Cities and the Environment (CATE)

Volume 4 | Issue 1 Article 2

7-20-2011

Eastern Coyote/Coywolf (Canis latrans x lycaon) Movement Patterns: Lessons Learned in Urbanized Ecosystems

Jonathan G. Way
Eastern Coyote Research, jw9802@yahoo.com

Eastern Coyote/Coywolf (Canis latrans x lycaon) Movement Patterns: Lessons Learned in Urbanized Ecosystems

Activity and movement patterns represent a fundamental aspect of a species natural history. Twenty four-hour movements of eastern coyotes or coywolves (*Canis latrans x lycaon*; hereafter eastern coyote for consistency purposes) ranged up to 31.9 linear km and averaged 23.5 + 7.3 (SD) km from 5-14 radio-fixes during each 24 hr monitoring period. Coyotes moved mostly at night and through altered open areas (e.g., powerlines, dumps) more than expected when compared to residential and natural areas. Coyotes inhabiting urbanized areas generally use residential areas for traveling and/or foraging. With large daily (or more aptly, nightly) movement patterns, resident coyotes can potentially be located anywhere within their large home ranges at any given time, as data revealed that one pack (3-4 individuals) can cover a combined 75-100 km per night, in a territory averaging 20-30 km^2. Transient movements from capture location to end location varied from 23.0—100.5 km and averaged 63.8 km for two females and 49.3 km for four males. Eastern coyotes travel long distances even in human-dominated areas, allowing transients to find vacant territories. Because of their ability to move through urban areas and to colonize and recolonize areas, management efforts should focus more on educating the public about actual coyote behavior and their life history needs than on killing them.

Keywords
Canis latrans x lycaon, coexistence, coyote, coywolf, eastern coyote, education, movements, non-lethal management, territoriality.

Acknowledgements
I thank my family, especially my wife Tara, for supporting me while writing this paper. Proceeds from my book Suburban Howls and donations to my website (www.EasternCoyoteResearch.com) partially financially supported this research. I thank B.R. Patterson for his important work with canids and for commenting on a previous draft of this manuscript. The additional suggestions of two anonymous reviewers improved this paper.

INTRODUCTION

Movement patterns represent a basic characteristic of the ecology of a species, and affect home ranges and territory sizes, habitat use, dispersal, corridor use, and population density (Patterson et al. 1999, Patterson and Messier 2001, Way et al. 2002a, Way et al. 2004, Way and Eatough 2006). In urban areas it is vital to know when a predator is active and where it moves, especially in relation to human activity, as this knowledge could potentially lead to the development of management strategies to reduce conflicts with humans. Additionally, studying predators in urbanized areas provides baseline data to inform residents of how species (e.g., coyotes [*Canis latrans*] nationwide, cougars [*Puma concolor*] in California) behave in human-dominated environments (Beier 1993, 1995; Way 2001, 2002a).

Movements of coyotes have been documented in rural/forested areas (Patterson et al. 1999), agricultural landscapes (Person 1988), and urbanized areas (Way et al. 2004, Way 2007a). Coyotes have also been documented to travel across seemingly disparate areas, such as wide canals (Way 2002), bridges (Way 2009), islands (Thomas and Dibblee 1986), and on drifting pack ice (Chubbs and Phillips 2002). Documenting the movement of transient coyotes in urbanized areas enables managers to compare how they move in these landscapes compared to more rural environs (e.g., Gese et al. 1996, Harrison 1992, Way 2007a), which could have practical implications. For example, if transient coyotes do not move far distances in urbanized locales (because of high road density) then localized control efforts may be more successful in reducing coyote numbers in those regions; conversely, if the opposite is true (i.e., coyotes move similar distances in urban and rural areas), then control efforts would likely be less successful, unless targeting a specific individual(s).

Here, I review and synthesize a decade of research that has taken place in eastern Massachusetts as a case study for lessons learned while studying eastern coyotes (coywolves) in urbanized areas (papers most relevant to this discussion are Way et al. 2002, Way et al. 2004, Way and Eatough 2006, Way 2007a, Way 2009). I will detail relevant findings and potential management opportunities for managing canids on our landscapes, ranging from rural and wilderness to urban.

METHODS USED TO STUDY EASTERN COYOTES 1998-2008

Recent genetic research on eastern coyotes indicates that they are actually a hybrid between western coyotes and eastern/red wolves (*Canis rufus/lycaon*; Wilson et al. 2000) and could be called coywolves (*Canis latrans x lyacon*) since they are larger than western coyotes (Way 2007b) and genetically distinct from both western coyotes and eastern/red wolves (Way et al. 2010). However, for consistency purposes (and because of the continued controversy surrounding the genetic nature of this animal) I will retain its original nomenclature of eastern coyote, or simply coyote, throughout this manuscript. Nevertheless, the eastern coyote is a successful and widespread hybrid canid living throughout northeastern North America (east of 80° longitude, and south of Algonquin Provincial Park, Ontario), similar to the western coyote found throughout most of the rest of the continent (Parker 1995).

Study Sites

This research took place in two urbanized locations from 1998-2008: Cape Cod and the towns and cities north of Boston. Most research conducted on the heavily urban north edge of Boston (~100-150 km^2; 42.43°, 71.06°) took place in the cities of Revere (3089 people/km^2, housing density = 1318/km^2), Everett (4345 people/km^2, housing density = 1817/km^2), and Malden (4291 people/km^2, housing density = 1800/km^2) (U. S. Census Bureau 2000 estimates). The area is characterized by high density housing with small woodland areas or open space such as cemeteries non-strategically situated in towns and cities. Coyotes were captured and spent most of their time in these wooded, green areas as the high density housing areas were often fenced and provided nowhere for coyotes to travel, except for main roads (Way and Eatough 2006). Railroad tracks and holes in some of the fences provided small corridors between some of the green areas (Way and Eatough 2006).

Research on Cape Cod was conducted within Barnstable County, Massachusetts (approximate study area 250 km^2) with a concentration in the town of Barnstable (41.67°, 70.28°; land area=155.5 km^2). Human population density in the town of Barnstable was 308 people/km^2 and housing density was 161/km^2, while the entire Barnstable County (1024 km^2) averaged 217 people/km^2 and 144 houses/km^2 (U. S. Census Bureau 2000 estimates). The town/city of Barnstable has a distinct rural-urban gradient within its borders; the highest and lowest densities of people were found in urban Hyannis (556 people/km^2, housing units = 328/km^2) and rural West Barnstable (89/km^2, housing units = 39/km^2) (Cape Cod Commission 1998). Road density, defined as centerline km of roadway per km^2, was 4.7 for the town of Barnstable and 4.0 for Barnstable County (Cape Cod Commission 1998). Cape Cod is characterized by being residential as well as having numerous small (5-10 ha) and a few large (~1000 ha) conservation areas interspersed throughout. Most of the neighborhoods are not fenced, however, and coyotes were readily able to travel through these areas to access various portions of their home range (Way et al. 2004). Eastern coyote pack territories were roughly 20-30 km^2 and were non-overlapping, similar to more rural areas (Patterson and Messier 2001, Way et al. 2002a), which are bigger than western coyote territories (Andelt 1985, Gehrt et al. 2009, Gese et al. 1996).

Capture Techniques

Eastern coyotes were captured by box trap (Way et al. 2002b) then radio-collared or radio-implanted (juveniles – i.e., pups of the year) using Telonics, Inc. (Mesa, Arizona) transmitters, aged based on tooth wear (Bowen 1982; Landon et al. 1998), weighed, blood drawn (ca. 4 cc), then released. Residents were classified as adults, yearlings, and juveniles that lived within a territorial boundary and were part of a pair (excluding juveniles) or pack. Transients (or nomads) were classified as individuals who had no discernable territory and nomadically moved throughout the study areas, including within the territories of resident (collared) pack members. These individuals are typically classified as young individuals that are in the process of dispersing from their natal pack (Harrison 1992, Way et al. 2002a, Way 2007a).

Radio-Telemetry Techniques

Tracking protocols were fully described by Way et al. (2002a) and Way et al. (2004). Portable receivers (Custom Electronics, Urbana, Illinois, USA) and hand-held 3-element Yagi antennas were used to radio-track eastern coyotes both on foot and from a vehicle, and I homed in on an animal's signal until its location was pinpointed by using the loudest-signal method (Springer 1979). Due to the highly developed landscape with many roads, coyotes were mostly radio-tracked in a vehicle which allowed closer approach than travel by foot (Way 2002a, Way et al. 2004). Binoculars and video-cameras were used when observing coyotes, and city street lights, night-scopes and occasionally headlights when following individuals at night with a vehicle (Way et al. 2002a, Way et al. 2004). Coyote movements were mapped and distances calculated using ArcView 3.x animal movement extension in the animal movement analysis Arc View extension program (Hooge and Eichenlaub 1997).

For each location I classified a coyote as being in a residential, altered, or natural landscape (Riley et al. 2003). Residential areas included areas around housing developments (e.g., driveways and front yards), local neighborhood roads, and commercial areas. Altered areas included human-manipulated areas such as dumps that were capped (i.e., no trash available to animals), cranberry bogs, cemeteries, athletic fields, sandpits, golf courses, powerlines, railroad tracks, and main roads and highways. Natural areas consisted of wooded areas, marshlands, and ponds/lakes – i.e., areas that were not permanently human altered. Natural areas (6 - 500 ha), cranberry bogs (2 – 50 ha), and golf courses exist in scattered, patchy areas throughout the study site (Way et al. 2004).

No systematic methodology (i.e., Andelt 1985) was employed to locate study animals over a 24-hour period because only I radio-tracked. Rather, individual coyotes were opportunistically located 5-14 times over a ca. 24-hr period. Locations were taken between 15 min and 8 hr apart and a complete tracking session took multiple locations during the course of a night of monitoring (i.e., when they were most likely to travel – Way et al. 2004). Estimates of daily (24 hr) distances traveled were summed from the total distance traveled during each sequential location in each monitoring session (Patterson et al. 1999, Way et al. 2004) and then by rounding up or down to standardize 24 hr movement rates (e.g., a 22 hr tracking session was standardized to 24 hr using rate pairs). Since coyotes were not continually tracked throughout a 24 hr period, movements reported herein should be regarded as conservative to potential/actual movements.

Animal activity was recorded as either resting or active based on signal modulation. Following Patterson et al. (1999), we assessed signal modulation by placing the antennae in a stationary position and listening for fluctuations in signal pitch or strength.

Finally, all statistical tests were reported in the original papers. Here, I summarize the most pertinent findings from Way et al. 2002a, Way et al. 2004, Way and Eatough 2006, Way 2007a, and Way 2009.

RESULTS: FINDINGS FROM A LONG-TERM STUDY

Resident Movement Patterns

Forty-eight individual eastern coyotes (26 M, 22 F) consisting of 11 juveniles (7 M, 4 F), 12 yearlings (8 M, 4 F), and 27 adults (12 M, 15 F) were captured 65 times during my 11 year study (1998-2008); 8 individuals were captured twice, 2 adults were captured 3 times, and 2 F were captured 4 times. Twenty four-hour movements of adults ranged up to 31.9 linear km and averaged 23.5 $\pm$ 7.3 (SD) km from 5-14 radio-fixes during each 24 hr monitoring period (Way et al. 2004). Adult males averaged 26.0 $\pm$ 4.6 (SD) km versus 20.4 $\pm$ 9.6 (SD) km for adult females (Table 1, Way et al. 2004).

Eastern coyotes moved mostly at night and through altered open areas (e.g., powerlines, dumps) more than expected when compared to residential and natural areas. Coyotes generally used residential areas for traveling and/or foraging and rested in more natural and altered areas (Way et al. 2004). When active, radio-monitored animals were difficult to track in neighborhoods because they moved so quickly and in any direction (ca. 10 km/hr in neighborhoods which is approximately human jogging pace). With large daily movement patterns, resident pack members could potentially be located anywhere within their home range at any given time, as data revealed that one pack (3-5 individuals; Way et al. 2002a, Way 2007c) could cover a combined 75-100 km per night, in a territory averaging 20-30 km^2 (Way et al. 2004).

Table 1. Summary statistics of a long-term study of eastern coyotes in urbanized eastern Massachusetts 1998-2008, focusing on movement and activity data.

Variable studied	Statistic
Number of animals monitored during the study	48 (26 M, 22 F)
Study sites	Cape Cod (~300 people/km^2) North Boston (3,000-4000 people/km^2)
Average pack size	3-5
Average territory size	20-30 km^2
Maximum movement per night (24 h period)	31.9 km
Average movement per night (24 h period)	23.5 km
Potential distance a pack could travel in 1 day (24 h)	75-100 km (combined movements of all pack members in a typical group)
Number of individuals documented using narrow, linear "micro-corridors" for movement	12[a]
Types of micro-corridors	Bridges, hole/gap in cemetery fence, railroad tracks in Boston
Minimum dispersal distance	23.0 km
Maximum dispersal distance	100.5 km

[a] Only includes radio-collared individuals. An unquantified number of un-marked animals were observed with them.

Use of passageways (micro-corridors) for movements

In heavily urbanized areas, eastern coyotes used very narrow, linear corridors (termed "micro-corridors") that facilitated movements by both transients and residents in and out of green/wooded areas (e.g., woods or cemeteries - Way and Eatough 2006). One corridor, a railroad line through downtown Boston, and a second, a hole and gap in a cemetery fence in urban north Boston, gave access to two separated cemeteries in a region of intense human development. Five radio-monitored individuals were documented using these passageways which facilitated their movement to adjacent habitats and allowed them to inhabit highly urbanized habitats (Table 1, Way and Eatough 2006). Individuals adapted to human-dominated areas by watching traffic from vantage points and then crossing through these corridors when traffic was minimal (Way and Eatough 2006).

Additionally, I made 11 observations of ≥ 7 different eastern coyotes (Table 1; note: these are different individuals than those reported in Way and Eatough 2006) crossing bridges within the territories of two packs (Way 2009). Sightings ranged from 1–4 (mean = 1.9) individuals crossing bridges at the same time and all involved 1 or 2 individuals wearing a radio-collar. I made 8 of the sightings at night, 1 at dusk, and 2 post-dawn when it was fully light outside (Way 2009). These bridges connected mainland sites and nearby small islands on Cape Cod. Based on the behavior of these animals crossing the bridges (e.g., looking both ways before crossing, standing on the bridges [in the middle of the roads] to make sure that cars were not coming from the other side of the bridge/road, and familiarity with the area to realize that they could indeed cross the bridges to begin with), this was probably a regular occurrence for both of these two packs as they traveled through their sizable territories (Way 2009). These observations suggest that eastern coyotes have adapted to urbanized areas in part by using small, linear corridors (e.g., bridge, railroad tracks, holes in fences), which has aided in their colonization of seemingly disparate areas in their expanding geographic range (Parker 1995; Way 2002, 2009; Way and Eatough 2006).

Transient movements

Transient movements from capture location to end location varied from 23.0—100.5 km and averaged 63.8 km for two females and 49.3 km for four males (Table 1). Eastern coyotes in the process of long-distance dispersal were all young (ca. 2 yr; n = 6) (Way 2007a). However, one unaffiliated individual ("localized floater" – see Way and Timm 2008) was very old (10-12 yr) and possibly post reproductive and moved among other territorial packs (using an area of ~ 200 km^2) in a fairly restricted area compared to other eastern coyotes that have been studied (Way and Timm 2008).

Eastern coyotes travel long distances even in human-dominated areas, allowing transients to quickly find and saturate vacant territories (Way 2007a). Transients can either nomadically roam a fairly localized area, presumably looking for territorial openings (e.g., Way and Timm 2008), or they can exhibit relatively straight long-distance dispersal, often to new distant areas (Harrison 1992, Way 2007a, and sources within both references). These combined dispersal strategies allow canids to quickly colonize and recolonize vacant habitat whether rural (Harrison 1992) or urban (Way 2007a).

DISCUSSION: LESSONS LEARNED IN URBANIZED ECOSYSTEMS

Eastern coyotes have the ability to travel very far in short periods of time both in localized areas (e.g., residents within their normal territory) and over vast distances (e.g., directional dispersers) (Harrison 1992, Patterson et al. 1999, Way 2007a, Way et al. 2004). Canids have the ability to rapidly colonize and recolonize areas as well as readily use human structures to aid in their movements (Way and Eatough 2006, Way 2009). Thus, I believe that management efforts should focus more on educating the public about actual coyote behavior and their life history needs than on killing them. Coyotes are known to kill pets (especially domestic cats - Grubbs and Krausman 2009) yet avoid humans especially when humans modify their behavior to prevent attracting coyotes to certain areas, like residential yards (Gehrt et al. 2009, White and Gehrt 2009). Residents should be encouraged to not feed coyotes and to leave pets inside during times when coyotes are most likely to be active, such as at night, dawn/dusk time periods, and during the pup rearing season (Way et al. 2001).

It is vital for homeowners to have access to accurate information on canid behavior and ecology, such as eastern coyotes living at relatively low densities in large territories with regular long distance movements of individuals making it seem like there are more in a given area than really exists. Unbiased recommendations will provide homeowners with the knowledge necessary to take proper precautions, such as how to guard pets and livestock and avoid leaving attractants (e.g., food) available to wild animals—proactive activities that are often more effective and publicly acceptable at avoiding conflicts compared to lethal control (Bruskotter et al. 2009, Gehring et al. 2010, Grubbs and Krausman 2009, Shivik 2006, White and Gehrt 2009). This type of information could be made obtainable through various public education venues like newspapers, television, talks by biologists, journal articles, and/or town/natural resource agency websites. Education efforts should also explain how a pack of resident coyotes guards their territory from other packs essentially limiting their own numbers in a local area and that killing them merely opens a vacant territory for a new group of individuals (Knowlton et al. 1999, Way et al. 2009). And we now know that transients can quickly fill those vacated territories through long or short-distance dispersal (Way 2007a).

Eastern coyotes travel across a gradient of urbanization (from wilderness to rural to urban) when dispersing (Harrison 1992, Way 2007a). Additional research, using the landscape genetics approach, should attempt to document if eastern coyotes settle in habitats similar to where they were raised as documented with coyotes and red foxes (*Vulpes vulpes*) in California (i.e., natal-habitat–biased dispersal – Sacks et al. 2004, 2008, 2010) or if they choose to establish themselves in different habitats from where they grew up, such as urban foxes dispersing to rural areas in east-central Illinois (Gosselink et al. 2010). In the latter scenario, an “urban coyote” merely represents where an individual currently lives, as it could have originated in a much more rural location, and vice versa. In the former situation, eastern coyotes would show strong selection for a habitat similar to where they were born and would disperse through unfamiliar areas until locating a suitable area that is similar to their natal home range. The resulting populations would then show genetic structure between various habitats (e.g., urban vs. rural) corresponding to natal-habitat-biased preferences of individuals (Sacks et al. 2004, 2008). Either way, it is important to realize that coyotes have the potential to move extensively and rapidly through any landscape.

Over the course of my research, people repeatedly expressed the opinion that coyotes should not exist near them because the person lives in a highly residential area, "which is not wildlife habitat" (J. Way, unpublished data). As wildlife managers and the general public become better educated as to actual canid ecology, there will a better realization that urbanized landscapes (including residential areas) are very much coyote habitat (Gehrt et al. 2009, this study), just as are more traditional rural or wilderness areas (Gese et al. 1996, Patterson and Messier 2001). Individuals/packs inhabiting urbanized areas will naturally have many more houses/humans within their home range boundaries compared to more rural coyotes. However, recent research informs us that coyotes generally behave similarly regardless of where they live. For instance, coyotes in the greater Chicago metropolitan area had a mostly natural diet (e.g., rodents, rabbits, and deer fawns), similar to less developed areas (Gehrt 2006, Morey et al. 2007). Individuals also preferentially resided in more natural (i.e., wooded) areas of their heavily urban territories which they guarded from conspecifics (Gehrt et al. 2009). This territoriality is a widespread characteristic of coyotes throughout their range (e.g., Gehrt et al. 2009, Gese et al. 1996, Knowlton et al. 1999, Patterson and Messier 2001, Way et al. 2002a, 2009).

In fact, the only major detectable difference between coyotes from various environments is that coyotes in urbanized areas are considerably more nocturnal (Gehrt et al. 2009, Way et al. 2004) than those inhabitating more rural/wilderness locations where they are often active during the day (Gese et al. 1996, Patterson et al. 1999). The widespread reasoning behind this difference is that coyotes try and avoid people in more developed areas by being most active when people (and their pets) are least active (see Gehrt et al. 2009).

Throughout their range, coyotes exhibit long-distance movement patterns (Harrison 1992, Way 2007a), live at fairly low densities (especially eastern coyotes), and provide rodent/rabbit and potentially pest control (Gehrt 2006). Human hunting/random killing may actually be counter-productive when trying to avoid conflicts with coyotes due to their territorial nature (see Way et al. 2009). Leaving resident territorial adults alone may naturally regulate populations in an area (e.g., see Way et al. 2009) and may best promote long-term coexistence with coyotes, especially when humans modify their behavior to prevent confrontations from occurring in the first place (Grubbs and Krausman 2009, White and Gehrt 2009).

Ecosystem Perspective

It is important that the layman become more aware of the importance of having predators in all type of landscapes. Canids (eastern coyotes, wolves, western coyotes, foxes), like many species, are directly involved in the evolution of their prey, and are vitally important to maintaining ecosystem health (see Stolzenberg 2009 for an exhaustive literature review on the role of top-order predators). Has anyone ever wondered why deer are so swift (because of coyotes and wolves), and why rabbits are so quick and secretive (due to predation pressure from coyotes and foxes)? The public needs to better realize that it is unnatural to have prey and not their canid predators like the East Coast had until 20-50 years ago (Parker 1995), even if some of those areas are urbanized. Coyotes are in neighborhoods to meet their ecological needs and their territoriality will naturally limit their numbers in a localized area yet also guarantee that vacant territories are quickly filled due to immigration of transients (Way 2007a, Way et al. 2009). We (not them) are the ones that need to more effectively learn how to live with our neighbors in order to prevent conflicts from happening (White and Gehrt 2009).

Summary

With the knowledge of canid behavior and ecological importance of predators outlined above, I believe that management programs need to focus on educating the public and not on killing/controlling them. Eastern coyotes are social, intelligent, family-oriented animals (Way 2007c) that are important for ecosystem health (Stolzenberg 2009). And they more or less regulate their own numbers. No doubt, the best way to live with coyotes is to control human behavior to avoid habituating them (e.g., leashing dogs, keeping cats inside, not feeding them – like advocated by Grubbs and Krausman 2009 and White and Gehrt 2009) and to better inform the general public as to actual coyote natural history. Then territorial coyotes can do what they do best, which is keeping other non-pack members out of their domain and regulate their own population density (Way et al. 2002a, 2009; Gehrt 2006; Patterson and Messier 2001). Adopting the ideas and research findings generated in this paper will help facilitate long-term coexistence between people (and their pets) and coyotes.

LITERATURE CITED

Andelt, W.F. 1985. Behavioral ecology of coyotes in south Texas. Wildlife Monographs 49:1-45.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. Conservation Biology 7: 94-108.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management 59: 228-237.

Bowen, W. D. 1982. Determining age of coyotes, *Canis latrans*, by tooth sections and tooth-wear patterns. Canadian Field-Naturalist 96: 339-341.

Bruskotter, J. T., J. J. Vaske, and R. H. Schmidt. 2009. Social and Cognitive Correlates of Utah Residents' Acceptance of the Lethal Control of Wolves. Human Dimensions of Wildlife 14:119-132.

Cape Cod Commission. 1998. Cape trends: demographic and economic characteristics and trends. Cape Cod Commission, Barnstable, Massachusetts, USA.

Chubbs, T. E., and F. R. Phillips. 2002. First record of an eastern coyote, *Canis latrans*, in Labrador. Canadian Field-Naturalist 116: 127-129.

Gehring, T. M., K. C. VerCauteren, and J.-M. Landry. 2010. Livestock Protection Dogs in the 21st Century: Is an Ancient Tool Relevant to Modern Conservation Challenges? BioScience 60(4):299-308.

Gehrt, S. 2006. Urban Coyote Ecology and Management: The Cook County, Illinois, Coyote Project. Bulletin 929, Ohio State University Extension, Columbus, Ohio. 32 pages

Gehrt, S.D., C. Anchor, and L.A. White. 2009. Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence. Journal of Mammalogy 90:1045-1057.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behavior 52: 1025-1043.

Gosselink, T.E., K.A. Piccolo, T.R. Van Deelen, R.E. Warner, and P.C. Mankin. 2010. Natal dispersal and philopatry of red foxes in urban and agricultural areas of Illinois. Journal of Wildlife Management 74:1204-1217.

Grubbs, S. E., and P. R. Krausman. 2009. Observations of Coyote-Cat Interactions. Jouranl of Wildlife Management 73: 683-685.

Harrison, D. J. 1992. Dispersal characteristics of juvenile coyotes in Maine. Journal of Wildlife Management 56: 128-138.

Hooge, P.N., and B. Eichenlaub. 1997. Animal movement extension to arcview. Version 1.1 Alaska Biological Science Center, U.S. Geological Survey, Anchorage, AK.

Knowlton, F. F., E. M. Gese, and M. M. Jaeger. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52: 398-412.

Landon, D. B., C. A. Waite, R. O. Peterson, and L. D. Mech. 1998. Evaluation of age determination techniques for gray wolves. Journal of Wildlife Management 62: 674-682.

Morey, P.S., E.M. Gese, and S. Gehrt. 2007. Spatial and temporal variation in the diet of coyotes in the Chicago metropolitan area. American Midland Naturalist 158: 147-161.

Parker, G.R. 1995. Eastern Coyote: The Story of Its Success. Nimbus Publishing, Halifax, Nova Scotia.

Patterson, B.R., S. Bondrup-Nielsen, and F. Messier. 1999. Activity patterns and daily movements of the eastern coyote, *Canis latrans*, in Nova Scotia. Canadian Field-Naturalist 113:251-257.

Patterson, B.R., and F. Messier. 2001. Social organization and space use of coyotes in eastern Canada relative to prey distribution and abundance. Journal of Mammalogy 82:463-477.

Person, D.K. 1988. Home range, activity, habitat use, and food habits of eastern coyotes in the Champlain valley region of Vermont. M.S. Thesis, University of Vermont, Burlington. 94 pp.

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. Conservation Biology 17:566-576.

Sacks, B.N., S.K. Brown, and H.B. Ernest. 2004. Population structure of California coyotes correspond to habitat-specific breaks and illuminates species history. Molecular Ecology 13: 1265–1275.

Sacks, B.N., D.L. Bannasch, B.B. Chomel, and H.B. Ernest. 2008. Coyotes demonstrate how habitat specialization by individuals of a generalist species can diversify populations in a heterogeneous ecoregion. Molecular Biology and Evolution 25: 1384–1394.

Sacks, B.N., M. Moore, M.J. Statham, and H.U. Witmers. 2010. A restricted hybrid zone between native and introduced red fox (*Vulpes vulpes*) populations suggests reproductive barriers and competitive exclusion. Molecular Ecology 20: 326-341.

Shivik, J. 2006. Tools for the Edge: What's New for Conserving Carnivores. BioScience 56:253-259.

Springer, J.T. 1979. Some sources of bias and sampling error in radio triangulation. Journal of Wildlife Management 43:926-935.

Stolzenberg, W. 2008. Where the wild things were: life, death, and ecological wreckage in a land of vanishing predators. Bloomsbury USA, New York. 291 pages.

Thomas, H. H., and R. L. Dibblee. 1986. A coyote, *Canis latrans*, on Prince Edward Island. Canadian Field-Naturalist 100: 565-567.

Way, J. G. 2002. Radio-collared coyote crosses Cape Cod Canal. Northeast Wildlife 57: 63-65.

Way, J.G. 2007a. Movements of transient coyotes (*Canis latrans* var.) in urbanized eastern Massachusetts. Canadian Field-Naturalist 121(4): 364-369.

Way, J. G. 2007b. A comparison of body mass of *Canis latrans* (Coyotes) between eastern and western North America. Northeastern Naturalist 14(1): 111-124.

Way, J.G. 2007c. Social and play behavior in a wild eastern coyote (*Canis latrans* var.) pack. Canadian Field-Naturalist 121(4): 397-401.

Way, J. G. 2009. Observations of coywolves, *Canis latrans* x *lycaon*, crossing bridges and using human structures on Cape Cod, Massachusetts. Canadian Field-Naturalist 123(3): 206-209.

Way, J.G, P.J. Auger, I.M. Ortega, and E.G. Strauss. 2001. Eastern coyote denning behavior in an anthropogenic environment. Northeast Wildlife 56: 18-30.

Way, J. G., I. M. Ortega, and P. J. Auger. 2002a. Eastern coyote home range, territoriality and sociality on urbanized Cape Cod, Massachusetts. Northeast Wildlife 57: 1-18.

Way, J. G., I. M. Ortega, P. J. Auger, and E. G. Strauss. 2002b. Box-trapping eastern coyotes in southeastern Massachusetts. Wildlife Society Bulletin 30: 695-702.

Way, J. G., I. M. Ortega, and E. G. Strauss. 2004. Movement and activity patterns of eastern coyotes in a coastal, suburban environment. Northeastern Naturalist 11: 237-254.

Way, J. G., and D. L. Eatough. 2006. Use of "micro"-corridors by eastern coyotes (*Canis latrans* var.) in a heavily urbanized area: implications for ecosystem management. Canadian Field-Naturalist 120(4): 474-476.

Way, J.G., and B.C. Timm. 2008. Nomadic behavior of an old and formerly territorial eastern coyote, *Canis latrans*. Canadian Field-Naturalist 122(4): 316-322.

Way, J. G., B. C. Timm, and E. G. Strauss. 2009. Coywolf (*Canis latrans* x *lycaon*) pack density doubles following the death of a resident territorial male. Canadian Field Naturalist 123(3): 199-205.

Way, J.G., L. Rutledge, T. Wheeldon, and B.N. White. 2010. Genetic characterization of eastern "Coyotes" in eastern Massachusetts. Northeastern Naturalist 17(2):189-204.

White, L.A., and S.D. Gehrt. 2009. Coyote attacks on humans in the United States and Canada. Human Dimensions of Wildlife 14:419-432.

Wilson, P.J., S. Grewal, I.D. Lawford, J.N.M. Heal, A.G. Granacki, D. Pennock, J.B. Theberge, M.T. Theberge, D.R. Voigt, W. Waddell, R.E. Chambers, P.C. Paquet, G. Goulet, D. Cluff, and B.N. White. 2000. DNA profiles of the eastern Canadian wolf and the red wolf provide evidence for a common evolutionary history independent of the gray wolf. Canadian Journal of Zoology 78:2156-2166.