Title
Ecological impacts of SR 200 on the Ross Prairie ecosystem

Permalink
https://escholarship.org/uc/item/65p0q695

Author
Smith, Daniel J.

Publication Date
2005-08-29
ECOLOGICAL IMPACTS OF SR 200 ON THE ROSS PRAIRIE ECOSYSTEM

Daniel J. Smith (Phone: 352-213-3833, Email: djs3@ufl.edu), Research Associate, Department of Biology, University of Central Florida, Orlando, Florida 32801

Abstract: Ross Prairie is a 6,500-ha conservation area in SW Marion County, Florida. It serves as an important regional habitat node connecting the Ocala National Forest to the Withlacoochee and Goethe State Forests. SR 200 is a major two-lane state highway that bisects the reserve. Rapid growth and development 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. 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. The study was conducted from May 2002 to December 2004. Results of the road-kill surveys included 759 individuals from 57 identifiable species. The majority were anurans followed by meso-mammals. Locations of significant numbers or rare species of road-kill by taxa were identified. A total of 537 sets of whitetail deer, 481 sets of carnivore, and 474 sets of snake tracks were recorded. Hotspots were identified for snake, white-tail deer, and carnivore tracks. A total of 1,777 herpetiles were captured in right-of-way drift fence traps. Southern leopard frogs and Florida gopher frogs were most abundant. 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; only six small mammals were found as road-kill. The road likely is a significant barrier to small mammal movement. Average home range of 18 gopher tortoises monitored 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. For gopher tortoise, the road is a semi-permeable barrier. Home range of the 13 eastern indigo snakes monitored averaged 127.6 ha. No road crossings were recorded; they seemed to use the road as a home range boundary. Because of road-kill, there is documented evidence that road crossings are attempted. 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. Average home range size was 13.67 km2 for bobcats. 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 recommended installing four box culverts in the upland sandhill areas, bridges at each wetland/upland ecotone, and a series of five culverts within the wetland basin adjoined by a herpetile exclusion wall. Between all these structures we suggested 2-m barrier fencing with herpetile-excluding mesh at the base of the fence.

Introduction

Ross Prairie is a 6,500-ha conservation area comprising three properties managed by three different agencies (Marjorie Harris Carr Cross-Florida Greenway – Office of Greenways and Trails; Ross Prairie State Forest – Division of Forestry; and Halpata Tastanaki Preserve – SW Florida Water Management District) (figure 1). It serves as an important regional habitat node connecting the Ocala National Forest to the Big Bend and Chassahowitzka Wildlife Management Area (figure 2). This diverse ecosystem is a naturally patchy mosaic of many habitat types, including bottomland hardwood swamps, hardwood hammocks, pine flatwoods, oak scrub, wet prairies, and longleaf pine-wiregrass sandhills (figure 3). 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.

**Methods**

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 herpetiles, and small mammals). The study was conducted between May 2002 and May 2004.
Successful and unsuccessful wildlife crossing locations were determined by performing road-kill (on all vertebrates) and track (large mammals and herpetiles) surveys. Road-kill surveys were conducted 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 one to two times weekly for carnivore, ungulate, snake, and turtle tracks. The mark-recapture study was conducted along the road right of way to determine species presence, habitat use, and movement patterns of small mammals and herptiles. Twenty-four drift fence arrays (consisting of 1-m-tall silt fences, each with 4 bucket and 2 funnel traps) were checked five days per week from May 2002 through December 2004. The radio-telemetry work targeted wide ranging species (bobcat, coyote, and eastern indigo snake) and key management-indicator species (gray fox, gopher tortoise, and eastern diamondback rattlesnake). Radio-tagged animals were tracked one to two times per week. Telemetry was conducted between May 2002 and December 2004.

GIS data (landscape and vegetation layers) were used in conjunction with results of telemetry, track, mark-recapture, and road-kill studies to create habitat use and connectivity layers for the area in reference to the overall greenways system and potential effects of SR 200. This information was used to predict movement patterns and behavior of individual species (and faunal groups) to the expansion of SR 200.

Results and Discussion

Road-kill surveys
Results of the road-kill surveys included 759 individual animals from 57 identifiable species. The majority were anurans followed by meso-mammals (figure 4). 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 (near Gainesville, FL) contains much more year-round surface water than Ross Prairie resulting in higher numbers of aquatic-dependents.
Critical locations of significant numbers or rare species of road-kills by taxa were identified. For example, figures 5 and 6 display concentrations of road-killed frogs in the Ross Prairie basin area of the Cross-Florida Greenway (CFG). Variability of road-kills by land cover type was significant for amphibians ($X^2=82.01$, $p<0.0001$) and reptiles ($X^2=32.74$, $p=0.0031$). Most herpetile road-kills occurred within the wet prairie basin, or in adjacent sandhill or mesic hammock communities.

Notable focal species killed included: 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 ($n=9$).
Small mammal and avian road-kills were recorded throughout the SR 200 corridor monitored. No relation was found by land cover. Similarly, no patterns were significant for larger mammals, such as gray fox (n=8) or coyote; however, bobcat (n=5) road-kills only occurred within and adjacent to the Ross Prairie basin (figure 7). Several owls (barred, great-horned and screech) preying upon these road-kill were also killed.

Figure 7. Location of Carnivore Road-kills Documented in the Ross Prairie Conservation Area.

**Track surveys**

A total of 474 sets of snake, 481 sets of carnivore, and 537 sets of whitetail deer 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. Figures 8 and 9 display locations of snake tracks in the Ross Prairie basin area of the Cross-Florida Greenway (CFG). The greatest concentration occurred in the sandhill sections north of the Ross Prairie basin.

Coyote tracks were recorded throughout the SR 200 corridor monitored (figure 10). In contrast, gray fox and bobcat tracks were only common within and adjacent to the Ross Prairie basin (figures 11 and 12). Of 21 land cover types, all but 18 sets of carnivore tracks were found adjacent to one of three types: sandhill, mesic hammock, or wet prairie ($X^2 = 23.52, p = 0.003$). A concentration of white-tail deer tracks were recorded to the south of the Ross Prairie basin (figures 13 and 14).
Figure 8. Spatial Distribution of Snake Tracks in the CFG Area of SR 200.

Figure 9. Road Sections Locations of Snake Tracks in the CFG Area of SR 200.
Figure 10. Road Sections Locations of Coyote Tracks in the CFG Area of SR 200.

Figure 11. Road Sections Locations of Gray Fox Tracks in the CFG Area of SR 200.
Figure 12. Road Sections Locations of Bobcat Tracks in the CFG Area of SR 200.

Figure 13. Spatial Distribution of White-tail Deer Tracks in the CFG Area of SR 200.
Mark-recapture surveys
A total of 1,777 individuals from 32 herpetile species were captured in the 24 right-of-way drift fence traps (figure 15) along the 4-km section of SR 200 monitored. Notable rare species captured included the southern hognose snake, gopher tortoise, and Florida gopher frog. Southern leopard frogs and Florida gopher frogs were most abundant. Figure 16 shows the number of gopher frogs captured by trap number (refer to figure 15 for trap location). It was commonly captured in traps adjacent to sandhill habitat areas north of the wetland basin. 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.
A total of 157 individuals from 16 herpetile species were recaptured. Of those recaptured, few species (n=14) and individuals (n=44) were recorded crossing the road. Recorded crossing frequency for each species (at least 10 captures) was less than 10 percent. Yet only one species with at least 10 captures, the peninsular crown snake, was not recorded crossing the road. The two sandhill crossings (figure 15 – trap nos. 1 to 4, 17, 18, and 24 to 27) and the wetland basin (figure 15 – trap nos. 5 to 7 and 21 to 23) 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.

A total of 342 individuals from 11 small mammal species were captured in drift fence traps. Trap location/land cover type was not statistically significant regarding number of small mammals captured; nevertheless, the highest numbers were found in traps to the south of the wetland basin in grassland areas (figures 15 and 17). The most notable mammals captured were the rare Florida mouse and southeastern pocket gopher. Twenty-four individuals from 7 species were recaptured, yet only 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. 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).

Figure 15. Location of Drift Fence Arrays Used in Mark-recapture Studies. Number of traps by habitat types (n) surveyed - sandhill (8), oak scrub (3), wet prairie (7), and hardwood hammock (6).

Figure 16. Number of Florida Gopher Frogs Captured/Recaptured by Trap Number.
Radio-telemetry studies
Fifty gopher tortoises were captured and marked in the entire study area (29 male, 19 female, 2 juvenile). Average home range (95% fixed kernel, minimum 30 points) of the 18 gopher tortoises monitored in burrow colonies adjacent to the road was 3.14 ha (slightly larger than control sites) (figure 18). 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.

Only three attempted crossings of SR 200 were recorded, two were successful and one resulted in death. Nine unmarked gopher tortoise road-kills were recorded. 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; still their poor mobility increases their risk of collisions with vehicles.
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.](image)

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 km² 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).

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).
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.

References


