We captured a total of 24 eastern indigo snakes (11 male, 8 female, and 5 of undetermined sex) over the entire study area, observed 2 others, and encountered 5 road-kills. Home range (95% fixed kernel, minimum 30 points) of the 13 eastern indigo snakes monitored averaged 127.6 ha (figure 19). Home range size found here was consistent with that of Breininger et al. (2004) from Brevard County, FL. 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 (also see Stevenson et al. 2003, and Diemer and Speake 1983). Telemetry data indicated that the road acted as a home range boundary (one signal echo was recorded indicating a possible crossing, but a positional fix could not be obtained). Because of road-kills, there is confirmed evidence that interactions with the road occur and road crossings are attempted.

Five eastern diamondback rattlesnakes were also captured (2 male, 2 female {one adult, one subadult}, and 1 adult of undetermined sex). Two of these were killed (human means) and one transmitter failed. Of note: one unmarked rattlesnake road-kill was also found. The average home range size of the two remaining eastern diamondbacks was 86.5 ha (95% FK contours). None of the tracked eastern diamondbacks was recorded crossing the road; however, two were commonly found in the adjacent right-of-way; as a result the subadult was killed by a utilities worker.

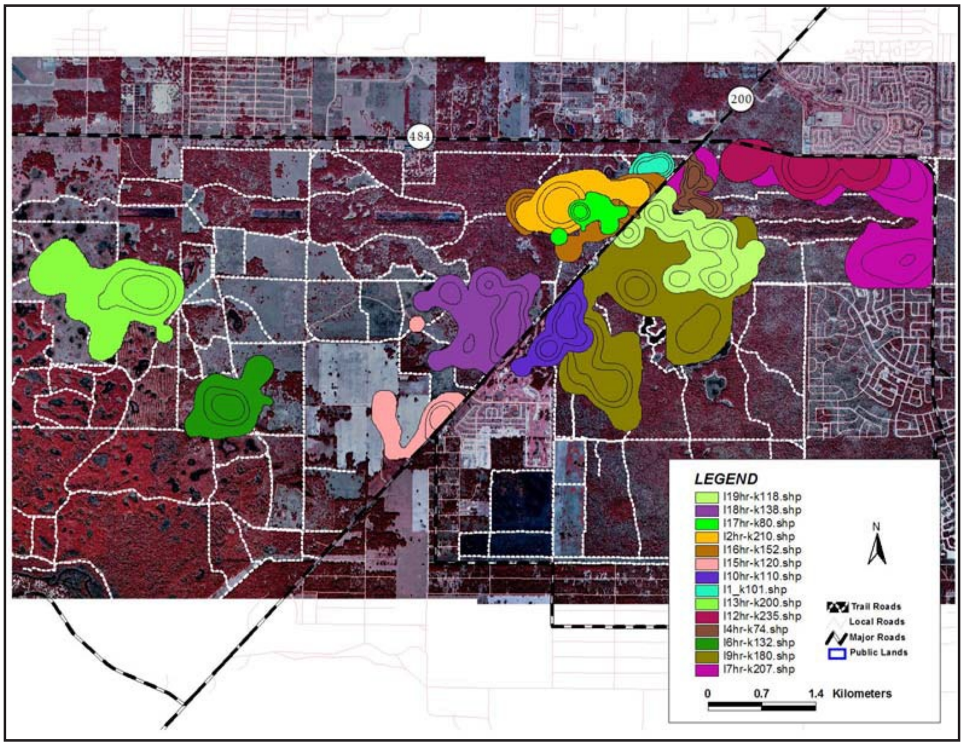

Figure 19. Combined Home Range (50, 75, and 95 % FK contours) for all Indigo Snakes.

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). 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%). Two of the bobcats died after being hit by motor vehicles, and one was shot by a poacher. The gray fox was shot by an adjacent farmer 1.5 months after being collared.

Useful telemetry data was only obtained from 4 bobcats, 2 coyotes, and 1 gray fox (figure 20). Average home range size (FK – 95% contour) was 13.67 km^2 for bobcats (n=3, minimum 40 locations). 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.

Bobcat no. 1 was recorded crossing SR 200 and CR 39, one crossing by an unmarked bobcat was observed, no other successful crossings were recorded. Bobcat no. 1 was a casualty of a vehicle collision on SR 200 near the end of the study. 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 (SR 200 and CR 484). 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. Understanding natural history requirements of species being considered (as described above) is essential in the design of functional habitat corridors (Burbrink et al. 1998).

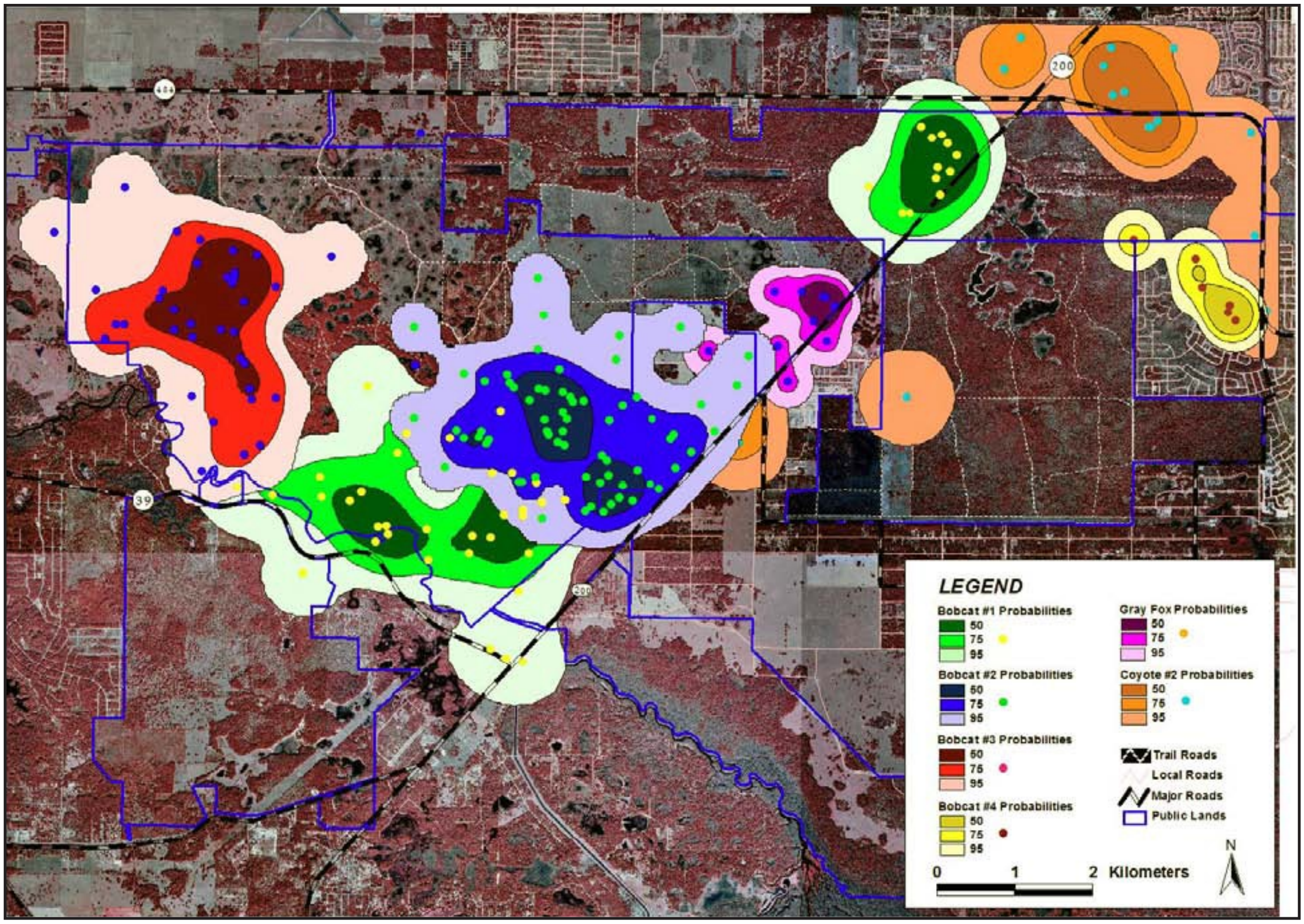

Figure 20. Combined Home Range (50, 75, and 95 % FK contours) for all Carnivores.

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). 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).

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 below) illustrate the use of wildlife crossings to permeate transport facilities (Noss 1995).

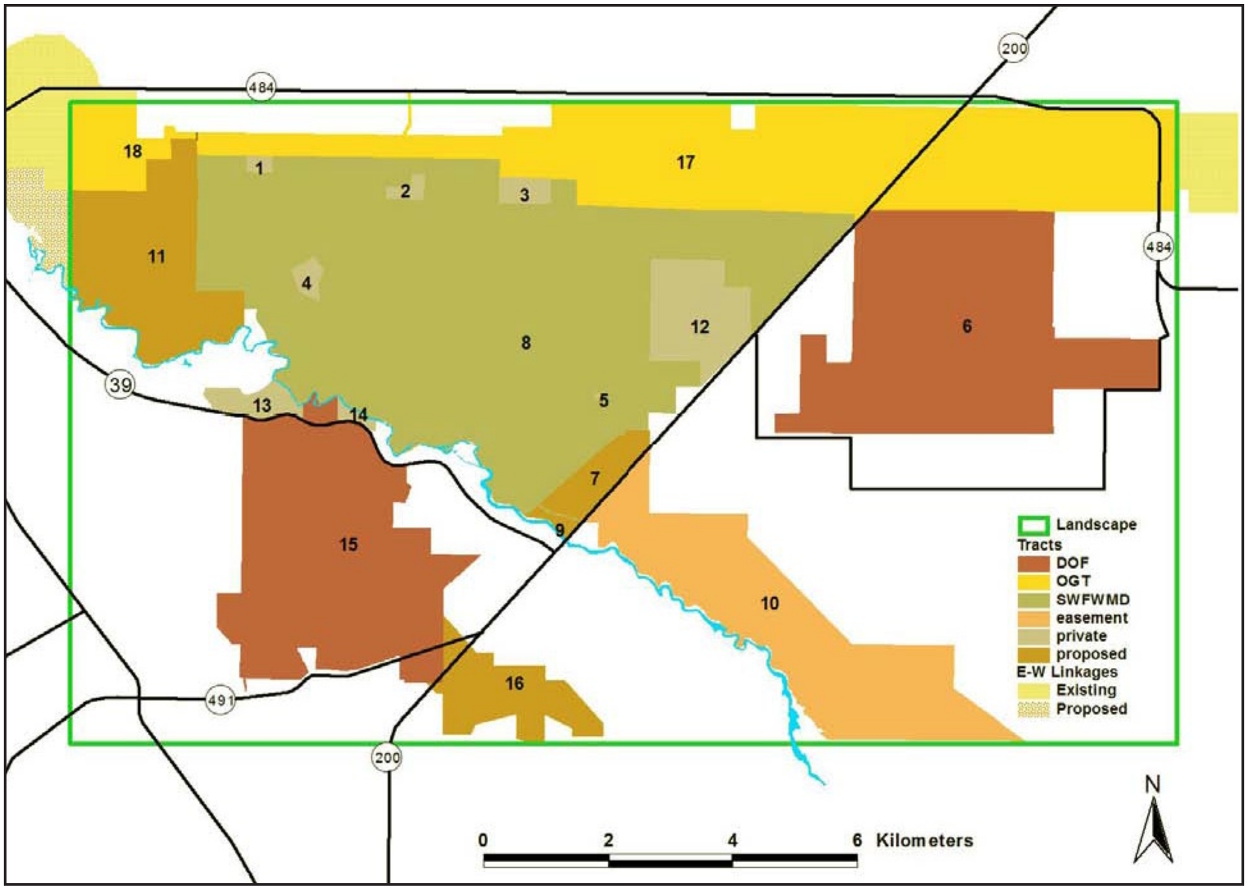

Figure 21. Contextual Analysis: Local Linkages to other Regional Conservation Areas. Ownership Abbreviations: DOF – Division of Forestry, OGT – Office of Greenways and Trails, and SWFWMD – SW Florida Water Management District. Numbers indicate different parcels of land.

Conclusions and Recommendations

Contextual issues

High levels of conversion to urban development are occurring in southwest Marion County; many proposed additions have already been lost (figure 1). Three proposed additions (figure 21 – nos. 7, 11, and 16) are needed to maintain connections to the larger conservation areas to the west, south, and southeast (figure 2). These are critical in minimizing isolation and preserving the area's integrity as a significant habitat node for wide-ranging species. The approximate 0.5-km-wide connection between the Halpata Tastanaki Preserve and the Withlacoochee State Forest tract (figure 1) should be increased to 3 km by establishing habitat buffers on the adjacent vacant parcels (figures 21 – nos. 13 and 14) to create a more functional connection for carnivores.

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 inter-specific competition and predation (Fedriani 2000). Considering all these factors, the area generally functions as a sink for these two carnivores, but may provide a functional habitat corridor between larger conservation reserves.

Highway issues

SR 200 is a high-volume transportation corridor that bisects the Ross Prairie conservation area. It inflicts significant direct impacts on wildlife in the immediate area (e.g., Florida gopher frog and Florida mouse) and negatively affects movement of wide-ranging resident and dispersing wildlife (e.g., bobcat and eastern indigo snake). The local gopher tortoise population has been segregated into two disjunct subpopulations. To improve habitat connectivity and eliminate road mortality within the Ross Prairie area, 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.

The Ross Prairie conservation area provides an opportunity to improve upon the design constructed at Payne's Prairie State Preserve (Smith 2003a). At Payne's Prairie, the low elevation of the existing four-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 2003a) 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

We recommend installing two box culverts (2-m wide x 1.2-m tall) in each of the two upland sandhill areas, bridges (12.3-m wide x 1.8-2.46-m tall) at each ecotone between the wetland basin and adjacent uplands, and a series of five culverts (1.5-m wide x 1-m tall) within the wetland basin. They should be spaced out along the elevational gradient and will flood and dry at different times as water levels naturally increase and decrease (Adair et al. 2002). Lastly, the equestrian underpass should be located across from the Ross Prairie trailhead to minimize adverse impacts and segregate wildlife and human crossing sites. Recommended dimensions of structures are consistent with structure preferences identified by Smith (2003b), Clevenger et al. (2001), Hewitt et al. (1998), and (Boarman and Sazaki 1996). Culvert amenities should include:

- Lighting grates within the median and on the shoulders (see Krikowski 1989)
- 3-sided design (concrete walls and ceiling with natural soil floor)
- Approaches landscaped with native shrub and ground cover vegetation
- 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

Between all these structures we suggested a 2-m tall fence to keep larger species off the road. At the base of the fence we recommended installation of a 0.4-m-high mesh-screen (or alternative material) herpetile barrier. The mesh screen should extend below the ground surface to prevent any openings. One-way gates/earthen ramps may be needed to allow escape for wildlife trapped in the fenced enclosure within the right of way (Bank et al. 2002).

Within the wetland basin we recommended a 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.

Even with these measures, the long-term effects of road expansion may be detrimental and could 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. More detail regarding this study can be found in the final report of the project (Smith 2005).

Biographical Sketch: Daniel J. Smith has a Ph.D. in wildlife ecology and conservation from the University of Florida (2003). He has conducted research on the ecological effects of roads for the past 10 years. Specific research interests include the effects of habitat fragmentation and land management practices on native biodiversity, and the change in landscape form and function. He is currently a research associate in the program for conservation biology in the Department of Biology at the University of Central Florida.

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