



Initial colonization of Long Island, New York by the eastern coyote, *Canis latrans* (Carnivora, Canidae), including first record of breeding

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Abstract

Coyotes (*Canis latrans* Say, 1823) have increased their range dramatically over the past century. Formerly restricted to western North America, they now roam across the continent, in many habitats including large cities. One of the last areas in North America without coyotes has been Long Island, NY, a 3629 km² island in the New York metropolitan area. Here we summarize all verified accounts of coyotes on Long Island, including the first record of breeding. There are few coyotes on Long Island currently; however, given the history of coyote success, we expect coyotes to establish a growing population there in the near future.

Key words

Range extension; camera trap survey; urban ecology; coywolf.

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Introduction

The coyote (*Canis latrans* Say, 1823) has become nearly ubiquitous across North America, colonizing and flourishing in a diverse set of landscapes through Canada, the United States (US), Mexico, and continental Central America. From a historical range that spanned the prairies and deserts of central and western North America (Parker 1995), they are now found in nearly all terrestrial habitats, including temperate and boreal forests (Kays et al. 2008), sub-tropical and tropical forests (Hidalgo-Mihart et al. 2004), suburbs and exurbs (Gompper 2002, Atwood et al. 2004), and even dense urban centers (Gehrt 2007, Nagy et al. 2016).

New York City (NYC), one of the largest and most densely populated urban centers in the world, has been colonized only recently by coyotes (Toomey et al. 2012). The geography of NYC influences how coyotes are expanding their distribution throughout this metropolis. The southernmost region of New York State consists of the 5 boroughs of NYC—the Bronx, Manhattan, Staten Island, Queens, and Brooklyn (Fig. 1) as well as Long Island, the largest island in the contiguous US (3269 km²). The Bronx is the only mainland borough of NYC while Manhattan and Staten Island are 2 islands in New York Harbor, and Queens and Brooklyn lie on the western end of Long Island. East of Queens are Nassau and Suffolk counties which make up the central and eastern

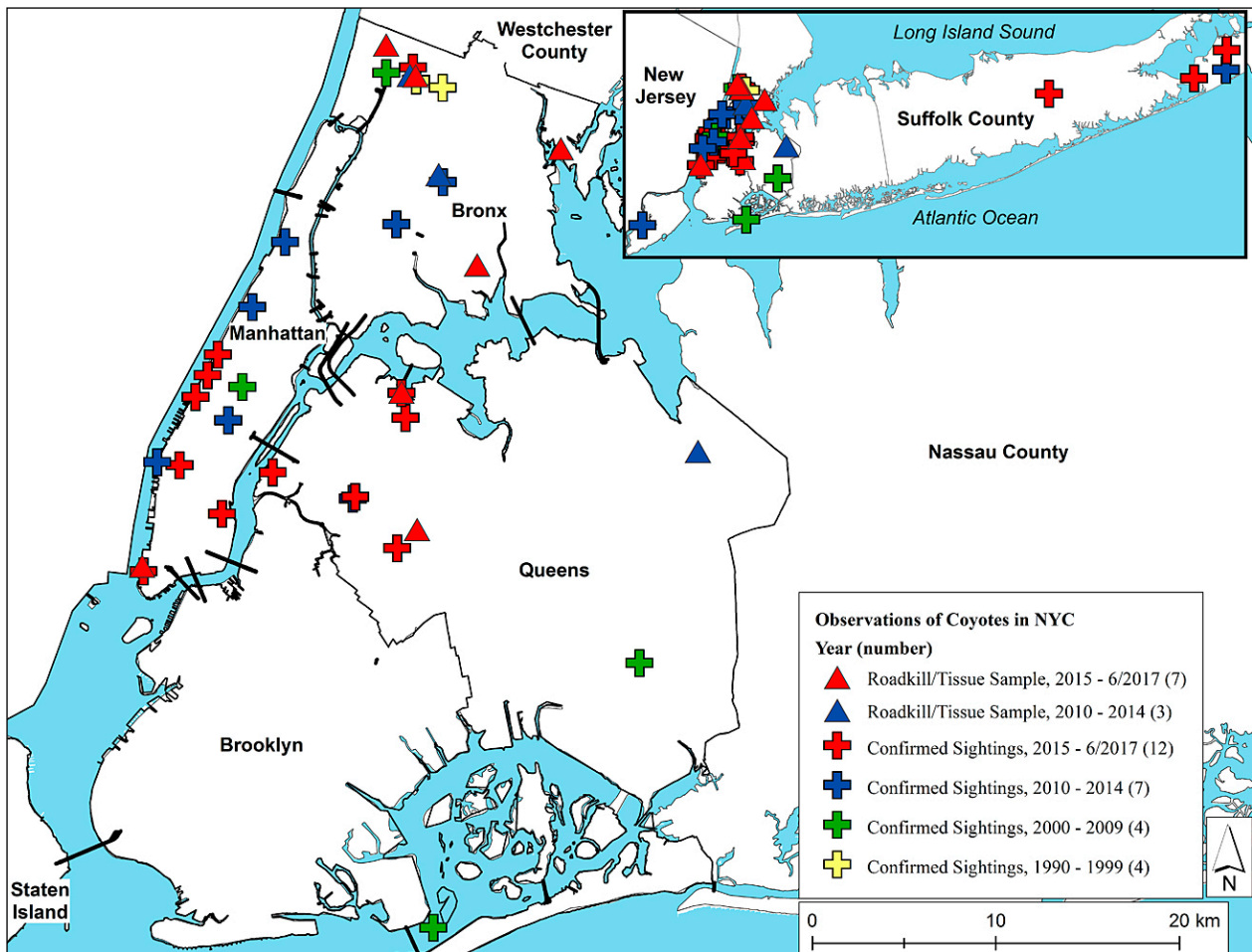


Figure 1. Verified sightings of coyotes in New York City and Long Island, 1990–June 2017. Reports of sightings were found in newspaper articles, local television news spots, or verified with a photograph and/or subsequent camera trap detection.

portions of Long Island. Nassau and Suffolk are not thought to presently support breeding coyotes, though recent sightings described below indicate that colonization is underway.

As the historic range of the coyote did not include New York State nor the northeastern US (Parker 1995, Fener et al. 2005, Kays et al. 2009, Wheeldon et al. 2010), the presence of coyotes in the region represents a large-scale range extension. Within New York State, coyotes gradually expanded southward from northern New England and/or New York's northern border with Canada, starting approximately in the 1940s until they were established in Westchester County, the county directly north of NYC, in the 1970s (Fener et al. 2005). This left NYC and Long Island the only regions of the Northeast without breeding populations of coyotes by the end of the 20th century. Rare sightings in the Bronx began in the late 1990s, and territory-holding, permanent residents have been documented only recently within NYC or Long Island (Toomey et al. 2012). By 2012 or possibly sooner, coyotes were breeding in 3 parks in the Bronx, with stable occupancy and breeding activity each year, and this number of breeding sites increased to 5 sites in 2014. However, only 1 individual was known to reside permanently on all of Long Island in a small park in Queens,

first photographed in 2009 by local residents and monitored from 2011 to the present by researchers (Nagy et al. 2016). More recent sightings and photographs placed another lone coyote in eastern Suffolk County (near 40.9607° N, 072.3423° W WGS84) from 2013 to early 2014 (R. Wesnofske, resident, and J. Stiller, New York State Department of Environmental Conservation, Stony Brook, NY, USA, 2014 pers. comm.). These 2 were the first confirmed records of coyotes on Long Island ever, but they were lone individuals and there has not yet been any evidence of successful breeding off of the mainland. Infrequent and unverified sightings of coyotes have been reported across Long Island for several years, but were never confirmed by researchers and may represent cases of mistaken identity, as the red fox, *Vulpes vulpes*, and gray fox, *Urocyon cinereoargenteus*, both live on Long Island, and domestic dogs, *Canis familiaris*, are common.

We have monitored the range expansion and site occupancy dynamics of the coyote in this area via camera traps, genetic sampling, and other methods. Here, we present a brief but timely report on the first record of a successful coyote den on Long Island, found in May 2016, along with other recent observations of coyotes in NYC, Nassau, and Suffolk.

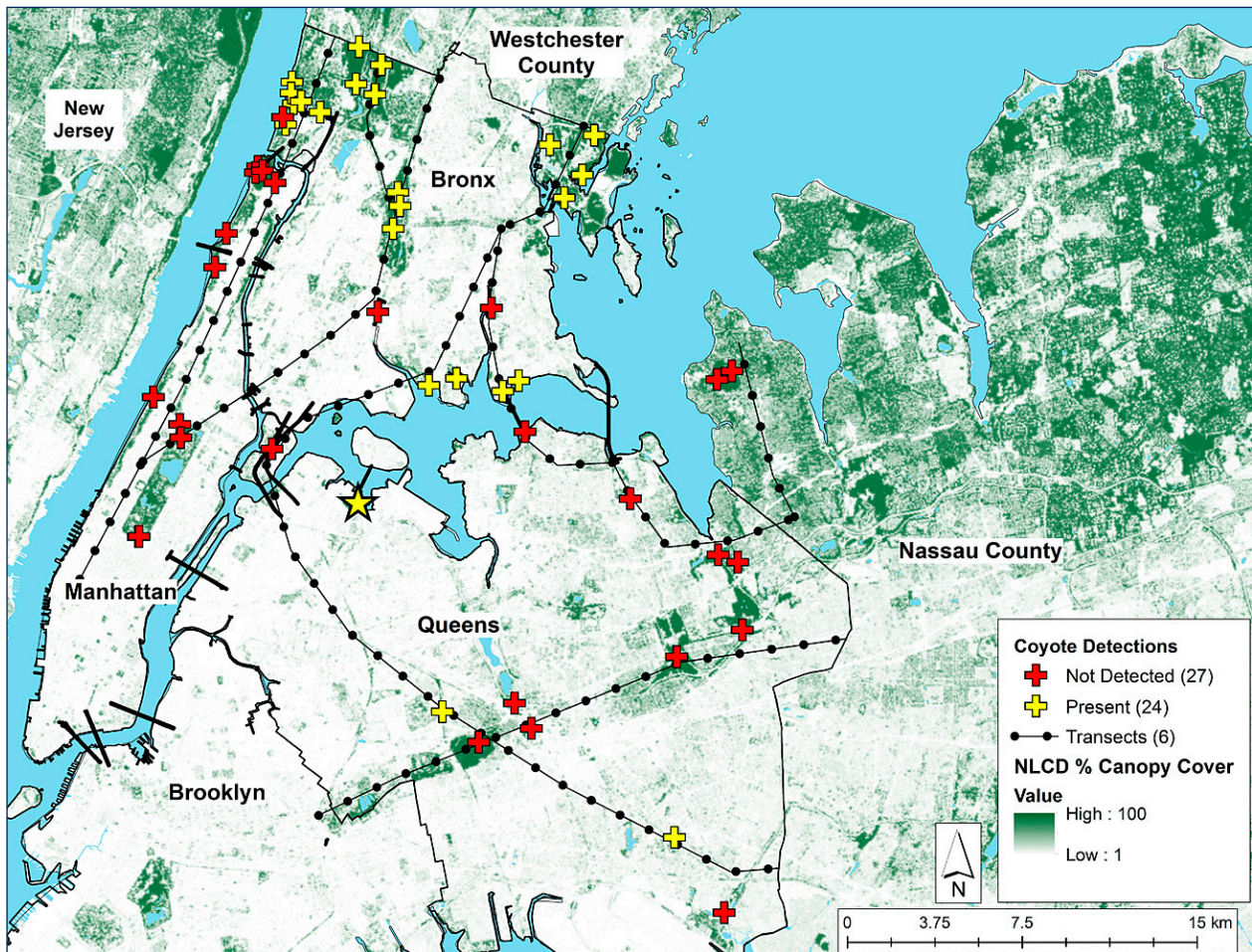


Figure 2. Camera trap locations placed along transects (dotted lines) and detections of coyotes (yellow cross: at least 1 coyote detection in 2016; red cross: no coyotes photographed in 2016; yellow star: site of breeding activity/pups photographed in 2016), mapped over National Landcover Database Tree Canopy Layer, New York City, 2016.

Methods

We used camera traps to monitor coyotes and other wildlife in NYC (40.730° N, 073.935° W WGS84) since 2011, typically in the protected, wooded parks located throughout the city. Procedures and site selection from 2011–2014 are detailed in Nagy et al. (2016). We followed similar protocols in 2015, but in 2016 we deployed 51 Reconyx PC800, HC500, and RC55 cameras at 45 sites in a winter and a summer survey across the Bronx, Manhattan, and Queens to also search for coyotes in less “traditional” habitats, e.g., smaller parks, potential corridors, and developed open spaces such as golf courses and cemeteries. Using a protocol adapted from Magle et al. (2015), we established camera stations within 1 km of 5 transects that ran from the Bronx south and turned east into Long Island (Fig. 2). We chose the specific, on-the-ground location for each camera based on the availability of a suitable tree out of sight of passersby. We baited cameras with a fatty-acid scent lure (United States Department of Agriculture, Animal and Plant Health Inspection Service, Pocatello, Idaho). Our expansion into small, high human use, or manicured/developed areas addressed three objectives: 1) to attempt to find new occupied sites and corridors; 2) to establish a thorough

camera array in as many locations as possible in expectation of coyotes’ arrival to Queens and the rest of Long Island in the near future; 3) to broaden sampling of new habitats to improve our ongoing habitat and occupancy modeling efforts.

In addition to camera trapping, we solicited sightings of coyotes and coyote roadkill from city and state agencies, residents, and other local researchers. Hereafter, we use the term “unconfirmed sightings” for reports from residents that, to our judgement, appear reasonable but have no associated hard evidence (e.g., clear photographs, scat, or carcass from locations that could be verified). Unconfirmed sightings are mentioned only for description and are not presented as data points. We use the term “confirmed sightings” for photographs we obtained that were taken by trusted local residents, media, government officials, or “unconfirmed sightings” that were later substantiated by our team via subsequent camera trap photographs or carcass recovery. Specimens—roadkill, scat, and tissue—were collected under New York State Department of Environmental Conservation Permit #1118 and, in the case of carcasses, deposited as vouchers at the American Museum of Natural History.

Results

In 2016, coyotes were detected via camera traps in 10 parks along transects and in 1 new location after following up on unconfirmed sightings (Fig. 2). We identified the animals as coyotes based on these photographs. Discrimination between eastern coyotes and domestic dogs was based on overall appearance: erect ears, shape of head and snout, shape and size of tail, body proportions, and pelage patterns (Bekoff 1977, Larrucea et al. 2007). Red and gray fox are present in the region but are easily distinguished from coyotes in the vast majority of camera trap photographs. No other free-roaming canids exist in the region.

In May 2016, adult coyotes caring for several small pups were photographed by camera trap (Fig. 3) in a narrow wooded strip bordering a baseball field and parking lot in northern Queens (40.7765° N, 073.8901° W WGS84). These camera trap photographs of pups represent the first confirmed observations of successful breeding on Long Island. Additional unconfirmed sightings suggest that this breeding pair had likely been established for several years before researchers detected them (G. Dugan, Queens resident, pers. comm.), likely living in a nearby 7.64 ha woodlot (40.7755° N, 073.8934° W WGS84) that was developed into a parking lot from 2014 – 2016. The parking lot was opened in the spring of 2016, which apparently ousted the coyote family from its selected denning area and, as the pups were still very young, forced them to move to the closest available habitat patch.

In August 2016, the Port Authority of New York and New Jersey, which owns the properties the coyotes were using, decided to eradicate the family. This decision was officially made by the Port Authority due to the perceived “potential threat to our employees and members of the community, including children who use nearby baseball fields” (Port Authority of NY and NJ, quoted by Colangelo 2016). Also cited was evidence that some residents were feeding the coyotes directly and indirectly (e.g., via the abundance of litter and feral cat feeding stations in the area). The Port Authority and USDA Wildlife Services attempted to haze the coyotes away from the area but this was performed in summer, likely before the pups were mature enough to disperse from the area. No aggressive encounters between people and the coyotes were reported and the decision to lethally remove the animals was controversial. Public opinion and media coverage included support for leaving them alone (Chan 2016, Cook 2016, Colangelo 2016, Durkin 2017); focusing on education, coexistence, and developing consistent wildlife management policy (Munshi-South 2016); or relocating them (Furfano et al. 2017). Local activists were involved on the ground and in the larger political arena: some conducted hazing of coyotes and educational outreach in an attempt to undo the harmful behavioral conditioning brought on by the feeding (Furfano et al. 2017); others unsuccessfully attempted to find wildlife sanctuaries willing to take the remaining animals (Chan



Figure 3. Example camera trap photographs showing first confirmed evidence of successful breeding of coyotes on Long Island, New York. The male and lactating female are rearing at least four pups. Researchers directly observed 8 pups and 2 adults later in the summer.

2016, Durkin 2017), although NYS Department of Environmental Conservation typically prohibits relocating “nuisance” wildlife. The situation was also complicated by perceived conflicts with feral cats (Lahmers 2016), some of the coyotes setting off perimeter alarms at the nearby prison, and Port Authority and Riker’s Island Prison Complex employees feeding coyotes in the same locations that these agencies sought to keep the coyotes out of. By the end of 2016 USDA Wildlife Services had euthanized 10 out of the 11 coyotes in this group, leaving 1 juvenile still alive in the area. The carcasses were accessioned permanently at the American Museum of Natural History (specimen vouchers AMNH 279593 to 279602).

Confirmed sightings and camera trap observations elsewhere in Queens and Long Island also occurred in 2016 (Figs 1, 2). A lone coyote has been reported in the Southampton area of Suffolk County since 2013, and was last photographed in March 2017 (N. Zaino, resident; Fig. 1). Additionally, a pair of coyotes was photographed in Middle Village in Suffolk County in December 2016

near 40.8801° N, 072.9741° W WGS84. This sighting is the first report of a pair of coyotes in eastern Long Island.

Discussion

Nagy et al. (2016) noted a contrast between the rapid spread of coyotes in the Bronx and the relatively unchanging status (i.e., only 1 known resident and no breeding activity) of Queens and Long Island from 2011 to 2014. Confirmed sightings and news reports tell a similar story: from 1990 to 2009 there were only 8 confirmed coyote sightings by news media or researchers on Manhattan, Staten Island, and all of Long Island; and from 2010 to June 2014 there were 7 confirmed sightings—still fewer than 2 confirmed sightings per year in an area inhabited by over 9 million people. After 2015, however, confirmed sightings in Manhattan and Queens increased to several each year (Fig. 1). The camera trap observations reported here represent the first ever record of breeding by coyotes on Long Island or any area of NYC outside the mainland. As of early 2017, coyotes remain rare in Long Island.

This breeding event surely is only the first step in the colonization of the last large coyote-free area in the Northeast US. Long Island resembles the mosaic landscape with early-successional and mature forests, meadows, and suburban areas that coyotes have successfully exploited throughout the eastern US. In particular, the north shore of both Nassau and Suffolk counties have large tracts of protected open space and, farther east, the land use of Suffolk County generally spans a spectrum from suburban to rural. The densely urban matrix of NYC and the surrounding waters have prevented coyote establishment on Long Island, but our research since 2010 (see Weckel et al. 2010, Nagy et al. 2012, Nagy et al. 2016) strongly indicates that this is a temporary delay.

The lethal removal strategy used on the Queens coyote family group is likely not a long-term nor scalable management plan. Historically, total eradication of coyotes from a large area has proven very difficult or impossible and coyote numbers can quickly rebound after removal efforts have ceased (Knowlton et al. 1999, Sacks et al. 1999, Gulsby et al. 2014). Public opinion, even in urban areas, is largely against broad-scale lethal removal of coyotes and other wildlife (Elliot et al. 2016). Other studies have found that, excepting cases of food-conditioning, urban and suburban coyotes tend to shift their activity to be largely nocturnal, concentrate their activity in open spaces, maintain a largely non-anthropogenic diet, and avoid humans (Atkinson and Shackleton 1991, Quinn 1997, McClennen et al. 2001, Tigas et al. 2002, Riley et al. 2003, Atwood et al. 2004, Morey et al. 2007, Gehrt et al. 2009, Lombardi et al. 2017). In this case, we received numerous—albeit unconfirmed—reports that this pair of coyotes had lived and bred for several years in the original 7.64 ha woodlot and, we speculate, only became visible to officials and the larger community once their territory was developed and they were forced to move their 8 young pups out of the woodlot. Also, coyotes are

one of the few predators that can thrive in developed environments and thus may fill a valuable ecological role (Rogers and Caro 1998, Henke and Bryant 1999, Crooks and Soule 1999, Cherry et al. 2016). Managers and officials should thus implement management policies that focus on coexistence, public education, aversive conditioning, and conservation ethics rather than broad-scale lethal removal, although targeted lethal removal needs to remain an option for genuine problem animals. Education focused on why feeding wildlife is dangerous for both people and animals is vital, and feeding coyotes and other wildlife should be prohibited and such bans should be enforced.

The events surrounding the group of coyotes in northern Queens highlight the many challenges of managing urban species in a large city such as NYC: wide ranging opinions, myriad private and public interests, several agencies at different levels of government with competing duties and priorities, a large local media, and lack of any substantial prior experience in managing top predators. NYC has begun to build a more comprehensive wildlife management plan with the establishment of three initiatives: 1) a new wildlife management team within the NYC Department of Parks and Recreation, 2) several outreach and education programs targeted at communities that have coyotes or a high likelihood of soon having coyotes (as well as other species), and 3) the WildlifeNYC campaign launched in 2016.

The colonization of NYC and Long Island by coyotes is also an opportunity for gaining knowledge on ecological and conservation issues in urban areas (Weckel et al. 2015, Weckel and Wincorn 2016). Important knowledge gaps include how coyotes move through the urban matrix within NYC and across Long Island and, similarly, how they are entering Long Island. Other studies have found that coyotes use backyards, power line right-of-ways, railroads, and other “green strips” to move between larger habitat patches (Way et al. 2004, Way and Eatough 2006, Gese et al. 2012); we expect such features to be important corridors in New York City as well. As for entering Long Island, both crossing the heavily trafficked bridges or swimming across the Long Island Sound appear challenging to individual coyotes and this has likely limited the rate of dispersal to and colonization of Long Island (see Nagy et al. 2016 for further details on potential crossings). Additionally, since any coyotes in Long Island are very likely part of the broader hybrid swarm of northeastern coyotes (Monzón et al. 2014), we are in the process of determining the proportion of coyote, wolf, and dog ancestry in the roadkill samples and the 10 carcasses from the Queens family group. Further long-term research and management objectives include investigating the population and meta-population dynamics of coyotes in the region, exploring the ensuing community and food web effects of the reestablishment of a mid-sized top predator (Thompson and Gese 2007, Levi et al. 2012), and developing strategies to foster human-wildlife coexistence (Weckel et al. 2015).

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Authors' Contributions

CN, MW, JM, and MR wrote the manuscript. CN processed data and maps. CN, MW, and ND deployed camera traps and collected specimens. ND managed permits and specimens.

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