FIELD REPORT 2010

New York City Wildlife

Project scientists
Dr. Catherine Burns

Country
United States of America

Research site / region
New York, United States (research in natural areas within 100 miles of New York City)

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Report completed by
Catherine Burns

Hello New York City Wildlife volunteers!

I hope this letter finds you happy and healthy and reflecting fondly on your experiences with us in New York. As you will see from the report, we've managed to accomplish quite a lot! None of it could have happened without your enthusiastic contributions, suggestions, and just plain hard work. I can't say thank you enough to adequately express my appreciation for your investment in our project. Each of the expeditions achieved the goals we set at the beginning of the project, and we have amassed an incredible amount of high-quality, interesting data as a result. Among other things, our data show that many amphibian, bird and mammal species appear to be quite sensitive to increasing urbanization (although some species are not). In addition, our plant surveys highlighted the important role that invasive plant species may be playing in parks in urban regions, showing a very strong pattern of increased invasive species abundance near park edges compared to that found within park interiors. This has particularly important implications for management of communities in small parks, or in very long, narrow parks, where much of the total area is in fact “edge” habitat.

A few of the highlights of the 2010 field season included: 1) documentation of 13 species of amphibians including the dusky salamander which was a new species for our study, 2) “capture” of coyote, black bear and many other mammal species using camera-traps and track tubes, and 3) documentation of an impressive 200+ species of native and non-native plants. It was a very productive and fun field season! In addition to your diligence in collecting the data for this project, each of you brought to the expedition your own personal interests, skills and experiences. Learning from each of you as we got to know you over the course of the week, and hearing about other adventures you've had, was one of the most rewarding parts of the field season for the staff. It is exciting to see how much we have accomplished as a team, and even more exciting to consider what more we will discover as we continue to analyze the three years of data from this project (a process that will continue for some time to come). Feel free at any time to touch base for an update.

Take care, and again, thank you.

Cat Burns

Principal Investigator, New York City Wildlife Project

Photo 1: Fisher, Catskills' Bluestone Wild Forest

Top highlight from the past field season

Downloading the images from our wildlife cameras is always one of the more exciting times of our field season. You never know what you're going to find, and there's almost always something exciting. This year, we were thrilled to "capture" images of black bear at one of our rural sites (Overlook Mountain Wild Forest) and coyotes at one of our suburban sites (Rockefeller State Park). Documenting the presence of these animals in the New York metropolitan area (i.e. within 100 miles of Manhattan) reminds us all of the conservation potential that still exists in even the most urban corners of the world.

Photo 2: Black bear, Black Rock Forest

Non-technical overview of results

During 2010, the “New York City Wildlife” project, funded by a grant from the Earthwatch Institute to Dr. Catherine Burns was organized and carried out by a diverse team of staff research scientists (8 people), volunteers (24), park managers (8), and student interns (2), with a total of 42 participants during the 2010 field season. Project participants included volunteers and staff from across the continental USA, as well as those from other countries, including Japan, Austria, the United Kingdom, and Germany. This meant that each of the research teams was made up of a group of people with diverse interests and experiences, which added immeasurably to the atmosphere and overall team experience.

As in 2008 and 2009, our primary research objective during the 2010 field season was to assess the abundance and diversity of amphibians, birds, mammals and plants at a suite of protected areas in the greater New York metropolitan area representing the gradient of urbanization from extremely urban to relatively remote, rural protected areas. Our research was focused on gathering information to address the following questions:

1) What are the human impacts on biodiversity along an urban-suburban-rural gradient?
2) Are there thresholds of urbanization and land use change beyond which species of concern cannot exist?
3) Do amphibians, birds, mammals and plants respond differently to urbanization?
4) Are there land use strategies that facilitate the coexistence of nature and people?
5) Are there specific habitat types and other features of protected areas within urban regions that are particularly important for supporting biodiversity?

While fully answering each of these questions will require additional data analysis now that the full three field seasons have been completed, I will highlight our key findings to date in this report. During 2010, we surveyed plants and animals at eight parks along a 100 mile urbanization gradient stretching generally north from NYC, including: Fahnestock State Park, Rockefeller State Park, Forest Park, Alley Pond Park, California Hill State Forest, Stewart State Forest, Taconic-Hereford State Forest, and Overlook Mountain Wild Forest. Below I provide summary information for each of the taxonomic groups surveyed by the Earthwatch expeditions in 2010, and an assessment of our key findings over the past three years. Detailed analyses of these data to be conducted in 2011 will allow us to more comprehensively address the questions above and to begin to publish the results of this work.

Amphibians: Amphibian surveys were conducted at seven parks (at a total of 37 ponds) by the 2010 Earthwatch team (128 total ponds surveyed during the three years of the study). For all 2010 parks combined, a total of 13 different amphibian species were identified (16 species total for all three years combined), and over 600 larval and adult individuals were captured and released (3275 for all surveys to date). The number of different species (species richness) and the number of individuals of each species (abundance) varied substantially from one park to the next, with both richness and abundance tending to increase as the distance of the park from Manhattan increased. Amphibian species richness was very strongly positively correlated with the percent forest cover within 1 and 5 km of park boundaries ($p<0.001$; Fig 1). Similarly, amphibian abundance was highly positively correlated with the percent forest cover surrounding each park ($p<0.01$; Fig 2). Given these relationships, it was not surprising that we also found a strong negative relationship between amphibian species richness (but not abundance) and the density of people within 1 km of park boundaries ($p<0.001$). Each of these relationships indicates that amphibians are very strongly negatively impacted by increasing urbanization. Further, our results suggest that the response of amphibians to urbanization is generally linear, with no strong threshold effects apparent. Interestingly, amphibian species richness and abundance were not significantly correlated with the size (area) of a park. The landscape context, specifically the degree of land use change, was a much more important determinant of amphibian richness and abundance.

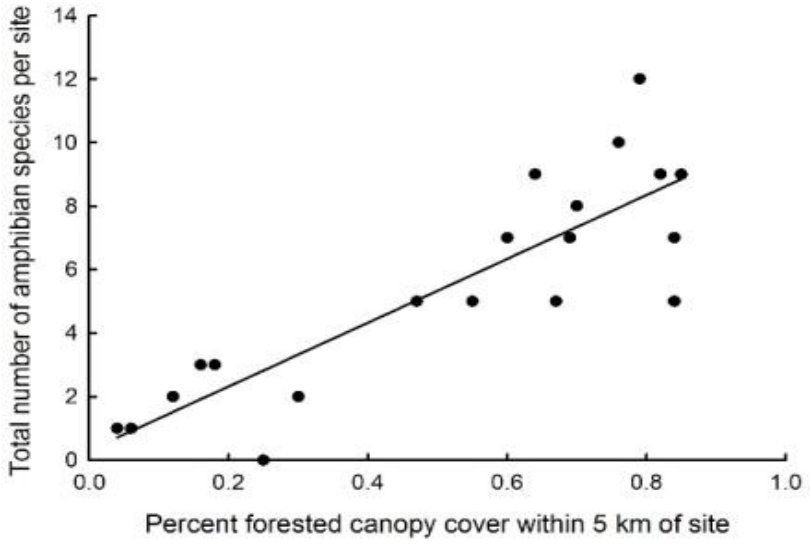

Figure 1: Amphibian richness increases sharply with increasing forest canopy cover within 5 km of park boundaries ($p<0.001$).

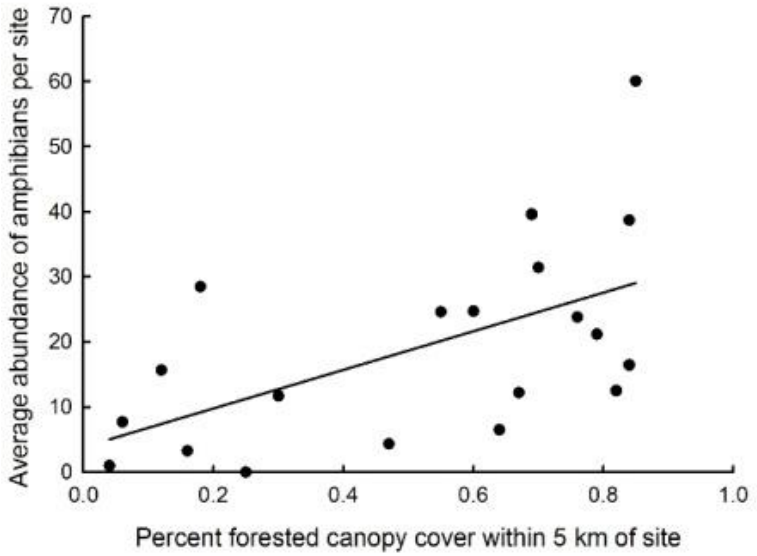

Figure 2: Amphibian abundance (mean abundance per pond) increases with increasing forest canopy cover within 5 km of park boundaries (p=0.009).

The amphibian species detected by our surveys ranged from fairly common species found at most parks (e.g. wood frogs (*Rana sylvatica*), spring peepers (*Pseudacris crucifer*)) to less common species like the pickerel frog (*Rana palustris*), and slimy (*Plethodon glutinosus*) and dusky salamanders (*Desmognathus fuscus*) (found primarily at our most rural parks). The species found during surveys of each park, and the number of larval and adult individuals,. Egg mass counts were also conducted and followed similar patterns to those shown for larvae and adults (data not shown).

Several of the amphibian species that we found during our surveys are of conservation concern and/or have ecological importance. Both the blue-spotted salamander (*Ambystoma laterale*) and the marbled salamander (*Ambystoma opacum*) are considered species of special concern in the state of New York. Dusky salamanders are listed as “declining” in Connecticut, and other studies have suggested that they are sensitive to land use changes associated with urbanization. Further, wood frogs and spotted, blue-spotted and marbled salamanders are widely used as vernal pool indicator species --their presence is believed to indicate general ecosystem health. In some states (e.g. MA, ME) the presence of these species certifies a vernal pool for certification/protection. In addition to being reliable indicator species, amphibians also provide important functions in a healthy ecosystem, including playing a strong role in nutrient cycling and forming an essential prey base for invertebrates and many wildlife species such as birds, snakes, turtles and raccoons.

Birds: Avian communities were not surveyed during 2010.. However, successful surveys conducted during 2008 and 2009 give us a good picture of the response of birds to urbanization. Surveys were conducted using visual and auditory point-counts at each of ten parks. At each park, 10 points were surveyed that were classified as “interior” points (those more than 150 m from park boundaries) and 10 points that were classified as exterior, or “edge” points (those less than 150 m from a park boundary). Each survey lasted 15 minutes, for a total of 300 survey minutes per park. The bird teams identified a total of 106 species during combined 2008 & 2009 surveys; (Appendix 2). The bird species detected ranged from

very common species, such as the American Robin (*Turdus migratorius*), American Goldfinch (*Spinus tristis*) and Blue Jay (*Cyanocitta cristata*), to rarer species only detected at one or two parks (e.g. Blackburnian Warbler (*Dendroica fusca*), Black-throated Blue Warbler (*Dendroica caerulescens*), and Cerulean Warbler (*Dendroica cerulean)).* Several of the bird species identified during our surveys have conservation status in the state of New York, including threatened species such as the Least Tern and Common Tern and species of special concern such as the Osprey (*Pandion haliaetus*) and Cerulean Warbler.

Based on combined data from 2008 & 2009, avian richness did not appear to be strongly impacted by urbanization as approximated by the distance of parks from Manhattan ($p>0.05$; see Fig 3, left panel), and was not strikingly different for edge vs. interior points (data not shown). Avian species richness was also not significantly correlated with other indicators of urbanization, such as the percent forest cover within 1 or 5 km, nor with the area of a park ($p>0.05$). Avian species richness was also not significantly correlated with elements of the understory plant community, such as plant richness or the percent understory plant cover ($p>0.05$).

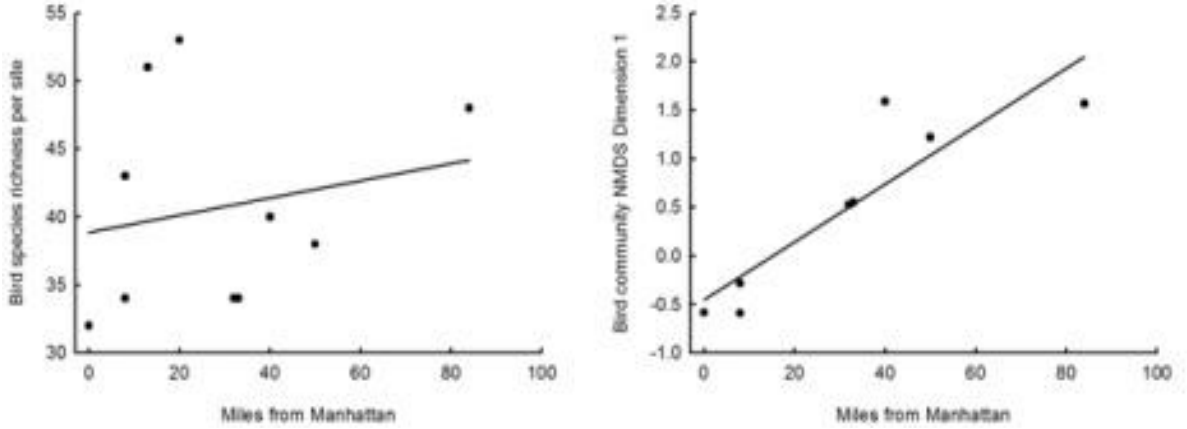

Figure 3: Left panel: Bird species richness is not strongly correlated with the distance of a park from Manhattan ($p>0.05$), with each point representing the bird community at one study site. Right panel: Significant variation in bird community composition as a function of distance from Manhattan ($p<0.05$).

However, the species composition (i.e. what bird species are found at each park) varied substantially from park to park. Non-metric multidimensional scaling (NMDS) analysis, which estimates “distances” between parks based on similarities and differences in bird community composition, revealed that much of the variation in bird community composition among parks could be explained by the location of a park along the urbanization gradient (see Fig 3, right panel). This provides a clear indication that although the number of different species at a park may not be strongly impacted by urbanization, the types of species found in a given location are significantly shaped by urbanization. This is an important distinction to make, as many conservation initiatives are based primarily on the number of species within an area and not on the composition of the community in an area.

Mammals: Mammals were surveyed at each of eight parks during 2010 using two different methods, camera-trapping for medium to large-bodied mammals, and track-tubing for small mammals. Five camera traps were set up at each park for 48 hours (240 total camera-trap hours per park). Camera trapping images documented the presence of 15 different mammal species, ranging in size from white-footed mice (*Peromyscus leucopus*) and eastern chipmunks (*Tamias striatus*) to white-tailed deer (*Odocoileus virginianus*) and black bears

(*Ursus americanus*) (Appendix 3). Several species were detected at all or most parks, such as the ubiquitous white-footed mouse, gray squirrel (*Sciurus carolinensis*) and raccoon (*Procyon lotor*), while other species were only found at a subset of parks (e.g. coyote (*Canis latrans*) at Rockefeller S.P., black bear at Black Rock Forest and Overlook Mtn. Wild Forest, and fisher at the Catskill's Bluestone Wild Forest). Not surprisingly, the rarer species and those requiring larger home ranges tended to be limited in distribution primarily to the most remote of our parks (see Appendix 3).

Photo 3: Raccoons, Taconic-Hereford State Forest.

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Track-tubing surveys targeting smaller-bodied mammals were conducted along 10 transects (5 interior and 5 edge transects) within each of the eight study parks for 2010. A track-tube was set every 15 m along each 150 m long transect (for a total of 100 tubes per park). Track-tubing records positively identified at least six mammal species (see Appendix 4). The majority of tracks recorded were those of white-footed mice and gray squirrels, with an intermediate frequency of eastern chipmunk and raccoon tracks detected (see Table 1). Due to the similarity in tracks between red-backed voles (*Clethrionomys gapperi*) and white-footed mice, we cannot at this stage rule out the possibility that a few of the tracks attributed to white-footed mice were made by voles. Likewise, similarities between red squirrel and gray squirrel tracks may have led to a minority of red squirrel tracks being identified as gray squirrels. To be conservative (and based on earlier live-trapping records from this region), at this point we are assuming that “mouse-like” tracks were made by white-footed mice and “squirrel-like” tracks by gray squirrels.

In combination, these two survey methods allowed us to document the presence of at least 16 species of mammals at our parks. These surveys showed that even the most urban parks supported mammal populations of several common species, and that larger and rarer species of mammals could be found at a number of our suburban and rural parks, including foxes and coyotes within 30 miles of Manhattan, black bears within 50 miles and fisher within 100 miles. Although none of the mammal species surveyed are federally or state-listed as endangered, threatened or of special concern, many of these species play important roles in their ecosystems. Species with large home range requirements such as bear, fox and fisher can provide a good indication of an ecosystem's integrity.

The small mammal community serves as an important prey-base for many predators, an important disperser of seeds in healthy systems, as well as vectors of diseases that impact people, such as Lyme disease. Within the small mammal community in the New York metropolitan area, the white-footed mouse is the most numerically dominant across the urbanization gradient, and has been shown to be one of the most highly competent reservoirs for Lyme disease. As such, we decided to take a closer look at urbanization's impacts on this species and particularly on the relative abundance of this species across the urbanization gradient. By relative abundance, I refer to the proportion of the small mammal community (all species combined) that is made up of white-footed mice.

Our data showed that there are relatively more white-footed mice in rural areas than in urban or suburban areas. Correspondingly, the relative abundance of white-footed mice is strongly positively associated with the percent forest cover surrounding a park (p=0.001, Fig 4), and negatively associated with the density of people (p=0.026). The relative abundance of mice was not, however, significantly correlated with park area, the percent cover in the understory plant community, nor understory plant species richness.

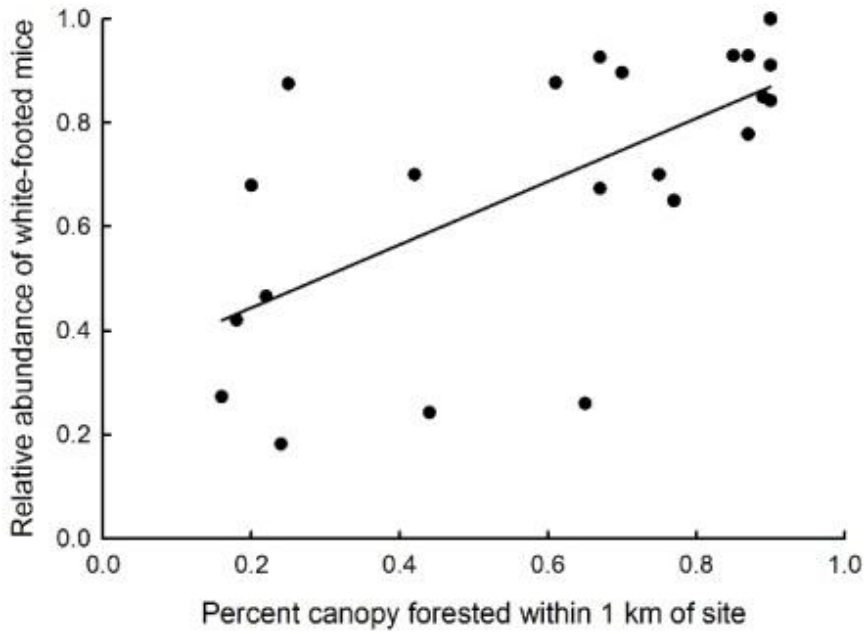

Figure 4: Relative abundance of white-footed mice (*Peromyscus leucopus*) increases with increasing forest canopy cover within 1km of park boundaries (p=0.001).

These results are intriguing, since our assumption (based on published literature) was that there would be a greater diversity of small mammal species at the most rural sites, and that no single species would dominate those communities. In contrast, we expected that white-footed mice, which are generalists capable of thriving under nearly all conditions, would dominate urban and suburban sites. Our findings show the opposite to be the case, with nearly all recorded tracks at rural sites belonging to white-footed mice, and a more even distribution of tracks across many species at our suburban and urban sites. To clarify why the small mammal communities are responding in this way to urbanization, our next step is to compare the characteristics of parks that support relatively more of the other species of small mammals with those parks that support nearly 100% white-footed mice.

Note: our camera-trapping and track-tubing surveys do not capture images of every mammal species found within a park. Instead, they allow us to compare general patterns of mammal composition and richness among parks, and when used in combination with current lists of mammal species sighted maintained by the parks (in progress), will allow us to further statistically evaluate changes in mammalian communities along this urbanization gradient.

Plants: Native and non-native understory plant species were surveyed using two methods along four transects within each of six parks during 2010. First, the abundance of three invasive species: Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculatus*), and multiflora rose (*Rosa multiflora*) was assessed along the length of four 150 m transects within each park (sampling a total area of 600 m2 per park). Two transects were located within the park interior and two along the park edge. The abundance of these three targeted invasive species ranged from a total of 0 individuals at Overlook Mtn Wild Forest to nearly 400 individuals at Rockefeller State Park (see Table 2). When looking at all three years of plant data, we can see that different invasive species dominated different parks --for example, bittersweet was highly abundant at Inwood Hill Park, Van Cortlandt Park, and Rockefeller State Park, while barberry was largely absent at these sites but was often found at more rural and suburban sites.

Although we did observe species-specific differences in the response to urbanization, in general the abundance of invasive plant species tended to increase with increasing urbanization (closer to Manhattan). Invasive species abundance was also influenced by whether transects were in edge or interior locations. At 17 of 20 parks surveyed, the abundance of these three target invasive species was higher along park edges than in the park's interior. Although invasive species were fairly common along park edges at nearly all parks, the abundance of invasive species found on interior transects declined markedly the farther a park was from Manhattan. This information provides a compelling indication that invasive plants are likely to be a much bigger problem in general for parks with greater edge area relative to interior (i.e. small parks, or those that are long and narrow), and that even rural parks are susceptible to invasion along park edges though interior regions may remain protected.

Photo 4: Coyote, Rockefeller state park.

Native and non-native understory plants were also surveyed comprehensively within 2 x 2 m plots stationed at three points along each of the four plant transects described above (for a total of 12 plots sampled per park). Within each plot, every plant species was identified and the percent cover of each was recorded. When species could not be identified in the field, a voucher specimen was taken for preservation and later analysis at the New York Botanical Garden. Although these “unknown” species are still being identified, and hence the final species lists for these parks are still being fine-tuned, our data indicates that the plant teams identified over 200 different plant species. Once all unknown plants are identified, final species lists will be provided to all parks as well as to interested project participants.

In general, our plant surveys indicate that overall plant species richness decreases with increasing distance from Manhattan. In other words, increasing urbanization appears to have a positive impact on the number of different plant species found in an area (likely due to enhanced numbers of non-native species). The percent cover of vegetation observed in a plot, a measure of how dense the understory is, also appears to increase as the degree of urbanization increases.

When we compare plant community species richness and percent vegetation cover for plots along edge versus interior transects, a general pattern emerges that mirrors that found for the targeted invasive species surveys. Both species richness and vegetation cover are generally, but not always, higher on edges than in interior park regions. This is particularly striking for the urban and suburban parks, and less so for the rural parks, where the “edges” do not mark such strong transitions between natural and man-made habitats. Again, this identifies potentially important differences in plant communities in parks dominated by “edge” areas, and those with larger, intact interior regions.

Summary: This project was completed with the input of thousands of staff and volunteer hours and represents one of the first ever studies that compares the responses of different types of organisms to urbanization. Although fully answering the questions we posed in the beginning of this document requires further data analysis, and in some cases additional data collection beyond the scope of this study, we have made significant strides towards a better understanding of urbanization's impacts on New York's animals and plants. Not surprisingly, for most of the taxonomic groups that we studied, we found evidence of the impacts of urbanization. Although different organisms were affected by urbanization in different ways - some groups showed reduced population numbers or declines in species richness while others instead showed differences in species composition across the urbanization gradient - all of these groups were in significant ways shaped by urbanization. Urbanization had strong impacts on amphibians via negative effects on abundance and richness, on birds and mammals via modification to species composition, and on plants, most strongly apparent in changes in the abundance of invasive species within park interiors.

We did not find evidence of strong threshold effects in any of the taxa that we studied. Most of the responses that we observed to increasing urbanization were linear. This lack of a threshold level of urbanization beyond which most species are compromised suggests that there is considerable potential for conservation in the New York metropolitan region and others like it. Although plant and animal communities within the metropolitan area have undeniably been negatively impacted by the pressures of urbanization, these parks without exception supported a surprising diversity of plants and animals thriving in their midst. For these reasons, we recommend further resources be devoted to protecting nature in urban areas - these systems can be surprisingly resilient and represent a key opportunity to not only protect nature, but to better involve people in the process.

Acknowledgments: Many thanks to the fantastic volunteers, field staff, and Earthwatch support staff who all worked hard to make this project successful. Also, thanks to the staff at each of the parks that we worked at, without whose support the project would not have happened.

TABLES AND APPENDICES

Table 1. The relative abundance of small mammal species' tracks detected during track-tube surveys. Values of relative abundance range from 0 to 1, with higher values indicating a greater relative abundance of that species.

Site		White-footed mouse	Gray squirrel	Raccoon	Eastern chipmunk	Northern short-tailed shrew	Domestic cat
Alley Pond Park	2010	0.18	0.58	0.21	0.03	0	0
Black Rock Forest	2008	0.93	0	0.04	0.04	0	0
Blue Mountain Park	2009	0.65	0.32	0.03	0	0	0
California Hill State Forest	2010	0.84	0.11	0.05	0	0	0
Catskills (Bluestone W.F.)	2009	1	0	0	0	0	0
Central Park	2008	0.27	0.34	0.2	0.18	0	0
Clarence Fahnestock S.P.	2010	0.91	0.07	0.02	0	0	0
Forest Park	2010	0.47	0.41	0.12	0	0	0
Gateway N.R.A.	2009	0.89	0	0.05	0.07	0	0
Great Swamp N.W.R.	2008	0.9	0.03	0.05	0.01	0.01	0
Harriman State Park (N)	2008	0.67	0.14	0.14	0.02	0.02	0
Harriman State Park (S)	2009	0.7	0.25	0	0.05	0	0
Inwood Hill Park	2009	0.42	0.58	0	0	0	0
Marshlands Conservancy	2008	0.24	0.52	0.09	0.15	0	0
Mianus River Gorge	2009	0.85	0.11	0.02	0.02	0	0
New York Botanical Garden	2008	0.88	0.04	0.01	0.07	0	0
Overlook Mtn Wild Forest	2010	0.88	0.05	0.03	0.02	0.03	0
Pelham Bay Park	2008	0.68	0.11	0.09	0.1	0.01	0.01
Rockefeller State Park	2010	0.93	0.02	0.02	0.04	0	0
Saxon Woods Park	2009	0.26	0.52	0.03	0.18	0	0
Taconic Hereford S.F.	2010	0.93	0.02	0.06	0	0	0
Van Cortlandt Park	2009	0.7	0.26	0.04	0	0	0
Ward Pound Ridge Res.	2008	0.78	0.07	0.11	0.04	0	0

Table 2. The abundance of three invasive plant species (Japanese barberry, Oriental bittersweet and multiflora rose) along fixed transects.
*Recorder only reported the total number of invasive species for all transects.

Site	Year	Combined Invasive Species Abundance	Edge Transect Invasive Abundance	Interior Transect Invasive Abundance	Japanese Barberry Abundance	Bittersweet Abundance	Multiflora Rose Abundance
Alley Pond Park	2010	13	41	9	1	11	1
Black Rock Forest	2008	58	58	0	26	32	0
Blue Mountain Park	2009	9	7	2	9	0	0
California Hill State Forest	2010	1	1	0	0	1	0
Catskills (Bluestone Wild Forest)	2009	0	0	0	0	0	0
Central Park	2008	42	9	33	0	27	15
Clarence Fahnestock S.P.	2010	10	4	6	2	3	5
Great Swamp N.W.R.	2008	80	69	11	8	1	71
Harriman State Park (N)	2008	4	4	0	4	0	0
Harriman State Park (S)	2009	56	56	0	44	5	7
Inwood Hill Park	2009	204	102	102	0	163	41
Marshlands Conservancy	2008	50	45	5	1	7	42
Mianus River Gorge	2009	64	24	40	17	44	3
New York Botanical Garden	2008	107	106	1	0	70	37
Overlook Mountain Wild Forest	2010	0	0	0	0	0	0
Rockefeller State Park	2010	378	226	148	37	341	0
Saxon Woods Park	2009	11	9	2	0	11	0
Taconic-Hereford State Forest	2010	21	*	*	*	*	*
Van Cortlandt Park	2009	160	87	73	0	100	60
Ward Pound Ridge Res.	2008	126	118	8	111	15	0

Appendix 1. Summary of amphibian data, all years. Numbers indicate total numbers of adult and larval amphibians detected during timed pond and stream/terrestrial surveys (egg masses not included). Note that we found over 750 toad larvae in one pond at Jamaica Bay. This pond was an anomaly and was considered an outlier and removed for statistical analyses.

Site name	Year	Wood frog	American toad	Spotted salamander	Spring peeper	Green frog	Marbled salamander	Red spotted newt	Grey tree frog	Red/lead backed salamander	Two-lined salamander	Pickerel frog	Bull frog	Slimy salamander	Blue spotted salamander	Four-toed salamander	Dusky salamander	Total amphibian abundance
Alley Pond Park	2010	189	0	0	57	0	0	0	0	10	0	0	0	0	0	0	0	256
Black Rock Forest	2008	248	0	69	23	1	6	8	0	1	0	0	0	0	0	0	0	356
Blue Mountain Park	2009	200	1	15	8	0	24	1	0	0	0	0	0	0	0	0	0	249
Bluestone Wild Forest (Catskills)	2009	8	4	18	4	31	4	61	1	1	1	1	0	6	0	0	0	140
California Hill S.F.	2010	7	2	4	0	9	0	1	19	3	8	7	0	0	0	0	0	60
Central Park	2008	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Clarence Fahnestock S.P.	2010	0	1	37	30	25	15	12	2	0	2	1	0	0	0	0	0	125
Forest Park	2010	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
Great Swamp N.W.R.	2008	92	0	11	14	2	0	3	0	0	0	0	0	0	0	0	0	122
Harriman S.P. (North)	2008	44	13	58	33	0	2	3	0	0	0	0	0	0	2	2	0	157
Harriman S.P. (South)	2009	194	15	2	3	2	2	1	19	3	0	0	0	1	0	0	0	242
Jamaica Bay (w/ single outlier)	2009	0	759	0	0	0	0	0	19	0	0	0	0	0	0	0	0	778
Marshlands Conservancy	2008	0	0	0	0	17	0	0	0	18	0	0	0	0	0	0	0	35
Mianus River Gorge	2009	145	0	74	8	0	1	0	0	0	4	0	0	0	0	0	0	232

New York Botanical Garden	2008	0	0	0	0	5	0	0	0	6	2	0	0	0	0	0	0	13
Pelham Bay Park	2008	3	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	47
Rockerfeller S.P.	2010	1	0	0	0	2	0	0	0	2	7	0	1	0	0	0	0	13
Saxon Woods Park	2009	18	0	45	50	0	9	0	0	3	0	0	0	0	0	0	0	125
Stewart S.F.	2010	0	1	18	16	93	0	1	0	0	0	2	9	0	0	0	0	140
Taconic - Hereford S.F.	2010	1	0	4	1	1	0	1	0	1	2	1	0	0	0	0	1	13
Van Cortlandt Park	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ward Pound Ridge Reservation	2008	38	0	41	2	12	46	7	0	0	0	2	0	0	0	0	0	148
ALL YEARS COMBINED		**1188**	**819**	**396**	**293**	**200**	**109**	**99**	**60**	**48**	**26**	**14**	**11**	**7**	**2**	**2**	**1**	**3275**

Appendix 2. Bird species recorded at each site during 2008 & 2009 Earthwatch surveys. An "x" indicates presence of a given species. *sp indicates that the individual was not identified to species.
Site abbreviations: BRF (Black Rock Forest), BMP (Blue Mountain Park), CAT (Catskills Bluestone Wild Forest), CEN (Central Park), HAR-N (Harriman State Park Northern Section), GATE (Gateway N.R.A.), MAR (Marshlands Conservancy), MRG (Mianus River Gorge), NYBG (New York Botanical Garden), VCP (Van Cortlandt Park)

Site & species name	BMP	BRF	CAT	CEN	HAR-N	JAM	MAR	MRG	NYBG	VCP
Acadian Flycatcher		x	x						x	
American Crow	x	x	x	x	x	x	x	x	x	x *sp
American Goldfinch	x	x	x	x	x	x	x	x	x	x
American Oystercatcher						x				
American Redstart		x	x			x	x			
American Robin	x	x	x	x	x	x	x	x	x	x
Baltimore Oriole				x		x	x		x	x
Barn Swallow						x	x			
Black-and-white Warbler		x	x		x					x
Blackburnian Warbler			x							
Black-capped Chickadee	x	x	x		x	x	x	x		x
Black-crowned Night-heron				x		x	x			
Black-throated Blue Warbler		x								
Black-throated Green Warbler			x							
Blue Jay	x	x	x	x	x		x	x	x	x
Blue-gray Gnatcatcher	x		x		x		x	x		
Blue-headed Vireo	x	x	x		x			x		
Blue-winged Warbler					x					
Brant						x				
Broad-winged		x								

Hawk										
Brown Thrasher						x				
Brown-headed Cowbird	x	x	x			x	x	x	x	x
Canada Goose	x			x	x	x				
Canada Warbler					x					
Carolina Wren			x			x	x	x		
Site & species name	**BMP**	**BRF**	**CAT**	**CEN**	**HAR-N**	**JAM**	**MAR**	**MRG**	**NYBG**	**VCP**
Cedar Waxwing	x	x	x	x	x	x			x	
Cerulean Warbler		x								
Chimney Swift	x			x		x		x	x	
Chipping Sparrow		x	x		x			x	x	
Clapper Rail							x			
Common Grackle	x		x	x		x	x	x	x	x
Common Tern						x				
Common Yellowthroat		x	x			x	x	x	x	
Double-crested Cormorant				x		x	x		x	
Downy Woodpecker	x	x	x	x	x	x	x	x	x	x
Eastern Bluebird	x		x							
Eastern Kingbird			x			x			x	
Eastern Phoebe		x	x		x				x	
Eastern Towhee		x			x	x	x		x	x
Eastern Wood-pewee	x	x	x	x	x		x	x	x	x
European Starling	x			x		x	x		x	x
Fish Crow						x	x	x		
Gadwall				x						
Glossy Ibis						x				
Gray Catbird	x	x		x	x	x	x	x	x	x
Great Black-backed Gull				x		x				

Great Blue Heron			x							
Great Crested Flycatcher	x	x	x	x	x			x	x	
Great Egret				x		x	x			
Green Heron						x				
Hairy Woodpecker	x	x					x	x	x	x
Hermit Thrush			x							
Herring Gull				x		x	x		x	
Hooded Warbler					x					
House Finch						x			x	
House Sparrow	x			x					x	x
House Wren				x		x	x			x
Site & species name	**BMP**	**BRF**	**CAT**	**CEN**	**HAR-N**	**JAM**	**MAR**	**MRG**	**NYBG**	**VCP**
Indigo Bunting			x		x		x			
Killdeer							x			
Laughing Gull						x				
Least Tern						x				
Louisiana Waterthrush		x			x					
Magnolia Warbler					x					
Mallard			x	x		x	x		x	
Marsh Wren							x			
Northern Mockingbird						x	x		x	x
Mourning Dove				x	x	x	x	x	x	x
Northern Cardinal	x		x	x		x	x	x	x	x
Northern Flicker	x		x	x	x		x		x	x
Northern Parula	x	x			x					
Northern Waterthrush			x		x					
Osprey						x	x			
Ovenbird		x	x		x			x		

Pileated Woodpecker	x		x							
Pine Warbler			x		x				x	
Prairie Warbler					x					
Red-bellied Woodpecker	x		x	x	x		x	x	x	x
Red-eyed Vireo	x	x	x		x		x	x	x	x
Red-tailed Hawk	x			x	x	x	x	x	x	x *sp
Red-winged Blackbird			x			x	x		x	x
Ring-necked Pheasant							x			
Rock Pigeon				x		x	x		x	
Rose-breasted Grosbeak	x	x	x					x		x
Rough-winged Swallow							x			
Ruby-throated Hummingbird							x			
Scarlet Tanager	x	x	x		x			x		x
Snowy Egret						x	x			
Song Sparrow		x		x		x	x		x	x
Tree Swallow		x				x	x	x	x	
Site & species name	**BMP**	**BRF**	**CAT**	**CEN**	**HAR-N**	**JAM**	**MAR**	**MRG**	**NYBG**	**VCP**
Tufted Titmouse	x	x	x	x	x		x	x	x	x
Turkey Vulture	x				x					
Veery		x						x		x
Warbling Vireo			x				x		x	x
White-breasted Nuthatch	x	x	x		x		x	x	x	x
White-eyed Vireo						x				
Wild Turkey							x			
Willet						x				
Willow Flycatcher						x				

Winter Wren			x							
Wood Duck			x						x	
Wood Thrush	x	x	x	x	x		x	x	x	x
Worm-eating Warbler	x	x	x		x			x		
Yellow Warbler		x				x	x			x
Yellow-billed Cuckoo			x							
Yellow-crowned Night-heron						x				
Yellow-throated Vireo		x	x		x		x	x		
TOTAL SPECIES: 106	**34**	**38**	**48**	**32**	**40**	**51**	**53**	**34**	**43**	**34**

Appendix 3. Mammal species recorded at each site during camera trapping surveys. An "x" indicates presence of a given species at a particular park. Site abbreviations: APP (Alley Pond Park), BRF (Black Rock Forest), BMP (Blue Mountain Park), CAT (Catskills Bluestone Wild Forest), CEN (Central Park), CFSP (Clarence Fahnestock State Park), CHP (California Hill S.F.), FP (Forest Park), GSP (Great Swamp), HAR-N (Harriman State Park Northern Section), HAR-S (Harriman State Park Southern Section), INW (Inwood Hill Park), GATE (Gateway N.R.A.), MAR (Marshlands Conservancy), MRG (Mianus River Gorge), NYBG (New York Botanical Garden), OMWF (Overlook Mtn. Wild Forest), PBP (Pelham Bay Park), RSP (Rockefeller State Park), SAX (Saxon Woods Park), THSP (Taconic Hereford S.F.), VCP (Van Cortlandt Park), WPR (Ward Pound Ridge)

Common name	Black bear	Coyote	Domestic cat	Domestic dog	Eastern chipmunk	Eastern cottontail	Fisher	Gray squirrel
Scientific name	*Ursus americanus*	*Canis latrans*	*Felis catus*	*Canis lupus familiaris*	*Tamias striatus*	*Sylvilagus floridanus*	*Martes pennanti*	*Sciurus carolinensis*
APP			x	x		x		x
BMP				x				
BRF	x			x				x
CAT				x			x	
CEN			x					x
CFSP								
CHP								x
FP					x			x
GSP								x
HAR-N								x
HAR-S								x
INW			x	x				x
JAM								
MAR			x					x
MRG								x
NYBG					x			x
OMWF	x			x				
PBP			x					x
RSP		x				x		x
SAX					x			x
THSF					x			x
VCP			x					x
WPR								x

Common name	Norway/black rat	Raccoon	Red fox	Skunk	Virginia opossum	White-footed mouse	White-tailed deer
Scientific name	*Rattus sp.*	*Procyon lotor*	*Vulpes vulpes*	*Mephitis mephitis*	*Didelphis virginiana*	*Peromyscus leucopus*	*Odocoileus virginianus*
APP		x			x		
BMP		x			x		
BRF		x					x
CAT							x
CEN		x					
CFSP		x					x
CHP							
FP		x			x		
GSP		x	x		x		
HAR-N		x			x		x
HAR-S							
INW				x			
JAM		x					
MAR		x					x
MRG		x			x		x
NYBG	x	x					
OMWF							
PBP	x	x					
RSP							x
SAX					x	x	
THSF		x			x	x	
VCP					x		
WPR		x	x		x		

Appendix 4. Mammal species recorded at each site during track tubing surveys. An "x" indicates presence of a given species at a particular park. Site abbreviations as in Appendix 3.

*Due to track similarities, it is possible that at some sites a portion of those tracks attributed to gray squirrels were made by red squirrels (*Tamiasciurus hudsonicus*).

**Due to track similarities, it is possible that a minority of those tracks attributed to white-footed mice may have been made by red-backed voles (*Clethrionomys gapperi*).

Common name	Domestic cat	Eastern chipmunk	Gray squirrel*	Northern short-tailed shrew	Raccoon	White-footed mouse**
Scientific name	*Felis catus*	*Tamias striatus*	*Sciurus carolinensis*	*Blarina brevicauda*	*Procyon lotor*	*Peromyscus leucopus*
APP		x	x		x	x
BMP			x		x	x
BRF		x			x	x
CAT						x
CEN		x	x		x	x
CFSP			x		x	x
CHP			x		x	x
FP			x			x
GSP		x	x	x	x	x
HAR-N		x	x	x	x	x
HAR-S		x	x			x
INW			x			x
JAM		x			x	x
MAR		x	x		x	x
MRG		x	x		x	x
NYBG		x	x		x	x
OMWF		x	x	x	x	x
PBP	x	x	x	x	x	x
RSP		x	x		x	x
SAX		x	x		x	x
THSF			x		x	x
VCP			x		x	x
WPR		x	x		x	x

SECTION TWO

REPORTING AGAINST RESEARCH OBJECTIVES

Objective 1: We aim to assess the abundance and diversity of mammals, birds, amphibians and plants at 10 protected areas in the greater New York metropolitan area

Progress toward/against Objective 1:
We have assessed the abundance and diversity of a wide variety of plants and animals at 24 study sites (parks) in the NY metropolitan area. We have met and greatly exceeded this objective.

Objective 2: We aim to gather the first baseline information necessary to examine the response of natural communities to urbanization over time

Progress toward/against Objective 2:
We have successfully gathered baseline information at 24 study sites, and have provided information on species composition and abundance of species to park managers for use in long-term comparisons and for management planning. This objective has been fully achieved. We hope to be able to compare our findings from this study with findings in the New York metro area in 15-20 years to see how upcoming land use changes and climate change impact wildlife, and whether proactive regional planning can work to protect diversity in this region.

Objective 3: We aim to inform management of natural and developed areas in metropolitan regions both locally and globally

Progress toward/against Objective 3:
Locally: we have provided each of the managers at the protected areas that we study with detailed species lists, locations of observations, and thorough analysis of the data, for their own uses. We also have provided a detailed report to each park that presents data showing how their park compares with others in the region, and to promote conservation-oriented planning across the region and not just within single parks. Globally: this part of the objective is difficult to fully achieve within the three years term of study, but we are working towards that goal by presenting talks at national and international meetings, and by preparing manuscripts for publication in journals with global impacts.

Objective 4: We aim to use research as a basis of formal and informal educational efforts and to foster a sense of environmental stewardship throughout the community

Progress toward/against Objective 4:
This research has involved over 130 participants, including volunteers, managers, students, project staff, visiting scientists, and others in the community. We feel that this represents considerable progress towards achieving this objective. In addition to running each of our ~~planned~~ standard teams, we have initiated an extensive set of 3-day (short duration) teams that are designed to engage non-traditional Earthwatch volunteers. Some of these 3-day teams have focused on small mammal live-trapping for population genetic studies within metro NY, while others have focused on documenting populations of coyotes in the 5 boroughs of NY and nearly suburbs. Many of the volunteers on these short duration teams have been from the New York metro area, and we feel that involving them in our research even for just a few days makes substantial progress towards fostering environmental stewardship in the local community. In addition to our ~~usual~~ standard teams, during 2010 ~~we planned eight short-duration teams and~~ seven short-duration teams fielded ~~of them had enough volunteers to run~~. We feel that this objective has been fulfilled.

REPORTING AGAINST MEASURES OF SUCCESS (MoS)

Partnerships

We have many partnerships that have been important to the success of this project, including local non-profit groups, organizations managing each of the protected areas that we study, and academic colleagues. The partnership between the University of Maine (C Burns' affiliation) and the environmental non-profit organization, WildMetro has been particularly strong and instrumental in achieving our project objectives. Each step of the project has involved close collaboration with WildMetro staff, interns and volunteers. We look forward to continuing this partnership in the future. In addition, our continuing partnership with the Westchester County Parks Department in New York has greatly facilitated our research at many parks in the region, and we are grateful for their support and guidance. Academic colleagues from Yale University (Susan Bolden, Dr. Kristof Zyksowski), the New York Botanical Garden (Dr. Michael Sundue, Matthew Pace) and Baruch College/CUNY (Dr. Jason Munshi-South, Stephen Harris) have also been extremely valuable partners in this project, ensuring that our data collection methods are accurate and helping to communicate our scientific goals and progress to project volunteers.

Contributions to conventions, agendas, policies, management plans

Local

Each of the 24 parks that we have conducted research in receives a report detailing our findings and how they relate to our findings at other parks in the NY metro area. Many of the park managers are actively using this information to inform management at their park.

Dissemination

Printed

Burns, C.E., K. Ravana, S. Bolden, K. Zyskowski and M. Sundue. Multi-species conservation in a changing world: Assessing the impacts of urbanization on flora and fauna in the New York metropolitan region. Conservation Biology. In preparation.
K. Ravana and C.E. Burns. Unforeseen consequences of urbanization: Lyme disease risk in the Big Apple. Conservation Biology. In preparation.

Mass media

Our project was filmed by a local television crew working out of CUNY, with the intention of featuring our research in a local broadcast series about nature in the City. The crew came out with one of our teams in the field, and also separately interviewed Dr. Burns. I am not sure if this piece has aired yet.

Meetings and conferences

1) Burns, C. (2009) Chaired oral session on urban ecology and conservation. Ecological Society of America, Albuquerque, NM. approx. 100.
2) Ecological Society of America, Albuquerque, NM. (2009) Lecture on the role of citizen science in conservation, featuring our Earthwatch research. Ecological Society of America, Albuquerque, NM. approx. 75.
No new related conferences in 2010.

Educational resources:

Several of our volunteers voiced an interest in using some of our field methods in their classes. We have sent supporting materials describing the methods we use, and in some cases how to construct the equipment needed for these methods, to each of the interested volunteers.

Developing Environmental Leaders

Our project involved several undergraduate and graduate students. As usual, we supported two undergraduate interns from the University of Maine. Both Joe and Caitlin gained extensive field experience, as well as invaluable experience working with people from all over the world and of all ages. Joe and Caitlin were with us in the field and at our accommodations as full team participants throughout the field season. They were integral members of the team. Our standard teams also supported three graduate students during the 2010 field season. Our field coordinator, Kyle, is a masters student at the University of Maine, and his research aims to understand land use changes associated with urbanization in New York, and the impacts that this has had on plants and animals in the area. Supporting Kyle during the summer 2010 has enabled him to gather the remaining data needed to complete his masters thesis (graduation anticipated in May 2011). Two other graduate students participated in our 2010 field season - Melanie, our Field Team Leader, is a conservation biology masters student, and Matthew one of our visiting scientists, is a PhD student working on plant conservation. Both of these students helped to provide our volunteers with the training needed to conduct our research, and they gained considerable insight into new research methods while working on the project.

Long term impact of project

Taxa of conservation significance enhanced, restored or maintained

Amphibians*:* Blue-spotted salamander (*Ambystoma laterale*) and marbled salamander (*Ambystoma opacum*) are considered species of special concern in the state of New York. Dusky salamanders (*Desmognathus fuscus*) used to be widely distributed but have become scarce in urbanized areas. They are currently listed as "declining" in Connecticut. They are important invertebrate predators in headwater streams. In addition, wood frogs (*Rana sylvatica*) and spotted (*Ambystoma maculatum*), blue-spotted and marbled salamanders are widely used as vernal pool indicator species--their presence is believed to indicate general ecosystem health. In some states the presence of these species certifies a vernal pool for certification/protection.

Birds*:* Threatened species (NY): Least Tern, Common Tern. Species of special concern (NY): Osprey and Cerulean Warbler.

Mammals: Although none of the mammal species surveyed are federally or state-listed as endangered, threatened or of special concern, many of these species play important roles in their ecosystems. Small mammals such as the white-footed mouse represent an important prey base for many of the region's larger mammals and birds. Further, species with larger home range requirements such as bear, fox and fisher can provide a good indication of an ecosystem's integrity. Coyotes are beginning to move into the metropolitan NY area, including its five boroughs. Our standard and short duration teams have helped to document the presence of existing populations of coyotes in the region.

Plants*:* Our teams have identified over 200 species of plants. Some of our plant specimens have not yet been identified to species, but progress is underway at the New York Botanical Garden. We anticipate that once our species list is complete, it will contain a number of

species of conservation significance. Once we have this information, we will make sure to send it along to Earthwatch.

Habitats enhanced, restored or maintained

We hope to impact habitat protection, maintenance and/or restoration as a result of this project in the long-term, but it will take more time. During the data collection phase of the project (first three years), we have gathered important information on the response of wildlife to urbanization, and anticipate that soon we will be able to use this data to help guide management and planning efforts in urban regions.

Cultural heritage enhanced, restored or maintained

Though our project is still young and full results have not been realized yet, we hope that our research will in part impact the relationship between people and the natural environment in urban regions. The more people we can involve in this project, and the farther we can disseminate our results, the better able we will be to achieve these goals. We feel that we have made substantial progress during the ~~first~~ three years of this project, by involving over 130 participants in the field work, and by giving regular formal and informal seminars on our research and on conservation in urban regions. We anticipate that our influence in this area will increase with time as we are able to fully disseminate the results of our work.

Livelihood assets enhanced, restored or maintained

Our standard teams have been designed and run without direct interaction with local community members. That said, we always take the time to thoroughly answer questions about our work when community members ask us about it (a frequent occurrence). Through expanding on our standard teams to include eight short duration teams in 2010 that were geared towards recruiting local volunteers, we feel we have had a greater level of involvement from the local community this year than in past years.