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SPECIES COMPOSITION AND LEGAL ECONOMIC VALUE OF WILDLIFE ROAD-KILLS IN AN URBAN PARK IN FLORIDA

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Wildlife mortality due to collisions with motor vehicles is a problem within managed natural areas in Florida and worldwide (Skoog 1982; Smith et al. 1994; Foster and Humphrey 1995; Jackson 1996; Bertwistle 1999; Brown et al. 1999; Evink 1999; Gunther and Biel 1999; Phillips 1999; Trombulak and Frissell 2000; Hels and Buchwald 2001; Bard et al. 2002a, b; Fahrig et al. 2002; Foresman 2002; Gilbert et al. 2002).

We here report wildlife mortality due to collisions with vehicles during 1997-2000 at John U. Lloyd State Park (JULSP), a 125.75-ha, mixed-use, urban state park located approximately 8 km south of Fort Lauderdale, on Florida's southeast coast. JULSP includes a mix of uplands and wetlands, consisting mostly of seven vegetation community and infrastructure cover types: beach dune (21.63 ha), coastal strand (4.01 ha), maritime hammock (7.64 ha), estuarine tidal swamp (35.01 ha), estuarine unconsolidated substrate (9.0 ha), ruderal areas mostly dominated by exotic plants (13.72 ha), and developed areas (17.29 ha) (Office of Park Planning, GIS data). The Atlantic coast beach is 3.86 km in length and supported a medium nesting density of marine turtle nests during 1997-2000.

A daily (7days/week) road-kill survey was conducted from 1 January 1997 to 31 December 2000 by JULSP Park Rangers and consisted of slowly searching road surfaces (ca. 8-24 km/h) for dead wildlife (see discussion of method as reported for other state parks in Smith et al. 1994, Bard et al. 2002a).

At JULSP, ca. 4.02 km of paved, two-lane road (with speed limit varying from 24.2-48.4 km/h) were first driven daily between approximately 0730 and 0800 providing opportunity to collect wildlife that had been struck by vehicles (road-kills). Motor vehicles have been observed to greatly exceed posted speed limits and JULSP roads are used 24 hours per day. Road-kills were identified to the species level if possible. Vegetation communities along the roadside are extremely patchy and consist of widely variable overstory and understory heights of hammock, mangrove wetland, and exotic plants, as well as mowed areas.

We recorded 64 mammals, 9 birds, and 16 reptiles as road-kills during the study (Table 1). Raccoons (*Procyon lotor*) were the most numerous victim (n = 30, 47%) among mammals, Eastern Screech-Owls (O*tus asio*) (n = 4, 44%) among birds, and black racers (*Coluber constrictor*) (n = 9, 56%) among reptiles.

Assuming expected frequencies were equal, there was a significant difference in road-kill frequency chi-squared goodness of fit among the three pooled classes of animals ($\chi^2 = 60.42$, $df = 2$, $p < .001$). Small cell sizes of only one road-kill (e.g., Cattle Egret, *Bubulcus ibis*; garter snake, *Thamnophis sirtalis*) rendered additional tests among species within classes statistically impractical (see Table 1).

In Florida, minimum monetary values for wildlife resources (penalties assessed for illegal "take") are specified in both statute and administrative code (Florida Statutes 370.021(5)d-f; Florida Administrative Code 39-27.002, 39-27.011, and 39-4.001). Likewise, federal laws also are applicable which impose greater values (e.g., Endangered Species Act, $25,000; Migratory Bird Treaty Act, $2,000). We used the State of Florida wildlife values (Engeman et al. 2002, Shwiff et al. 2003) for our economic analysis; the Wildlife Code of the State of Florida specifies up to a $500 fine for "take" applicable to all wildlife in section 39-4.001 F.A.C. Using the $500 per life unit value (each road-kill = $500) demonstrated a very conservatively valued $44,000 total economic loss of wildlife resources (Table 1). Had we used the Migratory Bird Treaty Act value of $2,000 for each bird, the total economic loss would have increased to $57,000.

Inasmuch as the area is managed for both wildlife resources and resource-based human recreation, it is inevitable that some wildlife losses will occur as a result of human interaction. We recorded at least 6 species of mammals as road-kills during the study (Table 1); all were commonly occurring species. We were not surprised by the prevalence of raccoons and conjecture that they have achieved a relatively high population density at JULSP as a result of their predation on marine turtle nest eggs (Stancyk 1982, Engeman et al. 2002). For wildlife species that inhabit urban environments, increased availability and concentrations of food, den sites, or other refuges also may induce dense populations (e.g., Dickman 1987, Dickman and Doncaster 1987, Riley et al. 1998). Smith and Engeman (2002) reported an extremely high trapping density of 238 raccoons/km^2 (minimum) in nearby Hugh Taylor Birch State Park in urban, coastal Fort Lauderdale.

Table 1. Basic species and economic analysis of wildlife road-kills during 1997-2000 at John U. Lloyd State Park, Florida.

Class Species	Road-kill Frequency *n*	Total economic loss per species in dollars[a]
Mammals		
Gray squirrel (*Sciurus carolinensis*)	12	6,000
Marsh rabbit (*Sylvilagus palustris*)	4	2,000
Virginia opossum (*Didelphis virginiana*)	13	6,500
Raccoon (*Procyon lotor*)	30	15,000
Feral cat (*Felis catus*)	1	NA (exotic species)
Unidentified rodents	4	2,000
Birds		
Green Heron (*Butorides virescens*)	2	1,000
Cattle Egret (*Bubulcus ibis*)	1	500
Eastern Screech-Owl (*Otus asio*)	4	2,000
Burrowing Owl (*Athene cunicularia*)	1	500
Unidentified birds	1	500
Reptiles		
Southern black racer (*Coluber constrictor*)	9	4,500
Red rat snake (*Elaphe guttata*)	6	3,000
Eastern garter snake (*Thamnophis sirtalis*)	1	500
		TOTAL $ 44,000

[a]Total dollar loss value calculated per species using Wildlife Code of State of Florida, Chap. 39-4.001 F.A.C. value of $500 per life unit.

At least 4 species of birds were killed by collisions with vehicles; this number as well as the total number ($n = 9$) killed, were unremarkable in relationship to other avian studies. Fahrig et al. (2002) in a five-year study conducted in Key Largo, Florida, reported much higher numbers of birds killed, including various warblers, nightjars, and thrashers. A number of synergistic factors contributed to the differences in findings for the avian species in the two studies. These included differences in latitude, vegetation community cover-types, and level of road use and speed limits. Our data suggest that most diurnal birds at JULSP are relatively secure from threat of road-kill. We presumed that the 4 Eastern Screech-Owls were killed at night.

Probably because of a combination of its commonness and diurnal habits, the black racer is the most frequently observed snake road-kill throughout southeast Florida state parks (H. Smith, pers. obs., Timmerman et al. 1991). Although no amphibians were reported during the JULSP study, various species of toads (*Bufo* spp.) occur in the park. We speculate that some anuran road-kills probably did occur and were somehow overlooked due to survey technique.

Wildlife losses also may translate into high economic losses as demonstrated for Royal Terns (*Sterna maxima*) (Shwiff et al. 2003), loggerhead turtles (*Caretta caretta)* (Engeman et al. 2002), and other species (Bodenchuk et al. 2002). At Sebastian Inlet State Park, located at the juncture of Brevard and Indian River counties, 97 Royal Terns were recorded as road-kills at a bridge site during 1989-1993 before simple structural improvements (Smith et al. 1994, Bard et al. 2002a, Shwiff et al. 2003). Total economic loss of Royal Terns calculated at the $500 value was $48,000, and at the Migratory Bird Treaty Act $2,000 value was $194,000 (Shwiff et al. 2003). In the five years (1995-1999) after structural improvements to the bridge these losses (26 terns) decreased to $13,000 and $52,000 respectively (Bard et al. 2002a, Shwiff et al. 2003).

Whereas protective closures and buffer zones have been implemented in Florida to protect breeding, foraging, and loafing waterbirds statewide (Rodgers and Smith 1995, 1997); protective measures to prevent wildlife resources from being killed on roads are more difficult to implement. Wildlife underpasses below roadways have been retrofitted on large (large mammals), and small scales (salamanders), with varying degrees of success and costs (see Jackson and Tyning 1989, Foster and Humphrey 1995, Jackson 1996, Land and Lotz 1996, Roof and Wooding 1996).

From a practical standpoint, pilot measures to reduce road-kills at JULSP (and elsewhere) must be proposed, and then evaluated, from both an efficiency and economic efficacy perspective. Wildlife management practices can then knowledgeably be discontinued, maintained, adjusted, or increased to reduce traffic-related mortality of vulnerable species.

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LITERATURE CITED

BARD, A. M., H. T. SMITH, E. D. EGENSTEINER, R. MULHOLLAND, T. V. HARBER, G. W. HEATH, W. J. B. MILLER, AND J. S. WESKE. 2002a. A simple structural method to reduce road-kills of Royal Terns at bridge sites. Wildlife Society Bulletin 30:603-605.

BARD, A. M., H. T. SMITH, T. V. HARBER, G. W. STEWART, M. M. BROWNE, AND S. T. EMSLIE. 2002b. Road-killed Royal Terns (*Sterna maxima*) recovered at Sebastian Inlet State Park, Florida, USA: A 23-year analysis of banding data. Pages 386-389 *in* L. M. Terwilliger and L. Coryell, eds. International Conference on Wildlife Ecology and Transportation. Proceedings of a Conference, 24-28 September 2001, at Keystone, CO.

BERTWISTLE, J. 1999. The effects of reduced speed zones on reducing bighorn sheep and elk collisions with vehicles on the Yellowhead Highway in Jasper National Park. Pages 89-97 *in* G. L. Evink, P. Garrett, and D. Zeigler, eds. Proceedings of the Third International Conference on Wildlife Ecology and Transportation FL-ER-73-99. Florida Department of Transportation, Tallahassee, FL.

BODENCHUK, M. J., J. R. MASON, AND W. C. PITT. 2002. Economics of predation management in relation to agriculture, wildlife, and human health and safety. Pages 80-90 *in* L. Clark, ed. Human conflicts with wildlife: Economic considerations. Proceedings of a Symposium, 1-3 August 2000 at Colorado State University, Fort Collins, CO.

BROWN, D. L., J. LAIRD, W. D. SUMMERS, AND A. HAMILTON. 1999. Methods used by the Arizona Department of Transportation to reduce wildlife mortality and improve highway safety. Pages 175-184 *in* G. L. Evink, P. Garrett, and D. Zeigler, eds. Proceedings of the Third International Conference on Wildlife Ecology and Transportation. FL-ER73-99. Florida Department of Transportation, Tallahassee, FL.

DICKMAN, C. R. 1987. Habitat fragmentation and vertebrate species richness in an urban environment. Journal of Applied Ecology 24:337-351.

DICKMAN, C. R., AND C. P. DONCASTER. 1987. The ecology of small mammals in urban habitats. 1. Populations in a patchy environment. Journal of Animal Ecology 56:629-640.

ENGEMAN, R. M., S. A. SHWIFF, B. CONSTANTIN, M. STAHL, AND H. T. SMITH. 2002. An economic analysis of predator removal approaches for protecting marine turtle nests at Hobe Sound National Wildlife Refuge. Ecological Economics 42:469-478.

EVINK, G. L. 1999. Watch out for wildlife. Page 301 *in* G. L. Evink, P. Garrett, and D. Ziegler, eds. Proceedings of the Third International Conference on Wildlife Ecology and Transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, FL.

FAHRIG, L, K. E. NEILL, AND J. G. DUQUESNEL. 2002. Interpretation of joint trends in traffic volume and traffic-related wildlife mortality: A case study from Key Largo, Florida. Pages 518-521 *in* L. M. Terwilliger and L. Coryell, eds. International Conference on Wildlife Ecology and Transportation. Proceedings of a Conference, 24-28 September 2001, at Keystone, CO.

FORESMAN, K. R. 2002. Small mammal use of modified culverts on the Lolo South Project of western Montana. Pages 581-582 *in* L. M. Terwilliger and L. Coryell, eds. International Conference on Wildlife Ecology and Transportation. Proceedings of a Conference, 24-28 September 2001, at Keystone, CO.

FOSTER, M. L. AND S. R. HUMPHREY. 1995. Use of highway underpasses by Florida panthers and other wildlife. Wildlife Society Bulletin 23:95-100.

GILBERT, T., R. KAUTZ, T. EASON, R. KAWULA, AND C. MOREA. 2002. Prioritization of statewide black bear roadkill problem areas in Florida. Pages 574-579 *in* L.M. Terwilliger and L. Coryell, eds. International Conference on Wildlife Ecology and Transportation. Proceedings of a Conference, 24-28 September 2001, at Keystone, CO.

GUNTHER, K. A., AND M. J. BIEL. 1999. Reducing human-caused black and grizzly bear mortality along roadside corridors in Yellowstone National Park. Pages 25-27 *in* G. L. Evink, P. Garrett, and D. Zeigler, eds. Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, FL.

HELS, T., AND E. BUCHWALD. 2001. The effect of road kills on amphibian populations. Biological Conservation 99:331-340.

JACKSON, S. 1996. Underpass systems for amphibians. *In* G. L. Evink, P. Garrett, D. Zeigler, and J. Berry, eds. Proceedings of the transportation related wildlife mortality seminar - trends in addressing transportation related wildlife mortality. FL-ER-58-96. Florida Department of Transportation, Tallahassee, FL. Unpaginated.

JACKSON, S. D., AND T. F. TYNING. 1989. Effectiveness of drift fences and tunnels for moving spotted salamanders (*Ambystoma maculatum*) under roads. Pages 93-99 *in* T. E. S. Langton, ed., Amphibians and Roads; Proceedings of the Toad Tunnel Conference. ACO Polymer Products, Shefford, England.

LAND, D., AND M. LOTZ. 1996. Wildlife crossing designs and use by Florida panthers and other wildlife in southwest Florida. *In* G. L. Evink, P. Garrett, D. Zeigler, and J. Berry, eds. Proceedings of the Transportation Related Wildlife Mortality Seminar—Trends in Addressing Transportation Related Wildlife Mortality. FL-ER-58-96. Florida Department of Transportation, Tallahassee, FL. Unpaginated.

PHILLIPS, M. 1999. Wildlife management on arterial highways in New Brunswick. Pages 259-262 *in* G.L. Evink, P. Garrett, and D. Zeigler, eds. Proceedings of the Third International Conference on Wildlife Ecology and Transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, FL.

RILEY, S. P. D., J. HADIDIAN, AND D. A. MANSKI. 1998. Population density, survival, and rabies in raccoons in an urban national park. Canadian Journal of Zoology 76:1153-1164.

RODGERS, J. A., AND H. T. SMITH. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9:89-99.

RODGERS, J. A., AND H. T. SMITH. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbances in Florida. Wildlife Society Bulletin 25:139-145.

ROOF, J., AND J. WOODING. 1996. Evaluation of the S.R. 46 wildlife crossing in Lake County, Florida. *In* G.L. Evink, P. Garrett, D. Zeigler, and J. Berry, eds. Proceedings of the Transportation Related Wildlife Mortality Seminar – Trends in Addressing Transportation Related Wildlife Mortality. FL-ER-58-96. Florida Department of Transportation, Tallahassee, FL. Unpaginated.

SHWIFF, S. A., H. T. SMITH, A. M. BARD, T. V. HARBOR, G. W. HEATH, AND R. M. Engeman. 2003. An economic analysis of a simple structural method to reduce road-kills of Royal Terns at bridges. Caribbean Journal of Science 39:250-253.

SKOOG, P. J. 1982. Highways and endangered wildlife in Florida: impacts and recommendations. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

SMITH, H. T., W. J. B. MILLER, R. E. ROBERTS, C. V. TAMBORSKI, W. W. TIMMERMAN, AND J. S. WESKE. 1994. Banded Royal Terns recovered at Sebastian Inlet, Florida. Florida Field Naturalist 22:81-83.

SMITH, H. T., AND R. M. ENGEMAN. 2002. An extraordinary raccoon density at an urban park in Florida. Canadian Field-Naturalist 116:636-639.

STANCYK, S. E. 1982. Non-human predators of sea turtles and their control. Pages 139-152 *in* K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

TIMMERMAN, W. W., W. J. B. MILLER, AND C. V. TAMBORSKI. 1991. The herpetofauna of Jonathan Dickinson State Park, Martin County, Florida. Project 7618 report to Florida Game and Freshwater Fish Commission. Florida Department of Environmental Protection, Hobe Sound, FL. 38 pp.

TROMBULAK, S. C., AND C. A. FRISSELL. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.