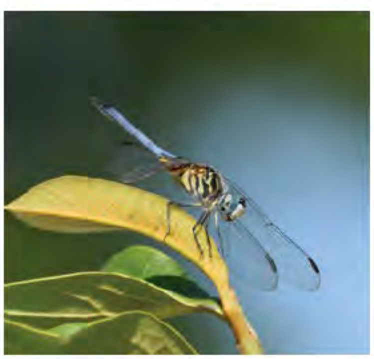
WILDLIFE AND ECOSYSTEM CONDITIONS AT THE GREEN-WOOD CEMETERY

A Survey with Restoration and Management Recommendations





2017-2018

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GW GREEN-WOOD

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Founded in 1838, The Green-Wood Cemetery lies in the western half of Brooklyn, New York and is one of the first rural cemeteries in America. Not only does Green-Wood possess impressive cultural history, but also near-unique natural history. The grounds total 478 acres and contain glacially-influenced topography with ponds, steep slopes, and narrow valley bottoms. The sandy loam soils are derived from the glacial till substratum/parent material and the bedrock beneath the glacial till is comprised of granitic schist and gneiss. Like much of New York City, Green-Wood's geographic position in the landscape, located between a major river system, a massive estuarine bay, and the Atlantic Ocean, is part of a concentrated section of the Atlantic flyway for billions of migratory birds. As a relatively large green space, Green-Wood has significant potential to provide suitable stopover habitat for birds moving along this migratory route, by supporting the many tiers of the trophic foundation beneath and alongside birds, i.e. native plants, insects, arachnids, amphibians, reptiles, mammals, etc.

As an active cemetery and Level III accredited arboretum (2018), Green-Wood is a highly managed landscape. Natural areas exist but are relatively marginalized and fragmented by roads, pathways, and landscaped areas. All water bodies are almost entirely ringed by stone walls preventing ease of ingress/egress for wildlife and are surrounded by mowed turf grass, eliminating the littoral shelf. Nevertheless, the extant faunal diversity surveyed is a testament to the resiliency in nature and the sheer tenacity of genetics. Although Green-Wood is surrounded on all sides by dense urban development, it supports a functional ecosystem, and there are many opportunities to improve and expand upon this functionality.

The data in this report are to be used for public interpretation and education as well as to guide management practices to be more harmonious with wildlife and instruct the implementation of ecological enhancements where possible. Green-Wood is committed to the preservation of its natural and cultural history and the data herein will aid in sustaining and expanding upon its existing natural resources.

The primary objective of this study is to collect wildlife data that can be interpreted for both educational and applied ecological opportunities. Over the past few years, Green-Wood has implemented natural plantings, pollinator gardens, experimental mowing strategies, and bioengineering strategies for slope stabilization. By having a baseline dataset on flora and fauna, the efforts to improve the health and resilience of the landscape can be measured in biological uplift. This data set is intended to not only document existing fauna, but also to serve as a comparative data set for future years, to correlate wildlife diversity and abundance directly to management actions.

Surveys were conducted within the boundaries of The Green-Wood Cemetery (GWC) in Brooklyn, New York (Appendix I, Map 1). A suite of peer-reviewed scientific survey methods were employed to collect taxa-specific data. All survey methods were constrained by seasonal, daily, and weather condition parameters. Below are descriptions and references for each survey method employed. Fixed survey locations were georeferenced using Garmin hand-held GPS units and maps of these locations were created using Esri ArcGIS.

GWC also engaged local researchers from the American Museum of Natural History (AMNH) and The New York State Department of Environmental Conservation (NYSDEC) to conduct Hymenoptera and Coleoptera-specific studies concurrent with our survey time frame. Their results are included in this report and formal summaries prepared separately are in the appendix section.

This project and the concurrent auxiliary surveys are framed as a baseline biological assessment and designed with the expressed intention of performing a comparative analysis of collected biological data over time to develop a faunal performance matrix.

2.1 Avifaunal Point Count Survey

Unlimited distance, single-observer point counts were conducted at predetermined survey locations (Appendix I - Map 2) as defined in Ralph et al. (1995). Counts were five minutes long during the breeding season and extended to ten minutes during wintering and migratory seasons. Intervals of 0-3, 3-5, and 5- 10 minutes were documented for future statistical power in data analysis. Data variables included direction from observer, behavior, height, flight pattern, and New York State Breeding Bird Atlas Code observations[i]. See Appendix II for data sheet example.

2.2 Herpetofauna Surveys

Calling Anuran Survey – Calling amphibian surveys were conducted at predetermined sampling locations (Appendix I- Map 3). These surveys are a non-intrusive and cost-effective means of determining critical habitat, species richness, and qualitative relative-abundance estimates. Protocol followed nationally implemented methodology to provide maximum comparability to other and future data sets (Crewe et al. 2006; Weir and Mossman 2005). Sites were visited during the anuran (frogs and toads) calling activity season in eastern New York (March-July) on warm, humid nights. Observers approached potential breeding pools and waited approximately five minutes for acclimation. The observer(s) then documented each species of anuran as identified by calling males. Relative abundance was estimated by the calling intensity of the chorus. Climatic and weather conditions including wind speed, temperature, and precipitation were recorded.

Basking Turtle Survey – Basking locations of all onsite water bodies were scanned for turtles using a Kowa Sporting Optics TSN Series 60mm lens spotting telescope with adjustable 20-60x power zoom lens and Manfrotto TriPod. These surveys were conducted during most visits at times when the temperature and other weather variables supported basking activity by turtles.

Species and abundance were noted.

Salamander Cover board Study– Cover boards are a preferred method for sampling terrestrial salamanders over time (Bonin and Bachand 1997, Bailey et al. 2004, DeGraaf and Yamanski 1992). *GWC* designed and implemented a long-term cover board study in April 2018, which intentionally used similar methods to a 2010 long-term cover board study of red back salamanders at The New York Botanical Garden (AES). The goal is to allow comparative analysis and shared data for publication, education, and other purposes between the two organizations. Parameters for cover board site selection included the following:

- No-mowed/actively landscaped areas
- Canopy cover >50%
- Leaf litter accumulation
- Coarse woody debris in area
- No highly visible locations

A total of 50 cover board plots were deployed (Appendix I – Map 3). Each plot consists of three boards. One at 24"x 24" and two at 15"x 15". The board material is recycled rubberized flooring, chosen because it conforms to the topography of the landscape, allowing for increased contact with the soil. These boards withstand the elements longer than plywood board and also provide a more homeostatic microclimate underneath. Boards are placed on mineral soil, requiring active removal of plant material and the organic soil layer at the site. Boards are left alone for at least 10 days between checks. At a minimum, these are to be checked once in the spring (~April 15) and once in the fall (~October 15) but, may be checked up to three times per season. This is intended to be a long-term study that can be implemented by Green-Wood staff and potentially used to engage citizen science volunteers with oversight and periodic review by AES. This data set can be used to produce peer-reviewed articles in the future as well. The morphometric data of captured individuals during each survey include:

- Snout-Vent Length (SVL)
- Total Length (ToL)
- Color morphology (lead-back or red-back)
- Age
- Sex (if determinable)
- Unique markings/lost limbs/missing tail
- Location of capture and board size

2.3 Mammal Surveys

***Camera Traps* –** AES deployed two Reconyx HC500 Hyperfire motion-triggered camera traps on site at predetermined locations (Appendix I - Map 4). Locations were selected close to water bodies and where natural cover was present. In addition to the two AES cameras, one camera trap was set by Chris Nagy of the Gotham Coyote Project. Mr. Nagy's data is included in the analysis of the camera trap data.

***Bat Acoustic Monitoring* –** Using custom-built towers and Anabat SD2 Active Bat (acoustic) Detectors, AES set up a remote data collection system to document bat activity in predetermined locations (Appendix I-Map 4). This was combined with an active searching method to maximize coverage of the site. Surveys were conducted on two evenings (June 6 and 7, 2018).

***Snow Track Search* –** On February 11, 2017 AES conducted a snow track detection survey. Fresh snowfall from the night before provided fresh tracks in the snow. The survey was conducted by walking the forested sections and driving the site with frequent stops to walk the road edge in search of tracks. If found (and of interest), tracks were followed and documented.

***Small Mammal Trapping* –** Sherman Live Traps were set along predetermined transects to sample small mammal diversity. These traps are designed to not harm captured animals. The traps were baited with a combination of oatmeal and peanut butter and checked every 24 hours while open. A NYSDEC scientific collection permit application was completed to conduct this work (Appendix V).

2.4 Moth (Nocturnal Lepidoptera) Surveys

Under the direct guidance of Steven Bransky, an entomologist and national moth expert, moths were systematically sampled (Appendix I - Map 5) in all months using two primary methods–sheet survey and bucket traps–and one auxiliary method of baited transects. Each method is described below.

***Universal Black Light Bucket Trap Survey* –** Two complete universal bucket traps were used to conduct overnight sampling of *GWC's* moth diversity (Figure 1). Trap nights were selected based on the lunar calendar with three survey events employed around new moon events (one week prior to the new moon, the night of the new moon, and one week following the new moon). Due to the start time of the survey effort (April 2017), the effort was continued to sample moths though April 2018 to account for a full year.

***Active Sheet Surveys* –** Using two mercury vapor bulbs and a cotton, king-sized white bed sheet, AES conducted three active nocturnal moth surveys to supplement the bucket trap survey data. Not all moths observed during these sheet surveys were collected. Photographs of live specimens and occasional collection of specimens that appeared new to the study were taken during this effort. One of these events was conducted as a public event (Figure 2).

***Bait Transect* –** A fermented concoction of bananas, yeast, and brown sugar, was painted onto limbs of trees and shrubs in target areas along a walking transect. Bait was checked approximately once every 60 minutes. This method can prove effective for finding certain species that are not typically attracted to UV or mercury vapor lights. All moths collected were placed in separate glassine envelopes using standard moth specimen preparation methods and sent to Mr. Bransky for identification and pinning. Select specimens were pinned for a display case to be held at GWC for educational purposes.

2.5 General and Diurnal Insect Surveys

Time- and Area-Constrained Searches (TCS) – Methods from Campbell and Christman (1982) were utilized to search for general and diurnal insects. Time-constrained searches are most useful for determining presence or absence of species and for providing initial data on the types of microhabitats occupied by individual species (Corn and Bury, 1990). AES researchers targeted peak activity seasons and times of day to traverse the site. After a rapid reconnaissance, areas that consisted of more natural conditions were strategically selected for searching. GWC was separated into four search blocks (Appendix I - Map 6). Within each block, search locations were identified. These were restricted to sites possessing elements which may be attractive to extant vertebrate wildlife, and/or which included key potential faunal habitat, including: basking structures, nesting mounds, surface cover (such as refuse piles and coarse woody debris), foraging habitat, and overwintering habitat for herpetofauna; burrows, middens, scat, and tracks for mammals; pockets of migrant passerines in shrubby areas, notable tree stands, open fields and ponds. TCS was employed for all target faunal assemblages and the survey events targeted key activity periods and optimal climatic conditions within these periods for the appropriate group.

Transect Searches – Walking and driving/road transects were established during the initial study design phase. These transects were walked and driven in search for any target fauna while noting opportunistically observed invertebrates as well. Walking transect search methods involved carefully and methodically advancing along pre-determined and opportunistic routes while searching for individuals or evidence of individuals within target faunal assemblages. Observers were allowed to leave the walking route to investigate potential observations and/or catch fauna to confirm identification. To minimize bias, a specific assemblage was targeted during each event–migratory birds in April, snakes and basking turtles in late June, mammal tracks in winter, etc. All vertebrate fauna observed during all transect search events were documented, regardless of the contemporaneous target group.

Random Opportunistic Searches – This scientifically valid survey method is not limited by temporal or spatial constraints and is largely dependent upon the discretion of the observer. The observer may exploit unforeseen encounters with optimal basking locations, potential nesting grounds, surface concealment cover, or other structural habitat attractive to snakes, turtles, or amphibians while conducting other activities onsite. Additionally, when an observer encounters heightened bird activity, regardless of what duties are being performed, he/she may opportunistically document the observation. This search method is best employed by experienced field biologists, as a keen sense for changes in climatic conditions during certain seasons and times of day or other subtleties associated with the landscape provide opportunities for this method to be successful.

2.6 Native Vegetation "Island" Study

As a supporting element to the wildlife study, AES conducted an assessment of shrub and tree "islands" within the more managed sections of the cemetery. These "islands" of vegetation occur under small trees and shrubs and appear to be protected from mowing. The primary goal was to determine the role and potential importance of these spaces for wildlife at GWC. These sites may act as critical resources for certain insect species via support of persistent native plant colonies and a more intact organic/duff layer (due to the absence of earthworms), which is necessary for myriad insect annual life cycles. A one-day assessment of these locations was conducted to characterize their botanical diversity and the relative potential value as critical habitat for native genetics and insect habitat on site. A summary of these findings can be reviewed in Appendix III.

Primary field investigation equipment is listed below. Specialized equipment such as mercury vapor lamps and acoustic monitoring equipment is detailed within the above sections

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- 10.5 x Roof Prism Kowa Series Binoculars
- 60 x Optical Zoom Kowa TSN Spotting Telescope and Manfrotto Tripod (for TCSand Transects)
- Thermo Hygrometer (Digital Temperature and Relative Humidity Gauge)
- Relevant Field Data Sheets and Metal Case Clipboard
- Field Observation Notebook
- Digital Camera
- GPS Unit
- Brimmed Hat, Pants, & Long Sleeves
- Sturdy 3⁄4 Boots
- Bug Spray, Sunscreen and Other Personal Protective Equipment
- Water, Protein Snacks
- Cell Phone (with Local/Relevant Emergency and Project Contact Sheet)
- Site Navigation Maps and Relevant Field Identification Guides
- 100% Cotton King-Sized Bed Sheet
- Honda EU2000i Gas Powered Generator
- 250 Watt Mercury Vapor Bulb, 175 Watt Self-Ballast, Mercury Vapor Bulb and Tripods
- Moth Collecting Equipment Kit (forceps, collection envelopes, ethyl acetate, collection jars, etc.)
- BioEquip Prefabricated Moth Collecting Bucket Traps (with AC/DC adaptors)
- Rechargeable 12V Small Engine Batteries (2) and Charging Station
- Reconyx HC500 Hyperfire Camera Trap and Security Mounting Kit (2)
- Elephant Bark recycled Rubber Matting (cut into sections as coverboards)
- (2) Titley Scientific Anabat SD2 CF Bat Detector Units (and associated memory cards)
- (1) Rain Shield for Remote Microphone Placement on Acoustic Monitoring Station
- (1) Custom-Built Acoustic Monitoring Station (weather-proof housing & 15' Tall Metal Tripod and Associated Stabilization Hardware)

4.0 Survey Effort Analysis

A total of 43 survey events were conducted over 21 separate days between Sept 6, 2016 and October 18, 2018. This does not include the additional efforts put forth by Green-Wood staff (Sara Evans, Project Manager, Department of Horticulture) and all other wildlife researchers (Chris Nagy, AMNH, Project TRUE, and NYSDEC). All survey events were documented using original data sheets, field notebooks, or through digital media (ex. ArcCollector). Table 1 shows the overall project effort. Standard variables include survey method, date and weather, duration of effort, survey goals, and notable observations.

Table 1. Survey Details for Entire Study to Date (in Chronological Order)

Survey Type	Date	Duration	Time	Weather Description	Notes
BBS– Prelim	6/24/16	2.0	1200 - 1400	73F, Partly Cloudy, Wind 0 mph	Kick-Off
ROS	6/24/16	1.0	1400 - 1500	75F, Ptly Cloudy, Wind 0	Limited Effort
MBS (Fall)	9/22/16	5.0	0840 – 1340	Sunny, Cool(64F),CC 25%, SE BWS 1	
TCS	9/22/16	1.5	1530 – 1700	Sunny, 69F, CC 0%, SEBWS 1	Block 1
LEP	9/22/16	0.75	1345 – 1430	Sunny, 68F, CC 0%, SEBWS 1	Walking Transect
MBS (Fall)	9/30/16	5.0	0900 – 1400	Rain (int),60F, CC 100% NE BWS 12	
TCS	9/30/16	3.25	1400 – 1715	Rain (int),66F, CC 100% NEBWS 12	Block 3 and 2
MBS (Fall)	11/03/16	5.0	1045 - 1545	Sunny, 61F, CC 15% Wind 0	
WBS	12/02/16	5.5	1000 – 1530	Chilly (35F), NEBWS 1	
WBS	1/26/17	5.0	1030 – 1530	24F, CC 25%, N-EBWS 1	
MTS	2/11/17	6.0	1000 – 1600	Fresh Snow, Sunny, Cold 28	Sitewide
LEP	4/10/17	1.0	1600 – 1700	70F, Ptly Cloudy, S BWS 1	Walking Transects and E Field Search
ACS	4/10/17	2.5	1830 - 2100	57F, 76% RH, CC 50%, Wind 0	No Peepers
MBS (Spr)	5/12/17	5.0	0900 – 1400	64F, CC 75%, NEBWS 1	
LEP	5/12/17	1.5	1420 – 1520	72F, CC 10%, Wind 0	Walking Transects
TCS/ROS	5/12/17	3.5	1530 - 1900	72F, CC 10%, Wind 0	Block 1
MBS (Spring)	5/20/17	5.0	0840 – 1340	69F, CC75%, ESEBWS 2	
TCS/ROS	5/20/17	4.0	1430 – 1830	73F, CC50%, SEBWS 2	Blocks 4 and 2
ACS	5/20/17	2.25	1900 – 2115	65F, 90%RH, CC%75, Light Rain	NGFR & BULL
MOTH	5/20/17	5.5	2020 – 0150	59F, CC75%, Light Rain	
BBS (1)	6/05/ 17	6.0	0430 – 1030	71F, CC15%, Sunny, Wind 0	Many NOMO
TCS/ROS	6/05/17	3.25	1230 - 1545	80F, CC0%, Sunny, Wind 0	Blocks 1 and 3
ACS	6/05/17	2.0	2000 – 2200	64F, 50%RH, CC10%, Wind 0	
BBS (2)	6/06/17	6.0	0500 – 1100	69F, CC25%, NEBWS 1	MAWA!
TCS	6/06/17	2.5	1130 – 1400	75F, CC40%, NEBWS 2	Block 1
MOTH	6/06/17	12	1900 - 0700	No weather data collected	Buckets
MOTH	6/22/17	3.75	2040 - 0030	74F, CC%0, Wind 0	Buckets & Sheet
ACS	6/22/17	2.0	1950 - 2150	74F, 61%RH, CC%0, Wind 0	
BBS (3)	6/23/17	6.0	0445 - 1045	64F, CC%50, NEBWS 1	
TCS/ROS	6/23/17	2.0	1315 - 1515	Sunny, Warm, Calm Wind	Driving Transect
MOTH	2/14/18	4.75	1900 - 2345	52F, CC25%, SE Wind BWS 1-2	Sheet, Bait
MAMMAL	4/12/18	24	All day		Sherman Live
HERPS	4/12/18	5	0900-1400		Coverboards
MOTHS	4/12/18	5	1900 - 0000		Sheet Survey
MAMMAL	4/13/18	24	All day		Sherman Live

HERPS	4/13/18	4.5	0800 - 1230	Coverboards
MAMMAL	6/6/18	17.5	1900 - 0700	Acoustic Monitoring (passive and active data collection
MAMMAL	6/6/18	3	0800 - 1100	Sherman Live Trapping
PLANTS	6/6/18	6.0	1100 - 1700	Island Habitat Assessment
MAMMAL	6/7/18	17.5	1900 – 0700	Acoustic Monitoring (passive and active data collection
MAMMAL	6/7/18	3	0800 - 1100	Sherman Live Trapping
HERPS	10/18/18	4.5	1000 - 1430	Checking Coverboards for eastern redback salamanders

4.1 Avifauna

A total of eleven point count survey events were conducted (two winter, two spring, four summer, and three in the fall) at 37 points. Table 1 displays the distribution of survey point locations within the study area. This effort spanned from June 24, 2016 to June 23, 2017. A total of 129 bird species were observed. Of these, nine species are currently protected as Endangered, Threatened, or Species of Special Concern in the state of New York (Table 2) and 22 species are listed as Species of Greatest Conservation Need.

Table 2. New York State Protected Species Observed During 2016 -17 Wildlife Survey of GWC

Species		NYS Endangered	NYS Threatened	NYS Special Concern	Onsite?	Breeding?
Common Name	Taxonomic Binomial					
Peregrine Falcon[1]	*Falco peregrinus*	X			X	N
Pied-billed Grebe[2]	*Podilymbus podiceps*		X		X	N
Bald Eagle[3]	*Haliaeetus leucocephalus*		X			N
Common Tern	*Sterna hirundo*		X			N
Common Loon	*Gavia immer*			X		N
Osprey	*Pandion haliaetus*			X		N
Sharp-shinned Hawk	*Accipiter striatus*			X	X	N
Cooper's Hawk	*Accipiter cooperii*			X	X	Y
Common Nighthawk	*Chordeiles minor*			X	X	Unknown

[1] The population of peregrine falcons has been severely affected over the decades of heavy pesticide use. Exposure to the pesticides has sub lethal effects on the offspring, causing the development of thin egg shells. This shell thinning reduces the rate of breeding success. Green-Wood is within the present breeding range. "Peregrine Falcon Fact Sheet." *SEQR - NYS Dept. of Environmental Conservation*, New York State Department of Environmental Conservation, www.dec.ny.gov/animals/7294.html.

[2] Relies on the existence of wetland habitat. "Pied-Billed Grebe Fact Sheet." *SEQR - NYS Dept. of Environmental Conservation*, www.dec.ny.gov/animals/85203.html.

[3] Exposure to pesticides, heavy metals, and persistent toxic compounds in fish from contaminated water bodies, as well as reduction habitat from human activity still threatens the population. "Bald Eagle Grebe Fact Sheet." *SEQR - NYS Dept. of Environmental Conservation*, https://www.dec.ny.gov/animals/74052.html.

***Breeding Birds* –** Despite a diverse assemblage for the entire year, breeding bird diversity is relatively low. A total of 22 species were confirmed breeding with an additional 23 species observed as probable or possible breeders, as per NYS Breeding Bird Code definitions. The most frequently observed species during the 2017 breeding season were American robin (*Turdus migratorius*), European starling (*Sturnus vulgaris*), and northern mockingbird (*Mimus polyglottos*) constituting 20.57%, 15.62%, and 11.81% respectively. The least expected observation during the breeding bird surveys was the presence of a male magnolia warbler (*Setophaga magnolia*) in a thicket of ornamental coniferous shrubs on June 6, 2017. With the exception of the Appalachian Mountains, southern New York is the extreme southern limit of this species' breeding range. Magnolia warblers are found regularly in spring and fall migration at GWC, but this is the first documented observation in the month of June on site as per an e-Bird data review. This observation does not confirm breeding, but breeding is considered probable based upon the date and behavior of the individual observed (adult male singing). There is a well-established breeding colony of monk parakeets (*Myiopsitta monachus*) on site. The colonial nest is on the central finial of the iconic Gothic Arches.

***Migratory Birds* –** A total of 102 species were observed during migration survey events. The greatest diversity of birds were observed in the spring and fall migrations. Rarities/oddities, such as clay-colored sparrow (*Spizella pallida*) and summer tanager (*Piranga rubra*) were documented during these events. The highest diversity of bird species observed during one survey event was on September 30, 2016 which included many Neotropical migrants such as Cape May warbler (*Setophaga tigrina*), black- poll warbler (*Setophaga striata*), bay-breasted warbler (*Setophaga castanea*), Tennessee warbler (*Oreothlypis peregrina*) and migrant raptors. In the local birding community, GWC is best known for its migratory bird diversity and potential for rarities/vagrants during these periods.

***Wintering Birds* –** A total of 33 species were observed during winter surveys. These included year-round residents such as northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristada*), and red-bellied woodpecker (*Melanerpes carolinus*), as well as winter specialists in the region (i.e., species that breed farther north but winter in our region) such as purple finch (*Haemorhous purpureus*), white-throated sparrow (*Zonotrichia albicolis*), white-crowned sparrow (*Zonotrichia leucophrys*), and fox sparrow (*Passerella iliaca*).

Good data points have been recorded for birds observed at GWC via citizen science applications like e-Bird for many years: a total of 223 species are documented in the e-Bird database since 1969. Some species recorded are quite rare or are otherwise vagrant individuals. In comparing the e-Bird data recorded during the time of our surveys, a total of 18 species were documented that our surveys did not confirm. Many of these are of an individual vagrant or species that are considered rare but regular in migration, such as evening grosbeak (*Coccothraustes vespertinus*), Nelson's sparrow (*Ammodramus nelsoni*), lark sparrow (*Chondestes grammacus*), white-eyed vireo (*Vireo griseus*), and Connecticut warbler (*Oporornis agilis*).

***Nuisance and Invasive Species* –** European starling (*Sturnus vulgaris*) and Canada goose (*Branta canadensis*) are two species that can have negative impacts on the ecosystem and pose risks to the health of humans and local wildlife. *S. vulgaris* are carriers of many diseases that affect humans and an array of wildlife that are transmitted through defecation (Linz, et. al, 2007). They often out-compete native cavity-nesting birds, such as bluebirds, woodpeckers, and wood ducks, in areas with limited nesting habitat. This behavior reduces the reproductive success of other species in the area and may force the out- competed birds to migrate elsewhere. The nesting range of *S. vulgaris* is inextricably linked to the proximity of their foraging habitat–pristine mowed grassland. Tall grasses and litter limit the movement needed for them to successfully forage. According to the U.S. Forest Service, research suggests that reducing the amount and frequency of parcels that are routinely mowed is sufficient to deter starlings and reduce their density in those areas (Purcell, 2016).

Grazing *B. canadensis* in high densities and higher visitation frequencies can have negative effects on the water quality of water bodies. Daily, individual geese can defecate up to 92 times, generating almost three pounds of organic waste. Annually, an individual goose produces upwards of three pounds of nitrogen per year and 1.4 pounds of phosphorous, which when overloading a water body can lead to algae blooms and ultimately the eutrophication of that system (Post et. al, 1998). Depending on the amount of animal waste entering the system, which is largely dependent on the number and frequency of visiting individuals around the water body, presence/absence of vegetative buffers, seasonality, and topography, the fecal matter can contaminate the water body with fecal coliforms that can negatively impact the health of other wildlife and the public through the transmission of disease (Jellison et. al, 2009). Two of the most humane and cost-effective ways to prevent geese from congregating in areas around water bodies and offset the potential threat to the aquatic ecosystems are: 1) to modify the landscape so as to render it unappealing to the geese and; 2) to eliminate the feeding of geese by visitors. For the landscape, creating a native vegetative buffer would function as not only a geese deterrent, but as a natural filtration system of organic waste, as well. Any fecal matter that may enter the system is slowed by the vegetative buffer and the nutrients may be utilized and taken up by the plants, saving the water system from nutrient over-loading (Murray and Hopper, 2003). Feeding the geese manipulates the natural habits of the animals, including their migration patterns, which results in an unnatural abundance of geese (and their droppings) year-round (NYDEC).

Table 3. Birds Observed During 2016-17 Avifaunal Surveys at Green -Wood Cemetery by Date

Common Name	Scientific Name	6/24/16	9/22/16	9/30/16	11/3/16	12/2/16	1/26/17	5/12/17	5/20/17	6/5/17	6/6/17	6/23/17
Common loon	*Gavia immer*		X									
Canada goose	*Branta canadensis*		X	X				X	X			
wood duck	*Aix sponsa*								X			
mallard	*Anas platyrhynchos*			X		X	X		X	X	X	X
pied-billed grebe	*Podilymbus podice ps*					X						
double-crested cormorant	*Phalacrocorax auritus*									X		
great blue heron	*Ardea herodias*		X		X		X					
great egret	*Ardea alba*	X		X							X	X
green heron	*Butorides virens*	X	X	X				X			X	X
black-crowned night heron	*Nycticorax nycticorax*									X	X	
turkey vulture	*Cathartes aura*			X								
bald eagle	*Haliaeetus leucocepha lus*				X			X				
osprey	*Pandion haliaetus*		X	X						X		
northern harrier	*Circus hudsonius*		X									
sharp-shinned hawk	*Accipiter s triatus*			X								
Cooper 's hawk	*Accipiter c ooperii*				X		X					
broad-winged hawk	*Buteo platypterus*			X								
red-shouldered hawk	*Buteo lineatus*							X				
red-tailed hawk	*Buteo jamaicensis*	X	X	X		X		X		X	X	X
American woodcock	*Sc olopax minor*				X							
spotted sandpiper	*Actitismaculatus*							X				
laughing gull	*Leucophaeus atricilla*								X			X
ring-billed gull	*Larus delawarensis*			X		X		X		X		
herring gull	*Larus argentatus*				X	X		X		X		X

Common Name	Scientific Name	6/24/16	9/22/16	9/30/16	11/3/16	12/2/16	1/26/17	5/12/17	5/20/17	6/5/17	6/6/17	6/23/17
common tern	*Sterna hirundo*								X			
rock pigeon	*Columba livia*		X	X	X	X						
mourning dove	*Zenaida macroura*	X	X	X	X	X		X		X	X	X
great horned owl	*Bubo virginianus*	X							X			
common nighthawk	*Chordeiles minor*		X									
chimney swift	*Chaetura pelagica*	X	X	X				X		X	X	X
ruby-throated hummingbird	*Archilochus colubris*		X									
belted kingfisher	*Ceryle alcyon*		X	X	X							
red-bellied woodpecker	*Melanerpes carolinus*		X	X	X	X	X		X			X
yellow-bellied sapsucker	*Sphyrapicus varius*			X	X	X	X					
downy woodpecker	*Picoides pubescens*	X	X	X	X	X	X	X		X	X	X
hairy woodpecker	*Picoides villosus*					X						
northern flicker	*Colaptes auritus*	X	X	X	X		X	X	X			X
peregrine falcon	*Falco peregrinus*					X						
merlin	*Falco columbarius*				X							
American kestrel	*Falco sparverius*			X								
monk parakeet	*Myiopsitta monachus*			X		X	X	X		X	X	X
eastern wood pewee	*Contopus virens*		X	X								
least flycatcher	*Empidonax minimus*		X									
eastern phoebe	*Sayornis phoebe*	X	X	X						X	X	X
great -crested flycatcher	*Myiarchus crinitus*										X	
eastern kingbird	*Tyrannus tyrannus*							X		X		
blue-headed vireo	*Vireo solitarius*			X	X				X			
warbling vireo	*Vireo gilvus*	X		X					X			X
Philadelphia vireo	*Vireo philadelphicus*			X								
red-eyed vireo	*Vireo olivaceus*	X	X	X					X			
blue jay	*Cyanocitta cristada*	X	X	X	X	X	X	X	X	X	X	X
common raven	*Corvus corax*	X		X							X	
American crow	*Corvus brachyrhynchos*	X		X		X			X		X	X
fish crow	*Corvus ossifragus*					X			X			
tree swallow	*Tachycineta bicolor*									X		
northern rough winged swallow	*Stelgidopteryx serripennis*		X									
barn swallow	*Hirundo rustica*							X		X	X	X
black capped -chickadee	*Poecile atricapillus*			X	X	X	X				X	
tufted titmouse	*Baeolophus bicolor*			X		X	X	X			X	X
red-breasted nuthatch	*Sitta canadensis*		X	X	X	X	X					
white-breasted nuthatch	*Sitta carolinensis*	X	X	X		X	X	X	X		X	
house wren	*Troglodytes aedon*		X	X				X			X	X
winter wren	*Troglodytes hiemalis*				X							
golden-crowned kinglet	*Regulus satrapa*			X	X							
ruby-crowned kinglet	*Regulus calendula*			X								
eastern bluebird	*Sialia sialis*			X								
wood thrush	*Hylocichla mustelina*			X								
hermit thrush	*Catharus guttatus*			X	X							
gray-cheeked thrush	*Catharus minimus*		X	X								
Swainson's thrush	*Catharus ustulatus*		X	X								
veery	*Catharus fuscescens*			X								
American robin	*Turdus migratorius*		X	X		X	X	X	X	X	X	X
northern mockingbird	*Mimus polyglottos*	X	X	X		X		X		X	X	X
gray catbird	*Dumetella carolinensis*	X		X				X		X		X
brown thrasher	*Toxostoma rufum*	X		X						X		
European starling	*Sturnus vulgaris*	X	X	X	X	X	X	X	X	X	X	X
cedar waxwing	*Bombycilla cedrorum*	X		X	X					X	X	X

Common Name	Scientific Name	6/24/16	9/22/16	9/30/16	11/3/16	12/2/16	1/26/17	5/12/17	5/20/17	6/5/17	6/6/17	6/23/17
ovenbird	*Seiurus*		X	X					X			
northern waterthrush	*Parkesia noveborace nsis*		X									
black-and-white warbler	*Mniotilta varia*		X	X					X			
Tennessee warbler	*Oreothlypis peregrina*			X								
Nashville warbler	*Leiothlypis ruficapilla*			X								
common yellowthroat	*Geothlypis trichas*		X	X						X		
American redstart	*Setophaga americana*		X	X							X	
Cape May warbler	*Setophaga tigrina*		X	X					X			
black-throated green warbler	*Setophaga virens*								X			
Magnolia warbler	*Setophaga magnolia*		X	X					X		X	
northern parula	*Setophaga americana*		X	X				X				
Blackburnian warbler	*Setophaga fusca*			X								
yellow warbler	*Setophaga petec hia*								X			
chestnut sided warbler	*Setophaga pensylvanica*			X								
black-throated blue warbler	*Setophagac aerulescens*			X					X			
blackpoll warbler	*Setophagas triata*			X								
bay-breasted warbler	*Setophagac astanea*			X								
pine warbler	*Setophaga pinus*			X								
palm warbler	*Setophaga palmarum*		X	X	X							
prairie warbler	*Setophaga discolor*			X								
yellow-rumped warbler	*Setophaga coronata*			X	X				X			
Wilson's warbler	*Cardellina pusilla*			X					X			
Canada warbler	*Cardellina canadensis*								X			
eastern towhee	*Pipilo erythrophthalmus*			X				X				
American tree sparrow	*Spizella arborea*					X						
clay-colored sparrow	*Spizella pallida*		X									
chipping sparrow	*Spizella passerina*	X	X	X	X			X		X	X	X
field sparrow	*Spizella pusilla*			X				X				
fox sparrow	*Passerella iliaca*					X	X					
song sparrow	*Melospiza melodia*		X	X						X		
Lincoln's sparrow	*Melospiza lincolnii*			X								
swamp sparrow	*Melospiza georgiana*		X	X	X							
dark-eyed junco	*Junco hyemalis*				X	X	X					
white-crowned sparrow	*Zonotrichia leucophrys*					X						
white-throated sparrow	*Zonotrichia albicolis*			X	X	X	X					
summer tanager	*Piranga rubra*							X				
scarlet tanager	*Piranga olivacea*		X	X				X	X			
northern cardinal	*Cardinalis cardinalis*	X	X	X	X	X	X	X	X	X	X	X
rose-breasted grosbeak	*Pheucticus ludovic ianus*		X	X								
indigo bunting	*Passerina cyanea*			X								
common grackle	*Quiscalus quiscula*	X	X	X				X	X	X	X	X
rusty blackbird	*Euphagus carolinus*			X								
red-winged blackbird	*Agelaius phoenice us*				X	X		X	X			
brown-headed cowbird	*Molothrus ater*										X	
orchard oriole	*Icterus spurius*										X	
Baltimore oriole	*Icterus galbula*	X		X				X	X	X	X	X
purple finch	*Haemorhous purpureus*				X	X						
house finch	*Haemorhous mexicanus*			X		X	X	X		X	X	X
American goldfinch	*Carduelis tristis*			X	X	X	X	X		X	X	X
house sparrow	*Passer domesticus*	X	X	X	X	X	X	X		X	X	X

Confirmed or Probable Breeding at Green-Wood per NYS Breeding Bird Atlas Observation Codes

This Color Indicates Possible Breeding at Green-Wood per NYS Breeding Bird Atlas Observation Codes

[i] New York State Breeding Bird Atlas Breeding Codes

Breeding Behavior	Breeding Code	Description
Possible Breeding (PO)	X	Species observed in possible nesting habitat, but no other indication of breeding noted; singing male(s) present (or breeding calls heard) in breeding season.
Probable Breeding (PR)	S	Singing male present (or breeding calls heard).
	P	Pair observed in suitable habitat in breeding season.
	T	Bird (or pair) apparently holding territory. In addition to territorial singing, chasing of other individuals of same species often marks a territory.
	D	Courtship and display, agitated behavior or anxiety calls from adults suggesting probable presence nearby of a nest or young; well-developed brood-patch or cloacal protuberance on trapped adult. Includes copulation.
	N	Visiting probable nest site. Nest building by wrens and woodpeckers. Wrens may build many nests. Woodpeckers, although they usually drill only one nest cavity, also drill holes just for roosting.
	B	Nest building or excavation of a nest hole.
Confirmed Breeding (CO)	DD	Distraction display or injury-feigning. Agitated behavior and/or anxiety calls are Probable-D.
	UN	Used nest found. Caution: These must be carefully identified if they are to be counted as evidence. Some nests (e.g. Baltimore Oriole) are persistent and very characteristic. Most are difficult to identify correctly.
	FE	Female with egg in the oviduct (by bird bander).
	FL	Recently fledged young (including downy young of precocious species - waterfowl, shorebirds). This code should be used with caution for species such as blackbirds and swallows, which may move some distance soon after fledging. Recently fledged passerines are still dependent on their parents and are fed by them.

	ON	Adult(s) entering or leaving nest site in circumstances indicating occupied nest. NOT generally used for open nesting birds. It should be used for hole nesters only when a bird enters a hole and remains inside, makes a change-over at a hole, or leaves a hole after having been inside for some time. If you simply see a bird fly into or out of a bush or tree, and do not find a nest, the correct code would be Probable-N.
	FS	Adult carrying fecal sac.
	FY	Adult(s) with food for young. Some birds (gulls, terns, and raptors) continue to feed their young long after they are fledged, and even after they have moved considerable distances. Also, some birds (e.g. terns) may carry food over long distances to their young in a neighboring block. Be especially careful on the edge of a block. Care should be taken to avoid confusion with courtship feeding (Probable-D).
	NE	Identifiable nest and eggs, bird setting on nest or egg, identifiable eggshells found beneath nest, or identifiable dead nestling(s). If you find a cowbird egg in a nest, it is NE for Cowbird, and NE for the identified nest's owner.
	NY	Nest with young. If you find a young cowbird with other young, it is NY for cowbird and NY for identified nest owner.

4.2 Herpetofauna

A total of six species were observed (Table 4): three reptiles (all turtles) and three amphibian (two frog, one salamander) species. No snakes or evidence of snakes (ex. shed skins) were observed. Calling anuran surveys were conducted in 2017 on April 10, May 20, and June 23. No calling frogs or toads were observed during the April event. On the May and June events male northern green frogs (*Lithobates clamitans melanota*) (Figure 3) were heard calling from survey locations ACS 001, 002, and 004. In June, bullfrogs were documented calling from Dell Water. The lack of hardy native species, such as northern spring peeper (*Pseudacris c. crucifer*) and northern gray tree frog (*Hyla versicolor*) are likely a direct result of absent emergent wetlands, which is critical breeding habitat. Land management practices in the wooded and lawn areas, such as the removal of leaf litter, use of fertilizers, and systematic mowing is also incompatible with the life-cycles of these native species. On September 22, 2016 a possible calling northern spring peeper was reported as coming from the woods to the north of Dell Water, but was never confirmed. Due to the lack of any other peeper observations during all other survey events and their relatively conspicuous audible nature we consider this an erroneous observation.

Basking turtle surveys were conducted on eight different occasions during the spring, summer, and fall months of 2017. A total of three turtle species were observed during these efforts (Table 3). The most abundant turtle species is the non-native red eared slider (*Trachemys scripta elegans*) (Figure 4). Common snapping turtles (*Chelydra serpentina*) are commonly observed in all water bodies, as well. In Sylvan Water, there is at least one adult yellow-bellied slider (*Trachemys s. scripta*) (Figure 5). Both the red-eared sliders and yellow-bellied sliders are likely to have been introduced to GWC via the pet trade and released by irresponsible pet owners. Considered invasive in the northeast, including in New York State, red-eared sliders are an aggressive species that regularly out-compete native turtles for basking locations, thus reducing metabolic fitness and reproductive capabilities of native turtles. Both of these outcomes have been directly attributed to population reductions and local extirpation of native turtle species. Native eastern redbelly turtles (*Pseudemys r. rubiventris*) and eastern painted turtles (*Chrysemys p. picta*) are considered absent from the site.

Table 4. Herpetofauna Observed During Wildlife Surveys in 2016 -17 at Green-Wood Cemetery

Common Name	Scientific Name	Abundance	Location(s) Observed	Additional Notes
eastern red -backed salamander	*Plethodon cinereus*	**Low** (5 individuals observed)	Hillside by Dell Water only	Isolated and sparse population. Likely in decline/ need of
northern green frog	*Lithobates clamitans melanota*	**Moderate** (high count = 16)	Dell/Crescent Water, Sylvan Water, and Valley Water)	At risk of extirpation
bullfrog	*Lithobates catesbeiana*	**Moderate** (high count = 9)	Same as above	Considered native invasive in NY
common snapping turtle	*Chelydra serpentina*	**Moderate** (high count = 7)	Observed in all water bodies on site	Observed breeding in Valley Water
red-eared slider	*Trachemys scripta elegans*	**Abundant** (over 60 individuals counted in one day)	Observed in all water bodies on site	Introduced and invasive. Overabundance impacting water quality
yellow-bellied slider	*Trachemys scripta scripta*	**Low** (1 individual observed)	Sylvan water	Introduced but not behaving invasively

TCS and ROS survey efforts were enacted on eight separate dates between June 23, 2016 and September 15, 2017 (see Table 1 for details on survey effort). All herpetofaunal species documented during other methods (ACS and Basking Turtle Searches) were also observed during TCS/ROS events. In the summer months northern green frogs and bullfrogs were often heard calling intermittently during daytime hours (especially on humid days or during light rain events). One additional amphibian species, eastern red-backed salamander (*Plethodon cinereus*) was found during three separate TCS events (Figure 7). Despite a significant search effort, this species was only documented in one section of Green-Wood. A long-term monitoring study has been implemented (via cover boards) to better understand the current population dynamics of this species at GWC (See Salamander Cover Board Survey below).

Salamander Cover Board Survey– In 2017, eastern red-backed salamanders were observed in the woodlot surrounding Dell Water. This species is the most abundant of all salamanders in North America (Petrank, 2010; Mueller et al., 2004) and represents the remarkable adaptive radiation of Plethodontidae throughout the eastern United States' Piedmont and The Ridge and Valley Physiographic Provinces (Verrell, 2000; Titus and Larson, 1996; Larson and Dimmick, 1993). One key to this radiation is the red-back salamander's evolved adaptation to lay eggs terrestrially in rotting logs and leaf litter, rather than in water bodies. Therefore, the juveniles are not fully aquatic, which is in contrast to all other salamanders and most anurans globally that require water bodies for egg deposition and have fully aquatic larvae. Despite their common occurrence in the northeast, a red-backed salamander population situated within GWC is most remarkable. To this extent, a long-term study was implemented using recycled rubber cover boards to first determine the abundance and distribution of this species throughout GWC. Methods and materials followed a modified version of an ongoing study developed by AES for New York Botanical Garden. A total of 50 cover board plots were placed in a stratified random arrangement throughout GWC in locations that would not conflict with routine cemetery maintenance and management: no mowed lawns or highly visible locations. Boards were deployed in April, 2018. They were checked once in the spring and once in the fall of 2018. No salamanders were observed in the spring. A total of ten individuals were observed using the boards for cover in the fall (Table 5). A variety of morphometric data (total length, snout- vent length, color morph, and age class) was collected. GWC staff has been trained on the process and will lead this survey effort moving forward.

Table 5. Morphometric Data from Fall 2018 Eastern Red-backed Salamander Coverboard Check

Coverboard ID	Board Size	Color Phase	Sex	Age Class	Total Length	Snout-Vent Length	Notes
34	24" x 24"	Red	U	Adult	3.4	1.8	
15	15" x 15"	Red	U	Adult	3.1	1.9	
14	15" x 15"	Red	U	Juvenile	1.9	1.1	Light red (orange)
13	24" x 24"	Red	U	Juvenile	1.2	0.6	Found on the corner of the mat in the center
12	15" x 15"	Red	U	Adult	2.6	1.6	
12	24" x 24"	Lead	U	Juvenile	1.7	0.9	
7	15" x 15"	Red	U	Adult	4.2	2.0	Tail longer than body
6	24" x 24"	Red	U	Adult	3.1	1.8	
4	15" x 15"	Red	U	Adult	3.7	1.9	Vertical holes visible under board
Plywood	Plywood	Red	U	Adult	3.8	2.0	In path between Dell Water and adjacent slope

4.3 Mammals

A total of twelve mammal species were observed on site during the entire survey period (Table 6). Humans (*Homo sapiens*) and domestic dogs on leashes (with visible owners) were excluded from this survey. Of these, five species (eastern gray squirrel, groundhog, skunk, opossum, and raccoon) were detected using camera traps. Five species were observed during TCS/ROS surveys (squirrel, groundhog, raccoon, unidentified bat species, and feral cat). Six bat species were recorded and identified during

during acoustic monitoring in June, 2018. A snow track survey revealed a canid track of interest (Figure 8). The track was indicative of a non-domesticated animal–it was not accompanied by human tracks, meandered across the site without correlation to the roads, and exited GWC through the fence. Track size and gait suggests red fox (*Vulpes vulpes*) or juvenile coyote (*Canis latrans*) but the observation remains unconfirmed.

Table 6. Mammal Species Observed during 2016-2017 Survey at Green-Wood

Common Name	Scientific Name	Abundance	Location Observed	Additional Notes
eastern squirrel	*Sciurus carolinensis*	Abundant	Sitewide	Average urban park density
groudhog	*Marmota monax*	Abundant	Sitewide	32 trapped/removed in Fall 2016
striped skunk	*Mephitis mephitis*	Sparse	Woods near water	Only observed via camera trap
Virginia opossum	*Didelphis virginiana*	Sparse	Woods near water	Only observed via camera trap
racoon	*Procyon lotor*	Abundant	Sitewide	Overabundance
little brown bat	*Myotis lucifugus*		Sitewide	Acoustic sonograms suggest less abundant than other species
big brown bat	*Eptesicus fuscus*		Sitewide	Commonly observed
eastern red bat	*Lasiurus borealis*		Sitewide	Commonly observed
hoary bat	*Lasiurus cinereus*		Sitewide	Commonly observed
silver-haired bat	*Lasionycteris noctivagans*		Sitewide	Acoustic sonogram suggests less abundant than other speceies
evening bat	*Nycticeius humeralis*		Sitewide	More frequently observed in northern section
feral cat	*Felis catus*	Moderate	Sitewide	Non-native

The camera trap survey was conducted in coordination with Chris Nagy of The Gotham Coyote Project (GCP). Two AES cameras and one GCP camera were deployed at predetermined locations within Green-Wood (Appendix I). Sites were baited with a scent lure (provided by GCP) when first set but not thereafter. Cameras were activated on January 26, 2017 and taken down on April 10, 2017. A total of 5,400 trap hours and over 75 consecutive days resulted in over 33,500 captured images. By far, the most commonly observed species was raccoon (*Procyon lotor*) followed by eastern gray squirrel (*Sciurus carolinensis*). Ten bird species were observed as well. (Table 7)

Table 7. Summary of Camera Trap Data from Green-Wood (1/26/2016-4/10/2017)					
Common Name	Scientific Name	Frequency of Days Observed			Notes
		AES TRAP #1	AES TRAP #2	GCP Trap	
eastern gray squirrel	*Sciurus carolinensis*	12	36	X	Mostly dark morph at AES Trap #1
groundhog	*Marmota monax*	1	10	X	Burrow located just behind AES Trap #2
striped skunk	*Mephitis mephitis*	4	3	X	No pattern observed in occurrences
Virginia opossum	*Didelphis virginiana*	6	3	X	Earliest obs. was 2/21. Most active late Mar & Apr
Raccoon	*Procyon lotor*	57	71	X	Family groups of 6+. Inactive day after snow. Copulation on 2/4/17
Feral cat	*Felis catus*	0	3	0	3 different cats
Human	*Homo sapiens*	2	38	0	Need to move AES Trap #2 for future surveys.
domestic dog	*Canis domesticus*	0	1	0	On leash with owner
song sparrow	*Melospiza melanota*	0	1	0	3/29
fox sparrow	*Passerculus iliaca*	4	1	0	1/27, 2/5, 2/7, 3/16, 3/25 (with NOCA on Feb dates)
northern cardinal	*Cardinalis cardinalis*	5	1	X	2/5, 2/7, 3/16, 3/17, 4/1, 4/5, 4/9
northern flicker	*Colaptes auritus*	3	0	0	3/8, 4/5, 4/8
American robin	*Turdus migratorius*	5	0	0	3/13, 3/30, 4/7, 4/8, 4/10
white-breasted nuthatch	*Sitta carolinensis*	1	0	0	2/5 (with NOCA and FOSP)
tufted titmouse	*Baeolophus bicolor*	1	0	0	2/17
dark-eyed junco	*Junco hyemalis*	4	0	X	3/16, 3/17, 3/18, 3/19 (all on snow, gone after melt)
blue jay	*Cyanocitta cristada*	0	1	X	3/30
house sparrow	*Passer domesticus*	0	0	X	data unavailable

Figure 10. Fox sparrow (*Passerculus iliaca*) foraging.

Figure 11. Raccoons (*Procyon lotor*) are, by far, the most commonly observed mammal via camera traps. Images of up to 6 individuals at one time were captured regularly.

Figure 12. Eastern gray squirrels (*Sciurus carolinensis*) are also quite common onsite. Dark morph in image below.

Figure 13. Northern flciker (*Colaptes auritus*) foraging.

Figure 14. Groundhog (*Marmota monax*) observed at AES Trap #2.

Figure 15. Striped skunk (*Mephitis mephitis*) observed on January 30, 2017.

Figure 16. Virginia opossum (*Didelphis virginiana*) observed February 21, 2017.

Sherman Live Trapping**-** On April 12-13, 2018 and June 6-7, 2018 fifty Sherman live traps were deployed along five transects (ten traps per transect). Sherman live traps are an industry standard and effective method for sampling small mammals. Each trap was baited with a combination of oatmeal and peanut butter. All traps were reset and rebaited after being checked after the first night and removed from the site after the second evening of trapping. No small mammals were captured during these efforts. Many of the traps were molested, tampered with, or moved after being set. While not proven, it is speculated that raccoons were tampering with the traps, impeding the effectiveness of this method for sampling small mammals. GWC initiated a raccoon population reduction program, led by the USDA-APHIS-Wildlife Services between August 14, 2018 and August 24, 2018 (eight nights of trapping). During this effort fifty traps were deployed on each night of trapping and a total of 171 raccoons were trapped and euthanized. With the population reduced on site, AES proposes that the Sherman live trap survey should be repeated to determine whether the raccoon overpopulation was the primary cause of the survey effort failure.

It is understood that Norway rat (***Rattus norvegicus***) and house mouse (***Mus musculus***) are likely present. In adition, it is likely that other small mammals occur on site, such as deer mouse (***Peromyscus manuculatus***), short-tailed shrew (***Blarina brevicauda***), and meadow vole (***Microtus pennsylvanicus***). Southern flying squirrel (***Glaucomys Volans***) is likely present, although it was not observed during the wildlife survey and Sherman live traps are not effective for surveying this species. Pitfall trapping is an effective method for sampling small mammals but there is often a high mortality rate associated with this method because the traps are less selective, capture more individuals over a broader range of weight and age classes, and the trapped animals may be killed by predators, drowning during rainfall, or by an attack from another trapped individual (Umetsu et al., 2006).

Bat Acoustic Monitoring **–** An acoustic survey for bats was conducted on the nights of June 6th and 7th, 2018. Two Titley Scientific Anabat SD2 units were used to collect sonogram data. One was set up as a passive monitoring station at Sylvan Water. This unit consisted of a microphone mounted on a 15 foot mast with an EME Systems BatHAt housing and reflector plate. The other unit was an active handheld unit that was activated for approximately three hours each night while traversing the site (both driving and on foot). Over the two nights, the automated recorder at the Sylvan Water site generated 121 recordings. These were run through an automatic identification software which resulted in six species being identified using the clearest recordings (n=85). An additional manual review of the data positively identified two species. These are big brown bat (*Eptiesicus fuscus* – EPTFUS) and eastern red bat (*Lasiurus borealis* – LASBOR). The software also identified hoary bat (*Lasiurus cinereus* – LASCIN), silver-haired bat (*Lasionycteris noctivagans*–LASNOC), little brown bat (*Myotis lucifugus* – MYOLUC), and evening bat (*Nycticeius humeralis* – NYCHUM). Despite lack of added confidence per the manual review, the level of confidence in the software supports all six of these species being present on site using the passive method. The active monitoring resulted in 290 recordings, which resulted in the same six species being identified. The manual review provided further positive identification for four of the six species: *Eptesicus fuscus* – EPTFUS, *Lasiurus borealis* – LASBOR, *Lasiurus cinereus* – LASCIN, and *Nycticeius humeralis* – NYCHUM. The combined software and manual analysis results support that all six species were observed and documented using both active and passive methods in June 2018.

Figure 17. Passive acoustic monitoring set-up by Sylvan Water. Image by MJ McGraw.

Table 8. Sylvan Water bat call summary counts by species per day directly from automatic identification software.

Date	EPTFUS	LASBOR	LASCIN	LASNOC	MYOLEI	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB	NOID	NOISE
All	66	12	1	1		1			4		15	21
20180606	19	6									5	8
20180607	47	6	1	1		1			4		10	13

Table 9. Sylvan Water bat call summary presence value estimate. Numbers less than 0.03 indicate a high likelihood of the species being present.

Presence P-Values:	EPTFUS	LASBOR	LASCIN	LASNOC	MYOLEI	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB
All	0	0	1	1	1	1	1	1	1	1
20180606	0	0	1	1	1	1	1	1	1	1
20180607	0	0.000001	1	1	1	1	1	1	0.816331	1

Table 10. Active monitoring bat call summary counts by species per day directly from the automatic identification software.

Date	EPTFUS	LASBOR	LASCIN	LASNOC	MYOLEI	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB	NOID	NOISE
20180606	16	4	5	1					5		7	71
20180607	29	12	1	1		4			21		27	86

Table 11. Active monitoring bat call summary presence value estimate. Numbers less than 0.03 indicate a high likelihood of the species being present.

Presence P-Values:	EPTFUS	LASBOR	LASCIN	LASNOC	MYOLEI	MYOLUC	MYOSEP	MYOSOD	NYCHUM	PERSUB
All	0	0	0.073181	1	1	1	1	1	0.00022	1
2018(	0	0.000356	0.005216	1	1	1	1	1	0.219775	1
20180607	0	0	1	1	1	0.901868	1	1	0.000888	1

Table 12. Summary of bat acoustic monitoring presence/absence data. No species observed warrant State or Federal Protection. (FE = Federally Endangered, FT = Federally Threatened, NYSE = NY State Endangered, NYST = NY State Threatened, and NYSSOSC = NY State Species of Special Concern)

Common Name	Scientific Name	Conservation Status	Present/Absent
little brown bat	*Myotis lucifugus*		Present
eastern small-footed bat	*Myotis leibii*	NYSSOSC	Absent
northern long-eared bat	*Myotis septentrionalis*	FT, NYST	Absent
Indiana bat	*Myotis sodalis*	FE, NYSE	Absent
tri-colored bat	*Perimyotis subflavus*		Absent
big brown bat	*Eptesicus fuscus*		Present
eastern red bat	*Lasiurus borealis*		Present
hoary bat	*Lasiurus cinereus*		Present
silver-haired bat	*Lasionycteris noctivagans*		Present
evening bat	*Nycticeius humeralis*		Present

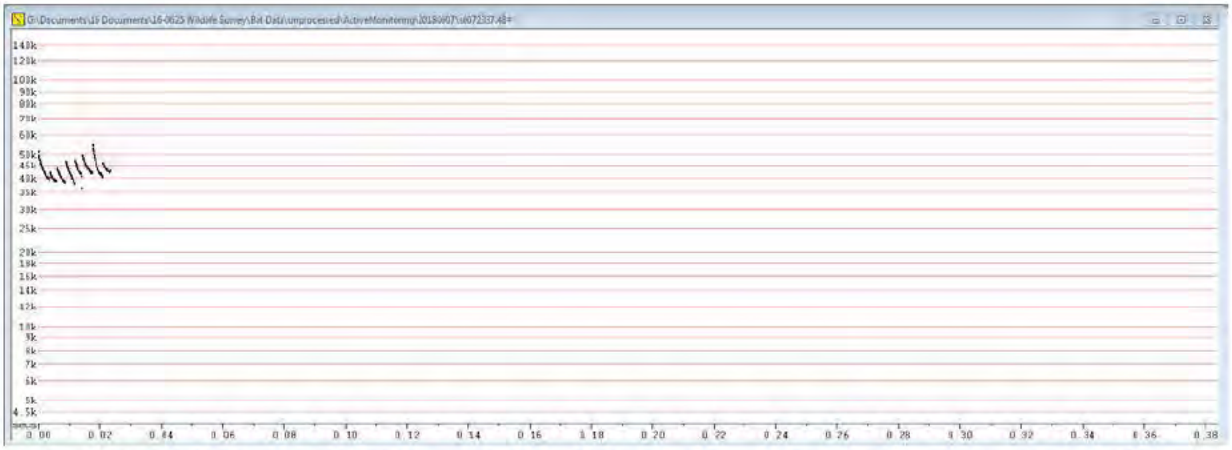


Figure 18. Little Brown Bat (*Myotis lucifugus*) sonogram produced from a recording at Green-Wood

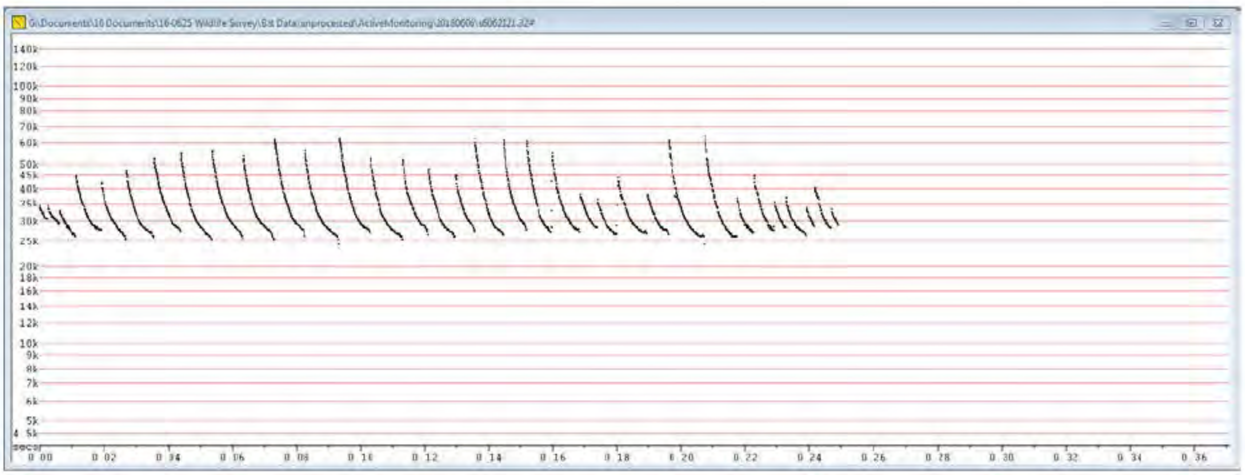


Figure 19. Big Brown Bat (*Eptesicus fuscus*) sonogram produced from a recording at Green-Wood

Figure 20. Eastern Red Bat (*Lasiurus borealis*) sonogram produced from a recording at Green-Wood

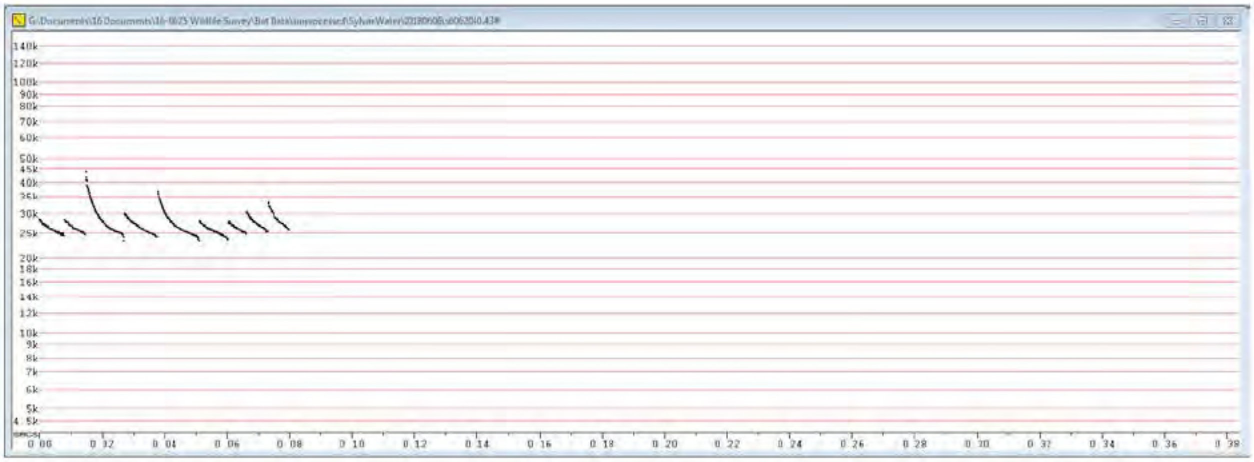


Figure 21. Hoary Bat (*Lasiurus cinereus*) sonogram produced from a recording at Green-Wood

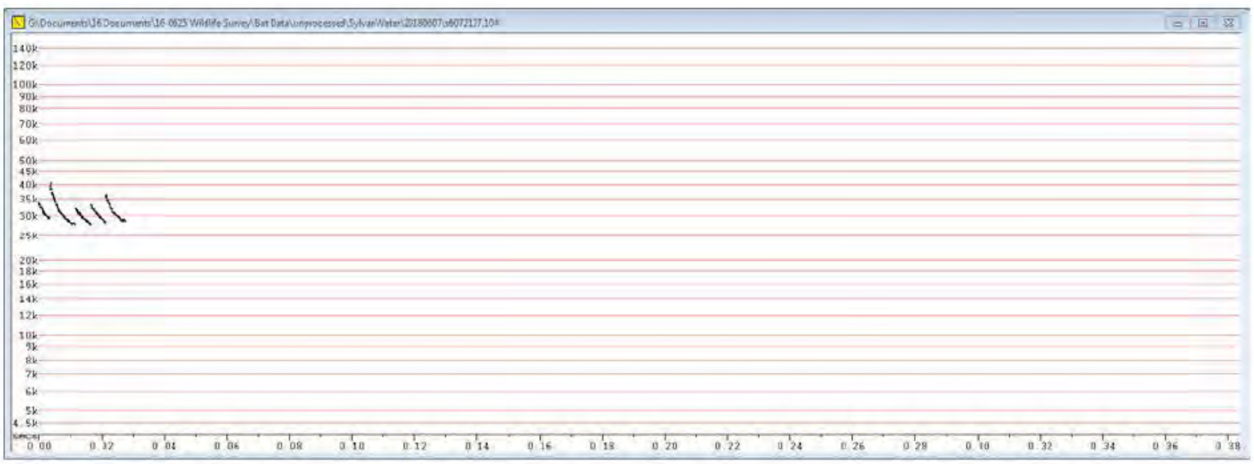


Figure 22. Silver-haired bat *(Lasionycteris noctivagans)* sonogram produced from a recording at Green-Wood

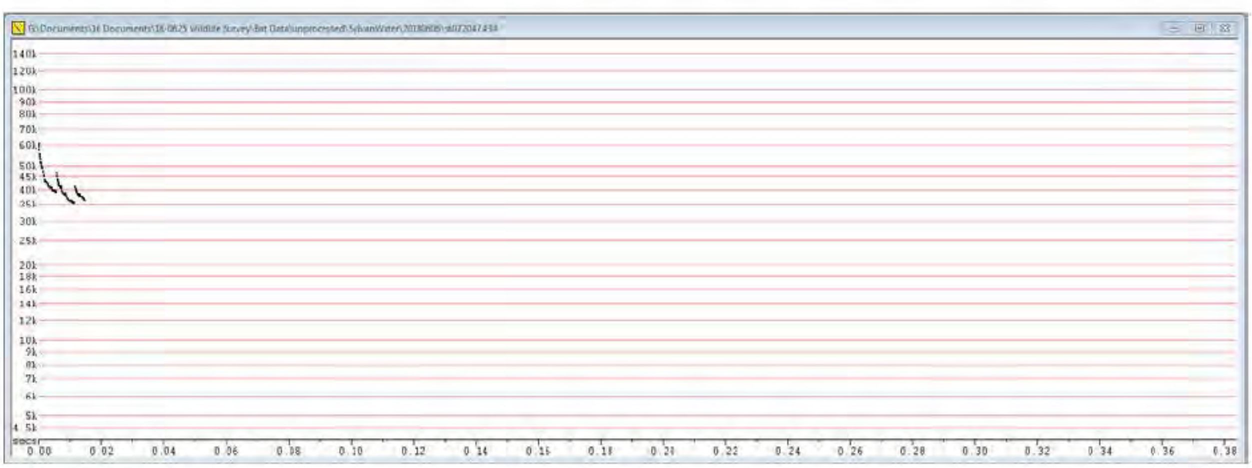


Figure 23. Evening Bat (*Nycticeius humeralis*) sonogram produced from a recording at Green-Wood

4.3 Moths

Seventeen overnight bucket trap surveys were performed between May 2017 and May 2018, totaling approximately 385 survey hours. A total of 355 individual moths were collected representing 66 species (Table 13). Two were unable to be confirmed to species (first two on list below). The remaining 64 species were used to develop summary information (Figure 24). Only individuals representing newly observed species were captured during active sheet surveys. A moth report summary was prepared by the project entomologist, Stephen Bransky, and can be found in Appendix IV. The 2018 spring data collection effort did not produce any new species.

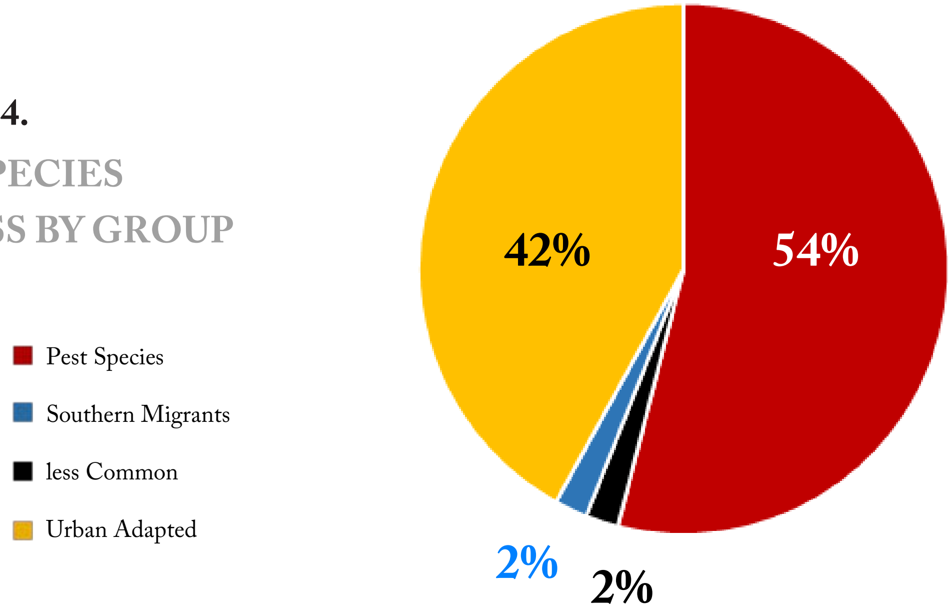
Table 13. Moth Species Observed and Iddentified at Green-Wood from May-November 2017

MONA#	*Family*	*Genus*	*Species*	**Quantity**
0.1	Geometridae	*Eupethecia*	*sp.*	1
0.2	Crambidae	*Neodactryia*	*sp.*	1
373	Tineidae	*Acrolophus*	*popeanella*	3
374	Tineidae	*Acrolophus*	*propinquus*	3
411	Tineidae	*Niditinea*	*fuscella*	1
422	Tineidae	*Eccritotherix*	*guenterella*	1
426	Tineidae	*Tineola*	*bisselliella*	1
1048	Noctuidae	*Agrotis*	*gladiaria*	1
1162	Blastobastidae	*Blastobasis*	*glandulella*	1
2366	Plutellidae	*Plutella*	*xylostella*	3
2401	Attevidae	*Atteva*	*aurea*	5
2859	Tortricidae	*Celypha*	*crispitana*	1
3469	Tortricidae	*Cydia*	*candana*	1
3494	Tortricidae	*Cydia*	*latiferreana*	1
3594	Tortricidae	*Pandemis*	*limitata*	1
3623	Tortricidae	*Argyrotaenia*	*quercifoloana*	1
3688	Tortricidae	*Clepsis*	*peritana*	1
3725	Tortricidae	*Cenopis*	*pettitana*	1
4975	Crambidae	*Achyra*	*rantalis*	1
5079	Crambidae	*Udea*	*rubigalis*	31
5156	Crambidae	*Nomophila*	*nearctica*	1
5362	Crambidae	*Crambus*	*agitatellus*	2
5363	Crambidae	*Crambus*	*saltuellus*	10
5364	Crambidae	*Crambus*	*multilinellus*	6
5403	Crambidae	*Agriphila*	*vulvivagellus*	3
5413	Crambidae	*Pediasia*	*trisecta*	5
5417	Crambidae	*Pediasia*	*dorsipunctellus*	1
5420	Crambidae	*Microcrambus*	*elegans*	1
5435	Crambidae	*Fissicrambus*	*mutabilis*	25

5533	Pyralidae	*Hypsopygia*	*olinalis*	3
5451	Crambidae	*Parapediasia*	*teterrellus*	127
5464	Crambidae	*Urola*	*nivalis*	1
5510	Pyralidae	*Pyralis*	*farinalis*	1
5999	Pyralidae	*Euglogia*	*ochrifontella*	1
6005	Pyralidae	*Moodna*	*ostrinella*	1
6339	Geometridae	*Macaria*	*transitaria*	1
7132	Geometridae	*Pleuropructa*	*insularia*	2
7146	Geometridae	*Haematopis*	*grataria*	1
7414	Geometridae	*Orthonama*	*obstipata*	5
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	12
7474	Geometridae	*Eupethecia*	*miserulata*	4
7701	Lasiocampidae	*Malacosoma*	*americana*	1
8203	Erebidae	*Halysidota*	*tessellaris*	1
8323	Erebidae	*Idia*	*aemula*	1
8447	Erebidae	*Hypena*	*madefactalis*	1
8465	Erebidae	*Hypena*	*scabra*	3
8689	Erebidae	*Zale*	*lunata*	1
8924	Noctuidae	*Anagrapha*	*falcifera*	4
8959	Eutelidae	*Paectes*	*pygmaea*	1
8974	Nolidae	*Garella*	*nilotica*	1
9666	Noctuidae	*Spodoptera*	*frugiperda*	4
9669	Noctuidae	*Spodoptera*	*ornithogalli*	1
9679	Noctuidae	*Elaphria*	*chalcedonia*	1
9688	Noctuidae	*Galgula*	*partita*	3
10368	Noctuidae	*Lacinipolia*	*meditata*	1
10397	Noctuidae	*Lacinipolia*	*renigera*	4
10438	Noctuidae	*Mythimna*	*unipuncta*	17
10446	Noctuidae	*Leucania*	*multilinea*	1
10524	Noctuidae	*Nephelodes*	*minians*	2
10585	Noctuidae	*Orthodes*	*majuscula*	1
10663	Noctuidae	*Agrotis*	*ipsilon*	9
10670	Noctuidae	*Feltia*	*jaculifera*	2
10911	Noctuidae	*Anicla*	*infecta*	6
10915	Noctuidae	*Peridroma*	*saucia*	1
10942	Noctuidae	*Xestia*	*c-nigrum*	7
11003.1	Noctuidae	*Noctua*	*pronuba*	8

FIGURE 24.

MOTH SPECIES RICHNESS BY GROUP



The species that are expected to be observed in a setting like Green-Wood are coded with a **GOLD** MONA number (Moths of North America). The species coded in **RED** are pest species. Species coded in **BLUE** are North American-native migrants; both belong to the genus ***Spodoptera***. As late summer progresses, species in this genus repopulate the northern states annually as adults and are commonly observed in this region in the fall. They do not survive the winter. Green-Wood is speculated to be a layover en route to more northern sites. It is assumed that as food plants in the south desiccate during the fall dry season the migrants head north in an attempt to find fresh food sources for larvae. The remaining five species coded in **BLACK** are less common than the species noted in gold and are briefly described below:

***#422-Eccitotherix guenterella*–** A rare native moth. Nothing is known about this species' food plant. It is not a common moth anywhere, with just two specimens recently recorded in Wisconsin in the past five years due to increased surveying effort. It is difficult to write a management plan for this species, but experts plotting its range hope to discover its food plant. As it is unlikely to be a stray, it is probable that the food plant occurs on site.

***#1162-Blastobasis gladulella*–** Found in the eastern half of the USA. It is not an uncommon species but more conducive to native habitat oak/hickory forests, making it an interesting find in a cemetery setting. Larva feed on the interior of acorns. It may be a more generalist feeder than recorded, suggesting this species could potentially be using other tree nuts along with acorns as a larval food source.

#5999-Euglogia ochrifontella– A moth not uncommonly encountered in the eastern half of the United States. The food plant of this species is also unknown, but assumed to be acorns. This moth is associated with oak/hickory habitats but not restricted.

#6005-Moodna ostrinella– This species is a scavenger of dried seeds, fruits, rose galls, rose buds and acorns. Not generally common, but can be locally abundant in various years at a particular location.

#8959-Paectes pygmaea– Can be common in southeastern states where sweetgum (*Liquidambar styraciflua*) is abundant. This species is likely associated with sweetgum trees onsite.

Results to date have revealed moth diversity being highest at the Oak Leaf site, followed by Locust Grove and Dell Water (Table 14). The Oak Leaf location (Figure 18) was selected due to a concentration of mature, native trees (oaks, sweetgum, and tulip poplar). Locust Grove produced the most pest species (7 total). The high number of individuals captured at Dell Water is dominated by one native lawn pest species, the bluegrass webworm moth (*Parapediasia teterrellus* – MONA #5451) which feed primarily on tall fescue and Kentucky bluegrass.

Table 14. Richness and Abundance of Moth Observation by Survey Location

Survey Location	Species Richness	Abundance	# of Survey Events
Southwood and Grove	1	1	1
30 Vault	9	19	1
Cliff Path	1	1	1
E35-102	1	2	1
Pine Oak	3	3	1
Que pal	8	9	2
Dell Water	12	129	3
501 Union	3	3	2
Landscape	3	9	1
Live Oaks	7	9	1
Locust Grove	18	55	2
Oak Leaf	21	64	1
Sylvan Water	7	12	2
W26-12	8	11	1
W37-45	5	16	3
W39-44	9	12	1

Moths were primarily collected using two bucket traps which were positioned at different locations throughout GWC. Active sheet surveys were conducted at three locations and baited transect surveys were conducted in the woodlots around Dell Water and behind the mausoleum of the Whitney family. Surveys were intentionally conducted in close proximity to native trees, shrubs, and native herbaceous and graminoid species when possible. A total of 17 locations were sampled over the 2017 calendar year (Map 5) with clustering in areas with higher densities of native plants. Discretion for site selection was made primarily by Green-Wood staff with intimate knowledge of the existing native plant assemblages on site. Pinned specimens will be kept at Green-Wood for future comparative analysis and educational purposes.

4.4 Diurnal Lepidoptera

Diurnal Lepidoptera (butterflies and moths active during daylight hours) were tallied using a combination of transect searches, TCS, and ROS. Four walking transect routes were selected due to concentrations of flowering plants and/or proximity to water (Map 7). These walking transects were visited three times in 2017 (4/10, 5/12, 6/23).

The primary focus was Lepidoptera, but other insects observed were identified when possible. Butterfly nets and magnifying boxes were used for difficult identifications. A total of 27 diurnal Lepidoptera (26 butterflies, one moth) were observed (Table 16). No species observed are currently listed as Endangered, Threatened, or Species of Special Concern in New York.

Figure 39. Pictured above are the adult stages of two common butterfly species observed. Left to right: monarch (*Danaus plexippus*) and silver-spotted skipper (*Epargyreus clarus*). Images taken by Sara Evans.

Table 16.	Family	Common Name	Scientific Name	Relative Abundance
True Butterflies	Papilionidae	black swallowtail	*Papilio polyxenes*	Common
	Papilionidae	Eastern tiger swallowtail	*Papilio glaucus*	Common
	Pieridae	Cabbage white	*Pieris rapae*	Abundant
	Pieridae	Orange Sulphur	*Golias eurytheme*	Abundant
	Pieridae	Clouded sulpher	*Colias philodice*	Common
	Lycaenidae	American copper	*Lycaena phlaeas*	Sparse
	Lycaenidae	Gray hairstreak	*Strymon melinus*	Sparse
	Lycaenidae	Eastern tailed blue	*Everes comyntas*	Abundant
	Lycaenidae	Holly blue	*Celastrina argiolus*	Common
	Nymphalidae	American snout	*Libytheana carinenta*	Sparse
	Nymphalidae	great spangled fritillary	*Speyeria callippe*	Sparse
	Nymphalidae	pearl crescent	*Phyciodes tharos*	Common
	Nymphalidae	eastern comma	*Polygonia comma*	Sparse
	Nymphalidae	painted lady	*Vanessa cardui*	Common
	Nymphalidae	red admiral	*Vanessa atalanta*	Common
	Nymphalidae	common buckeye	*Junonia coenia*	Sparse
	Nymphalidae	red-spotted purple	*Limenitis a. astyanax*	Sparse
	Nymphalidae	viceroy	*Limenitis archippus*	Sparse
	Nymphalidae	monarch	*Danaus plexippus*	Common
Skippers	Hesperidae	silver-spotted skipper	*Epargyreus clarus*	Common
	Hesperidae	northern cloudywing	*Thorybes pylades*	Common
	Hesperidae	least skipper	*Ancyloxypha numitor*	Common
	Hesperidae	European skipper	*Thymelicus lineola*	Common
	Hesperidae	tawny-edged skipper	*Polites themistocles*	Sparse
	Hesperidae	Peck's skipper	*Polites peckius*	Sparse
	Hesperidae	sachem	*Atalopodes campestris*	Sparse
Diurnal Moths	Erebidae	Virginia ctenucha	*Ctenucha virginica*	Sparse

4.6 Insect Data from Specialists at AMNH and NYSDEC Collected Concurrent to this Study

Parker Gambino and Sarah Kornbluth, Hymenoptera specialists from the American Museum of Natural History, surveyed the bee diversity in 2017 and 2018. Individuals were mainly collected using plastic cups that were painted either white, blue, or yellow (the attractant), and filled with a slightly soapy solution to break the surface tension of the water (trapping/killing agent). Twelve cups were placed along transects at eleven locations that were sited to have the highest density of flowering trees (Appendix I–Map 10). The other method of sampling was actively netting individuals that were harvesting nectar and pollen on flowers. A total of 23 collection events occurred between April of 2017 and September of 2018. A total of 33 bees, ten wasps, and one fly species were documented in 2017 (Table 17). All bees were identified to species. Wasp specimens were keyed to family and, when possible, to genus and species. So far as of 2018, there are 77 species of bees and wasps that have been identified, spanning five bee families and two wasp families. Refer to Appendix V for additional details.

Table 17. Bee and Wasp Species observed by AMNH at Green-Wood in 2017

Group	*Scientific Name*	*NYS Listed?*
BEES	*Agapostemon sericeus*	No
	Agapostemon virescens	No
	Andrena alleghaniensis	No
	Andrena banksi	No
	Andrena carlini	No
	Andrena crataegi	No
	Andrena cressonii	No
	Andrena hippotes	No
	Andrena miserabilis	No
	Andrena nasonii	No
	Apis mellifera	No
	Bombus griseocollis	No
	Bombus impatiens	No
	Colletes thoracicus	No
	Halictus confusus	No
	Halictus ligatus	No
	Heriades carinatus	No
	Hoplitis producta	No
	Lasioglossum cinctipes	No
	Lasioglossum coreopsis	No
	Lasioglossum gotham	No
	Lasioglossum hitchensi	No
	Lasioglossum leucocomum	No
	Lasioglossum platyparium	No
	Lasioglossum tegulare	No
	Lasioglossum weemsi	No
	Lasioglossum zephyrum	No
	Megachile rotundata	No
	Nomada australis	No
	Nomada illinoensis	No

	Nomada ovata	No
	Osmia pumila	No
	Xylocopa virginica	No
WASPS	Ichneumonidae [Family]	No
	Chalcididae [Family]	No
	Chrysididae [Family]	No
	Pemphredonina [Subtribe in Family Crabronidae]	No
	Liris argentatus [Species in Family Crabronidae]	No
	Oxybelus emarginatus [Species in Family Crabronidae]	No
	Anacrabro ocellatus [Species in Family Crabronidae]	No
	Chalybion californicum [Species in Family Sphecidae](sighting, no specimen)	No
	Polistes dominula [Species in Family Vespidae]	No
	Tiphia [Genus in Family Tiphiidae]	No

In addition, Jessica Cancilliere, an NYSDEC invasive Coleoptera specialist, conducted a wood-boring beetle-specific study in 2017. These data were provided to Joe Charap on February 10, 2017 and subsequently shared with AES by Mr. Charap on March 3, 2017. A total of fourteen species were identified at Green-Wood Cemetery by NYSDEC in 2016 (Table 18).

Table 18. Species of Pest Coleoptera Detected by NYSDEC in 2016 at Green-Wood

Year	State	Pest Scientific Name	County	Location
2016	NY	*Ips grandicollis*	Kings	The Green-Wood Cemetery
2016	NY	*Euwallacea validus*	Kings	The Green-Wood Cemetery
2016	NY	*Dendroctonus terebrans*	Kings	The Green-Wood Cemetery
2016	NY	*Phloeotribus liminaris*	Kings	The Green-Wood Cemetery
2016	NY	*Ambrosiodmus obliquus*	Kings	The Green-Wood Cemetery
2016	NY	*Ambrosiophilus atratus*	Kings	The Green-Wood Cemetery
2016	NY	*Orthotomicus caelatus*	Kings	The Green-Wood Cemetery
2016	NY	*Xylosandrus crassiusculus*	Kings	The Green-Wood Cemetery
2016	NY	*Dendroctonus frontalis*	Kings	The Green-Wood Cemetery
2016	NY	*Gnathotrichus materiarius*	Kings	The Green-Wood Cemetery
2016	NY	*Hypothenemus* sp.	Kings	The Green-Wood Cemetery
2016	NY	*Monarthrum mali*	Kings	The Green-Wood Cemetery
2016	NY	*Xyleborinus attenuatus*	Kings	The Green-Wood Cemetery
2016	NY	*Xyleborus pfeili*	Kings	The Green-Wood Cemetery

4.7 AES Anecdotal (non-Target) Observations

A variety of invertebrate species were observed during the course of this survey. Efforts were made to identify non-target species when possible. Species already identified in the moth, bee, and beetle studies were not replicated in this list. Anecdotal observations (of an opportunistic nature but still worthy of note) revealed an additional 23 insect species (Table 19).This is not a complete list of extant invertebrates. Systematic analyses of these taxa should continue (ex. repeat surveys from NYSDEC and AMNH).

Table 19. Anecdotally Observed Invertebrates at Green-Wood during the 2017 Wildlife Study

Asian multicolored lady beetle	*Harmonia axyridis*
baldface hornet	*Dolichovespula maculata*
black carpenter ant	*Camponotus pennsylvanica*
cicada killer	*Sphecius speciosus*
common green darner	*Anax junius*
common whitetail	*Plathemis lydia*
damselfly sp.	*Zygoptera sp.*
dragonfly sp.	*Anisoptera sp.*
drone fly	*Eristalis tenax*
earwig spp	*Dermaptera spp*
eastern carpenter bee	*Xylocopa virginica*
firefly sp.	*Lampyridae sp*
housefly	*Musca domestica*
hoverfly	*Syrphus ribesii*
hoverfly	*Helophilus sp*
large milkweed bug	*Oncopeltus fasciatus*
long-legged fly species	*Condylostylus spp*
may beetle	*Phyllophaga spp*
sirex wood wasp	*Sirex noctillio*
oleander aphid	*Aphis nerii*
plain-faced drone fly	*Eristalis arbustorum*
transverse flower fly	*Eristalis transversa*
white-banded flower fly	*Eristalis dimidiatus*

Avifauna –Breeding bird diversity is low but representative of an urban woodland setting in the northeastern United States. GWC supports common native and non-native species that are well-adapted to city life and park-like settings. The most common/abundant breeding native birds on site are American robin, northern mockingbird, and blue jay. By far, the most common non-native species is the European Starling, followed by house sparrow and rock pigeon. Native, open-woodland and edge-adapted species, such as white-breasted nuthatch and indigo bunting, are well represented within suitable habitat areas, respectively. Overall site acreage and the patchiness of lawn/woodland likely play a key role in supporting a variety of these species that are less well-adapted to urban parks and green spaces but are still relatively hardy resident species in natural settings. At Green-Wood there is high potential to increase breeding bird diversity via native plant community establishment, especially understory tree and native forb/graminoid communities.

GWC remains an exceptional place to observe not only regular, but also uncommon, migratory passerine in the spring and fall months. The geographic positioning of New York City, which lies between the ocean and Hudson River within the Atlantic Flyway, coupled with its limited parcels of green space, has long resulted in notable migration stopover events in city parks (Seewagen, 2008). Prospect Park and Central Park are better known for these events, but Green-Wood provides a similar draw to migrant birds flying overhead looking for a green space to drop in and fuel up while in migration. Central Park has a large water body system that attracts additional bird guilds (waterfowl, gulls, and shorebirds), but the potential for songbird stopover habitat is roughly equivalent at Green-Wood and Prospect Park. Prior to fall migration, Green-Wood supports local dispersal activity by breeding birds. During this time hatch-year birds and adults of flocking migrant species will gather en masse and flock-forage while in preparation for migration. Large seasonal movements of certain species are commonly observed. Northern flickers are abundant in August at GWC after the young have fledged from nest cavities. The patchiness of the woods and lawn areas are supporting these ground foragers that are nesting in, and likely, outside of the gates. Three species categorized as "blackbirds" behave similarly (red-winged blackbird, common grackle, and European starling) in the late summer months.

There is a scarcity of true forest-breeding species at Green-Wood in the summer months. There are no significant patches of trees that constitute a large enough block to support these species. Further, there are understory canopy and forest floor dynamics that are critical habitat elements for forest birds that are absent or impeded throughout Green-Wood, much like in most urban parks and public gardens.

Birds are a reliable and significant indicator of overall ecosystem health (O'Connell et al., 2000a; O'Connell et al., 2000b; Blair, 1999; Kati, 2004; Butler et al., 2012; Butler et al., 2014; Mikusinski et al., 2001). As stewardship continues in the natural areas, supporting interior forest breeding birds should not be a goal, but rather, enhanced edge habitat, shrub thicket, and woodlot bird species should be identified as indicators of successful habitat management. This avifaunal survey effort should be repeated after ecological improvements are enacted at GWC to determine if onsite habitat is more of a limiting factor than local diversity.

Herpetofauna – Even when considering the urbanized nature of the site, the overall diversity of reptiles and amphibians is low. No snakes were observed during our study. Snakes have a lower detection probability than many other faunal groups (Durso et al., 2011) and can require intense studies to confirm presence/absence. Two species, the eastern garter snake (*Thamnophis s. sirtalis*) and the northern brown snake (*Storeria dekayi*), are common in the region and resilient in urban settings (Kjoss and Litvaitis, 2000; McGraw pers. obs.). We cannot state with confidence that no snakes are present on site without a more intensive study. However, from anecdotal observations over many years and the considerable search effort put forth in 2017 for snakes or evidence thereof, it is possible there are no snakes present on the site. At this time we speculate that eastern garter snakes may be locally extirpated and that northern brown snakes may remain present at Green-Wood, but this requires confirmation.

Frog populations are low and limited to the most hardy/tolerant true frog species; a population of *Lithobates* frogs survives at Dell Water. The depth of sediment in the water body likely serves as overwintering habitat for these individuals, facilitating survival (Collins and Lewis, 1979). The low diversity and population numbers are likely due to a variety of factors, including the lack of emergent vegetation and the presence of hardscaped banks at most water body margins, which results in a pitfall-like scenario where animals can get in but not out of the water body. With limited structural habitat within the walls (ex. wetland, logs, rocks, etc.) there is little to support trapped individuals. Proposed wall breaches and native plant community establishment would directly support an increase in amphibians on site by allowing for increased survivorship of extant populations. Northern gray tree frog (*Hyla versicolor*) and northern spring peeper (*Pseudacris c. crucifer*) can be abundant in urban settings (Price et al. 2004) but are absent from GWC. This may be due to a variety of reasons, including leaf litter removal, chemical use in vegetation management, frequent mowing and lawn maintenance, and a lack of critical breeding and egg development habitat (wetland vegetation) in the water bodies. Heightened predation pressure from an overpopulation of raccoons is also a likely contributor to missing herpetofauna. Following certain interventions, Green-Wood could be a candidate site for re-introduction of spring peepers and/or northern gray tree frogs. Proposed restoration actions involving upland/wetland connectivity, emergent vegetation establishment, and mammal population control would make it reasonable to consider a reintroduction of these iconic amphibians via egg translocation (Germano and Bishop, 2008).

The composition of turtle species is overwhelmingly invasive, with only one native species present: the common snapping turtle. Red-eared sliders are one of the 100 worst invasive species by the International Union for Conservation of Nature (IUCN) and are present in all of Green-Wood’s water bodies. This species' aggression, adaptability to environmental variability, size, fecundity, and omnivorous diet leads them to out-compete native turtle species and pose considerable negative impacts on native ecosystems. In conjunction with their population density, they feed on aquatic vegetation and small aquatic vertebrates, which impairs the water quality, and subsequently, negatively impacts the aquatic communities within Green-Wood's water bodies.

Efforts to reduce and control the red-eared slider populations will begin in spring 2019.

Mammals – The diversity of mammals at Green-Wood cannot be fully determined without a more robust small mammal study. A Sherman live trap study was attempted in 2018 but failed to sample any small mammals due to excessive tampering, presumably by raccoons. Pitfall trapping or track pads might provide added insight, but the cost/benefit comparison of this effort questions the return on investment. It was evident at the project inception (Fall 2016) that two species, groundhog and raccoon, were overpopulated and causing negative impacts to the ecosystem as a result. Groundhogs were trapped and removed in a systematic fashion in late 2016. The frequency with which groundhogs were observed on site was noticeably reduced in 2017. Raccoons remained in overabundance until a concerted trapping effort occurred in 2018. Raccoons were the second most commonly observed mammal species, with gray squirrels being only slightly more regularly observed. With a marked reduction of raccoons on site it is hypothesized that there will be a population increase of amphibians in the short-term and, possibly, the ability to reintroduce common snake species into the ecosystem.

Eastern gray squirrel is the most frequently observed mammal species at GWC. Green-Wood is optimal gray squirrel habitat with abundant mast-producing trees and mowed lawn within an urban setting. Predation by red-tailed hawks is confirmed on site. Great-horned owls are also known to predate squirrels to a lesser extent. Colonization by red fox or coyote may help control the squirrel population in future years.

It is feasible to assume that eastern coyote will eventually colonize the site. Our studies did not confirm presence of coyote during the 2016-2017 study effort. Future studies should be done to continue tracking this pending colonization. It would be interesting and of great scientific value to compare groundhog and raccoon population data (plus other groups) before and after any colonization by coyotes, since both are documented prey items for eastern canids (Gompper, 2002). Coyotes colonizing Green-Wood would likely help naturally mitigate the overpopulation issues from raccoons and groundhogs, a problem that is currently mitigated by episodic trapping and removal efforts.

Bats are quite active in the summer breeding months. Six species were confirmed on site, constituting nearly two-thirds of the diversity of bats known to New York. Big brown bat and eastern red bat were most commonly observed along waterbody margins near tree lines. Evening bat was most commonly observed foraging below the tree line on upland tree/lawn edges in the eastern and northern parts of the property. Evening bats are not known to New York, and thus further surveying is required to verify their presence at GWC. No observed bat species at Green-Wood warrant New York State or Federal protection, although bats in general have been experiencing precipitous declines in northeastern, Midwestern, and southern states in recent decades. That six species are present at Green-Wood is a positive natural history element and efforts should be made to support and promote bat communities on site, such as erecting bat boxes, creating emergent wetland habitat, and establishing native plantings near water bodies. Reliable water, many live roost trees, abundant insects, and a wide array of man-made/artificial structures for roosting and rearing young are all present on site. An inspection of the Catacombs, Receiving Tomb, and boiler rooms showed they had been cleaned and restored. Prior to improvements it is believed that many bats would roost in these locations, including the receiving and 30 vaults (Green-Wood Security Personnel; Pers. Obs).

Insects – Moth data was completed in spring of 2018. No rare species were found. It's highly encouraged that Green-Wood continue this survey effort in the coming consecutive years to better understand the site's Lepidoptera population. There are certain families of moths that are known to not come to bucket traps or sheets, such as *Catocala* and *Papaipema*. These species are best surveyed actively in the tree canopy. The moth study revealed many non-native and pest species but also some native species that are considered uncommon for the region. The diurnal insect data collection reflected concentrations of native butterflies, beetles, ants/wasps, bees, and flies that were strongly related to the proximity of areas with native herbaceous and graminoid species. The diversity of butterflies observed at Green-Wood indicates that some locations are providing suitable leaf litter accumulation for cocoon development and successful metamorphosis. No species observed suggest rare or unique host plant-relationships. However, multiple native plant generalists that depend on a variety of native plants were documented. Many of the observed butterflies feed on oaks and beeches and are likely supported by the many Fagaceae specimens in the cemetery. Adult monarchs migrating through GWC were observed feeding on species of Asteraceae that were in bloom in September and larvae were observed feeding on ***Asclepia spp***. The dragonflies observed were almost entirely migratory species. The dearth of emergent wetland habitat, which is critical for egg deposition and larval development of most dragonfly and damselfly species, reflects the lack of breeding ***Odonata*** species. Wetland enhancement in the water bodies would likely result in a robust increase in native insect species richness and abundance. As critical primary and secondary consumers, this would have positive effects up the trophic web of Green-Wood's ecology. Explicitly, more insects support more birds, amphibians, mammals, etc.

At the inception of this study both Green-Wood and AES agreed that a wildlife survey should be used to inform management decisions and help to improve both ecological function and the visitor experience (via educational, wildlife watching, and aesthetic potential). To that extent, we have identified 18 management and ecological restoration recommendations that were derived from both the species presence/absence and our team's interpretation of the ecological condition and contextual potential for improved function. These are listed below with descriptions and some suggestions for implementation and associated details. For three water resources-based recommendations, we have provided some renderings prepared by an AES ecological designer to help illustrate the concepts.

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1. Sylvan Water Ecological Restoration–Map A

In its current state, Sylvan Water is the largest water resource on site. It is also the only water body that is not physically disconnected entirely from the adjacent terrestrial landscape via a retaining wall. The immediately surrounding land use is mowed turf grass, creating a harsh transition from open water to mowed lawn. There are forested slopes adjacent to three sides of Sylvan Water just beyond the mowed lawns. Two identified locations within the margins of Sylvan Water are prime to establish emergent wetland and physically connect the open water to the surrounding forested slopes using ecological restoration practices that do not conflict with family-owned mausoleums (Map A). This presents an opportunity to connect the wooded uplands to this glacially-derived water body and provide safe corridors for a wide variety of native wildlife (Semlitsch and Bodie, 2003; USFWS, 2000). Benefits would not only include the positive effects of habitat creation, but also mitigate existing nuisance wildlife issues.

Anticipated Ecological Benefits:

- Minimize/eliminate Canada goose loafing and resultant deleterious effects.
- Create connectivity for upland terrestrial species to access water without crossing lawn.
- Create adequate turtle basking habitat.
- Improve water quality via upper watershed infiltration and phytoremediation by wetland plants.

- Provide wood duck critical nesting habitat
- Increase songbird nesting
- Increase fledgling bird foraging habitat (critical!)
- Create designated critical turtle nesting habitat
- Create critical Odonata and Coleoptera ovipositing, foraging, and larval development habitat.
- Provide natural area where myriad insects and small vertebrates can overwinter and forage.

2. Dell Water Ecological Restoration–Map B

Dell Water and the surrounding wooded landscape is, without question, a biodiversity hot-spot: it is the only location in Green-Wood where obligate wetland plants occur when the water table drops low enough seasonally. The retired road circling the water body allows for more leaf litter retention in and near the adjacent wooded slopes than all other locations on site. The retaining wall drastically disconnects the terrestrial surroundings from the water resource, allowing only larger mammals and birds access without the risk of pit-falling and being trapped (Rothermel, 2004; Semlitsch, 2008; Semlitsch and Bodie, 1998). This location and proposed restoration project offers significant potential for ecological connectivity, increases wildlife and plant diversity, and increases wildlife populations overall (Alvey, 2006; Simmons et al., 2015; Vidra et al., 2007). Anticipated benefits include all the aforementioned in Project #1 and would also allow for the protection of the extant eastern red-backed salamander population found in this location. The proposed components to this restoration can be phased:

- Trail reduction and restoration of the tow of the wooded slope.
- Breaching the retaining wall and creating a physical ingress/egress for fauna.
- Native meadow installation.
- Invasive woody plant removal (*Acer platanoides*) and forested slope restoration to oak-hickory woods. Native trees are critical to increasing and sustaining native insect populations (Sobek 2009).

Implementation of these proposed restoration actions at Dell Water are reviewed as high priorities (Figure 41) from and ecological perspective based on the results of the faunal inventories. There is a significant probability of enacting quantifiable benefits to wildlife populations, wildlife diversity, aesthetic value, visitor experience, and educational programming. To further consider this effort

Stacey Libra, RLA, provided a profile view, as well (Figure 42). While the slopes are notional in this depiction, the sequence of features is correct.

3. Cescent Water Naturalization and Restoration–Map C

Adjacent to Dell Water, Crescent Water is also surrounded by an artificial wall, albeit a shorter one. Rather than breach the wall in this location, the construction of "wildlife ramps" may serve a dual purpose of allowing animals to enter and exit the pond as well as provide space to bask and thermoregulate (Peterman and Ryan, 2009). Locations for meadow buffer enhancements and the most suitable locations for designing turtle nesting habitat are identified in Map C. The meadow buffers can provide multiple ecosystem service benefits such as storm water management, sediment and pollutant reduction in the adjacent water body, and improved pollination and plant health (Water Environment Federation, 2012; Salisbury et al., 2015).

4. Valley Water Naturalization–Map D

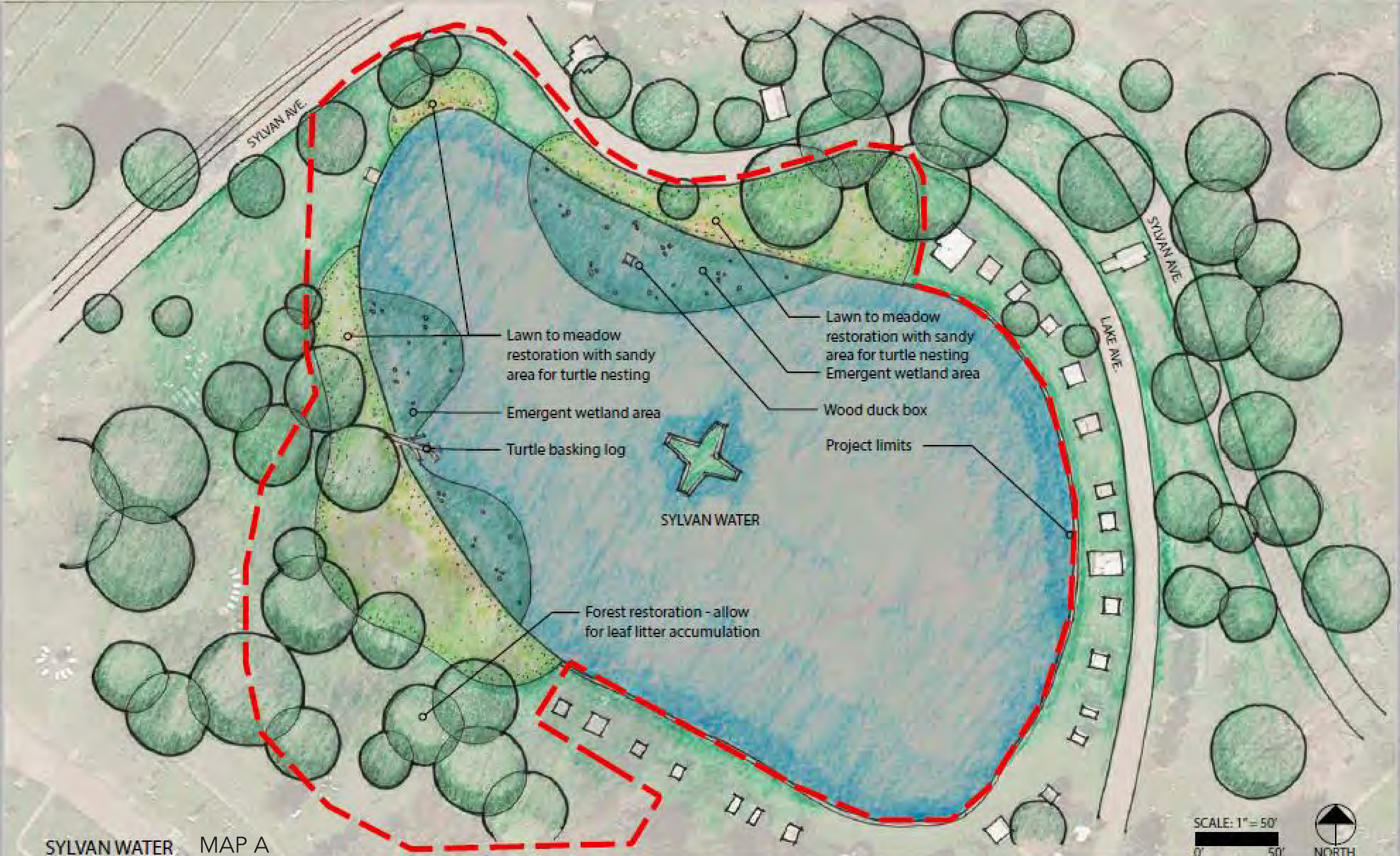
Similar to Crescent Water, the construction of "wildlife ramps" to serve a dual purpose of allowing animals to enter/exit the pond as well as providing more area to bask/thermoregulate is also appropriate for Valley Water. In addition, select areas along the water body margin have been identified as ideal areas to design and construct a littoral shelf to increase plant diversity, provide new aesthetics, and to support key aquatic insects and wetland associated birds and herpetofauna (Figure 44). This would increase support for the extant frog population in this pond and provide new habitat for additional species. Emergent wetlands are the "kidneys of the ecosystem" and provide vital services for maintaining water quality (Keddy, 2010). This pond is near the main entrance and as a result many visitors pass it (by car and on foot). Existing plantings of sweetbay magnolia (*Magnolia virginiana*), pawpaw (*Asilima triloba*), and common milkweed (*Asclepias syriaca*) around Valley Water is a great example of using native plants in the landscape. The population of native pollinators in these gardens is very high and, relatively speaking, very diverse (see diurnal Lepidoptera survey details in Section 4.0). The inclusion of a wetland feature and enhanced native plant buffers to this water body can be designed to maintain a "clean" and inviting look, but also provide ecological value (Costanza et al., 1997). This is also a prime location to consider educational signage associated with any ecological restoration.

5. Head Start Tree Recruitment in Woodlots

Historically, the forested slopes and hilltops within this region and geology supported a wide variety of spring ephemeral perennials, such as trilliums (*Trillium cernuum, Trillium erectum)*, bloodroot (*Sanguinaria canadensis*), trout lily (*Erythronium americanum* ssp. *americanum, Erythronium albidum),* and bellwort (*Uvularia perfoliata*, *U. puberula*, *U. sessilifolia*), to name a few (Gleason and Cronquist, 1991). An opportunity exists to consider re-introducing some of these plants back into the landscape at Green-Wood, not only for the ecosystem services they provide, like soil erosion and habitat, but also for the aesthetic purposes, as well. Using native, local genetic material is always encouraged, due to positive correlations with native fauna (Ehrlich and Raven 1964) and plant hardiness (Skalova et al., 2011).. A proposed approach would involve coordination with Greenbelt Native Plant Nursery to determine the availability of seed within a 25 mile radius for various species.

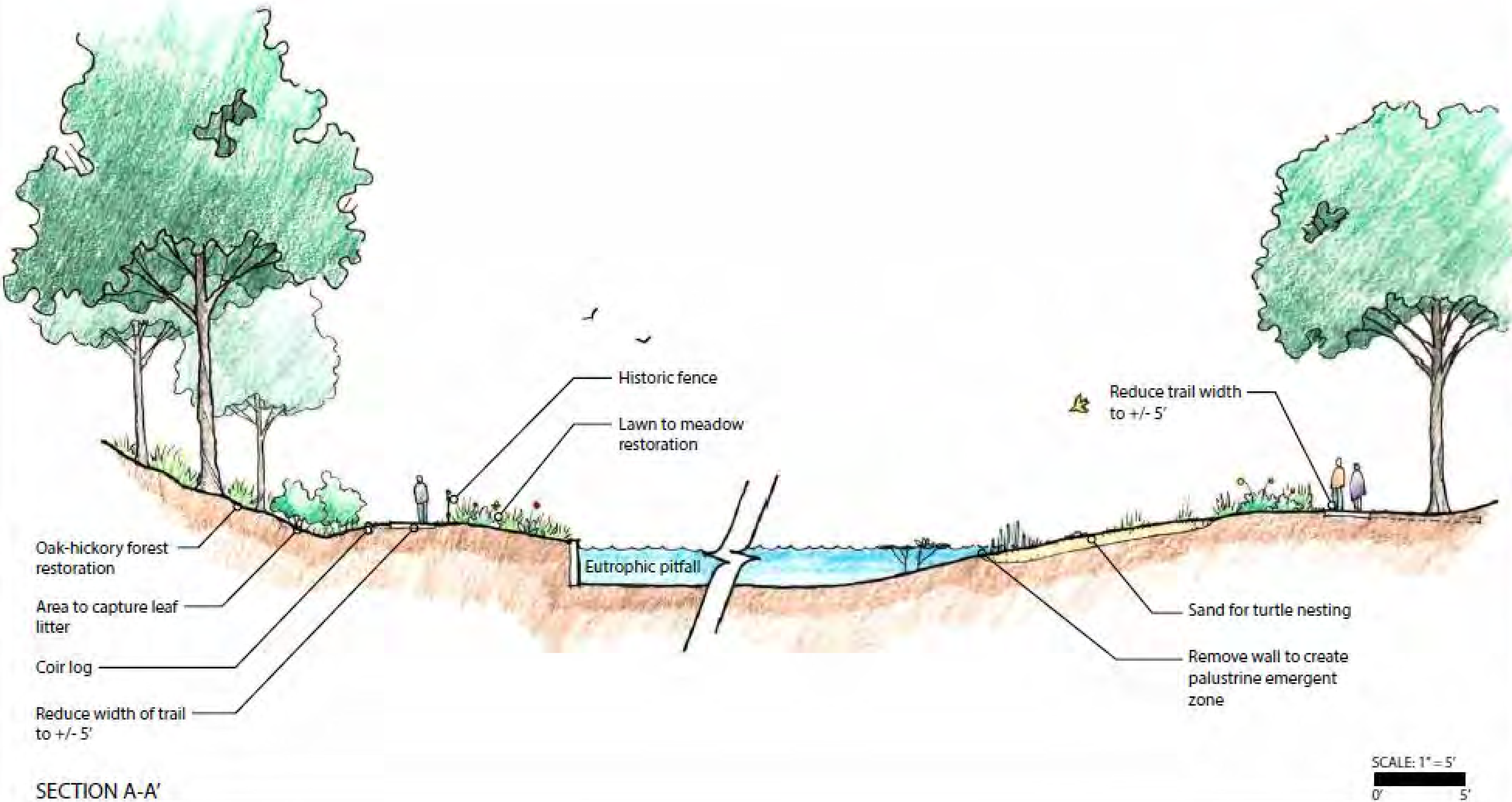
6. Woodland Connectivity

There are very few wooded sections of the site that are connected via safe corridors for small vertebrate mammals. Green-Wood mows most of the property to maintain the open, more traditional setting that dominates cemetery aesthetic nationwide, creating harsh edges around the woodlots. AES recommends a conceptual approach to identifying key connector areas where promoting the naturalization of all vegetative strata, which would allow for nutrient cycling therein by not removing leaf litter, adding chemicals, or labor, would conceivably increase connectivity for small vertebrates and non-volant insects. This connectivity increases the success of these species by reducing the amount of harsh edge between the woodlots and the more open areas, which would result in an increase in access to a diversity of resources including food and water, decrease competition between individuals, reduce brood parasitism, and reduce the risk of predation by providing cover (M. Fleury and Brown, 1997; Wilcove et. al, 1986). Facilitating the mobility of wildlife and expanding their resources throughout Green-Wood's landscape is vital to sustain them.

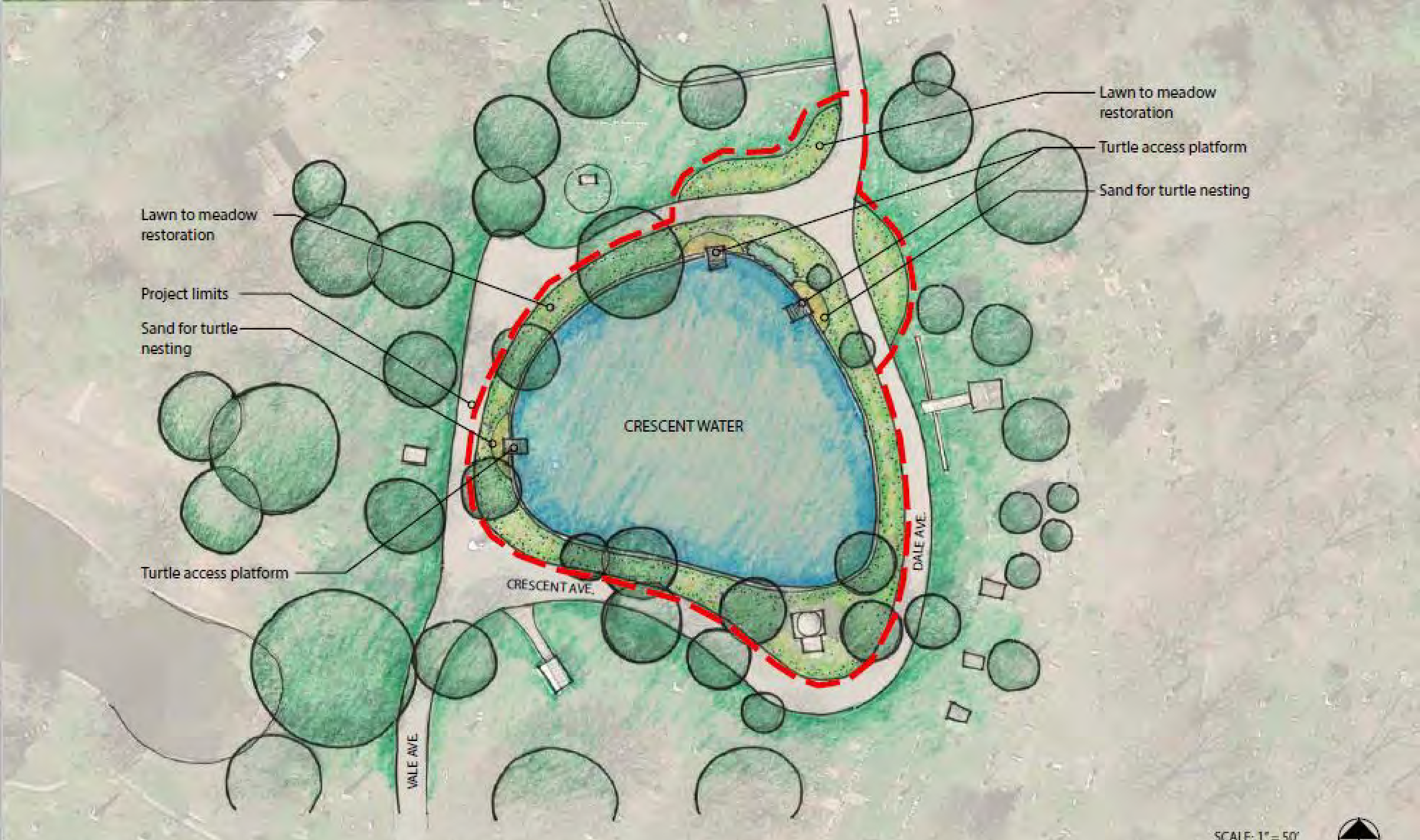


SYLVAN WATER MAP A

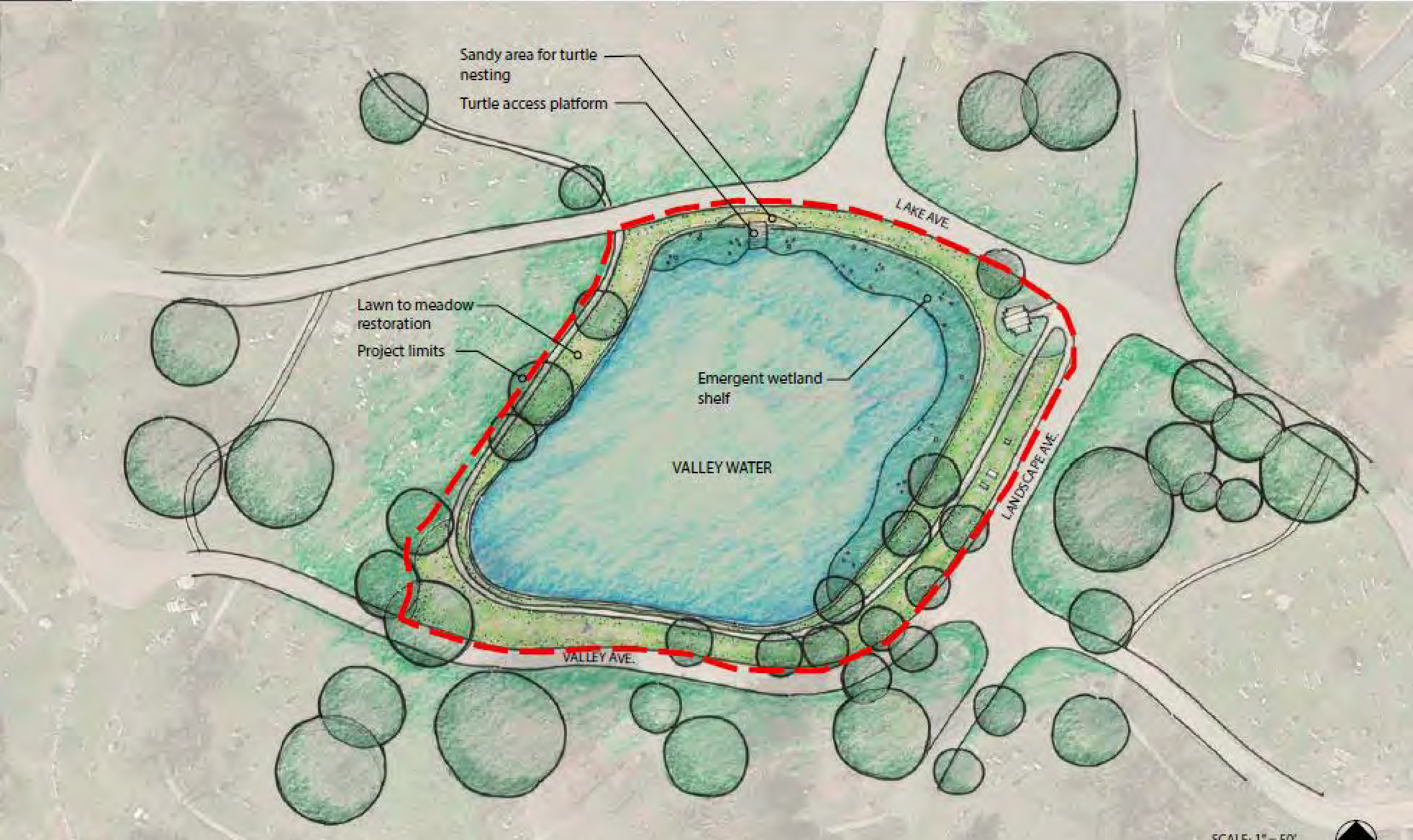
DELL WATER MAP B


Historic fence
Lawn to meadow restoration
Reduce trail width to +/- 5'
Eutrophic pitfall
Oak-hickory forest restoration
Area to capture leaf litter
Coir log
Reduce width of trail to +/- 5'
Sand for turtle nesting
Remove wall to create palustrine emergent zone
SCALE: 1" = 5'
0'
5'

SECTION A-A'



CRESCENT WATER MAP C



VALLEY WATER MAP D

1. Leaf Litter Retention in Natural Areas and around Planted Trees as Native Mulch

All natural systems have cyclic processes that have evolved and have been refined over millennia. In temperate region deciduous forests, leaf litter plays an extremely critical role for both deciduous trees (Vild et al., 2015) and the entire faunal and microbial ecological communities that live adjacent (Bernays and Graham, 1988). Decaying leaves release valuable nutrients that are fed on by microbes, fungi, arthropods, and insects. The leaves are broken down into chemical forms of parent nutrients that are plant-available via root uptake. Further, the varying states of decaying leaves put organic carbon back into soils and provide a three-dimensional, diverse sub-ecosystem. Most native butterflies and moths (Lepidoptera), and beetles (Coleoptera), of which both families appear under-represented on site, rely directly on leaf litter for completing their life cycle. Near the top of this sub-community trophic web is the eastern red back salamander (Walton and Steckler, 2005). Our preliminary data suggests that this species is still extant but likely in peril. Efforts to cease leaf litter collection in certain areas, such as Dell Water hillslopes, Sylvan Water hillslopes, and all woodlots, will have considerable positive impacts to the trophic web and flow of nutrients through the entire system including flora, fauna, and abiota (Vild et al. 2015). This recommendation involves the cessation/modification of existing efforts which offer observable cost savings as related to maintenance labor, fuel/equipment costs, loading/hauling, etc. Since Green-Wood must maintain its historic character and continue to provide memorial services, distance from roads and other aesthetic concerns must be considered as counterbalances of the ecological driver when siting these areas.

2. Retire Select Roads

Roads take up around 44 acres of surface area within Green-Wood and fragment natural transition zones. An internal traffic analysis that includes safety concerns and ecological variables is recommended for Green-Wood to determine which roads can be retired.

3. Identify Locations for Lawn-to-Meadow Conversions

Existing ongoing efforts are related to the implementation of native meadows at GWC. It is highly recommended that more turf-to-meadow conversion demonstrations and experimental plots be implemented using a combinations of short, native, cool and warm season grasses, maintained, and studied. Results of these native meadow plots could then be used to scale the effort appropriately throughout Green-Wood. Resultant faunal and ecosystem service impacts (ex. water holding capacity and organic carbon sequestration of soil) support visitor education and programmatic opportunities (Gulay Ogelman, 2012). Additionally, this can contribute to the body of work that is driving modern cemetery management and stewardship (Horvath et al., 2007; Vezzani, 2007; Cloke and Owens, 2004; Casler, 2004). A project similar to the proposed offers potential for conducting various comparative research projects (mowed lawn versus meadow conversion) in conjunction with this effort, such as:

- Soil organic carbon and water retention/infiltration capability
- Soil microbe diversity
- Insect and springtail abundance and richness (larval and adults)
- Bird species foraging rates
- A-Horizon development and significance for insects

4. Groundhog Population Control

Groundhogs have been a nuisance animal on the property for many years (Charap, pers. comm. 2016). The overpopulation of mammals can result in or occur from ecological imbalances (Speed et al., 2009; Dutta et al., 2017). The burrowing behavior of groundhogs results in soil instability and disturbance that promotes invasive plant colonization (English, 1994), and specific to the site, occasional excavation of human remains. Green-Wood hired a professional to trap and remove groundhogs in 2016 which markedly reduced the onsite population (32 individuals removed in two weeks of trapping). With a life expectancy of approximately four years, trapping efforts should be conducted every two to three years to prevent overpopulation. Few natural predators (red-tailed hawk and great-horned owl) occupy the site and assist in population control and stewardship of these predators should continue.

5. Raccoon Population Control

Before the trapping and euthanization effort in 2018, the density of raccoons in GWC was very high. Effects of this removal are to be determined through future monitoring, but it is suspected to have positive ecological benefits. Raccoons in high densities can impact vegetation and wildlife populations through foraging, especially frogs and snakes (Rulison et al., 2012), which are observably low in diversity and population count. The access to human refuse as a food source in

Green-Wood and in the surrounding city blocks attribute to supporting the high populations density. Various man agement changes may aid in continuing a reduced population of raccoons, such as:

- Modifying the trash receptacles to exclude raccoon access.
- Repeating trapping effort to reduce the current population (similar to the removal effort in 2018).
- Supporting any colonization of Green-Wood by red fox or coyote.

6. Red-eared Slider Population Control

Red-eared sliders are the most abundant turtle species on site. They negatively impact the water quality of the ponds and are notorious for outcompeting native turtle species for critical basking locations. We suggest conducting an intensive trapping study where select criteria are set for incremental removal of an (to be determined) amount of adult sliders from the site. Due to the sensitivity of this topic, a phased population reduction in concert with other ecological projects should be carried out over the next 5-10 years. The currently accepted humane methods for euthanization of this species, as defined by the NYSDEC and NYSDEP, are freezing the animal followed by vertebral separation. After the reduction in red-eared slider populations and modifications around the water bodies are completed (refer to Management & Ecological Restoration Recommendations 1-4), Green-Wood may succeed at the reintroduction of native turtle species.

7. Stewardship of Existing Salamander Population

The status of the extant salamander population is uncertain and long-term population surveys to determine the status of this species is advised. The holistic restoration recommendations above will have positive benefits to this population but it would be wise to collect data to examine this hypothesis. A study using cover boards and morphometrics in 2018 was designed and implemented. Under the supervision of AES, The New York Botanical Garden conducts a similar survey, and we see great benefit in replicating much of this effort at Green-Wood. Both citizen science and Green- Wood staff integration can help reduce project costs, engage stakeholders, and elevate awareness of this unique natural heritage on site. Currently, the boards are deployed and have been checked in the spring of 2018 (no salamanders observed). The boards were again checked on October 18, 2018. A total of ten salamanders were captured, measured, and released. This survey may be utilized to engage the public and recruit citizen scientists at Green-Wood.

8. Monk Parakeet Population

A colony of monk parakeets has been nesting on the spires of the Gothic Arches for many years. Deleterious effects to the historic structure are a result of the weight and size of the communal nest and, presumably, from the collection of fecal matter therein (causing increased weathering of the edifice through acidification). Artificial nest structures for relocating colonies have not been very successful in the past. Studies in Chicago show that monk parakeets have no negative effects on native bird populations (Appelt et al., 2016), although local competition for food resources is evident. This species has established feral colonies in cities around the world (Appelt et al., 2016). Studies have shown behaviors that indicate naturalization and a semblance of metapopulation dynamics in the southern and eastern United States (Buhrman-Deever et al., 2007). The opportunity to coordinate with this research effort to investigate behavioral relationships to nearby colonies in areas such as Bronx, NY and Connecticut is valuable to the scientific community researching the species.

9. Artificial Habitat/Breeding Boxes

There are specific locations at Green-Wood that may be appropriate for the installation of artificial nest boxes to increase nesting habitat for breeding birds (Map 8). The species prioritized for these nest boxes are American kestrel, eastern bluebird, black-capped chickadee, eastern screech owl, house wren, wood duck, and all present bat species.

10. Migratory Stopover Habitat Improvements

Green-Wood boasts a great diversity of migrant passerines in the spring and fall months. This is an attractive feature that brings many regular and new visitors to the cemetery each year. With increasingly limited stopover habitats in the region for migratory birds (Dettmers and Rosenber, 2000), Green-Wood has great potential to sustain and increase its migratory bird population through native habitat stewardship and the resultant boost in the trophic web (i.e. increased native plants equals increased insects/food for migrants). Enacting the recommended restoration and management projects will support an increase in healthy structure, food, and water sources for these animals (Nagy and Holmes, 2005).

11. Breeding Birds

Breeding bird diversity at Green-Wood is typical for an urban park setting. There is a distinct lack of ground-nesting and interior forest breeding species that are breeding in NYC within unmanaged forests with minimal trails, such as the Thain Family Forest (NYBG) and areas in Central Park near The Ramble. Breeding bird diversity is comparable to that of nearby Prospect Park but is limited by the paucity of unmanaged forest, wetland habitat, and functional water bodies. The baseline of breeding bird data provided in this report enables GWC to now use breeding bird diversity and abundance as indicators of habitat condition moving forward (Eglington et al., 2012). The presence of certain species can suggest thresholds for habitat size and fragmentation in northeastern forests. Using threshold models for generalist forest breeding birds in our region (van der Hoek et al. 2015) and comparing our breeding bird data in this study, Green-Wood has areas that fit within two categories: High Fragmentation/Low Forest Cover and Low Fragmentation/ Low Forest Cover. Specific bird species that were not observed breeding on site during the survey could serve as indicators of successful forest restoration and defragmentation of habitat (Table 20). Creating missing habitat types (ex. emergent wetland) and restoring missing elements to the existing natural areas (ex. native shrub thicket, native meadow, herbaceous ground story, and "teenage forest" structure) can increase the breeding bird species richness on site (Rich et al., 2004; Beissinger and Osbourne, 1982; Donnelly and Marzluff, 2004; Blair, 1999; Kati, 2004). As with forest habitat, target birds can indicate the functionality of various habitat types (Table 21)

Table 20. Proposed Target Breeding Birds as Indicators of Future Forest Restoration Initiatives at Green-Wood					
Common Name	Genus	Species	Currently Observed in Migration	Indicator of Reduced Fragmentation	Indicator of Increased Forest Cover
hermit thrush	*Catharus*	*guttatus*	YES	NO	YES
veery	*Catharus*	*fuscescens*	YES	NO	YES
blue-headed vireo	*Vireo*	*solitaria*	YES	YES	YES
least flycatcher	*Empidonax*	*minimus*	YES	NO	YES
pileated woodpecker	*Dryocopus*	*pileatus*	NO/ Resident	NO	YES
ovenbird	*Seiurus*	*aurocapillus*	YES	YES	YES

Table 21. Proposed Target Breeding Birds as Indicators of Future Restoration Success by Habitat Type						
Common Name	Genus	Species	Currently Observed in Migration	Shrub Thicket	Emergent Wetland	Old Field
blue-winged warbler	*Vermivora*	*cyanoptera*	YES	X		
chestnut-sided warbler	*Setophaga*	*pennsylvanica*	YES	X		
indigo bunting	*Passerina*	*cyanea*	YES	X		
field sparrow	*Spizella*	*pusilla*	YES			X
yellow warbler	*Setophaga*	*petechia*	YES	X	X	
marsh wren	*Cistothorus*	*palustris*	NO		X	
red-winged blackbird	*Agelaius*	*phoeniceus*	YES		X	

The long history of The Green-Wood Cemetery as an oasis of "green" in an increasingly urbanized environment over the past 250 years, coupled with its unique geographic positioning, sustain its value for migratory birds. Breeding bird diversity can be increased through improved forest conditions and the establishment of wetland habitats. GWC is one of the very few green spaces in Brooklyn of its size. Others in the borough of comparable size include Prospect Park (near adjacent to the northeast), The Cemetery Complex/Highland Park (farther northeast), and Marine Park/ Floyd Bennett Field (to the southeast). From a migratory bird's perspective, the proximity to Prospect Park likely increases Green-Wood's collective value as a stopover location.

The inherent variables that disrupt ecosystem function in a maintained urban landscape are chronic traditional lawn maintenance practices that affect soil-dependent invertebrates, hydrophobic soil conditions from hydrocarbon emissions (Thornes 19 74), road fragmentation, and invasive species. This study provides a baseline of faunal communities at Green-Wood to inform ecological conditions over time as modifications to land use and maintenance occur. Additionally, these data support educational and interpretive opportunities to enhance visitor experience (ex. mobile application development). The proposed maintenance, management, and restoration recommendations, if executed, will increase critical habitat and support native wildlife, and subsequently increase GWC's floral diversity. These recommendations are primarily prescribed for the water bodies and areas around and within the woodlots because these are the most important locations for sustaining the current wildlife populations. Additionally, converting areas of turf lawn to native graminoid-dominant areas is believed to have positive impacts on native wildlife with no predicted increases of nuisance populations. A literature review related to the on-site nuisance wildlife (Canada goose, European starling, raccoon, and groundhog primarily) supports that native meadows are less exploitable and less preferred than mowed lawn/turf.

Native plantings at Green-Wood are overwhelmingly visited by native pollinating insects and, in turn, insectivorous invertebrates and vertebrates. Connecting the upland habitat with the water bodies through native plantings is important for increasing wildlife habitat and beneficial wildlife population. Green-Wood has enacted various study recommendations and native planting initiatives, which are notable testaments to their commitment to ecological and wildlife stewardship. Now that baseline wildlife data exist ongoing, project-based restoration efforts are highly encouraged.

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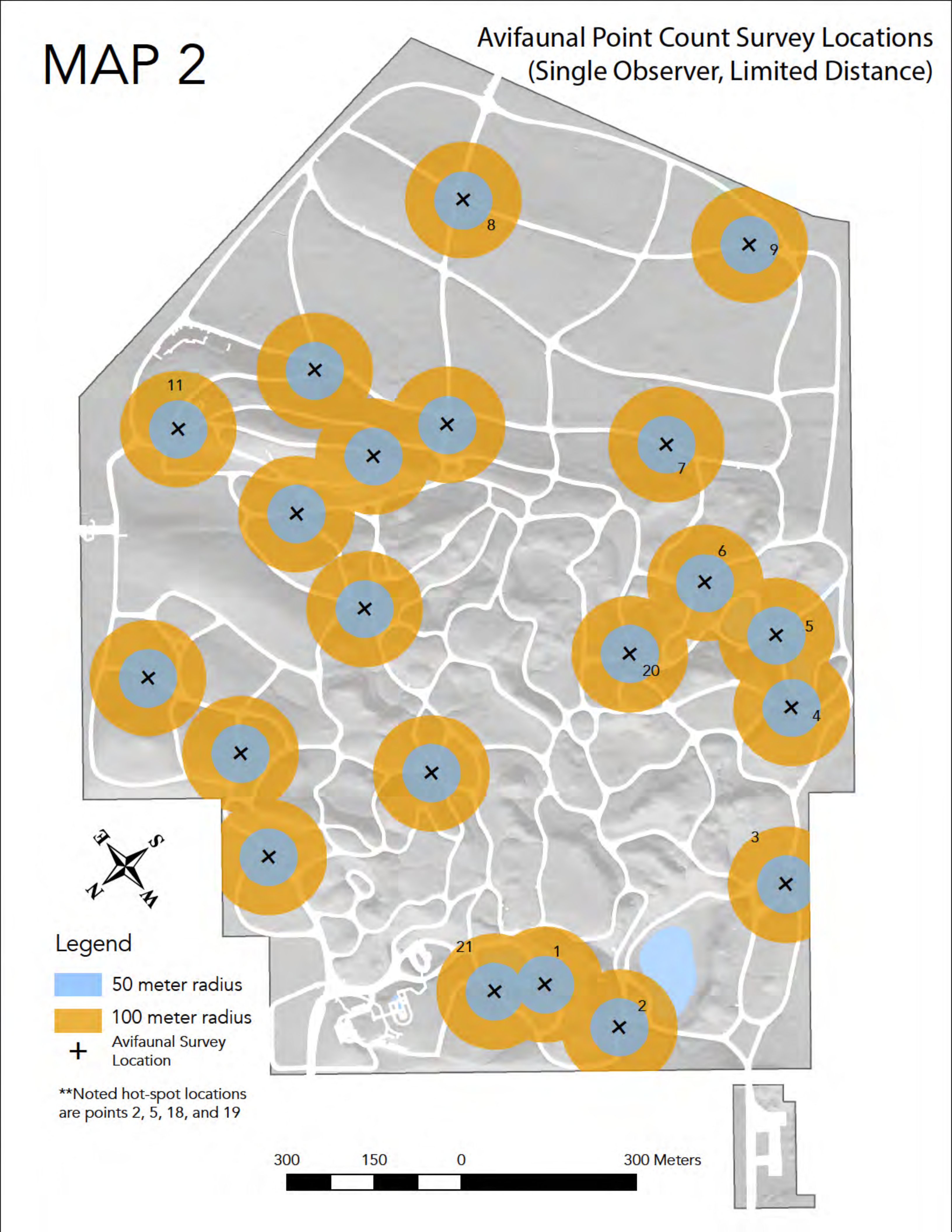
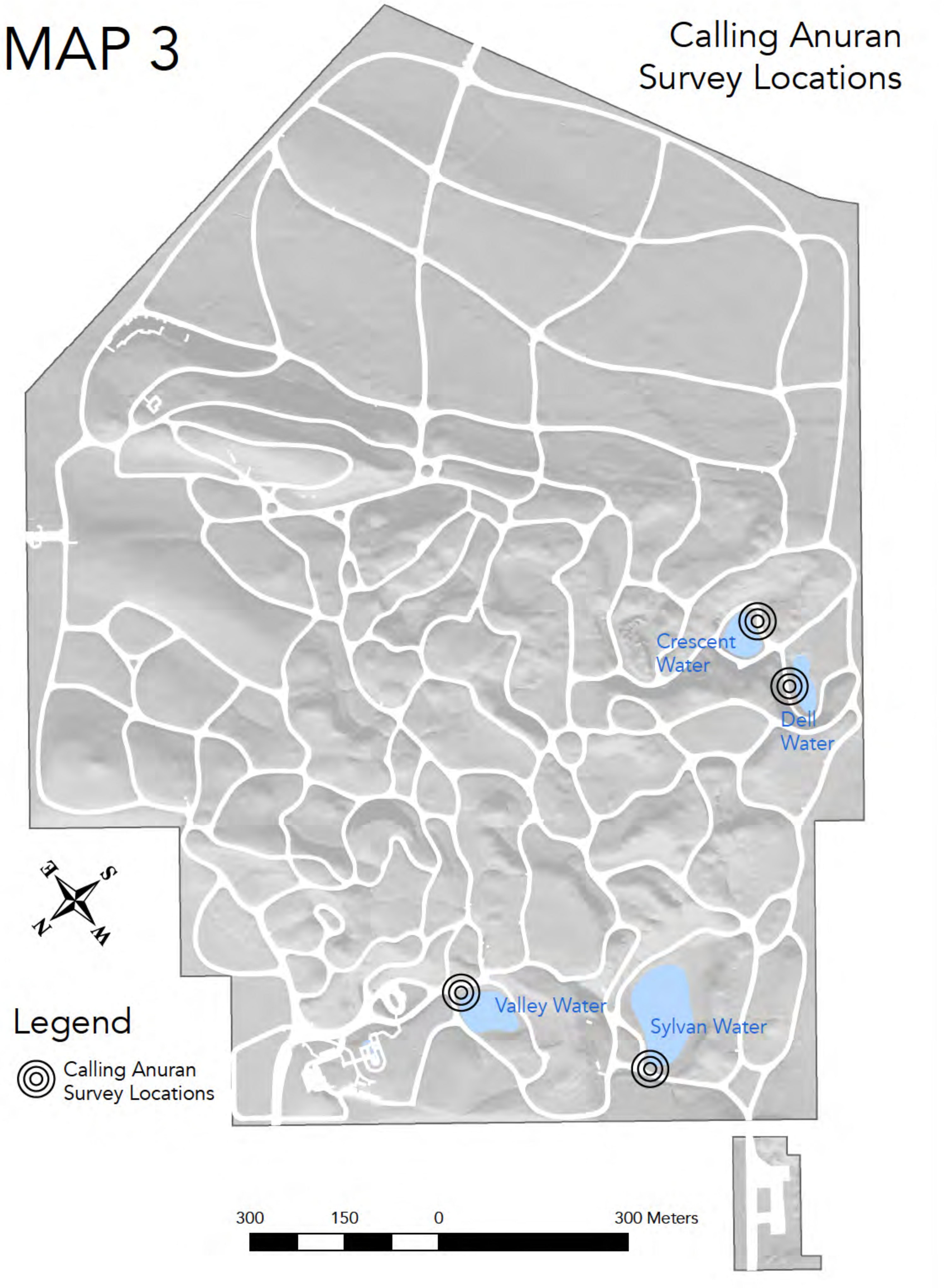
MAP 1

Site Location



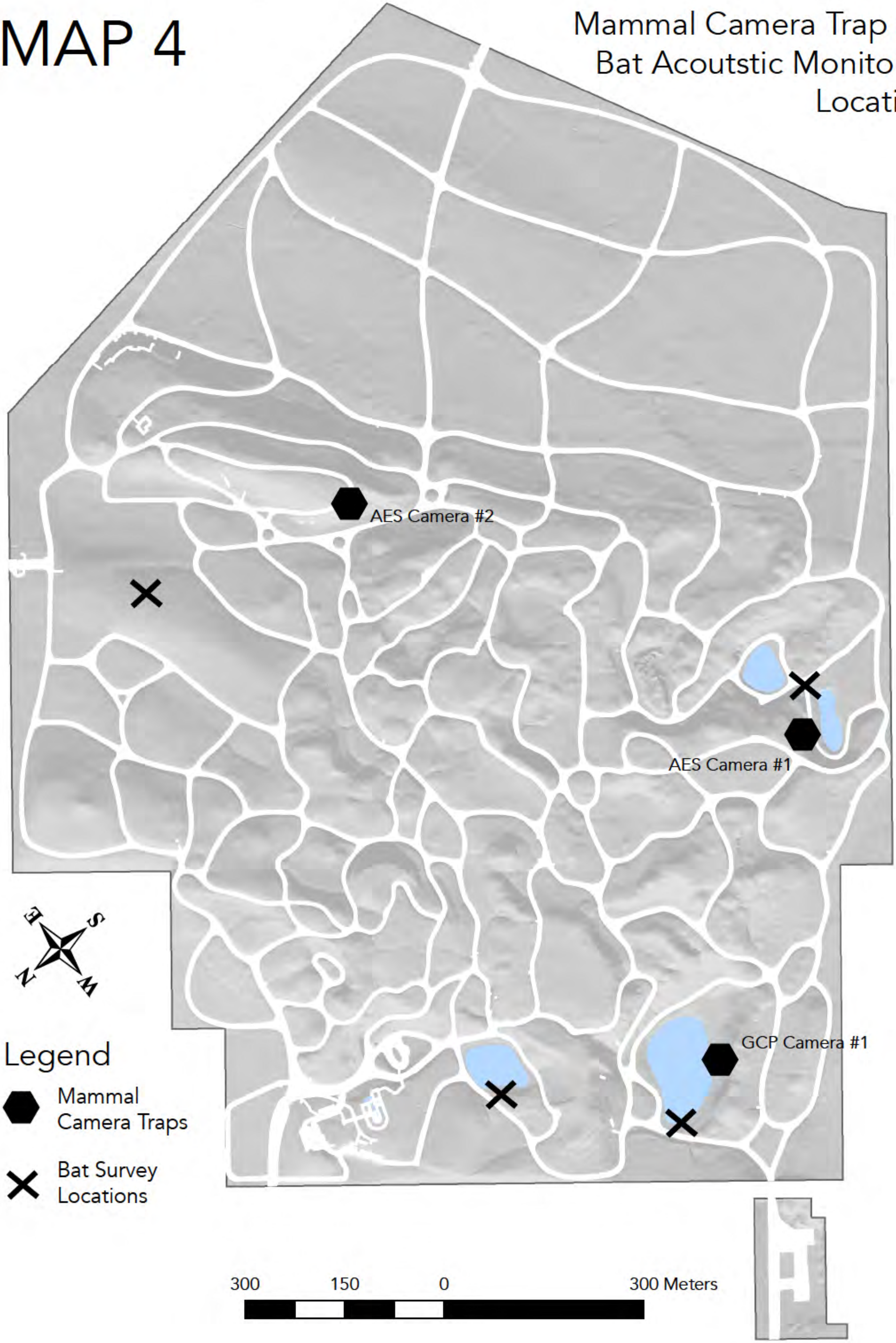
MAP 2
Avifaunal Point Count Survey Locations
(Single Observer, Limited Distance)
8
9
11
7
6
5
20
4
3
21
1
2
E
S
N
W
Legend
50 meter radius
100 meter radius
Avifaunal Survey Location
**Noted hot-spot locations are points 2, 5, 18, and 19
300
150
0
300 Meters

MAP 3


Calling Anuran
Survey Locations
Crescent
Water
Dell
Water
Valley Water
Sylvan Water
S
E
N
W
Legend
Calling Anuran
Survey Locations
300
150
0
300 Meters

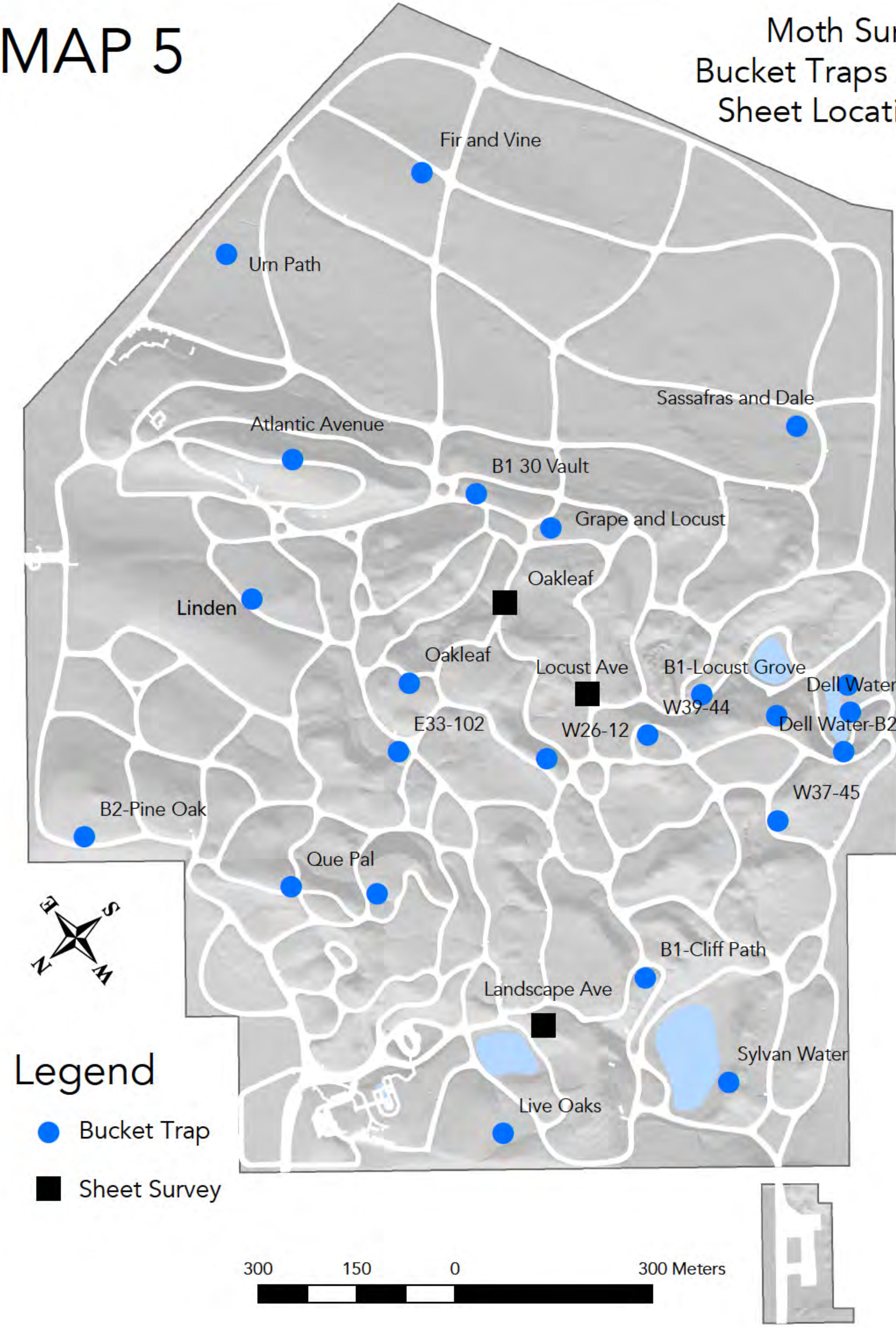
MAP 4

Mammal Camera Trap and Bat Acoutstic Monitoring Locations



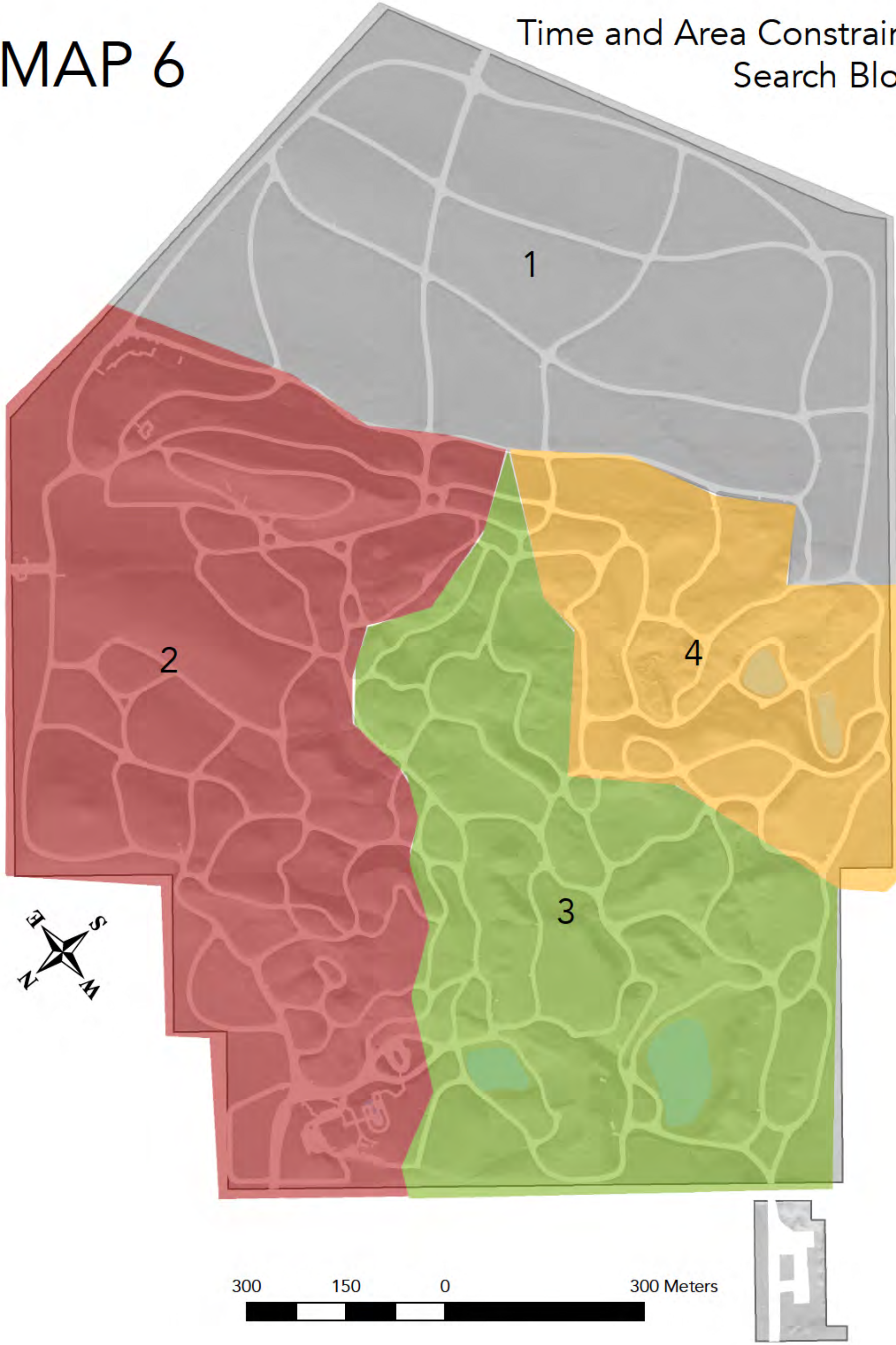
MAP 5

Moth Survey Bucket Traps and Sheet Locations



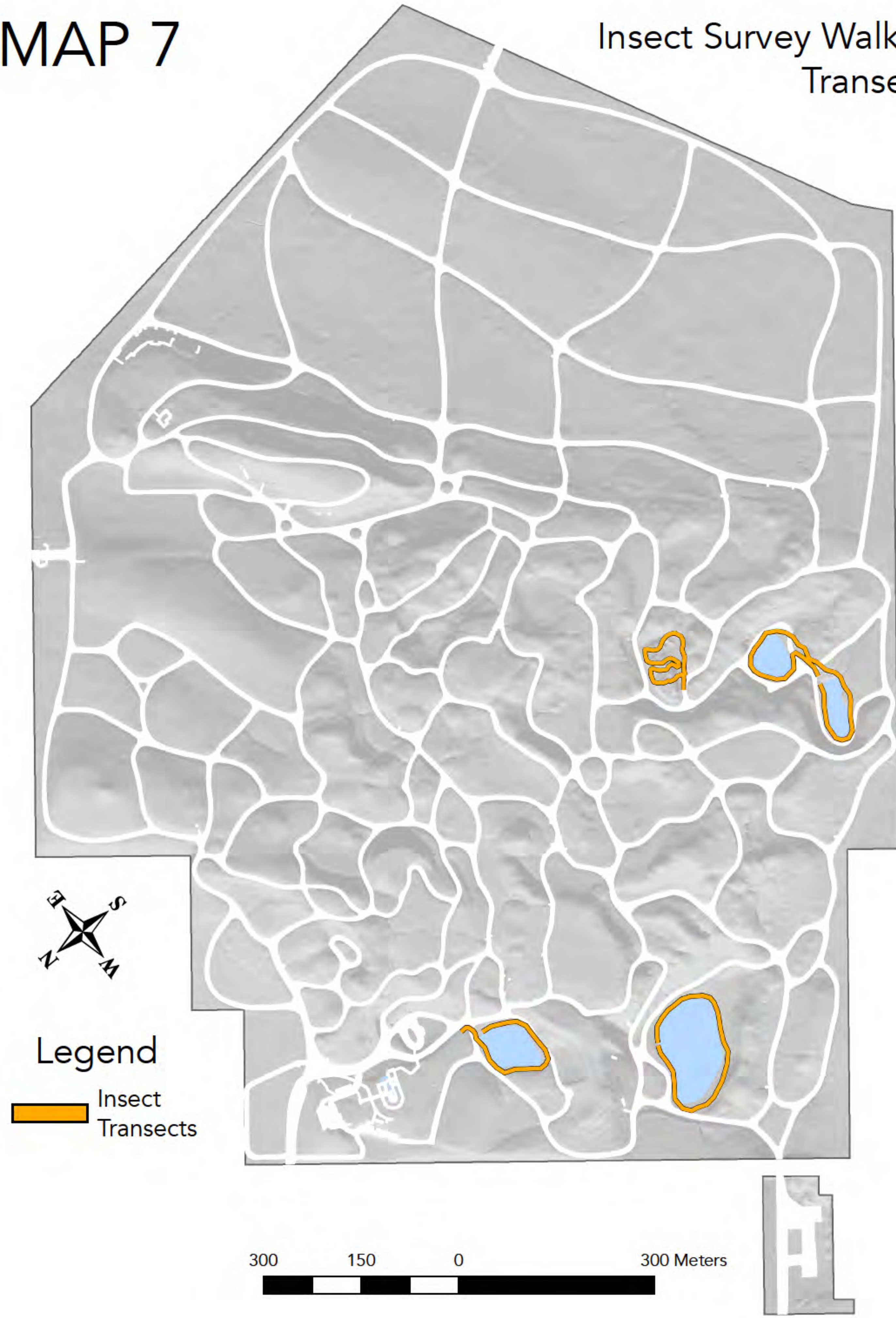
MAP 6

Time and Area Constrained Search Blocks



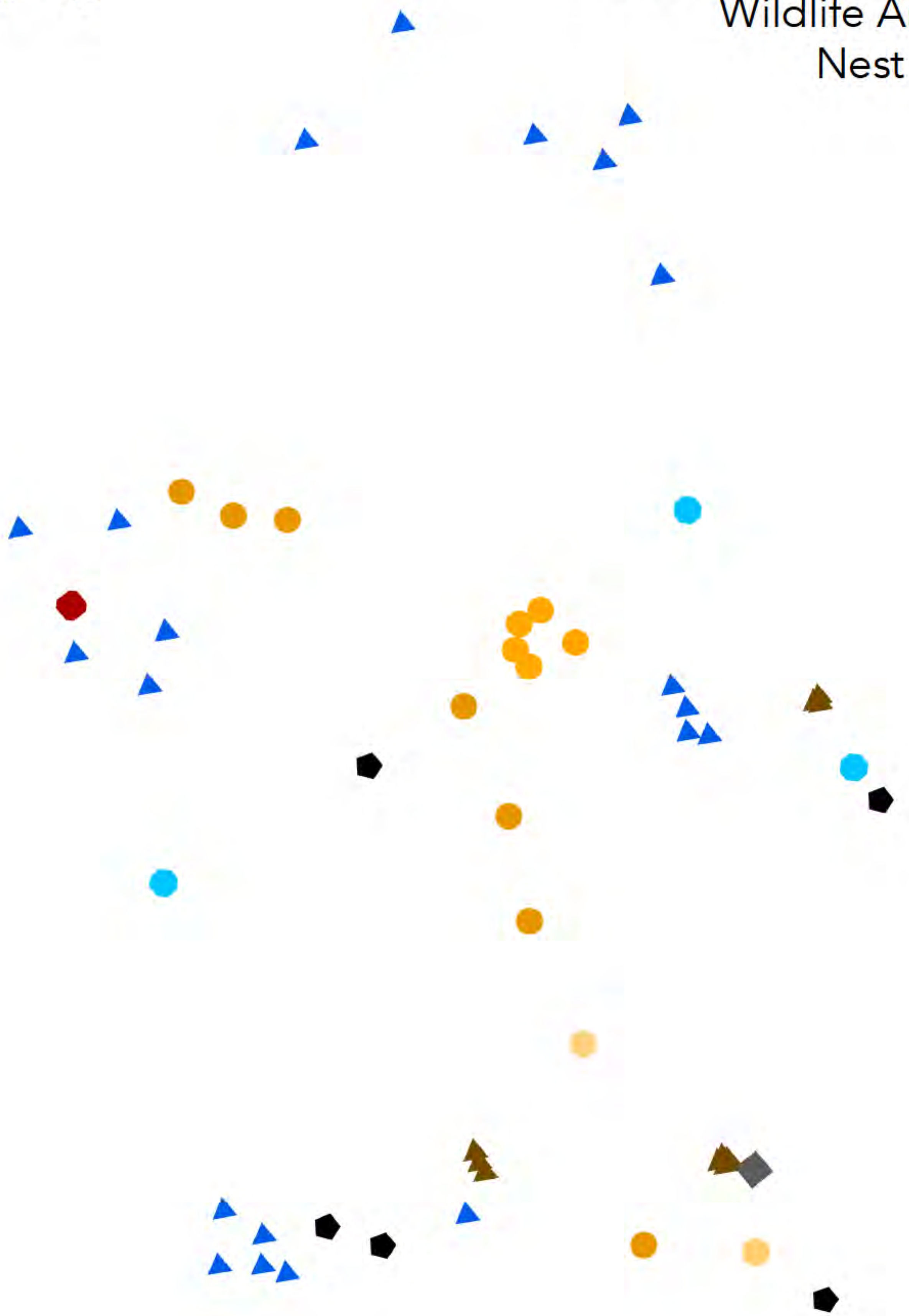
MAP 7

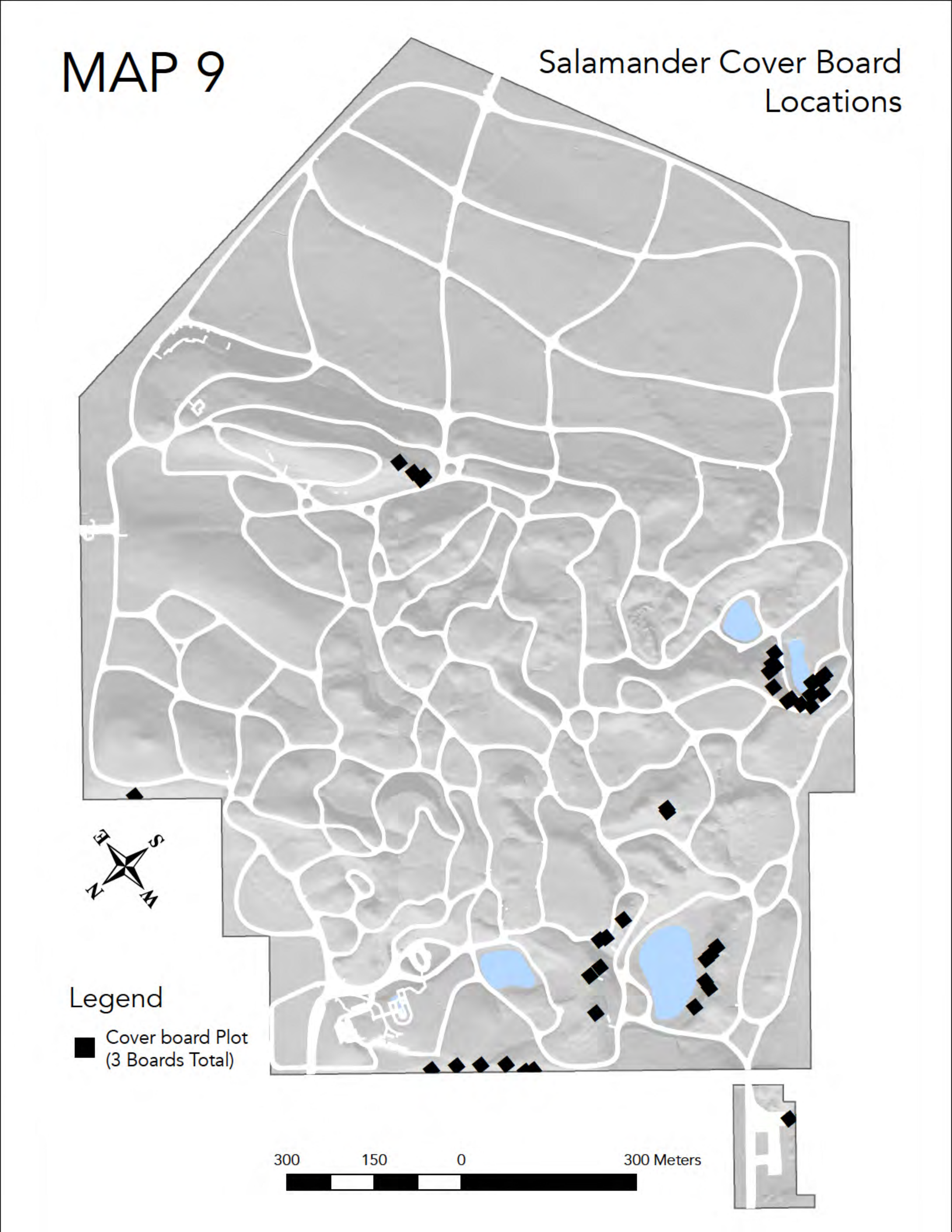
Insect Survey Walking Transects



MAP 8

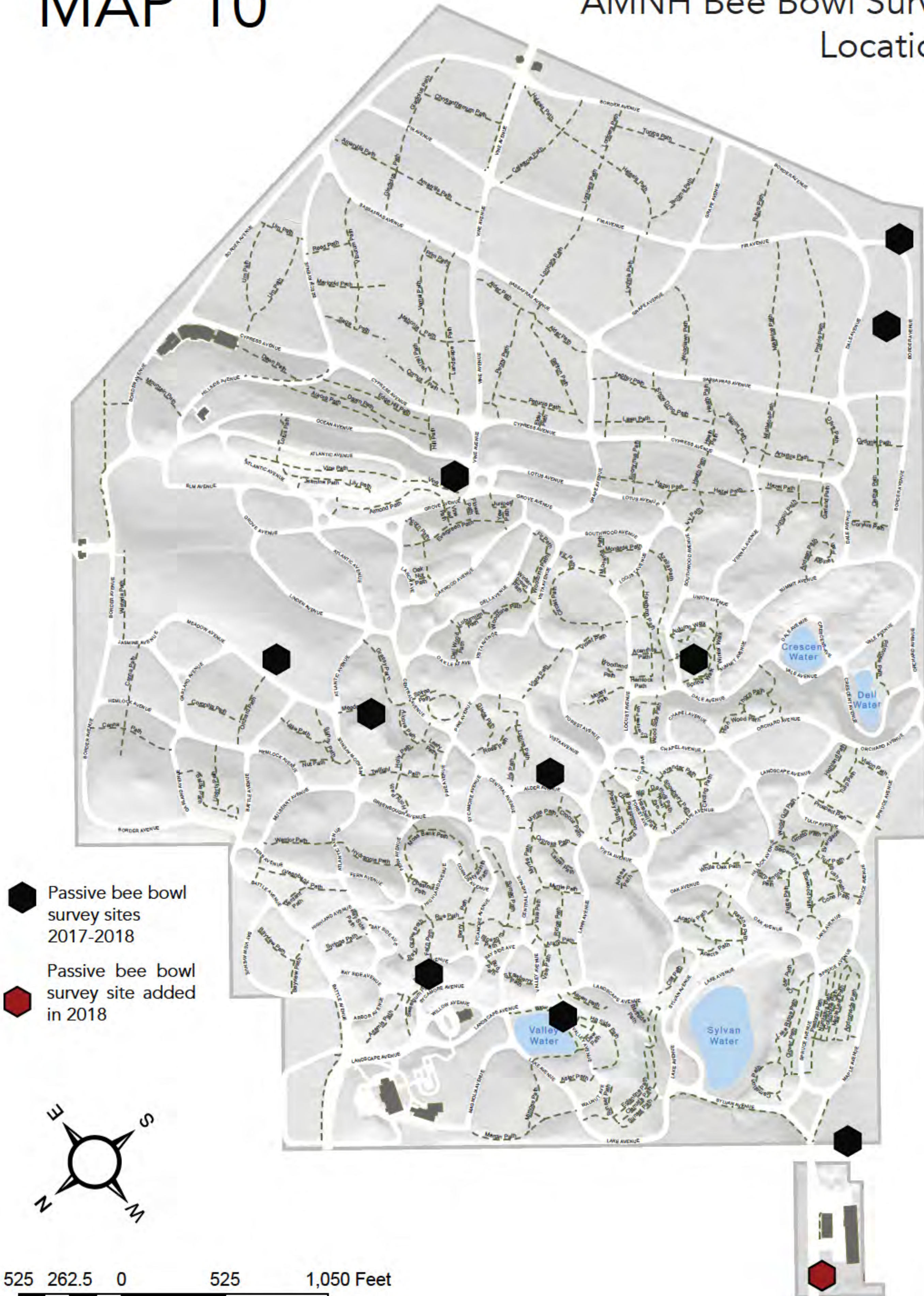
Suggested Locations for Wildlife Artificial Nest Boxes




MAP 9
Salamander Cover Board Locations
Legend
Cover board Plot (3 Boards Total)
300
150
0
300 Meters
S
E
N
W

MAP 10

AMNH Bee Bowl Survey Locations



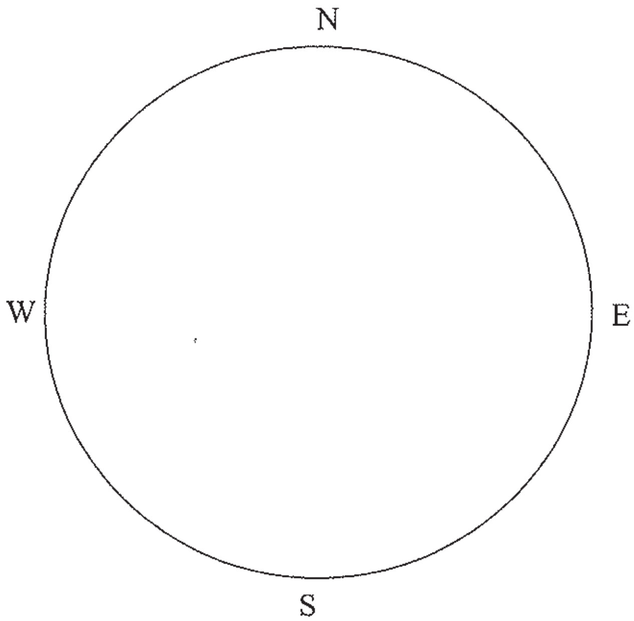
PASSERINE - Bird Point Count Data Sheet

Project Name ____________________ Sample Point ID # & Name ____________________

Date __________ Start Time __________ Stop Time __________ X coordinate, Y coordinate ____________________

Observer ______ Wind Spd. ______ Wind Dir. ______ Sky ______ Temp ______ Dominant (>50%) AES Habitat Type ____________________

Other Habitats____________________



Wind	Sky	AES Habitat Type
0 = none	0 = <10% clouds	Developed
1 = 1-3mph	1 = partly cloudy	Cropland
2 = 4-7 mph	2 = mostly cloudy	Barren Land
3 = 8-12 mph	3 = overcast	Grassland
4 >12 mph	4 = rain	Upland Shrub-Scrub
	5 = fog	Upland Broadleaf Forest
Behavior		Upland Coniferous Forest
F = flying		Upland Mixed Forest
S = soaring		Wetland Forested
P = perching or on water		Wetland Shrub-Scrub
Fo = foraging		Wetland Emergent
MD = mating display		Open Water
O = other		

Notes:

Alpha Code	Behav. Code	Dir. from Point	Dist. from Point (m)	Flight Dir.	Ht. (ft or m)	0-3 min	3-5 min	5-10 min	10-15 min	15+ min	Notes

Appendix III - Native Vegetation Island Study

Dr. David Hewitt

Micro-sites subtending trees and shrubs ("coves")–

Sites underneath a number of shrubs and trees were found to sustain mixed plant communities composed of native and non-native species, with natives generally dominant (Table 13). Six locations (Table 14) were formally sampled as representatives (with additional sites informally checked for consistency). Common invasives, such as Alliaria petiolata, Celastrus orbiculatus, and Lonicera japonica were not observed to be invasive in these habitats.

These sites have relatively low cover (commonly <50%. i.e., the majority of the area is exposed soil or leaf litter). This implies that colonization of undesired plants species is at low risk if there is managed removal of plant material (that is, if there were a high probability of plants colonizing exposed soil or litter, a) it would have happened already, b) plants would be growing there, and c) soil would not currently be exposed). Therefore invasive removal would presumably not necessarily need to be immediately accompanied with plantings of new materials.

Earthworms were not observed at these sites, and leaf litter / duff was present and native soil development is in process. The absence of earthworms is likely due to the geographic isolation of these sites and therefore is likely to be of indefinite persistence, thereby providing earthworm free sites having capacity for development and persistence of native soil invertebrate communities (including e.g., Lepidoptera/moths; Coleoptera).

For continued "as-is" management of these micro-sites, the potential for aesthetic conflict is likely low (evidence of this is that the sites are currently present and exposed to visitors, presumably without complaint), and these sites therefore have high potential for continuing to serve as native plant refugia, and also can serve as experiments and showrooms for native plant design.

These sites could impart ideas for native plant conservation and landscape design that visitors can bring home with them, and/or that other sites (e.g. other arboreta, city parks, other cemeteries, other urban or suburban green areas) could incorporate into their own management, design and associated communications (e.g, signage, brochures, webpages, educational programming). This offers opportunity to collaborate with other arboreta, and internal opportunity to interpret Green-Wood's ecology for the public.

These sites also present excellent opportunity for citizen science projects – for experts in botany (to look for rare plants) or beginners (e.g., to track specific, easily-identifiable species at sites across the park or through time to assess persistence and/or growth and development, and associated fauna – herbivores/pollinators/etc), or any other rank of expertise.

They[1] also present opportunities for other avenues of scientific research, including research on trees, urban vegetation and soil science – for example, an assessment of the link between tree species and subtending communities (i.e., do different plant species grow under different trees?), and associated soil characteristics (e.g, pH, WHC, extractable cations), would be of enormous scientific value, in addition to the conservation and management value that would be created by such research.

These sites contain plants that are potential food sources for insects, and therefore there would be great scientific value in the study of associated and/or nearby faunal associates (e.g, Lepidoptera/moths; Coleoptera) and up-trophic predators (e.g, salamanders & bats; small mammals) near to these sites to assess these sites' potential for forming the basis of trophic webs at and near these sites.

Corticolous Lichen Communities–

The corticolous (i.e., growing on bark) lichen community was not observed to be highly diverse, following a rapid-overview survey; five species (all common to urban areas of the mid-Atlantic) were observed: *Candelaria concolor*, *Physcia millegrana*, *Flavoparmelia caperata*, *Punctelia rudecta*, and *Amandinea* (*polyspora* or *punctata*). This depauperate richness could be due to colonization limitation and therefore transplantation of lichens may be successful in increasing lichen diversity at this site.

Additional Notes -

Throughout sites: Sweet vernal grass (*Anthoxanthum odoratum*) very common; nimblewill (*Muhlenbergia schreberi*) common; *Carex annectens* common.

Table 1: Overview plant community assessments

Type	Native / Adventiv	Species						
			1	2	3	4	5a	5b
Woody Seedlings	Native	*Carya spp.*	X					
	Native	*Celtis spp.*	X	X		X		X
	Native	*Liriodendron tulipifera*	X	X				
	Native	*Prunus serotina*	X	X	X			X
	Native	*Quercus spp.*	X		X	X	X	
	Native	*Quercus phellos*					X	
	Native	*Robinia pseudoacacia*	X					
	Native	*Acer rubrum*		X	X			
	Native	*Liquidambar styraciflua*		X				
	Native	*Ilex opaca*			X			X
	Native	*Juglans nigra*					X	
	Native	*Cornus spp.*						X
	Adventive	*Acer pseudoplatanus*	X		X	X		X
	Adventive	*Acer palmatum*		X				
	Adventive	*Acer platanoides*		X	X			
	Adventive	*Ginko biloba*	X	X			X	X
	Adventive	*Morus sp. (likely alba)*			X			
	Adventive	*Taxus baccata*		X		X		X
Graminoids, Herbs and Vines	Native	*Carex radiata*		X				
	Native	*Juncus tenuis*	X					
	Native	*Luzula multiflora*	X					
	Native	*Panicum cf. capillare*	X	X				
	Native	*Phytolacca americana*	X	X	X		X	
	Native	*Veronica peregrina*	X					
	Native	*Parthenocicssus quinquefolia*		X		X	X	
	Native	*Toxicodendron radicans*		X	X			
	Native	*Prunella vulgaris*					X	
	Native	*Viola sp.* (likely *sororia)*		X			X	
	Native	*Oxalis stricta*				X		
	Adventive	*Anthoxanthum odoratum*	X					
	Adventive	*Polygonum aviculare*		X				
	Adventive	*Solanum dulcamara*				X		
	Adventive	*Solanum nigrum*					X	
	Adventive	*Hieracium sp.*					X	
	Adventive	*Parthenocissus tricuspidata*					X	

Table 2. Site Descriptions

Site #	Tree Tag Association	Additional
1	SO4 122-124 and adj trees and shrubs	Cove just off of Heath Path near Cypress Ave.
2	SO5 – 30	Snowdrop and Zeyphyr Paths (by lg balding LIRTUL)
3	S05 – 26 & SO5 – 25	Along Snowdrop @ Sassafrass Ave
4	SO8 – 103	No additional notes
5a	WNW of SO8 – 103	2 azaleas
5b	SO9 – 15	Between buttress roots

Appendix IV–
Checklist of Lepidoptera Green-Wood Cemetery, New York

Steven C. Bransky-Grayslake, IL
February 20, 2018

Abstract: Lepidoptera are the second largest order of insects worldwide, dwarfed only by Coleoptera. Estimates for the number of species of Lepidoptera found in New York State are between 3,000 and 4,000 species. 67 species were collected during the survey period for Green-Wood in Brooklyn, New York.

Introduction: Sampling was initiated throughout the site limitedly from May 2017-May 2018 to identify and document species found at the site. Methods include Ultraviolet bucket traps and Mercury Vapor lamps placed in various points throughout the site to attract nocturnal adults. Voucher specimens will be housed on site for reference and future study.

Discussion: A detailed documentation of moth species occurrence at a site requires the implementation of multiple survey methods, repeated over many nights, throughout many years. Weather, temperature, moon cycle, and yearly fluctuations in populations are all variables that can influence survey results. The list of species captured by this survey is by no means complete and will require future efforts to acquire a more complete understanding of the moth population diversity at Green-Wood.

Increased predation from invasive species (namely birds), presence or absence of certain plants, pesticide use, and landscape management practices such as raking leaves, all impact native Lepidoptera populations. Leaf collection physically removes immature insect larva, eggs, and pupa from the site, as well as harborage required for hibernation. The isolation of Green-Wood caused by the surrounding urban habitat adds complications that prevent the repopulation native species. Many species of moths are environmentally sensitive to these changes brought by development and are generally dependent on specific habitat types. Therefore, human intervention is required to facilitate the repopulation of these vulnerable native species.

However, there are species of moth that have adapted to thrive in urban landscapes. For some species, urban habitats are more suitable for their biology and will facilitate their expansion, which allows them to thrive in our parkways and urban green spaces. They utilize multiple food sources, including native and non-native plants as larva sources to expand into parks, cities and urban habitats. These domineering species make up the majority of the moth species found to date at Green-Wood. Expected to be in most survey sites for all States east of the Rocky Mountain chain, these species are not considered environmental indicators or species of special concern. These species are denoted with MONA numbers thatare colored GOLD.

The species denoted with MONA numbers in RED are prevalent urban and agricultural pests throughout the United States. Species numbers 411 and 426 are pests of clothes and textiles worldwide. Their native biology most likely involves breeding in the nests of birds or rodent dens. The species MONA numbers 5403, 5412, 5417, and 5451 are sod pests and millions of dollars are spent annually in all States on efforts to eradicate them from lawns, often at the expense of native species. Species #8465 is a pest of agricultural crops, but not considered a pest in urban environments. Species #10438 may be a concern for forest management. Commonly known as the armyworm moth, it is a strong flier and when populations peak, the larvae can defoliate thousands of acres of forest in a short amount of time. Species #11003.1 *Noctua pronuba* was just recently introduced into the USA by way of imported hay bales from Europe. This species is of particular concern due to the unknown/unforeseen impact it may have on the environment. It has spread rapidly, and confirmed in all states that are actively surveying moth communities. Species #5510 is also a global pest of stored grain. It may have escaped from packaged grains, and viable broods can survive on native seeds in the growing season, but this species cannot survive the winter months. The two species denoted with MONA numbersin BLUE are native migrants. As late summer progresses the *Spodoptera sp*. (and others not found at the site yet, but expected to be there) repopulate the north annually as adults and can be the most predominant species in fall, however they do not survive the winter. Green-Wood may be a stop-over site on their migration north. This is not a species of concern for Green-Wood. It is assumed that as food plants dwindle in the south during the fall dry season these migrants head north in an attempt to find fresh food sources forlarva.

The species that have MONA numbers denoted in BLACK are less common than the species noted in gold:

#422-*Eccitotherix guenterella*- A rare native moth nothing known about this species food plant. It is not a common moth anywhere, only two specimens just recently recorded in WI the past 5 years due to increased surveying. It is difficult to write a management plan for this species, but as we plot the range we hope to one day discover the food plant. Unlikely to be a stray the good plant once discovered would be found on site.

#1162-*Blastobasis gladulella*- Found in Eastern half of the USA. It is not uncommon but more conducive to native habitat oak/hickory forests. Larva feed on the interior of acorns. It may be a more generalist feeder than recorded meaning this species potentially could be using other tree nuts along with acorns as a larval food source.

#5999-*Euglogia ochrifontella*-Not uncommonly encountered in eastern half of the USA. Food plant also unknown but assumed to be acorns. This moth is associated with oak/hickory habitats but not restricted.

#6005-*Moodna ostrinella*-Scavanger of dried seeds, fruits, rose galls, rose buds and acorns. Not generally common but can be locally abundant in various years.

#8959-*Paectes pygmaea*- Can be common in southern states up the eastern seaboard where sweetgum is found. Not a species encountered in the upper Midwest.

Overview: Noctuidae is the largest family of Lepidoptera and I expect the list should grow in relation to this group of moths. On nights during a new moon that are cloudy, warm, with a little wind would yield the best search results. Light emitted by a mercury-vapor (MV) bulb, rather than a ultra-violet (UV) bulb, tends to attract the best diversity of moths, especially with competition from surrounding city lighting. Some species have 1-5 year cycles and may not be encountered in some years based on weather, disease, predation, and pesticide use. Bait is a useful tool in both early spring before the tree leaves emerge and in mid-June through late fall. The survey did not yield many large moths such as *Catocala*, *Saturniidae* or *Sphingidae*. It is expected that a few *Catocala* (underwing moths) species are present on site. It is suspected that there will be no sphinx and silk moths, the largest of the native moths, found at Green-Wood. Their absence may not be directly related to the conditions of Green-Wood because there has been a major decline of these species throughout the entire east coast region. It is theorized that the overuse of *Bacillus thuringiensis* for the control of gypsy moths is a leading factor in their decline. In addition, a non-native fly that has been introduced in the US, *Compsilura concinnata,* which is a larval parasite of gypsy moths, has come to parasitize the larvae of large native moths, especially *Hyalophora* species. The long-standing urban mosquito abatement programs that use broadcast spray along parkways and throughout neighborhoods at night during the summer months has assured the slow eradication of many tree moth species due to the inability of the larvae to escape contact with the spray. Increased predation over many years by nonnative birds is also a suspected cause of moth decline.

Acknowledgement:

Thank you to The Green-Wood Cemetery for allowing access to the site. A special thank you to Joseph Charap, Director of Horticulture and Curator of The Green-Wood Cemetery for interest and need for understanding of the insects on site. We are grateful for the efforts and surveys conducted by Sara Evans, Project Manager for the Department of Horticulture of The Green-Wood Cemetery. We are especially appreciative of Michael J. McGraw (Senior Wildlife Biologist/Ecologist Applied Ecological Services) for his knowledge of the site, east coast biota, interest and need for understanding of entomology in preservation processes and site assessment.

MONA	Family	Genus	Species	Location	Date	#	Of interest
0.1	Geometridae	*Eupethecia*	*sp.*	Locust Grove	6/20/2017	1	
0.2	Crambidae	*Neodactryia*	*sp.*	Locust Grove	6/20/2017	1	
373	Tineidae	*Acrolophus*	*popeanella*	Oakleaf	6/22/2017	2	
373	Tineidae	*Acrolophus*	*popeanella*	Locust Grove	6/20/2017	1	
374	Tineidae	*Acrolophus*	*popinquus*	Oakleaf	6/22/2017	1	
374	Tineidae	*Acrolophus*	*propinquus*	Sylvan water	7/25/2017	1	

374	Tineidae	*Acrolophus*	*propinquus*	B1-Cliff Path	7/20/2017	1	
411	Tineidae	*Niditinea*	*fuscella*	504 Southwood & Grove	5/20/2017	1	
422	Tineidae	*Eccritotherix*	*guenterella*	B2 Pine Oak	6/5/2017	1	*YES*
426	Tineidae	*Tineola*	*bisselliella*	Oakleaf	6/22/2017	1	
1048	Noctuidae	*Agrotis*	*gladiaria*	Live Oaks	9/22/2017	1	
1162	Blastobastidae	*Blastobasis*	*glandulella*	Que Pal	6/15/2017	1	
2366	Plutellidae	*Plutella*	*xylostella*	GPS 501 Union Ave	5/20/2017	1	
2366	Plutellidae	*Plutella*	*xylostella*	Que Pal	6/5/2017	2	
2401	Attevidae	*Atteva*	*aurea*	Sylvan water	7/25/2017	4	
2401	Attevidae	*Atteva*	*aurea*	Sylvan water	9/18/2017	1	
2859	Tortricidae	*Celypha*	*crispitana*	Dell Water	9/18/2017	1	
3469	Tortricidae	*Cydia*	*candana*	W26-12	6/22/2017	1	
3494	Tortricidae	*Cydia*	*latiferreana*	Oakleaf	6/22/2017	1	
3594	Tortricidae	*Pandemis*	*limitata*	Oakleaf	6/22/2017	1	
3623	Tortricidae	*Argyrotaenia*	*quercifoloana*	B1-locust grove	6/29/2017	1	
3688	Tortricidae	*Clepsis*	*peritana*	W39-44	9/27/2017	1	
3725	Tortricidae	*Cenopis*	*pettitana*	Oakleaf	6/22/2017	1	
4975	Crambidae	*Achyra*	*rantalis*	Locust Grove	6/20/2017	1	
5079	Crambidae	*Udea*	*rubigalis*	Oakleaf	6/22/2017	12	
5079	Crambidae	*Udea*	*rubigalis*	Locust Grove	6/20/2017	4	
5079	Crambidae	*Udea*	*rubigalis*	B1 30 Vault	6/5/2017	7	
5079	Crambidae	*Udea*	*rubigalis*	504 GPS	6/5/2017	1	
5079	Crambidae	*Udea*	*rubigalis*	B2 Que Pal	6/5/2017	1	
5079	Crambidae	*Udea*	*rubigalis*	GPS 501 Union Ave	5/20/2017	1	
5079	Crambidae	*Udea*	*rubigalis*	Landscape Ave.	5/20/2017	5	
5156	Crambidae	*Nomophila*	*nearctica*	B1 30 Vault	6/5/2017	1	

5362	Crambidae	*Crambus*	*agitatellus*	W26-12	6/22/2017	1	
5362	Crambidae	*Crambus*	*agitatellus*	Locust Grove	6/20/2017	1	
5363	Crambidae	*Crambus*	*saltuellus*	W39-44	9/27/2017	1	
5363	Crambidae	*Crambus*	*saltuellus*	Oakleaf	6/22/2017	4	
5363	Crambidae	*Crambus*	*saltuellus*	Locust Grove	6/20/2017	5	
5364	Crambidae	*Crambus*	*multilinellus*	Locust Grove	6/20/2017	6	
5403	Crambidae	*Agriphila*	*vulvivagellus*	Live Oaks	9/22/2017	3	
5413	Crambidae	*Pediasia*	*trisecta*	W39-44	9/27/2017	1	
5413	Crambidae	*Pediasia*	*trisecta*	Dell Water	6/20/2017	3	
5413	Crambidae	*Pediasia*	*trisecta*	30-Vault	6/5/2017	1	
5417	Crambidae	*Pediasia*	*dorsipunctellus*	Locust Grove	6/20/2017	1	
5420	Crambidae	*Microcrambus*	*elegans*	W26-12	6/22/2017	1	
5435	Crambidae	*Fissicrambus*	*mutabilis*	Locust Grove	6/20/2017	24	
5435	Crambidae	*Fissicrambus*	*mutabilis*	Locust Grove	6/20/2017	1	
5451	Crambidae	*Parapediasia*	*teterrellus*	Dell Water-B2	6/20/2017	112	
5451	Crambidae	*Parapediasia*	*teterrellus*	Dell Water	9/18/2017	1	
5451	Crambidae	*Parapediasia*	*teterrellus*	Locust Grove	6/20/2017	1	
5451	Crambidae	*Parapediasia*	*teterrellus*	Oakleaf	6/22/2017	13	
5451	Crambidae	*Parapediasia*	*teterrellus*	Que Pal	6/15/2017	1	
5464	Crambidae	*Urola*	*nivalis*	Oakleaf	6/22/2017	1	
5510	Pyralidae	*Pyralis*	*farinalis*	Dell Water B2	6/20/2017	1	YES
5533	Pyralidae	*Hypsopygia*	*olinalis*	Locust Grove	6/20/2017	3	
5999	Pyralidae	*Euglogia*	*ochrifontella*	W26-12	6/22/2017	1	
6005	Pyralidae	*Moodna*	*ostrinella*	Oakleaf	6/22/2017	1	
6339	Geometridae	*Macaria*	*transitaria*	Dell Water	9/18/2017	1	

7132	Geometridae	*Pleuropructa*	*insularia*	Oakleaf	6/22/2017	2	
7146	Geometridae	*Haematopis*	*grataria*	Oakleaf	6/22/2017	1	
7414	Geometridae	*Orthonama*	*obstipata*	W26-12	6/22/2017	4	
7414	Geometridae	*Orthonama*	*obstipata*	Oakleaf	6/22/2017	1	
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	Oakleaf	6/22/2017	8	
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	B2 Que Pal	6/5/2017	1	
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	B2 Pine Oak	6/5/2017	1	
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	GPS 501 Union Ave	6/5/2017	1	
7416	Geometridae	*Costaconvexa*	*centrostrigaria*	Locust Grove	6/20/2017	1	
7474	Geometridae	*Eupithecia*	*miserulata*	B1 30 Vault	6/5/2017	2	
7474	Geometridae	*Eupithecia*	*miserulata*	B2 Que Pal	6/5/2017	1	
7474	Geometridae	*Eupethecia*	*miserulata*	504 GPS	6/5/2017	1	
7701	Lasiocampidae	*Malacosoma*	*americana*	Locust Grove	6/20/2017	1	
8203	Erebidae	*Halysidota*	*tessellaris*	Oakleaf	6/22/2017	1	
8323	Erebidae	*Idia*	*aemula*	Live Oaks	9/22/2017	1	
8447	Erebidae	*Hypena*	*madefactalis*	Oakleaf	6/22/2017	1	
8465	Erebidae	*Hypena*	*scabra*	Oakleaf	6/22/2017	1	
8465	Erebidae	*Hypena*	*scabra*	W16-12	6/22/2017	1	
8465	Erebidae	*Hypena*	*scabra*	B2 Que Pal	6/5/2017	1	
8689	Erebidae	*Zale*	*lunata*	Oakleaf	6/22/2017	1	
8924	Noctuidae	*Anagrapha*	*falcifera*	W16-12	6/22/2017	1	
8924	Noctuidae	*Anagrapha*	*falcifera*	B1 30 Vault	6/5/2017	1	
8924	Noctuidae	*Anagrapha*	*falcifera*	B2 Que Pal	6/5/2017	1	
8924	Noctuidae	*Anagrapha*	*falcifera*	Sheet Landscape 1/2	5/20/2017	1	
8959	Eutelidae	*Paectes*	*pygmaea*	Oakleaf	6/22/2017	1	YES

8974	Nolidae	*Garella*	*nilotica*	Del Water	6/20/2017	1	
9044	Noctuidae	*Marimatha*	*nigrofimbria*	Dell Water	9/18/2017	1	
9666	Noctuidae	*Spodoptera*	*frugiperda*	Sylvan water	7/25/2017	1	
9666	Noctuidae	*Spodoptera*	*frugiperda*	Sylvan water	9/18/2017	1	
9666	Noctuidae	*Spodoptera*	*frugiperda*	W39-44	9/27/2017	1	
9666	Noctuidae	*Spodoptera*	*frugiperda*	Live Oaks	9/22/2017	1	
9669	Noctuidae	*Spodoptera*	*ornithogalli*	w37-45	11/8/2017	1	
9679	Noctuidae	*Elaphria*	*chalcedonia*	W39-44	9/27/2017	1	
9688	Noctuidae	*Galgula*	*partita*	W39-44	9/27/2017	1	
9688	Noctuidae	*Galgula*	*partita*	B2 E35-102	10/17/2017	1	
9688	Noctuidae	*Galgula*	*partita*	E33-102	10/17/2017	1	
10368	Noctuidae	*Lacinipolia*	*meditata*	Vaults-B1	6/5/2017	1	
10397	Noctuidae	*Lacinipolia*	*renigera*	Locust Grove	6/20/2017	1	
10397	Noctuidae	*Lacinipolia*	*renigera*	B2 Pine Oak	6/5/2017	1	
10397	Noctuidae	*Lacinipolia*	*renigera*	Dell Water	9/18/2017	1	
10397	Noctuidae	*Lacinipolia*	*renigera*	Live Oaks	9/22/2017	1	
10438	Noctuidae	*Mythimna*	*unipuncta*	Oakleaf	6/22/2017	9	
10438	Noctuidae	*Mythimna*	*unipuncta*	W26-12	6/22/2017	1	
10438	Noctuidae	*Mythimna*	*unipuncta*	Locust Grove	6/20/2017	1	
10438	Noctuidae	*Mythimna*	*unipuncta*	B1 30 Vault	6/5/2017	1	
10438	Noctuidae	*Mythimna*	*unipuncta*	Sheet Landscape 1/2	5/20/2017	3	
10438	Noctuidae	*Mythimna*	*unipuncta*	B1-locust grove	6/29/2017	1	
10438	Noctuidae	*Mythimna*	*unipuncta*	Sylvan water	7/25/2017	1	
10446	Noctuidae	*Leucania*	*multilinea*	Live Oaks	9/22/2017	1	
10524	Noctuidae	*Nephelodes*	*minians*	W39-44	9/27/2017	2	

10585	Noctuidae	*Orthodes*	*majuscula*	Dell Water	9/18/2017	1	
10663	Noctuidae	*Agrotis*	*ipsilon*	Sylvan water	7/25/2017	1	
10663	Noctuidae	*Agrotis*	*ipsilon*	W37-45	11/18/2017	8	
10670	Noctuidae	*Feltia*	*jaculifera*	Sylvan water	7/25/2017	1	
10670	Noctuidae	*Feltia*	*jaculifera*	W39-44	9/27/2017	1	
10911	Noctuidae	*Anicla*	*infecta*	Sylvan water	7/25/2017	1	
10911	Noctuidae	*Anicla*	*infecta*	w37-45	11/8/2017	5	
10915	Noctuidae	*Peridroma*	*saucia*	w37-45	11/8/2017	1	
10942	Noctuidae	*Xestia*	*c-nigrum*	W39-44	9/27/2017	3	
10942	Noctuidae	*Xestia*	*c-nigrum*	w37-45	9/27/2017	1	
10942	Noctuidae	*Xestia*	*c-nigrum*	Dell Water	9/18/2017	2	
10942	Noctuidae	*Xestia*	*c-nigrum*	Live Oaks	9/22/2017	1	
11003	Noctuidae	*Noctua*	*pronuba*	Locust Grove	6/20/2017	1	
11003	Noctuidae	*Noctua*	*pronuba*	B1 30 Vault	6/5/2017	3	
11003	Noctuidae	*Noctua*	*pronuba*	Dell Water	9/18/2017	4	

Appendix V–Hymenoptera at Green-Wood Interim Report

Parker Gambino and Sara Kornbluth
Division of Invertebrate oology, American Museum of Natural History
March 14, 2019

This is a summary report of insect collecting activities at Green-Wood. A total of 757 insects are recorded, taken during 22 collection events from April 18, 2017 to September 29, 2018 (Table 1). Insects collected belonged to 34 genera in seven Hymenoptera families (two wasp families, five bee families). Pan-trap collections used series of 12 traps, set out for approximately one flight day, on 11 transects (Table 2). Preliminary examination of the bees and wasps collected at the eleven survey sites in Green-Wood allows reveals both the numbers of insects and numbers of species from each site. Some factors that may influence the abundance and diversity of bees and wasps are floral resource availability (i.e. a diversity of flowering herbaceous and woody plants), prey availability for predatory wasps, and nesting site availability (i.e. cavities in stems or patches bare soil that is not compacted or bound with grass roots). It is plausible that the species present are able to forage or nest throughout the grounds because Green-Wood is relatively non-fragmented and areas where the resources that meet particular species requirements are selected.

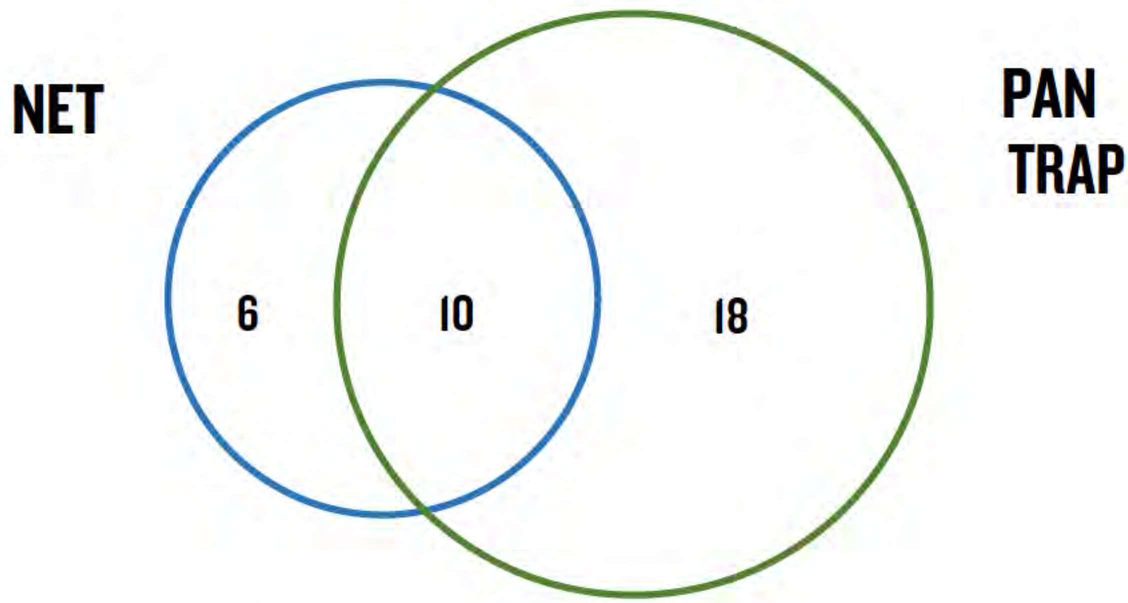
The greatest numbers and diversity of bees and wasps were captured at the Joe's Garden location, Locust Grove, Meadow Path and Thirty-sixth Street sites. We collected nearly or greater than twice as many species at each of these four sites, compared to the other nine sites. Also, these four sites were among the top five in terms of overall number of insects captured. This is not surprising, because the most productive sites have higher floral diversity due to special plantings and/or reduced mowing practices. This greater habitat diversity produces a wider variety of food and nesting site resources, which supports greater bee and wasp diversity.

Table 1. Green-Wood Collection Events			
Date	*Net/Pan*		
April 18, 2017	Pan	June 7, 2018	Pan
May 16, 2017	Net	June 11, 2018	Net
May 16, 2017	Pan	June 14, 2018	Pan
June 28, 2017	Pan	June 24, 2018	Net
June 29, 2017	Net	June 27, 2018	Pan
August 25, 2017	Pan	July 19, 2018	Pan
September 17, 2017	Net	July 19, 2018	Net
April 13, 2018	Pan	July 27, 2018	Pan
April 30, 2018	Pan	August 15, 2018	Pan
May 8, 2018	Net	September 2, 2018	Pan
May 21, 2018	Pan	September 29, 2018	Pan

Table 2. Pan-Trap Transect Locations			
Location Name	*Code*	*Latitude*	*Longitude*
Joe's Garden/Chapel Meadow	JG	40°39'24.48"	-73°59'38.24"
Weintraub Garden	WG	40°39'19.45"	-73°59'48.70"
Birch Grove	BG	40°39'16.84"	-74°00'10.52"
36 St No Mow	TS	40°39'12.89"	-74°00'04.24"
Vista Control	VC	40°39'11.39"	-73°59'36.41"
Locust Grove	LG	40°39'03.44"	-73°59'35.45"
Ft Hamilton No Mow	FH	40°38'40.40"	-73°59'21.79"
Dale Ave Control	DC	40°38'43.71"	-73°59'25.55"
30 Vaults	TV	40°39'04.78"	-73°59'13.75"
Meadow Path No Mow	MP	40°39'16.66"	-73°59'22.45
Battle Meadow No Mow	BM	40°39'19.21"	-73°59'19.34"
Joe's Garden/Chapel Meadow	JG	40°39'24.48"	-73°59'38.24"

84 bees and wasps were captured by net, the remaining 672 were captured using the bee-bowl pan traps.

Chart 1. Shows the numbers of bee and wasp genera captured by the two methods.

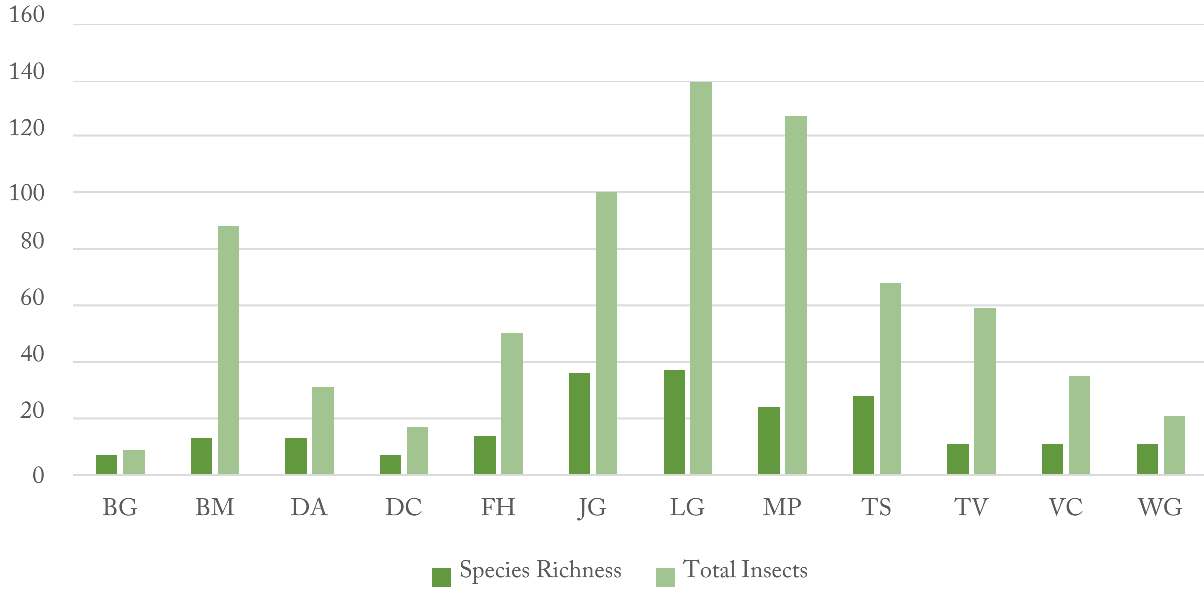


The taxonomic distribution is shown in Table 3. The vast majority of captured insects (411) were in 15 species of the genus *Lasioglossum* (Family Halictidae), including 154 *Lasioglossum tegulare* (20 % of all Hymenoptera)

Table 3. Taxonomic Distribution

Family	*# of genera*	*# of species*	*# of insects*
Vespidae	3	3	9
Crabronidae	10	10	30
Colletidae	2	3	4
Andrenidae	2	14	50
Halictidae	5	21	540
Megachilidae	5	9	34
Apidae	7	17	90
Total	*34*	*77*	*757*

Chart 2. Hymenoptera diversity at the eleven pan trap sites



LICENSE
Under the Environmental Conservation Law (ECL)

Licensee Information

License Issued To:
MICHAEL J MCGRAW
467 East Church Rd
King of Prussia, PA 19406

(610) 585-7746
COUNTY: ALBANY
REGION: 4

DEC Contact Information

DIVISION OF FISH, WILDLIFE AND MARINE RESOURCES
SPECIAL LICENSES UNIT
625 BROADWAY, ALBANY, NEW YORK 12233-4752
PHONE: (518) 402-8985 FAX: (518) 402-8925
WEBSITE: www.dec.state.ny.us

[License Authorizations

License to Collect or Possess: Scientific
License # 2360

New License   Effective Date: 3/21/2018   Expiration Date: 3/20/2019

NYSDEC Approval

By acceptance of this license, the licensee agrees that the license is contingent upon strict compliance with the ECL, all applicable regulations, and all conditions included as part of this license.

License Regulations

6 NYCRR Part 175
ECL 11-0515 (1)
6 NYCRR Part 189

LICENSE TO COLLECT OR POSSESS: SCIENTIFIC - LICENSE CONDITIONS

1. Collection from the Wild: Authorized Species, Specific The licensee is authorized to collect and possess the following species: 20 Red-backed salamander (Plethodon cinereus), Small mammals (NY Indigenous)

2. Scientific Collection - Authorized Activities The licensee is authorized to possess the collected species for the following activity(ies): Species presence survey.

3. Scientific Collection - Location The licensee is authorized to collect species from the following locations only:
Green-Wood Cemetary, Brooklyn, NY, Kings County, NYSDEC Region 2.

4. Scientific Collection - Authorized Collection Equipment General The licensee shall only collect authorized species using: Sherman box traps, coverboards and hand collection.

5. Scientific Collection - Gear Marking and Monitoring The licensee shall mark all gear deployed with the licensee's name, resident address and license type and number. All traps and nets shall be checked no less than once every twenty-four (24) hours.

6. Scientific - LCP - Collection or Possession of Endangered or Threatened Species Prohibited The licensee shall not collect or possess any endangered/threatened species pursuant to this license.

7. Scientific Collection - Reptile and Amphibian Bio-Safety Protocols The licensee shall conform with all guidelines contained in the Bio-safety Protocols for Reptile and Amphibian Sampling in NYS, attached to this license as Appendix 1. Any questions regarding the protocols may be directed to the Regional Wildlife Manager at:

Regional Wildlife Manager
NYSDEC Region 2 Headquarters
47-40 21st St
Long Island City, NYl 1101 -5401

8. Scientific Collection -Temporary Possession and Release The licensee shall possess the listed animal(s) only for the minimum time necessary for the collection of biological data. The licensee shall immediately release the listed animals unharmed at the point of original capture following the collection of biological data.

9. Scientific Collection - Removal of Species from the Wild Prohibited The licensee shall not remove the listed animals from the wild.

10. Scientific Collection - Authority to Designate Agents The licensee is authorized to designate agents to assist the Licensee with the listed animals while conducting activities authorized pursuant to this license provided that:

a. the licensee submits a written request to the NYSDEC Special Licenses Unit at the address listed on the front of this license containing the:

i) name
ii) address
iii) age
iv) phone number of the person he or she is nominating as a designated agent, and;

b. the licensee receives an amended license from the Special Licenses Unit listing the designated agents he or she has nominated before that person can conduct activities authorized by this license.

11. Authorized Designated Agents The following Designated Agents are authorized: Joseph Charap, Sara Evans, Neela Wickremeinghe and Sara Wells.

12. Scientific Collection - Reporting Requirement - Prior to Expiration The licensee shall file a written annual report prior to the expiration date of this license. Such annual report shall contain: a) name of the licensee, b) license number, c) common name of the listed animals collected, d) Jocat i o n(s) ofc ollect io n, e) date(s) of collection , f) biologica l data collected and g) final disposition of collected animals. The licensee shall send this report to the NYSDEC Special Licenses Unit 625 Broadway, Albany, NY 12233-4752.

GENERAL CONDITIONS - Apply to ALL Authorized Licenses

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1. GC - Licensee Shall Read All Conditions The licensee shall read all license conditions prior to conducting any activities authorized pursuant to this license.

2. GC - License is Not Transferrable This license is not transferrable and is valid only for the person identified as the licen see.

3. GC - Licensee Responsible for Federal, State or Local Permits/Licenses The licensee is responsible for obtaining any and all necessary, corresponding Federal, State or lo ca l permits or licenses prior to conducting any activity authorized pursuant to this license.

4. GC - Reasons for Revocation This license may be revoked for any of the following reasons:

i. licensee provided materially false or inacc urate statements in his or her application, supporting documentation or on required reports;
ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal Jaws or regulations of the department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the department for insufficient funds or nonpayment after the license has been issued.

5. GC - Licensee Shall Carry Copy of License The licensee shall carry a copy of this license or a document provided by the department, ifr elevant , when conducting activities pursuant to this license.

6. GC - Licensee Shall Notify of Change of Address The licensee shall notify the Special Licenses Unit in writing , by mail or email, within five (5) days of the official change of residence.

7. GC - Licensee is Liable for Designated Agents If designated agents are authorized pursuant to this license, the licensee shall be liable and responsible for any activities conducted by designated agents purs uant to this license or any actions by designated agents resulting from activities authorized by this license.

8. GC - Licensee Renewal The licensee shall submit a written request for the renewal of this license prior to the expiration date listed on the license. The licensee shall include accurate and complete copies of any required reports with their renewal request. This renewal paperwork shall be sent to:

NYSDEC
Special Licenses Unit
625 Broadway
Albany, NY 12233-4752.

This license is deemed expired on the date of expiration listed on the license.

NOTIFICATION OF OTHER LICENSEE OBLIGATIONS

MN- Licensee is Liable

The licensee shall be liable and responsible for any activities conducted under the authority of this license or any actions resulting from activities authorized by the license.

MN - Access by Law Enforcement

The licensee shall allow representatives of the NYS DEC Division of Law Enforcement to enter the licensed premises to inspect his or her operations and records for compliance with license conditions.

Trespassing Prohibited

This license is not a license to trespass. The licensee shall obtain permission from the appropriate landowner/land manager prior to conducting activities authorized pursuant to this license

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Division of Fish and Wildlife
625 Broadway, 5th Floor, Albany, NY 12233-4750
P: (518) 402-8924 I F: (518) 402-8925
www.dec.ny.gov

Appendix 1
Bio-safety Protocols for Reptile and Amphibian Sampling in NYS.
September 23, 2011
Prepared by the NYS Reptile and Amphibian Diversity Team

Captive Protocols

For animals being kept as part of a reintroduction, translocation or head-starting program, consult the "Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs," edited by Pessier and Mendelson in 2010.

Reptile Protocols

Reptiles may be encountered in a variety of terrestrial and aquatic habitats. Care should be taken·when sampling in a population, especially if there are ahy obvious sick individuals. Obviously sick individuals should not be handled unless there is a scientific need for handling. All gear that comes in contact with obviously sick individuals should be washed as described below before it comes in contact with another individual.

In an effort to avoid infecting all individuals in a population the following protocols should be incorporated into the applicants sampling plan.

Sampling Gear - Any gear that physically touches animals. Gear may include snake tongs, snake hooks, snake holding bags, tubes, turtle traps, shell notching files, buckets, poles, dip nets, gender probes, scales and PIT Tag injectors.

- Wash sampling gear in between sites (site= interbreeding population of the species being handled).
    - Wash all sampling gear in disinfecting solution (disinfecting solution= a solution of diluted bleach [nine parts water to one part bleach] or in a commercially prepared disinfectant such as *Novalsan, glutaraldehyde* or *Virkon)* or alcohol solution (70% ethanol or isopropyl) and rinse with sterile water between sites.

- When handling state listed species (E, T or SC), washing must be done b twnindil'duals in the population, unless the species is comm f.!|}. }'§ f1 e history such as hibernation or breeding, at which point it can be expected that all individuals have been exposed to pathogens.

- Machine launder snake holding bags using detergent arid bleach, if possible, in the hot water.
- Small items such as gender probes and PIT tag injectors must be autoclaved between uses. Minimally, between individual specimens in the field, tools must be cleaned with disinfecting solution and rinsed with sterile water.
  - o If an autoclave is unavailable, items should be soaked overnight in the disinfecting solution.
- Files for notching of turtle shells must be cleaned with a wire brush or file card and autoclaved. If autoclaving is not possible, wash with disinfecting solution and rinse with sterile water.

Personal Gear - Personal gear such as waders, hip boots and gaiters must be treated using the following methods. Only lug-bottom hip boots or waders shouldbe used in the field (no felt-bottom soles).

- Washing must be done in between sites (site= interbreeding population of the species being handled).
- Remove all visible debris from personal gear.
- Spray with disinfecting solution so that it is saturated or immerse personal gear in solution. If equipment or gear is porous (e.g., breathableor neoprene waders) let soak in solution for 10 minutes. If this is not possible, let personal gear dry for at least three hours before enteringa new site.
- Rinse personal gear with tap water or with water from the next water body to be sampled.
- Dispose of disinfecting solution away from bodies of water and drinking water sources (follow protocol in MSDS).
- Machine launder clothing using detergent(and bleach if possible) in hot water.

Amphibian Protocols

Amphibians may be encountered in a variety of terrestrial and aquatic habitats. Care should be taken at all sampling sites, especially ones known to contain ranavirus, Chytridiomycosis(caused by *Batrachochytrium dendrobatidis),* or other present or emerging diseases. In an effort to avoid infecting all individuals in a population, the following protocols should be followed.

Sampling Methodology

- When handling amphibians, use disposable, powder-free, non-latex gloves,or bare hands rinsed with the water present at the samplingsite.
- Refrain from using insect repellent on hands.
- Captured amphibians should be housed individually (e.g., using zipper storage bags or other sealable plastic bags). Each bag must be used only once.

Sampling Gear - Any gear that physically touches an animal, including tubes, traps, poles, dip nets, buckets, gender probes, scales, specimen holding bags and PIT Tag injectors.

- Washing must be done between sites (site= interbreeding population).

- Wash all sampling gear with disinfecting solution (sterilizing solution= diluted bleach [nine parts water to one part bleach] or in a commercially prepared disinfectant such as *Novalsan*, *glutaraldehyde* or *Virkon)* or alcohol solution (70% ethanol or isopropyl) and rinse with water.
    - When handling state listed species, this must be done between individuals within the population.
- Small items such as gender probes and PIT tag injectors must be autoclaved between uses on individual specimens. If an autoclave is unavailable, tools must be soaked overnight in disinfecting solution and rinsed with sterile water.
- Machine launder specimen holding bags (if made of mesh or other reusable material) using detergent and bleach, in hot water.

Personal Gear - Personal gear such as waders, hip boots and gaiters must be treated using the following methods. Only lug-bottom hip boots or waders should be used in the field (no felt-bottom soles).

- Wash personal gear in between sites (site = interbreeding population).
- Remove all visible debris from personal gear.
- Spray personal gear with disinfecting solution so that it is saturated or immerse gear in solution. If personal gear is porous (e.g., breathable or neoprene waders) let soak in solution for 10 minutes.
- Rinse personal gear with tap water or with water from the next wat r body to be sampled.
- Dispose of waste water polluted with disinfecting solution away from bodies of water and drinking water sources (follow protocol in MSDS).
- Clothes should be machine laundered using detergent (and bleach if possible) in hot water.

References

Cheatwood, Joseph. An outbreak of Fungal Dermatitis and Stomatitis in a Wild Population of Pigmy Rattlesnakes, *(Sistrurus miliarius barbouri)* in Florida: Description, Factors, Cyclicity, and Prevention. University of Florida. 2000.

Department of Environmental Conservation Fish Management Bio-Security Protocols

Pessier, A.P. and J.R. Mendelson (eds.). 2010. A Manual for Control oflnfectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs. IUCN/SSC Conservation Breeding Specialist Group: Apple Valley, MN.

Risk Assessment of Chytridiomycosis to European Amphibian Diversity. Hygiene Protocol to Contain the Spread of Chytridiomycosis During Fieldwork.

U.S. Fish and Wildlife Service, Disinfection Protocol for Bog Turtle Field Research and Monitoring. Revised August 5, 2009.

LICENSE

Under the Environmental Conservation Law (ECL)

Licensee Information

License Issued To:
MICHAEL J MCGRAW
467 East Church Rd
King of Prussia, PA 19406

(610) 585-7746
COUNTY: ALBANY
REGION: 4

DEC Contact Information

DIVISION OF FISH, WILDLIFE AND MARINE RESOURCES
SPECIAL LICENSES UNIT
625 BROADWAY, ALBANY, NEW YORK 12233-4752
PHONE: (518) 402-8985 FAX: (518) 402-8925
WEBSITE: www.dec.state.ny.us

License Authorizations

License to Collect or Possess: Scientific
License # 2360

New License Effective Date: 3/21/2018 Expiration Date: 3/20/2019

NYSDEC Approval

By acceptance of this license, the licensee agrees that the license is contingent upon strict compliance with the ECL, all applicable regulations, and all conditions included as part of this license.

License Regulations

6 NYCRR Part 175
ECL 11-0515 (1)
6 NYCRR Part 189

LICENSE TO COLLECT OR POSSESS: SCIENTIFIC - LICENSE CONDITIONS

1. Collection from the Wild: Authorized Species, Specific The licensee is authorized to collect and possess the following species: 20 Red-backed salamander (Plethodon cinereus), Small mammals (NY Indigenous)

2. Scientific Collection - Authorized Activities The licensee is authorized to possess the collected species for the following activity(ies): Species presence survey.

3. Scientific Collection - Location The licensee is authorized to collect species from the following locations only:
Green-Wood Cemetary, Brooklyn, NY, Kings County, NYSDEC Region 2.

4. Scientific Collection - Authorized Collection Equipment General The licensee shall only collect authorized species using: Sherman box traps, coverboards and hand collection.

5. Scientific Collection – Gear Marking and Monitoring The licensee shall mark all gear deployed with the licensee's name, resident address and license type and number. All traps and nets shall be checked no less than once every twenty-four (24) hours.

6. Scientific - LCP - Collection or Possession of Endangered or Threatened Species Prohibited The licensee shall not collect or possess any endangered/threatened species pursuant to this license.

7. Scientific Collection - Reptile and Amphibian Bio-Safety Protocols The licensee shall conform with all guidelines contained in the Bio-safety Protocols for Reptile and Amphibian Sampling in NYS, attached to this license as Appendix 1. Any questions regarding the protocols may be directed to the Regional Wildlife Manager at:

Regional Wildlife Manager
NYSDEC Region 2 Headquarters
47-40 21st St
Long Island City, NY11101 -5401

8. Scientific Collection –Temporary Possession and Release The licensee shall possess the listed animal(s) only for the minimum time necessary for the collection of biological data. The licensee shall immediately release the listed animals unharmed at the point of original capture following the collection of biological data.

9. Scientific Collection – Removal of Species from the Wild Prohibited The licensee shall not remove the listed animals from the wild.

10. Scientific Collection - Authority to Designate Agents The licensee is authorized to designate agents to assist the licensee with the listed animals while conducting activities authorized pursuant to this license provided that:

a. the licensee submits a written request to the NYSDEC Special Licenses Unit at the address listed on the front of this license containing the:

i) name
ii) address
iii) age
iv) phone number of the person he or she is nominating as a designated agent, and;

b. the licensee receives an amended license from the Special Licenses Unit listing the designated agents he or she has nominated before that person can conduct activities authorized by this license.

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4. GC – Reasons for Revocation This license may be revoked for any of the following reasons:

i. licensee provided materially false or inaccurate statements in his or her application, supporting documentation or on required reports;
ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal laws or regulations of the department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the department for insufficient funds or nonpayment after the license has been issued.

5. GC – Licensee Shall Carry Copy of License The licensee shall carry a copy of this license or a document provided by the department, if relevant, when conducting activities pursuant to this license.

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The licensee shall allow representatives of the NYS DEC Division of Law Enforcement to enter the licensed premises to inspect his or her operations and records for compliance with license conditions.

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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Appendix 1
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September 23, 2011
Prepared by the NYS Reptile and Amphibian Diversity Team

<u>Captive Protocols</u>

For animals being kept as part of a reintroduction, translocation or head-starting program, consult the "Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs," edited by Pessier and Mendelson in 2010.

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        - When handling state listed species (E, T or SC), washing must be done between individuals in the population, unless the species is communal in an aspect of its life history such as hibernation or breeding, at which point it can be expected that all individuals have been exposed to pathogens.

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- Rinse personal gear with tap water or with water from the next water body to be sampled.
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References

Cheatwood, Joseph. An outbreak of Fungal Dermatitis and Stomatitis in a Wild Population of Pigmy Rattlesnakes, (*Sistrurus miliarius barbouri*) in Florida: Description, Factors, Cyclicity, and Prevention. University of Florida. 2000.

Department of Environmental Conservation Fish Management Bio-Security Protocols

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