

Field Report

Inventory of Amphibians and Reptiles at Farm Lane and Top Cottage at the Home of Franklin D.
Roosevelt National Historic Site with Recommendations for Recreational Trail Management

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Executive Summary

This inventory was conducted at Farm Lane and Top Cottage properties, part of the Home of Franklin D. Roosevelt National Historic Site (HOFR), New York, in 2015 and 2016 to (1) determine the reptile and amphibian species present, (2) identify important reptile and amphibian habitat, and (3) to determine any adverse impacts of proposed bicycle trails on reptile and amphibian habitat. Survey methods included visual encounter transect surveys, flipping cover objects, and turtle (hoop) traps.

During this inventory, 100% of frogs, 78% of salamanders, 38% of snakes, 38% of turtles known to the adjacent National Park Service properties were documented at Farm Lane, and 50% of amphibians and 13% of reptiles at Top Cottage. Species richness was much lower at Farm Lane and Top Cottage than historical data from either Eleanor Roosevelt's National Historic Site (ELRO) or HOFR main property, likely due to the difficulties of surveying for secretive species, increased urbanization since 1989 of these much smaller parcels, a shorter study period, and in the case of Top Cottage, topographic setting.

This inventory failed to find evidence of Blanding's Turtles (*Emydoidea blandingii*), a New York State Threatened Species, at Farm Lane or Top Cottage. Given the exurban setting, it is likely that the four individuals documented in Klemens et al. (1992), which have not been seen since 2003, either emigrated, died of natural causes, or fell victim to road mortality.

Additional species may remain undetected at Farm Lane and Top Cottage. New registrations of reptiles or amphibians should depend on digital photographs as vouchers that could be emailed to knowledgeable park staff. Verification of new species records should be confirmed by a herpetologist or personnel of the New York Department of Environmental Conservation (NYDEC).

Recommendations for HOFR management of Farm Lane and Top Cottage include: (1) Restrict property access via unofficial park entrances; (2) Restrict access to informal trails with physical barriers and informative signs; (3) Locate new formal biking trails by replacing existing, informal trails close to forest edges or creating new bike trails near forest edges and away from water bodies; (4) Improve visibility and placement of informative signs to clarify which trails allow biking.

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This research was carried out under NYDEC Scientific Collection Permit #1792 and SUNY-ESF IACUC approval #150202.

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Introduction

The Home of Franklin D. Roosevelt National Historic Site is located in the lower Hudson River Valley of New York State, a region that supports some of the greatest herpetofaunal diversity in the state (Gibbs et al. 2007). Situated 4.8 km east of the Hudson River and 9 km north of urban Poughkeepsie (est. pop 31,000, USCB), HOFR supports natural areas of cultural and biodiversity significance in a highly developed landscape, bordering roads, businesses, forest, and suburban neighborhoods. Roosevelt Farm Lane sees an average of 14,000 visitors a year (D. Hayes, pers. comm), although the recent centennial of the National Park Service (NPS), predict an uptick in future visitors to HOFR. The NPS has a mission to preserve habitats and wildlife for the enjoyment of people, which can be a difficult task, particularly with little understanding of the species present.

In the past fifteen years, the Home of Franklin D. Roosevelt National Historic Site (HOFR) has nearly doubled in size with the acquisition of over 174 ha of land in two parcels known as Roosevelt Farm Lane (RFL) and Top Cottage. These areas have been assimilated into existing park lands, and are now open for public tours and non-motorized recreational use, including biking in specified areas at RFL. However, there has been demand from local bicycle users to open more of RFL to biking, contingent on the collection of information of rare species in this area to inform management and ecologically prudent placement of trails.

Prior reptile and amphibian inventory work was performed by Klemens et al. (1992) in the late 1980s at HOFR on the original property (118.5 ha), as well as the intervening Eleanor Roosevelt National Historic Site (ELRO; 73 ha), and neighboring Vanderbilt Mansion National Historic Site. Since there, amphibian and reptile monitoring on all properties has been inconsistent. The previous inventory documented 32 species on the property. Additionally, Klemens et al. (1992) found Blanding's Turtles, a New York state Threatened species, at HOFR and ELRO, but no Blanding's Turtles have been seen since 2003. Moreover two properties were recently added to HOFR – Roosevelt Farm Lane (RFL) (155.72 ha) and Top Cottage (16.15 ha)– which have not been inventoried (Figure 1). Roosevelt Farm Lane is separated from HOFR to the west and ELRO to the east by roads (NY Route 9 and Route 9G), while Top Cottage is directly connected to easternmost side of ELRO. Both RFL and Top Cottage are bordered in places by

suburban backyards (Figure 1). All areas support substantial recreational use by hikers, and bikers are allowed on the paved trail (Farm Lane Trail) of RFL. During tourist season, NPS offers a trolley tour that follows the paved Farm Lane Trail from HOFR to Val-Kill Cottage at ELRO.



Figure 1: Map of study area where herpetofauna were surveyed from May – August of 2015 and 2016 at the Home of Franklin D. Roosevelt National Historic Site in the lower Hudson River Valley of New York State. Wetlands are in light gray. Edges are speckled black and white. Insert shows location of Hyde Park within New York State.

Beyond collecting baseline herpetofaunal data for future species monitoring within these properties – data increasingly important in the face of the unknown effects of climate change – knowledge of these important animal groups is imperative for responsible stewardship and management of these lands. Species inventories that include locality and population information provide a valuable database for use in habitat-specific or site-specific resource management decision-making.

This report includes the results of a herpetofauna inventory conducted at the Top Cottage and Roosevelt Farm Lane properties of the Home of Franklin D. Roosevelt National Historic Site

in 2015 and 2016, as well as the findings of the author's (SHD) thesis work, which focused on the impact of recreational trails on the distribution of reptiles and amphibians at Roosevelt Farm Lane.

The urban location and context of HOFR as a recreational area provides unique challenges to the persistence of reptiles and amphibians. Inherently, urbanization negatively affects reptile and amphibian populations, and is also a major driver of other negative impacts including habitat loss, habitat fragmentation, pollution, creation of road networks, edge effects, and predator subsidization (Figure 2) (Dean 2017). Additionally, a large body of literature documents the negative effects of recreational activities on wildlife. In urban parks such as HOFR, the stressors of urbanization and recreation combine, exemplified by fragmented habitats that are often close to roads and contain multiple habitat edges within an urbanized landscape; these stressors also likely interact to affect wildlife. Animals in these areas are also subject to disturbance from recreationists, bikers, and dogs, with likely negative effects on herpetofauna. Balancing biological consideration with public demand for recreation can be a daunting task for park managers.

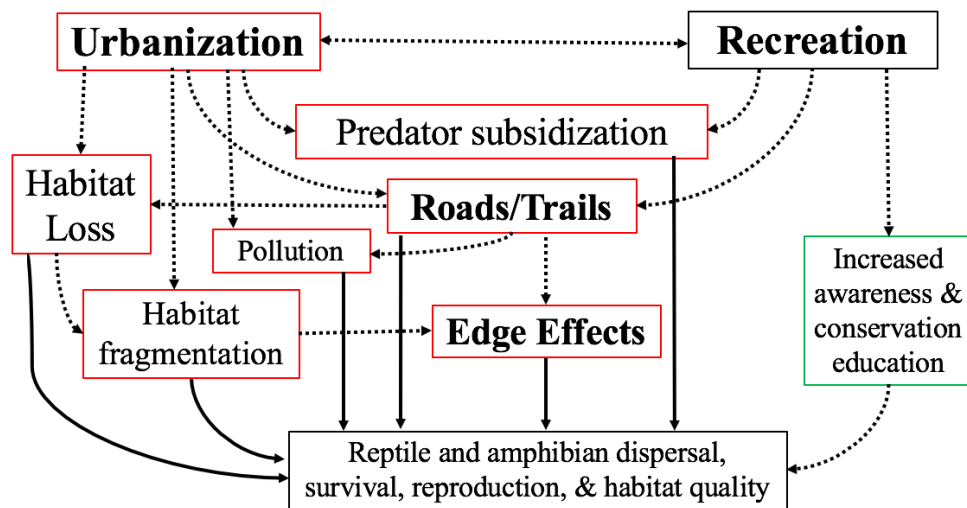


Figure 2: Major effects of urbanization that can impact reptiles and amphibians. Positive relationships have dotted lines, negative relationships have solid lines. The majority of these effects negatively impact reptile and amphibians, although recreation results in increased awareness and conservation education, which positively impacts herpetofauna.

Prior research by Klemens et al. (1992) documented 16 amphibian and 16 reptile species between 1988 and 1990 at the HOFR main property, ELRO, and Vanderbilt sites. These included Blanding's Turtles, a New York State Threatened Species, and multiple New York Species of Special Concern, including: Marbled Salamander (*Ambystoma opacum*), Spotted Turtle (*Clemmys guttata*), Wood Turtle (*Glyptemys insculpta*), and E. Box Turtle (*Terrapene carolina*). Additionally, the Jefferson's Salamander complex (*A. jeffersonianum* x *A. laterale*) was documented at ELRO, which is notable because both Jefferson's Salamander (*A. jeffersonianum*) and Blue-spotted Salamander (*A. laterale*) are also New York Species of Special Concern. Furthermore, HOFR and related properties fall within the range of several more species as yet undocumented here, including: Northern Dusky Salamander (*Desmognathus fuscus*), Fowler's Toad (*Anaxyrus fowleri*), N. Cricket Frog (*Acris crepitans*), N. Leopard Frog (*Lithobates pipiens*), N. Redbelly Snake (*Storeria occipitomaculata*), DeKay's Brown Snake (*S. dekayi*), Eastern Hognose Snake (*Heterodon platirhinos*), E. Ribbonsnake (*Thamnophis sauritus*), and Timber Rattlesnake (*Crotalus horridus*).

The inventory of Farm Lane and Top Cottage was conducted from May – August of 2015 and 2016. Project objectives were to: (1) determine the reptile and amphibian species present, (2) identify important reptile and amphibian habitat, and (3) to determine any adverse impacts of proposed bicycle trails on reptile and amphibian habitat.

Study Area and Habitats

Roosevelt Farm Lane, acquired in 2007 by the National Park Service, is located between ELRO and HOFR, nestled between NY Routes 9 and 9G. Top Cottage makes up the easternmost section of the site, and shares a small border with ELRO to the west. Both areas share boundaries with residential lots, and RFL also shares some boundaries with local businesses. RFL has four formal trails, and Top Cottage has one. Hiking is allowed on trails, and biking is allowed on the paved trail (Farm Lane Trail) at RFL. These areas are within an ecoregion subsection of the Hudson Limestone Valley in the Northern Piedmont ecoregion, which is defined by low mountains and lakes throughout the landscape (Cole et al. 2012). At HOFR, primary soils include: Hoosic gravelly loam, Colonie fine sandy loam, Steep ledgy loam, and Staatsburg gravelly loam (Cole et al. 2012).

Roosevelt Farm Lane supports the most intact forest within the entire HOFR site, and is dominated by hemlock-northern hardwood forest, with areas of beech-maple mesic areas with basswood and white ash trees and red maple-black gum swamps. Small patches of old field, pockets of former conifer plantation, and landscaped grounds are also present. Water sources (wetlands, streams, a pond) are abundant in RFL, and stone outcroppings are common. The hemlock-northern hardwood forest and vernal pools within RFL are considered rare and significant by the New York Natural Heritage program (Cole et al. 2012). The average elevation of Farm Lane is 76 m. Top Cottage is situated on a Taconic foothill, which holds the highest elevation on the property (137 m). Unlike RFL, Top Cottage only supports a small segment of stream and a single vernal pool (Figure 3).

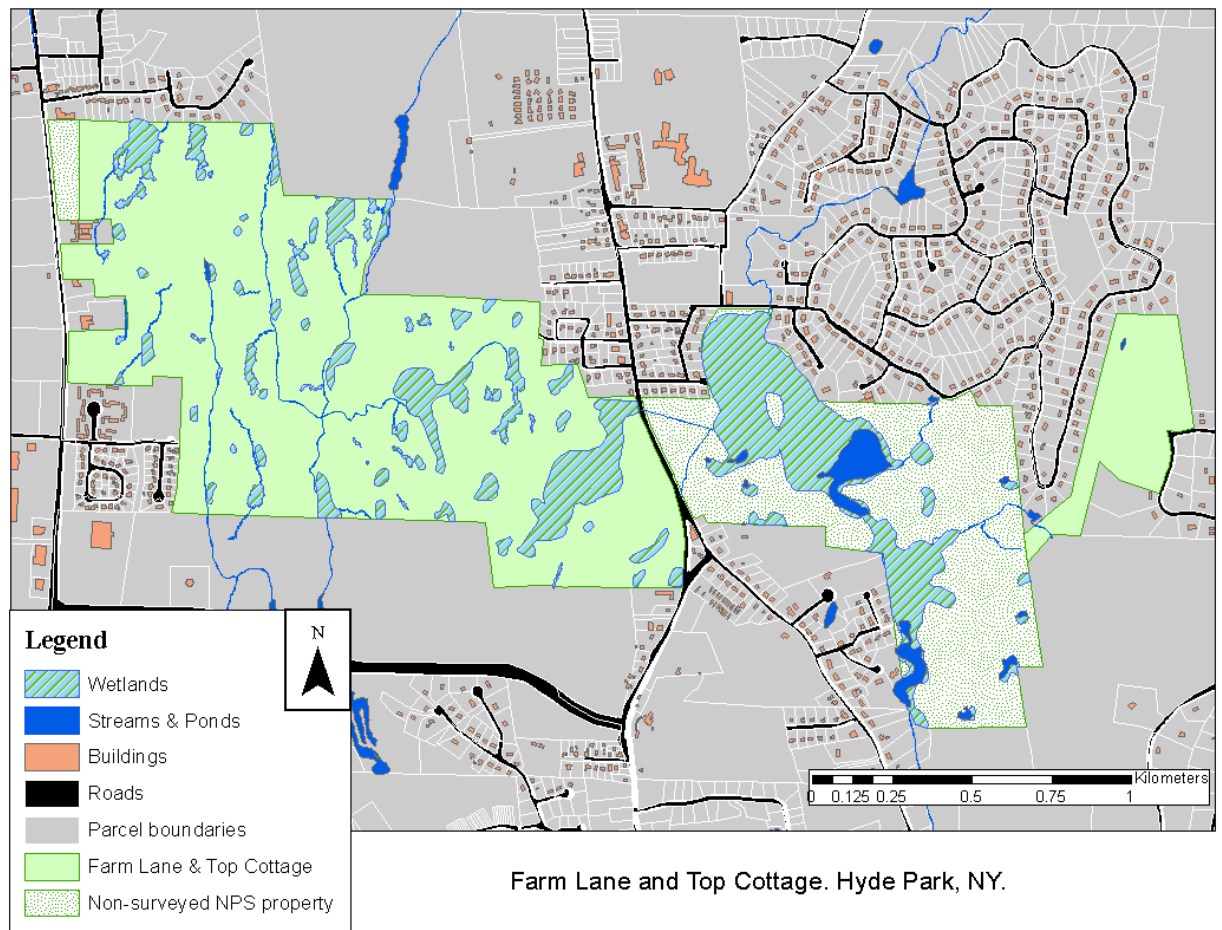


Figure 3: Map of wetland and stream areas at Roosevelt Farm Lane, ELRO, and Top Cottage, at the Home of Franklin D. Roosevelt National Historic Site in Hyde Park, New York.

Methods

In 2015 reptiles and amphibians were surveyed across the RFL and Top Cottage properties to estimate abundance, and community structure. To do so the property was gridded into 159, ~1 ha parcels (referred to as sampling “units”), and assessed using area-constrained surveys. Two researchers walked roughly four transects ~25 m apart through all sampling units turning over cover objects (logs, pieces of bark, refuse, etc. judged large enough for an amphibian to hide beneath) while also searching for surface-active amphibians and reptiles (including calling amphibians). Hoop trapping using 3 ft diameter hoop nets and Promar Collapsible Minnow Traps baited with sardines in oil was attempted for aquatic species in the single pond and Maritje Kill, but after a week was abandoned due to inadequate water levels. Surveys were replicated three times from May to August 2015 (May 12 – Jun 5, Jun 6 – Jul 6, Jul 7 – Aug 5), and were conducted between 0800 and 1800 hrs on non-rainy days. Each individual was georeferenced with a Garmin GPS (GPSMap 78) accurate to 10 m, and track points were automatically recorded every 10 meters while surveying in order to record effort. With the exception of turtles to add to the historical long-term mark-recapture data of the park, animals were minimally handled and not measured. For turtles, data were collected on carapace length, plastron length, and overall body condition, and they were individually marked via power drill on the marginal scutes.

In 2016, over 300, 100 m² circular plots were established within RFL as part of SHD’s thesis work (investigating the effects of disturbances on the distribution of reptiles and amphibians in relation to six habitat types, Figure 4). Plots were sampled for reptiles and amphibians as well as multiple habitat variables (leaf litter depth/cover, canopy cover, tree density/size, coarse woody debris cover/size) for 10 minutes by two researchers on non-rainy days between the hours of 0800 and 1800 from May to July 2016, and only terrestrial areas were sampled. In addition to habitat data, location of each plot was recorded using a Trimble (Sunnyvale, CA) GeoXH receiver and Nomad data collector at the plot center. For more detailed methods of plot surveys, see Dean 2017. Additionally, the width (m) of all trails within RFL was measured at 25 m intervals to calculate total trail coverage of the property.



Figure 4: Locations of disturbance plots and controls within RFL in 2016. Recreational trails are in black with a gray 50 m buffer, habitat edges are shown as a light gray 20 m buffer around edges. Inset shows location of Hyde Park within New York.

Results

2015 season. – A total of 5,246 individuals (12 amphibian, 6 reptile species) were found at RFL and Top Cottage (159, ~1 ha units) in 590 search hours (Figure 5) during 2015. Together, Redback Salamanders and Wood Frogs accounted for 73% of total species captures. Eastern Newts comprised 8% of captures, and Spotted Salamanders and Spring Peepers each comprised 5% of captures. On average, 18 individuals were encountered per hour.



Figure 5: Survey results from the 2015 herpetofaunal survey and illustration of disturbances in an urban landscape context. Clockwise from top left: (1) Reptiles found at HOFR during 2015 survey; snakes = triangle, hoop trapped turtle = gray circle, E. Box Turtle = dotted circle. (2) Amphibians found during 2015 survey at HOFR (black dots). (3) Wetlands, streams, and ponds at HOFR, ELRO, and Top Cottage. (4) Edges (dark gray) and both formal (black line) and informal (dotted black line) trails present at HOFR.

Amphibians, comprised of five species of frogs and seven species of salamanders, made up the vast majority of individuals found (99%, $n = 5217$, Fig. 4). Forty percent ($n = 2099$) were frogs and 59% ($n = 3,118$) were salamanders. As expected from a northeastern forest, the most prevalent species in this survey was Red-backed Salamander (*Plethodon cinereus*) (43% of all individuals found; $n = 2249$), followed by Wood Frog (*Lithobates sylvaticus*) (30%; $n = 1572$), and Red-spotted Newt (*Notophthalmus viridescens*) (8%; $n = 441$).

Of the twenty-nine individuals representing six reptile species, 41% were Black Rat Snake (*Pantheropsis alleghaniensis*) ($n = 12$), followed by Eastern Box Turtle (*T.c. carolina*) (20%; $n = 6$). Forty-six trap nights revealed three individuals of two aquatic turtle species (*Chelydra serpentina*, *Chrysemys picta*), which is a trap success of 0.03 turtles per trap night.

Two additional species (one possible Wood Turtle (*Glyptemys insculpta*), one possible Northern Watersnake (*Nerodia sipedon*), both unverified) were noted by park staff to be on the property but were not observed by researchers during this survey. Additionally, one snake skeleton and one depredated turtle nest (likely a *T. carolina* nest) were observed but could not be positively identified to species.

2016 season.— Across 304, 100 m² plots, 791 individuals (789 amphibians, 2 reptiles) of 12 species (6 salamander, 4 frog, 1 turtle, 1 snake) were found in plot surveys. Wood Frogs and Redback Salamanders were the most prevalent species, both occurring in 39% of all plots ($n = 119$, and 120 , respectively). Reptile captures consisted of one Box Turtle and a snakeskin of unknown species. Along with two reptiles, three amphibian species (*Anaxyrus americanus*, *Hemidactylium scutatum*, *Ambystoma opacum*) occurred in fewer than 5% of plots (< 15 plots). Plots that were devoid of herpetofauna (“None”) comprised 29% of all plots ($n = 89$), and were most common in Edge plots.

No species new to HOFR were documented during either 2015 or 2016. Several species, including *Eurycea bislineata*, *Lithobates catesbeianus*, *Chelydra serpentina*, and *Chrysemys picta* were found at Farm Lane in 2015, but not 2016. This is likely because plot work was not focused on aquatic areas, and there was no effort to trap for turtles. Four species, *Lithobates clamitans*, *Coluber constrictor constrictor*, *Pantherophis allaghamensis*, and *Thamnophis sirtalis* were incidentally observed during 2016 fieldwork, but did not occur in research plots. No state or federally listed species were documented during this survey.

All of the species observed in this study were found by Klemens et al. (1992) in previous inventories, however, one amphibian and nine reptile species previously documented at HOFR, ELRO, and the adjoining Vanderbilt National Historic Site were not found in this survey. These species include (*indicates species only found at only one of either HOFR, ELRO, VAMA): Jefferson Salamander complex* (*Ambystoma jeffersonianum* x *A. laterale*), Spotted Turtle* (*Clemmys guttata*), Wood Turtle (*Clemmys insculpta*), Common Map Turtle* (*Graptemys geographica*), Common Musk Turtle (*Sternotherus odoratus*), Copperhead (*Agkistrodon contortrix*), Northern Ringneck Snake* (*Diadophis punctatus*), Eastern Milk Snake (*Lampropeltis traingulum*), and Northern Water Snake (*Nerodia sipedon*). Smooth Green Snake (*Opheodrys*

vernalis)* and Dusky Salamander (*Desmognathus fuscus*) were documented nearby but not on NPS property by Klemens et al. (1992). In addition, a newly described species since the Klemens et al. (1992) survey, the Atlantic Coast Leopard Frog (*Lithobates kauffeldi*), was not observed in this survey.

One finding of note is the unusual sparsity of American Toads (*Anaxyrus americanus*), which Klemens' (1992) also detailed. Additionally, Black Rat Snakes were only previously documented at the Vanderbilt site. Turtle numbers may be lower than expected due to limited trapping opportunities (water level was low later in season). No Blanding's Turtles were documented in this survey whereas Klemens' (1992) detected four individuals.

Trail width. – The width of all trails within RFL, both formal and informal, were measured every 25 m. The total area of each trail was calculated two ways, multiplying the average width by trail length, and by multiplying the sum of the width measurements by the total trail length. The results of both calculations were averaged to get the most accurate estimate of trail coverage (Table 1).

Table 1: Results of trail measurements taken every 25 m from formal and informal trails within the Roosevelt Farm Lane property of the Home of Franklin D. Roosevelt National Historic Site, Hyde Park, NY.

	Formal Trails (<i>n</i> = 4)	Informal Trails (<i>n</i> = 40)
Length (km)	5.3	12.9
Surface area (ha)	1.5	1.49
Mean width (m)	2.38	1.22

Discussion

Inventory. – As ectotherms, reptiles and amphibians are particularly responsive to changes in temperature and precipitation, and season. For herpetofauna, particularly amphibians (Dodd and Dorazio 2004), this close relationship with climate patterns can have effects on activity outside of the bounds of a survey period. New York saw much lower than average precipitation from March–May of 2015, which may have contributed to drier than normal conditions during the survey, even as conditions were normal under the Palmer Drought Severity Index (NOAA 2016)

during surveying. Additionally, much of the 2016 survey period was performed in moderate drought. These climatic factors likely affected encounter rates of reptiles and amphibians (i.e. they are probably lower than expected). Many species of herpetofauna are notorious for secretive behaviors and being difficult to detect, thus it is possible that there are species that were missed in this inventory. Future surveys would benefit by utilizing multiple methods of herpetofaunal detection, such as dipnet surveys, minnow traps, acoustic surveys, drift fences, and surveying during the amphibian breeding/migration season. As faunal surveys represent snapshots in time, repeated future surveys would assemble a dataset capable of investigating site population trends over time.

All twelve amphibian species detected in this study were previously documented on adjacent NPS property by Klemens et al. (1992). Similarly, this study also failed to find Dusky Salamanders (*Desmognathus fuscus*) or Northern Leopard Frogs (*Lithobates pipiens*) at RFL or Top Cottage. Farm Lane supported all twelve species of amphibians, likely owing to a large diversity of wetland and stream habitats. The rarest species, Two-lined Salamander (*Eurycea bislineata*), was only found at the edge of first-order streams; in the future a focus on aquatic areas may turn up more of this species. Top Cottage supported eight amphibians, most of which were greatly concentrated in the “bottleneck” of the parcel, where Top Cottage meets the eastern edge of ELRO, owing to the stream that crosses the property here, as well as the neighbor’s pond (the one vernal pool at Top Cottage was dry for most of 2015 and 2016). Top Cottage did not support three of the more uncommon amphibians, which included Two-lined Salamander, Marbled Salamander (*Ambystoma opacum*), and Four-toed Salamander (*Hemidactylium scutatum*), however a single American Toad was found in 2015 (*Anaxyrus americanus*).

The species assemblage found at RFL and Top Cottage represent a robust sampling of the amphibians native to the area, but a poor showing from reptiles, particularly snakes. No lizards have been documented at HOFR, although Dutchess County is within the range of Five-lined Skink (*Plestiodon fasciatus*). The plethora of aquatic habitats and availability of surrounding uplands allow for relatively stable populations of common forest amphibians such as Red-backed Salamanders, Spotted Salamanders, Eastern, Newts, and Wood Frogs at RFL, although aquatic habitats are very limited within Top Cottage which is reflected in the amphibian diversity found there.

Six of the sixteen reptile species documented by Klemens et al. (1992) were documented at RFL and Top Cottage. Three turtle species were detected in this survey, and all individuals were seemingly healthy and marked for monitoring in future mark-recapture studies. Top Cottage supported only the most terrestrial turtle known to the area, Eastern Box Turtle. This animal was found by SHD outside the bounds of the official survey period, but as it represents the only turtle from this parcel it is of note. Top Cottage supports only an ephemeral vernal pool, so aquatic turtle presence is unlikely (though the neighbor's pond may provide habitat). Five other Box Turtles were found at RFL (1 in 2016; 4 in 2015). Painted Turtles were hoop-trapped in the pond at RFL, and Snapping Turtles were trapped in Maritje Kill.

While unfortunate that no Blanding's Turtles were found in this survey, it is unsurprising. Neither RFL nor Top Cottage support wetlands with good sun exposure or deep-water wetlands, conditions that Blanding's Turtles prefer (Beaudry et al. 2009). These conditions exist at ELRO and elsewhere at HOFR (i.e. the areas in which Blanding's Turtles were originally documented by Klemens et al. (1992)), but those areas were not a focus of this survey. The lack of sightings of the four original individuals in the past decade suggests they are no longer present. Blanding's Turtles are known for making large, frequent terrestrial movements (Congdon et al. 2011), exposing them to road mortality (Gibbs and Steen 2005) and illegal collection (Garber and Burger 1995). It is also possible that these individuals sought more suitable habitats elsewhere, relocated to look for mates, or perished from other natural causes. Thorough surveys of ELRO and the main HOFR properties are recommended to confirm absence of Blanding's Turtles from the area.

Snakes are a notoriously difficult taxa to study, as many species exhibit secretive behavior, large home ranges, and naturally low population densities (Gibbons et al. 2000). Many ecological patterns of herpetofauna take several years of data (sometimes decades) to become apparent (Gibbons et al. 1997), so conclusions about reptile distribution at HOFR should be understood in the context of a short-term sampling effort. This survey documented three of the eight snake species at RFL and Top Cottage known to occur at HOFR, specifically Black Rat Snakes (*Pantherophis allagheniensis*), Garter Snakes (*Thamnophis sirtalis*), and Black Racers (*Coluber constrictor constrictor*). All surveyed snakes were found at RFL; no snakes were surveyed at Top Cottage. However, outside of the bounds of 2016 plot surveys, five Garter

Snakes were found at Top Cottage in the span of two hours. Snakes may not be as prevalent in RFL and Top Cottage due to the smaller parcel size and more fragmented nature of these areas as compared to ELRO, HOFR, and VAMA. It may also be that in RFL, snake populations have been affected by the two major roads (NY Route 9 and 9G) bordering RFL on two sides. Roads can be attractive to reptiles because they use the heat-retaining properties of the road surface to thermoregulate (Sullivan 1981), which makes them extremely susceptible to road mortality. Given the majority of snakes found in this study were in habitat edge and close to roads, it is possible road mortality has negatively impacted snake populations at RFL.

Management Issues

Trails.— Although research on the effects of recreational trails on herpetofauna is limited to two studies, both have demonstrated a negative effect of trails on reptile and amphibian abundance, primarily due to trampling caused by recreationists on trails (Ficetola et al. 2006, Dean 2017). Trampling on trails themselves is often exacerbated by trail widening, which is trampling immediately adjacent to the trail when visitors have difficulty discerning where the trail is located (Svajda et al. 2016; Wimpey 2009). There is a direct negative relationship between trampling intensity and plant cover, and species, leaf litter, and soil density (Kissling et al. 2009). Reduction in leaf litter is the most important variable in determining presence of terrestrial salamanders (Petranka et al. 1993), the most abundant of which in the northeast – Redback Salamanders – are positively associated with leaf litter depth (Pough et al. 1987). Large amounts of leaf litter retain moisture for several days after rain, which create plentiful foraging opportunities for amphibians (Harpole and Haas 1999). Over the long term, trail-adjacent vegetation loss from trampling creates larger gaps in the tree canopy, perpetuating a positive feedback loop that further reduces the availability of leaf litter for reptiles and amphibians.

Trails are further limiting to herpetofauna because they support lower levels of coarse woody debris. Amphibians in particular are positively correlated with downed woody material (Hicks and Pearson 2002, McKenny et al. 2006), and this relationship is especially strong with debris that is large and well-decayed (Otto et al. 2013). This association is partially due to increased invertebrate abundance with larger coarse woody debris (Riffell et al. 2011), and because amphibians use them as refugia and nesting areas. Of the most consequence to

herpetofauna are places where trails enter forest patches, as these habitats are influenced by both edge effects, and trail effects. Dean (2017) found these areas show drastically reduced abundances of common forest amphibians, likely because they support microhabitats ill-suited for amphibians.

Impacts of trails can differ based on their construction and maintenance, which generally divides them into two categories: formal trails and informal trails. Formal trails can be dirt, gravel, or paved, and are differentiated from informal trails, which usually have a bare ground substrate, because they are created and/or maintained by land managers, while informal trails are visitor-created. Often, informal trails consist of shortcuts to other trails and trails that are created to connect existing tracks (Marion and Wimpey 2007). Measurements from RFL (Table 1) highlight the differences between formal and informal trails in length, surface area, width, and number. Informal trails outnumber formal trails ten to one. Although on average twice as long and half as wide, the 40 informal trails at RFL cover the same amount of surface area as the four formal trails, taking up three hectares of the property in total.

Formal trails may provide artificially high amounts of large coarse woody debris for herpetofauna compared to informal trails as a result of trail maintenance practices. Specifically, when dealing with downed trees blocking a trail, maintenance generally involves cutting the tree into large chunks and rolling these logs to areas immediately adjacent to the trail; given time these may become attractive refugia to reptiles and amphibians. Although these logs may represent an ecological trap for herpetofauna – representing poorer habitat while also placing them in greater propinquity to trail-using humans and predators – they also constitute inexpensive and natural trail markers which help to demarcate trail locations.

The networked structure of trails also contributes to their detrimental effect on herpetofauna. Given that trails have “edge effects” (referred to here as “trail effects”), or changes in population and community structure that occur at the boundary between two habitats, the effects of trails are significantly greater than the space taken up by the trails themselves. Research on trail effects as a type of edge effect is scant in the literature, with the exception of Dean (2017), who found that trail effects negatively affected amphibian relative abundance 50 m away from trails at HOFR, likely because these areas provide poor habitat.

Although the research on trail effects is limited, amphibians are likely to avoid these areas because they resemble habitat edges, which are widely known to have negative effects on

amphibian abundances (Maynard et al. 2016; deMaynadier and Hunter 1998; Ferreira et al. 2016), presumably because of the poor (e.g. variable) microclimate that often extends significant distances into these habitats (De Paula et al. 2016). In contrast, edge effect research on reptile has indicated that they may actually prefer edge habitats because they offer good thermoregulation opportunities and prey availability (Barrett and Guyer 2008; Grundel et al. 2014; and Venegas-Guerrero et al. 2016), although inconsistent results among studies show this pattern may not hold true for all reptiles (Maynard et al. 2016).

Additional concerns from vast networks of trails in recreational areas are erosion (Pickering et al. 2010. Ballantyne and Pickering 2015c) and increased opportunities for the spread of invasive species (Ballantyne and Pickering 2015a,b).

Wildlife disturbance. – The proliferation of trails within RFL and Top Cottage increases the likelihood of interaction between visitors and wildlife, and thus the risk of poaching, wildlife harassment, and conflict. Disturbance from visitors can cause changes in animal behavior (Parent and Weatherhead 2000; Beale et al. 2016), and reptiles, particularly snakes, may be most at risk from harassment or persecution by recreationists and dogs (Burger 2001). Reptiles, especially those that are long-lived, are the most threatened by poaching because even removing a few individuals from populations can have a disproportionately large effect on population demography (Gibbs and Steen 2005, Row et al. 2007). While there was no evidence of poaching at HOFR, it would not be difficult for visitors to illegally remove animals from the park without catching the attention of park staff.

Biking. – While there is no direct literature on the effects of mountain biking on reptiles and amphibians, prior studies have demonstrated negative effects on habitats. While mountain biking reduces vegetation height, cover, and species richness, causes changes in species composition, and increases litter and soil compaction (Pickering et al. 2011), the major disturbance from bikers is the creation of “technical trail features” (TTF) to enhance their riding experience. These can include created ramps, dirt ramps, riding on logs, ditches, mounds, or creating jumps across logs, and these are often combined with the unauthorized creation of informal trails because bikers seek more challenging trails than those provided (Newsome and Davies 2009; Pickering et al. 2010). Even though biking is technically only allowed on the Farm Lane Trail, multiple

examples of TTFs exist amongst the other trails in Farm Lane, such as created ramps, creation of informal trails with more “challenging” terrain (e.g. Trails M and N), and the shifting of footbridges by visitors to allow riding through streambeds (Figure 6). Particularly alarming are the informal trails that are created through wetlands or vernal pools where SHD observed recent bike tracks through these sensitive habitats. Issues resulting from biking were only encountered at RFL and not Top Cottage, as the mountainous topography and rather rocky terrain of the latter limits all but the most intense of bikers.

Although park rules posted at the formal trail entrances/exits indicate that biking is only allowed on the Farm Lane Trail (a pavement/gravel trail), all other trails, which are dirt trails, showed evidence of bike tracks (Figure 7). A few trails have explicit ‘No Biking’ signs, however these are not the norm. It should be noted that bikers encountered by SHD on dirt trails, even when politely informed of the biking rules within the park, continued to be encountered throughout the season on dirt trails, indicating ignorance of park rules is not the only reason unauthorized biking occurs.



Figure 6: Pictured here is a streambed (flowing left to right) where informal trail users have filled the streambed in with rocks in order to cross it (center). Located at Roosevelt Farm Lane, the Home of FDR National Historic Site, Hyde Park, New York.



Figure 7: Example of bike tracks on an informal trail that cross through a vernal pool. Located in Roosevelt Farm Lane, the Home of FDR National Historic Site, Hyde Park, New York.

Management Recommendations

Trail management. – Generally, park managers should strive to keep maintained trails clearly marked, both in regards to where trails are in space and directionality, and at ground level the desired trail width. Clear trail markings keep visitors on formal trails by limiting confusion with informal trails, and also decreases trail width from excessive trampling (on dirt trails) (Wimpey 2009). Currently the formal trails are generally well-marked at major intersections with direction-based signs, however there are no signs at or on informal trails.

Given that trails negatively impact amphibians (and presumably reptiles as well), reducing the number of trails will limit the impacts of recreational activities on herpetofauna by reducing fragmentation, and both habitat and animal disturbance. This creates more “core” habitat that is neither affected by edge or trail effects. In particular, informal trails are often more detrimental to herpetofauna and habitats, because they are unplanned, and as a result are usually poorly located with respect to terrain (Moskal and Halabisky, unpubl. data. 2014), such as through wetlands, and their lack of maintenance increases their potential to degrade habitats (Marion et al. 2006). Informal trails can lead to liability concerns with trails created in unsafe areas (Marion et al. 2006), an issue that is at play at RFL on the M trail, which juts out onto the top of a cliff face with a steep drop.

Although it is recommended to close all informal trails that are not maintained by park staff, the resources to accomplish this goal are limited. Thus, three sections of informal trails have been identified as priority areas that should be barred to visitors and allowed to revegetate naturally or with active restoration. The first is the area encircled by the Farm Lane Trail, Yellow Trail, and Blue Trail, comprised of seven informal trails: AF, AG, AK, AC, AD, AB, and AE (Area 1, Fig 8). This section of the park is highly diverse in herpetofauna, and housed the highest concentration of Box Turtles at RFL. Box Turtles are at risk of poaching (Garber and Burger 1995), and are in limited number at RFL. Additionally, closing the informal trails in this area would create the largest parcel of trail-less and habitat-edge-less habitat within this section of the park.

The remaining high priority areas to close are located in the northern section of RFL. Area 2 (Fig 8), straddling the western end of the Red Trail, is highly diverse and dense with

herpetofauna, particularly the area where trail N nears the only pond on the property. Informal trails N and M appear to be biker-created trails, with evidence of multiple tire tracks, meandering patterns, and several steep drops. Trail M also extends out onto a large boulder, with a potentially hazardous drop, creating liability concerns. With only four points of entry, between Farm Lane Trail, Red Trail and Trail L, barring access to this area would not be difficult. Area 3 (Fig 8; trails A, B, C, D, E) northeast of the Red Trail, is also highly diverse in reptiles and amphibians, and is adjacent to another forested area to the north. This area houses a large wetland complex, and would keep visitors from disturbing the upper streambed of Maritje Kill.

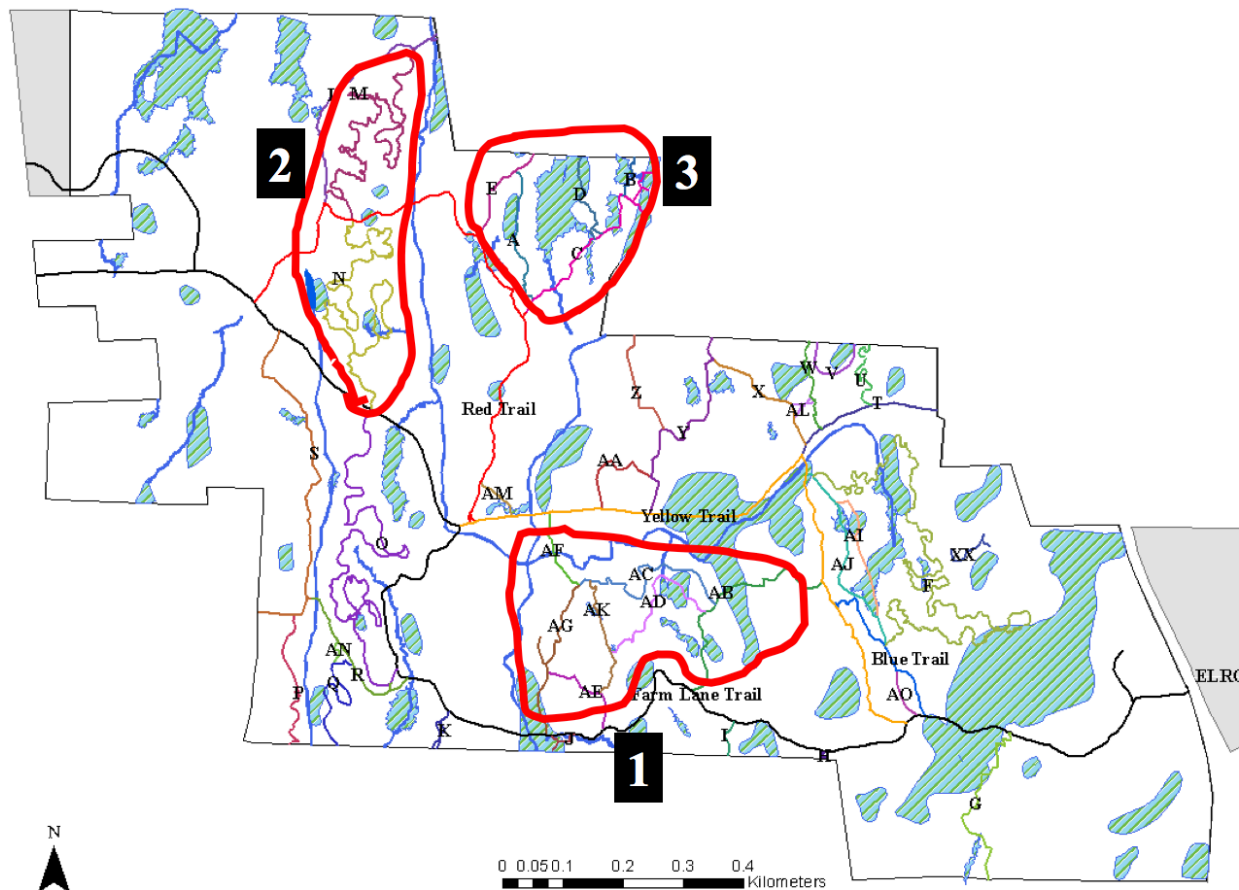


Figure 6: High priority informal trail closings within Roosevelt Farm Lane (Hyde Park, NY). Area 1 is high in diversity and a concentrated area for Box Turtles. Area 2 is highly diverse and simple to restrict access to. Area 3 is highly diverse with a large wetland complex.

In conjunction with closing excess informal trails, NPS staff should strive to limit access to the park via unsanctioned entrances, which will also hopefully curtail the formation of new informal trails. Of the 20 entrances to RFL property, 17 are not maintained by NPS, as well as a one out of three entrances at Top Cottage (Figure 9). These extra entrances allow for after-hours access to the park after it has closed via neighboring properties. They also contribute to the creation, spread, and widening of informal trails, as well as other prohibited activities. Unsanctioned entrances associated with high priority trail closing areas should take precedence in considering which to close first. Contact, partnerships, and cooperation with neighboring property owners to the north and south of RFL, and to the east of Top Cottage, as well as posted signs may help facilitate these closings.

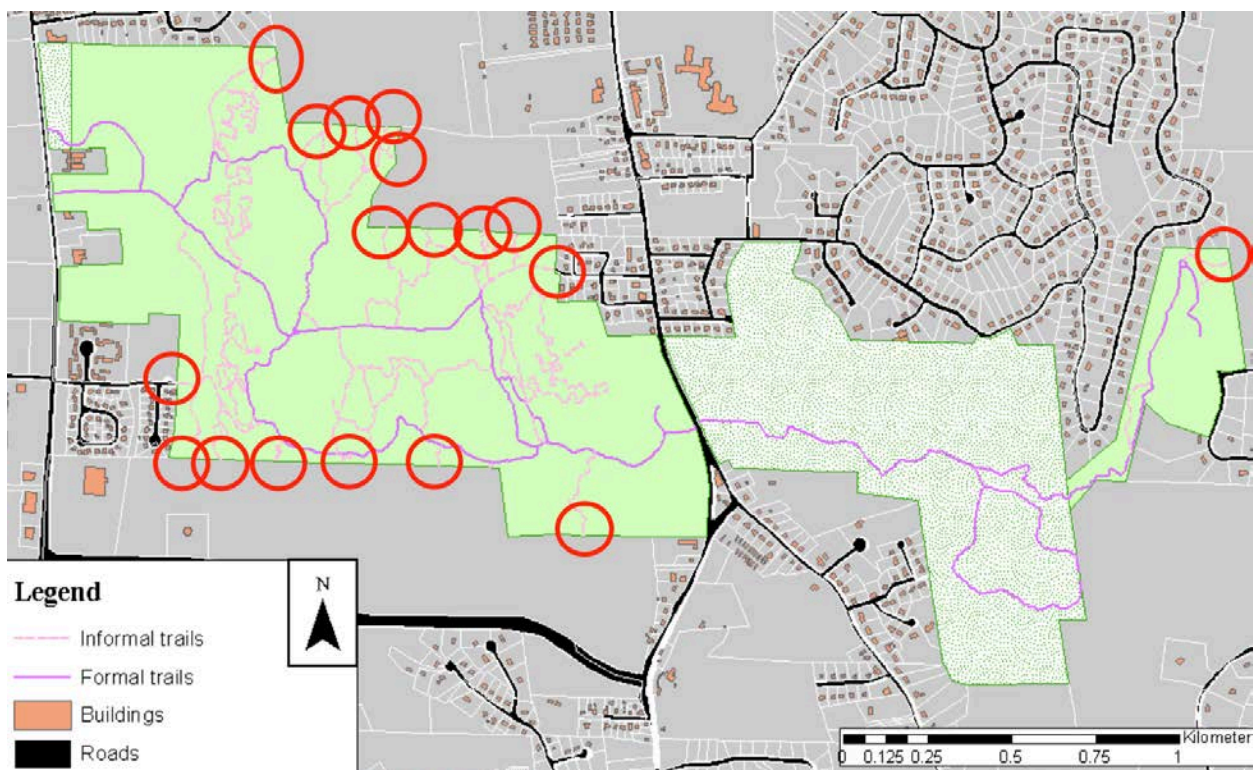


Figure 7: Map of trails of Farm Lane, Eleanor Roosevelt National Historic Site, and Top Cottage (Hyde Park, NY). Circled areas are unofficial entrances to NPS property that are recommended to either be monitored by park staff or closed to public access.

Trail closures should provide a very clear indication on whether the trail is accessible or not. This should be accomplished with the combination of a physical barrier, such as a wooden barricade, and posted signs from NPS. These signs should go beyond a simple “Trail Closed” or “Do Not Enter” in the spirit of full transparency, to give visitors a short explanation of why the trail is closing. Multiple options exist as reasons for trail closure, including: allowing habitat recovery, protecting habitat for native species or NY Species of Special Concern (without specifying species), reducing erosion from dirt trails to protect waterways, limiting the spread of invasive species, or because a trail is prone to floods (such as those crossing through vernal pools) (see example Figure 10). These areas will need to be monitored, particularly in the early stages where visitors can still discern a trail on the other side of the barricade, to ensure visitors do not ignore signs and create new pathways *around* the barricade, thereby hampering recovery efforts.



Figure 8 Example area closure sign that is clear and informative in explaining to visitors why an area is closed, from Cape Cod National Seashore, Massachusetts. Photo from National Park Service.

Bike trails. – Two areas of RFL have been identified as preferred areas of future bike trail development (Figure 11). These areas are least likely to impact reptiles and amphibians either because they support low density and diversity of herpetofauna and/or because they represent areas of lesser habitat quality (i.e. habitat edge). The impacts to wildlife from trails differs based

on their design, location, construction, maintenance, and use (Ballantyne and Pickering 2015b). The conversion of an informal trail already in existence into an officially maintained bike trail is undoubtedly less destructive to habitat than the creation of an entirely new trail. With that in mind, the area encompassing informal trails S, O, AN, and R would be well suited for a new biking trail. This could be achieved by forming a loop between Farm Lane Trail (where biking is already allowed) and trails S and R, as well as creating a new, NPS-maintained park entrance in the southwest corner to connect the park to the neighboring community. Alternatively, the southeastern end of Farm Lane that borders Route 9G would be an appropriate location for the creation of a new biking trail. These areas should be clearly marked as biker-friendly with pictogram signs on trail markers or near trails.

The construction of biking trails should also take into account slope and soil wetness to limit impacts to habitats. Steeper slopes and muddier trails increase the erosive impact of biking (Marion and Wimpey 2007; White et al. 2006), as well as opportunities for skidding (i.e. sharp turns) and unauthorized building of TTFs (Newsome and Davies 2009; Pickering et al. 2010; 2011; Pickering and Barros 2015). Thus, trail designers should focus on flatter, dryer areas for new trail construction within the recommended zones.

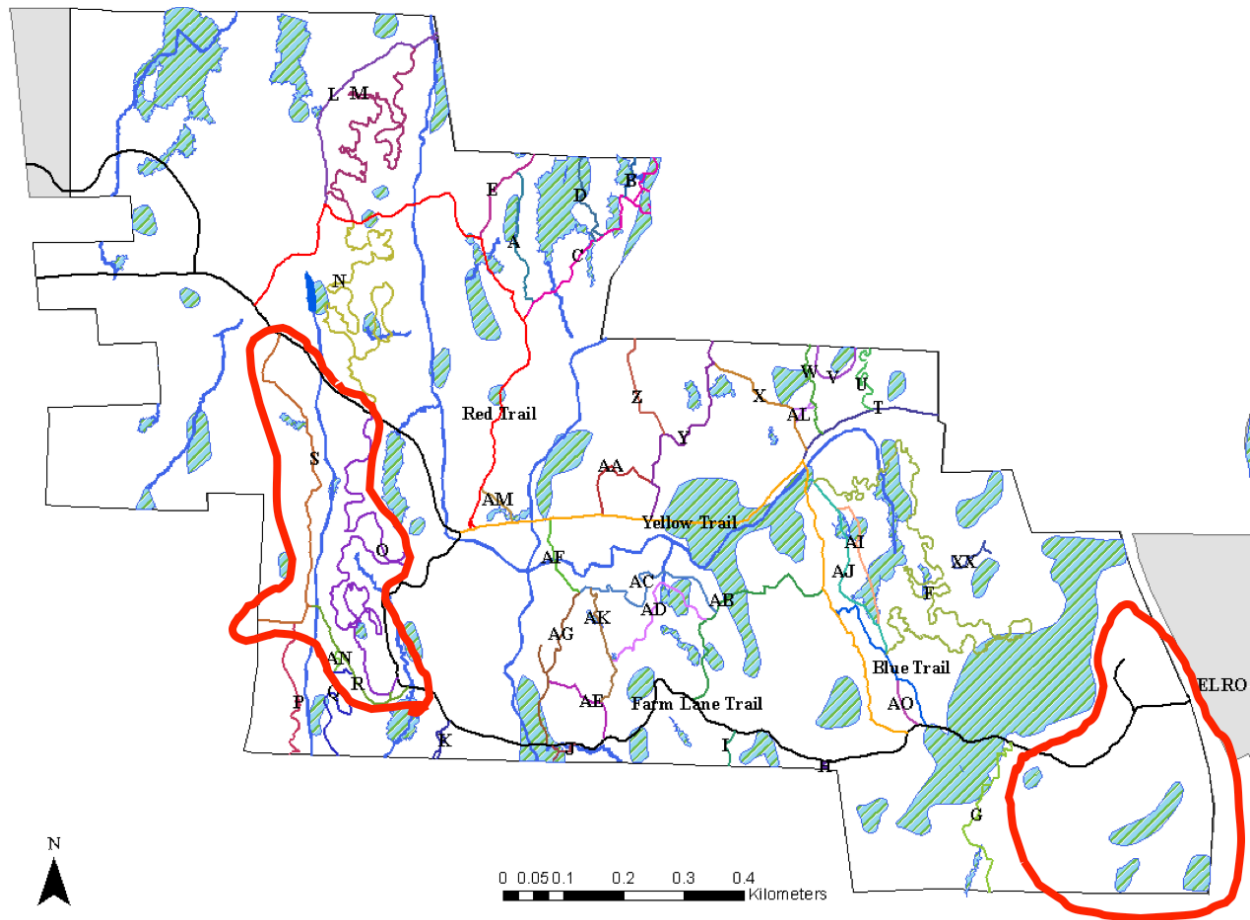


Figure 9: Map of Roosevelt Farm Lane (Hyde Park, New York) with each trail individually labeled. Based on their herpetofaunal density and diversity, and their proximity to habitat edges and roads, the far Eastern portion of RFL east of the G trail, and area immediately surrounding the S and O trails (circled in red) are the most suitable locations for future bike trails in order to minimize impacts on reptiles and amphibians.

Species specific recommendations.— A small subset of species deserve individual attention at HOFR. The first is the Eastern Box Turtle, which is a NY State Species of Special Concern due to declining populations and habitat loss throughout its range. Other populations, such as those in the St. Louis Box Turtle Project, and in Aiken, SC (Brisbin et al. 2008) have established that turtle populations can survive and thrive in urban and exurban environments. However, they face challenges in these environments such as subsidized predators (Feinberg and Burke 2003; Ner and Burke 2008), harassment or injury by people and pets (Burger 2001), poaching for the pet trade (Garber and Burger 1995), and road mortality (Gibbs and Steen 2005). The addition of recreational pressures presumably create additional challenges to survival for these animals.

Though this study did not document instances of Box Turtle harassment or poaching, this is potentially an issue, particularly from harassment of unleashed pets. Approximately half of pets encountered during fieldwork for this survey were unleashed, which is a violation of park rules. Though keeping pets on leashes is likely intended to keep visitors safe from pets, this also prevents pets from wandering and/or disturbing wildlife. Visitors often mistook SHD for an NPS staff member when encountered on trails, and would leash their dogs (if previously unleashed) as they approached. These encounters suggest that an increased presence of park staff would likely lead to an increase in leashed animals within the park.

The only evidence of Box Turtle reproduction was a depredated nest found in an area very close to the location of a female Box Turtle (nest is presumed to be Box Turtle, although ID is uncertain; no other turtles were found within 500 m). This small peninsular parcel, comprised of mostly meadow on the western edge of RFL, is sandwiched between a suburban neighborhood and the Roosevelt Theater parking lot, and bordered by Route 9 on the west side. The openness of this area, compared to high canopy cover throughout the remainder of RFL, makes it prime Box Turtle nesting habitat. The often lethal results of turtle encounters with cars (Gibbs and Steen 2005) makes the propinquity of this area to a major road and busy parking lot concerning. Box Turtles in this area would benefit from short exclusion fencing to prevent wandering into paved areas. Wildlife in this area would also benefit from a cleanup of abundant litter, which is likely spillover from the movie theater parking lot and accompanying dumpster.

Outreach and citizen science.— That there are still common species such as E. Ribbonsnake and N. Redbelly Snake that are as-yet undocumented at HOFR provides a citizen science opportunity for visitors to contribute to park management. Park staff can post signs requesting that digital photos of roadkill or live snakes (though this can be extended to all wildlife, not just herpetofauna) be emailed to park staff. Verification of these records should be confirmed by a herpetologist or the NYDEC. Additionally, the park should continue with its ongoing monitoring and outreach efforts using the coverboard array at RFL.

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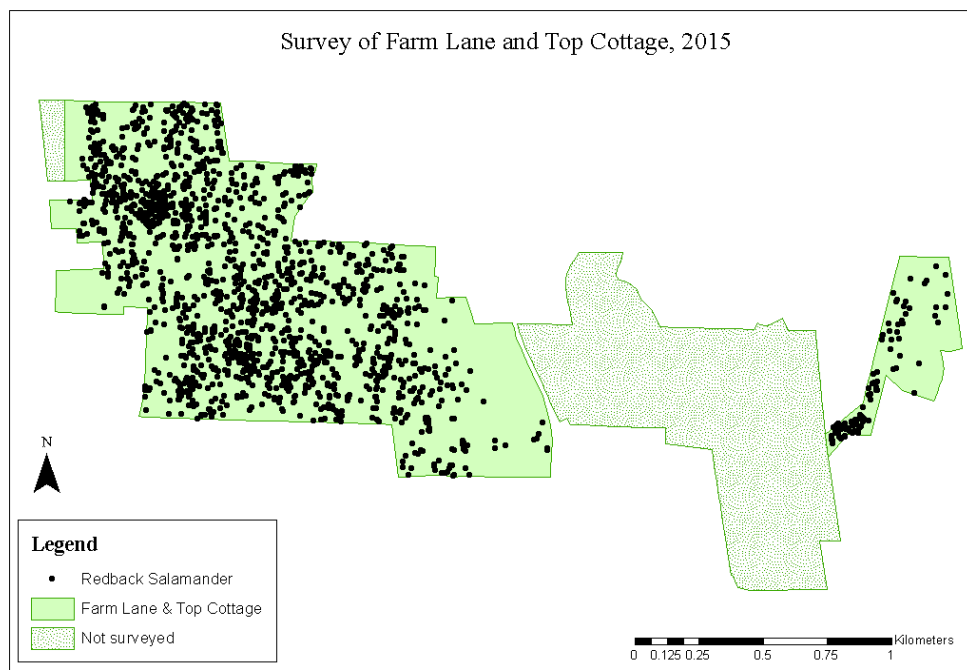
Appendix

Table A1.1: Species totals by search effort for 2015 survey of Roosevelt Farm Lane and Top Cottage (Hyde Park, New York). Survey consisted of 295 search hours and 46 hoop trap nights.

Species	Individuals	% of total individuals	Individuals per search hour
Redback Salamander	2249	0.43	7.6
Slimy Salamander	104	0.02	0.35
Spotted Salamander	240	0.05	0.81
Four-toed Salamander	43	0.008	0.15
Two-lined Salamander	9	0.002	0.03
Marbled Salamander	31	0.006	0.11
Eastern Newt	441	0.08	1.49
Gray Treefrog	37	0.007	0.13
American Bullfrog	5	0.001	0.01
American Toad	6	0.001	0.02
Green Frog	51	0.01	0.17
Wood Frog	1572	0.30	5.33
Spring Peeper	224	0.05	0.76
E. Box Turtle	6	0.001	0.02
Black Ratsnake	12	0.002	0.04
Black Racer	2	0.0004	0.007
Gartersnake	3	0.0006	0.01
Painted Turtle	3	0.0006	0.07 (46 trap nights)
Snapping Turtle	2	0.0004	0.008 (46 trap nights)

Table A1.2: Turtles captured and marked via scute drilling during 2015 and 2016 at Roosevelt Farm Lane and Top Cottage, at the Home of Franklin D. Roosevelt National Historic Site, Hyde Park, New York.

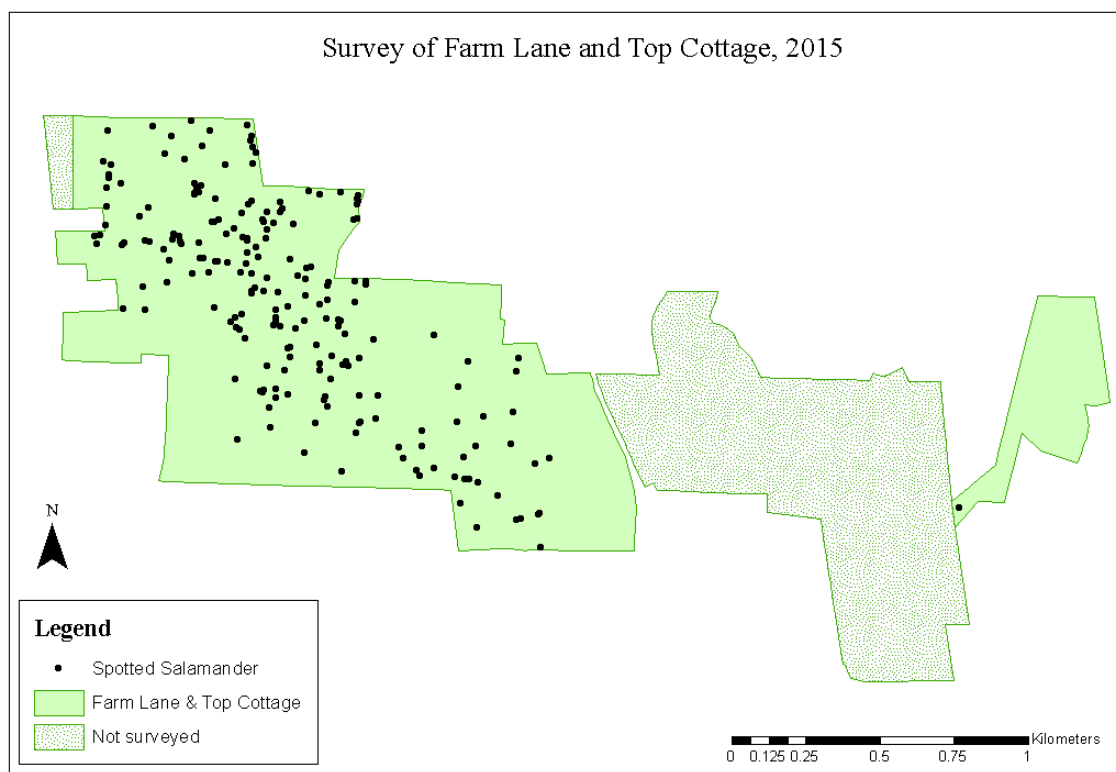
Turtle species	Date	Location	Sex	CL (mm)	ID mark	Notes
Box	5/11/2015	TC	F	150	L1L2	Slight scar between vertebrals 3 & 4.
Box	5/19/2015	RFL	F	140	L1L3	Double 4 th vertebral; very small 3 rd L costal
Box	5/20/2015	RFL	F	125	L2L3	Scars on plastron, left side. Shell dark w/yellow orange spots
Box	5/06/2015	RFL	M	154	R1R2	Old scars on 1 st /2 nd L costal; 2 medium-large scars on lower plastron.
Box	5/06/2015	RFL	M	159	R2R3	Very orange legs
Box	5/26/2016	RFL	M	149	R8L8	R10 chipped; Small scar in R4 costal; Nuchal reduced & chipped. Shell yellow along costals but faded at marginals
Snapping*	5/25/2015	RFL	NA	NA	NA	Unverified report by jogger.
Snapping	6/04/2015	RFL	Unk	NA	L10L11	.
Snapping	6/05/2015	RFL	Unk	205	L11L12	.
Painted	6/05/2015	RFL	M	.	L1L3R3	Notched due to size
Painted	5/14/2015	RFL	Unk	NA	NA	Two individuals basking on log
Unk.	6/20/2015	RFL	NA	NA	NA	Depredated nest, likely E. Box Turtle



Redback Salamander

Plethodon cinereus

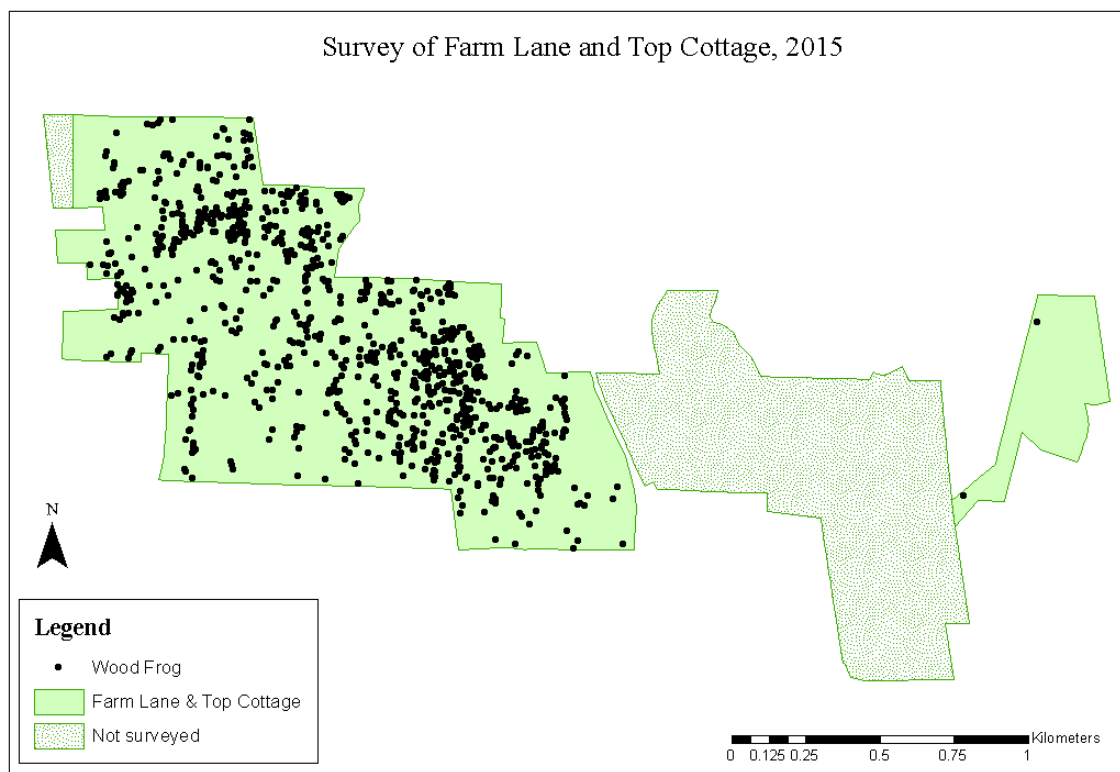
Figure A1.1: Redback Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Spotted Salamander

Ambystoma maculatum

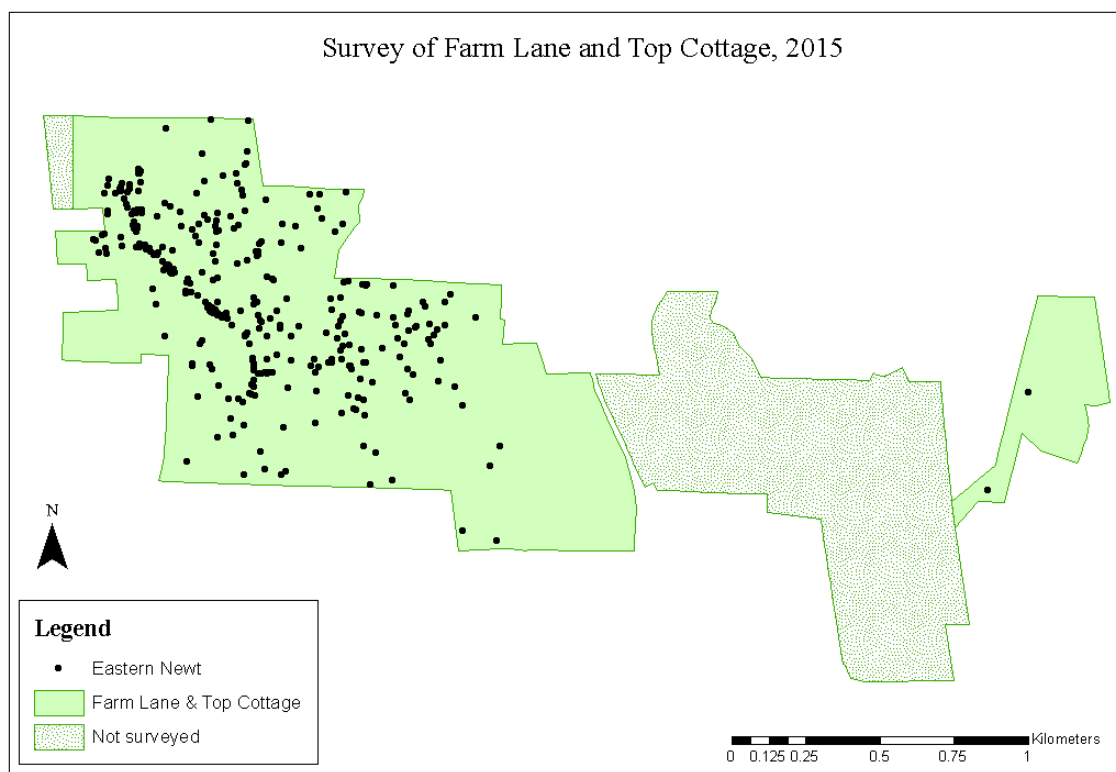
Figure A1.2: Spotted Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Wood Frog

Lithobates sylvaticus

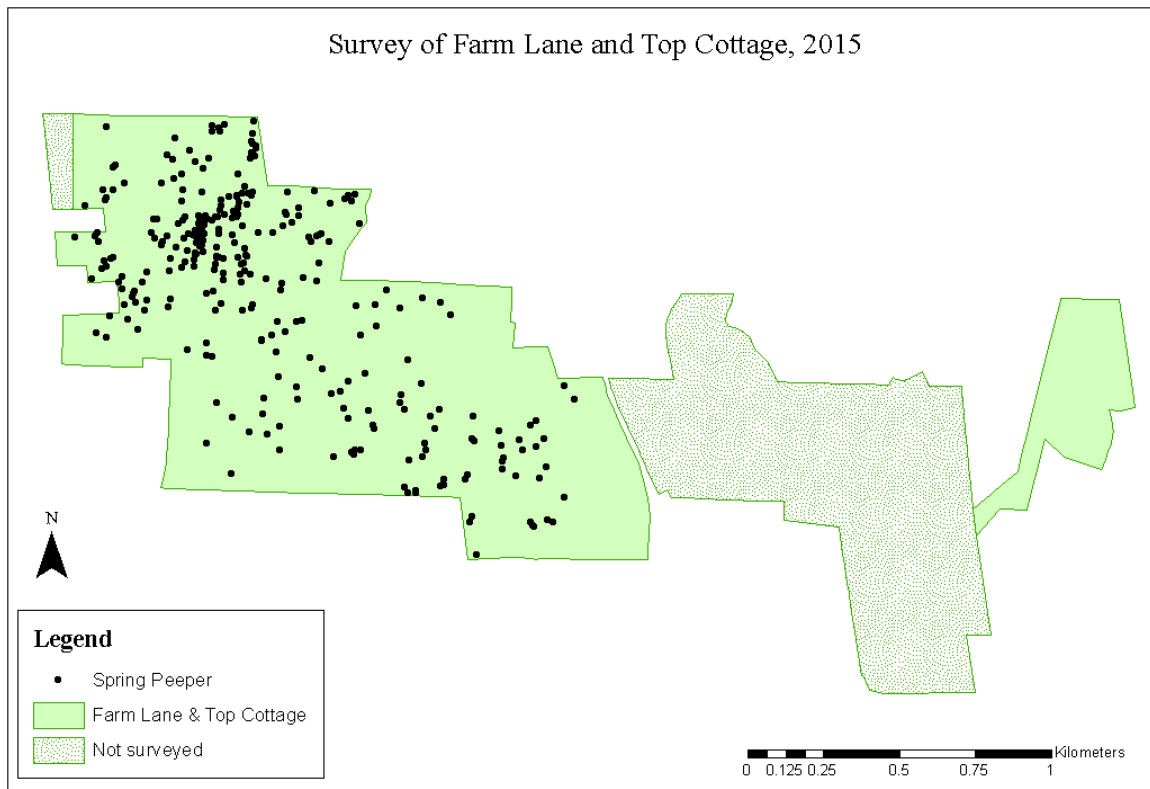
Figure A1.3: Wood Frog locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Eastern Newt

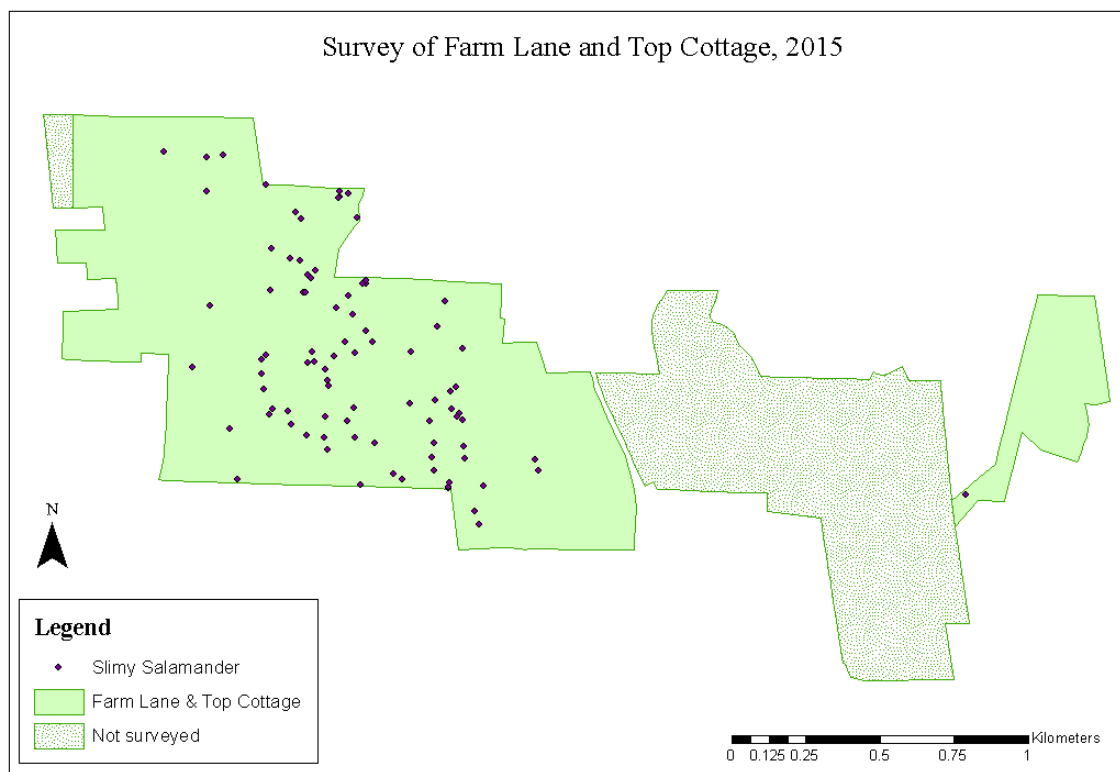
Notophthalmus viridescens

Figure A1.4: Eastern Newt locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Spring Peeper
Pseudacris crucifer

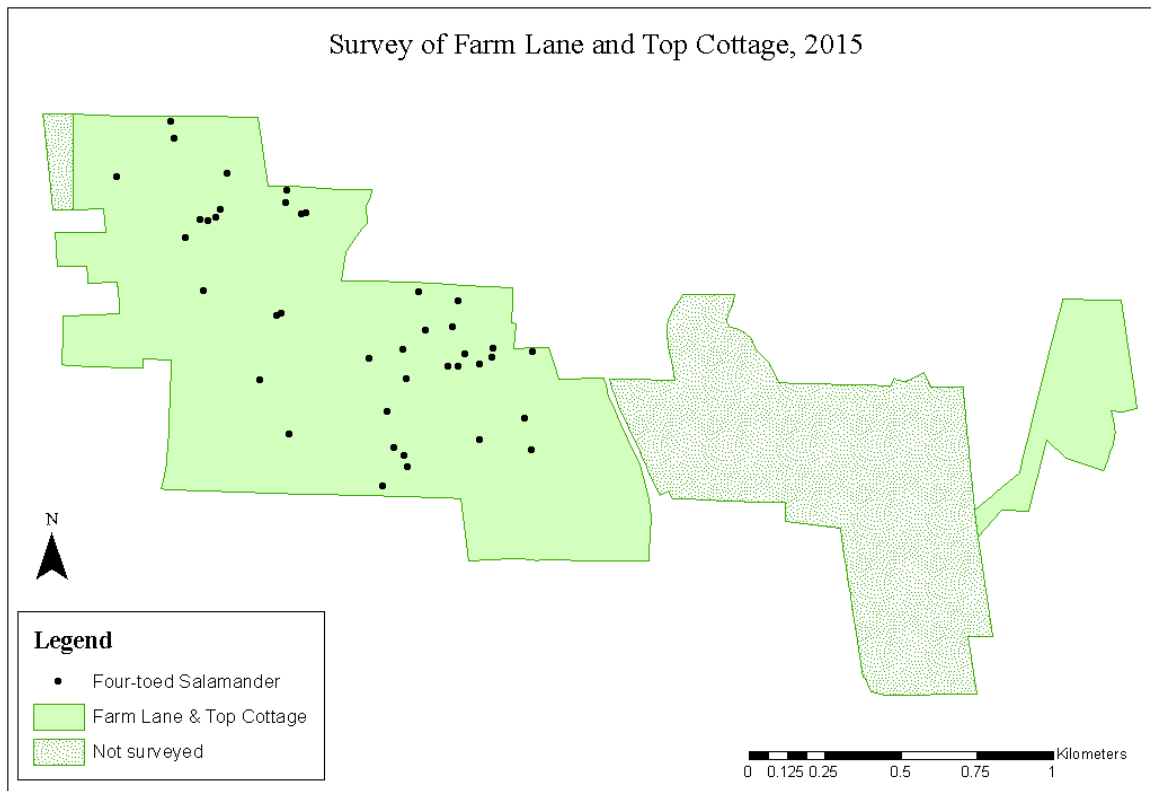
Figure A1.5: Spring Peeper locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Slimy Salamander

Plethodon glutinosus

Figure A1.6: Slimy Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Four-toed Salamander

Hemidactylium scutatum

Figure A1.7: Four-toed Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).

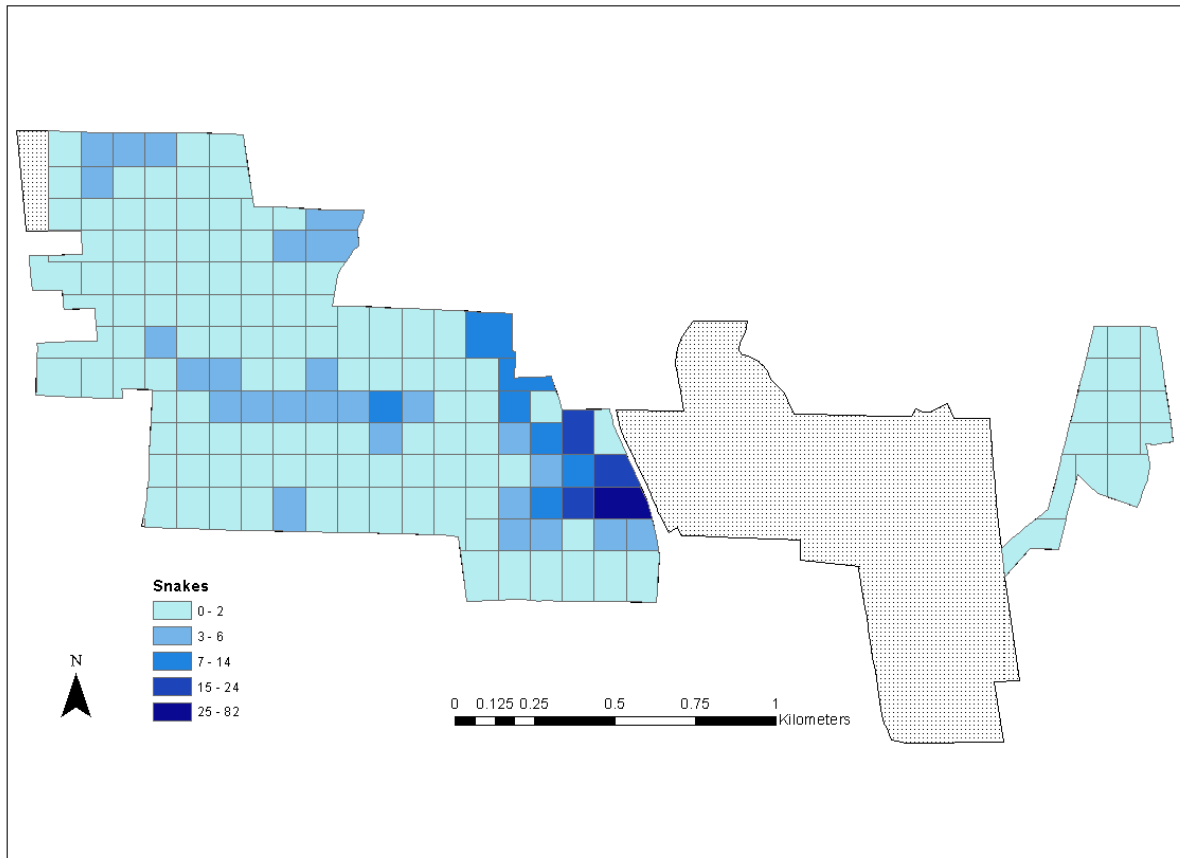


Figure A1.8: Predicted abundances at Farm Lane and Top Cottage at the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY) for all snake species, from abundance modeling using 2015 survey data (Dean 2017). Darker blue indicates a higher predicted relative abundance.

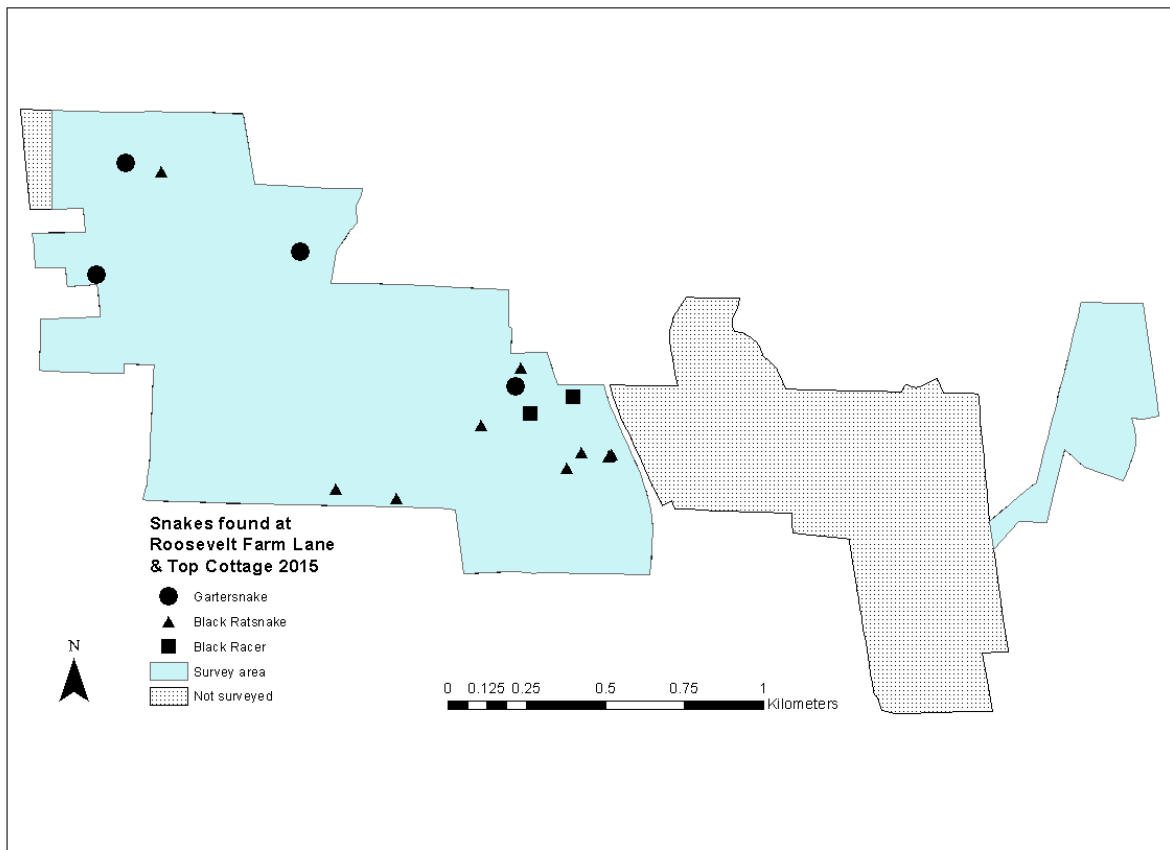


Figure A1.9: Snake locations of three species from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).

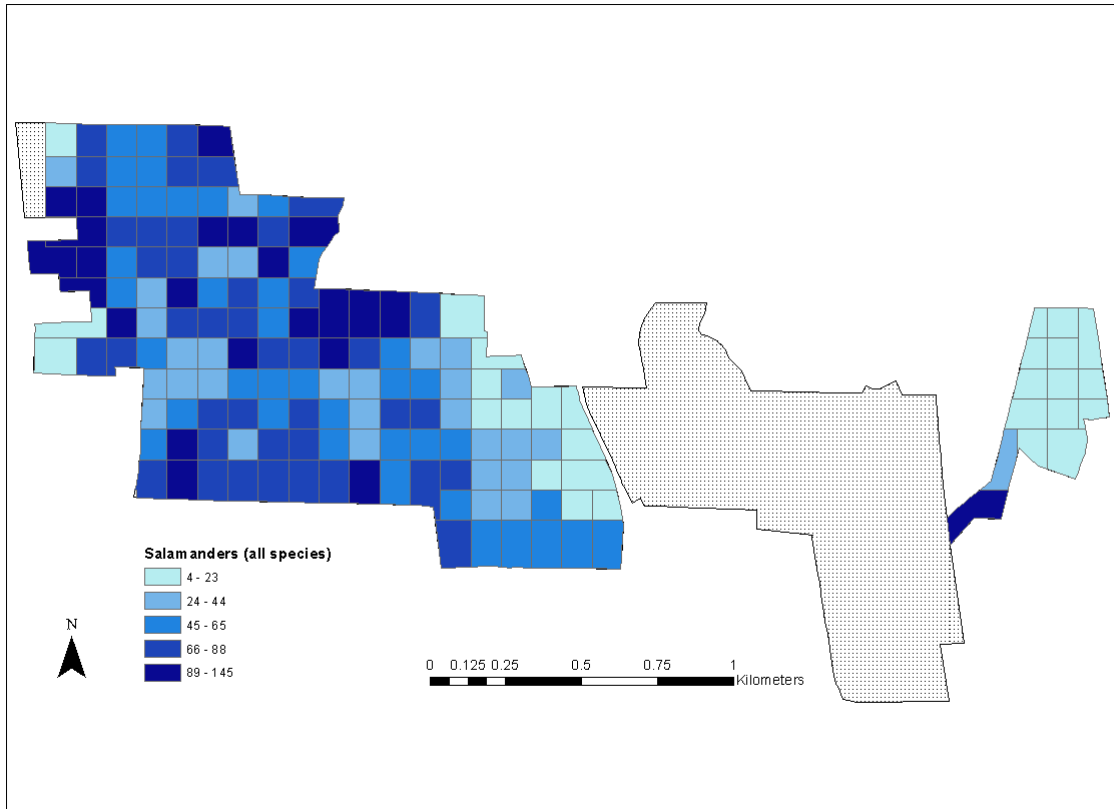
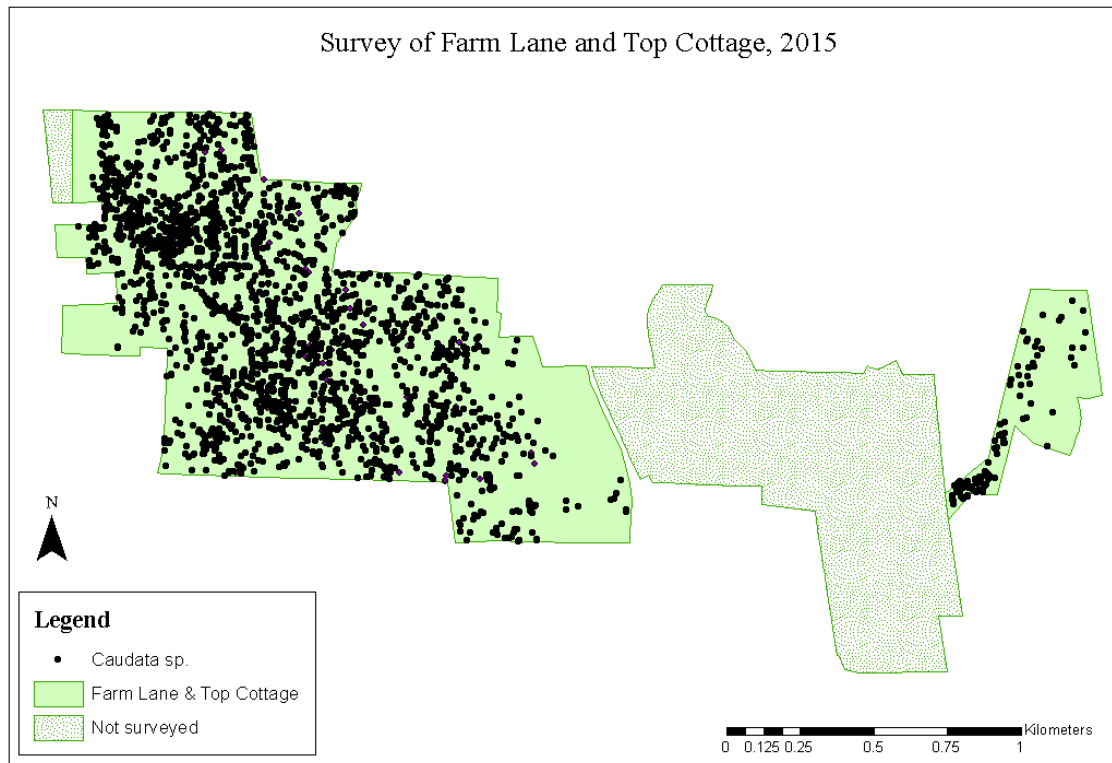


Figure A1.10: Predicted abundances at Farm Lane and Top Cottage at the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY) for all salamanders, from abundance modeling using 2015 survey data (Dean 2017). Darker blue indicates a higher predicted relative abundance.



All salamanders

Ambystoma maculatum, *A. opacum*, *Eurycea bislineata*, *Hemidactylium scutatum*, *Notophthalmus viridescens*,
Plethodon cinereus, *P. glutinosus*

Figure A1.11: All salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).

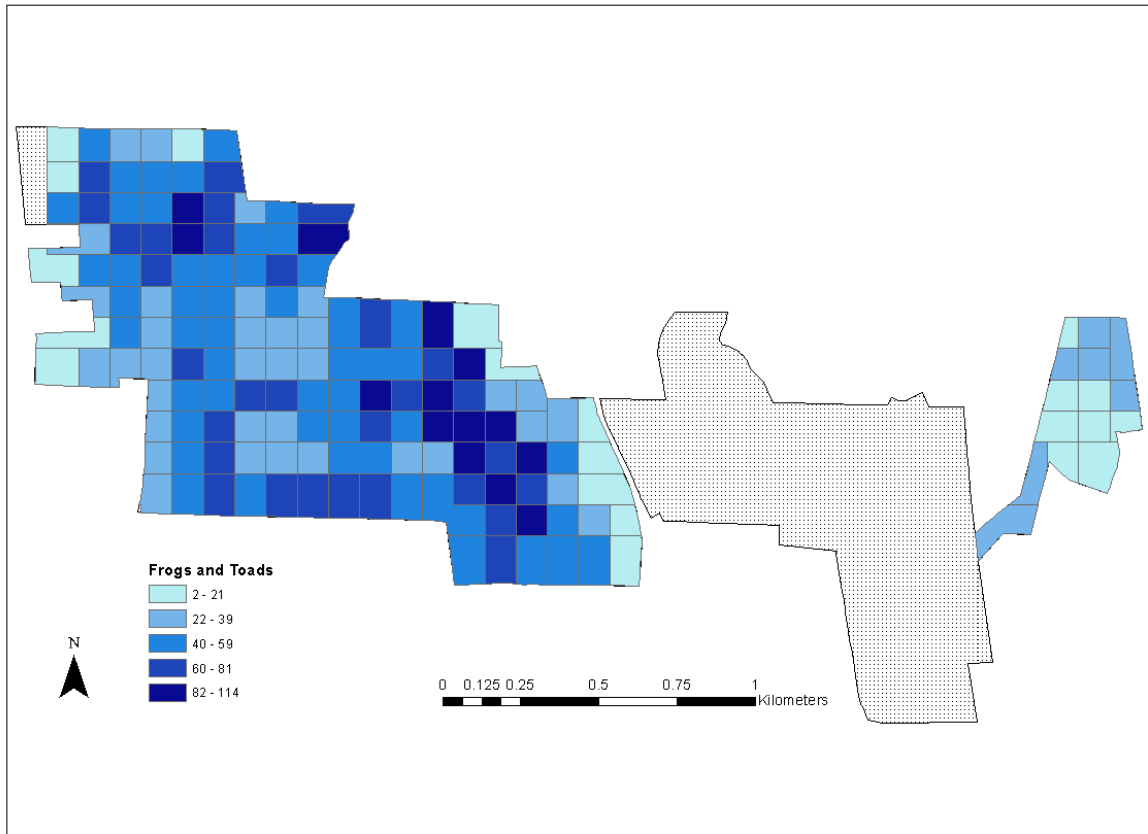
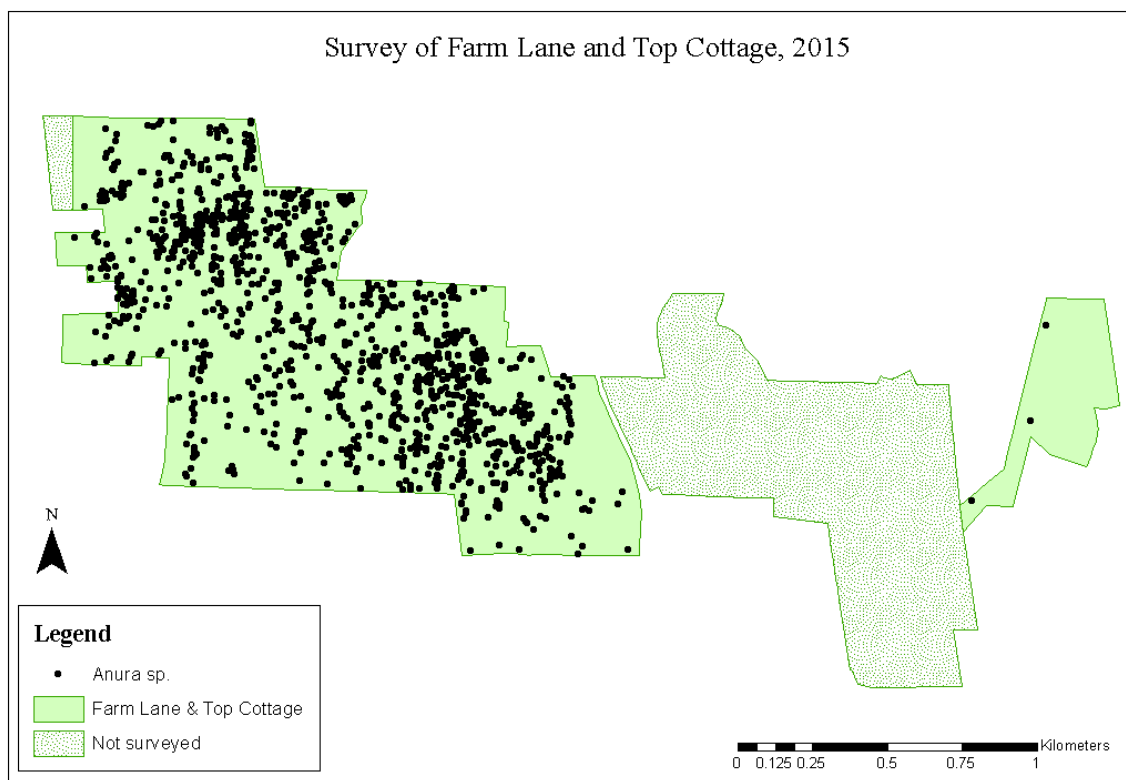


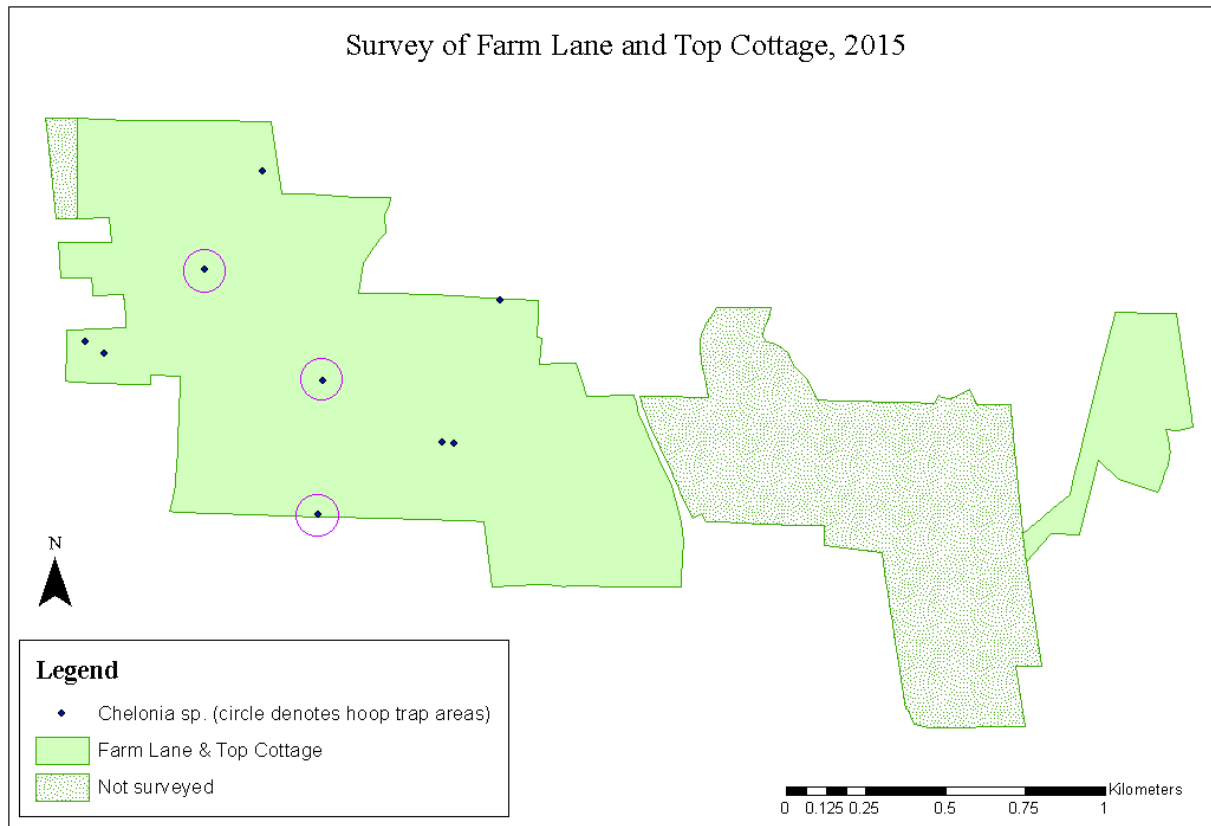
Figure A1.12: Predicted abundances at Farm Lane and Top Cottage at the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY) for all frogs and toads, using 2015 survey data (Dean 2017). Darker blue indicates a higher predicted relative abundance.



All frogs

Anaxyrus americanus, *Lithobates catesbeianus*, *L. clamitans*, *Hyla versicolor*, *L. sylvaticus*, *Pseudacris crucifer*

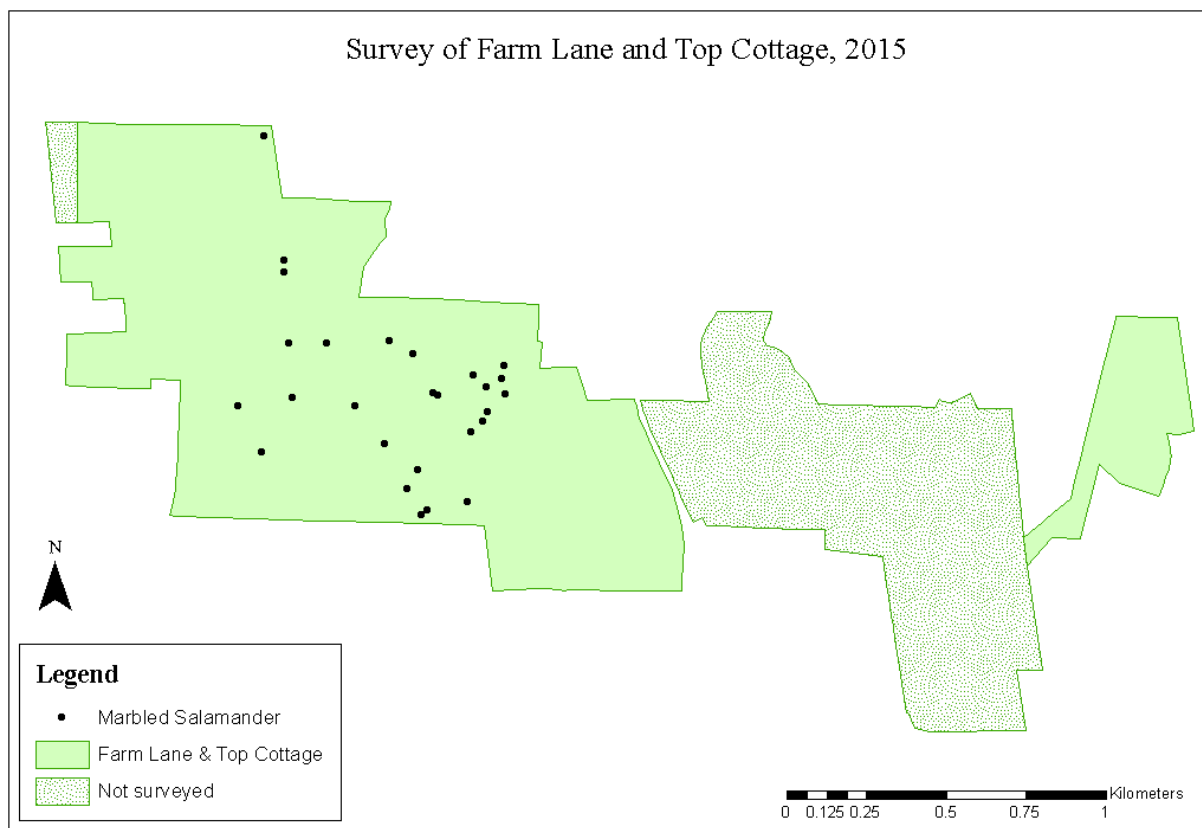
Figure A1.13: All frog locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



All turtles

Terrapene carolina carolina, *Chrysemys picta*, & *Chelydra serpentina*

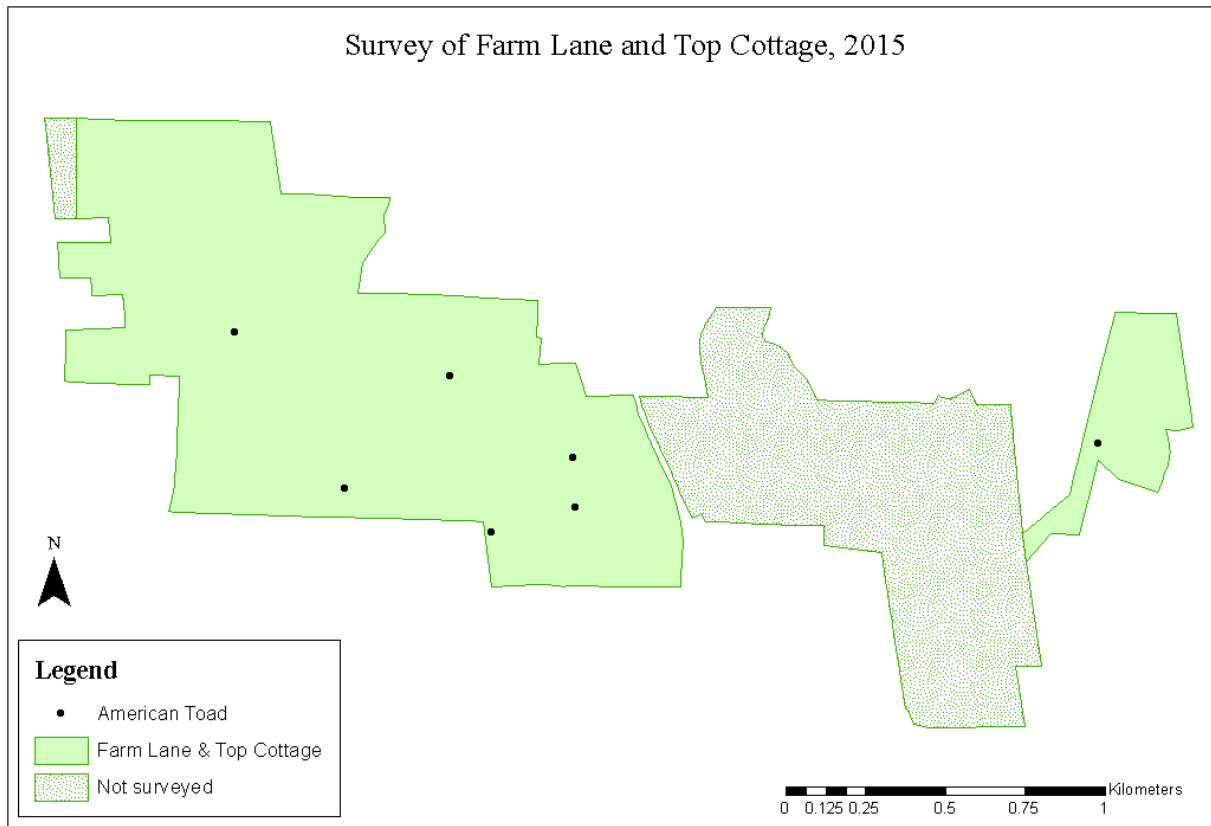
Figure A1.14: All turtle locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY). Circled areas denote hoop trap sites.



Marbled Salamander

Ambystoma opacum

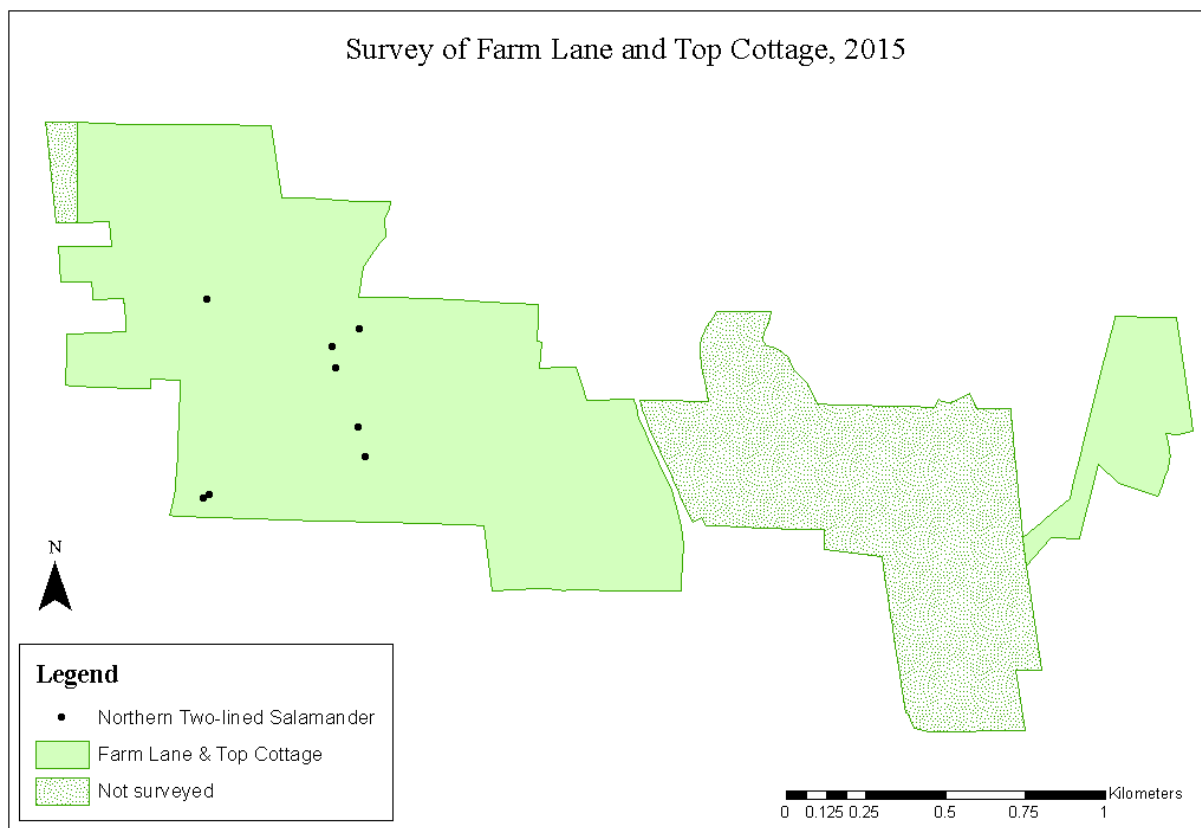
Figure A1.15: Marbled Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



American Toad

Anaxyrus americanus

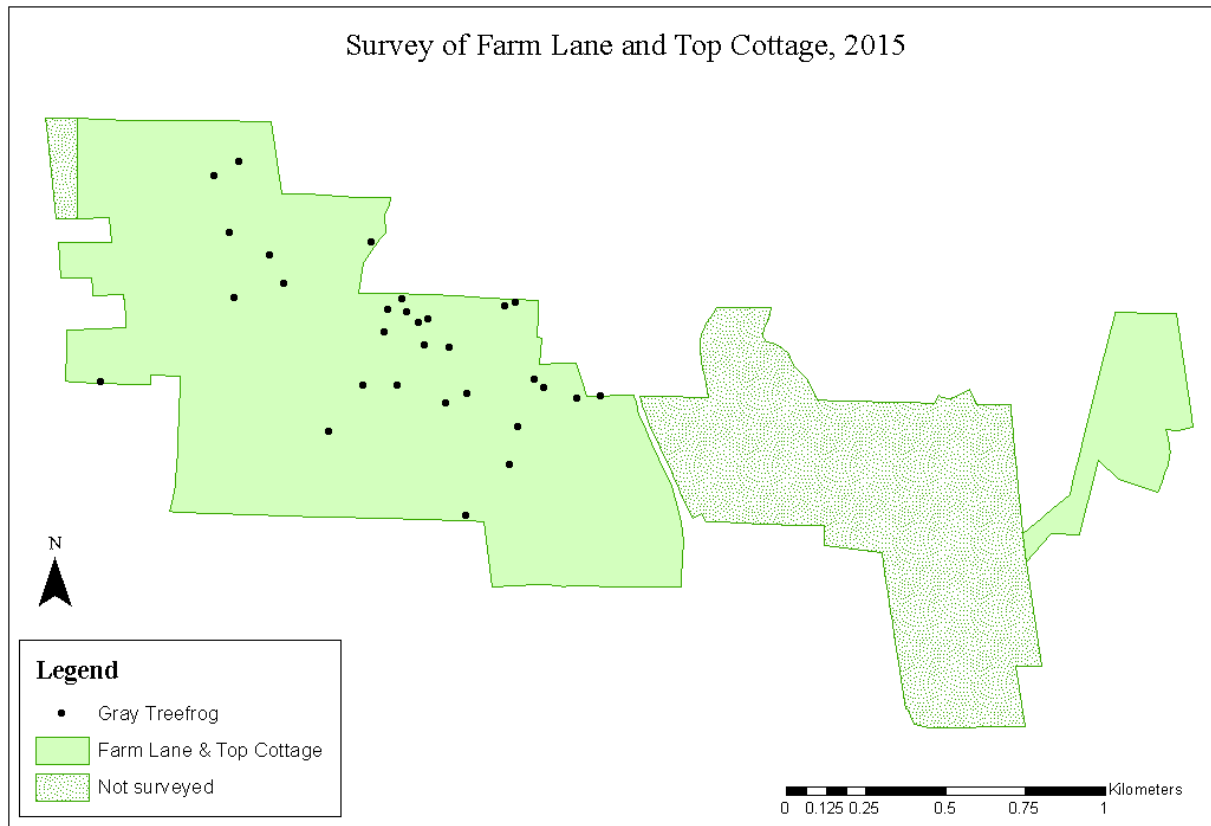
Figure A1.16: American Toad locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Northern Two-lined Salamander

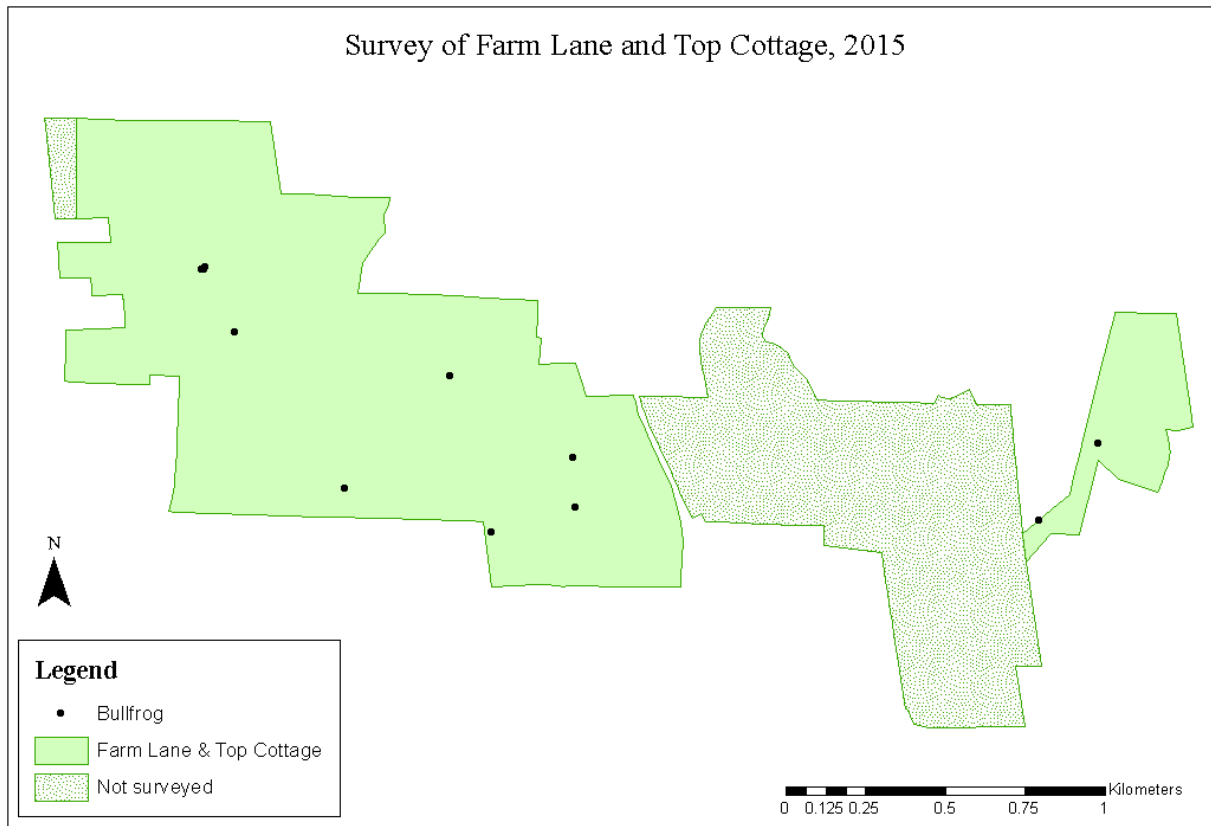
Eurycea bislineata

Figure A1.17: Northern Two-lined Salamander locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



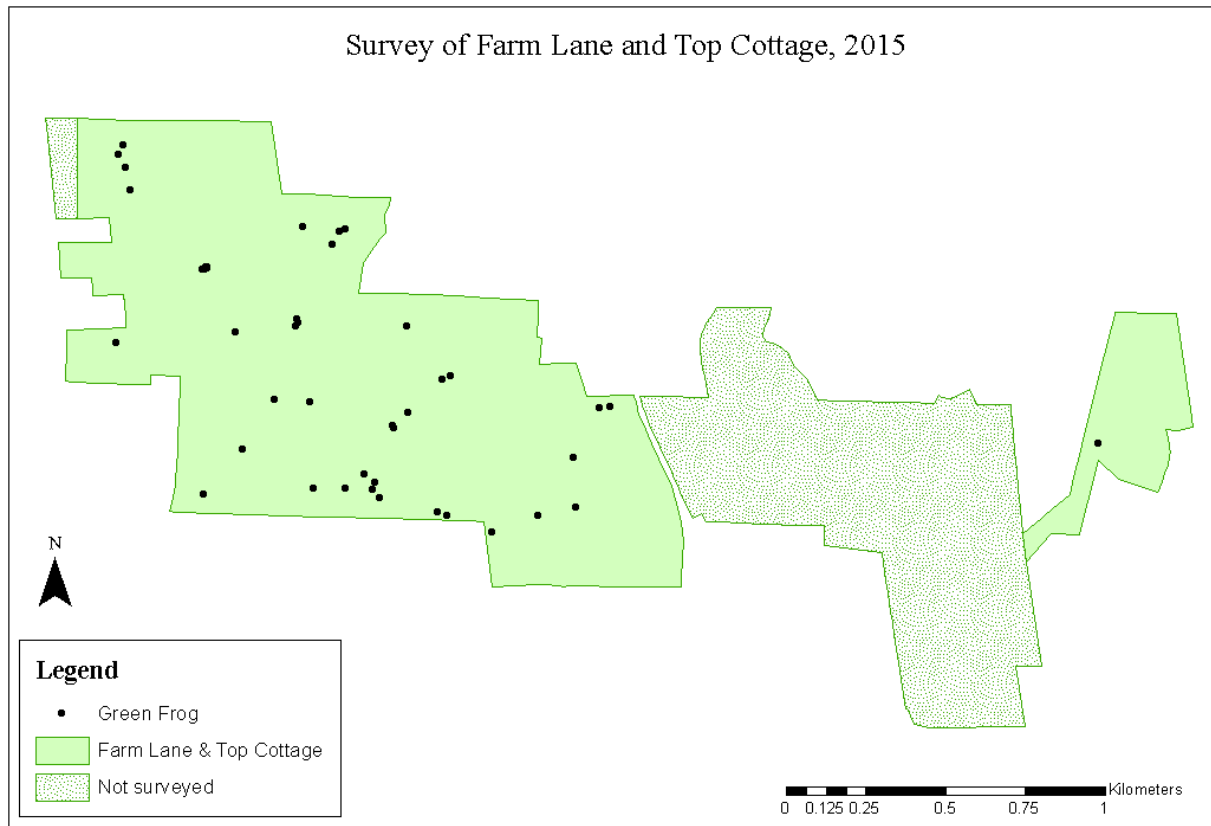
Gray Treefrog (calls only)
Hyla versicolor

Figure A1.18: Gray Treefrog call locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Bullfrog
Lithobates catesbeianus

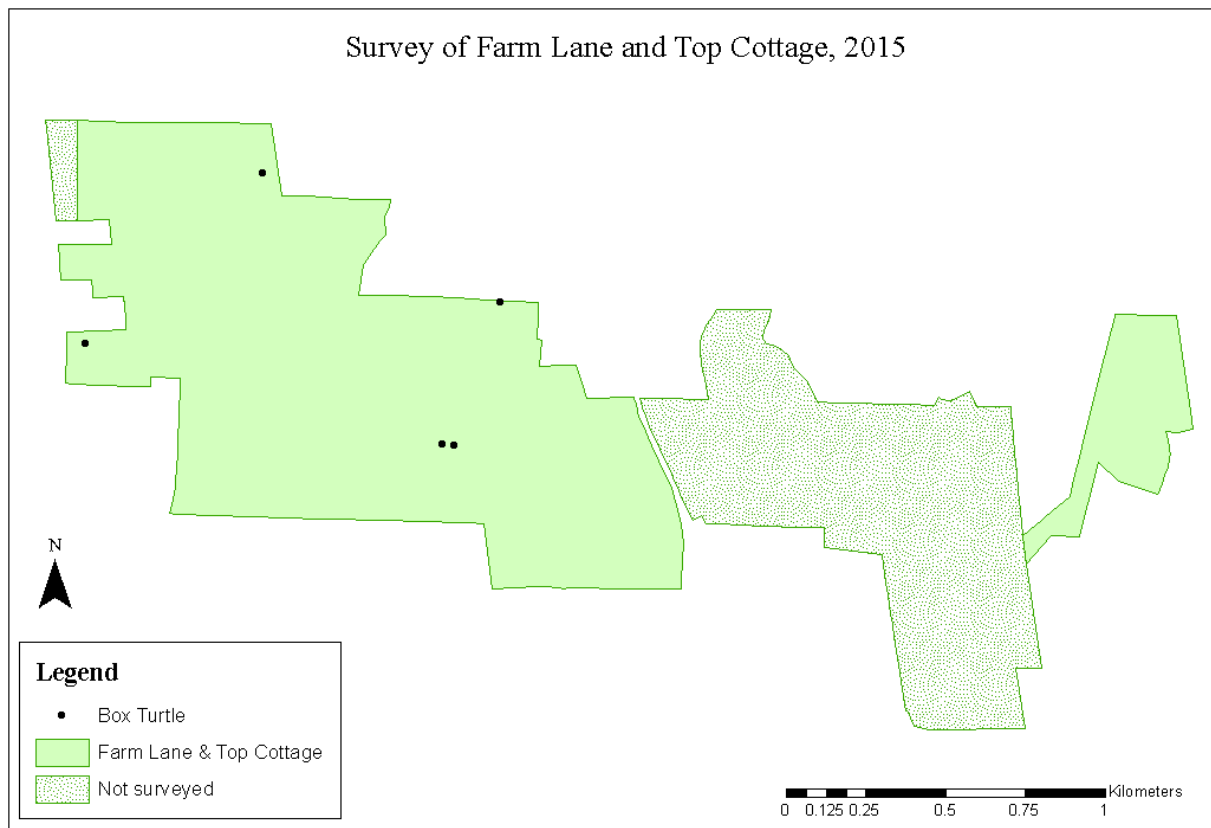
Figure A1.19: American Bullfrog locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Green Frog

Lithobates clamitans

Figure A1.20: Green Frog locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).



Eastern Box Turtle

Terrapene carolina carolina

Figure A1.21: Eastern Box Turtle locations from the 2015 herpetological survey at Farm Lane and Top Cottage of the Home of Franklin D. Roosevelt National Historic Site (Hyde Park, NY).