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Chapter 7

.....Habitat Connectivity

Placement of Crossing Structures

CONSERVATION STRATEGIES IN THE FLORIDA KEYS: FORMULA FOR SUCCESS

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Abstract: The extensive and growing road network in the United States has substantial ecological, economic, and social impacts. In the case of the endangered Florida Key deer (Odocoileus virginianus clavium), nearly 50 percent of the total mortality is attributed to deer-vehicle collisions. Over half of the deer-vehicle collisions occur on U. S. Highway 1, the only highway linking the Keys to the mainland. Since the early 1990's, various agencies and stakeholders have been trying to address deer-vehicle collisions in the Florida Keys. Initially, underpasses in combination with fencing were chosen to address deer-vehicle collisions. An apparently simple solution, however, was complicated due to access management issues and environmental regulations related to urban development. The Florida Department of Transportation (FDOT) was instrumental in resolving many of these issues, and provided resources and expertise which served as a catalyst in this process. The FDOT's U. S. Highway 1 improvement project, testing of a bridge grating system, and a habitat conservation plan illustrate successful conservation strategies in the Florida Keys.

In the continental United States, roads and roadsides cover approximately 1 percent of the surface area, and impact 22 percent of it ecologically (Forman 2000). For species that readily cross roads, wildlife-vehicle collisions can have serious costs in several forms. For example, each year in the United States, deer-vehicle (*Odocoileus virginianus*) collisions cost $1.1 billion in property damage or losses, and cause an estimated 29,000 human injuries and 211 human fatalities (Conover et al. 1995). Continued urban sprawl and suburban development are likely to increase costs associated with deer-vehicle collisions.

Florida Key deer *(O. v. clavium)* occupy 20-25 islands in the lower Florida Keys and are the smallest sub-species of white-tailed deer in the United States (Hardin et al. 1984, Lopez 2001, fig. 1). Approximately 75 percent of the overall population is found on Big Pine and No Name keys (Lopez et al. 2003*a*). Since 1960, urban development and habitat fragmentation have threatened the Key deer (Lopez 2001, Lopez et al. 2003*c*). In addition to a loss of habitat, an increase in urban development is of particular concern because highway mortality accounts for the majority of the total deer mortality. Over half of the deer-vehicle collisions occur on U. S. Highway 1 (US 1), the only highway linking the Keys to the mainland (fig. 1, Lopez et al. 2003*c*). Since the late 1980's, U. S. Fish and Wildlife Service (USFWS), Florida Department of Transportation (FDOT), and local residents have been trying to address deer-vehicle collisions on Big Pine Key (Lopez et al. 2003*c*). In 1993, FDOT began efforts to reduce Key deer mortality along the US 1 corridor on Big Pine Key. This proactive effort resulted in the formation of the Key Deer Ad-Hoc Committee in 1993. Based on recommendations from the committee, the Key Deer/Motorist Conflict Concept Study was initiated in 1995 to evaluate viable solutions in reducing Key deer mortality along US 1 (Calvo 1996, Calvo and Silvy 1996).

Key Deer Dilemma

Recommendations from the Key Deer/Motorist Conflict Concept Study proposed the construction of barriers (fences) with two wildlife crossings (underpasses) to prevent Key deer access onto US 1 (fig. 2, Calvo 1996, Calvo and Silvy 1996). Underpasses in combination with fencing have been successfully used to reduce wildlife- (Foster and Humphrey 1995, Clevenger and Waltho 2000) and deer- (Bellis and Graves 1971, Falk et al. 1978, Reed et al. 1975, Ford 1980, Reed et al. 1974, Reed et al. 1975) vehicle collisions in many parts of the country. Furthermore, FDOT has successfully reduced road mortality for other federally-listed species (e.g., Florida panther (*Puma concolor coryi*) and Florida black bear (*Ursus americanus floridanus*) with the use of wildlife crossings. At this point, an apparently simple solution was complicated due to access management issues and environmental regulations related to urban development.

First, access management is a critical factor in the success of fence/underpass-type wildlife crossings. For example, along the US 1 corridor there are a number of access points (e.g., side roads, driveways) making continuous fencing impossible (fig. 2). Previous studies (Reed et al. 1974, Reed et al. 1975, Sebesta 2000) proposed modified cattle guards or "deer guards" (defined as cattle guards adapted for deer) as a method to

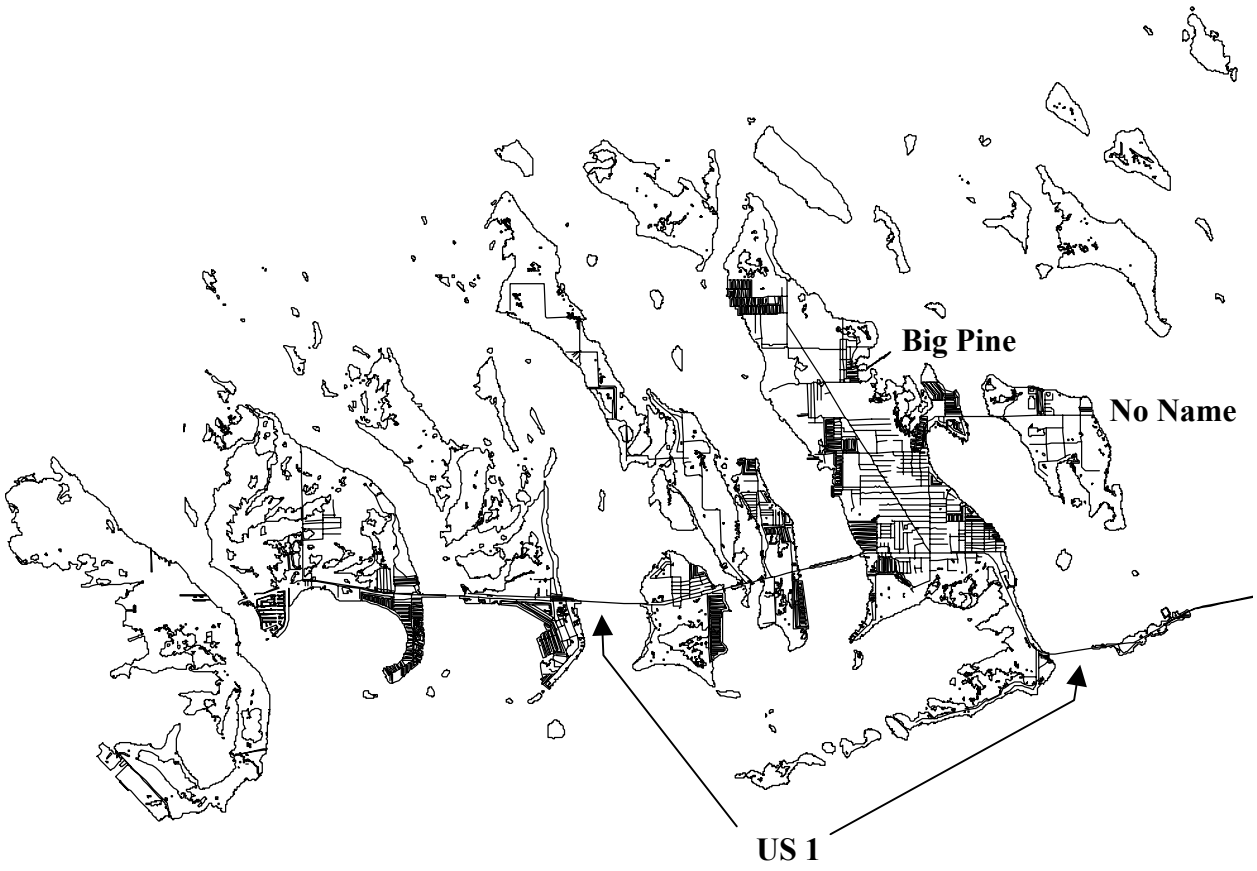

Fig. 1. Range of Florida Key deer, Monroe County, Florida.

allow unrestricted vehicle access while excluding deer. The use of traditional deer guards in preventing Key deer access into the corridor, however, were considered a hazard to pedestrians and cyclists, unproven in supporting heavy vehicular loads, and a skid hazard due to their required length (Rick Crooks, EAC Consulting, Project Engineer, personal communication). This required the development and testing of an effective and safe deer grate (defined as rectangular bridge grating material used to prevent deer crossing) that could be used in preventing Key deer access into the proposed project area (Peterson et al. 2003).

Second, environmental regulations prohibited road improvements on Big Pine and No Name keys without a habitat conservation plan (HCP). As previously mentioned, US 1 is the only highway linking the Keys to the mainland (Fig. 1). Safe and expedient evacuation during hurricanes depends on the US 1 level of service (Lopez et al. 2003*b*). In 1995, Monroe County authorities imposed a building moratorium due to the failure in level of service on the US 1 segment servicing Big Pine and No Name keys. Highway improvements, such as intersection widening and/or adding a third lane northbound (traffic direction towards mainland), were proposed that would improve the level of service and lift the building moratorium (Lopez 2001). Because additional traffic and development on Big Pine and No Name keys also might result in an incidental take of Key deer, however, highway improvements could only be permitted with the initiation and approval of a HCP (Endangered Species Act, Section 10a, 16 U.S.C. §1539a). In short, efforts to reduce Key deer mortality along the US 1 corridor could effectively increase Key deer mortality on other areas of the island, thus, our Key deer dilemma.

Complex Problem, Multi-Dimensional Solution

Engineering constraints and environmental regulations complicated the solution in reducing Key deer mortality. Due to the complexity of the Key deer dilemma, multiple solutions were necessary in achieving the overall project objective – reducing Key deer mortality on Big Pine and No Name keys. Furthermore, solutions to reduce Key deer mortality required coordination with several agencies (e.g., USFWS, Florida Fish and Wildlife Conservation Commission, Florida Department of Community Affairs [DCA], and Monroe County), stakeholders (e.g., Key Deer Protection Alliance, Big Pine Key Chamber of Commerce,), and the public. In 1998, efforts

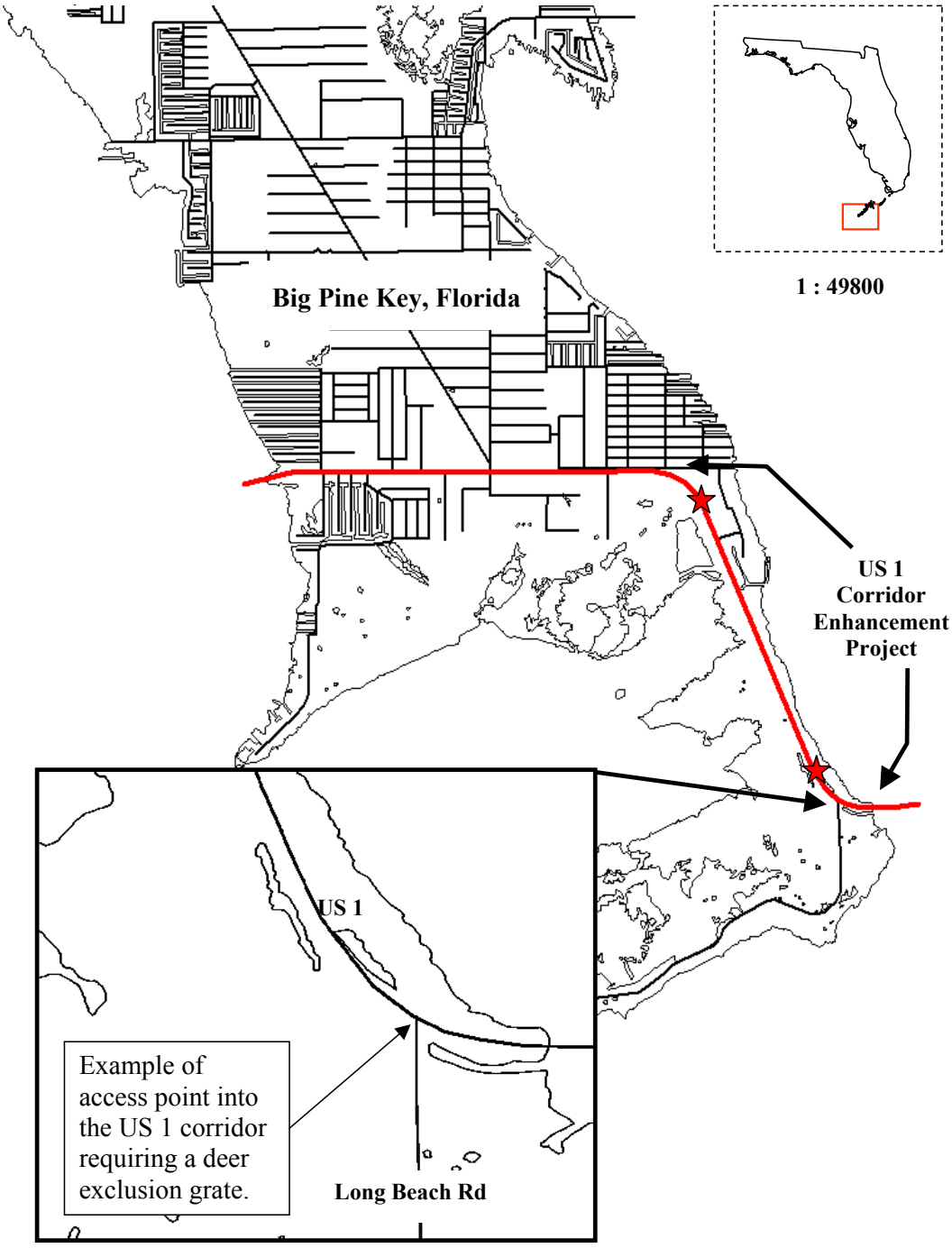

Fig. 2. U.S. Highway 1 corridor enhancement project, Big Pine Key, Florida. Arrows represent beginning and end points of fencing; star represent wildlife underpasses.

to address Key deer mortality began with (1) engineering design of improvements to US 1 (fencing and underpasses), (2) testing and implementation of a bridge grating system, and (3) the initiation of an HCP for Big Pine and No Name keys. Initial testing of a bridge grating system was completed in August 2002. Construction on the US 1 corridor was completed in February 2003. An HCP draft was submitted in May 2003 to USFWS for final review and approval. At this point, we will present and discuss preliminary results for actions implemented in resolving the Key deer dilemma separately, though in reality these solutions were not mutually exclusive.

US 1 Improvement Project

In June 2002, road construction along the "undeveloped" segment of US 1 between mile markers 31-33 consisted of two underpasses placed one mile apart in areas of high road mortality (mile markers 31.5 and 32.5), and fencing along the corridor to prevent Key deer access onto US 1 and to help direct deer toward underpasses (fig. 2). Underpasses consisted of concrete bridge structures with an effective crossing width of 25 feet and height of 8 feet, and were designed to provide safe crossing opportunities for Key deer. A vinyl-covered, chain link fence (8 feet in height) was installed, with four inches of ground clearance to allow movement of the Federally-endangered Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) but restrict Key deer movement into the project area. The fencing was continuous except for five access points where deer guards were used. FDOT also created a travel corridor parallel to the fencing between mile markers 31 and 33 to promote Key deer use of underpasses. The corridor was created through selective trimming of mangrove wetland vegetation along the outside (not on the roadway side) of the fencing.

Bridge Grating System

In May 2001, Peterson et al. (2003) evaluated 3 types of bridge grating material for Key deer-exclusion efficiency that were deemed safe for pedestrians, cyclists, and motorists by FDOT engineers. Each grate consisted of 20-ft x 20-ft bridge grating material (L. B. Foster, Pittsburgh, Pennsylvania) each with a different grate pattern: deer grate 1 had 4-in x 5-in openings with a diagonal cross member; deer grate 2 had 4-in x 3-in openings with no diagonal; deer grate 3 had 3-in x 4-in openings with no diagonal (Peterson et al. 2003). Peterson et al. (2003) reported deer grate 1 excluded less than 99 percent of Key deer crossing attempts, while deer grates 2 and 3 were greater than 75 percent effective. Thus, in addition to aforementioned use of fencing and underpasses, 5 Key deer grates were installed along the US 1 corridor (4 side roads, 1 at project terminus on US 1). Each Key deer guard consisted of bridge grating tailored to the width of the roadway and having a standard length of 25 feet.

Habitat Conservation Plan

In 1998, a planning process began with FDOT, Monroe County, and Florida Department of Community Affairs (DCA) representatives to draft and submit a regional Key deer HCP to USFWS biologists. The HCP applicants (i.e., FDOT, DCA, and Monroe County) employed a population viability analysis (PVA) to determine the effects of development (roadway improvement and houses) on the Key deer population. A PVA is a method or a collection of methods used to evaluate the viability of threatened or endangered species using computer simulation models (Boyce 1992, Burgman et al. 1993). Species viability is often expressed as the risk or probability of extinction, population decline, expected time to extinction, or expected chance of recovery (Akçakaya and Sjogren-Gulve 2000). PVA models attempt to predict such measures based on demographic and habitat data, and provide outputs or predictions that are relevant to conservation goals (Akçakaya and Sjogren-Gulve 2000). A demographic and spatially-structured Key deer model was developed for this purpose (Lopez 2001, Lopez et al. 2003*b*, Fig. 3), and was used in evaluating proposed development scenarios *a priori* in the final HCP draft submitted to USFWS in May 2003. Proposed development included limited residential and commercial building, improvement to public facilities (e.g., parks, fire station), and road improvements (e.g., three-laning US1, paving of unimproved roads). Currently, the Key deer HCP is being reviewed by USFWS.

Formual for Success

Although many wildlife crossing projects have been implemented throughout the country, this project was unique in several ways. First, although every aspect of the project was based on the expertise of Key deer biologists, there was no precedent project elsewhere; thus, the probability of success was somewhat uncertain. This did not deter FDOT as it collaborated and used best science to keep the project moving forward. In resolving the Key deer dilemma, FDOT was proactive, and preliminary results from the US 1 project indicate 100 percent efficiency in the first six months of the project. The HCP also is unique in that a spatially-structured population model was used to evaluate development scenarios *a priori* and as a conservation-planning tool in making conservation decisions for the next 20 years on Big Pine and No Name keys. The Key deer model promises to serve this island community by providing some relief from building restrictions and traffic congestion without seriously impairing the viability of the Key deer population.

Second, collectively these efforts were conducted for the purpose of benefiting an endangered species; there was no regulatory requirement to implement the project. The Key deer project represents FDOT's dedication to work with the local community, regulatory agencies, and USFWS to implement a plan that maintains the continuity of vehicular traffic, while achieving the objectives of reducing Key deer mortality. The FDOT formed a collaborative partnership with several agencies, stakeholders, and the public in this process. FDOT's initiative resulted in improved trust and strengthened the relationship between all stakeholders. This partnership also illustrates the successful balancing of the (often competing) needs of the motoring public, businesses, residents, and the environment.

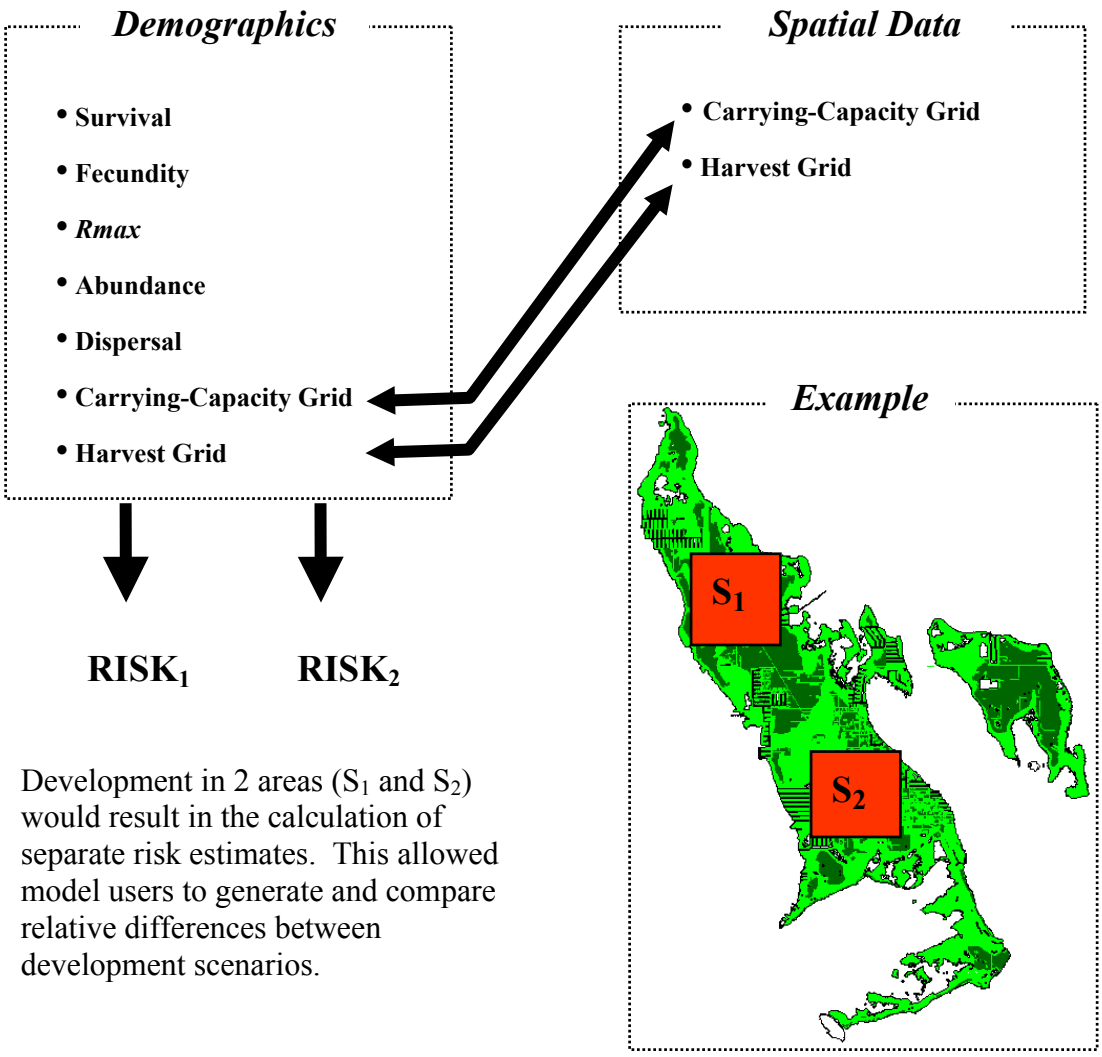

Fig. 3. Conceptual model used in the Key deer population viability analysis, Big Pine and No Name Keys, Florida.

Finally, what best illustrates the unique nature of this project was that environmental needs led the project, and that aspects of traditional engineering had to be adjusted in order to accomplish these needs. There was no truly defined engineering goal at the start of the project, rather, an environmental goal achieved through engineering design. Currently (August 2003), no Key deer mortalities have been recorded within the project area.

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References

Akçakaya, H. R. and P. Sjogren-Gulve. 2000. Population viability analyses in conservation planning: an overview. *Ecological Bulletins* 48:9-21.

Bellis, E. D., and H. B. Graves. 1971. Deer mortality on a Pennsylvania interstate highway. *Journal of Wildlife Management* 35:232–237.

Boyce, M. S. 1992. Population viability analysis. *Annual Reviews Ecology and Systematics*. 23:481-506.

Burgman, M. A., S. Ferson, and H. R. Akçakaya. 1993. Risk assessment in conservation biology. Chapman and Hall, London, England.

Calvo, R. 1996. US-1/SR 5 Key deer/motorist conflict study concept report. Dames and Moore, Miami, Florida, USA. and N. J. Silvy. 1996. Key deer mortality, U.S. 1 in the Florida Keys. Paper 23, Pages 1-10 G. L. Evink, P. Garrett, D. Zeigler, and J. Berry, editors. *Trends in addressing transportation related wildlife mortality. Proceeding of Transportation Related Wildlife Mortality Seminar.* Florida Department of Transportation, Tallahassee, Florida, USA.

Clevenger, A. P., and N. Waltho. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. *Conservation Biology* 14:47–56.

Conover, M. R., W. C. Pitt, K. K. Kessler, T. J. DuBow, and W. A. Sanborn. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. *Wildlife Society Bulletin* 23: 407–414.

Falk, N. W., H. B. Graves, and E. D. Bellis. 1978. Highway right-of-way fences as deer deterrents. *Journal of Wildlife Management* 42:646–650.

Ford, S. G. 1980. Evaluation of highway deer kill mitigation in SIE/LAS-395. Report Number FHWA/CA/TP-80-01. California Department of Transportation, Sacramento, California, USA.

Forman, R. T. 2000. Estimate of the area affected ecologically by the road system in the United States. *Conservation Biology* 14:31–35.

Foster, M. L., and S. R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. *Wildlife Society Bulletin* 23:95–100.

Hardin, J. W., W. D. Klimstra, and N. J. Silvy. 1984. Florida Keys. Pages 381-390 L.K. Halls, editor. *White-tailed deer: ecology and management*. Stackpole Books, Harrisburg, Pennsylvania, USA.

Lopez, R. R. 2001. Population ecology of Florida Key deer. Dissertation, Texas A&M University, College Station, Texas, USA.

B. L. Pierce, P. A. Frank, M. T. Wilson, and K. M. Burke. 2003*a*. Population density of the endangered Florida Key deer. *Journal of Wildlife Management.* In revision.

R. N. Calvo, P. A. Frank, P. M. Harveson, N. M. Peterson, and C. B. Owen. 2003*b*. A demographic and spatially-structured population model for Florida Key deer. *Journal of Wildlife Management.* In review.

M. E. P. Vieira, N. J. Silvy, P. A. Frank, S. W. Whisenant, and D. A. Jones. 2003*c*. Survival, mortality, and life expectancy of Florida Key deer. *Journal of Wildlife Management.* 67:34-45.

Peterson, M. N., R. R. Lopez, N. J. Silvy, C. B. Owen, P. A. Frank, and A. W. Braden. 2003. Evaluation of deer exclusion grates in urban areas. *Wildlife Society Bulletin*. In revision.

Reed, D. F., T. M. Pojar, and T. N. Woodard. 1974. Mule deer response to deer guards. *Journal of Range Management* 27:111–113.

Woodard, T. N., and T. M. Pojar. 1975. Behavioral response of mule deer to a highway underpass. *Journal of Wildlife Management* 39:361–367.

Sebesta, J. D. 2000. Design and evaluation of deer guards for Florida Key deer. Thesis, Texas A&M University, College Station, USA.