 76% was residential-oak scrub and 24% was residential-sandhill (Figure 112). Residential oak scrub accounted for all points recorded in the 50% FK contour. The entire area of the 50% contour, where the bobcat was found active at night was on private land. If bobcat no. 4 would have survived longer, greater use of public lands may have been detected.



**Figure 112. Percent Habitat Composition in 95% and 50% FK Contours for Bobcat no. 4.**

Bobcat no. 2 (an adult male) was monitored from July 2002 to April 2004; 68 points were obtained. Sixty-nine percent of these points were recorded at night. It had a 95% FK home range of 11.2 km<sup>2</sup> and a 50% core area of 1.3 km<sup>2</sup> (Figure 113). Percent land ownership in the 95% FK home range includes 72% public, 27% private, and 1% road rights-of-way.

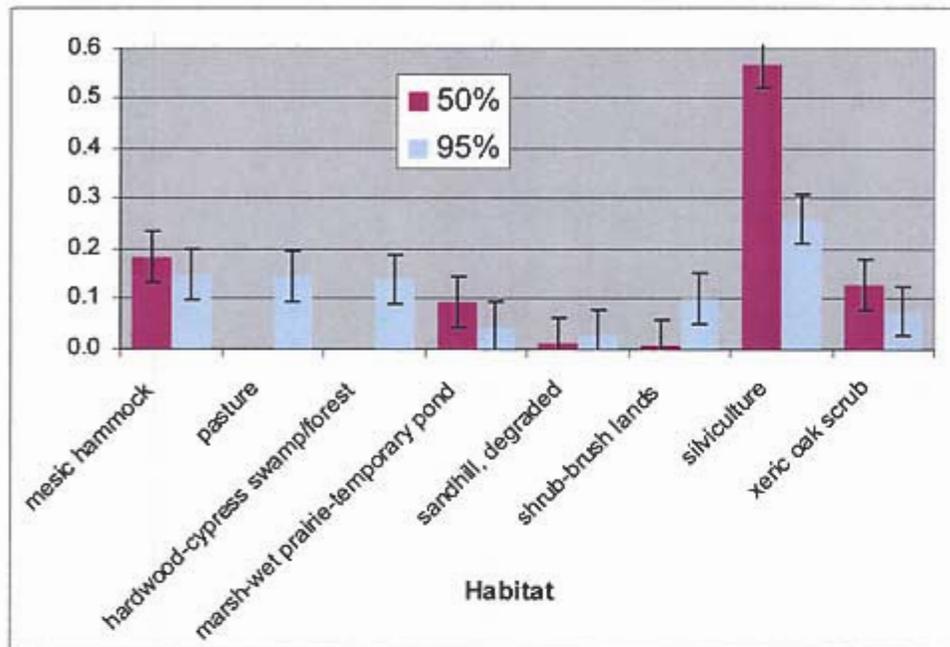
The habitat composition of the 95% FK home range was 26% silviculture, 15% mesic hammock, 14% each of hardwood-cypress swamp/forest and pasture, 10% shrub-brushlands, 8% xeric oak scrub, 4% marsh-wet prairie-temporary pond, 3% sandhill-degraded, and 2% or less of each of agriculture, built-environment, dry prairie/grasslands, mixed pine-hardwood, residential-rural, right-of-way, and water (Figure 114). For the 50% FK core area, 57% was silviculture, and 18% was mesic hammock, 13% was xeric oak scrub, 9% was marsh-wet prairie-temporary pond, and 1% or less each was hardwood-cypress swamp/forest, sandhill-degraded, and shrub-brushlands (Figure 114). Of the actual points (recorded locations) within the 50% core area, 57% were found in silviculture and 15% each in mesic hammock, marsh-wet prairie-temporary pond, and xeric oak scrub (Figure 115). Many silvicultural stands in this part of the HTP included established ground cover, herb and shrub layers that from observations provided significant cover and prey densities.



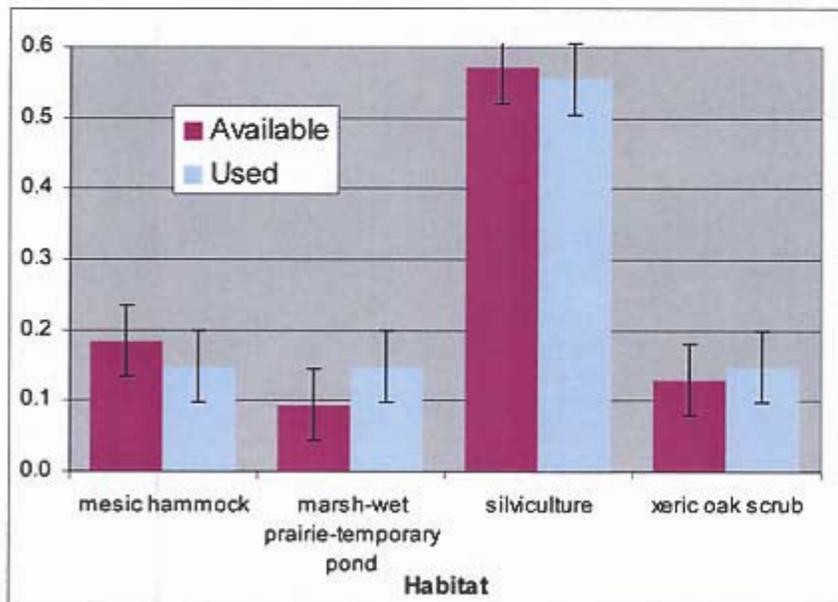
**Figure 113. Home Range (FK) Polygons, Bobcat Nos. 2 (blue) and 3 (red).** The outer contour represents 95%-, middle contour 75%- and the inner contour 50% probabilities.

Bobcat no. 3 (an adult male) was tracked from September 2002 to April 2004; a total of 39 positions were recorded before it was found dead in the HTP. Although cause of death is uncertain, only signs of natural mortality were present. It had a 95% FK home range of 12.1 km<sup>2</sup> and a 50% core area of 1.6 km<sup>2</sup> (Figure 113). In the 95% FK home range, land ownership percentages include 87% public and 13% private.

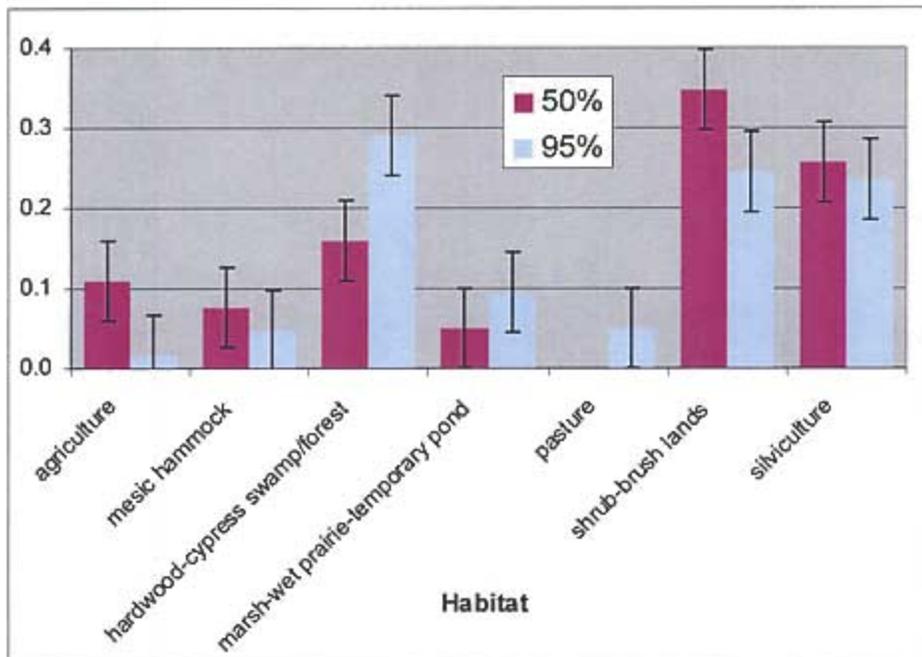
Within the 95% FK home range, habitat composition was 29% hardwood-cypress swamp/forest, 24% silviculture, 24% shrub-brush lands, 9% marsh-wet prairie-temporary pond, 5% pasture, and 2% or less each of agriculture, mixed pine-hardwood, residential-rural, right-of-way and water (Figure 116). For the 50% FK core area, 35% was shrub-brushlands, 26% was silviculture, 16% hardwood-cypress swamp/forest, 11% agriculture, 8% mesic hammock, and 5% marsh-wet prairie-temporary pond (Figure 116). For the 50% core area, actual habitat use (based on location of recorded positions) included silviculture (37%), shrub-brushlands, hardwood-cypress swamp/forest (21%), and 5% each of agriculture and mesic hammock (Figure 117).



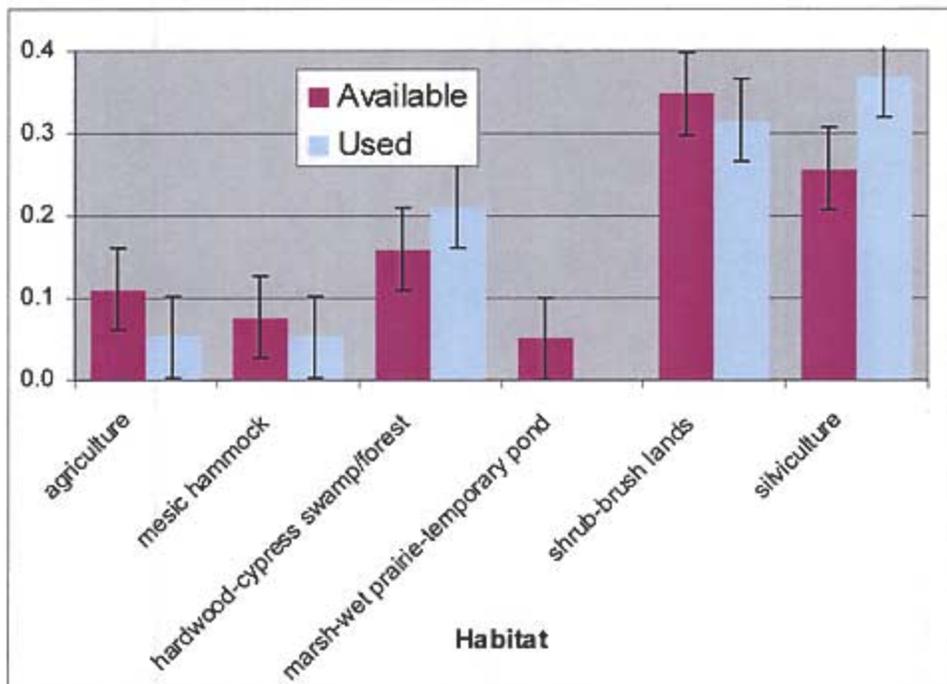
**Figure 114. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Bobcat no. 2.** Not included in this chart were minimal amounts of the following habitat types (less than 2%): agriculture, built-environment, dry prairie/grasslands, residential-rural, pasture, water, and right-of-way.



**Figure 115. Percent Composition of Actual Habitat Used vs. Available Habitat for Bobcat no. 2 in the 50% FK Core Area.** Not included in this chart were minimal amounts of the following habitat types (less than 1%): hardwood-cypress swamp/forest, pasture, sandhill-degraded, and shrub-brushlands.



**Figure 116. Percent Habitat Composition in 95% FK Home Range and 50% FK Core Area for Bobcat no. 3.** Not included in this chart were minimal amounts of the following habitat types (less than 2%): agriculture, mixed pine-hardwood, residential-rural, water, and right-of-way.



**Figure 117. Percent Composition of Actual Habitat Used vs. Available Habitat for Bobcat no. 3 in the 50% FK Core Area.**

Coyote no. 3 (an adult female) was monitored from August 2002 to May 2003. Signal reception for this animal was sporadic, as such only 17 positions were recorded; after May the signal was not reacquired despite periodic signal monitoring through April 2004. Coyote no. 3 was captured along the boundary of the RPSF and Spruce Creek Golf Course, it spent about 3 months in this area before its signal was lost; it was reacquired 4 months later near the road maintenance compound on CR 484 in the east CFG. This likely explains the split polygons obtained from home range calculations. Given the small number of points, home range calculations are only meant to indicate habitat use for the period monitored. For coyote no. 3 the 95% FK contour was 9.9 km<sup>2</sup> and a 50% FK contour was 1.2 km<sup>2</sup> (Figure 118). Only 36% of the area it used while being monitored was publicly owned; 3% was road right-of-way and the remaining 61% was private lands.

Habitat in the 95% FK contour was comprised of 23% sandhill, 16% built-environment, 15% sandhill-degraded, 11% residential-oak scrub, 7% xeric oak scrub, 5% pasture, 4% mixed pine-hardwood, 3% each of agriculture, mesic hammock, planted longleaf pine, residential-rural and right-of-way, and 2% or less each of golf course, residential-sandhill, sand pine scrub, shrub-brushlands and water (Figure 119). For the 50% FK contour, 44% was sandhill, 17% was built-environment, 13% was sandhill-degraded, 9% was golf course, 8% was xeric oak scrub, 7% was sand pine scrub, 3% was right-of-way, and 1% or less each of mixed pine-hardwood and residential-rural (Figure 119). An overlay of land cover on canid home range is shown in Figure 120.

Percent of actual points recorded in the 50% FK contour were 43% sandhill, 43% xeric oak scrub, and 14% built-environment. Xeric oak scrub was used disproportionate to what was available in the 50% FK contour (Figure 121). This coyote was typically found denning in xeric habitats in the CFG and a vacant lot and foraging in built-environment areas (residential and commercial areas along CR 484). It crossed SR 200 at least twice and CR 484 on several occasions.

The gray fox (an adult female) was monitored from January 2003 to March 2003; only 10 points were recorded prior to its death. It was shot on a farm adjacent to the HTP. Given that number of points collected is small, home range calculations are presented to indicate habitat use for the period monitored only. The 95% FK contour was 2.3 km<sup>2</sup> and the 50% FK contour was .26 km<sup>2</sup> (Figure 118). It crossed SR 200 on at least two occasions while we were monitoring it, moving between the HTP and Spruce Creek Subdivision. Fifty-three percent of the area used by the gray fox was publicly owned, while 2% was road right-of-way and 45% was private lands.

Within the 95% FK contour habitat composition was 24% xeric oak shrub, 17% shrub-brush lands, 16% built-environment, 14% pasture, 12% golf course, 9% mesic hammock, 4% sandhill, and 2% or less each of dry prairie/grasslands, marsh-wet prairie-temporary pond, residential-rural and right-of-way (Figure 122). For the 50% FK contour, 33% was xeric oak scrub, 33% was shrub-brush lands, 20% was mesic hammock, 8% was golf course, and 5% was right-of-way (Figure 122). Mesic hammock comprised 60% of actual use (based on recorded telemetry points) even though it accounted for only 20% of the area in the 50% FK contour (Figure 123). The other 40% of recorded positions were in xeric oak scrub (33% of area in the 50% FK contour).

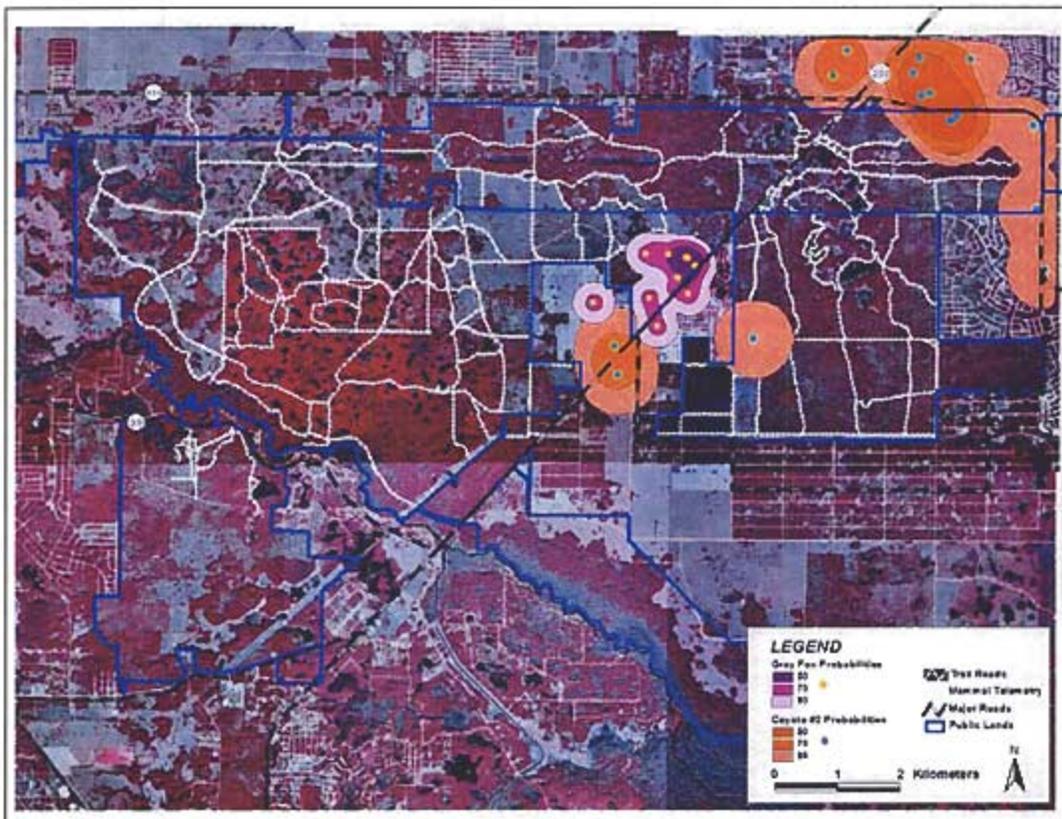


Figure 118. FK Contours for Coyote no. 3 (orange) and the Gray Fox (purple). The outer contour represents 95%-, middle contour 75%- and the inner contour 50% probabilities.

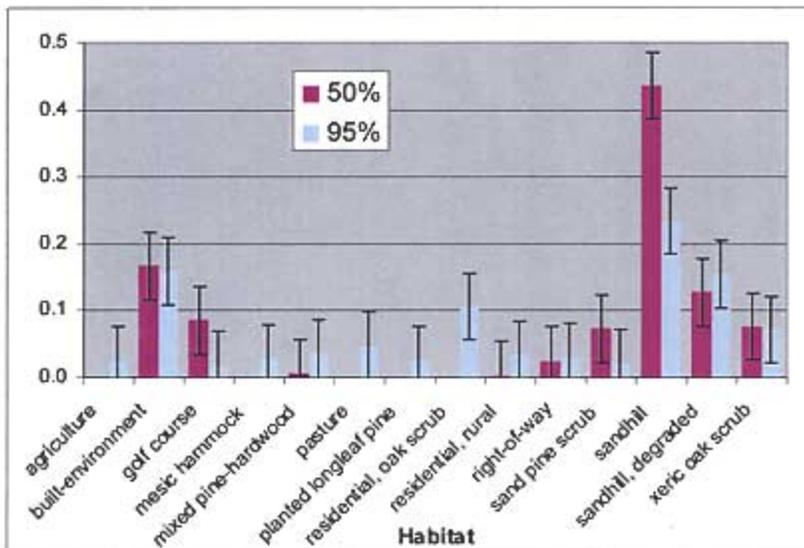


Figure 119. Percent Habitat Composition in the 95% and 50% FK Contours for Coyote no. 3. Not included in this chart were minimal amounts of the following habitat types (less than 2%): shrub-brushlands, residential-sandhill, and water.

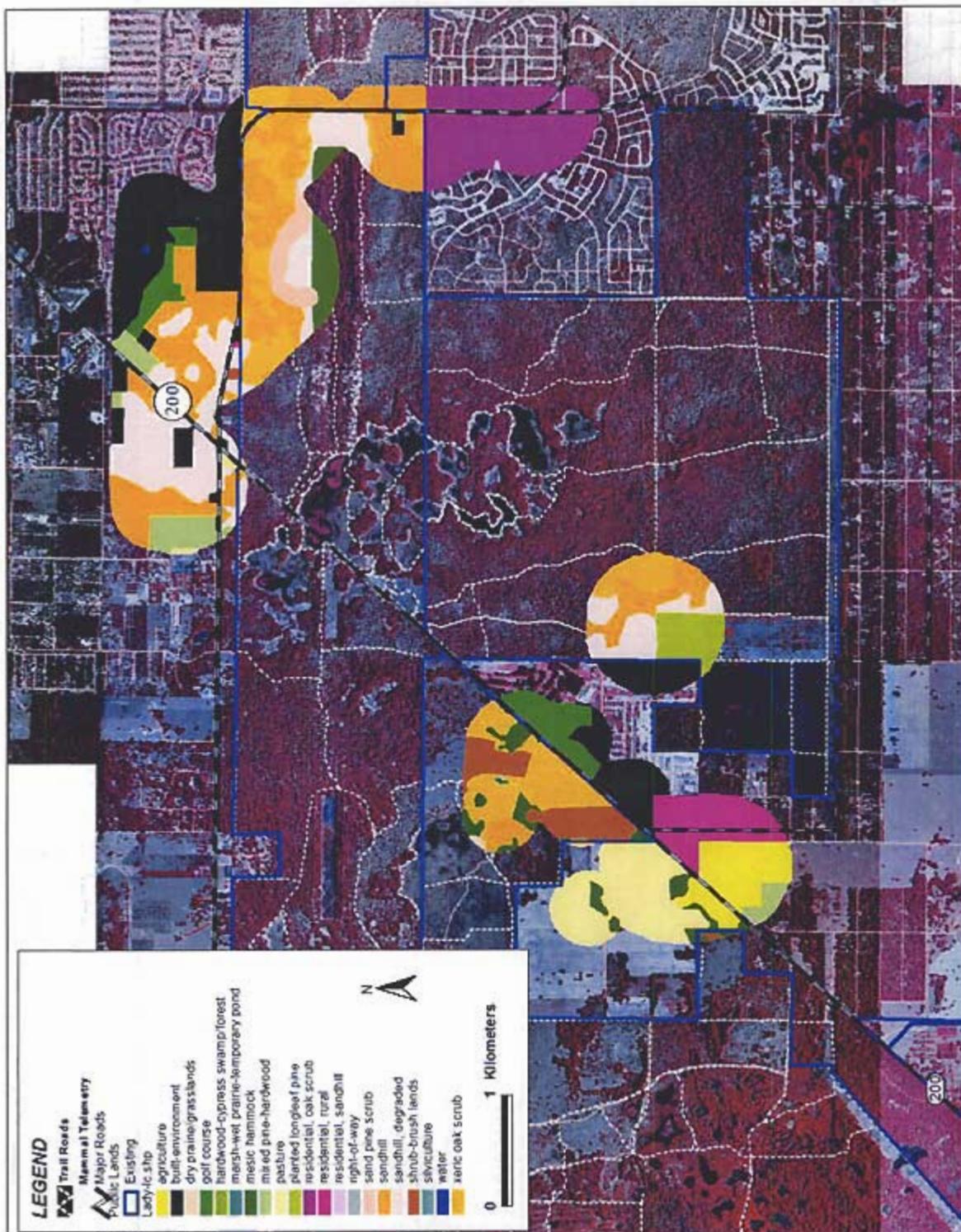
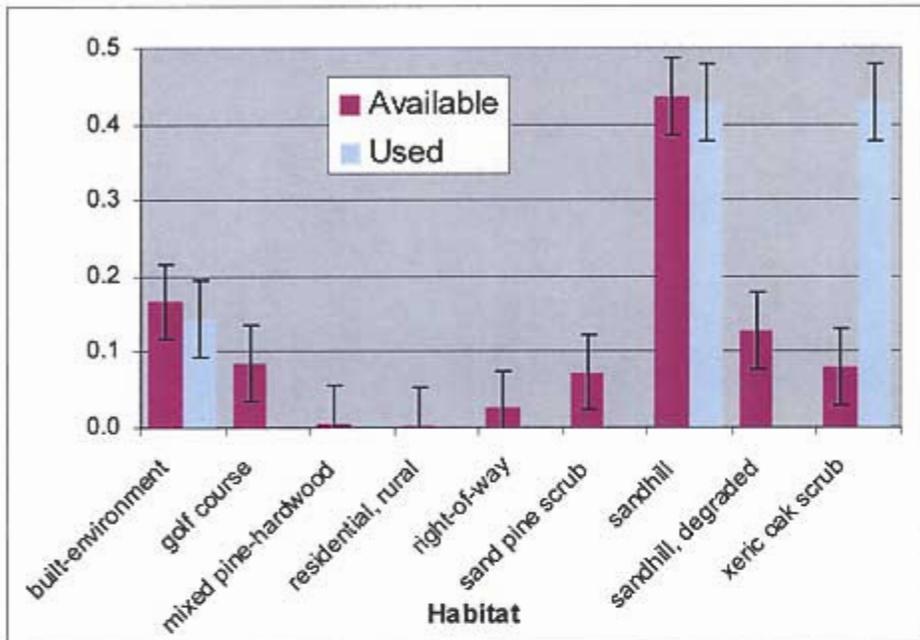
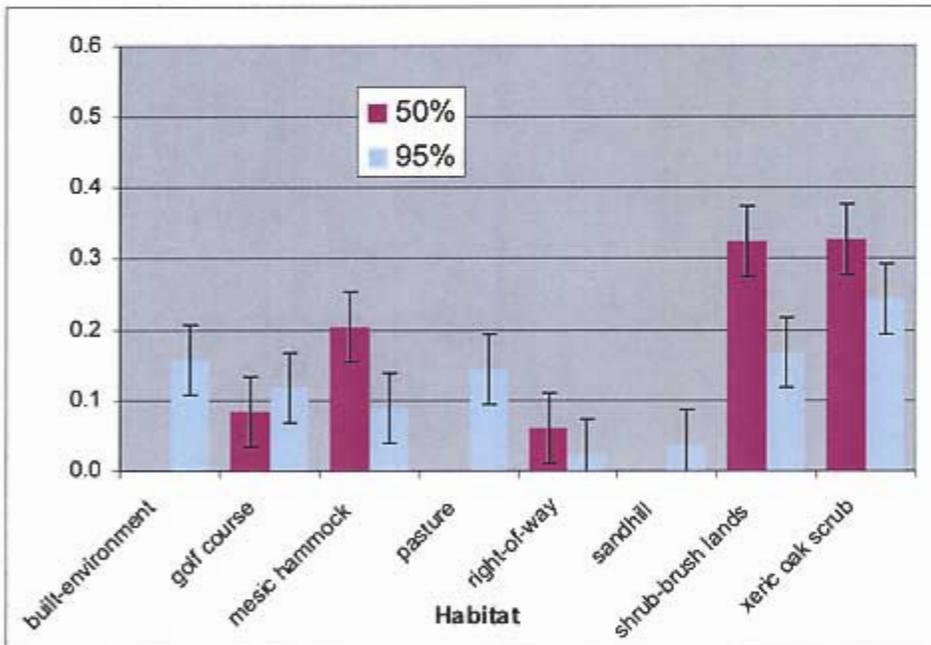


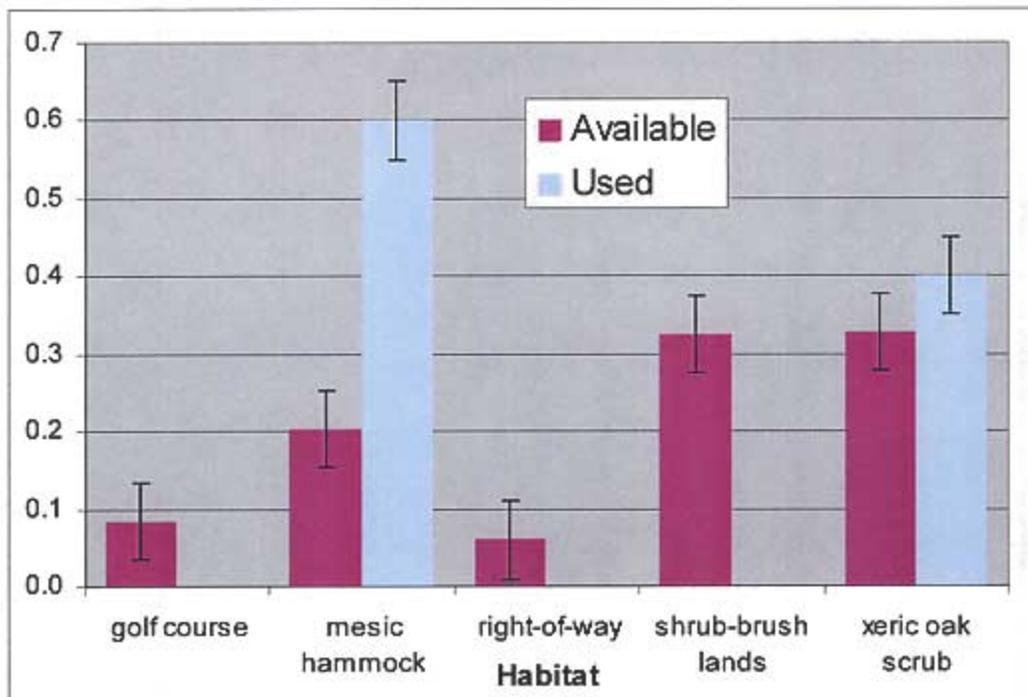
Figure 120. Land Cover for all Canid Home Range Areas (95% FK).



**Figure 121. Percent Composition of Actual Habitat Used vs. Available Habitat for Coyote no. 3 in the 50% FK Contour.**



**Figure 122. Percent Habitat Composition in 95% and 50% FK Contours for the Gray Fox.** Not included in this chart were minimal amounts of the following habitat types (less than 2%): dry prairie/grasslands, marsh-wet prairie-temporary pond, residential-rural and right-of-way.



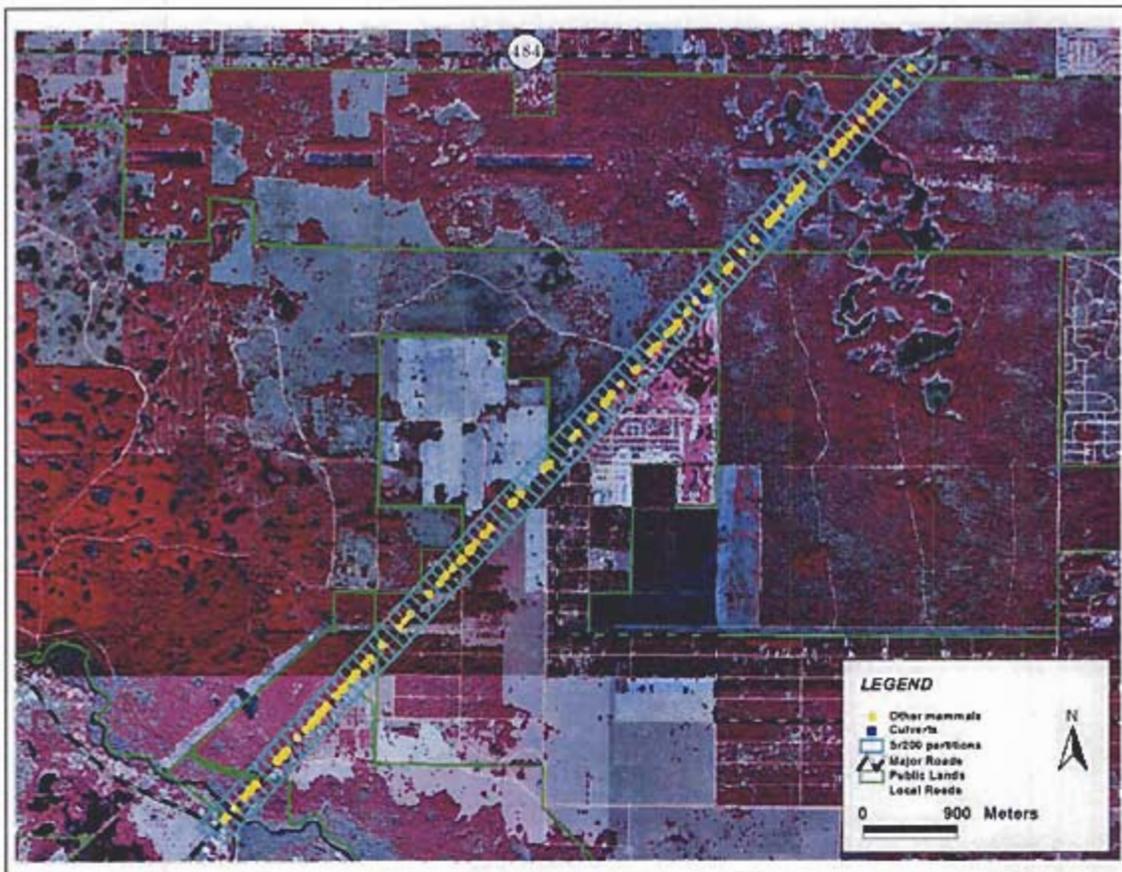
**Figure 123. Percent Composition of Actual Habitat Used vs. Available Habitat for the Gray Fox in the 50% FK Contour.**

Telemetry positions for coyote no.1 were only recorded three times in November 2002; following this its signal was never reacquired. At its frequency 155.020 MHz, we continuously received overwhelming interference. From its capture area in the CFG, it made two recorded trips across CR 484 into a formerly vacant lot and the Oak Run Subdivision (same area as coyote no. 3—see Figure 118). The vacant parcel is now a Wal-Mart. On one evening we followed it for several hours through Oak Run, where it appeared to be foraging through garbage or in search of domestic prey behind houses. Only two telemetry points were recorded for the red fox, both in the CFG in December 2002 - January 2003. We were never able to relocate it.

#### **Small- and medium-sized mammals**

Three monitoring activities were conducted to assess potential adverse impacts of the road to small- and medium-sized mammals and also to estimate diversity and approximate abundance in habitat areas adjacent to the road right-of-way. These included road-kill monitoring, mark-recapture studies, and culvert track monitoring.

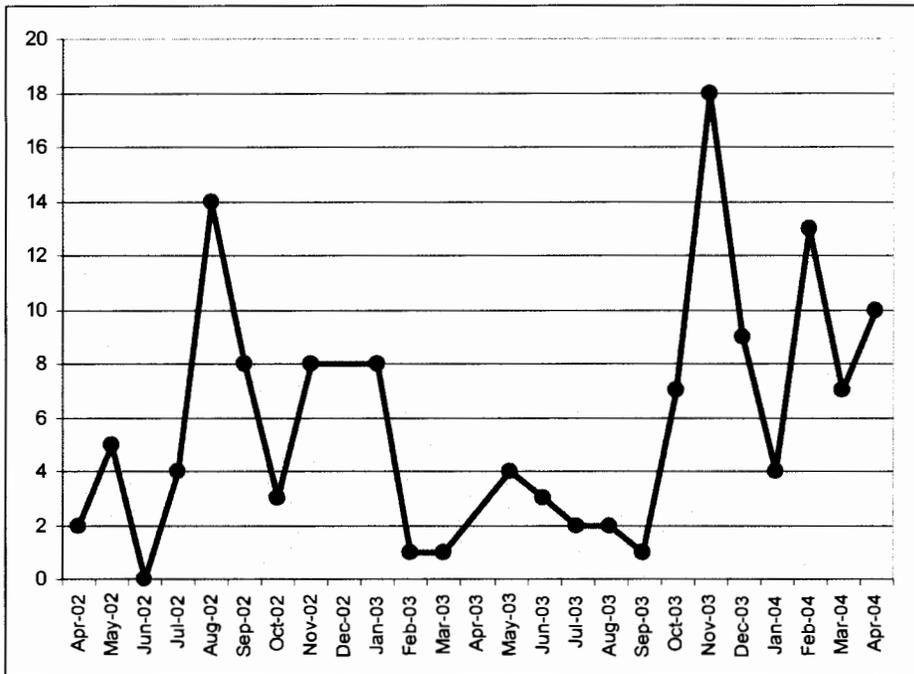
**Road-kill.** Surveys were conducted five days per week on SR 200 from April 2002 to April 2004 (except mid-December 2002 to mid-January 2003 and April 2003). Figure 124 shows all road-kills recorded between April 2002 and April 2004. Road-kill surveys were conducted 5 days per week during this period (except mid-December 2002 to mid-January 2003 and April 2003). A total of 134 small- to medium-sized mammals were recorded, an average of about 1 road-kill every four days checked (a total of 480 road-kill check days). A list of all road-kills recorded can be found in Appendix D.



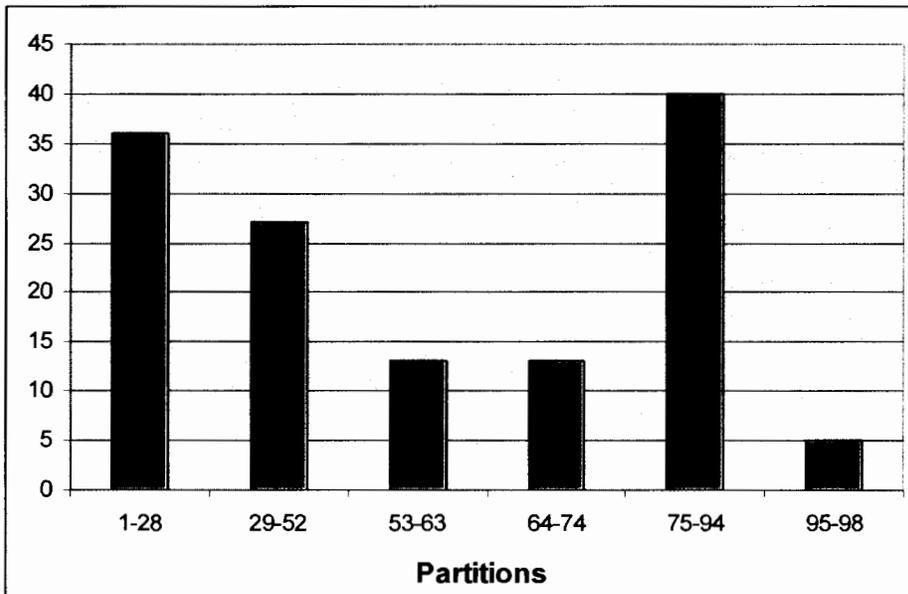
**Figure 124. Location of all small- to medium-sized mammal road-kills recorded between April 2002 and April 2004.**

Temporal change of recorded small- and medium-sized mammal road-kills is shown in Figure 125. There were 54 road-kills recorded in 2002-3 and 80 in 2003-4, an increase of 20%. Two consecutive peaks in road-kills occurred in 2002; one in August and a second from November to January 2003, 83% of these were meso-mammals. In 2003, two similar peaks occurred in November and February. Again, meso-mammals represented a large portion of these (48%). Small- and medium-sized mammal road-kills were not significantly related to season (ANOVA) or rainfall (Pearson's Correlation Coefficient).

Small- and medium-sized mammal road-kills were distributed fairly even from CR 484 to CR 39. No road partition (For analysis, the monitored section of SR 200 was spatially divided by 100 m wide partitions) had more than 5 road-kills, 73 of 98 had at least one road-kill, and only six times did two consecutive 100 m partitions have no road-kills. Spatially, there were about 14 road-kills per km. Grouping partitions by significant adjacent land use/ownership revealed different patterns (Figure 126). A Kruskal-Wallis test showed significant variability of meso-mammal and small mammal road-kills by land-use jurisdiction ( $\chi^2=10.46$ ,  $p=0.06$  and  $\chi^2=11.42$ ,  $p=0.04$ ), but not for land cover type ( $\chi^2=15.47$ ,  $p=0.34$  and  $\chi^2=16.44$ ,  $p=0.29$ ). The majority (77%) of small- and medium-sized mammals were found adjacent to public conservation lands.



**Figure 125. Temporal Change in Small to Medium-sized Mammal Road-kills, April 2002 – April 2004.**



**Figure 126. Small- and Medium-sized Mammal Road-kills on SR 200 by Grouped Partitions.** From CR 484 traveling southwest, Group 1-28 represents the CFG/RPSF interface, group 29-52 represents the HTP/Spruce Creek Golf Course interface, group 53-63 represents the pasture/agriculture interface, group 64-74 represents a rural residential interface, group 75-94 represents the Gum Slough conservation easement, and group 95-98 represents the Withlacoochee R. interface.

Three groups of small- to medium-sized mammal road-kills were found, meso-mammals (n=87), rabbits and squirrels (n=41), and rodents (n=6). Meso-mammals (Figure 127) include raccoon (n=24), nine-banded armadillo (n=26), Virginia opossum (n=28), striped skunk (n=8) and domestic cat (n=1). The rabbit-squirrel group (Figure 128) includes E. cottontail (n=6), marsh rabbit (n=1), gray squirrel (n=33) and fox squirrel (n=1). The rodent group (Figure 129) includes Florida mouse (n=2), oldfield mouse (n=1), hispid cotton rat (n=1), and rat or rodent (n=2). Due to their small size, persistence of dead rodents on pavement is short, likely why few were found.

Road-kills of two species of special concern, the Florida mouse and Sherman's fox squirrel are shown in Figure 130. Two Florida mice were found in road partition no. 6 in sandhill habitat in the CFG northeast of the Ross Prairie basin. The fox squirrel was found in road partition no. 49 across from scrub habitat in the HTP.

**Mark-recapture.** The 24 right-of-way drift fence arrays (Figure 31) were checked from June 2002 to January 2004, except for April 2003. Control drift fence arrays (Figure 32) were checked from mid-February 2004 to mid-April 2004. A total 342 different individuals from 11 species were captured in the right-of-way traps. The number of each species captured and recaptures is shown in Table 15. Southern short-tail shrew (n=104), Florida mouse (n=100), hispid cotton rat (n=39), oldfield mouse (n=35), and golden mouse (n=31) were abundant. The fewest individuals captured were cotton mouse and southeastern shrew (n=11 each), southeastern pocket gopher, eastern wood rat and eastern mole (n=3 each), and least shrew (n=2).

**Table 15. Small Mammals Caught in ROW Drift Fence Arrays, June 2002 – January 2004.**

Scientific Name	Species	# Captures	# Individuals Recaptured	Recapture Frequency	Recorded Road Crossings	Sex Ratio (M:F)	Avg. Body Length (SNV - snakes, lizards)(cm)	Avg. Tail Length (cm)	Avg. Weight (g)
<i>Blarina carolinensis</i>	S. Short-tail Shrew	104	5	0.05	0	30:63	4.8	2.0	4.7
<i>Cryptotis parva</i>	Least Shrew	2	0	0.00	0	1:0	4.0	4.5	5.0
<i>Geomys pinetis</i>	SE Pocket Gopher	3	1	0.33	0	3:0	16.0	7.0	146.0
<i>Neotoma floridana</i>	E. Wood Rat	3	0	0.00	0	2:1	13.5	11.4	84.3
<i>Ochrotomys nuttalli</i>	Golden Mouse	31	1	0.03	0	26:4	5.6	3.2	11.6
<i>Peromyscus gossypinus</i>	Cotton Mouse	11	1	0.09	1	10:1	6.6	5.8	14.9
<i>Peromyscus polionotus</i>	Oldfield Mouse	35	2	0.06	0	28:4	3.2	2.2	10.1
<i>Podomys floridanus</i>	FL Mouse	100	12	0.12	0	74:16	5.7	4.2	11.7
<i>Scalopus aquaticus</i>	Eastern Mole	3	0	0.00	0	0:2	9.0	2.0	47.7
<i>Sigmodon hispidus</i>	Hispid Cotton Rat	39	2	0.05	0	23:10	9.2	6.7	49.0
<i>Sorex longirostris</i>	SE Shrew	11	0	0.00	0	3:6	5.1	2.3	4.5

Monthly difference in captures of small mammals in right-of-way drift fence traps is shown in Figure 131. In 2002 (n=263), 2.3 times as many small mammals were captured as in 2003 (n=114). From May to December in 2002 (50.72 in) there were 18.76 in more rain than over the same period in 2003 (32.25). The highest number of captures of small mammals was in August 2002 (n=57).

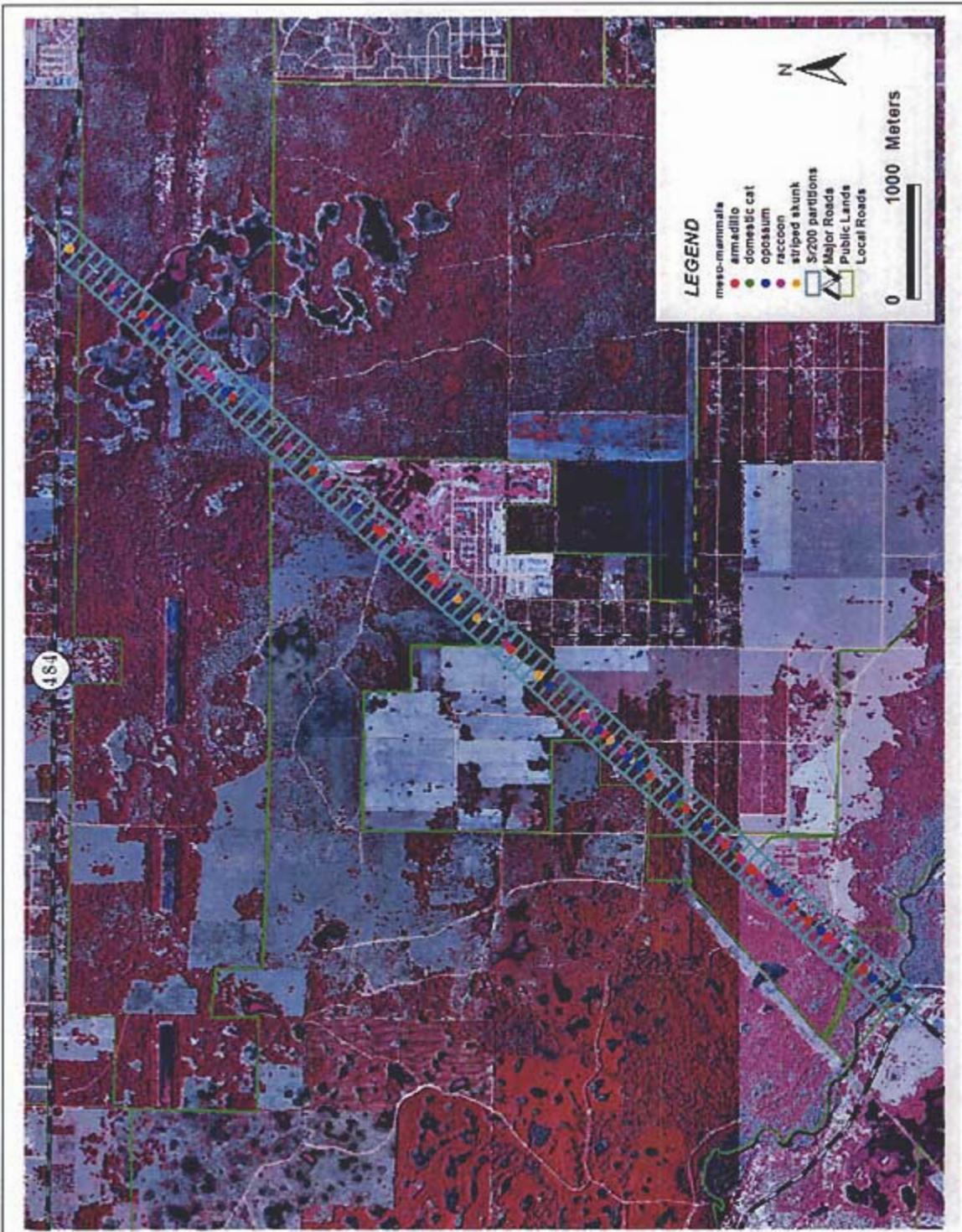
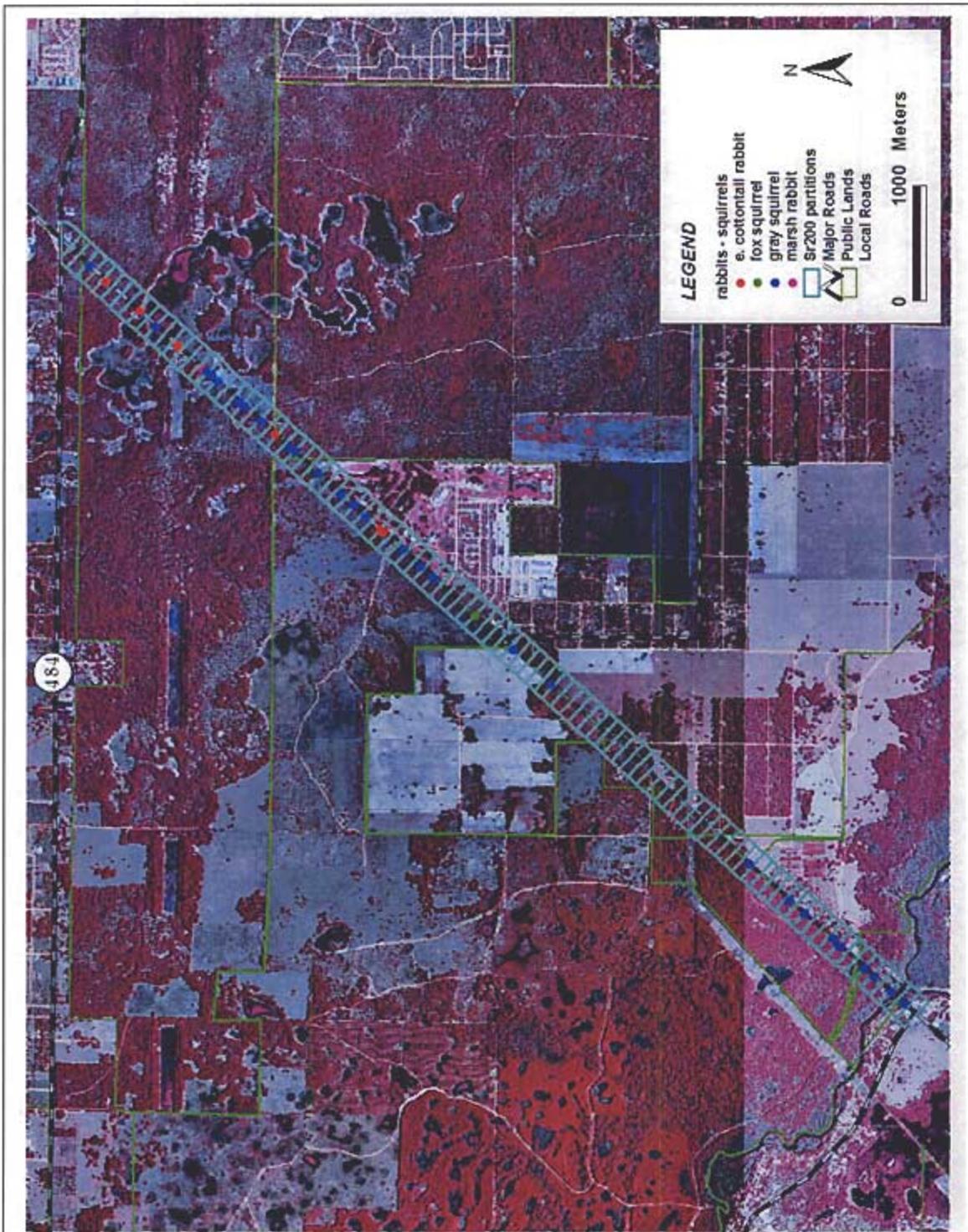


Figure 127. Spatial Distribution of Road-killed Meso-mammals on SR 200 between April 2002 and April 2004.



**Figure 128. Spatial Distribution of Road-killed Rabbits and Squirrels on SR 200, between April 2002 and April 2004.**

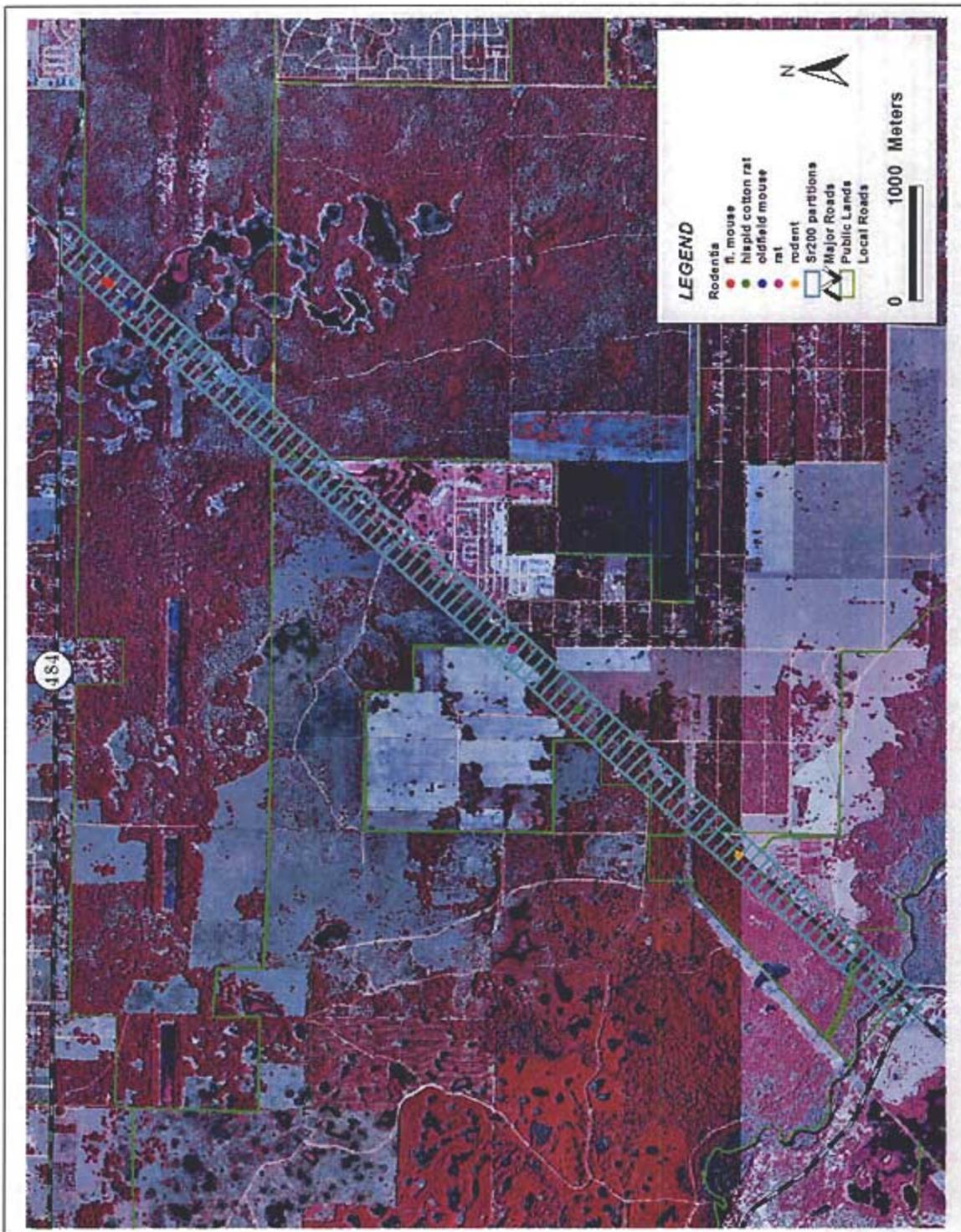


Figure 129. Spatial Distribution of Road-killed Rodents on SR 200 between April 2002 and April 2004.



Figure 130. Location of Road-killed Florida Mouse and Sherman's Fox Squirrel on SR 200.

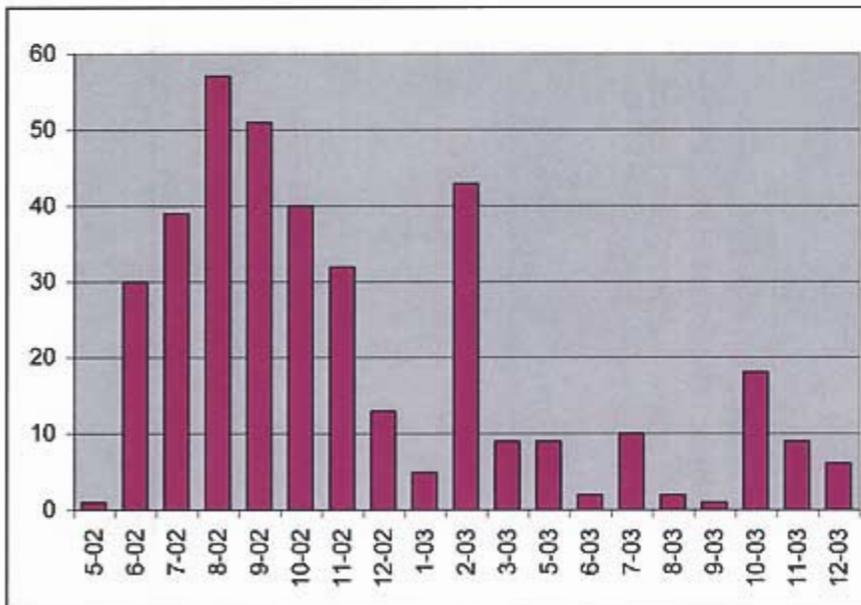
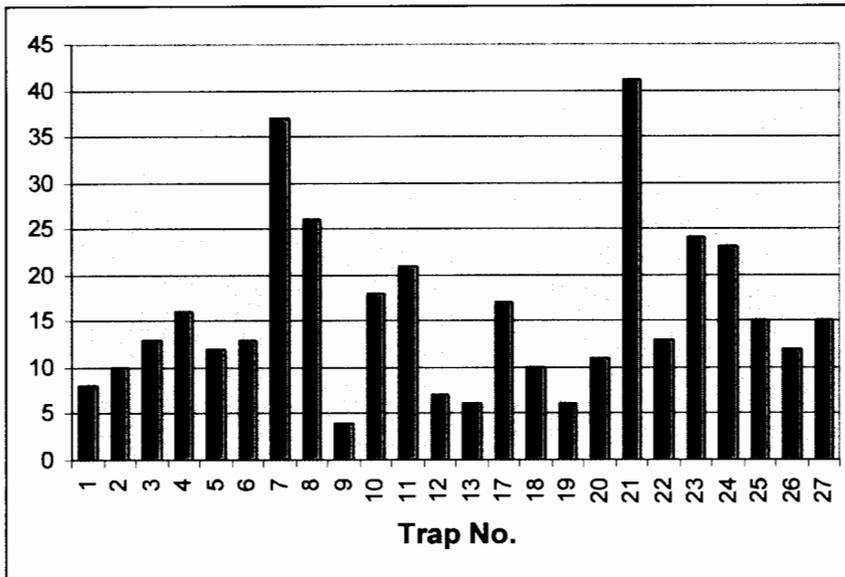


Figure 131. Captures of Small Mammals in Right-of-Way Drift Fences by Month, May 2002 – December 2003.

Capture locations of small mammals are shown in Figure 32 and Figure 132. Traps were located in five separate habitat areas (Figure 33). They include: two sandhill sections (trap nos. 1-4 and 24-27 and trap nos. 8-10 and 17-18), the wetland basin (trap nos. 5-7 and 21-23), oak scrub areas (trap nos. 11-13), and ruderal/disturbed areas (trap nos. 19-20). Of 378 captures/recaptures of small mammals, 50% were in sandhill areas, 37% were in the wetland basin, 9% were in scrub habitat areas, and 4% in ruderal/disturbed habitats.



**Figure 132. Capture Locations of Small Mammals in Right-of-Way Drift Fences, May 2002 – December 2003.**

The Florida mouse, a state-listed species of special concern, was caught at all drift fence sites except trap nos. 9 and 22 (Figure 133). The two traps along the southwest edge of the wetland basin (trap nos. 7 and 21) accounted for the most captures (n=9 and n=14, respectively).

Capture locations of other mice are shown in Figure 134. Oldfield mouse was represented by captures from trap sites in each habitat type. Cotton mouse was caught in all trap habitat types except for ruderal/disturbed sites. Golden mouse was caught in at least one trap from each habitat type except ruderal/disturbed sites. Capture locations of rats are shown in Figure 135. Hispid cotton rat was caught in at least one trap from each habitat type except oak scrub sites. Eastern wood rat was captured at drift fence nos. 8, 20 and 25. Capture locations of moles and shrews are shown in Figure 136. Eastern mole was captured at drift fence nos. 6, 10 and 12. Short-tail shrews were captured in every drift fence array. Southeastern shrew was represented by captures from trap sites in each habitat type. Only two least shrews were captured, both at sandhill sites.

A total of 24 individuals from 7 species were recaptured. Recaptures of the following occurred: Florida mouse (n=12), southern short-tail shrew (n=5), oldfield mouse and hispid cotton rat (n=2 each), and southeastern pocket gopher, golden mouse and cotton mouse (n=1 each). Of those recaptured, only one was recorded crossing the road. One cotton mouse crossed the road between trap nos. 5 and 22, a distance of approx. 180 m (Figure 137). Most recaptures occurred in the

same drift fence array (n=35); the remainder was found in the drift fence immediately next to the original capture site (n=2). Several individuals were recaptured more than once. Two Florida mice were recaptured 4 times each.

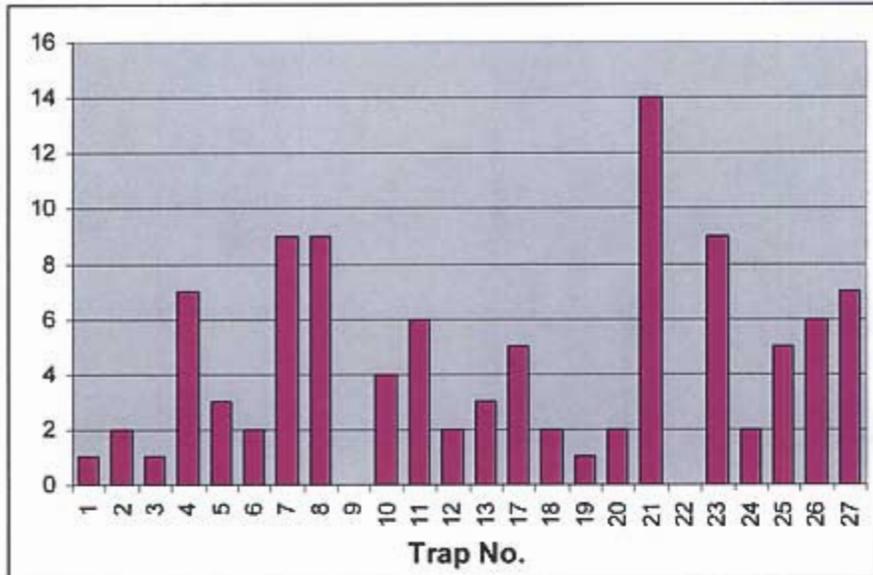


Figure 133. Capture Locations of Florida Mouse, May 2002 – December 2003.

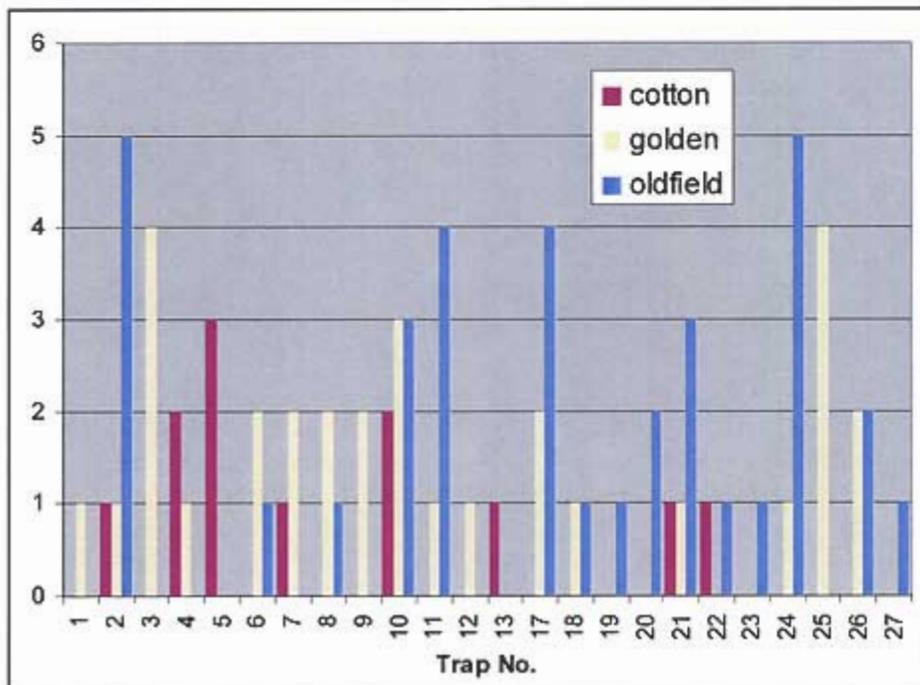


Figure 134. Capture Locations of Other Mice, May 2002 – December 2003.

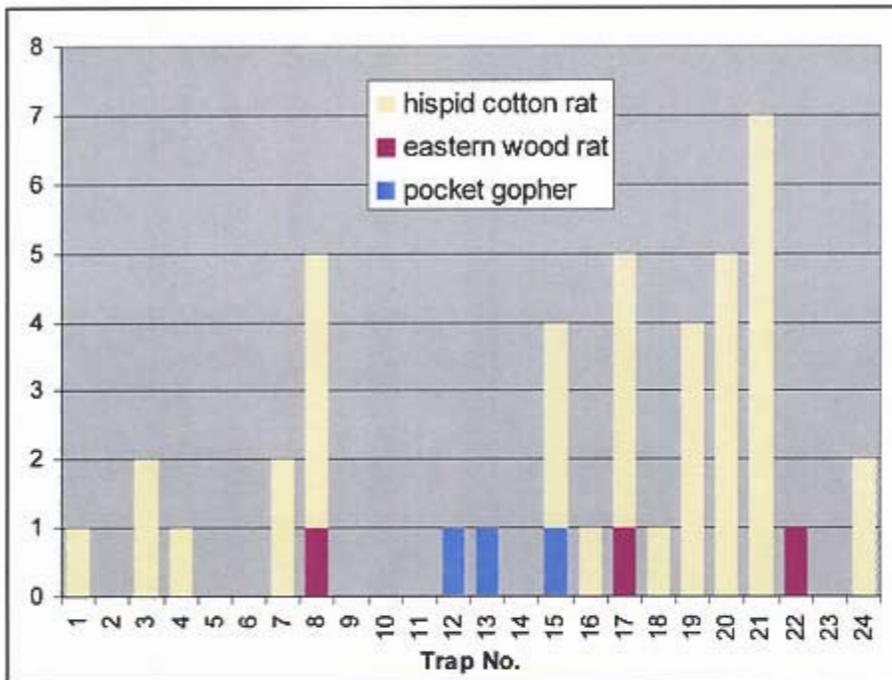


Figure 135. Capture Locations of Rats and Pocket Gophers, May 2002 – December 2003.

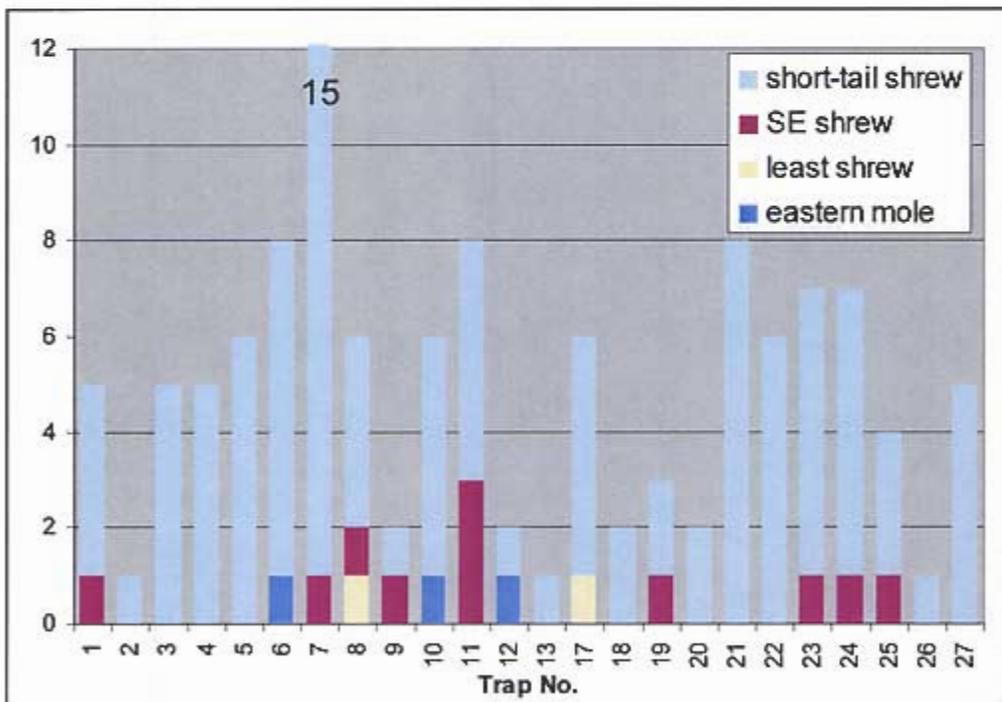


Figure 136. Capture Locations of Moles and Shrews, May 2002 – December 2003.

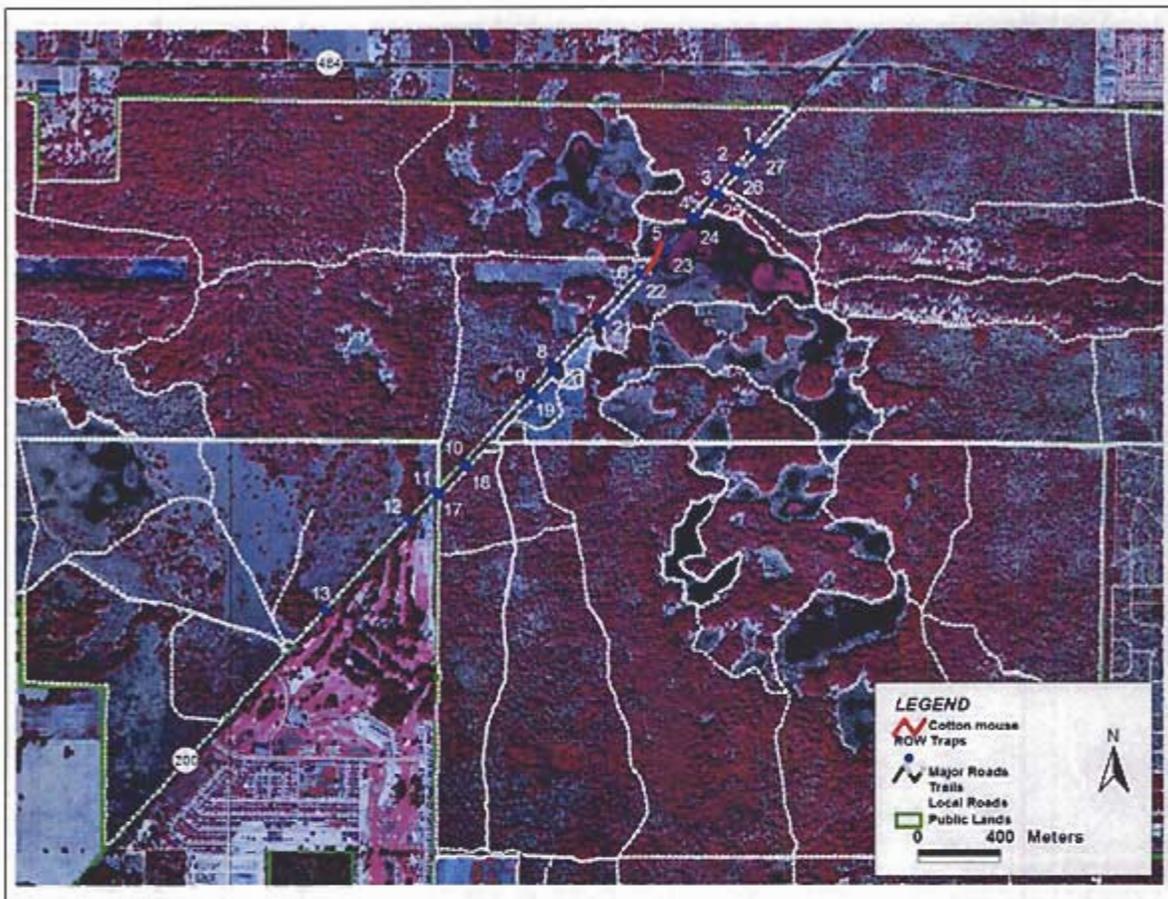


Figure 137. Location of Recorded Road Crossing of Cotton Mouse on SR 200.

Control drift fences were operated for only two months in the late winter – early spring of 2004 following the collection of right-of-way data. All habitat types sampled at the right-of-way drift fences are represented at control sites except for ruderal/disturbed. Small mammals captured in control drift fence arrays include Florida mouse ( $n=31$ ) and golden mouse ( $n=1$ ). Recaptures included 9 Florida mice and 1 golden mouse. Notably absent are the oldfield mouse and hispid cotton rat that are common in this area. In addition, no shrews were captured. Given more time to conduct control sampling, we suspect that most representatives found in right-of-way traps would have been captured in control areas.

A Kruskal-Wallis Test was performed on those species described in Table 15 to evaluate significance of plant community type to number of captures. The Short-tailed shrew was significant showing an increase in mean captures in traps in sandhill, mesic hammock and wet prairie habitat near the Ross Prairie basin area ( $\chi^2 = 10.96$ ,  $p = 0.027$ ). None of the other 10 species were significant regarding mean number of captures and capture site plant community type. Student's  $t$  was used to determine central tendency and Kolmogorov-Smirnov was used to determine departures from normality. Results of these tests were inconsistent. For most species sample size was too small, thus distributions were not normal and the means within each community type were not central to the distribution. As explained under the section on herpetiles,

disturbance-dominated habitat edges and coarse land cover resolution account for the lack of difference by plant community type.

**Culvert Use.** Culverts were checked twice weekly from December 2002 to February 2004 (locations are shown in Figure 138). Few small mammals and no herptiles were recorded using these culverts over this period. This was likely due to weather conditions and substrate properties. Substrate at the golf course site was sandy soil of loose consistency and the prairie site contained moist organic-clay based soils with a rigid consistency. Neither of these soil types is conducive to reading small tracks from animals of little mass. In the loose sand precipitation can easily wipe away small tracks; a significant amount of rainfall occurred in 2003. In the rigid organic-clay soils, animals of little mass do not weigh enough to leave a significant impression. Also, as mentioned in the carnivore section, significant flooding prevented our ability to read tracks and precluded use by many terrestrial-based organisms.

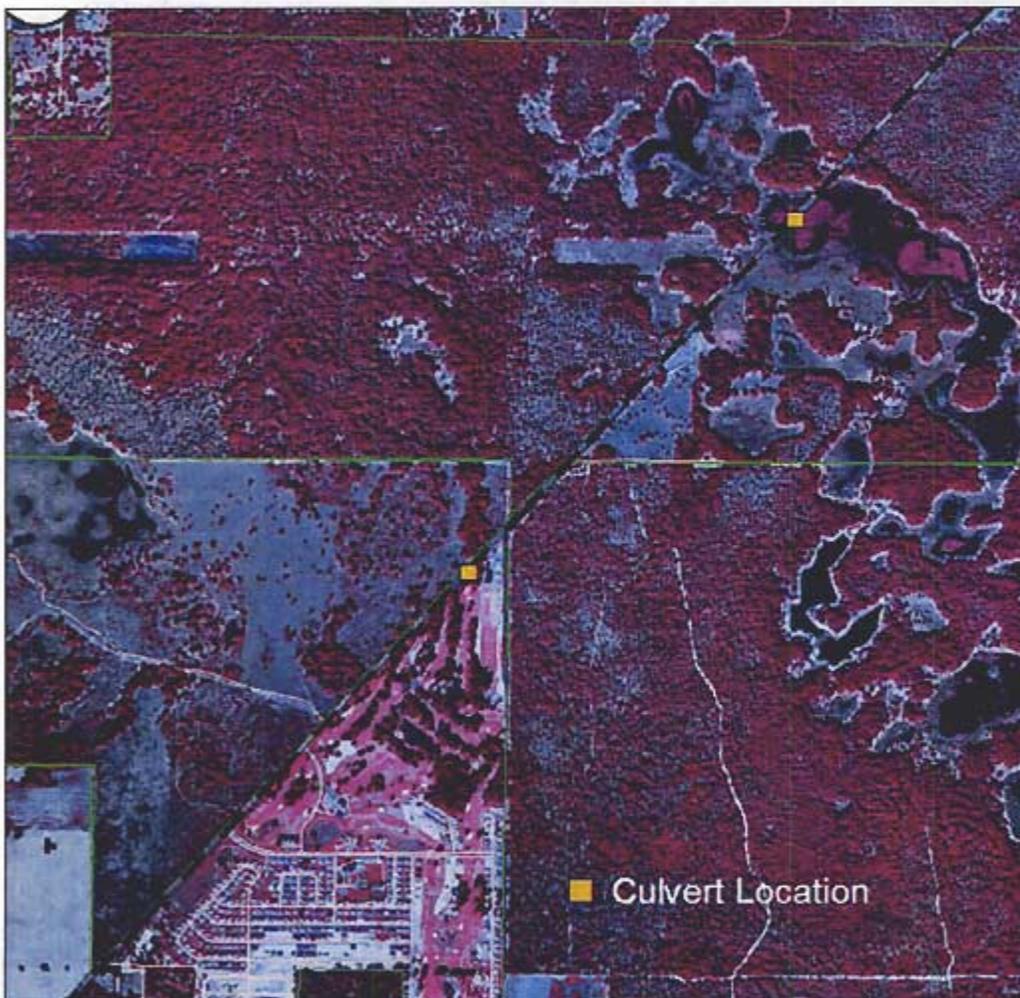
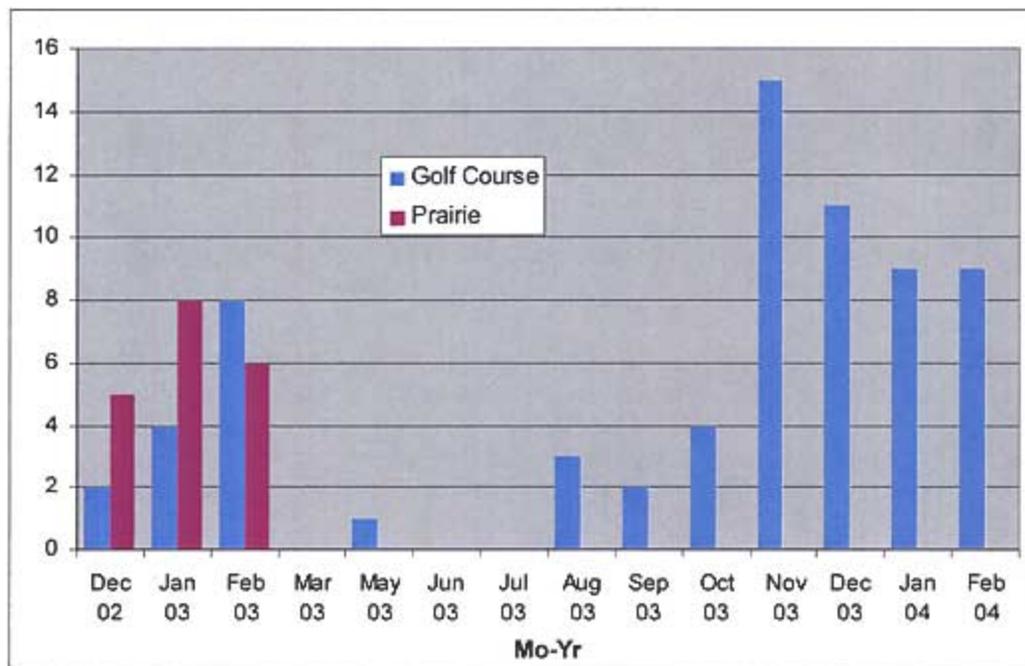


Figure 138. Location of Monitored Culverts on SR 200 in the Ross Prairie Area.

Of 110 trips to each site, the golf course site had no tracks on 62 occasions and the prairie site had no tracks on 7 visits. Records for the golf course site showed animal use in 42 of 104 functional visits (40%). The prairie site produced the following results, though it was not functional for terrestrial species for much of the study period: tracks found in 9 of 16 functional visits (56%). Table 16 provides a list of small- to medium-sized mammals that used each culvert. Seventy-seven of these animals were recorded from both sites. Of all taxa recorded (n=87), opportunistic meso-carnivores were dominant at the golf course and prairie sites (78% and 58%, respectively). A breakdown of total culvert use by month is provided in Figure 139. Mammal use of culverts was higher in cooler than warmer months.

**Table 16. Small and Medium-sized Mammal Use of Existing Culverts, December 2002 to February 2004.**

Species	Golf Course	Prairie
Armadillo	44	
Opossum	3	6
Raccoon	6	5
Rodent	13	
<b>Total</b>	<b>66</b>	<b>11</b>

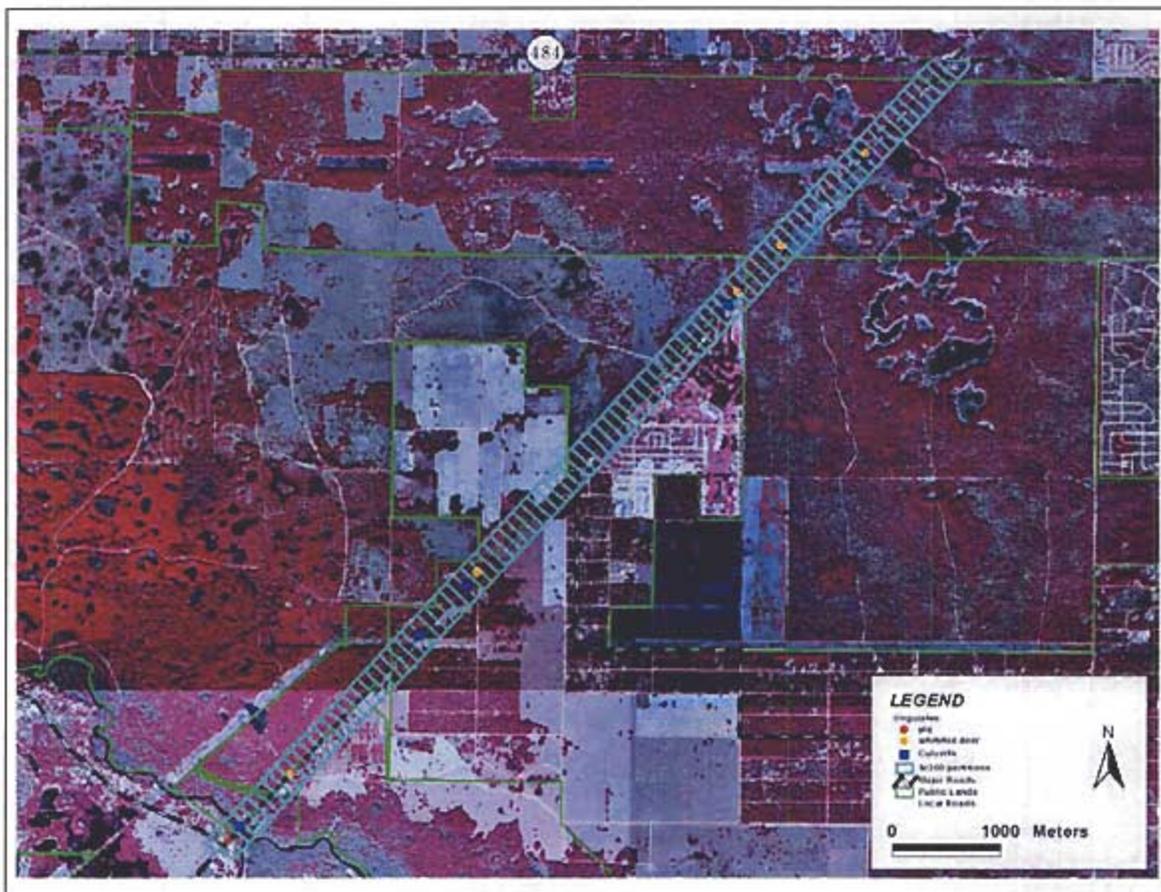


**Figure 139. Change in Wildlife Use of Culverts by Month, December 2002 to February 2004.** Note that monitoring was not conducted in April 2003 and that the prairie site was flooded from March 2003 to February 2004.

## Ungulates

Besides general observations of ungulates, specific tasks performed to determine road impacts included road-kill, track and culvert monitoring.

**Road-kill.** Surveys were conducted five days per week on SR 200 from April 2002 to April 2004 (except mid-December 2002 to mid-January 2003 and April 2003). Six ungulates were found killed by collisions with motor vehicles (Figure 140). This included 5 white-tail deer and 1 pig. One white-tail deer was reported by SWFWMD in 2001. Three of the deer were located adjacent to public lands, specifically between the north and south boundary of the CFG. All deer road-kills occurred in cool weather months, one in April 2001, one in May 2002, two in November 2003 and one in April 2004. A list of all road-kills recorded can be found in Appendix D.

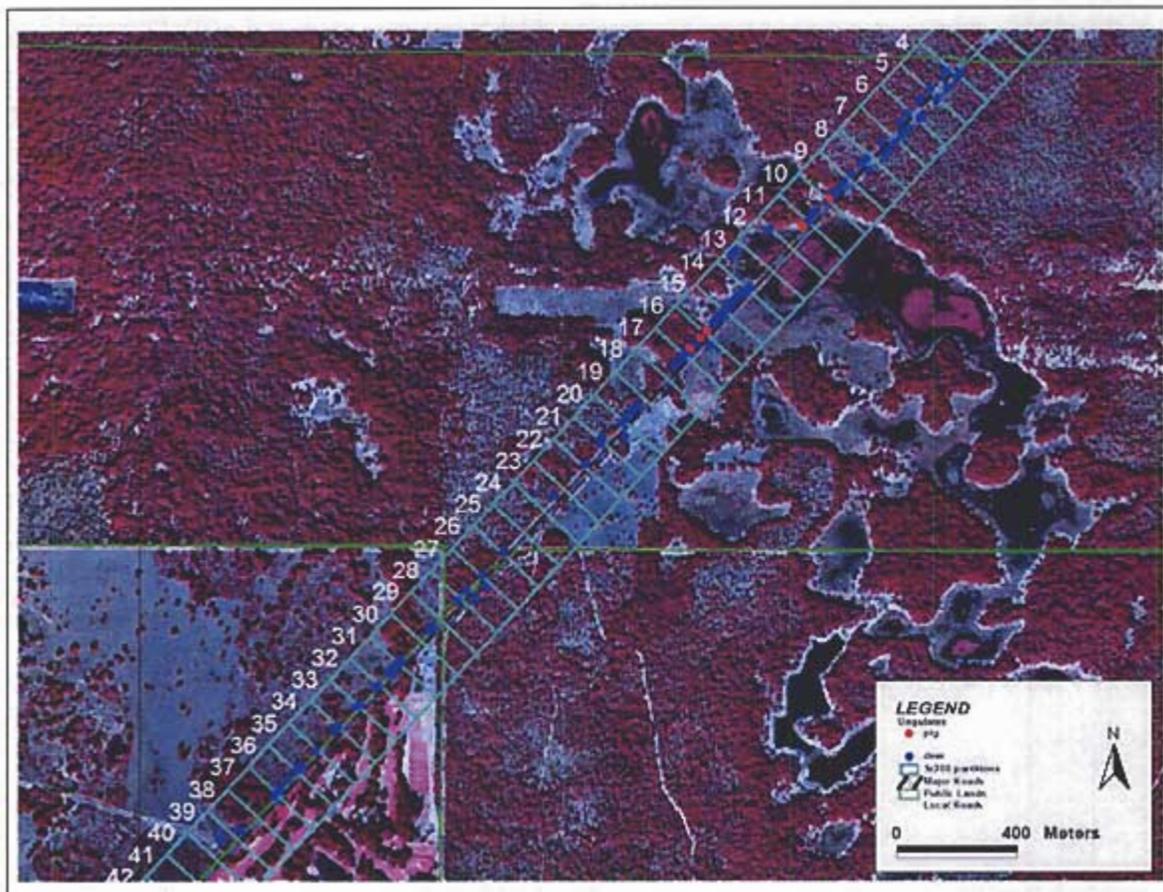


**Figure 140. Location of Ungulate Road-kills Documented from April 2001 to April 2004.** Orange dots represent white-tail deer, red dots represent pig, and blue squares represent culverts.

**Tracks.** Tracks were monitored on firebreaks on both sides of SR 200 from CR 484 to the main entrance to the HTP. This task was executed once or twice weekly from September 2002 to April 2004 (except November 2002 – February 2003, and April and September 2003). We recorded 547 sets of ungulate tracks. This included 537 sets of white-tail deer tracks, and 10 sets of feral

pig tracks. We were only able to document two successful crossings by white-tail deer (road partition nos. 7-8 and 27). See additional explanation regarding track identification and confirmation of road crossings in the tracks section for carnivores.

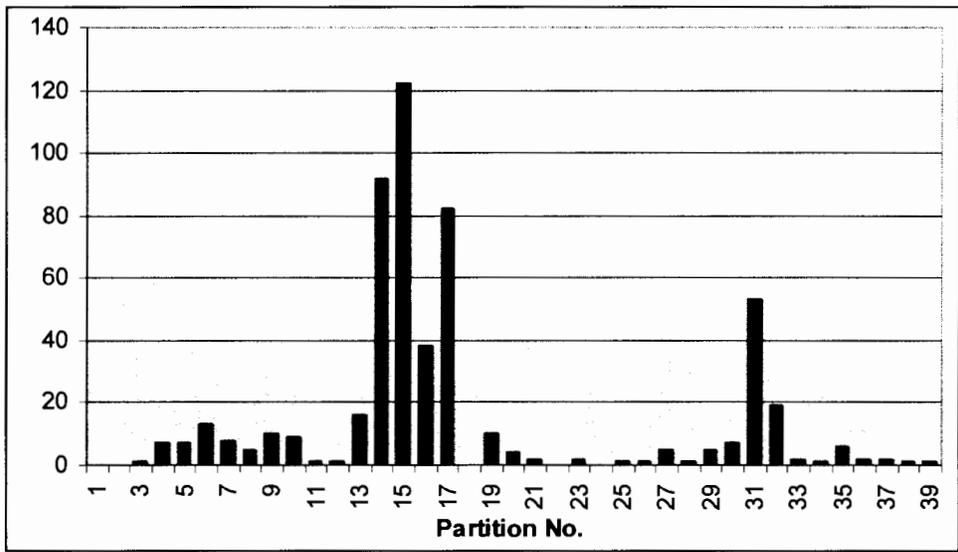
Location of ungulate tracks is shown in Figure 141. Feral pig tracks were found in road partition nos. 9, 11, 15 and 16. White-tail deer tracks were found throughout the monitoring transects. Certain locations had more deer movement activity than others. To illustrate this point, road partitions were divided into four general habitat areas (Figure 141). They include: sandhill sections (partition nos. 1-8 and 20-27), the wetland basin (partition nos. 10-15), hardwood hammocks (partition nos. 9, 16-19, 30 and 37) and oak scrub areas (trap nos. 28-29, 31-36 and 38-39). Of 537 sets of white-tail deer tracks, 45% were in the wetland basin, 28% were in hardwood hammock habitats, 17% were in scrub habitat areas, and 10% were in sandhill areas.



**Figure 141. Track Locations of White-tail Deer and Feral Pig, September 2002 to April 2004.** Road partitions are 100 m wide sections; red dots represent white-tail deer and blue dots represent feral pig.

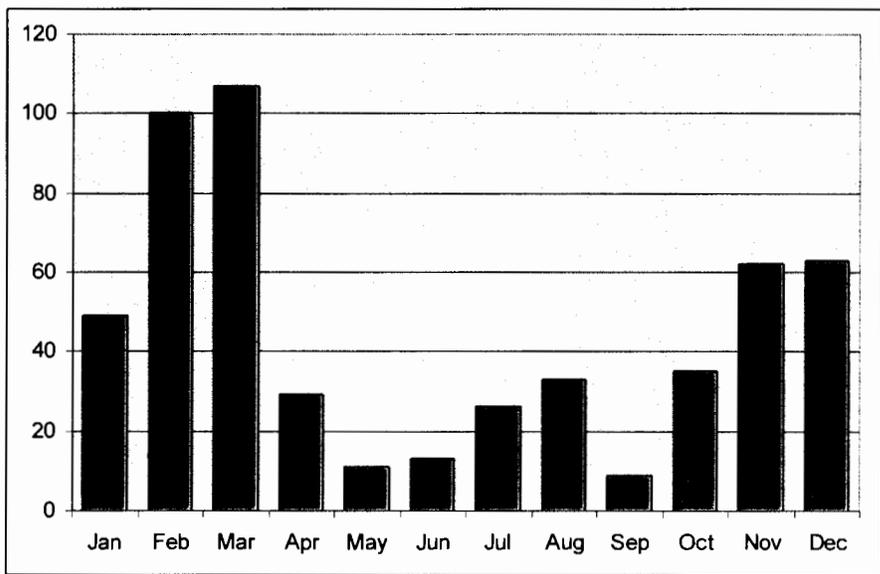
Figure 142 displays actual number of tracks recorded by road partition. In sandhill habitats the tracks were spread across all partitions. In the wetland basin and part of the hardwood hammocks (road partition nos. 13-17) a large spike occurs. Another peak occurs in the oak scrub area (road

partition no. 31). This partition has a small depression wetland in it. These trends would indicate that significant deer movement occurs between hardwood hammock and wet prairie areas, however a Kruskal-Wallis test revealed no such association ( $\chi^2 = 8.88, p = 0.35$ ).



**Figure 142. Number of White-tail Deer Tracks by Road Partitions.**

Monthly distribution of white-tail deer tracks is shown in Figure 143. Despite the months when track monitoring was not conducted, there still appears to be more movement in the cooler months.



**Figure 143. White-tail Deer Track Records by Month, September 2002 to April 2004 (n=431).** Tracks were not monitored in November-December 2002 and January-February, April, and September 2003.

**Culvert Use.** The two existing structures were monitored twice weekly from December 2002 to February 2004. Only the prairie site (Figure 138) was large enough to accommodate ungulates, though it was flooded and impassable by terrestrial species for all but 3 months of the study. This resulted in few records of white-tail deer (n=3) and wild pig (n=2).

### Birds

Even though terrestrial species were the primary focus of this study, some road-kill data was collected that provides indications of potential road impacts to this faunal class.

**Road-kill.** Surveys were conducted five days per week on SR 200 from April 2002 to April 2004 (except mid-December 2002 to mid-January 2003 and April 2003). Figure 144 shows all road-kills recorded between April 2002 and April 2004. Road-kill surveys were conducted 5 days per week during this period (except mid-December 2002 to mid-January 2003 and April 2003). A total of 20 birds were recorded. A list of all road-kills recorded can be found in Appendix D.

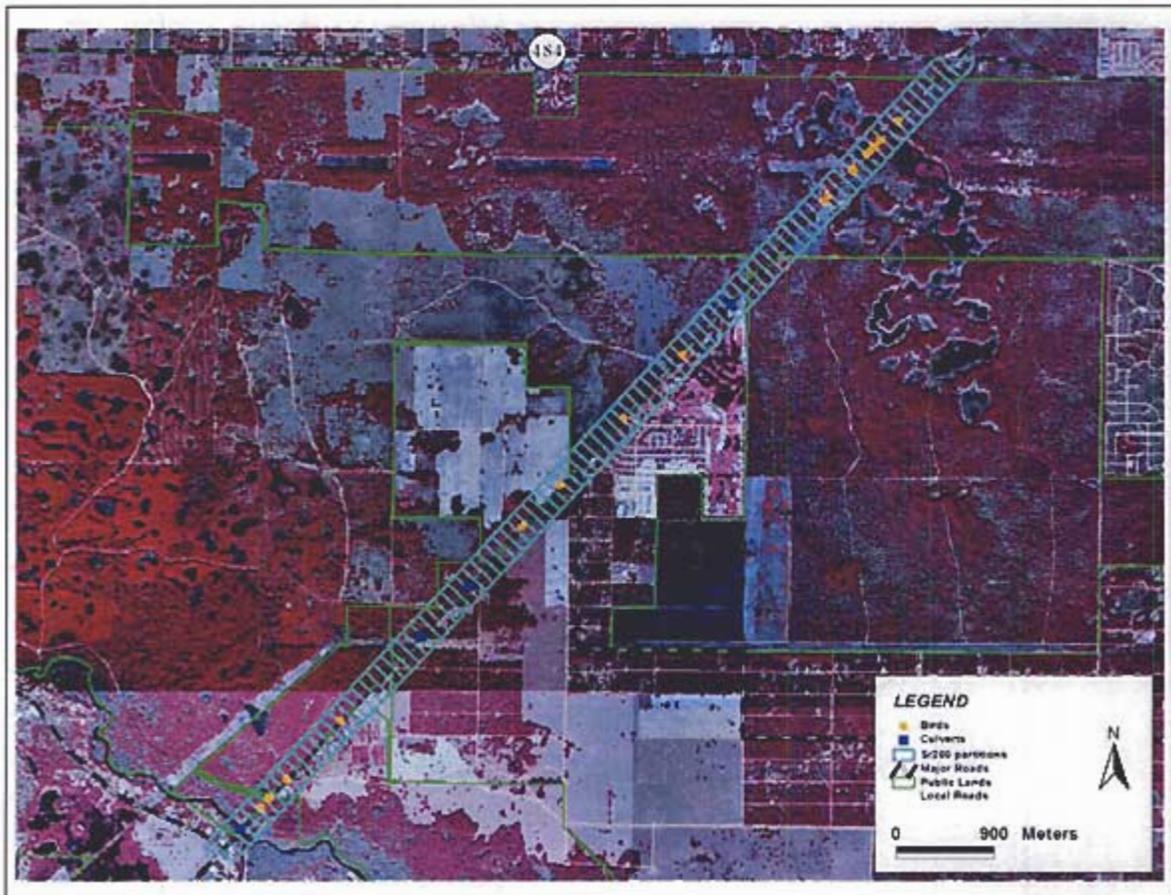


Figure 144. Location of all avian road-kills recorded between April 2002 and April 2004.

Aside from two concentrated clusters at the Ross Prairie basin and near the Withlacoochee River, avian road-kills were sporadically distributed from CR 484 to CR 39. No road partition (For analysis, the monitored section of SR 200 was spatially divided by 100 m wide partitions) had more than 2 road-kills. Grouping partitions by significant adjacent land use/ownership (Figure 12) revealed different patterns. The majority (70%) of birds were found adjacent to public conservation lands.

Three types of birds were found, raptors/scavengers, passerines and wetland-dependents (Table 17). Raptors/scavengers (Figure 145) include screech owl (n=4), great-horned owl (n=1), barred owl (n=1), unknown owl (n=1) and black vulture (n=1). The passerines (Figure 146) include boat-tailed grackle (n=2), northern cardinal (n=1), yellow-shafted flicker (n=1), tufted titmouse (n=1), Carolina wren (n=1), and crow (n=1). The wetland-dependent species found (Figure 146) were the purple gallinule (n=2) and the red-winged blackbird (n=1). Because of their small size, birds do not persist on the pavement for long once killed. This is likely why not many were found.

**Table 17. Road-killed Birds on SR 200, April 2002 – April 2004.**

<b>Scientific Name</b>	<b>Common Name</b>	<b>No.</b>
<i>Agelaius phoeniceus</i>	Red-wing Blackbird	1
Aves	Bird	2
<i>Bubo virginianus</i>	Great-horned Owl	1
<i>Cardinalis cardinalis</i>	Northern Cardinal	1
<i>Colaptes auratus</i>	Yellow-shafted Flicker	1
<i>Coragyps atratus</i>	Black Vulture	1
<i>Corvus spp.</i>	Crow	1
<i>Otus asio</i>	Screech Owl	4
<i>Parus bicolor</i>	Tufted Titmouse	1
<i>Porphyryla martinica</i>	Purple Gallinule	2
<i>Quiscalus major</i>	Boat-tailed Grackle	2
Strigidae	Raptor (possible owl)	1
<i>Strix varia</i>	Barred Owl	1
<i>Thryothorus ludovicianus</i>	Carolina Wren	1

Figure 147 shows the cluster (road partition nos. 14 and 18) of screech owls (n=4) all killed 11/8 and 12/27 of 2003 in the Ross Prairie basin. Raptors commonly scavenge on other road-kills and frequently are struck by vehicles themselves. Figure 148 shows the cluster of other species killed in close proximity to the Ross Prairie basin. The wetland basin appears to be a hotspot for avian road-kills, particularly wetland-dependent species and scavenging raptors.

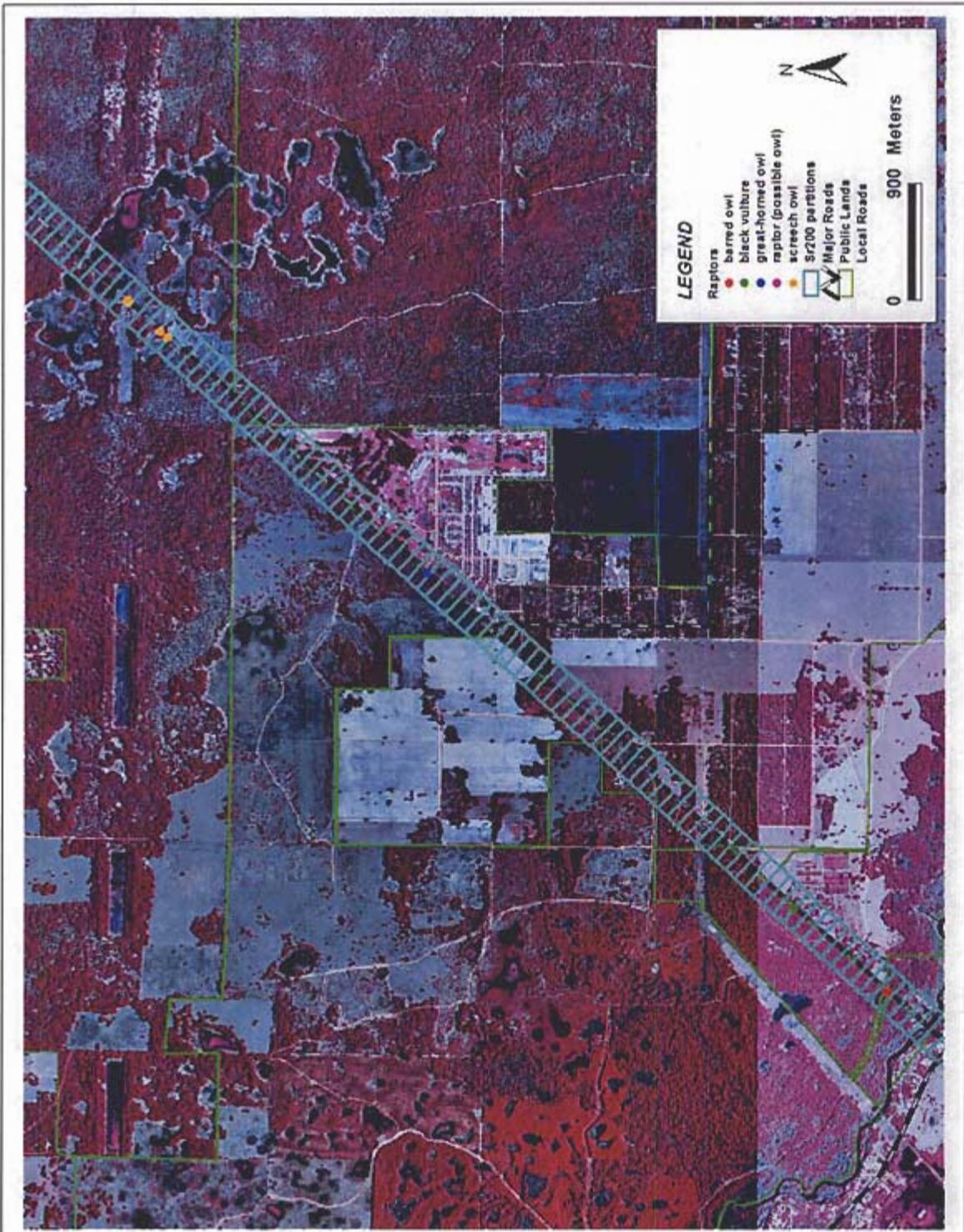


Figure 145. Spatial Distribution of Raptor/Scavengers on SR 200.

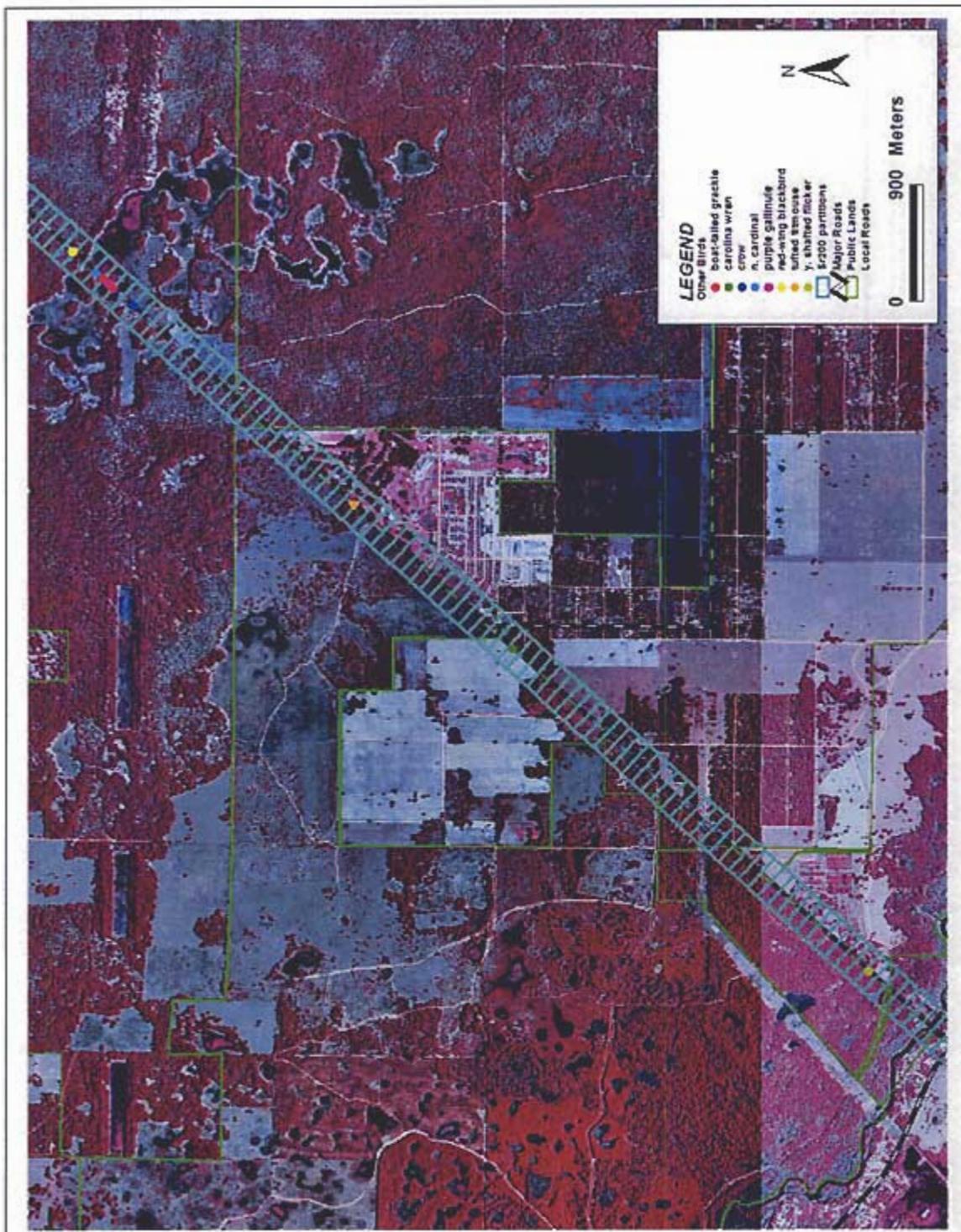


Figure 146. Spatial Distribution of Other Birds on SR 200.

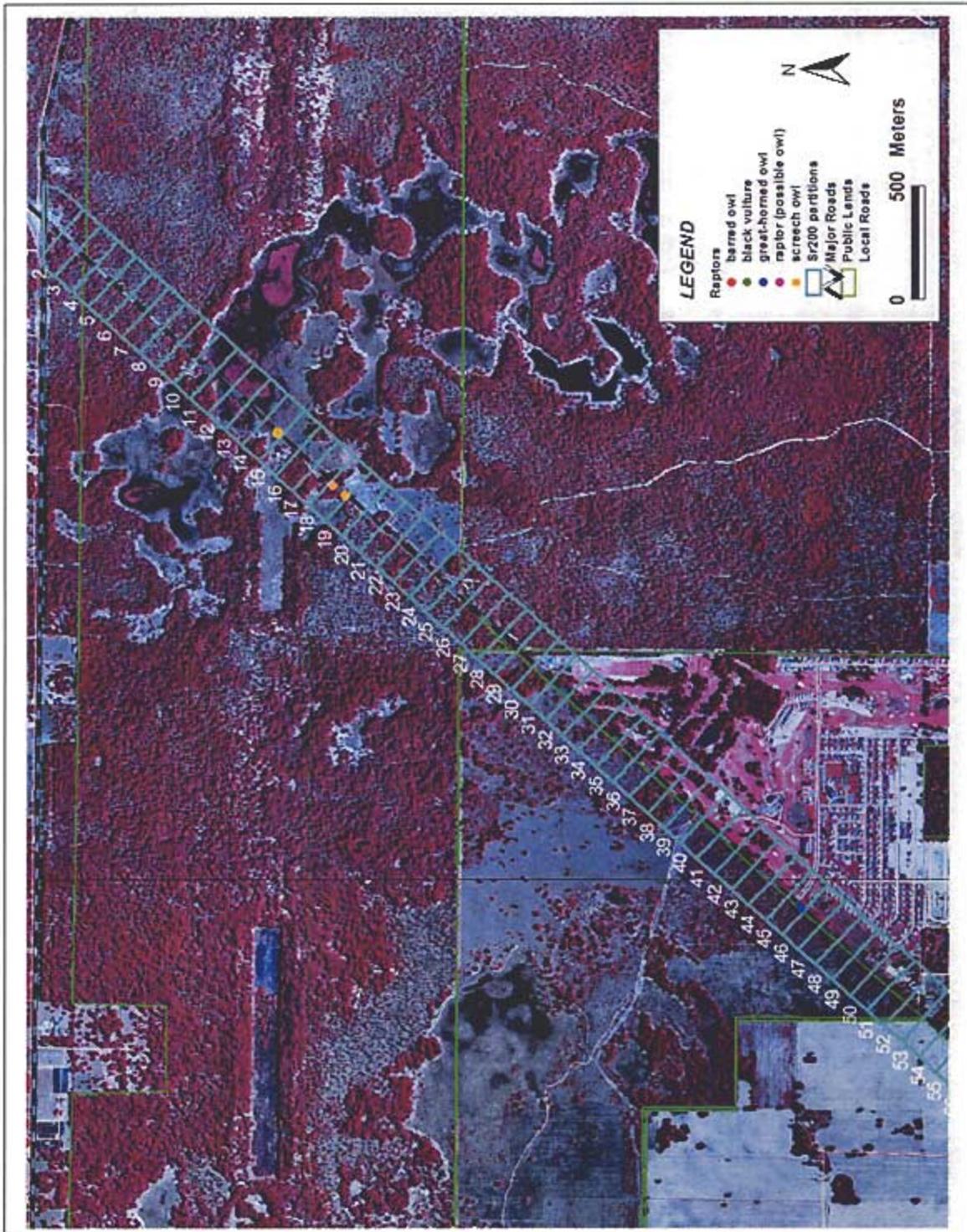


Figure 147. Inset of Raptor Road-kill Locations on SR 200.

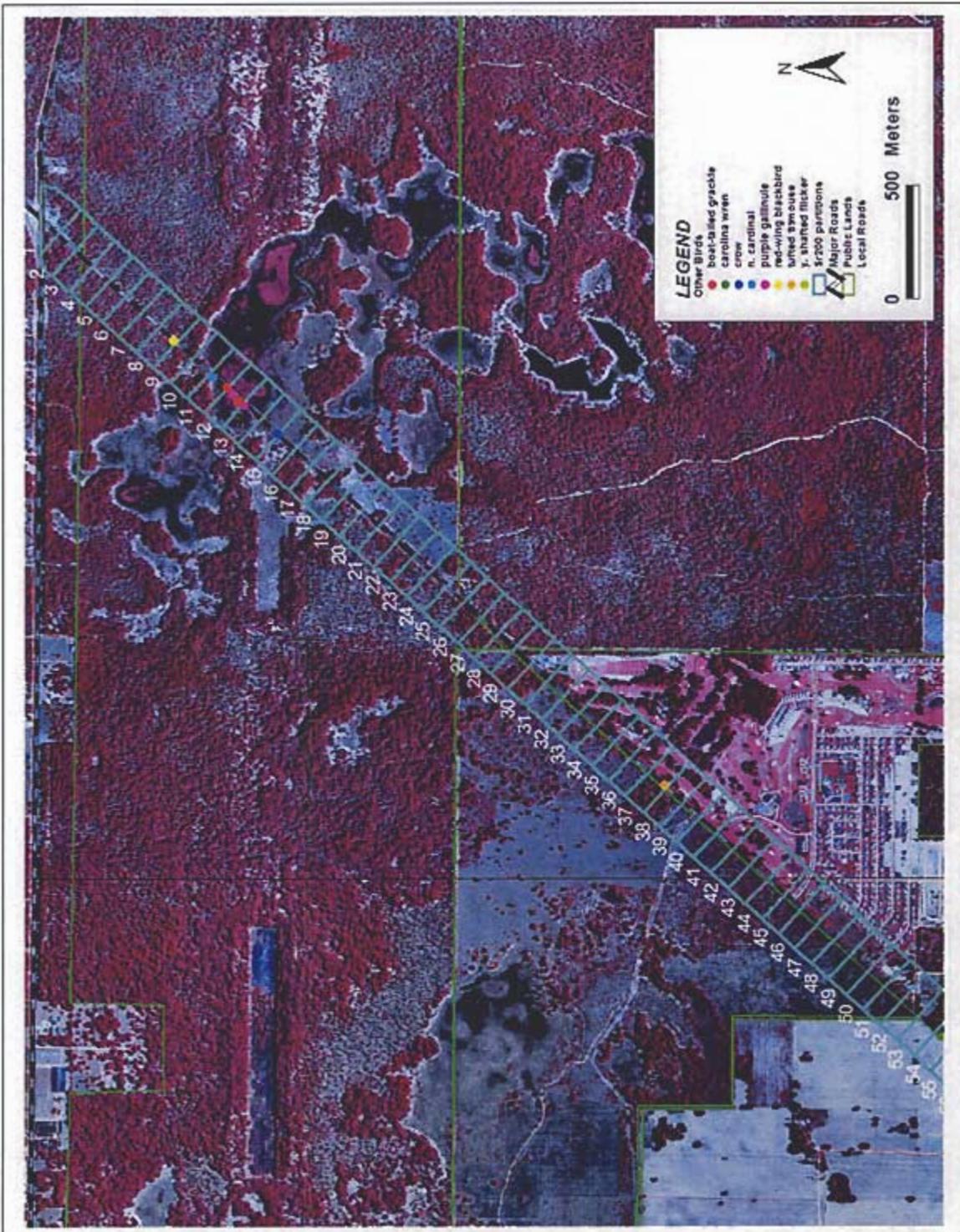


Figure 148. Inset of Other Bird Road-kill Locations on SR 200.

## DISCUSSION

This discussion includes a summary of the results and sections on highway retrofitting, planning and management implications.

### Summary of Results

This section provides a summary of the extensive findings of the different research activities conducted in the project. The application of these findings is discussed with regard to adverse impacts of the road and potential changes that may occur if road widening takes place. Most road-kill, track, and mark-recapture will be discussed with reference to Figure 149, the road partition grid.

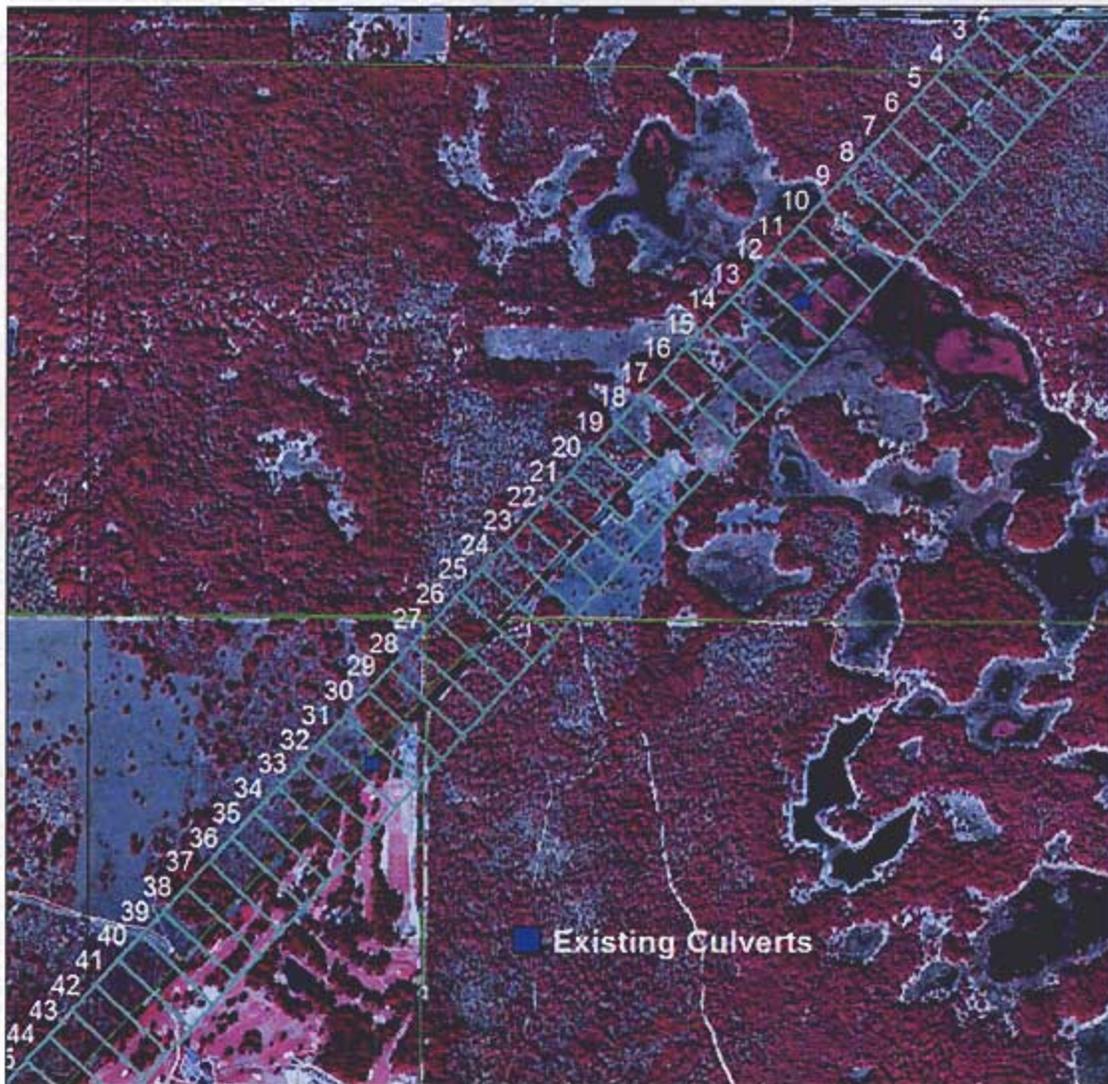
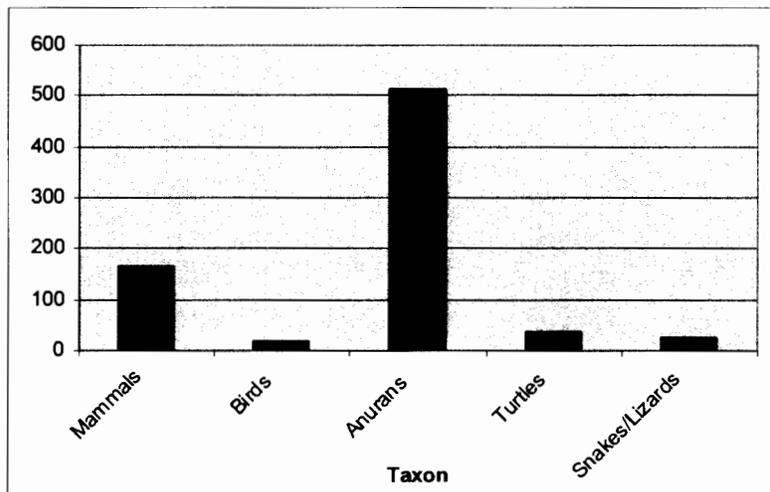


Figure 149. SR 200 Road Partition Grid. Each grid cell is 100 m wide.

### **Road-kill summary**

During the period of April 2002 to June 2004, 759 individual animals were found on 9.8 km of SR 200 (CR 484 to CR 39). There was 57 identifiable species. The majority were anurans followed by mammals (Figure 150). Proportions by taxa differ from that recorded at Payne's Prairie State Preserve in 1998-99 (Smith and Dodd 1999). In that study significantly greater numbers of alligators, aquatic snakes and turtles were found. Payne's Prairie contains much more year-round surface water than Ross Prairie resulting in higher numbers of aquatic-dependents. Most notable were the focal species killed: bobcat (n=5), gray fox (n=8), eastern indigo snake (n=5), eastern diamondback (n=1), Florida gopher frog (n=51), bullfrog (n=24), Florida box turtle (n=3) and gopher tortoise (n=9). Notably, several owls (barred, great-horned and screech) preying upon these road-kill were also killed.



**Figure 150. Total Number of Road-kills by Taxon.**

Critical locations (Figure 149; road partition nos.) of significant numbers or rare species of road-kills by taxa include anurans (4-16, 20-21, 25-27), snakes (10-12, 14, 20-21, 27, 31, 37), turtles (4, 7, 9-13, 15-17, 24, 27, 48, 77, 85, 94), carnivores (5, 10-11, 17, 26, 33, 52), small mammals (6, 49), ungulates (12, 32, 89) and birds (14, 18, 35). Three significant areas need attention: the two sandhill crossing areas (road partition nos.3-8 and 25-28) and the wetland basin (road partition nos. 9-17). Another significant hotspot was the river buffer area (Gum Slough CE). Some significant road-kill also occurred in sections where public land is on the west and private land on the east of the road.

We found a significant positive relation between amount and timing of rainfall with number of road-killed herptiles. Similar findings have been reported (Smith 1996, Bernardino and Dalrymple 1998, Dodd et al. 1989).

### **Track summary**

A total of 537 sets of whitetail deer, 481 sets of carnivore, and 474 sets of snake tracks were recorded. Contrary to a similar track study performed in Ocala National Forest on SR 40 for

black bears (McCown et al. 2004), we did not assume that presence of tracks equaled a successful crossing. Several factors contributed to this: 1) possibility of aborted crossing attempts, 2) two of three faunal groups we monitored (snakes and ungulates) use the right-of-way for foraging, and 3) transects were not proximal to the paved surface making it difficult to match tracks from either side of the highway. Because of these factors we reported the degree of activity as well as confirmed crossings. Confirmed crossings for species by road partition nos. are shown in Table 18.

**Table 18. Confirmed Crossing Locations from Tracks Recorded on Sand Transects.**

<b>Species</b>	<b>Road Partition No.</b>
Bobcat	7-8 and 10
Coyote	3-10, 14-20, 23-24 and 27-30
White-tailed Deer	7-8 and 27

Note: refer to Figure 149 for road partition locations.

As with the road-kill, significant hotspots of activity are evident. Track site hotspots were identified for snakes, white-tail deer and carnivores. In most instances these correspond to the same road partitions identified as road-kill hotspots. For snakes, road partition nos. 3-10, 13-16, 24-29, and 32-37) had significant activity. Crossing attempts were evident for bobcats and gray fox at road partition nos. 3-10, 15, 17, 19-20, 22-23, 27-28, and 31. For white-tail deer many tracks were recorded at road partition nos. 4-10, 14-17, 19-20, 27, 31, and 36.

### **Trapping summary**

A total of 1,777 herptiles were captured in right-of-way drift fence traps. The highest number of captures of Florida gopher frog occurred in road partitions 5-10, 21-22, and 25-29 indicating significant population densities of these species in these areas. We suspect that the wetland basin was only a significant hotspot during breeding season, but because those traps were flooded at that time we were unable to capture many individuals. Despite the lack of captures at the basin, their presence is evident due to the high number of road-kills. Also, several crossings were recorded at traps near the basin during breeding season indicating movement by adults to/from the sandhill areas. These recruitment patterns are similar to that of previous studies in central (Greenberg 2001) and panhandle (Palis 1998) Florida. Greenberg (2001) found that recruitment was influenced by rainfall and pond hydrology as well as competition and predation. Consistent with findings by Means (1989), the current level of road-kills have not threatened the population with extinction, but changes in highway configuration and intensity could effect long-term presence and population size if sufficient measures are not taken to insure successful recruitment and dispersal to/from the wetland basin.

Figure 37 displayed locations of other herptile captures; again it is apparent that the two sandhill crossings and the wetland basin are important from a population density standpoint as well as for crossing attempts. Individuals of several species of snakes, frogs, and lizards were recorded crossing the road in the two sandhill crossing sections, and moving to/from the Ross Prairie wetland basin (road partitions 5-10, 21-22, and 25-29).

For Florida mouse the most captures (5-15) occurred in traps in road partition nos. 6-10, 12-13, 17, 20, and 28. When all small mammal captures are considered the graph is a near mirror image (Figure 132 and 133), meaning highest densities of small mammals occurred in the aforementioned road partitions. Of 342 small mammals (Rodentia) captured, one cotton mouse was recorded crossing the road at partition nos. 12-13. In addition, only six were found as road-kills. Apparently, the road is a significant barrier to small mammal movement. Several factors influencing this barrier effect are artificial substrate (pavement), road surface and clearance width, right-of-way vegetation management, vehicle traffic, emissions, noise and vibration (Garland and Bradley 1984, Mader 1984, Wilkins 1982, Kozel and Fleharty 1979, and Oxley et al. 1979).

### **Telemetry summary**

***Gopher tortoise.*** We captured 50 gopher tortoises in the entire study area. Average home range (95% FK, minimum 30 points) of the 18 gopher tortoises monitored in burrow colonies adjacent to the road was 3.14 ha. Average home range of 4 tortoises monitored in the control area was 2.00 ha. Home ranges found in this study were higher than those found at Kennedy Space Center (Smith et al. 1997) and Lochloosa Wildlife Management Area (Diemer 1992). Habitat differences may account for the variation in home range size. Our sites were primarily sandhill communities. Kennedy Space Center sites were dominated by scrub habitats and Lochloosa WMA consisted of managed pinelands.

Available quality habitat in the four colonies adjacent to the road was 64.69 ha. Burrow density for the four areas was 3.25 burrows/ha. Total home range area of monitored tortoises used in these four areas was 46.99 ha. Home range overlap of those monitored was 26.62 ha (approx. 57%). Given these figures potential carrying capacity for the areas adjacent to the road is about 32 adult tortoises. With this number of tortoises, periodic crossing attempts are almost a certainty.

Only three attempted crossings of SR 200 were recorded, two were successful and one resulted in death. Tortoises used habitat as close as 10-20 m from the pavement. For gopher tortoise, the road is a semi-permeable barrier. Successful crossings are possible; however their poor mobility increases their risk of collisions with vehicles.

***Eastern indigo snake.*** We captured a total of 24 eastern indigo snakes over the entire study area, observed 2 others and encountered 5 road-kills. A notable population of eastern indigo snakes is present in the Ross Prairie area. It is paramount to take measures to maintain and enhance this population. Total area within the 95% FK home range of the 13 eastern indigo snakes monitored was 1,335 ha. Considerable overlap of habitat use occurred. Individually, the home ranges equal 1,676 ha; this results in an overlap of 26% (341 ha), primarily between males and females, adult males and juvenile (or subadult) males, and females and females. Large adult males had little to no overlap of area usage. Home range size found here was consistent with that of Breininger et al. (2004) from Brevard County.

The areas we monitored seemed to be the best available habitat for eastern indigo snakes. The areas of highest density of eastern indigo snakes coincided with gopher tortoise colonies and

sandhill communities (also see Stevenson et al. 2003 and Diemer and Speake 1983). Though they also used oak scrub, mesic hammock, wetlands, and shrub-brushlands for foraging, the burrow areas were preferred refuge areas. Percent habitat composition of the combined home range area of the 13 subjects and overlap between them is shown in Table 19. There is another 2,900 ha of habitat available in the Ross Prairie core area in the same proportions as those seven types used most frequently by the telemetry subjects (Table 7). However additional analysis is needed to determine how much is available in similar juxtaposition to that used by telemetry subjects. This is likely an important factor so a direct translation of quantity of required habitat to available habitat is not suggested. Based on current data, and if habitat restoration efforts continue, a potentially sustainable population of 30-50 may be possible.

**Table 19. Combined Eastern Indigo Snake Home Range (95% FK) Habitat Available and Used.**

habitat	total used (n=13), ha	%	total area (combined home range), ha	overlap
agriculture	0.49	0.00	0.49	0.00
built-environment	9.38	0.01	8.23	1.15
dry prairie/grasslands	103.82	0.06	73.42	30.40
golf course	22.71	0.01	22.71	0.00
marsh-wet prairie-temporary pond	153.70	0.09	114.61	39.09
mesic hammock	346.79	0.21	250.21	96.58
mixed pine-hardwood	1.27	0.00	0.95	0.33
pasture	30.34	0.02	30.34	0.00
residential, oak scrub	4.58	0.00	4.58	0.00
residential, rural	0.73	0.00	0.38	0.35
residential, sandhill	1.43	0.00	1.43	0.00
right-of-way	8.07	0.00	6.88	1.19
sand pine scrub	24.14	0.01	14.04	10.11
sandhill	271.80	0.16	202.25	69.54
sandhill, degraded	307.16	0.18	236.60	70.55
shrub-brush lands	159.81	0.10	159.27	0.54
silviculture	40.50	0.02	40.50	0.00
water	0.01	0.00	0.01	0.00
xeric oak scrub	189.04	0.11	168.27	20.77
<b>Total - all Habitat Types</b>	<b>1675.75</b>		<b>1335.16</b>	<b>340.59</b>

Regarding the road, the individuals we tracked seemed to use it as a home range boundary. We had signal echoes of one individual that may have crossed the road, though we were not able to confirm this possibility. Its transmitter failed and we were unable to relocate it. Of course, because of road-kills, there is confirmed evidence that they do attempt to cross on occasion.

**Carnivores.** Only 5 bobcats, 2 coyotes, 1 gray fox and 1 red fox were captured and used in the carnivore telemetry study. Yet observations, track and scat evidence suggest that a significantly higher number of these animals were present in the Ross Prairie area. Known human-related mortality for those captured was high (50%) and disposition of the coyotes and red fox are unknown. Four of five bobcats died (2 road-kills, 1 shot, and 1 natural).

Average home range size was 13.67 km<sup>2</sup> for bobcats with more than 40 recorded positions. This is greater than that recorded by Thornton et al. (2004), less than Maehr (1997) or Foster and Humphrey (1992), but similar to that of Tigas et al. (2002). The former three studies were conducted in much larger conservation areas whereas the latter study was similarly conducted in smaller fragmented habitat areas.

Highest percentages of habitat within the 95% FK home ranges (bobcat nos. 1-3) included hardwood-cypress swamp/forest (25%), silviculture (22%), mesic hammock (12%), and shrub-brushlands (10%). The bobcats in this study seemed to avoid some of the typical areas, such as non-forested wetlands which generally lacked adequate numbers of prey, or were not appropriate for denning. Though they used silvicultural areas more than expected, condition of most planted pine areas had significant shrub and ground cover layers favoring high densities of rabbits (based on daily observations), one of the bobcats preferred prey. Habitat types used in this study were more similar to that in Maehr (1997) and Foster and Humphrey (1992) than that in Thornton et al. (2004).

The unexpected habitat utilized by bobcat no. 4, very close to a residential neighborhood and substantially comprised of scrub habitat, may have been related to her age, inexperience, intraspecific competition, or interspecific (with coyotes) competition. Results also may be skewed due to the low number of locations generated for this bobcat before it died. High levels of use of scrub in the core area of a bobcats' home range has been reported in Florida at the Avon Park Air Force Bombing Range (Thornton et al. 2004). They suggested that scrub habitat may contain high levels of desired prey and increase a bobcat's stalking effectiveness.

Most radio-collared felids avoided SR 200 or used the road as a home range boundary, whereas the radio-collared canids commonly crossed major roads. Tigas et al. (2002) found that bobcats and coyotes adapted to habitat fragmentation and human activity through temporal and spatial avoidance. They also supplemented diet with available human-related foods (fruit, garbage, and pets). Lastly, roads and developed areas were commonly crossed when moving between habitat fragments. Vehicular collision was the principal means of mortality. We found similar behavioral characteristics and movement patterns.

Bobcats generally maintain intrasexual exclusiveness but neighboring bobcats may have some degree of overlap (Foster and Humphrey 1992). Conversely, the intersexual coexistence of bobcats is commonly found (Foster and Humphrey 1992). Our results in the HTP were consistent with this, a female bobcat with overlap into two separate male bobcat home ranges.

Based on telemetry and observational data, the size and configuration of the core area (a significant amount of edge habitat and high road density), and the level and sources of mortality the Ross Prairie core area can only sustain a small number of bobcats, perhaps 8-10 animals. Life expectancy of bobcats and gray foxes in this area is probably below average due to the risks associated with the proximity to human-dominated habitats. In addition, the presence of coyotes may increase mortality levels as a result of interspecific competition and predation (Fedriani 2000). Considering all these factors, the area generally functions as a sink for these two carnivores.

## Highway Retrofit Recommendations

Current culvert configurations are inadequate to provide necessary levels of permeability for wildlife in the bisected conservation area (Figure 149). We only recorded marginal use of these structures, one 1.3 m wide box culvert and one .75 m pipe culvert (Table 16). In addition significant numbers of road-kills were recorded adjacent to both culverts. These included an eastern indigo snake road-kill found near the golf course culvert and 140 frogs killed within 50 m of the prairie basin culvert. The location of the culvert at the prairie basin was chosen based on hydrological needs, not wildlife accessibility; it was flooded and impassable to terrestrial-based species for 12 months of the time we were monitoring the structure. However, there was indication that with proper design and placement more consistent use by animals such as bobcat, fox, and deer may occur.

The Ross Prairie Conservation Area provides an opportunity to improve upon the design constructed at Payne's Prairie State Preserve (Smith 2003). At Payne's Prairie, the low elevation of the existing 4-lane highway limited the ability of engineers to design and construct a system of structures that function in all environmental conditions. Structures that were installed were smaller than recommended because of low clearance between the pavement and mean high water line of the prairie. Also, recent visits to Payne's Prairie have demonstrated that during high water periods, the structures are completely inundated. This likely prevents most air-breathing animals from using the culverts. To exacerbate the problem, private ownership at the ecotones of the prairie prevented construction of additional culverts/bridges that would have allowed for safe passage of terrestrial species moving along the perimeter of the prairie during high water periods. Ross Prairie does not possess these limitations and therefore, should give engineers more flexibility in design and implementation. For example, Ross Prairie and the surrounding uplands are in public ownership and the bed that the pavement is constructed on "appears" to be at higher elevation within the wetland basin.

The following parameters (from Smith 2003) were considered in making recommendations for improvements to the SR 200 corridor:

- Context Sensitivity—vegetation consistent with surrounding habitat
- Environmental variability—provide for terrestrial passage at semi-aquatic sites during periods of high water levels
- Directional fencing—funnel wildlife through passages and away from road surface
- Berming—reduce effects of traffic noise and lights
- Topography—road should be designed to "fit into" the landscape (e.g., minimize alteration in slope of underpass/ overpass approaches)
- Substrate—consistent with adjacent area
- Lighting—reduce tunnel effects by increasing openness value (height\*width/length) and providing light penetration in medians of divided highways
- Human presence—reduce human access associated with crossing sites

To improve habitat connectivity within the Ross Prairie area, we propose a system of culverts, bridges and barrier fences to eliminate road-kills and increase permeability of the road for the wide diversity of wildlife in the area. We recommend installing four box culverts in the upland

sandhill areas, bridges at each ecotone between the wetland basin and adjacent uplands, a series of five culverts within the basin, and an equestrian crossing across from the trailhead. Between all these structures should be 2 m barrier fencing with herptile excluding mesh at the base of the fence. Recommended dimensions of structures are similar to wildlife use thresholds generated from an extensive culvert monitoring project conducted for FDOT by Smith (2003) and consistent with structure preferences identified by Clevenger et al. (2001).

Referring to Figure 149, 2 m wide x 1.2 m tall box culverts should be placed in road partition nos. 5, 7, 26, and 28. Amount of light available within culverts can help counter tunnel effects. Certain amphibian species will not use culverts when sufficient light is not present (Krikowski 1989). These culverts should include lighting grates within the median and on the shoulders to maximize light penetration. The culverts should also be three-sided (concrete walls and ceiling, natural soil floor). If erosion at the entrances is a concern, rip-rap should not be used (Smith 2003); if soil substrates cannot be maintained, then the approaches should be paved with porous concrete or tiles. These structures are targeted toward herptiles and small mammals (special emphasis on rare/listed species- eastern indigo snake, gopher tortoise, Florida gopher frog and Florida mouse), though Hewitt et al. (1998) demonstrated infrequent use of similar-sized structures by ocelot and bobcat. Comparable structures were monitored for desert tortoise in Arizona and produced good results (Boarman and Sazaki 1996).

The SR 200 Task Team recommended 12.3 m wide x 1.8-2.46 m tall bridges at each wetland/upland ecotone. In general, we subscribe to this recommendation based on the level of road-kills and captures of herptiles, and the road-kills and tracks of carnivores and white-tail deer. From our data we further suggest that these structures be placed at road partition nos. 10 and 17 (Figure 149). Since these are designed specifically for wildlife, we strongly recommend that a height of no less than 2 m and no more than 2.5 m. This is to try and prevent use by horses, but facilitate use by large wildlife species, e.g., bobcats, white-tail deer, black bear. Approaches of these structures need to be landscaped with native shrub and ground cover vegetation; and final elevation within the structure and the adjacent approaches needs to be higher than adjacent areas to prevent pooling of water and buildup of sand and silt within the structure. This type structure has proven functional for a wide variety of wildlife species (Smith 2003).

Within the basin, we disagree with the recommendations of the SR 200 Task Team. One large (3 m x3 m) structure in the center will share the same fate as the one already existing; it will remain flooded most of the time preventing use by those species that are wetland-dependent but not necessarily aquatic. With the installation of a barrier wall the same fragmented landscape that occurs at Payne's Prairie during high water periods will be created. A better solution is to install an array of smaller structures distributed along the natural topographic gradient of the wetland basin (see example in Adair et al. 2002). The center of the basin (Figure 149, road partition no. 12) nearly always maintains surface water but the water recedes as one moves NE or SW on SR 200. We suggest five smaller culverts spaced out along this gradient that will flood and dry at different times as the water levels naturally increase and decrease. Wildlife activity is almost always greatest along the edge of wet and dry habitats. As this wet/dry interface fluctuates seasonally and inter-annually, the center of wildlife activity changes also. Road-kill data suggests that high numbers of road-kills occur throughout most of the wetland basin. By providing multiple culverts, more crossing opportunities are afforded during amphibian breeding seasons.

Recommended locations of these culverts (1.5 m wide x 1 m tall) include one each in road partition nos. 11 through 15 (Figure 149). Each culvert should include lighting grates within the median and on the shoulders to maximize light penetration. These structures should also be designed with natural substrate floors; although we recognize that in some cases hydrology and potential for erosion/subsidence may prevent this.

The equestrian crossing was originally recommended to go on the north side of the basin. This location is inappropriate for two reasons. First, the highest levels of wildlife activity are on the north side of the basin; a human-based recreational crossing will be counterproductive to wildlife conservation in this area. Second, since that recommendation was made a trailhead has been placed south of the basin; if the original recommendation were followed it would direct horses completely around the basin to get to the trailhead increasing the level of impact on native plant and animal communities. The design should be such to minimize adverse impacts on the habitat. Logically, we recommend that the equestrian underpass be placed across from the trailhead to minimize such impacts and to somewhat segregate the wildlife and human crossing sites. A depression exists at road partition no. 20 (Figure 149) that should aid in providing the necessary clearance for the recommended tall structure.

Lastly, two types of road-kill barriers are suggested. A perimeter long 2 m fence that extends from the north boundary of the CFG to the south boundary of the HTP on SR 200 is needed to keep larger species off the road. At the base of the fence we recommend installation of a 0.4 m high mesh-screen herptile barrier. The mesh screen should extend below the ground surface to prevent any openings. Fencing should terminate at all culvert and bridge openings to aid in funneling wildlife through the crossing structures. One-way gates/earthen ramps may be needed to allow escape for wildlife trapped in the fenced enclosure within the right-of-way (see Bank et al. 2002). Within the core of the wetland basin (Figure 149, road partition nos. 10-13) we recommend the 1.3 m high concrete barrier wall with a 0.4 m mesh-screen fence placed on top. The wall should be placed at the normal water line or higher. Also, the design should be a pre-casted recurved shape (at least 75 degrees) facing outward into the habitat to prevent climbing by snakes and frogs. Engineers should consult with biologists prior to the final design of this structure.

Even with these measures the long-term effects of road expansion may be detrimental and can take decades to determine (Findlay and Bourdages 2000). Following construction we recommend that funding be earmarked to monitor crossing structure performance and population stability of focal species in and around the Ross Prairie basin.

### **Planning Considerations**

To preserve the character of the Greater Ross Prairie Conservation Area we strongly support a context-sensitive approach to land-use planning and highway design (see Moler 2002 and Gesing 2003). Ross Prairie forms a critical regional habitat node in the Florida Statewide Greenway System and faces severe threats from urban development and highway expansion. Resource agencies need to monitor proposed developments and future highway upgrades on SR 200, CR 484, CR 39 and CR 491 and engage themselves in local government planning to protect this area.

## **2-lane vs. 4-lane configuration: aversion factors and negative edge effects**

Two lane and four lane highways can produce varying negative effects on wildlife in adjacent areas. The extent of these effects is regulated by width and traffic volume. Consider that traffic volume is equal. In this case, two lane highways generally produce more road-kills, but are more permeable (Smith 2003). Four lane highways would have fewer road-kills, but have been demonstrated to become aversion zones for many species and therefore are greater habitat fragmenting forces (Smith 2003, Carr and Pelton 1984, and Garland and Bradley 1984).

Langton (1989b) and Tynning (1989) documented the obstruction of normal migratory patterns of amphibian populations by roads. Mortality rates increased as mobility of various species decreased (Hels and Buchwald 2001). For populations of slower amphibian species (many of which occur in Ross Prairie), wider, high-traffic roads become an interminable barrier, effectively disrupting the breeding process.

Widening of highways increases the potential magnification of negative edge effects, including the absence or reduction of species sensitive to noise or visual disturbance and increased presence of predators and weedy species (e.g., birds, rodents, and omnivores) (Forman and Alexander 1998; Gibbs 1998; Reijnen et al. 1997, 1995; Bennett 1991; Andrews 1990; Garland 1984; Adams and Geis 1983; Wilkins 1982; Ferris 1979; Kozel and Fleharty 1979; and Oxley et al. 1974). In summary, roads seem to increase the richness of species that are competitively advantaged in disturbed environments, while decreasing the abundance and richness of area-sensitive or forest-interior species.

Reijnen et al. (1997, 1995) attributed forest breeding bird's aversion to road verges to reduced habitat quality (primarily caused by traffic noise; and to a much lesser extent, visual disturbance or pollutants). These studies examined the effect of proximity to roads on breeding-bird density and found a 60% reduction in species diversity in plots adjacent to roads. The threshold where bird densities decline was defined as the distance from the highway where traffic noise is 42 decibels (dB) or higher (Reijnen et al. 1995). SR 200, in its current configuration, had traffic noise levels in excess of 50 dB as far as 500 m in all land cover types. With widening this zone is expected to increase.

Increased edge can impact interior species by increasing predation from edge predators as far as 300 to 600 m into a forested patch (Norse et al. 1986). Disruption of normal behavior, communication skills, and mating success can also result, as was shown for nocturnal frogs by artificial lighting (Buchanan 1993) and for anurans and birds by traffic and other technogenous noise pollution (Il'ichev et al. 1995, and Barrass 1985). For these reasons we discourage placement of artificial lighting along the highway between road partition nos. 3 and 28 (Figure 148).

## **Habitat fragmentation and encroachment by secondary development**

Habitat isolation and fragmentation by linear structures such as roads may have drastic effects on biological diversity. Human influence threatens native biological diversity through loss of species from genetic inbreeding, elimination of large uninterrupted habitat, and invasion of alien

species (Forman and Alexander 1998, Andrews 1990, and Harris and Gallagher 1989). Western Marion County is currently experiencing tremendous growth and development pressure. Landscape character has switched from one of humans in a natural landscape matrix to one of natural areas in a human-dominated landscape. The widening of SR 200 will almost certainly increase construction of secondary roads and residential and commercial development.

Rapid fragmentation of landscapes by roads and urbanization result in loss of normal dispersion patterns and population instability (Rosen and Lowe 1994, Harris and Scheck 1991, and Andrews 1990). Prior to the construction of SR 200 this area once was a contiguous sandhill-hardwood hammock-wet prairie system that animals regularly moved through. The same movement phenomenon appears to be occurring with the exception that the animals now have to cross a significant barrier (the road) at great risk due to high traffic flow. What once was a simple 75-100 m movement event across continuous sandhill or wet prairie now involves an abrupt habitat edge consisting of many shrubs and non-native ground cover species, a section of grass or bare ground, and a section of pavement with dense high speed traffic. This presents a daunting task to a slow moving Florida gopher frog, gopher tortoise or eastern indigo snake. The result is significantly high road mortality, fewer successful crossings and habitat fragmentation for those species that are not well adapted to artificial landscape features. Only one successful crossing was recorded for small mammals (one cotton mouse). For the Florida mouse, a state-listed species of special concern, this means segregation of local populations. Negative effects this may have on long-term population genetics, though unknown, may be significant.

Extent of habitat fragmentation and isolation caused by increasing road densities in developing areas is critical for determining the persistence of disturbance-sensitive species. Based on numerous studies that have documented these impacts for various species (Bowers and Matter 1997, Rodgers and Smith 1996, Van Dyke et al. 1986, and Opdam et al. 1985), the best prescription for retaining disturbance-sensitive species would include conservation reserve designs that maintain contiguous large reserves. Ideally these reserves would contain wetland-upland gradients of suitable habitat (high landscape structural complexity preferred) and network connections that contain similar characteristics and that minimize negative edge effects. Although enlarging the core area at Ross Prairie is restricted by current development, we have recommended some critical landscape linkages to maintain the current ecological function of this area. Of particular importance is widening the linkage between the HTP and WSF, completing the connection from the CFG west to Goethe SF and completing the conservation easement from the HTP to Potts Preserve.

Harris and Silva-Lopez (1992) argued that faunal collapse occurs when disturbance levels are sufficient to cause fundamentally different intensities of ecological processes to prevail. An example of such collapse may result from removal or extirpation of gopher tortoises *Gopherus polyphemus* that provide habitat within their burrows for many other species. Such loss would reduce populations of all commensals. Without proper management and planning, the divisive fragmentation caused by SR 200 may facilitate this effect, thus altering the existing ecological processes.

## **Regional landscape connectivity**

Along with the encroachment of roads and development, isolation and fragmentation of ecosystems and associated wildlife populations has occurred with varying detrimental effects, as previously discussed. Coordination between transportation agencies and resource conservation agencies is essential to the development of effective policies that protect ecological systems, while simultaneously providing safe and efficient transportation systems.

The Statewide, Greenways Network Plan was designed to provide guidance for conserving valuable natural resources of Florida; and to restore connectivity between core conservation reserves and other isolated conservation areas. The Ross Prairie area functions as a critical node in this network connecting Ocala National Forest to Goethe State Forest and Withlacoochee State Forest. Connecting corridors must have sufficient width to maintain interior habitat qualities that would enhance use by threatened area-sensitive species (Noss 1983; see also Noss and Cooperider 1994, and Soulé 1991). Understanding natural history requirements of species being considered is essential in design of functional corridors (Burbrink et al. 1998). Design of these landscape connections; however, are thwarted by the presence of roads within and surrounding habitat islands.

Studies of reserve network design recognize road density as a critical indicator for evaluating system integrity (Noss 1995). Roads, as a barrier to animal movement, are considered one of the six major determinants of functional connectivity (Noss and Cooperider 1994). The use of highway crossing structures at intersections with greenway linkages (habitat corridors) offers a method to reduce transportation-related, wildlife mortality and restore connectivity to the landscape. Recommended designs (as presented in this case) illustrate the use of wildlife crossings to permeate transport facilities (Noss 1995).

Being a node in the MHC Cross-Florida Greenway presents the opportunity for dispersal of nonresident carnivores. Observations, road-kill locations, and photographic records from the 49<sup>th</sup> Avenue underpass suggest that dispersal of different individuals pass through the area; if a home range area becomes vacant, a dispersing individual may become a resident.

## **Management Implications**

### **Recreational activities, trails and public access**

Access provides opportunities for recreational activities within wildlands, yet negative ecological consequences often result. Campgrounds located in or near carnivore habitat areas are an intrusion into otherwise native habitat that attract coyotes, foxes, etc. in search of food, often resulting in human-wildlife conflicts (Creachbaum et al. 1998). Trail systems used for ecotourism, recreation, and research can also change ecological systems (e.g., increased erosion, light penetration, and disturbance from humans and domestic predators). Human traffic caused activity shifts or avoidance by sensitive species near trails, and increased numbers of unaffected or habituated species (Griffiths and van Schaik 1993).

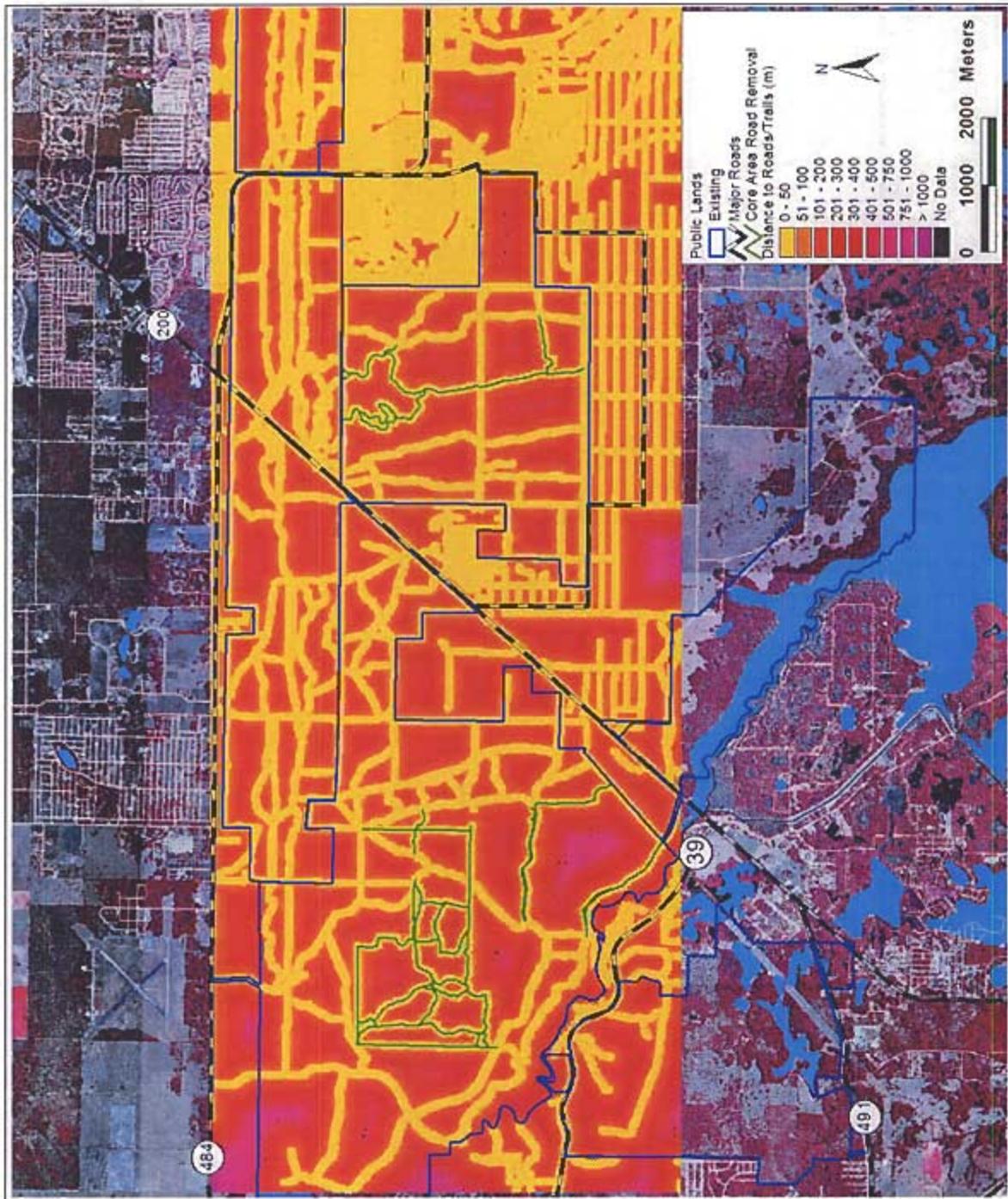
Regulations need to be drafted and enforced that control private clubs constructing recreational trails. Also, better management of trail use and construction needs to be implemented. The current density of trails in the CFG is too high and threatens to impact wildlife in the area. Each group currently constructs their own trails. These should be planned to avoid duplication where possible, e.g., cyclists and hikers should use the same trails. Trails through sandhills must avoid tortoise burrows and horse trails should be placed at least 5 m from burrow entrances. For the CFG, HTP and RPSF combined, there is approximately 327.6 km (4.1 km/km<sup>2</sup>) of recreational trails, access roads and firebreaks. Only four areas exist greater than 500 m from a trail, firebreak or road (Figure 150). Resource agencies could easily lower the intensity by using firebreaks and management access roads as recreational trails. Also, many roads/firebreaks are in such close proximity that they do not serve any logical management purpose. One route should be selected and the other closed to human access.

Trails need to be routed away from the wildlife crossing sites. Several studies have found that human presence reduces use and effectiveness of underpasses (Smith 2003, Clevenger and Waltho 2000), McClellan and Shackleton 1988). Also presence of domestic predators was a deterrent to use of crossings by wildlife (Smith 2003). Relevance of this is with regard to pack dogs from adjacent rural residential areas. Several gaps occur in the fence along the north side boundary of the CFG west of SR 200. On many occasions we witnessed pack dogs roaming through the greenway. The fences need to be repaired and access other than at regulated gate access points should be restricted and enforced.

Sensitive and forest-interior species would benefit by the creation of roadless areas within the core area of Ross Prairie. In the HTP, the large hardwood-cypress swamp/forest adjacent to the Withlacoochee River represents one such area. Two bobcats used this as a refuge area. River otter, wild turkey, great-horned owl and other species were also observed. We propose the removal of certain roads/trails/firebreaks (Figure 151) to create four restricted-access areas for wildlife without significantly limiting public access within the conservation area. The two areas in the RPSF would create areas at least 750 m from the nearest access road, whereas the two areas in the HTP expand one area to at least 750 m to the nearest road and create another over 1000 m to a road. The areas in the HTP would be the end result of current forest restoration efforts. These measures would improve opportunities for public viewing of rarer wildlife by insuring their continued persistence in the Ross Prairie area.

### **Environmental education**

A kiosk should be constructed at the Ross Prairie trailhead that presents information on the value of wildlife and measures that should be taken while visiting that protects habitat and species for enjoyment by future visitors. Threatened and endangered species in the area should be publicized at all public units to protect people and these species. This resource should be utilized by local schools and non-government organizations (NGOs) to promote environmental protection and study of ecological systems. This project touched on many different aspects of the Ross Prairie system and its ecological function; more research on effects of management techniques and basic wildlife biology is suggested.



**Figure 151. Distance from Roads, Trails and Firebreaks in the core area of the Ross Prairie Conservation Area.** Only four areas (all in the HTP) have zones that are greater than 500 m from a man-made linear feature. Only eight areas exist that are 401- 500 m from a road or trail (5 in the HTP, 3 in the RPSF and 1 in the CFG). We propose removal of roads/trails highlighted in green to create three core wildlife reserve areas (no public access).

Public-private partnerships are needed to educate the public and local government officials about the value of nature and the protection of natural systems. NGOs can play a significant role as liaisons between resource agencies, the public and local government politicians and planners. The value of Ross Prairie to local economic development and quality of life must be emphasized.

### Resource management activities

Prescribed burns were executed in different years in the different burrow colonies where telemetry was conducted (Figure 152):

- Colony 1 – 12/99 and 3/03
- Colony 7 – no data
- Colony 6 – 2/00
- Colony 9 – 4/04, no data previous years

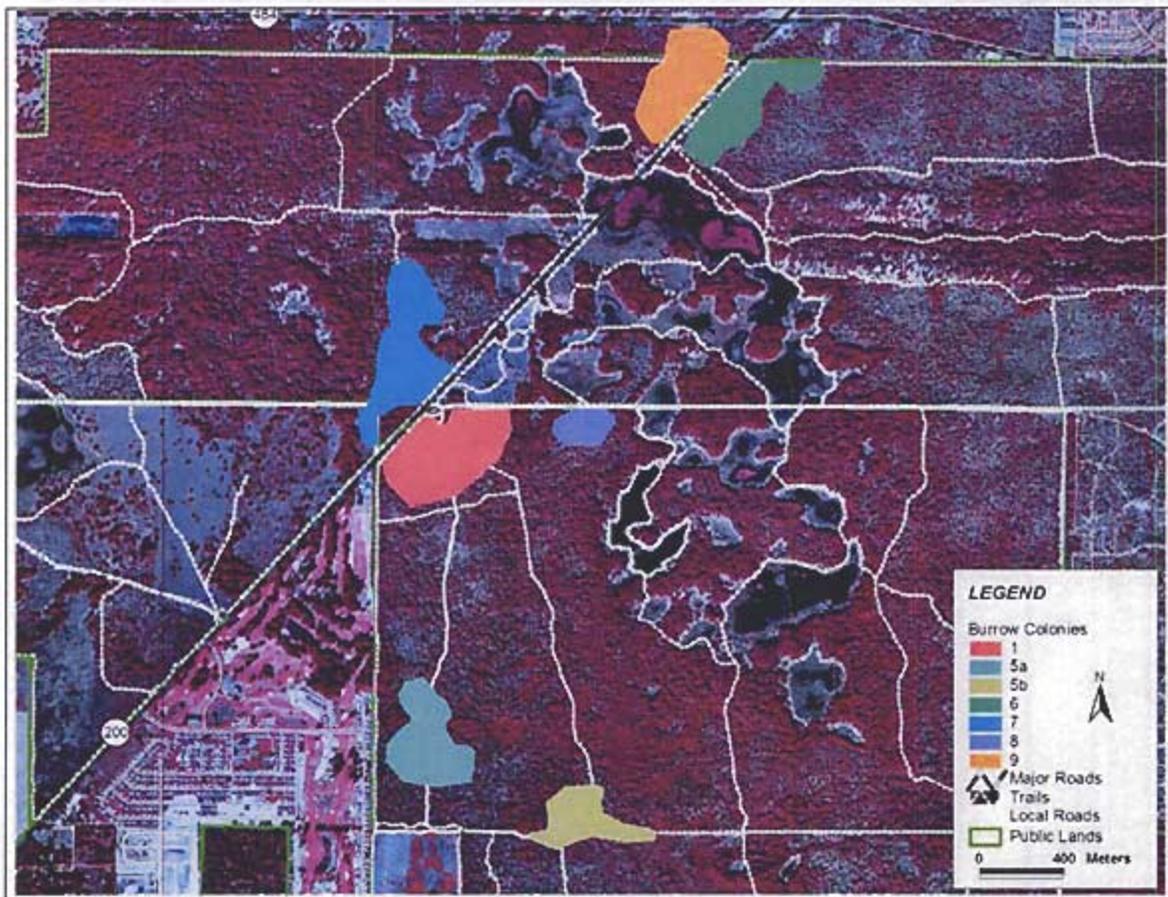
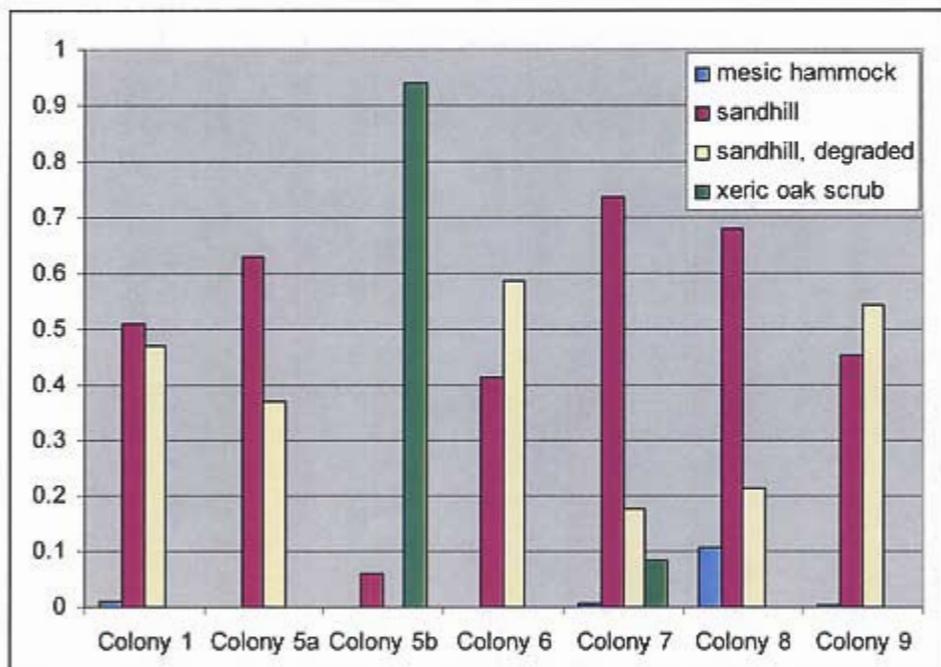


Figure 152. Location of Gopher Tortoise Burrow Colonies.

The timing of these burns determined the habitat quality (denseness of shrub and ground cover layers) while we were conducting telemetry studies. Number of shrubs found in vegetation transects was highest in colony 6, 7, 9 and 1, respectively. Wiregrass density found in vegetation

transects was greatest in colony 7, 6, 1, and 9, respectively. Because of the patchiness of the habitat, it's not surprising that these are not correlated. Our vegetation study was performed to determine extent of weedy species from the edge of the road into the core of the different habitat areas. To properly evaluate overall density of ground covers or shrub layers, vegetation sampling should include randomly located quadrats rather than transects.

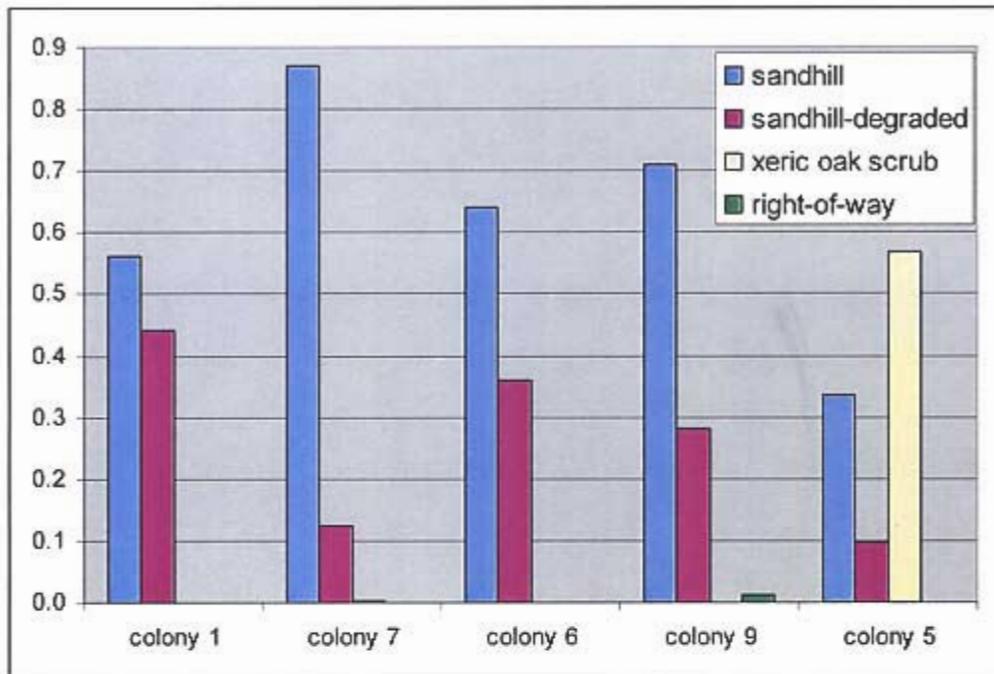
Percent of habitat types available in each colony may portray a more accurate picture of relative quality in each burrow colony (Figure 153). Note that the amount of degraded sandhill (denotes a high degree of shrub layers) is greatest in colony 6 and 9, and colony 5b is composed of mostly oak scrub. Colony nine and six had not been burned for a few years, and shrub layers were thick; colony seven there was no data, but appeared to have been burned one or two years prior to our study (sparsely located shrubs). Colony one was burned in the second year of our study (Initially shrub layers were dense, then sparse; our vegetation sampling was performed prior to the burn). Comparing actual location of telemetry points implies preference of habitat types. Figure 154 shows that in all colonies, tortoises preferred habitat with sparse shrub and brush layers (sandhill). The exception was at colony 5b; at this location was dense oak scrub adjacent to sandy firebreaks with strips of sparsely vegetated wiregrass areas. Tortoises used these firebreaks to move from place to place. This data belies the need for prescribed burns to reduce density of shrub layers.



**Figure 153. Percent of Habitat Types in Monitored Gopher Tortoise Burrow Colonies.**

We found greatest densities of eastern indigo snakes in or near tortoise burrow colonies in sandhill communities. Only 3 of 24 indigo snakes were not captured in or near tortoise burrow colonies. Though their home ranges were much larger and included wet prairie, hardwood hammock and xeric oak scrub habitats, when refuge was sought it was almost always in tortoise burrows. Based on the telemetry data we collected, the eastern indigo snake appears to hunt as a

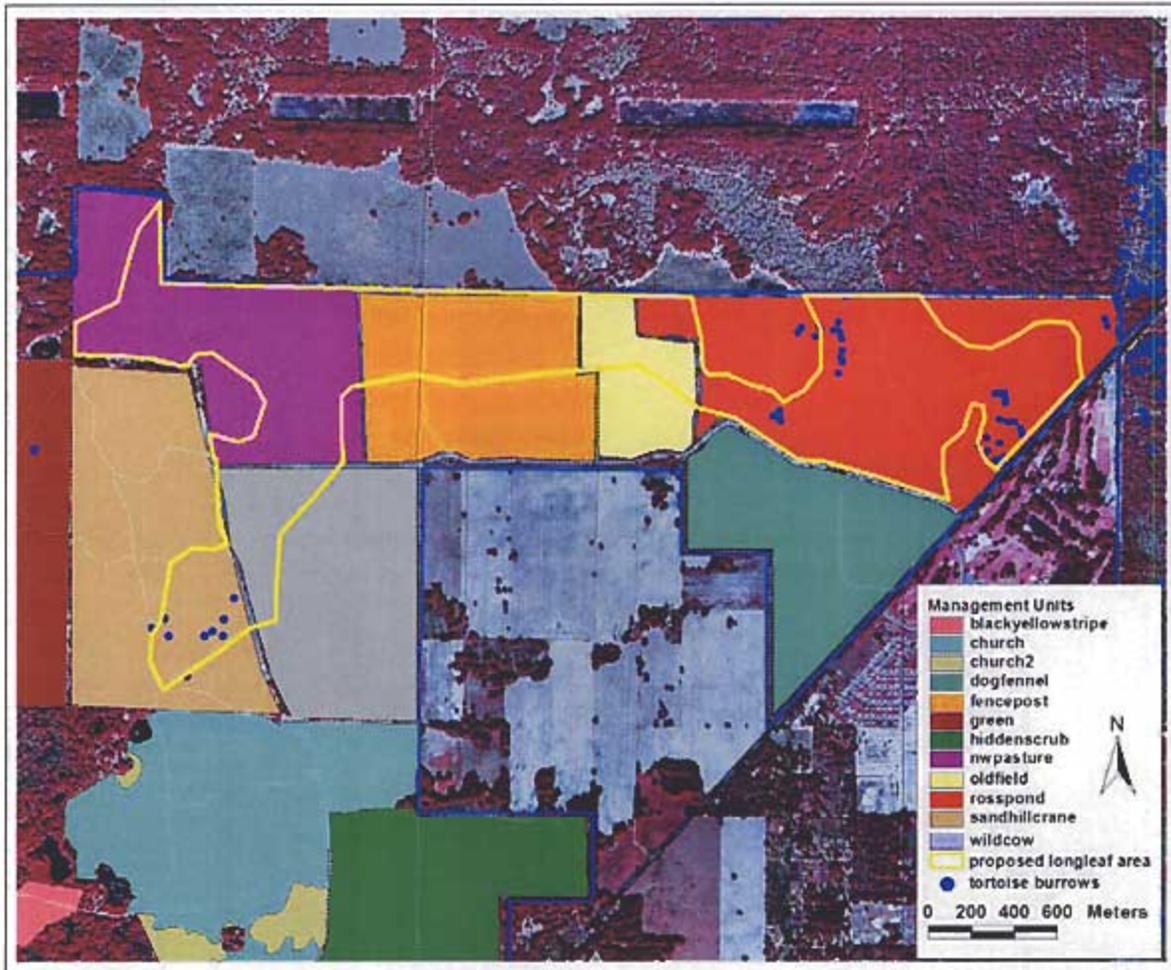
generalist, choosing habitat types based on availability of prey. This conclusion was shared by Breininger et al. (2004). Rodents and frogs were the most common prey items witnessed in areas where the snakes were observed. Despite this, they also seem to specifically choose sandhill areas with tortoise burrows for winter refuge and reproduction.



**Figure 154. Percent of Habitat Types Used by Gopher Tortoises (n=24).** Values are based on the location and number of telemetry positions recorded between May 2002 and November 2004.

To increase and stabilize the population of eastern indigo snake, we recommend efforts by all agencies to use and coordinate prescribed burns to improve quality of existing sandhill habitat areas. We also encourage conversion of planted pine areas and open pastures to longleaf pine forest. Specifically, longleaf pine-wiregrass community restoration is strongly suggested for a large open area in the HTP (Figure 155) where several burrows exist (management units – Ross pond, oldfield, fence post, NW pasture, wild cow and sandhillcrane). This proposed restoration area consists of about 260 ha of former longleaf pine-wiregrass savanna; relic gopher tortoise colonies still exist in these areas with low numbers of tortoises because of habitat degradation over many years. This restoration would conform to adjacent habitat areas and tortoise burrow colonies to the north in the CFG including another large pasture area that was recently planted in longleaf pine (75 ha). Many rare and listed species would benefit from this restoration including gopher tortoise, E. indigo snake, E. diamondback rattlesnake, Florida mouse, Florida gopher frog, etc.

Management actions that may have affected the movement patterns and habitat use of bobcats include logging and prescribed burns of timber areas, hydraulic-ax thinning of scrub areas, and prescribed burns of prairie and grassland areas.



**Figure 155. Proposed Longleaf Pine Restoration in Halpata-Tastanaki Preserve NW Management Units.** The area proposed for restoration (260 ha) includes existing tortoise burrow areas used by eastern indigo snakes and consists of former longleaf pine-wiregrass savanna that corresponds to restoration efforts in the adjacent Cross-Florida Greenway to the north.

Logging occurred on 89 ha of habitat in the home range of bobcat no. 1, much of this occurring in its' 50% core area. Timber cuts were conducted from mid-February 2003 to late-July 2003 and again in October – November 2003. Though the logging areas only accounted for about 10% of the original home range of bobcat no. 1, the noise and human presence may have had a greater impact. Coincidentally the timing of logging activities and home range shift intersect. Prescribed burns of 256 acres occurred from August 2002 through January 2004, 142 acres in a three day period in January 2003. Hydraulic-ax thinning also occurred in three of those months. Combined, tree thinning and burning in the area may have led to the movement patterns of bobcat no. 1.

In the home range of bobcat no. 2 (adjacent to bobcat no. 1), there was 3<sup>rd</sup> row thinning from February 14 through July 23, 2003 and October 14 to November 18, 2003. There were seven burns from January 2003 through January 2004 totaling 615 acres, 400 acres burned within a

month period from December 2003 to January 2004. Hydroaxing also occurred within the same timeframe. During these periods, bobcat no. 2 was primarily found on adjacent private lands and scrub areas near the cemetery road. Notably, a couple of brief visits to recently burned areas occurred, possibly to investigate exposed prey or carrion.

The home range of bobcat no. 3 had ten different burns in seven different units, two burns in one unit (riverside) following initial capture on 8/30/02. Seven of the burns were within a one month period (late December 2002 through late January 2003), leaving few management units within the bobcats' core area untouched. Hydroaxing occurred in one area simultaneous to the prescribed burns.

Standard management activities such as these are necessary to recycle nutrients, and maintain or restore high quality habitat, but may result in the temporary displacement of resident species in these areas. This displacement is attributable to the loss of cover and food and presence of humans. We suggest that future management activities be staged to limit the number of simultaneous actions in any one or adjacent management units. This will guarantee that an adjacent management unit (of similar resources) with sufficient cover and food is available for resident bobcats and other species to move to.

More research needs to be conducted regarding the effect of time of year of prescribed burns on certain wildlife. Reactions by mammals and herptiles are likely different. Mammals, in this study were more active in cooler months, whereas herptiles were more active in warmer months (though indigo snakes were recorded moving at certain times during the winter). Bobcats seemed to be curious about recently burned areas, but did not frequent the areas again once it was investigated. Unfortunately, none of the eastern indigo snakes being monitored were in areas when burns occurred. On two occasions we investigated gopher tortoise behavior during prescribed burns, one in colony 1 (RPSF) and the other in colony 9 (CFG). All tortoises in colony 1 remained in burrows during the prescribed burn and remained there for approximately a week without emerging. Shortly thereafter, they relocated to adjacent areas with standing ground cover forage. Tortoise no. 32 was one of these subjects. It briefly relocated to areas in colony one closer to the road; instead of remaining there it gradually "burrow-hopped" to the golf course and crossed the road moving into colony 2 in the HTP. It possibly kept moving because other tortoises resided in these other sections of colony 1. We cannot confirm if the dispersal was linked to the prescribed burn, but the coincidence is evident. Tortoise no. 47 in colony 9 was found outside the burrow moving toward the fireline, it was rescued prior to encountering the flames. We returned it to its original burrow. It stayed there and did not vacate the area following the prescribed burn.

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## APPENDICES

## **APPENDIX A**

### **Land Cover Types and Landscape Metrics by Jurisdiction**

Appendix A. Land Cover Types and Landscape Metrics by Jurisdiction.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgtd. MSI	Perimeter/ Area Ratio (m/ha)	Mean Area Wgtd. Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
<b>Total Landscape</b>	<b>11,544</b>		<b>1,391</b>	<b>8.30</b>	<b>4.18</b>	<b>34.66</b>	<b>1,912,121</b>	<b>1,375</b>	<b>165.64</b>	<b>3.34</b>	<b>9,369</b>	<b>1.94</b>	<b>0.84</b>		
pasture	929	8%	42	22.13	3.47	212	47.01	3,029	11.02	3.32	8,816	1.35			
mixed pine-hardwood	261	2%	47	5.56	0.81	217	12.05	884	3.60	1.45	5,333	1.27			
built-environment	358	3%	31	11.53	0.50	320	36.87	958	2.57	1.61	5,384	1.25			
sandhill, degraded	1,309	11%	85	15.40	1.00	324	49.95	1,979	14.57	3.09	11,165	1.33			
golf course	75	1%	3	24.89	14.30	92	22.81	7,805	0.68	1.65	168	1.28			
sandhill	1,001	9%	53	18.89	4.10	255	48.25	2,151	9.88	2.61	7,119	1.32			
residential, rural	940	8%	60	15.66	1.74	190	29.77	1,706	8.87	1.74	4,735	1.27			
shrub-brush lands	868	8%	65	13.35	1.14	454	60.65	153,877	2,367	13.33	7,147	1.39			
right-of-way	105	1%	11	9.51	3.10	205	19.54	107,394	9,763	9.30	2,429	1.63			
marsh-wet prairie-temporary pond	652	6%	427	1.53	0.51	213	3.25	200,146	469	17.34	1.54	2,708	1.32		
hardwood-cypress swamp/forest	1,072	9%	140	7.66	0.39	557	42.68	174,778	1,248	15.14	3.44	10,021	1.35		
mesic hammock	1,194	10%	193	6.19	1.25	254	15.74	261,515	1,355	22.65	2.79	4,225	1.42		
silviculture	904	8%	17	53.20	2.90	276	147.00	7,367	10.85	7.76	4,076	1.44			
dry prairie/grasslands	133	1%	56	2.38	0.57	206	4.91	63,159	1,128	5.47	4.23	19,177	1.32		
xeric oak scrub	663	6%	56	11.84	1.49	238	28.23	90,668	1,619	7.85	2.31	2,735	1.31		
sand pine scrub	21	0%	1	21.18	21.18	0	0.00	3,077	3,077	0.27	1.89	145	1.26		
planted longleaf pine	335	3%	21	15.95	0.00	244	39.00	28,659	1,365	2.48	1.68	11,152	1.27		
residential, sandhill	205	2%	5	41.09	1.60	171	70.15	15,524	3,105	1.34	1.85	12,279	1.25		
residential, oak scrub	205	2%	11	18.65	1.21	222	41.43	15,634	1,421	1.35	1.53	7,688	1.27		
agriculture	234	2%	10	23.37	16.93	89	20.79	24,237	2,424	2.10	1.62	7,213	1.48		
water	80	1%	57	1.40	0.19	258	3.62	57,343	1,006	4.97	5.53	88,039	1.36		
<b>Core conservation area</b>	<b>6,543</b>		<b>804</b>	<b>8.14</b>	<b>0.65</b>	<b>499</b>	<b>40.58</b>	<b>1,093,687</b>	<b>1,360</b>	<b>167.14</b>	<b>4.02</b>	<b>4,491</b>	<b>0.99</b>		
mesic hammock	723	11%	104	6.95	1.14	256	17.81	157,072	1,510	24.00	3.18	3,579	1.37		
marsh-wet prairie-temporary pond	478	7%	335	1.43	0.53	179	2.55	155,820	465	23.81	1.50	1,185	1.32		
mixed pine-hardwood	27	0%	13	2.07	0.46	220	4.54	8,232	633	1.26	1.50	5,198	1.30		
residential, rural	6	0%	9	0.63	0.31	93	0.59	8,218	913	1.26	4.25	4,889	1.55		
sandhill	685	10%	36	19.04	3.41	282	53.74	77,448	2,151	11.84	2.87	7,687	1.33		
pasture	151	2%	14	10.79	2.95	148	16.00	33,289	2,378	5.09	2.91	13,310	1.35		
dry prairie/grasslands	123	2%	44	2.80	0.48	195	5.45	58,324	1,326	8.91	4.45	7,440	1.45		
built-environment	9	0%	5	1.87	1.36	98	1.83	5,722	1,144	0.87	2.27	1,072	1.39		
shrub-brush lands	778	12%	24	32.40	1.23	298	96.71	108,812	4,534	16.63	6.08	1,705	1.39		

Appendix A. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgt. MSI	Perimeter/ Area Ratio (m/ha)	Mean Area Wgt. Dimension	Shannon Diversity Index	Shannon Evenness Index
<b>Core conservation area</b>															
(continued)															
sandhill, degraded	1,078	16%	59	18.26	0.08	323	59.04	125,743	2,131	19.22	3.39	15,570	1.33		
xeric oak scrub	546	8%	50	10.92	1.49	243	26.51	75,629	1,513	11.56	2.14	1,971	1.31		
hardwood-cypress swamp/forest	749	11%	67	11.17	0.50	533	59.50	99,284	1,482	15.17	3.91	5,379	1.36		
sand pine scrub	21	0%	1	21.18	21.18	0	0.00	3,077	3,077	0.47	1.89	145	1.31		
planted longleaf pine	268	4%	19	14.13	0.00	284	40.18	23,237	1,223	3.55	1.77	12,315	1.26		
silviculture	866	13%	11	78.70	6.19	225	177.46	119,342	10,849	18.24	8.04	2,977	1.43		
residential, sandhill	2	0%	2	1.07	0.54	50	0.53	4,247	2,123	0.65	5.96	2,329	1.65		
residential, oak scrub	1	0%	2	0.31	0.24	22	0.07	1,896	948	0.29	4.40	3,658	1.59		
water	32	0%	8	4.03	0.08	198	7.96	27,033	3,379	4.13	9.46	29,402	1.58		
agriculture	1	0%	1	0.82	0.82	0	0.00	1,263	1,263	0.19	3.92	1,532	1.58		
<b>DOF-roof prairie</b>															
1,404 114 12.32 0.08 334 41.17 171,194 1,502 14.83 2.80 9,711 1.32 2.09 0.79															
shrub-brush lands	2	0%	3	0.53	0.02	139	0.74	3,335	1,112	2.37	7.17	7,272	1.67		
pasture	0	0%	1	0.02	0.02	0	0.00	425	425	0.30	8.86	23,229	2.32		
mesic hammock	157	11%	5	31.31	7.41	169	52.82	24,331	4,866	17.32	4.51	897	1.39		
xeric oak scrub	170	12%	9	18.89	0.04	261	49.24	13,945	1,549	9.93	2.53	5,864	1.31		
mixed pine-hardwood	18	1%	2	8.78	0.21	98	8.58	1,868	934	1.33	1.12	557	1.23		
marsh-wet prairie-temporary pond	37	3%	15	2.46	0.62	150	3.69	8,609	574	6.13	1.31	2,236	1.28		
sandhill	364	26%	13	28.00	0.01	301	84.38	31,284	2,406	22.27	3.56	12,753	1.34		
sandhill, degraded	455	32%	39	11.68	0.01	238	27.78	45,959	1,178	32.72	1.87	13,555	1.28		
dry prairie/grasslands	31	2%	6	5.20	0.86	179	9.31	19,072	3,179	13.58	7.60	5,172	1.53		
residential, sandhill	2	0%	1	1.60	1.60	0	0.00	2,629	2,629	1.87	5.87	1,648	1.63		
residential, oak scrub	0	0%	1	0.38	0.38	0	0.00	318	318	0.23	1.45	832	1.40		
built-environment	1	0%	1	1.36	1.36	0	0.00	2,363	2,363	1.68	5.72	1,742	1.63		
residential, rural	1	0%	2	0.68	0.00	100	0.67	2,969	1,484	2.11	7.14	4,778	1.68		
planted longleaf pine	166	12%	16	10.40	0.00	383	39.84	14,088	880	10.03	1.86	14,426	1.26		
<b>OGT</b>															
1,902 230 8.27 1.04 376 31.05 340,903 1,482 29.53 3.11 5,153 1.35 2.23 0.79															
mesic hammock	380	20%	43	8.83	1.25	199	17.60	73,204	1,702	38.50	2.93	3,545	1.35		
marsh-wet prairie-temporary pond	145	8%	61	2.38	0.69	176	4.17	37,174	609	19.55	1.59	1,746	1.31		
mixed pine-hardwood	1	0%	4	0.34	0.33	63	0.21	1,728	432	0.91	2.34	15,148	1.48		
residential, rural	3	0%	3	0.91	1.04	69	0.63	3,489	1,163	1.83	4.20	1,293	1.56		
sandhill	309	16%	22	14.06	4.32	150	21.07	43,899	1,995	23.08	2.10	5,034	1.31		

Appendix A. continued.

Class	Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgtd. MSI	Area Perimeter/ Area Ratio (m/ha)	Mean Area Wgtd. Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
OGT (continued)															
pasture	126	7%	9	13.96	4.61	134	18.66	22,176	2,464	11.66	2.90	7,304	1.35		
dry prairie/grasslands	78	4%	27	2.87	0.67	168	4.81	33,026	1,223	17.37	3.49	8,550	1.43		
built-environment	8	0%	4	2.00	0.50	102	2.03	3,359	840	1.77	1.69	905	1.34		
shrub-brush lands	52	3%	8	6.56	0.71	198	12.95	14,299	1,787	7.52	3.48	1,288	1.40		
sandhill, degraded	568	30%	14	40.60	0.44	268	108.79	66,636	4,760	35.04	4.68	25,678	1.38		
xeric oak scrub	93	5%	26	3.57	1.32	142	5.08	24,286	934	12.77	1.78	1,328	1.33		
hardwood-cypress swamp/forest	0	0%	3	0.10	0.00	141	0.14	466	155	0.25	2.30	12,165	1.53		
sand pine scrub	21	1%	1	21.18	21.18	0	0.00	3,077	3,077	1.62	1.89	145	1.31		
planted longleaf pine	101	5%	2	50.67	17.51	65	33.16	7,225	3,612	3.80	1.59	84	1.26		
silviculture	15	1%	1	14.99	14.99	0	0.00	3,665	3,665	1.93	2.67	245	1.38		
residential, sandhill	1	0%	1	0.54	0.54	0	0.00	1,617	1,617	0.85	6.22	3,010	1.72		
residential, oak scrub	0	0%	1	0.24	0.24	0	0.00	1,578	1,578	0.83	9.02	6,483	1.89		
<b>SFWMD</b>	<b>3,237</b>		<b>460</b>	<b>7.04</b>	<b>0.62</b>	<b>631</b>	<b>44.39</b>	<b>581,591</b>	<b>1,264</b>	<b>50.38</b>	<b>5.09</b>	<b>2,866</b>	<b>1.38</b>	<b>2.10</b>	<b>0.77</b>
water	32	1%	8	4.03	0.08	198	7.96	27,033	3,379	8.35	9.46	29,402	1.58		
marsh-wet prairie-temporary pond	296	9%	259	1.14	0.49	156	1.78	110,037	425	33.99	1.48	992	1.32		
hardwood-cypress swamp/forest	748	23%	64	11.69	0.65	520	60.83	98,818	1,544	30.52	3.91	5,061	1.36		
pasture	25	1%	4	6.37	2.95	102	6.47	10,688	2,672	3.30	2.92	24,343	1.38		
shrub-brush lands	724	22%	13	55.67	20.75	227	126.40	91,178	7,014	28.16	6.27	677	1.39		
residential, rural	2	0%	4	0.40	0.27	93	0.37	1,760	440	0.54	1.88	7,641	1.42		
mesic hammock	187	6%	56	3.33	1.06	174	5.81	59,537	1,063	18.39	2.57	3,844	1.37		
silviculture	851	26%	10	85.07	2.90	217	184.92	115,677	11,568	35.73	8.13	3,250	1.43		
mixed pine-hardwood	8	0%	7	1.13	0.66	118	1.34	4,637	662	1.43	2.19	838	1.41		
dry prairie/grasslands	14	0%	11	1.31	0.39	233	3.06	6,227	566	1.92	2.81	5,954	1.41		
sandhill, degraded	54	2%	6	8.96	3.91	120	10.72	13,148	2,191	4.06	2.55	5,078	1.35		
planted longleaf pine	1	0%	1	0.64	0.64	0	0.00	1,924	1,924	0.59	6.79	3,013	1.73		
xeric oak scrub	283	9%	15	18.87	3.85	135	25.44	37,399	2,493	11.55	2.03	749	1.30		
sandhill	12	0%	1	11.95	11.95	0	0.00	2,265	2,265	0.70	1.85	190	1.32		
agriculture	1	0%	1	0.82	0.82	0	0.00	1,263	1,263	0.39	3.92	1,532	1.58		
<b>DOT rights-of-way</b>	<b>109</b>		<b>14</b>	<b>7.80</b>	<b>1.43</b>	<b>226</b>	<b>17.63</b>	<b>112,083</b>	<b>8,006</b>	<b>9.71</b>	<b>17.41</b>	<b>2,122</b>	<b>1.63</b>		

Appendix A. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgt. MSI	Perimeter/ Area Ratio (m/ha)	Mean Patch Dimension	Shannon Diversity Index	Shannon Evenness Index
DOF-withlacocoehee	585		37	15.81	3.00	185	29.28	77,003	2,081	6.67	2.13	1,211	1.30	2.11	0.85
hardwood-cypress swamp/forest	32	5%	5	6.33	2.96	136	8.61	8,109	1,622	13.86	2.18	638	1.35		
residential, rural	1	0%	2	0.56	0.15	74	0.41	1,714	857	2.93	3.97	1,439	1.58		
mesic hammock	69	12%	7	9.90	8.01	113	11.22	16,151	2,307	27.60	2.62	398	1.36		
water	12	2%	4	2.97	0.85	133	3.96	2,601	650	4.45	1.34	501	1.28		
sandhill, degraded	77	13%	4	19.33	13.10	83	15.95	7,763	1,941	13.27	1.35	234	1.25		
dry prairie/grasslands	6	1%	4	1.47	1.47	35	0.52	2,617	654	4.47	1.54	480	1.34		
sandhill	196	34%	3	65.39	29.03	84	55.19	16,549	5,516	28.28	2.09	121	1.29		
xeric oak scrub	109	19%	3	36.47	2.96	136	49.49	12,728	4,243	21.75	3.14	9,921	1.35		
planted longleaf pine	67	11%	2	33.30	16.06	52	17.24	5,422	2,711	9.27	1.34	100	1.24		
mixed pine-hardwood	9	2%	1	8.92	8.92	0	0.00	1,196	1,196	2.04	1.13	134	1.24		
marsh-wet prairie-temporary pond	3	1%	1	3.00	3.00	0	0.00	879	879	1.50	1.43	293	1.32		
shrub-brush lands	4	1%	1	3.85	3.85	0	0.00	1,273	1,273	2.18	1.83	331	1.35		
<b>Private inholdings</b>	<b>97</b>		<b>91</b>	<b>1.06</b>	<b>0.00</b>	<b>325</b>	<b>3.44</b>	<b>29,587</b>	<b>325</b>	<b>2.56</b>	<b>1.88</b>	<b>55,191</b>		<b>2.21</b>	<b>0.89</b>
marsh-wet prairie-temporary pond	12	12%	27	0.44	0.00	241	1.07	4,987	185	51.66	1.39	20,922	1.32		
hardwood-cypress swamp/forest	11	11%	15	0.72	0.00	258	1.84	4,682	312	48.50	2.22	16,408	1.39		
mesic hammock	2	2%	13	0.16	0.00	189	0.31	1,799	138	18.64	1.74	22,421	n/a		
silviculture	9	10%	4	2.33	0.01	153	3.56	2,544	636	26.35	1.83	7,475	1.33		
residential, rural	8	9%	2	4.11	3.50	15	0.61	1,686	843	17.47	1.18	206	1.27		
mixed pine-hardwood	5	5%	8	0.66	0.00	239	1.57	2,435	304	25.22	1.75	13,931	1.35		
shrub-brush lands	4	4%	14	0.27	0.00	197	0.54	3,965	283	41.07	3.10	19,332	1.50		
dry prairie/grasslands	3	3%	3	0.83	0.32	115	0.96	1,123	374	11.63	1.62	232,590	1.36		
sandhill, degraded	26	27%	1	25.65	25.65	0	0.00	4,357	4,357	45.13	2.43	170	1.35		
pasture	0	0%	1	0.00	0.00	0	0.00	20	20	0.21	4.42	123,136	12.46		
agriculture	17	18%	1	16.93	16.93	0	0.00	1,985	1,985	20.56	1.36	117	1.26		
water	0	0%	2	0.00	0.00	75	0.00	5	2	0.05	4.10	1,343,135	-0.75		
<b>Proposed additions (all)</b>	<b>470</b>		<b>89</b>	<b>5.28</b>	<b>0.97</b>	<b>392</b>	<b>20.67</b>	<b>109,842</b>	<b>1,234</b>	<b>9.52</b>	<b>3.10</b>	<b>16,175</b>	<b>1.36</b>	<b>1.87</b>	<b>0.78</b>
sandhill	2	0%	2	1.00	0.36	64	0.64	1,044	522	2.22	1.59	644	1.37		
residential, rural	0	0%	2	0.23	0.15	32	0.07	502	251	1.07	1.44	1,285	1.41		
shrub-brush lands	7	1%	6	1.11	1.14	43	0.48	7,110	1,185	15.13	2.92	1,519	1.45		
sandhill, degraded	8	2%	2	4.12	1.64	60	2.49	2,782	1,391	5.92	2.20	338	1.37		

Appendix A. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgt. MSI	Area Ratio (m/ha)	Mean Patch Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
<b>Proposed additions (all)</b>															
<b>(continued)</b>															
marsh-wet prairie-temporary pond	38	8%	23	1.66	0.71	109	1.80	12,319	536	26.22	1.44	1,689	1.32		
mesic hammock	162	34%	14	11.54	1.37	210	24.22	28,337	2,024	60.32	2.13	563	1.31		
hardwood-cypress swamp/forest	42	9%	18	2.31	0.49	152	3.50	17,886	994	38.07	2.53	8,571	1.39		
pasture	197	42%	4	49.22	5.42	144	71.09	26,543	6,636	56.50	4.38	7,012	1.38		
mixed pine-hardwood	2	0%	2	1.14	0.00	100	1.14	1,284	642	2.73	2.39	14,919	1.43		
water	12	3%	15	0.80	0.25	123	0.99	11,987	799	25.51	3.33	75,766	1.50		
built-environment	0	0%	1	0.00	0.00	0	0.00	48	48	0.10	3.41	30,510	2.81		
<b>Proposed add. (west)</b>															
marsh-wet prairie-temporary pond	35	11%	20	1.73	0.71	107	1.86	11,255	563	36.32	1.47	523	1.32		
mesic hammock	40	13%	10	4.00	1.14	120	4.81	17,459	1,746	56.33	3.42	679	1.44		
hardwood-cypress swamp/forest	26	8%	11	2.33	0.83	137	3.18	13,359	1,214	43.10	3.03	2,886	1.44		
pasture	197	64%	3	65.62	19.75	115	75.24	26,536	8,845	85.62	4.38	165	1.38		
mixed pine-hardwood	2	1%	2	1.14	0.00	100	1.14	1,284	642	4.14	2.39	14,919	1.43		
water	9	3%	9	1.02	0.57	106	1.09	9,535	1,059	30.77	3.58	1,335	1.51		
shrub-brush lands residential, rural	1	0%	1	1.28	1.28	0	0.00	2,235	2,235	7.21	5.58	1,748	1.63		
	0	0%	1	0.15	0.15	0	0.00	281	281	0.91	2.02	1,829	1.54		
<b>Proposed add. (east)</b>															
marsh-wet prairie-temporary pond	4	2%	2	1.77	0.59	67	1.18	1,056	528	7.13	1.18	418	1.29		
hardwood-cypress swamp/forest	16	11%	5	3.20	0.97	137	4.36	4,474	895	30.19	1.73	15,882	1.32		
shrub-brush lands	4	3%	4	1.06	0.55	55	0.58	4,446	1,112	30.00	2.60	1,748	1.43		
mesic hammock	122	82%	4	30.40	3.61	127	38.69	10,877	2,719	73.40	1.71	273	1.27		
water	3	2%	3	0.94	0.75	78	0.74	2,099	700	14.17	2.48	831	1.45		
<b>Proposed add. (other)</b>															
sandhill	2	17%	6	1.95	1.14	111	2.15	4,476	746	383.01	1.97	513	1.36		
residential, rural	0	3%	1	0.30	0.30	0	0.00	1044	522	89.34	1.59	644	1.37		
shrub-brush lands	1	10%	1	1.14	1.14	0	0.00	221	221	18.93	1.14	741	1.35		
sandhill, degraded	8	71%	2	4.12	1.64	60	2.49	2,782	1,391	238.04	2.20	338	1.37		
														<b>3.19</b>	<b>0.79</b>
														<b>2.49</b>	<b>0.86</b>
														<b>1.46</b>	<b>0.81</b>

Appendix A. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgt. MSI	Perimeter/ Area Ratio (m/ha)	Mean Area/ Mean Patch Dimension	Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
<b>Existing conservation easement</b>	<b>242</b>		<b>30</b>	<b>8.07</b>	<b>1.33</b>	<b>210</b>	<b>16.97</b>	<b>49,750</b>	<b>1,658</b>	<b>4.31</b>	<b>2.28</b>	<b>2,574</b>	<b>1.32</b>	<b>1.63</b>	<b>0.78</b>	
mesic hammock	61	25%	2	30.47	0.09	100	30.37	5,274	2,637	21.78	1.71	3,058	1.27			
shrub-brush lands	52	21%	11	4.71	1.33	154	7.25	22,387	2,035	92.47	3.73	5,049	1.42			
marsh-wet prairie-temporary pond	2	1%	5	0.33	0.20	100	0.33	1,087	217	4.49	1.26	1,359	1.35			
mixed pine-hardwood	6	3%	2	3.21	1.87	42	1.34	1,660	830	6.86	1.33	287	1.30			
residential, rural	3	1%	1	2.85	2.85	0	0.00	811	811	3.35	1.36	285	1.31			
agriculture	71	29%	1	70.79	70.79	0	0.00	5,428	5,428	22.42	1.82	77	1.28			
hardwood-cypress swamp/forest	42	17%	4	10.40	2.05	114	11.88	8,336	2,084	34.43	2.00	363	1.32			
water	6	2%	4	1.50	0.14	152	2.29	4,766	1,191	19.68	4.59	1,594	1.52			
<b>Proposed add. lost (all)</b>	<b>710</b>		<b>40</b>	<b>17.75</b>	<b>2.21</b>	<b>258</b>	<b>45.74</b>	<b>71,014</b>	<b>1,775</b>	<b>6.15</b>	<b>2.01</b>	<b>805</b>	<b>1.28</b>	<b>2.22</b>	<b>0.87</b>	
pasture	199	28%	2	99.63	1.58	98	98.05	13,573	6,786	19.11	2.61	198	1.31			
mixed pine-hardwood	24	3%	2	12.04	8.14	32	3.90	4,051	2,026	5.70	1.72	166	1.30			
built-environment	36	5%	6	6.05	0.66	193	11.71	5,135	856	7.23	1.44	742	1.27			
sandhill, degraded	26	4%	7	3.76	1.60	132	4.96	7,852	1,122	11.06	1.81	1,695	1.32			
golf course	4	1%	1	3.78	3.78	0	0.00	925	925	1.30	1.34	245	1.30			
sandhill	38	5%	3	12.69	1.05	133	16.85	6,904	2,301	9.72	2.53	797	1.35			
residential, oak scrub	155	22%	3	51.81	5.79	129	66.80	8,544	2,848	12.03	1.58	141	1.25			
mesic hammock	34	5%	11	3.05	3.03	68	2.07	11,535	1,049	16.24	1.97	391	1.36			
marsh-wet prairie-temporary pond	1	0%	1	1.20	1.20	0	0.00	483	483	0.68	1.25	404	1.32			
residential, sandhill	180	25%	1	180.33	180.33	0	0.00	8,827	8,827	12.43	1.85	49	1.26			
agriculture	10	1%	1	10.38	10.38	0	0.00	1,749	1,749	2.46	1.53	168	1.29			
shrub-brush lands	1	0%	1	1.25	1.25	0	0.00	774	774	1.09	1.95	619	1.41			
silviculture	0	0%	1	0.10	0.10	0	0.00	663	663	0.93	5.88	6,553	1.88			
<b>Proposed add. lost (pd)</b>	<b>244</b>		<b>16</b>	<b>15.26</b>	<b>2.21</b>	<b>309</b>	<b>47.18</b>	<b>28,255</b>	<b>1,766</b>	<b>115.71</b>	<b>2.47</b>	<b>757</b>	<b>1.31</b>	<b>2.04</b>	<b>0.73</b>	
mesic hammock	34	14%	11	3.05	3.03	68	2.07	11,535	1,049	47.24	1.97	391	1.36			
marsh-wet prairie-temporary pond	1	0%	1	1.20	1.20	0	0.00	483	483	1.98	1.25	404	1.32			
pasture	198	81%	1	197.68	197.68	0	0.00	13,051	13,051	53.45	2.62	66	1.31			
agriculture	10	4%	1	10.38	10.38	0	0.00	1,749	1,749	7.16	1.53	168	1.29			
shrub-brush lands	1	1%	1	1.25	1.25	0	0.00	774	774	3.17	1.95	619	1.41			
silviculture	0	0%	1	0.10	0.10	0	0.00	663	663	2.72	5.88	6,553	1.88			

Appendix A. continued.

Class	Class Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgtd. MSI	Area Perimeter/ Area Ratio (m/ha)	Mean Patch Dimension	Area Wgtd. Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
<b>Proposed add. lost (Timberwalk)</b>	<b>337</b>		<b>8</b>	<b>42.17</b>	<b>0.63</b>	<b>167</b>	<b>70.47</b>	<b>20,992</b>	<b>2,624</b>	<b>62.23</b>	<b>1.74</b>	<b>1,637</b>	<b>1.26</b>	<b>1.52</b>	<b>0.73</b>	
sandhill, degraded	1	0%	3	0.36	0.30	55	0.20	2,797	932	8.29	4.22	3,658	1.63			
sandhill	1	0%	1	0.50	0.50	0	0.00	824	824	2.44	3.29	1,647	1.58			
residential, oak scrub	155	46%	3	51.81	5.79	129	66.80	8,544	2,848	25.33	1.58	141	1.25			
residential, sandhill	180	53%	1	180.33	180.33	0	0.00	8,827	8,827	26.17	1.85	49	1.26			
<b>Proposed add. lost (Walmart, etc)</b>	<b>77</b>		<b>10</b>	<b>7.69</b>	<b>3.78</b>	<b>136</b>	<b>10.48</b>	<b>14,379</b>	<b>1,438</b>	<b>186.95</b>	<b>2.03</b>	<b>451</b>	<b>1.32</b>	<b>1.91</b>	<b>0.83</b>	
built-environment	2	3%	2	1.10	0.22	80	0.88	1,041	521	13.53	1.31	1,237	1.31			
mixed pine-hardwood	8	11%	1	8.14	8.14	0	0.00	1,278	1,278	16.62	1.26	157	1.27			
sandhill, degraded	25	33%	4	6.31	4.18	84	5.27	5,055	1,264	65.72	1.71	223	1.31			
golf course	4	5%	1	3.78	3.78	0	0.00	925	925	12.02	1.34	245	1.30			
sandhill	38	49%	2	18.78	1.05	94	17.73	6,080	3,040	79.05	2.52	372	1.34			
<b>Proposed add. lost (other)</b>	<b>52</b>		<b>6</b>	<b>8.61</b>	<b>0.76</b>	<b>138</b>	<b>11.90</b>	<b>7,388</b>	<b>1,231</b>	<b>143.09</b>	<b>1.59</b>	<b>413</b>	<b>1.28</b>	<b>1.39</b>	<b>0.77</b>	
pasture	2	3%	1	1.58	1.58	0	0.00	521	521	10.10	1.17	329	1.29			
mixed pine-hardwood	16	31%	1	15.94	15.94	0	0.00	2,773	2,773	53.70	1.96	174	1.32			
built-environment	34	66%	4	8.53	0.66	160	13.67	4,094	1,024	79.29	1.44	494	1.26			
<b>Private - Spruce Creek</b>	<b>167</b>		<b>11</b>	<b>15.15</b>	<b>0.00</b>	<b>225</b>	<b>34.07</b>	<b>11,579</b>	<b>1,053</b>	<b>69.48</b>	<b>1.64</b>	<b>9,598</b>	<b>1.26</b>	<b>1.01</b>	<b>0.46</b>	
built-environment	110	66%	9	12.22	0.00	283	34.56	6,353	706	38.12	1.66	10,356	1.25			
golf course	57	34%	1	56.57	56.57	0	0.00	4,251	4,251	25.51	1.59	75	1.26			
mixed pine-hardwood	0	0%	1	0.08	0.08	0	0.00	975	975	5.85	9.77	12,301	2.06			
<b>Private - other</b>	<b>2,621</b>		<b>276</b>	<b>9.50</b>	<b>1.15</b>	<b>250</b>	<b>23.73</b>	<b>357,600</b>	<b>1,296</b>	<b>136.43</b>	<b>2.00</b>	<b>9,717</b>	<b>1.29</b>	<b>4.84</b>	<b>0.88</b>	
hardwood-cypress swamp/forest	198	8%	31	6.39	0.08	338	21.58	36,480	1,177	13.92	2.43	20,567	1.32			
residential, rural water	918	35%	42	21.86	6.04	154	33.72	85,243	2,030	32.52	1.71	5,508	1.27			
mixed pine-hardwood	18	1%	24	0.74	0.11	206	1.53	10,952	456	4.18	3.02	39,662	1.41			
built-environment	187	7%	18	10.41	2.28	169	17.56	21,707	1,206	8.28	1.40	1,580	1.26			
pasture	202	8%	11	18.35	0.67	282	51.69	12,470	1,134	4.76	1.59	4,126	1.25			
sandhill	381	15%	20	19.03	3.47	210	39.95	53,283	2,664	20.33	3.32	1,598	1.34			
agriculture	80	3%	9	8.84	5.27	135	11.91	12,085	1,343	4.61	1.66	10,728	1.29			
golf course	135	5%	6	22.46	24.11	67	15.00	13,812	2,302	5.27	1.54	11,706	1.27			
golf course	14	1%	1	14.30	14.30	0	0.00	2,629	2,629	1.00	1.96	184	1.33			

Appendix A. continued.

Class	Area (ha)	% Total Area (ha)	# Patches	Mean Patch Size (ha)	Median Patch Size (ha)	Patch Size Coeff. Var.	Patch Size SD	Total Edge (m)	Mean Patch Edge (m)	Edge Density (m/ha)	Area Wgted. MSI	Perimeter/Area Ratio (m/ha)	Mean Area Wgted. Fractal Dimension	Shannon Diversity Index	Shannon Evenness Index
Private - other (continued)															
marsh-wet prairie-temporary pond	117	4%	35	3.35	0.52	229	7.67	24,572	702	9.37	1.73	4,228	1.31		
sandhill, degraded mesic hammock	94	4%	12	7.84	1.15	189	14.82	19,731	1,644	7.53	1.80	1,398	1.30		
xeric oak scrub	8	0%	3	2.54	0.01	141	3.59	2,311	770	0.88	2.23	8,281	1.37		
dry prairie/grasslands	2	0%	5	0.35	0.05	127	0.44	1,095	219	0.42	1.41	9,377	1.36		
shrub-brush lands	23	1%	8	2.86	1.44	126	3.59	9,556	1,195	3.65	2.64	10,924	1.40		
residential, oak scrub	49	2%	6	8.18	0.00	147	12.04	5,194	866	1.98	1.35	12,806	1.25		
silviculture	29	1%	1	29.33	29.33	0	0.00	2,682	2,682	1.02	1.40	91	1.25		
residential, sandhill	23	1%	2	11.49	0.00	100	11.49	2,450	1,225	0.93	1.43	28,343	1.26		

Notes:

Edge Density (ED) is the amount of edge relative to the landscape area. Edge is the same as perimeter.

Mean Shape Index (MSI) is the sum of each patch's perimeter divided by the square root of patch area (hectares) for each class (Class Level) or all patches (Landscape Level), adjusted for circular standard (polygons), and divided by the number of patches. MSI is greater than one, MSI = 1 when all patches are circular (polygons). Area weighted MSI includes individual patch area weighting applied to each patch.

Mean Perimeter-Area Ratio (MPAR) is the sum of each patch's perimeter/area ratio divided by the number of patches.

Area weighted mean patch fractal dimension (AWMPFD) is the same as mean patch fractal dimension with the addition of individual patch area weighting applied to each patch. Because larger patches tend to be more complex than smaller patches, this has the effect of determining patch complexity independent of its size. Mean fractal dimension approaches one for shapes with simple perimeters and approaches two when shapes are more complex.

Shannon's diversity index (SDI) is a relative measure of patch diversity. The index will equal zero when there is only one patch in the landscape and increases as the number of patch types or proportional distribution of patch types increases.

Shannon's evenness index (SEI) is equal to zero when the observed patch distribution is low and approaches one when the distribution of patch types becomes more even.

**APPENDIX B**

**Contextual Analyses  
Site Photographs of Surrounding Properties**



**Appendix B-1.** Site #1 – small lot of sandhill for sale adjacent to asphalt plant.

**Appendix B-2.** Site #2 – large vacant lot of sandhill adjacent to site#1.



**Appendix B-3a.** Site #3 – former sandhill/scrub habitat (proposed addition to CFG) being cleared along SR 200.



**Appendix B-3b.** Site #3 – Walmart construction at former proposed addition to CFG.



**Appendix B-4.** Site #4 – 110 ac site for sale; adjacent to Walmart site.



**Appendix B-5.** Site #5 – small lot of sandhill for sale contiguous with CFG n CR 484.



**Appendix B-6a.** Site #6 – small lot of sandhill for sale contiguous with CFG on CR 484.



**Appendix B-6b.** Site #6 – small lot of sandhill for sale; view from west.



**Appendix B-7a.** Site #7 – platted roads in Marion Oaks with undeveloped lots.



**Appendix B-7b.** Site #7 – roads in disrepair in undeveloped portion of Marion Oaks.



**Appendix B-8a.** Site #8 – vacant lots of sandhill and scrub in Timber Walk development.



**Appendix B-8b.** Site #8 – undeveloped land in Timber Walk adjacent to CR 484 and CFG.



**Appendix B-9.** Site #9 – rural lot development in the eastern part of the Highlands.



**Appendix B-10.** Site #10 – wet prairie site in the Highlands adjacent to RPSF.



**Appendix B-11.** Site #11 – dirt road adjacent to RPSF in the eastern part of the Highlands.



**Appendix B-12.** Site #12 – rural development in the southern part of the Highlands.



**Appendix B-13.** Site #13 – rural character of the southern part of the Highlands.



**Appendix B-14.** Site #14 – entrance to the Highlands across SR 200 from HTP.



**Appendix B-15.** Site #15 – 12 ac lot for sale on SR 200 contiguous with HTP.



**Appendix B-16a.** Site #B – twin box culvert on SR 200 at proposed southeast WSF connection.



**Appendix B-16b.** Site #B – view east from culvert.



**Appendix B-16c.** Site #B – view west from culvert.



**Appendix B-17a.** Site #17 – view east of ponds split by SR 200.



**Appendix B-17b.** Site #17 – view west of ponds at proposed southeast WSF connection.



**Appendix B-18.** Site #18 – box culvert on SR 200 in proposed southeast WSF connection.



**Appendix B-19.** Site #19 – view east on CR 491 of wet prairie in WSF two-mile prairie addition.



**Appendix B-20.** Site #20 – view west of wet prairie in WSF split by CR 491.



**Appendix B-21.** Site #21 – view east of wetland split by SR 200.



**Appendix B-22.** Site #23 – waterfront lots for property sale on CR 39 and Withlacoochee R.



**Appendix B-23.** Site #24 – Terra Research on CR 39.



**Appendix B-24.** Site #25 – riverfront acreage for sale on CR 39.

**Appendix B-25.** Site #26 – auction sale of surrounding Dunnellon airport across from Pruitt trailhead; previously proposed addition to CFG.



**Appendix B-26.** Site #27 – nursery acreage for sale north of CR 484 across from CFG.

**Appendix B-27.** Site #28 – 5 ac lots for sale on CR 484 adjacent to west CFG.

## APPENDIX C

### Plant Species Recorded in ROW Transects by Growth Form and Plant Community Preference

### Appendix C. Plant Species Recorded in ROW Transects by Growth Form and Plant Community Preference.

Scientific Name	Common Name	Growth Form	Community Preference	Transects Found
Cyanobacteria	algal mat	algae	marshes/wet areas	5
Axonopus furcatus	big carpet grass	gr cover	marshes/wet areas	1,4-6,9,10
Carex spp.	sedge	gr cover	marshes/wet areas	5
Cyperus echinatus	sedge	gr cover	marshes/wet areas	6,7
Cyperus odoratus	sedge	gr cover	marshes/wet areas	7
Eleocharis spp.	spikerush	gr cover	marshes/wet areas	5
Eriocaulon compressum	hat pins	gr cover	marshes/wet areas	5
Hydrochloa carolinensis	watergrass	gr cover	marshes/wet areas	5
Hydrocotyle verticellata	pennywort	gr cover	marshes/wet areas	5
Lachnocaulon anceps	bog buttons	gr cover	marshes/wet areas	5
Myriophyllum spp.	water milfoil	gr cover	marshes/wet areas	5
Panicum hemitomon	maidencane	gr cover	marshes/wet areas	5
Panicum repens	torpedo grass	gr cover	marshes/wet areas	4,5,7,10
Panicum spp.		gr cover	marshes/wet areas	5,6
Paspalum distichum	knot-grass	gr cover	marshes/wet areas	5
Polygonum punctatum	smartweed	gr cover	marshes/wet areas	5
Rhynchospora divergens	beak-rush	gr cover	marshes/wet areas	4,5,10
Rhynchospora spp.	beak-rush	gr cover	marshes/wet areas	5
Spirodella punctata	giant duckweed	gr cover	marshes/wet areas	5
Xyris fimbriata	yellow-eyed grass	gr cover	marshes/wet areas	5
Fabaceae spp.		gr cover	pinelands/disturbed	0,3
Hedyotis boscii		gr cover	pinelands/disturbed	6,7
Hedyotis procumbens	innocence	gr cover	pinelands/disturbed	8,10
Poaceae spp.	misc. grasses	gr cover	pinelands/disturbed	0-7,9
Polypremum procumbens	rustweed	gr cover	pinelands/disturbed	0,6
Pteridium aquilinum	bracken fern	gr cover	pinelands/disturbed	1
Schrankia microphylla	sensitive briar	gr cover	pinelands/disturbed	1-3
Vinca minor	periwinkle	gr cover	pinelands/disturbed	10
Bahia spp.		gr cover	ruderal/disturbed	all
Cynodon dactylon	bermuda	gr cover	ruderal/disturbed	1-6,8-10
Cyperus spp.	nut sedge	gr cover	ruderal/disturbed	0,9,10
Digitaria pentzii	crabgrass	gr cover	ruderal/disturbed	0,9
Eremochloa ophiuroides	centipede grass	gr cover	ruderal/disturbed	2,3,8
Imperata cylindrica	cogongrass	gr cover	ruderal/disturbed	8
Lindernia grandiflora	false pimpernel	gr cover	ruderal/disturbed	5
Medicago lupulina	black medic	gr cover	ruderal/disturbed	1,4-6,8
Milium vernale	milium	gr cover	ruderal/disturbed	4,8,10
Panicum milaceum	wild proso millet	gr cover	ruderal/disturbed	8,10
Pennisetum ciliare	buffelgrass	gr cover	ruderal/disturbed	5
Pennisetum clandestinum	kikuyu grass	gr cover	ruderal/disturbed	4
Phyla nodiflora	capeweed	gr cover	ruderal/disturbed	3,5,6
Poaceae sp. 1		gr cover	ruderal/disturbed	5,8
Poaceae sp. 2		gr cover	ruderal/disturbed	5,8
Poaceae sp. 3		gr cover	ruderal/disturbed	5
Richardia brasiliensis	mexican clover	gr cover	ruderal/disturbed	1-10
Trifolium spp.	hop clover	gr cover	ruderal/disturbed	0,6,9,10

Appendix C. continued.

Scientific Name	Common Name	Growth Form	Community Preference	Transects Found
<i>Aristida stricta</i>	wiregrass	gr cover	sandhills/pinelands	1-3,6-9
<i>Diodia teres</i>	poor Joe	gr cover	sandhills/pinelands	7,9
<i>Polygonella polygama</i>	jointweed	gr cover	sandhills/pinelands	2
<i>Rhynchosia</i> spp.	Dollar-weed	gr cover	sandhills/pinelands	2
<i>Cladonia</i> spp.	Deer moss lichen	gr cover	sandhills/scrub	0,3,7,8
<i>Licania michauxii</i>	gopher apple	gr cover	sandhills/scrub	0-3,8,9
<i>Mitchella repens</i>	partridge berry	gr cover	upland forests/hammocks	7,9,10
<i>Bacopa caroliniana</i>	blue hyssop	herb	marshes/wet areas	5
<i>Boehmeria cylindrica</i>	false nettle	herb	marshes/wet areas	5
<i>Lobelia feayana</i>	bay lobelia	herb	marshes/wet areas	8
<i>Ludwigia octovalvis</i>		herb	marshes/wet areas	2,4
<i>Mikania</i> spp.	Hempweed	herb	marshes/wet areas	5
<i>Nymphaea odorata</i>	white waterlily	herb	marshes/wet areas	5
<i>Pontederia cordata</i>	pickerelweed	herb	marshes/wet areas	5
<i>Rhexia mariana</i>	pale meadow beauty	herb	marshes/wet areas	0,6,9
<i>Sabatia dodecandra</i>	ten-petal sabatia	herb	marshes/wet areas	5
<i>Utricularia</i> spp.	Bladderwort	herb	marshes/wet areas	5
<i>Andropogon</i> spp.	Broom sedge	herb	pinelands/disturbed	1-5,8,10
<i>Aster dumosus</i>	bushy aster	herb	pinelands/disturbed	6
Asteraceae spp.		Herb	pinelands/disturbed	0
<i>Berlandiera subacaulis</i>	green eyes	herb	pinelands/disturbed	1-3,8
<i>Chamaecrista fasciculata</i>	partridge pea	herb	pinelands/disturbed	8
<i>Chrysopsis mariana</i>	golden aster	herb	pinelands/disturbed	6,8
<i>Chrysopsis</i> spp.	Golden aster	herb	pinelands/disturbed	4
<i>Chrysopsis subulata</i>	golden aster	herb	pinelands/disturbed	1,6
<i>Cirsium horridulum</i>	thistle	herb	pinelands/disturbed	2
<i>Crotalaria pumila</i>	small rattlebox	herb	pinelands/disturbed	5,10
<i>Crotalaria purshii</i>		herb	pinelands/disturbed	8
<i>Desmodium</i> spp.		Herb	pinelands/disturbed	4
<i>Elephantopus elatus</i>	elephant foot	herb	pinelands/disturbed	2,3,8
<i>Erigeron</i> spp.	Fleabane	herb	pinelands/disturbed	2,6,7
<i>Eupatorium capillifolium</i>	dog fennel	herb	pinelands/disturbed	1,2,4-6,9,10
<i>Eupatorium compositifolium</i>	dog fennel	herb	pinelands/disturbed	1,6,8,9
<i>Eupatorium mohrii</i>		herb	pinelands/disturbed	1,6
<i>Eupatorium rotundifolium</i>	false hoarhound	herb	pinelands/disturbed	5,8
<i>Eupatorium</i> spp.	Dog fennel	herb	pinelands/disturbed	0,3
<i>Euthamia minor</i>	flat-topped goldenrod	herb	pinelands/disturbed	1,3,10
<i>Galium hispidulum</i>		herb	pinelands/disturbed	8,10
<i>Helianthemum carolinianum</i>	Carolina rock-rose	herb	pinelands/disturbed	3,10
<i>Helianthemum corymbosum</i>	rock rose	herb	pinelands/disturbed	4,8,10
<i>Heterotheca subaxillaris</i>	camphorweed	herb	pinelands/disturbed	10
<i>Hieracium gronovii</i>	hawkweed	herb	pinelands/disturbed	8,10
<i>Indigofera</i> spp.		Herb	pinelands/disturbed	3
<i>Krigia virginica</i>	dwarf dandelion	herb	pinelands/disturbed	5,8,10
Lamiaceae spp.		Herb	pinelands/disturbed	10
<i>Lygodesmia aphylla</i>	roserush	herb	pinelands/disturbed	1,2
<i>Physalis arenicola</i>	ground cherry	herb	pinelands/disturbed	8,10

Appendix C. continued.

Scientific Name	Common Name	Growth Form	Community Preference	Transects Found
<i>Pluchea rosea</i>		herb	pinelands/disturbed	6
<i>Portulaca pilosa</i>	pink purslane	herb	pinelands/disturbed	8
<i>Rudbeckia mollis</i>		herb	pinelands/disturbed	8
<i>Rudbeckia</i> spp.	Black-eyed susan	herb	pinelands/disturbed	6
<i>Rudbeckia/Aster</i> spp.		Herb	pinelands/disturbed	3
<i>Salvia</i> spp.		Herb	pinelands/disturbed	2,3,9
Scrophulariaceae spp.		Herb	pinelands/disturbed	10
<i>Sida cordifolia</i>		herb	pinelands/disturbed	10
<i>Silphium compositum</i>	rosinweed	herb	pinelands/disturbed	8
<i>Solidago fistulosa</i>	goldenrod	herb	pinelands/disturbed	1,3
<i>Solidago</i> spp.	Goldenrod	herb	pinelands/disturbed	7
<i>Stachys floridana</i>	hedge nettle	herb	pinelands/disturbed	3,5,10
<i>Stylosanthes biflora</i>	pencilflower	herb	pinelands/disturbed	7,10
<i>Toxicodendron radicans</i>	poison oak	herb	pinelands/disturbed	1-3
<i>Trichostema dichotomum</i>	blue curts	herb	pinelands/disturbed	1,3
<i>Zornia bracteata</i>	Marsilea sandweed	herb	pinelands/disturbed	8
<i>Ambrosia artemisiifolia</i>	common ragweed	herb	ruderal/disturbed	0-2,4-6,8,10
<i>Astragalus villosus</i>	hairy milk vetch	herb	ruderal/disturbed	2-4,6
<i>Chenopodium album</i>	lamb's quarters	herb	ruderal/disturbed	2,4,6,7
<i>Chenopodium ambrosioides</i>	Mexican tea	herb	ruderal/disturbed	3-6,8-10
<i>Cnidioscolus stimulosus</i>	stinging nettle	herb	ruderal/disturbed	0-4,9
<i>Conyza canadensis</i>	dwarf horseweed	herb	ruderal/disturbed	0,6,7
<i>Daucus carota</i>	Queen Anne's lace	herb	ruderal/disturbed	0
<i>Descurainia pinnata</i>	tansy mustard	herb	ruderal/disturbed	5,10
<i>Desmodium incanum</i>	beggarweed	herb	ruderal/disturbed	8
<i>Desmodium triflorum</i>	beggarweed	herb	ruderal/disturbed	2
<i>Geranium carolinianum</i>	crane's bill	herb	ruderal/disturbed	5,8,10
<i>Glandularia pulchella</i>	moss verbena	herb	ruderal/disturbed	5
<i>Gnaphalium falcatum</i>	cudweed	herb	ruderal/disturbed	1,4,5,8,9
<i>Gnaphalium obtusifolium</i>	rabbit tobacco	herb	ruderal/disturbed	3
<i>Indigofera hirsuta</i>	hairy indigo	herb	ruderal/disturbed	5
<i>Indigofera spicata</i>		herb	ruderal/disturbed	6
<i>Kummerowia striata</i>		herb	ruderal/disturbed	0
<i>Lepidium virginicum</i>	peppergrass	herb	ruderal/disturbed	0,3-6,8,10
<i>Oxalis dillenii</i>	sorrel	herb	ruderal/disturbed	8,10
<i>Oxalis</i> spp.	Sorrel	herb	ruderal/disturbed	6
<i>Phlox drummondii</i>	phlox	herb	ruderal/disturbed	4,6
<i>Rumex hastatulus</i>	hastate-leaf dock	herb	ruderal/disturbed	1-3,10
<i>Salvia coccinea</i>	tropical sage	herb	ruderal/disturbed	8
<i>Salvia lyrata</i>	lyre-leaf sage	herb	ruderal/disturbed	10
<i>Solidago canadensis</i>	goldenrod	herb	ruderal/disturbed	1,3,4,10
<i>Spermolepis divaricata</i>		herb	ruderal/disturbed	10
<i>Youngia japonica</i>	hawk's beard	herb	ruderal/disturbed	8
Acanthaceae spp.		Herb	sandhills/pinelands	7
<i>Aster concolor</i>	silvery aster	herb	sandhills/pinelands	4,6,8
<i>Carphephorus carnosus</i>		herb	sandhills/pinelands	8
<i>Carphephorus corymbosus</i>	paint brush	herb	sandhills/pinelands	8

Appendix C. continued.

Scientific Name	Common Name	Growth Form	Community Preference	Transects Found
<i>Cassia nictitans</i>	sensitive plant	herb	sandhills/pinelands	1-3,8
<i>Centrosema virginianum</i>	butterfly pea	herb	sandhills/pinelands	1-4
<i>Clitoria mariana</i>	blue pea	herb	sandhills/pinelands	2
<i>Crotalaria rotundifolia</i>	rabbit bells	herb	sandhills/pinelands	2,3,8,9
<i>Croton argyranthemus</i>	silver croton	herb	sandhills/pinelands	0-3,6,7,9
<i>Dyschoriste oblongifolia</i>	twin flower	herb	sandhills/pinelands	1-4,6,8,9
<i>Galactia</i> spp.		Herb	sandhills/pinelands	7
<i>Hypericum crux-andraea</i>	St. John's wort	herb	sandhills/pinelands	8
<i>Indigofera caroliniana</i>		herb	sandhills/pinelands	4
<i>Opuntia humifusa</i>	prickly pear	herb	sandhills/pinelands	1-3,7,8
<i>Phoebanthus grandiflora</i>		herb	sandhills/pinelands	6,8
<i>Pityopsis graminifolia</i>	goldenaster	herb	sandhills/pinelands	1-4,8
<i>Polygala nana</i>	bachelor button	herb	sandhills/pinelands	1-3,9
<i>Sorghastrum secundum</i>	lopsided indian grass	herb	sandhills/pinelands	1,3
<i>Stillingia sylvatica</i>	queen's delight	herb	sandhills/pinelands	1-3,8,9
<i>Tephrosia chrysophylla</i>		herb	sandhills/pinelands	0,2,3,6-8
<i>Tephrosia florida</i>		herb	sandhills/pinelands	2,3
<i>Asclepias humistrata</i>	purple milkweed	herb	sandhills/scrub	1,8
<i>Asclepias longifolia</i>	longleaf milkweed	herb	sandhills/scrub	8
<i>Asclepias pedicellata</i>	pedicellate milkweed	herb	sandhills/scrub	2,3
<i>Asclepias</i> spp.	Milkweed	herb	sandhills/scrub	10
<i>Asclepias tomentosa</i>	velvet-leaf milkweed	herb	sandhills/scrub	3
<i>Asclepias tuberosa</i>	butterfly-weed	herb	sandhills/scrub	10
<i>Aster tortifolius</i>	white-topped aster	herb	sandhills/scrub	6,8
<i>Balduina angustifolia</i>	yellow buttons	herb	sandhills/scrub	7
<i>Chrysopsis scabrella</i>	goldenaster	herb	sandhills/scrub	1,2
<i>Dalea feayi</i>		herb	sandhills/scrub	8
<i>Galactia volubilis</i>	milk pea	herb	sandhills/scrub	10
<i>Gratiola ramosa</i>	hedge hyssop	herb	sandhills/scrub	10
<i>Palafoxia integrifolia</i>	coastal plain palafox	herb	sandhills/scrub	3
<i>Erythrina herbacea</i>	coral bean	herb	upland forests/hammocks	4
<i>Polypodium polypodioides</i>	resurrection fern	herb	upland forests/hammocks	8
<i>Tillandsia</i> spp.	Air plant	herb	upland forests/hammocks	10
<i>Cephalanthus occidentalis</i>	button bush	shrub	marshes/wet areas	0,5-7,10
<i>Ludwigia peruviana</i>	primrose willow	shrub	marshes/wet areas	5
<i>Salix caroliniana</i>	Carolina willow	shrub	marshes/wet areas	6
<i>Spartina bakeri</i>	cordgrass	shrub	marshes/wet areas	5
<i>Callicarpa americana</i>	beauty berry	shrub	pinelands/disturbed	8,10
<i>Rhus copallina</i>	winged sumac	shrub	pinelands/disturbed	1-3,8-10
<i>Rubus cuneifolia</i>	blackberry	shrub	pinelands/disturbed	2-8,10
<i>Baccharis halmifolia</i>	salt bush	shrub	ruderal/disturbed	4
<i>Asimina angustifolia</i>	narrow-leaf paw paw	shrub	sandhills/pinelands	8
<i>Asimina incana</i>	paw paw	shrub	sandhills/pinelands	1,4,8
<i>Asimina reticulata</i>	paw paw	shrub	sandhills/pinelands	9
<i>Bumelia lanuginosa</i>	gum bumelia	shrub	sandhills/pinelands	2
<i>Gaylussacia dumosa</i>	dwarf huckleberry	shrub	sandhills/pinelands	1,6,8-10
<i>Hypericum</i> spp.	St. John's wort	shrub	sandhills/pinelands	2,4,7,8

**Appendix C. continued.**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Growth Form</b>	<b>Community Preference</b>	<b>Transects Found</b>
<i>Serenoa repens</i>	saw palmetto	shrub	sandhills/pinelands	1-4,8,9
<i>Quercus pumilla</i>	running oak	shrub	sandhills/scrub	3
<i>Quercus incana</i>	blue jack oak	shrub	sandhills/scrub	8
<i>Quercus minima</i>	dwarf live oak	shrub	sandhills/scrub	1,9
<i>Quercus myrtifolia</i>	myrtle oak	shrub	sandhills/scrub	4,7
<i>Quercus pumila</i>	running oak	shrub	sandhills/scrub	1-4,9
<i>Ilex glabra</i>	inkberry	shrub	upland forests/hammocks	4
<i>Myrica cerifera</i>	wax murtle	shrub	upland forests/hammocks	4
<i>Osmanthes americana</i>	wild olive	shrub	upland forests/hammocks	2,4,7
<i>Vaccinium arboreum</i>	sparkleberry	shrub	upland forests/hammocks	1,4,9
<i>Vaccinium stamineum</i>	southern gooseberry	shrub	upland forests/hammocks	4
<i>Diospyros virginiana</i>	persimmon	tree	sandhills/pinelands	1-4,8-10
<i>Ilex opaca arenicola</i>	scrub holly	tree	sandhills/pinelands	9
<i>Pinus palustris</i>	longleaf pine	tree	sandhills/pinelands	1-3,8,9
<i>Quercus geminata</i>	sand live oak	tree	sandhills/scrub	2,4,6-9
<i>Quercus laevis</i>	turkey oak	tree	sandhills/scrub	1-3,8,9
<i>Ilex opaca</i>	American holly	tree	upland forests/hammocks	0,4
<i>Persea borbonia</i>	red bay	tree	upland forests/hammocks	2,3
<i>Persea humilis</i> or <i>P. littoralis</i>	scrub bay	tree	upland forests/hammocks	4
<i>Prunus serotina</i>	black cherry	tree	upland forests/hammocks	3,10
<i>Quercus hemisphaerica</i>	laurel oak	tree	upland forests/hammocks	0-4,8-10
<i>Quercus virginiana</i>	live oak	tree	upland forests/hammocks	0,4,7-10
<i>Ipomaea aquatica</i>	morning glory	vine	marshes/wet areas	5
<i>Smilax auriculata</i>	greenbrier	vine	pinelands/disturbed	10
<i>Smilax glauca</i>	wild sarsaparilla vine	vine	pinelands/disturbed	8,10
<i>Smilax laurifolia</i>	catbrier	vine	pinelands/disturbed	10
<i>Smilax pumila</i>	sarsaparilla vine	vine	pinelands/disturbed	2,4
<i>Smilax</i> spp.	greenbrier	vine	pinelands/disturbed	1-4,6,7,9
<i>Ampelopsis arborea</i>	pepper vine	vine	upland forests/hammocks	10
<i>Parthenocissus quinquefolia</i>	virginia creeper	vine	upland forests/hammocks	4,8-10
<i>Vitis rotundifolia</i>	muscadine grape	vine	upland forests/hammocks	1-4,6,8-10

**APPENDIX D**

**Road-kills Recorded from August 2001 to April 2004**

**Appendix D. Road-kills Recorded from August 2001 to April 2004.**

<b>Species</b>	<b>Scientific name</b>	<b>Amount</b>
<b>Mammals (n=163)</b>		
Armadillo	<i>Dasypus novemcinctus</i>	26
Bobcat	<i>Lynx rufus</i>	5
Coyote	<i>Canis latrans</i>	5
Domestic cat	<i>Felis catus</i>	1
Eastern cottontail rabbit	<i>Sylvilagus floridanus</i>	7
Florida mouse	<i>Podomys floridanus</i>	2
Fox squirrel	<i>Sciurus niger</i>	1
Gray fox	<i>Urocyon cinereoargenteus</i>	8
Gray squirrel	<i>Sciurus carolinensis</i>	34
Hispid cotton rat	<i>Sigmodon hispidus</i>	1
Marsh rabbit	<i>Sylvilagus palustris</i>	1
Oldfield mouse	<i>Peromyscus polionotus</i>	1
Opossum	<i>Didelphis virginiana</i>	30
Raccoon	<i>Procyon lotor</i>	25
Striped skunk	<i>Mephitis mephitis</i>	8
Whitetail deer	<i>Odocoileus virginianus</i>	5
Wild Pig	<i>Sus scrofa</i>	1
Rat/rodent	<i>Rodentia</i>	2
<b>Birds (n=20)</b>		
American crow	<i>Corvus brachyrhynchos</i>	1
Barred owl	<i>Strix varia</i>	1
Black vulture	<i>Coragyps atratus</i>	1
Boat-tailed grackle	<i>Quiscalus major</i>	2
Carolina wren	<i>Thryothorus ludovicianus</i>	1
Great-horned owl	<i>Bubo virginianus</i>	1
Northern cardinal	<i>Cardinalis cardinalis</i>	1
Purple gallinule	<i>Porphyryla martinica</i>	2
Red-wing blackbird	<i>Agelaius phoeniceus</i>	1
Screech owl	<i>Otus asio</i>	4
Tufted titmouse	<i>Parus bicolor</i>	1
Yellow shafted flicker	<i>Colaptes auratus</i>	1
Bird	Unidentified species	2
Raptor (possible owl)	Unidentified species	1
<b>Anurans(n=513)</b>		
Barking treefrog	<i>Hyla gratiosa</i>	2
Bull frog	<i>Rana catesbeiana</i>	24
Florida gopher frog	<i>Rana capito aesopus</i>	51
Green treefrog	<i>Hyla cinerea</i>	15
Pinewoods treefrog	<i>Hyla femoralis</i>	4
Southern leopard frog	<i>Rana sphenoccephala</i>	67
Southern toad	<i>Bufo terrestris</i>	10
Eastern spadefoot toad	<i>Scaphiopus holbrookii</i>	3

**Appendix D. continued.**

<b>Species</b>	<b>Scientific name</b>	<b>Amount</b>
Frog	Unidentified species	301
Frog/toad	Unidentified species	15
Toad	Unidentified species	18
Treefrog	<i>Hyla spp.</i>	3
<b>Turtles (n=36)</b>		
Chicken turtle	<i>Deirochelys reticularia</i>	2
Common musk turtle	<i>Sternotherus odoratus</i>	2
Florida box turtle	<i>Terrapene carolina</i>	3
Florida cooter	<i>Pseudemys floridana</i>	5
Florida(Eastern) mud turtle	<i>Kinosternon subrubrum</i>	4
Florida softshell turtle	<i>Apalone ferox</i>	1
Gopher tortoise	<i>Gopherus polyphemus</i>	9
Peninsula cooter	<i>Pseudemys peninsularis</i>	2
Suwannee cooter	<i>Pseudemys concinna</i>	2
Turtle	Unidentified species	6
<b>Snakes (n=25)</b>		
Southern black racer	<i>Coluber constrictor</i>	6
Corn snake	<i>Elaphe guttata</i>	4
Eastern coachwhip	<i>Masticophis flagellum</i>	1
Eastern diamondback	<i>Crotalus adamanteus</i>	1
Florida green water snake	<i>Nerodia floridana</i>	2
Eastern indigo snake	<i>Drymarchon corais</i>	5
Florida pine snake	<i>Pituophis melanoleucus mugitus</i>	1
Yellow rat snake	<i>Elaphe obsoleta spiloides</i>	3
Water snake	Unidentified species	2
<b>Lizards(n=2)</b>		
Eastern glass lizard	<i>Ophisaurus ventralis</i>	2