UC Agriculture & Natural Resources

Proceedings of the Vertebrate Pest Conference

Title

Activity Patterns of the Coyote (*Canis latrans*) Along an Urban-Rural Gradient

Permalink

<https://escholarship.org/uc/item/9832x5nq>

Journal

Proceedings of the Vertebrate Pest Conference, 25(25)

ISSN

0507-6773

Authors

Jantz, Holly E.
Armstrong, James B.
Arjo, Wendy
et al.

Publication Date

2012

DOI

10.5070/V425110351

Activity Patterns of the Coyote (*Canis latrans*) Along an Urban-Rural Gradient

Holly E. Jantz and James B. Armstrong

School of Forestry and Wildlife Sciences, Auburn University, Auburn, Alabama

Wendy Arjo

AGEISS, Inc., Dugway, Utah

Micah J. Moore

School of Forestry and Wildlife Sciences, Auburn University, Auburn, Alabama

ABSTRACT: Throughout the past several decades, coyotes have become common inhabitants of urban areas in the southeastern United States. Because their southward expansion is recent, there is a lack of information on activity patterns of urban coyotes in the Southeast. We trapped and radio-collared 20 coyotes to determine seasonal activity patterns along an urban-rural gradient in east-central Alabama during 2007 - 2009. We created an urban-rural gradient based on percentage of urban land-cover in home ranges. Percentage of urbanization in home ranges was 2% - 45%. Mixed logistic-regression models indicated that coyotes along the gradient were active at similar times during all seasons. Information presented in this study will allow biologists and resource managers to gain an understanding of movements of coyotes in urban areas and will be helpful in predicting and mitigating potential human-coyote interactions in the Southeast.

KEY WORDS: activity, behavior, *Canis latrans*, coyotes, radio-telemetry, Southeast, urban-rural gradient

Proc. 25th Vertebr. Pest Conf. (R. M. Timm, Ed.)
Published at Univ. of Calif., Davis. 2012. Pp. 341-346.

INTRODUCTION

Most ecosystems are dominated by humans (McIntyre et al. 2000). As global expansion of urban areas increases, interest in the ecology of wildlife in urban areas is expanding rapidly (DeStefano and DeGraaf 2003). The earliest literature concerning wildlife in urban areas was published in the early 1900s, but the number of studies increased substantially after publication of Leopold's *Game Management* in 1933 (DeStefano and DeGraaf 2003). As metropolitan areas grow worldwide, it is becoming more important to study impacts of the urban-rural gradient on the changing ecology of landscapes (McDonnell and Pickett 1990). Studying ecological changes along the urban-rural gradient helps us to understand how urbanization is changing ecological patterns and processes (McDonnell and Pickett 1990). As landscapes urbanize, many species are able to adapt to the changes; *synurbanization* (Andrzejewski et al. 1978, Babińska-Werka et al. 1979, Luniak 2004) is a term coined to describe the ability of animals to exist in urban areas in their wild state.

Recent studies have investigated behavior of coyotes in cities across the United States (Quinn 1997, Grindler and Krausman 2001, Riley et al. 2003, Way et al. 2004, Gehrt et al. 2009), but no study has been conducted in urban areas of the southeastern United States. Studies have been conducted on behavior (Sumner et al. 1984, Holzman et al. 1992, Chamberlain et al. 2000, Constible et al. 2006, Schrecengost et al. 2009) and expansion of geographic range in the Southeast (Hill et al. 1987), but none investigated the influence of urban environments on behavior.

Because activity of coyotes vary among localities, knowledge of general patterns of activity is vital to un-

derstanding needs and responses of coyotes in urbanized areas (Grinder and Krausman 2001). Previous research demonstrated that coyotes that were subjected to little or no hunting pressure tended to be more active during diurnal and crepuscular hours (Gipson and Sealander 1972, Andelt 1985) than those that were hunted intensively (Andelt and Gipson 1979). Daytime and crepuscular activity directly correlates with hours when the visual system functions most efficiently (Kavanau and Ramos 1975). In urban areas, researchers have reported that nocturnal activity increases with amount of development or activity by humans (Grinder and Krausman 2001, McClellenn et al. 2001, Tigas et al. 2002, Riley et al. 2003, Morey 2004). This increase in activity of coyotes may be due to a decrease in vehicular traffic and lowered likelihood of human-coyote interactions during the night (Gehrt 2007). However, under certain circumstances, coyotes living in urban areas have become habituated to human activities and have become more active during daytime hours (Timm et al. 2004). Because activity patterns of coyotes differ among localities, an understanding of activity patterns in the Southeast would serve as a predictor of habituation and help improve management techniques to reduce the risk of human-coyote conflict (Way et al. 2004).

We examined the effect of urbanized land on activity patterns along an urban-rural gradient. The objectives of our study were to quantify an urban-rural gradient within Lee County, Alabama, and to determine how seasonal and diel activity patterns are affected by varying levels of urbanization. Because the southward expansion of coyotes is recent, we expected coyotes in areas with greater percentages of urbanization to be more active during nocturnal hours, thereby avoiding interaction with humans, whereas

coyotes in areas with lesser percentages of urbanization would be most active during dawn and dusk. Information from this study will allow biologists, planners, and managers to gain an understanding of behavior of coyotes in southeastern urban, exurban, and rural areas, and will be helpful in determining how the coyote has adapted to urban areas.

METHODS

Study Area

Lee County is in east-central Alabama and includes the Auburn-Opelika Metropolitan Statistical Area (MSA); MSAs are defined by the U.S. Census Bureau as urbanized areas with $\geq 50,000$ inhabitants. The population of the Auburn-Opelika MSA has increased 18.1% during 2000 - 2009, from 115,094 to 135,883 people (U.S. Census Bureau 2010). Lee County has extensive biotic diversity and a pronounced urban-rural gradient with almost equal amounts of urban and rural areas. Of the 2,966 census blocks in the county, 56% are rural and 44% are urban.

East-central Alabama has a subtropical climate with an average high temperature of 32°C in July and an average low of 1°C in January; average precipitation is 1,337 mm. Lee County contains 1,595 km² of land, 18 km² of surface water (U. S. Census Bureau 2000), and is in the southeastern Mixed Forest Province (Bailey 1980). There is an abundance of biotic variation in Lee County because it is at a physiographic fall line; the southern one-half is in the East Gulf Coastal Plain, and the northern one-half is in the southern Piedmont Upland region. Forests consist of a variety of broadleaf deciduous trees mixed with pines and bottomland hardwoods.

The Auburn-Opelika MSA is composed of urban and suburban features within a patchwork of natural areas. The populated core of the county is comprised of schools, single-family homes, condominiums, apartments, shopping centers, operating and abandoned factories, and recreational areas. Outskirts of the MSA are both exurban and rural landscapes and contain natural areas, agricultural lands, fallow fields, clear cuts, managed hunting areas, pastures, pine plantations, recreational areas, single-family homes, schools, scattered small businesses, and roadside markets.

Live Captures

Fieldwork was conducted during July 2007 - July 2009 in Lee County, AL during all biological seasons as defined by Holzman et al. (1992): breeding (1 January - 30 April), pup-rearing (1 May - 31 August), and dispersal (1 September - 31 December). To maximize trapping success and ensure an even sample across the study area, we placed 5 motion-sensing cameras (DV-5, Leaf River Outdoor Products, Taylorsville, MS) in areas of suspected activity throughout the county during June - September 2007. Cameras were placed at 10 sites, both on university and private lands, for ≥ 7 nights. We used dirt-hole sets in conjunction with a long-range canid lure (Carmen's Canine Call, New Milford, PA) and a meso-carnivore bait (Caven's Hiawatha Valley, Minnesota Trapline Products, Pennock, MN) to attract coyotes to camera sites. Sites where coyotes were photographed were used for trapping.

We used number 3 Victor Soft-Catch foothold traps

(Woodstream Corporation, Lititz, PA) modified with crunch-proof swivels (Minnesota Trapline Products) to capture coyotes. We set traps during September 2007 - May 2008 and November - December 2008. Trapping was discontinued during pup-rearing (1 May - 31 August) due to high temperatures and to minimize risk of capturing lactating females or pups. We placed traps in areas that were part of the camera study, as well as in areas with reported activity. Traps were set at forks in roads in fields and forests, in game trails, and in other areas easily accessible by coyotes; to reduce accidental capture of non-target species, we did not set traps close to water or fruiting trees.

Caven's Hiawatha Valley and Kozy Kitten cat food (Promark International, Boise, ID) were alternated as baits, and Carmen's Canine Call, urine of coyotes, and urine of red foxes (*Vulpes vulpes*) were alternated as lures. We deployed traps in mid-afternoon and checked them after sunrise and before sunset. Non-target captures were released immediately and traps were removed from the area. We photographed and described each captured coyote. Coyotes were pinned to the ground with a snare pole, their muzzles and legs were bound with electrical tape, and each coyote was weighed using a hanging spring scale. Sex, approximate age (by tooth wear), and reproductive status were determined. Measurements included total length, length of body, length of right hind foot, and length of ear. All injuries were recorded. VHF collars (160 g) with mortality sensors (Advanced Telemetry Systems, Isanti, MN) were attached to coyotes weighing ≥ 3.2 kg, as described by White and Garrott (1990). We released coyotes at the point of capture. Capture and handling followed guidelines of the American Society of Mammalogists (Animal Care and Use Committee 1998).

Radiotelemetry

After initial capture, we waited 2 weeks before tracking to allow time for coyotes to adjust to radiocollars (White and Garrott 1990). Coyotes were located initially by using an Omni antenna fixed to a moving vehicle. Once a signal was received, we used a portable, hand-held, 3-element Yagi antenna (Wildlife Materials, Carbondale, IL) and a R2000 Scientific Receiver (Advanced Telemetry Systems) to triangulate locations for home range calculations. Sequential locations were taken a minimum of 2 times/week during: breeding (1 January - 30 April), pup-rearing (1 May - 31 August), and dispersal (1 September - 31 December) seasons. We tracked coyotes during 8-hour intervals, randomly across the 24-hour day. Each coyote was located ≥ 2 times during a session. We waited ≥ 2 hours between locations to avoid temporal autocorrelation of data. We gathered data on activity by using signal-attenuation techniques during all hours of the day and during all seasons following recommendations of Patterson et al. (1999) and Riley et al. (2003). We held the antenna stationary and animals were recorded as active or inactive depending on changes in attenuation over a 30-second period following Patterson et al. (1999).

Urban-Rural Gradient

Urban gradients are difficult to quantify; each place may have a variety of factors affecting the gradient. Via McIntyre et al. (2000), we created a working definition of

urban, one that described the Auburn-Opelika MSA with the least redundancy as suggested by Hahs and McDonnell (2006). We used ArcMap (v 9.3.1, ESRI, Redlands, CA) with a digital land-use map from the Alabama Gap Analysis Project (AL-GAP; Silvano et al. 2010) to quantify the urban gradient. Maps were projected on North American Datum 83 (NAD 83). We reclassified the AL-GAP digital map to reduce land-use types from 23 to 11 following Riley et al. (2003) and Way et al. (2004).

Because Lee County has grown markedly in the past 10 years, analyses required more recent data on land-cover than were available from AL-GAP. To correct this problem, we used the Geospatial Modeling Environment (GME) in ArcMap to generate 200 random 30×30 -m blocks (AL-GAP imagery pixel size) in each home range and compared their AL-GAP-land-cover classifications to 2006 digital-orthophoto-quarter quadrangles (DOQQ) produced by the Alabama State Water Program. Using the same classification criteria as the AL-GAP, we updated all points so the land-cover classification was consistent with the DOQQ. This method was less laborious than reclassifying the entire study area. We used ground truthing to validate areas where the classification had changed.

We calculated land-use association as the percentage of the 11 classes of land in each home range following Riley et al. (2003). Employing data on use of land, we summed amounts of low, medium, and high urbanization in each home range to create an urbanization variable (Atwood et al. 2004). Urbanization was measured by the percentage of each home range consisting of urbanized land (Riley et al. 2003).

We examined relationships between amount of urbanization and size of home range using linear-regression models following Gehrt et al. (2009). We tested for non-linearities in data using polynomial regression. We used linear-regression models, in the statistical package R, to determine effects of urbanization on seasonal size of home range.

Activity Patterns

To determine variation in diel activity, we divided data into nocturnal (1931-0430 hour), crepuscular (0431-0730 and 1631-1930 hours), and diurnal (0731-1630 hour) based on average yearly length of day using the technique described by McClennen et al. (2001). Percentage of activity was number of active signals divided by total amount of active and inactive signals for each individual. We used a logistic regression model to determine differences in activity patterns for all coyotes during all seasons and diel periods.

A mixed-effects, logistic-regression model (lme4 library in R; R Development Core Team, R Foundation for Statistical Computing, Vienna, Austria) was used to describe effects of diel period, season, and urbanization on activity patterns. We used mixed-effects logistic regression because data on activity was in binary form and each coyote was considered an individual. Active was coded as 1 and inactive as 0.

RESULTS

We captured and radiocollared 20 coyotes (3 males, 17 females). Of these 20, 14 (2 males, 12 females) survived long enough to be included in analyses of home range and activity. During May 2008 - August 2009, we acquired 2,382 locations on 14 collared coyotes throughout Lee County, AL. As of 8 May 2011, 9 of the original 20 coyotes had died. Of the 9 mortalities, 4 females and 1 male dispersed prior to their death. Dispersal distances ranged from 40 - 402 km from the trap site. Percentage of urbanization in individual home ranges was 2% - 45%.

When all coyotes were grouped together, 381 (53%) locations in the breeding season, 207 (39%) in the dispersal season, and 404 (47%) in the pup-rearing season were classified as active. We classified 317 (65%) of crepuscular locations, 364 (36%) of diurnal locations, and 390 (63%) of nocturnal locations as active. Coyotes were least active during dispersal season ($z = -2.8$; $P < 0.01$) and most active during breeding season ($z = 2.5$; $P < 0.01$; Table 1). Coyotes were most active during nocturnal hours ($z = 0.60$; $P < 0.01$) and least active during diurnal hours ($z = -0.52$; $P < 0.01$; Table 2). Coyotes along the gradient had similar levels of activity during all biological seasons and diel periods (Table 3).

DISCUSSION

Activity patterns are difficult to compare among studies. Researchers study activity of coyotes in a variety of ways, including successive locations, modulation of signals, and activity sensors on radiocollars. These varying techniques, along with inherent differences among populations, limit comparisons (McClennen et al. 2001). However, in suburban and urban areas, activity patterns provide important insight into how much coyotes in the area have become habituated to humans.

Coyotes had the highest percentage of active locations during nocturnal hours in breeding (70% of points ac-

Table 1. Results of logistic-regression-activity model for 14 coyotes (*Canis latrans*) in Lee County, Alabama, 2007-2009.

Season ^a	Coefficient estimate ^b	Standard error	P-value
Breeding	0.26	0.10	0.01
Dispersal	-0.32	0.11	<0.01

^a Reference is pup-rearing season

^b A positive estimate means coyotes in areas with more urbanization are more likely to be active during a specific season than coyotes in areas with less urbanization, and a negative estimate means that coyotes in areas with more urbanization are less likely to be active during a specific season than are coyotes in areas with less urbanization.

Table 2. Results of logistic-regression-activity model for 14 coyotes (*Canis latrans*) in Lee County, Alabama, 2007-2009.

Time ^a	Coefficient estimate ^b	Standard error	P-value
Crepuscular	-0.59	0.12	<0.01
Diurnal	-1.11	0.11	<0.01

^a Reference is nocturnal hours

^b A positive estimate means coyotes in areas with more urbanization are more likely to be active during a specific time than coyotes in areas with less urbanization, and a negative estimate means that coyotes in areas with more urbanization are less likely to be active during a specific time than are coyotes in areas with less urbanization.

Table 3. Log odds of activity during all times and seasons for 14 coyotes (*Canis latrans*) in Lee County, Alabama, 2007-2009.

Season ^a	Diel period ^b	Odds ratio	Standard error	P-value	95%	CI ^c
Breeding	Diurnal	0.50	1.01	0.5	(0.07,	3.6)
	Crepuscular	0.27	1.90	0.5	(0.01,	11.41)
	Nocturnal	0.62	1.39	0.7	(0.04,	9.4)
Pup-rearing	Diurnal	0.47	1.33	0.6	(0.04,	6.35)
	Crepuscular	0.21	1.69	0.4	(0.01,	5.8)
	Nocturnal	2.17	1.49	0.6	(0.12,	40.03)
Dispersal	Diurnal	0.00	1.69	0	(0.0,	0.12)
	Crepuscular	0.90	1.51	0.9	(0.05,	17.2)
	Nocturnal	1.36	1.46	0.8	(0.08,	23.7)

^a Breeding (1 January–30 April), pup-rearing (1 May–31 August), and dispersal (1 September–31 December).

^b Diurnal (0731–1630 h), crepuscular (0431–0730 h) and nocturnal (1931–0430 h).

^c 95% Confidence interval on the odds ratio

tive) and pup-rearing (64% of points active) seasons and the lowest percentage of activity in diurnal hours during dispersal (29% of points active) and pup-rearing (32% of points active). Activity was lowest in diurnal hours during dispersal and greatest in diurnal hours during breeding season. This variation may be due to weather. Breeding season occurs during the coldest season of the year and coyotes may be more energetically capable of handling cool weather rather than hot weather. Laundré and Keller (1984) suggested that coyotes in some parts of the country may be nocturnal due to heat in daylight hours and stress associated with thermoregulation and osmoregulation; however, Shargo (1988) believed that disturbance by humans may be a more important factor influencing activity. Shargo (1988) reported that two coyotes in Los Angeles, one of which demonstrated no fear toward humans, foraged primarily during diurnal hours. All other coyotes in his study were most active at night and they demonstrated fear and avoidance towards humans. He also detected no seasonal variation in activity. If this was caused by physiological reasons alone, there should have been some seasonal change in activity. Similarly, a study by Kitchen et al. (2000) suggested that coyotes subjected to persecution by humans were more active at night and less active during diurnal times. When persecution ended, 8 years later, coyotes increased diurnal activity (Kitchen et al. 2000).

Along the urban-rural gradient in Lee County, AL, there were no differences in coyote activity. Coyotes were mostly nocturnal in other urban areas (Tigas et al. 2002, Riley et al. 2003, Atwood et al. 2004, Morey 2004, Way et al. 2004), but they were more active in rural areas during diurnal hours (Andelt 1985, Patterson et al. 1999, Kitchen et al. 2000). Nocturnal activity is beneficial to urban coyotes, as they are able to avoid people and cross roads at times when vehicular traffic is least (Gehrt 2007). Coyotes were least active during diurnal hours. This may have been due to an increase in vehicular traffic at these times; however, it also may have been due to availability of prey. To increase foraging efficiency, activity patterns likely are dependent on activity patterns of prey (Laundré and Keller 1984, Morton 1988, Shargo 1988, Patterson et

al. 1999, McClennen et al. 2001).

Further studies with larger samples over longer periods in other areas of the Southeast are needed. Baker and Timm (1998) pointed out that coyotes are most habituated in areas where they have been for several generations. It is hypothesized that young coyotes learn new behaviors from parents and pass these behaviors to pups. If true, we need to continue to monitor these areas to determine rate of habituation. Studies investigating the effect urbanization has on activity of prey is also important. The urbanization gradient should be standardized so that use of habitat by coyotes can be compared among areas.

After assessing results of the study, we believe that a local effort to educate citizens on the biology of coyotes, as well as to cultivate awareness of this urban resident, may be the most effective plan of action for Lee County, AL. As the coyote population in Lee County increases, citizens must learn to take appropriate actions to correct behavior of coyotes before feeding patterns are established or they become habituated. Proper disposal of garbage, keeping pet foods indoors, and using scare devices and hazing techniques may help prevent coyote habituation. If a coyote becomes a problem in an urban area, the problem individual should be removed. Trapped coyotes should not be relocated. Relocation enables potential transmission of diseases and usually is unsuccessful among canids. Most relocated coyotes are killed after release, by cars or hunters, while trying to get back to their original home range (Gehrt 2006).

ACKNOWLEDGEMENTS

We extend a special thanks to Dr. Graeme Lockaby and the Center for Forest Sustainability for fully funding this project. A special thanks go to Mr. Frank Boyd and everyone at the Alabama Wildlife Services state office for their help and advice. Also, we thank Dr. Todd Steury for his tireless assistance with statistics and Ms. Amy Silvano for GIS support. This research was approved by Auburn University Institutional Animal Care and Use Committee and by the Alabama Department of Conservation and Natural Resources.

LITERATURE CITED

- ANDELT, W. F. 1985. Behavioral ecology of coyotes in South Texas. *Wildl. Monogr.* 94:1-45.
- ANDELT, W. F., and P. S. GIPSON. 1979. Home range, activity, and daily movements of coyotes. *J. Wildl. Manage.* 43:944-951.
- ANDRZEJEWSKI, R., J. BABIŃSKA-WERKA, J. GLIWICZ, and J. GOSZCZYŃSKI. 1978. Synurbanization processes in an urban population of *Apodemus agrarius*. I. Characteristics of population in an urbanization gradient. *Acta Theriologica* 23:341-358.
- ANIMAL CARE AND USE COMMITTEE. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. *J. Mammal.* 79:1416-1431.
- ATWOOD, T. C., H. P. WEEKS, and T. GEHRING. 2004. Spatial ecology of coyotes along a suburban-to-rural gradient. *J. Wildl. Manage.* 68:1000-1009.
- BABIŃSKA-WERKA, J., J. GLIWICZ, and J. GOSZCZYŃSKI. 1979. Synurbanization processes in an urban population of *Apodemus agrarius*. II. Habitats of the striped field mouse in town. *Acta Theriologica* 26:405-415.
- BAILEY, R. G. 1980. Descriptions of the ecoregions of the United States. Miscellaneous Publication 1391, U. S. Department of Agriculture, Washington, D.C. 77 pp.
- BAKER, R. O., and R. M. TIMM. 1998. Management of conflicts between urban coyotes and humans in southern California. *Proc. Vertebr. Pest Conf.* 18:299-312.
- CHAMBERLAIN, M. J., C. D. LOVELL, and B. D. LEOPOLD. 2000. Spatial-use patterns, movements, and interaction among adult coyotes in central Mississippi. *Can. J. Zool.* 78:2087-2095.
- CONSTIBLE, J. M., M. J. CHAMBERLAIN, and B. D. LEOPOLD. 2006. Relationships between landscape pattern and space use of three mammalian carnivores in central Mississippi. *Am. Midl. Nat.* 155:352-362.
- DESTEFANO, S., and R. M. DEGRAFF. 2003. Exploring the ecology of suburban wildlife. *Front. Ecol. Environ.* 1:95-101.
- GEHRT, S. D. 2006. Urban coyote ecology and management. The Cook County, Illinois coyote project. Bulletin 929, Ohio State University Extension, Columbus, OH. 32 pp.
- GEHRT, S. D. 2007. Ecology of coyotes in urban landscapes. *Proc. Wildl. Damage Manage. Conf.* 12:303-311.
- GEHRT, S. D., C. ANCHOR, and L. A. WHITE. 2009. Home range and landscape use of coyotes in a metropolitan landscape: Conflict or coexistence? *J. Mammal.* 90:1045-1057.
- GIPSON, P. S., and J. A. SEALANDER. 1972. Home range and activity of the coyote (*Canis latrans frustror*) in Arkansas. *Proc. Ann. Conf. SE Assoc. Game Fish Comm.* 26:82-95.
- GRINDER, M. I., and P. R. KRAUSMAN. 2001. Home range, habitat use, and nocturnal activity of coyotes in an urban environment. *J. Wildl. Manage.* 65:887-898.
- HAHS, A. K., and M. J. McDONNELL. 2006. Selecting independent measures to quantify Melbourne's urban-rural gradient. *Landscape and Urban Planning* 78:435-448.
- HILL, E. P., P. W. SUMNER, and J. B. WOODING. 1987. Human influences on range expansion of coyotes in the Southeast. *Wildl. Soc. Bull.* 15:521-524.
- HOLZMAN, S., M. CONROY, and J. PICKERING. 1992. Home range, movements and habitat use of coyote in south-central Georgia. *J. Wildl. Manage.* 56:139-146.
- KAVANAU, J. L., and J. RAMOS. 1975. Influences of light and phasing on carnivores. *Am. Nat.* 109:391-418.
- KITCHEN, A. M., E. M. GESE, and E. R. SCHAUSTER. 2000. Changes in coyote activity patterns due to reduced exposure to human persecution. *Can. J. Zool.* 78:853-857.
- LAUNDRE, J. W., and B. L. KELLER. 1984. Home-range size of coyotes: A critical review. *J. Wildl. Manage.* 48:127-139.
- LEOPOLD, A. S. 1933. *Game Management*. Chas. Scribner's Sons, New York, NY. 481 pp.
- LUNIAK, M. 2004. Synurbanization adaption of animal wildlife to urban development. Pp. 50-55 in: W. W. Shaw, L. K. Harris, and L. Vandruuff (Eds.), *Proc. 4th Int. Symp. Urban Wildl. Conserv.*, University of Arizona, Tucson, AZ.
- MCCLENNEN, N., R. R. WIGGLESWORTH, S. H. ANDERSON, and D. G. WACHOB. 2001. The effect of suburban and agricultural development on the activity patterns of coyotes (*Canis latrans*). *Am. Midl. Nat.* 146:27-36.
- MCDONNELL, M. J., and S. T. A. PICKETT. 1990. Ecosystem structure and function along urban-rural gradient: An unexploited opportunity for ecology. *Ecology* 71:1232-1237.
- MCINTYRE, N. E., K. KNOWLES-YÁNEZ, and D. HOPE. 2000. Urban ecology as an interdisciplinary field: Differences in the use of "urban" between the social and natural sciences. *Urban Ecosyst.* 4:5-24.
- MOREY, P. S. 2004. Landscape use and diet of coyotes, *Canis latrans*, in the Chicago metropolitan area. M.S. thesis, Utah State University, Logan, UT.
- MORTON, L. D. 1988. Winter ecology of the eastern coyote (*Canis latrans*) in Fundy National Park. M.S. thesis, University of New Brunswick, Fredericton, NB, Canada.
- QUINN, T. 1997. Coyote (*Canis latrans*) habitat selection in urban areas of western Washington via analysis of routine movements. *Northwest Sci.* 71:289-297.
- PATTERSON, B. R., S. BONDRUP-NIELSEN, and F. MESSIER. 1999. Activity patterns and daily movements of the eastern coyote, *Canis latrans*, in Nova Scotia. *Can. Field-Nat.* 113:251-257.
- RILEY, S. P. D., R. M. SAUVAJOT, T. K. FULLER, E. C. YORK, D. A. KAMRADT, C. BROMLEY, and R. K. WAYNE. 2003. Effects of urbanization and habitat fragmentation on bobcats and coyotes in southern California. *Conserv. Biol.* 17:566-576.
- SCHRECEGOST, J. D., J. C. KILGO, H. S. RAY, and K. V. MILLER. 2009. Home range, habitat use and survival of coyotes in western South Carolina. *Am. Midl. Nat.* 162:346-355.
- SHARGO, E. M. 1988. Home range, movements, and activity patterns of coyotes (*Canis latrans*) in Los Angeles suburbs. Ph.D. dissert., University of California at Los Angeles, Los Angeles, CA. 76 pp.
- SILVANO, A. L., K. J. KLEINER, J. A. GRAND, M. D. MACKENZIE, M. S. MITCHELL, and E. R. IRWIN. 2010. Alabama gap analysis project. *Gap Anal. Bull.* 17:40-46.
- SUMNER, P. W., E. P. HILL, and J. B. WOODING. 1984. Activity and movements of coyotes in Mississippi and Alabama. *Proc. Ann. Conf. SE Assoc. Fish Wildl. Agencies* 38:174-181.

- TIGAS, L. A., D. H. VAN VUREN, and R. M. SAUVAJOT. 2002. Behavioral responses of bobcats and coyotes to habitat fragmentation and corridors in an urban environment. *Biol. Conserv.* 108:299-306.
- TIMM, R. M., R. O. BAKER, J. R. BENNETT, and C. C. COOLAHAN. 2004. Coyote attacks: An increasing suburban problem. *Proc. Vertebr. Pest Conf.* 21:47-57.
- U.S. CENSUS BUREAU. 2010. Annual estimates of the population of metropolitan and micropolitan statistical areas: April 1, 2000 to July 1, 2009. Document CBSA-EST2009-01. U.S. Census Bureau, Washington, D.C.
- U.S. CENSUS BUREAU. 2000. Population, housing units, area, and density: 2000 county subdivision and place. Document GCT-PH1. U.S. Census Bureau, Washington, D.C.
- WAY, J. G., I. M. ORTEGA, and E. G. STRAUSS. 2004. Movement and activity patterns of eastern coyotes in a coastal, suburban environment. *Northeast. Nat.* 11:237-254.
- WHITE, C. G., and R. A. GARROTT. 1990. *Analysis of Wildlife Radio-Tracking Data*. Academic Press, New York, NY. 383 pp.