



Saratoga National Historical Park Amphibian and Reptile Inventory

March-September 2001

Natural Resource Technical Report NPS/NETN/NRTR—2012/562



Saratoga National Historical Park Amphibian and Reptile Inventory

March-September 2001

Natural Resource Technical Report NPS/NETN/NRTR—2012/562

Robert P. Cook¹, David K. Brotherton², Brad C. Timm³, and John L. Behler²

¹ National Park Service
Cape Cod National Seashore
Wellfleet, MA 02667

² Department of Herpetology
Wildlife Conservation Society
Bronx Zoo
Bronx, NY 10460-1099

³ Department of Environmental Conservation
University of Massachusetts, Amherst
Amherst, MA 01003

March 2012

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Northeast Temperate Network website (<http://science.nature.nps.gov/im/units/netn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Please cite this publication as:

Cook, R. P., D. K. Brotherton, B. C. Timm, and J. L. Behler. 2012. Saratoga National Historical Park amphibian and reptile inventory: March-September 2001. Natural Resource Technical Report NPS/NETN/NRTR—2012/562. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	vii
Tables.....	viii
Executive Summary	x
Acknowledgements.....	xii
Introduction.....	1
Study Area	3
Methods.....	5
Sampling Overview	5
Marking, Measurement, and Aging/Sexing of Captured Animals	5
Anuran Calling Surveys (ACS)	9
Egg Mass Counts (EMC)	10
Time-constrained Search (TCS)	10
Stream TCS.....	10
Woodland TCS.....	11
Field TCS	11
Pond TCS.....	12
Coverboards (CB)	12
Turtle Trap Surveys (TTS).....	13
Minnow Trap Surveys (MTS).....	13
Incidental Encounters (IE)	14
Quantifying Overall Abundance	14
Environmental Variables	15
Data Management	15

Contents (continued)

	Page
Results.....	17
Overview of Park Herpetofauna	17
Survey Method Summaries.....	29
Anuran Calling Surveys.....	29
Egg Mass Counts	29
Time-constrained Search	35
Stream TCS.....	35
Woodland/Field TCS	35
Pond TCS.....	35
Coverboards.....	42
Turtle Trap Surveys	42
Minnow Trap Surveys	46
Incidental Encounters	46
Discussion.....	51
Community Analysis, Factors Affecting Species Presence and Absence, and Important Habitats	51
Species at Risk.....	56
Population Trends.....	56
Stressors.....	59
Recommendations for Management and Future Inventory and Monitoring	65
Monitor/Prevent/Mitigate External Threats and Stressors	65
Monitor/Prevent/Mitigate Internal Threats and Stressors.....	65
Maintain Habitat Diversity	65

Contents (continued)

	Page
Minimize Direct Mortality From Mowing Operations	66
Minimize Direct Mortality From Vehicles	66
Additional Inventory and Monitoring.....	67
Species Accounts: Species Likely Present Historically at or Adjacent to Saratoga NHP	69
Jefferson – Blue-spotted Salamander and complexes (<i>Ambystoma</i> <i>jeffersonianum</i> , <i>A. laterale</i> , <i>Ambystoma jeffersonianum</i> x <i>A. laterale</i>).....	69
Spotted Salamander (<i>Ambystoma maculatum</i>)	71
Red-spotted Newt (<i>Notophthalmus v. viridescens</i>)	73
Northern Dusky Salamander (<i>Desmognathus fuscus</i>)	74
Northern Two-lined Salamander (<i>Eurycea bislineata</i>).....	76
Northern Spring Salamander (<i>Gyrinophilus porphyriticus</i>)	77
Eastern Red-backed Salamander (<i>Plethodon cinereus</i>).....	79
Eastern Spadefoot Toad (<i>Scaphiopus h. holbrookii</i>)	80
Eastern American Toad (<i>Anaxyrus americanus</i>).....	81
Fowler’s Toad (<i>Anaxyrus fowleri</i>).....	82
Gray Treefrog (<i>Hyla versicolor</i>).....	83
Northern Spring Peeper (<i>Pseudacris c. crucifer</i>)	86
American Bullfrog (<i>Lithobates catesbeianus</i>).....	87
Northern Green Frog (<i>Lithobates clamitans melanota</i>).....	88
Northern Leopard Frog (<i>Lithobates pipiens</i>).....	89
Pickerel Frog (<i>Lithobates palustris</i>)	90
Wood Frog (<i>Lithobates sylvaticus</i>).....	91
Common Snapping Turtle (<i>Chelydra s. serpentina</i>).....	93

Contents (continued)

	Page
Stinkpot (<i>Sternotherus odoratus</i>)	95
Painted Turtle (<i>Chrysemys picta</i>)	96
Northern Map Turtle (<i>Graptemys geographica</i>)	97
Spotted Turtle (<i>Clemmys guttata</i>).....	98
Wood Turtle (<i>Gleptemys insculpta</i>).....	99
Eastern Box Turtle (<i>Terrapene c. carolina</i>)	100
Eastern Hog-nosed Snake (<i>Heterodon platirhinos</i>).....	101
Eastern Milk Snake (<i>Lampropeltis t. triangulum</i>).....	102
Northern Water Snake (<i>Nerodia s. sipedon</i>).....	104
Smooth Green Snake (<i>Liochlorophis vernalis</i>)	104
Northern Brown Snake (<i>Storeria d. dekayi</i>)	105
Northern Red-bellied Snake (<i>Storeria o. occipitomaculata</i>).....	106
Eastern Ribbon Snake (<i>Thamnophis s. sauritis</i>).....	108
Common Garter Snake (<i>Thamnophis sirtalis</i>).....	108
Common Mudpuppy (<i>Necturus maculosus</i>).....	111
Four-toed Salamander (<i>Hemidactylum scutatum</i>)	111
Allegheny Mountain Dusky Salamander (<i>Desmognathus ochrophaeus</i>).....	112
Northern Ringneck Snake (<i>Diadophis punctatus edwardsii</i>)	114
Northern Black Racer (<i>Coluber c. constrictor</i>)	115
Eastern Ratsnake (<i>Elaphe alleghaniensis</i>).....	116
Literature Cited	119
Appendix E. Summary of measurements for snakes captured at Saratoga National Historical Park.	143

Figures

	Page
Figure 1. Location of standardized sampling sites and time-constrained search areas used in herpetofaunal inventory at Saratoga National Historical Park.	8
Figure 2. Location of salamander detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual.	24
Figure 3. Location of frog and toad detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual.	25
Figure 4. Location of snake detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual. Open symbol represents incidental encounter site.	26
Figure 5. Location of turtle detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual. Open symbol represents incidental encounter site.	27
Figure 6. Species richness of areas sampled for amphibians and reptiles at Saratoga National Historical Park.	28

Tables

	Page
Table 1. Overview of the 39 standardized survey sites at Saratoga National Historical Park and sampling methods used at each site.	6
Table 2. Number of all adult amphibians and reptiles recorded in 2001 at Saratoga National Historical Park, listed by habitat category and type, and ordered by relative abundance within taxonomic group.	18
Table 3. Distribution by habitat category and type of the 21 species of amphibians and reptiles recorded in 2001 at Saratoga National Historical Park.	19
Table 4. Number of adult amphibians recorded and amphibian species richness (S) at each of 39 standardized survey sites and 7 incidental encounter only locations at Saratoga National Historical Park.	20
Table 5. Number of adult reptiles recorded and reptile species richness (S) at each of 39 standardized survey sites and 7 incidental encounter locations at Saratoga National Historical Park.	22
Table 6. Number and species richness (S) of amphibians recorded by survey method at Saratoga National Historical Park in 2001.	30
Table 7. Number and species richness (S) of adult-form reptiles recorded by survey method at Saratoga National Historical Park in 2001.	31
Table 8. Percentage of adult-form individuals of each amphibian and reptile species detected by each survey method at Saratoga National Historical Park. Derived from Tables 6 and 7.	32
Table 9. Results of anuran calling surveys at 13 standardized survey sites at Saratoga National Historical Park in 2001.	33
Table 10. Number of egg masses recorded during egg mass counts at 10 standardized survey sites at Saratoga National Historical Park in 2001.	33
Table 11. Time constrained search effort and dates listed by habitat type at Saratoga National Historical Park in 2001.	36
Table 12. Number of amphibians and reptiles recorded during stream time-constrained search at seven standardized survey areas at Saratoga National Historical Park. The capture rate (CR) is the number of individuals divided by total search hours.	37
Table 13. Number of amphibians and reptiles recorded during woodland and field time-constrained search at 17 standardized survey areas at Saratoga National Historical Park. The capture rate (CR) is the number of individuals divided by search hours.	37

Table 14. Number of adult-form amphibians and reptiles recorded during pond time-constrained search at eight standardized survey sites at Saratoga National Historical Park and herpetofaunal species richness (S). The capture rate (CR) is the number of individuals divided by search hours.	40
Table 15. Number of reptiles and amphibians recorded during woodland and field coverboard surveys at 15 standardized survey sites at Saratoga National Historical Park. Capture rate (CR) is the number of captures per 100 board checks. Board checks are number of boards/site, multiplied by number of site visits.	43
Table 16. Seasonal variation in snake captures during coverboard surveys at Saratoga National Historical Park, April to June versus August to September 2001. Board checks are the number of boards per site, multiplied by the number of site visits.	44
Table 17. Number of snakes captured under metal versus plywood during coverboard surveys at Saratoga National Historical Park in 2001.	44
Table 18. Number of unique individuals (Inds) and turtle captures (Caps) during turtle trapping at 12 standardized survey sites at Saratoga National Historical Park in 2001. Capture rate (CR) is the number of captures per 100 trap nights and S is species richness.	45
Table 19. Number of amphibians and reptiles captured in minnow traps at 10 standardized survey sites at Saratoga National Historical Park in 2001. Capture rate (CR) is the number of captures per 100 trap nights and S is species richness.	47
Table 20. Number of adult-form amphibians and reptiles recorded as incidental encounters at 19 localities at Saratoga National Historical Park. S is species richness.	49
Table 21. Historic and current status and apparent trends since the 1980's in "historic baseline" species of amphibians and reptiles at Saratoga National Historical Park.	58
Table 22. Mean, maximum, and minimum pH values, and sample size (n) of water in SARA streams and wetlands during this survey in 2001. Habitat means are weighted averages based on averaging data from all sites in each habitat type.	60
Table 23. Number of adult amphibians recorded at each of 11 wetland survey sites that overlapped between the current project ("NPS") and survey work by Sienna College ("S") during 2001 (Woolbright 2001) at Saratoga National Historical Park.	85

Executive Summary

Under a National Park Service/Wildlife Conservation Society Cooperative Agreement, the amphibians and reptiles of Saratoga National Historical Park (SARA) were inventoried from April through September 2001. Monthly sampling periods ranged from 5 days/4 nights to 11 days/10 nights and employed six standard methods: anuran calling surveys, egg mass counts, time-constrained search (TCS), coverboards, turtle trap surveys, and minnow trap surveys. In addition, animals encountered outside of standardized surveys, including observations of rare species by SARA staff, were recorded as incidental encounters.

We recorded 21 species in 2001. Two additional species, stinkpot and wood turtle, were added subsequently. A total of 23 species (five salamander, eight anuran, five turtle, and five snake) are therefore currently known to occur at SARA: 22 at the Battlefield Unit, 16 at the Schuyler Estate Unit, and 10 at Victory Woods Unit. These 23 species represent 59% of the 39 species present in the Hudson River Valley of Saratoga County and 72% of SARA's 32 species "historic baseline". Based on numbers of adults and sites recorded from in 2001, the most abundant and widespread species, respectively, in each taxonomic group, were spring peeper and northern green frog (anuran), red-spotted newt and eastern red-backed salamander (salamander), painted turtle and snapping turtle (turtle), and common garter snake (snake). Amphibians numerically dominated the herpetofauna: anurans (frogs and toads) comprised 90.6%, salamanders 8.1%, turtles 0.4%, and snakes 0.9%. We recorded 15 species as incidental encounters, 14 with woodland TCS, 13 with pond TCS, 12 with stream TCS, 11 in minnow traps, seven with anuran calling surveys, five each with coverboard and turtle trap surveys, three with egg mass counts, and two during field TCS.

In 2001, species richness was greatest in forest (16 species), marsh (15), permanent stream, permanent and temporary pond (12 each), permanent canal (10), and field (6). Schuyler Estate Canal had the greatest species richness, 15. Burdyl Pond, Beaver Pond, Canal Below Stop 10, Victory Woods Pond, and Vly Marsh were also important wetlands. We recorded nine species in Mill Creek and, with Great Falls Creek, these two streams accounted for 95% of all northern two-lined salamanders. Of the 32 species "historic baseline", we consider three species to be abundant, nine common, seven uncommon, four rare, and nine went unrecorded. Although historic data are limited, 22 species appear stable since the 1980's, one (smooth green snake) has declined, and the trend for nine is unknown. Most unknowns are currently unrecorded, and for seven of them, their historic status is also unknown.

Stressors associated with amphibian and reptile declines are present at SARA and include deforestation, agriculture, development, and PCB's from the Hudson River. However, there has been significant forest recovery and, although invasive alien plants are a problem, the current landscape at SARA provides a relatively large patch of quality habitat. SARA provides important habitat for many species experiencing decline, such as Jefferson/Blue-spotted salamander, eastern box turtle, wood turtle, and historically, the spotted turtle, which are New York "Special Concern" species. For many of these declining species, SARA provides habitat as part of a larger landscape that supports species richness at the town or county level. To further this value, the park should promote protection of the adjoining landscape and watershed. Future work at SARA

should begin with additional inventories to clarify status of several species and progress to periodic monitoring of pond breeding amphibians, snakes, and aquatic turtles.

Acknowledgements

Funding for this project was provided by the National Park Service, and many people helped with fieldwork and logistics. Tami Ransom and Eric Leibgold spent long days and many hours in the field, as well as recording and inputting field data. Chris Martin and Linda White provided critical logistic support and background information, and/or contributed important observations. SARA Ranger Jacquie Tinker documented several significant records of turtles at SARA. Larry Woolbright and his students at Sienna College generously shared their observations and long term data on SARA amphibians. These data have been extremely valuable in helping to interpret some of the data collected during this survey. Dennis Skidds, Adam Kozlowski, Tim Shepherd, and Kevin Morris helped with data review and created the maps used in this report.

Preliminary drafts of this report were improved as a result of critical review and comments by Adam Kozlowski and Brian Mitchell.

Introduction

Saratoga National Historical Park (SARA) is where American forces defeated British troops in 1777, a key victory in the American War of Independence. Congress established the park in 1938 to preserve and interpret significant cultural resources, historic structures and properties associated with the American Revolution. SARA is located in Stillwater, New York, Saratoga County (43° 0' N, 73° 38' W), 48 km (30 miles) north of Albany, and approximately 152 m (500') above sea level. Topographically, the park consists of low hills with flat-bottomed valleys to the west, and an upper and lower terrace with the Hudson River floodplain to the east (Heath et al. 1963). Saratoga County is underlain with unconsolidated deposits on the surface and bedrock formations thousands of feet thick below (Vana-Miller et al. 2001). The park area is 1,378 ha (3,406 ac) and is predominately mixed and deciduous forest with open fields. In addition, a mixture of fresh water wetlands totaling 71 ha (176 ac) occurs in the park, including permanent and temporary emergent, scrub/shrub, forested farmed, unconsolidated bottom, floodplain, and isolated wetlands (Tiner et al. 2000).

In 1998, a Cooperative Agreement between the National Park Service and the Wildlife Conservation Society was established to assess amphibian and reptile assemblages within the parks of the “New England Cluster” of the National Park Service. While the goals of the project varied depending on the park being inventoried, they generally were as follows:

- Assist the National Park Service in documenting at least 90% of the species currently estimated to occur in the park.
- Determine the occurrence and status of species of management concern (e.g., state and federal Threatened, Endangered, and Special Concern species, and other declining species).
- Determine abundance categories, distribution, and habitat use of documented species.
- Identify critical habitats of Threatened, Endangered, and Special Concern species.
- Provide a basis for the future development of a long-term monitoring program.
- Analyze species occurrence against historical occurrence and evaluate the state of the park’s herpetofauna, on a site and regional scale.

SARA was surveyed as part of this inventory project. Because information was lacking or inadequate for the amphibians and reptiles of SARA, a comprehensive, broad-based inventory was conducted monthly from March through September 2001 using several survey techniques.

Determining the historic herpetofauna of SARA is extremely challenging due to the incomplete and relatively recent nature of SARA-specific data and absence of historic documents with data specific to SARA or Saratoga County. Both DeKay (1842) and Eckel and Paulmier (1902) provide general distributional data on New York State amphibians and reptiles, with very few specific localities mentioned. In contrast, Bishop (1941) provides detailed locality data, but only for salamanders. In the absence of detailed historic data on the amphibians and reptiles of SARA or Saratoga County, more recent data on the presence of native species may provide the best insight into the region’s past. The New York State Herp Atlas provides recent data on Saratoga County. However, because Saratoga County includes portions of the Adirondack Mountains, whereas SARA lies in the lower elevations of the Hudson River valley, data for the entire county may overestimate the species that occurred historically in the vicinity of SARA. In contrast, finer

scale resolution maps in Gibbs et al. (2007), which incorporate recent Herp Atlas Data as well as historic data, enable us to identify species whose range includes the Hudson River Valley portion of Saratoga County. Based on these maps, a total of 39 species, consisting of 11 salamanders, 10 anurans, seven turtles, and 11 snakes can be considered as “historically present” in the Hudson River Valley of Saratoga County and possibly present historically on the lands that now comprise SARA (Appendix A).

On a more site-specific basis, prior to this survey, the species of amphibians and reptiles present at or near SARA were moderately well known as a result of NPS surveys (NPS 1986, Lynch 1988), employee records (Troha 1995, Chris Martin, pers. comm.), and data collected by the New York State Herp Atlas, primarily in the 1990’s but continuing thru 2007 (Breisch and Ozard, in prep). Because the Battlefield Unit of SARA lies at the junction of the Quaker Springs, Mechanicville, Schuylerville, and Schaghticoke topographic map quadrangles, and the Schuyler Estate and Victory Woods Units are in the Schuylerville quad, we considered Herp Atlas records for Saratoga County from these four quads as species recorded near SARA. In addition, NPFauna (a mid-1980’s inventory effort by NPS based on all available sources of information at a park) for SARA also provided a species list (NPS 1998). Combining these sources creates a list of 32 species, including seven salamanders, 10 anurans, seven turtles, and eight snakes (Appendix A). Although all of the species on the source lists were not documented with specimens, photos, or confirmed by experts, and/or Herp Atlas records are based on areas larger and presumably more diverse than SARA, most of these 32 species were historically fairly common, widespread, and/or readily identifiable. Thus, although we can’t be certain that all these species occurred historically at SARA, this is the best available estimate of the species that likely occurred at what we now know as SARA. We consider these 32 species the “historic baseline” (Appendix A).

A combination of six standardized survey methods was used during this inventory. Incidental encounters (observations made while not conducting a standardized survey) were also recorded to provide additional information on species presence and distribution in the park. The habitat type of all sites where amphibians and reptiles were found was described. Combined with relative abundance and species richness data, habitat data provided context for species presence and was used to identify local landscape features important to herpetofauna.

Study Area

SARA totals 1,378 ha (3,406 ac), 1,156 ha (2,856 ac) of which are owned by the National Park Service. The remainder is owned by local and state governments (34 ha or 83 ac) and private parties (183 ha or 453 ac) (Vana-Miller et al. 2001). The park consists of four separate areas, three of which are of interest from a natural resource perspective. The largest area, known as the Battlefield Unit, is 1,133 ha (2,800 ac) of park-owned land. It is 29% open field (grasslands and agricultural field) and 57% forest. This unit contains four streams (Kroma Kill, Mill Creek, American's Creek, and Great Falls Creek) that range from first to third order, and are direct tributaries to the Hudson River, which the park abuts in several places along its eastern boundary. In addition, SARA contains a variety of standing water habitats, both temporary and permanent, totaling 175.9 acres or 6% of the park. These include several woodland vernal ponds, three farm ponds, beaver ponds, marshes, Hudson River floodplain swamps, and remnants of the Champlain Canal. Approximately 79% of the park's wetlands occur along rivers and streams, and 68% are forested wetlands (Tiner et al. 2000). Smaller, satellite units of the park occur in Schuylerville, eight miles north of the Battlefield Unit, and include the Schuyler Estate Unit and Victory Woods Unit. The Schuyler Estate Unit is 12 ha (30 ac) and, in addition to the historic structure and its grounds, contains woodlands, cornfields, and remnants of the Champlain Canal. The canal remnant (approximately one acre) provides habitat for amphibians and reptiles, including a spotted turtle (New York State species of *Special Concern*) observed around 1995-1998 by NPS staff Chris Martin of SARA and Dave Hayes of ROVA (pers. comm., Chris Martin, SARA Integrated Resource Manager, April 15, 2011). The Victory Woods Unit is a 9.3 ha (23 ac) parcel of second growth deciduous forest, with a shallow, 0.2 ha (0.5 ac) pond that supports a number of vernal pond amphibians.

Methods

Sampling Overview

We sampled SARA with a two person crew as part of an effort to survey the herpetofauna of four NPS sites over the course of the 2001 field season. Because the herpetofauna of most sites in the Northeast United States consists of a variety of species, each with different periods of greatest activity and detectability (which can also vary somewhat annually), the sampling plan called for distributing the sampling effort over the course of the spring and summer activity season. Given this, and the logistics of sampling at four sites (located in Cornish, NH; Stillwater, NY; Lexington, MA; and Saugus, MA), we sampled sites in bouts that varied in duration in proportion to a site's size and presumed faunal/zoogeographic complexity. Over the course of a month the crew sampled a site and moved on to the next, such that a full round of sampling was conducted each month during the months of April, May, June, August, and September. There was also a short sample period in March. The time periods we sampled SARA during 2001 were: 24 March, 2 to 12 April, 2 to 7 and 11 to 13 May, 6 to 8 and 12 to 13 June, 1 to 7 and 11 August, and 3 to 7 September.

The general approach of sampling was to balance the need for standardized methods and quantifiable results with the primary goal of determining species presence. Since amphibians and reptiles found at SARA are variable in habitat use and seasonal patterns of detectability, we employed a number of methods, both general and habitat/taxa specific (Table 1). These were: Anuran Calling Surveys (ACS), Egg Mass Counts (EMC), Coverboard Surveys (CB), Turtle Trap Surveys (TTS), Minnow Trap Surveys (MTS), Habitat or Area-specific Time Constrained Search (TCS) and Incidental Encounters (IE). We employed general methods (i.e. TCS) across all habitats for the entire field season, whereas habitat/taxa specific methods were employed at those times of the year when the target species/habitat were known to be most efficiently sampled. The combination of methods chosen recognized that multiple methods were necessary to detect the wide range of potentially-occurring species and that some species are difficult to detect due to rarity or behavior. Thus, a degree of redundancy was needed to increase the likelihood of encountering rare or hard to find species. Collectively, the methods we employed were designed to provide a comprehensive list of species occurrence and a reasonable estimate of relative abundance and habitat use.

Site selection for standardized surveys was designed to sample across the range of habitat types available as well as be spatially balanced (Table 1, Appendix B, C, Figure 1). Appendix D contains a crosswalk map and table to facilitate conversion of field numbers used during this inventory to field numbers currently used by the park. Based on existing maps of wetland (Tiner et al. 2000) and upland habitats, as well as field reconnaissance, all of the ponds/wetlands, streams/canals, major seeps, rivers, field and woodland habitats were identified. Because of the park's small size, the number of streams and wetlands were limited and nearly all were sampled. Similarly, woodland habitat in the park was partitioned into nine areas and all were sampled, and eight field areas were sampled.

Marking, Measurement, and Aging/Sexing of Captured Animals

Captured animals were treated differently (depending on species) in terms of marking and measuring, with exact details determined by data desired and the ease or difficulty of marking.

Table 1. Overview of the 39 standardized survey sites at Saratoga National Historical Park and sampling methods used at each site.

Site	Habitat Type	Calling Survey	Egg Mass Count	TCS Stream	TCS Woodland	TCS Field	TCS Pond	Cover board	Turtle Trap	Minnow Trap
Stream 1 Upper Kroma Kill	Permanent Stream			X						
Stream 2 Lower Kroma Kill	Permanent Stream			X						
Stream 3 Mill Creek North	Permanent Stream			X						
Stream 4 Mill Creek Middle	Permanent Stream			X						
Stream 5 American's River	Permanent Stream			X						
Stream 6 Mil Creek South	Permanent Stream			X						
Stream 8 Great Falls Creek	Permanent Stream			X						
Canal Below Stop 10	Permanent Canal	X							X	X
Canal North of Entrance	Permanent Canal								X	
Canal South of Entrance	Permanent Canal	X								
Burdyl Pond	Permanent Pond	X	X				X		X	X
North Entrance Pond	Permanent Pond								X	
Service Road Pond	Permanent Pond	X	X				X		X	X
Stop 1 Pond	Permanent Pond	X	X				X		X	X
Victory Woods Pond	Permanent Pond	X	X				X		X	X
Davidson Pond	Temporary Pond	X	X						X	X
Stop 2 Pond	Temporary Pond	X	X							
Stop 8 Ponds	Temporary Pond	X	X				X		X	X
Beaver Marsh	Marsh	X	X				X		X	X
River Road Marsh	Marsh	X								
Schuyler Estate Canal	Marsh	X	X				X		X	X
Vly Marsh	Marsh	X	X				X		X	X
Woodland 6	Coniferous Forest				X			X		
Victory Woods	Hardwood Forest				X					

Table 1. Overview of the 39 standardized survey sites at Saratoga National Historical Park and sampling methods used at each site (continued).

Site	Habitat Type	Calling Survey	Egg Mass Count	TCS Stream	TCS Woodland	TCS Field	TCS Pond	Cover board	Turtle Trap	Minnow Trap
Woodland 1	Mixed Forest				X			X		
Woodland 2	Mixed Forest				X			X		
Woodland 3	Mixed Forest				X			X		
Woodland 4	Mixed Forest				X			X		
Woodland 5	Mixed Forest				X			X		
Woodland 7	Mixed Forest				X			X		
Woodland 8	Mixed Forest				X			X		
Field 1	Field					X		X		
Field 2	Field					X		X		
Field 3	Field					X		X		
Field 4	Field					X		X		
Field 5	Field					X		X		
Field 6	Field					X		X		
Field 7	Field					X		X		
Field 8	Field					X				

Saratoga National Historical Park Herpetological Survey

Sampling Methods and Locations

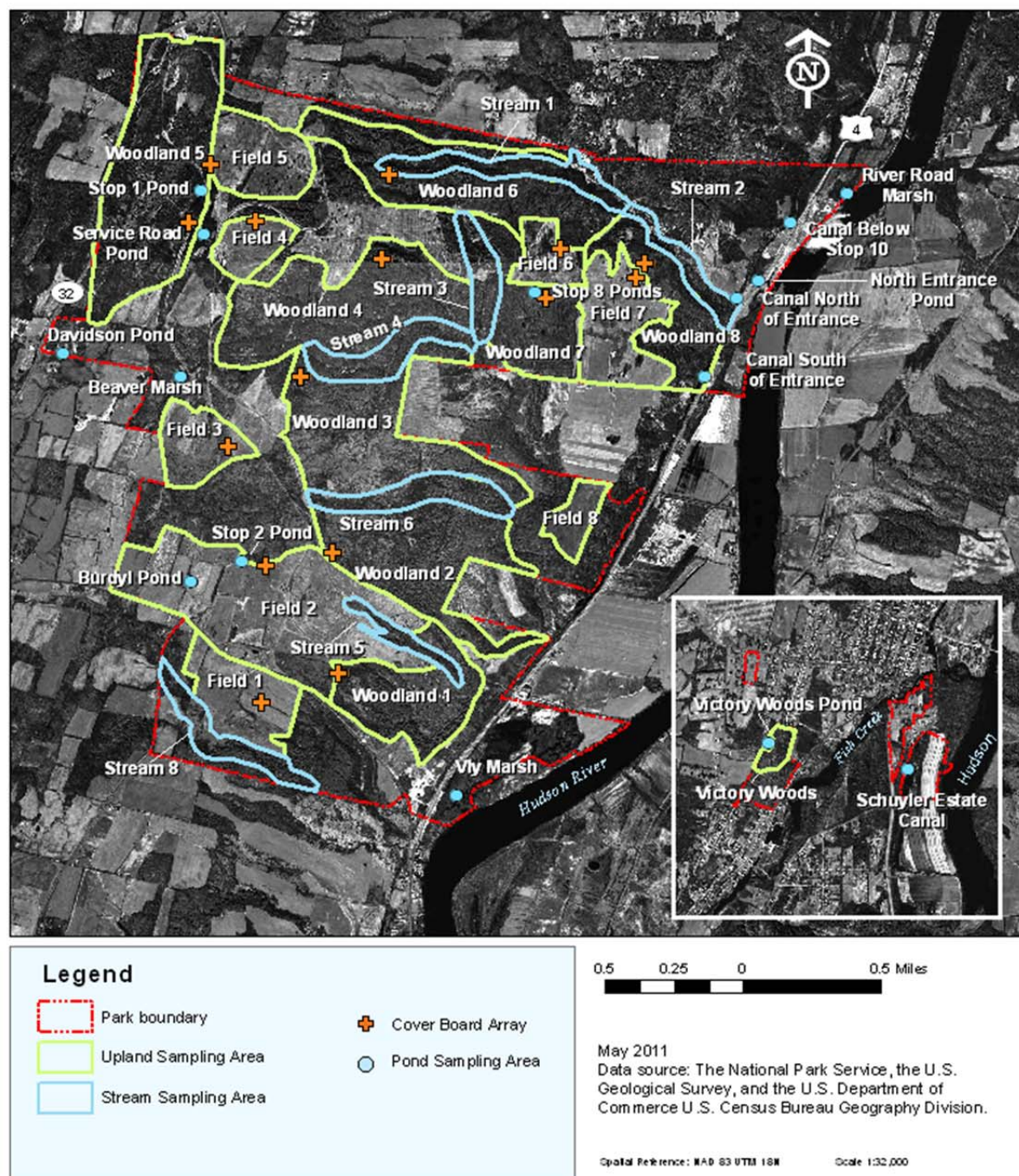


Figure 1. Location of standardized sampling sites and time-constrained search areas used in herpetofaunal inventory at Saratoga National Historical Park.

Although several different methods were used to capture animals, the details of marking and measuring were based on species, not method of capture. We classified amphibians as larvae or adult-form, and adult-form individuals into age categories (metamorph, juvenile, adults) but did not mark, measure, or weigh them. We measured snakes' snout-vent length (SVL), total length (TL), and mass, and sexed them based on degree of tail contour (Conant and Collins 1998). All snakes were given a cohort mark with a veterinary cauterizer (Jorgensen Laboratories, Loveland, CO). We marked all turtles for individual identification, with each given a unique set of notches in the marginal scutes, using a code system modified from Cagle (1939). For all turtles captured, we measured carapace length (CL), carapace width (CW), plastron length (PL), and mass. We sexed turtles based on external features for each species described in Ernst et al. (1994). Individuals were classified as adult, as opposed to juvenile, based on the following size criteria: common snapping turtles, males with CL >210 mm and females with CL >200 mm (Congdon et al. 1987, 1992, Ernst et al. 1994); spotted turtles, PL >80 mm Graham (1995).

Anuran Calling Surveys (ACS)

Anuran calling surveys were conducted at 14 ponds using the Wisconsin frog and toad survey method (Heyer et al. 1994). Anuran calling surveys record the presence of species at specific sites and provide an index of abundance based on the calling intensity of species heard. Call index values and criteria for assigning them were: 0 = no calls, 1 = individuals can be counted (no overlapping of calls), 2 = overlapping of calls (can still be counted), 3 = full chorus (calls are constant and individually indistinguishable). The surveyors arrived at each sample site at least a half-hour after dusk and listened for anuran calls for 5 minutes, recording an index value for each species heard. For each sampling occasion, the number of individuals of each species calling was also counted or estimated.

Due to variable activity patterns among anuran species, multiple calling surveys conducted throughout spring and early summer months were necessary to thoroughly document species presence at a site (Conant and Collins 1998, Crouch and Paton 2002). Of the 13 anuran calling survey sites, eight were surveyed six times, four were surveyed five times, and one was surveyed three times each between 2 April and 12 June 2001.

Beaver Marsh – 6 call surveys
Burdyl Pond – 6 call surveys
Canal Below Stop 10 – 6 call counts
Canal South of Entrance – 6 call surveys
Davidson Pond – 6 call surveys
River Road Marsh – 5 call surveys
Schuyler Estate Canal – 6 call surveys
Service Road Pond – 6 call surveys
Stop 1 Pond – 5 call surveys
Stop 2 Pond – 3 call surveys
Stop 8 Ponds – 5 call surveys
Victory Woods Pond – 5 call surveys
Vly Marsh – 6 call surveys

Egg Mass Counts (EMC)

Spotted salamanders and wood frogs migrate to ponds in the early spring to breed, depositing gelatinous egg masses attached to branches and vegetation in the water (Petranka 1998). Egg mass counts were conducted to determine presence and document evidence of breeding by these species. When counting egg masses, the observer traversed the entire pond, searching for egg masses, identifying and counting all egg masses observed and recording developmental stage and % mortality (individual egg mortality within each egg mass). While every effort was made to count all masses in a pond, because spawning is only loosely synchronized, counts based on a single survey may underestimate total numbers of egg masses laid. For ponds receiving multiple counts, the highest count (maximum) was used for analyses of abundance (Cook and Boland 2005). Egg mass counts were conducted on 9, 10, and 11 April and 2, 7, and 11 May at ten sites as follows:

1. Beaver Marsh – 2 counts
2. Burdyl Pond – 2 counts
3. Davidson Pond – 2 counts
4. Schuyler Estate Canal – 2 counts
5. Service Road Pond – 2 counts
6. Stop 1 Pond – 2 counts
7. Stop 2 Pond – 1 count
8. Stop 8 Ponds – 2 counts
9. Victory Woods Pond – 2 counts
10. Vly Marsh – 1 count

Time-constrained Search (TCS)

Habitat-specific time-constrained search (TCS) was conducted in all habitats likely to support amphibians and reptiles, i.e., streams, woodlands, fields, and wetlands. Each wetland, stream section, or upland TCS area (woodlands and fields) was searched for a pre-determined period of time, which was commensurate with size. The amount of time allotted to search an area on a given occasion was not enough to search all available cover, and searchers used an approach intended to maximize the numbers and diversity of captures by moving through the area and searching under the best available cover (e.g. logs, rocks, boards, metal debris) favored by amphibians and reptiles (Bury and Raphael 1983), and by dip netting ponds (Heyer et al. 1994). Although the original plans called for sites within each habitat type to be sampled the same number of times, and sampling sessions at a given site to be the same duration each time, due to the exigencies of field work, this was not always possible. Results of TCS were standardized as a capture rate (CR) for each species, calculated by dividing the total number of individuals recorded by the total search effort (person hours) spent for each search. Person hours are the total amount of time spent searching, multiplied by the number of people participating in the search.

Stream TCS

Stream TCS was employed primarily to survey for stream salamanders at seven survey sites. Investigators systematically moved upstream, using a dip net in the stream to capture amphibians as rocks were overturned. Rocks, logs, and debris in the splash zone and on the bank were overturned and searched under. Identification and life stage (adult or larva) were recorded for each animal captured. The adult life stage was defined as any individual not in the larval stage,

and the larval stage was defined as an individual with gills, showing pre-metamorphic characteristics. Starting and ending times (Eastern Daylight Time) and the number of people searching were recorded. The following permanent stream sections were searched at least once per month for April, May, June, August, and September, 2001, except for several stream segments that were not sampled in September:

1. Stream Site 1 (Upper Kroma Kill) – 6 surveys, 3.4 search hours
2. Stream Site 2 (Lower Kroma Kill) – 6 surveys, 3.0 search hours
3. Stream Site 3 (Mill Creek North) – 5 surveys, 1.9 search hours
4. Stream Site 4 (Mill Creek Middle) – 4 surveys (no September survey), 3.0 search hours
5. Stream Site 5 (American's River) – 4 surveys (no September survey), 1.3 search hours
6. Stream Site 6 (Mill Creek South) – 4 surveys (no September survey), 4.1 search hours
7. Stream Site 8 (Great Falls Creek, formerly Devil's Hollow) – 5 surveys, 2.3 search hours

Woodland TCS

Woodland TCS was employed to survey for the broad range of species likely to occur in SARA woodlands, especially terrestrial salamanders, several anurans, and snakes. Start and end times, number of searchers, and the identification, number, and sex of individuals found were recorded. The following woodland areas were searched at least once per month in April, May, June, August, and September, 2001, as follows:

1. Woodland #1 – mixed forest: 6 surveys, 1.8 search hours
2. Woodland #2 – mixed forest: 5 surveys, 1.6 search hours
3. Woodland #3 – mixed forest: 5 surveys, 1.8 search hours
4. Woodland #4 – mixed forest: 5 surveys, 2.1 search hours
5. Woodland #5 – mixed forest: 5 surveys, 1.5 search hours
6. Woodland #6 – coniferous forest: 5 surveys, 1.7 search hours
7. Woodland #7 – mixed forest: 8 surveys, 5.2 search hours
8. Woodland #8 – mixed forest: 5 surveys, 1.7 search hours
9. Victory Woods – hardwood forest: 5 surveys, 3.9 search hours

Field TCS

Field TCS was employed primarily to search for snakes, which are often found basking along edges. Start and end times, number of searchers, and the identification, number, and sex of individuals found were recorded. The following sites (see Appendix D for cross-walk to current park field numbers) were surveyed once in April, May, June, and August, 2001, as follows:

1. Field #1 – 4 surveys, 1.0 search hours
2. Field #2 – 4 surveys, 1.3 search hours
3. Field #3 – 4 surveys, 1.6 search hours
4. Field #4 – 4 surveys, 1.3 search hours
5. Field #5 – 4 surveys, 1.4 search hours
6. Field #6 – 5 surveys (including 2 surveys in August), 1.6 search hours
7. Field #7 – 4 surveys, 1.3 search hours
8. Field #8 – 4 surveys, 1.2 search hours

Pond TCS

Pond TCS was conducted at night to survey primarily for amphibians. However, aquatic turtles were also often observed. Searches were conducted by traversing the entire pond, sampling with a dip-net for amphibian larvae and adults, as well as turtles and snakes. Start and end times, number of searchers, and the identification, number and sex of individuals found were recorded. Pond TCS occurred between 6 April and 4 September 2001 and, except for Stop 8 Ponds which was only surveyed twice, was generally conducted once per month in April, May, June, and August. Specific details of ponds surveyed are:

Beaver Marsh – 4 surveys, 1.0 search hours
Schuyler Estate Canal – 10 surveys, 4.8 search hours
Vly Marsh – 4 surveys, 1.1 search hours
Burdyl Pond – 5 surveys, 1.6 search hours
Service Road Pond – 4 surveys, 1.2 search hours
Stop 1 Pond – 4 surveys, 1.2 search hours
Victory Woods Pond – 5 surveys, 1.5 search hours
Stop 8 Ponds – 2 surveys, 0.5 search hours

Coverboards (CB)

Coverboards (Grant et al. 1992) were used primarily to inventory snakes. Coverboards located near wetlands were also expected to provide cover for terrestrial amphibians. Boards were 0.6 m x 1.2 m (2 ft x 4 ft) and made of corrugated sheet metal or plywood. In March 2001, coverboards were deployed on top of vegetation at eight woodland and seven field sites (see Appendix D for cross-walk to current park field numbers). Eight boards were placed 5 meters apart in linear “arrays” consisting of alternating wood and metal boards. Coverboards were checked once or twice per month in April, May, June, August, and September as follows:

1. Woodland #1 – 10 visits, 80 CB checks
2. Woodland #2 – 10 visits, 80 CB checks
3. Woodland #3 – 10 visits, 80 CB checks
4. Woodland #4 – 10 visits, 80 CB checks
5. Woodland #5 – 10 visits, 80 CB checks
6. Woodland #6 – 10 visits, 80 CB checks
7. Woodland #7 – 10 visits, 80 CB checks
8. Woodland #8 – 11 visits, 88 CB checks
9. Field #1 – 11 visits, 88 CB checks
10. Field #2 – 11 visits, 88 CB checks
11. Field #3 – 11 visits, 88 CB checks
12. Field #4 – 12 visits, 96 CB checks
13. Field #5 – 11 visits, 88 CB checks
14. Field #6 – 11 visits, 88 CB checks
15. Field #7 – 11 visits, 88 CB checks

Capture rates (CR) were calculated as the number of snake captures divided by the total number of board checks for each site. Each time a board was checked constituted a “board check.”

Therefore, a site with eight boards visited six times equaled 48 board checks. The number of snakes captured per 100 coverboard checks was calculated as:

$$CR = \frac{(\# \text{ of snake captures})}{(\text{total} \# \text{ of board checks})} \times 100$$

Turtle Trap Surveys (TTS)

Welded-wire crab traps measuring 30.5 cm x 30.5 cm x 60.1 cm (12" x 12" x 24"), with a mesh size of 1.3 cm x 2.5 cm (0.5" x 1"), were used to sample shallow areas for small aquatic/semi-aquatic turtles such as spotted turtles (*Clemmys guttata*). Funnel traps made of D-shaped metal hoops and 2.5 cm (1") nylon mesh were used to sample deeper pond areas for aquatic turtles such as painted (*Chrysemys picta*) and common snapping turtles (*Chelydra s. serpentina*) (Harless and Morlock 1989). The number of traps used ranged from one to six, depending on pond size. Traps were baited with sardines in vegetable oil and checked daily. Except as noted below, we trapped each site for two sessions, each spanning 6 days and 5 nights; 2 May thru 7 May and 2 June thru 7 June. Survey sites were:

1. Beaver Marsh – 3 traps
2. Schuyler Estate Canal – 2 and 6 traps (plus six traps set from 2 April thru 7 April)
3. Vly Marsh – 4 traps
4. Burdyl Pond – 4 traps
5. Canal Below Stop 10 – 5 traps
6. Canal North of Entrance – 1 trap, 1 trapping session (3 September thru 7 September)
7. North Entrance Pond – 1 trap, 1 trapping session (4 June thru 7 June)
8. Service Road Pond – 4 traps
9. Stop 1 Pond – 4 traps
10. Victory Woods Pond – 4 traps
11. Davidson Pond – 4 traps
12. Stop 8 Ponds – 4 traps

We quantified turtle abundance as a capture rate, "captures/100 trap nights." In addition, when possible, the size of turtle populations at specific wetlands was estimated using Chapman's modification of the Lincoln-Petersen method (Thomson et al. 1998) to provide an unbiased estimate of population size. Multiple trapping occasions at a site were consolidated into two periods of equal sampling effort to provide the two sampling periods required to use the Lincoln-Petersen method (Menkens and Andersen 1988).

Minnow Trap Surveys (MTS)

Standard funnel-shaped wire mesh minnow traps measuring 15.2 cm x 15.2 cm x 30.5 cm (6" x 6" x 12") were used to sample ponds for adult and larval *Ambystoma* salamanders, adult and larval anurans, and aquatic snakes (Heyer et al. 1994). Except as noted below, each site had two or three traps and we trapped each site for five sessions, each spanning between 3 and 5 nights, with most trapping sessions spanning 5 nights during the Months of April (131 trap nights), May (151 trap nights), June (150 trap nights), August (104 trap nights), and September (limited; 42 trap nights). Survey sites were:

1. Beaver Marsh – 2-3 traps
2. Schuyler Estate Canal – 2-3 traps
3. Vly Marsh – 3 traps, 3 trapping periods
4. Burdyl Pond – 3 traps
5. Canal Below Stop 10 – 3 traps
6. Service Road Pond – 3 traps, 4 trapping periods
7. Stop 1 Pond – 3 traps
8. Victory Woods Pond – 2-3 traps, 4 trapping periods
9. Davidson Pond – 3 traps
10. Stop 8 Ponds – 2-3 traps, 3 trapping periods

Since this method primarily captures amphibians, which were not marked for individual recognition, abundance was quantified as captures per 100 trap nights.

Incidental Encounters (IE)

Any encounter with an amphibian or reptile not recorded as data in a standardized survey was considered an incidental encounter. These were recorded on observation cards (“Green Cards”) to augment data collected during formal surveys, and include credible observations made by park staff and visitors. For each incidental encounter the species, life stage, method of documentation, as well as location, habitat, and UTM coordinates were recorded. Subsequent to the 2001 field season, there were a number of significant incidental encounters that increased the number of species documented at SARA or expanded the known range of rare species. These were: wood turtle in 2004 (pers. comm., Jacquie Tinker, SARA Ranger, 9 September 2004); eastern box turtle in 2006 (pers. comm., Jacquie Tinker, SARA Ranger, 7 July 2006); common musk turtle in Schuylerville in 2010 (pers. comm., Jacquie Tinker, SARA Ranger, 19 June 2010); and a Jefferson-blue spotted salamander complex in the Battlefield Unit in 2011 (pers. comm., Lawrence Woolbright, Sienna College, 13 April 2011). Although not included in this report’s tables, these records have been included in our discussion of species currently present at SARA.

Quantifying Overall Abundance

Quantifying overall abundance of the species encountered was not possible for a number of reasons. The methods used generally did not estimate actual population size, but rather provided a method-specific index of abundance, such as a capture rate (catch per unit effort). In addition, each of the seven methods used provided a sample biased towards a particular species, group of species, age or sex. Although sampling effort was divided among the different methods in an attempt to compensate for possible sampling bias, the amount of sampling bias, the extent to which the use of different methods may have balanced this bias, and the influence of other covariates, such as habitat type and breeding habits, were not estimated.

An index of overall abundance for each species was derived by summing the number of adult form individuals (as opposed to eggs or larvae) encountered during each of the seven survey methods. For time-constrained search, coverboard checks, turtle and minnow trap surveys, and incidental encounters, the numbers of adults of a given species encountered during each sampling occasion were summed. For anuran calling surveys we used counts or estimates of numbers of calling males made when the calling index values were recorded. Although not calibrated against known numbers, the relationship between calling index value and numbers of

calling males was similar to values obtained by Crouch and Paton (2002) for Rhode Island anurans (except northern spring peeper, *Pseudacris c. crucifer*) and Nelson and Graves (2004) for northern green frog (*Rana clamitans melanota*). When anurans were recorded calling in the course of TCS, the number of males calling was recorded in all instances, except for those involving full choruses of northern spring peeper. In these instances of full chorus, the mean number of males estimated calling during ACS occasions was used. Because egg mass counts do not directly count adults, the numbers of females represented was estimated as follows. For spotted salamanders (*Ambystoma maculatum*), Cook (1978) determined that, on average, each egg mass represented 0.633 females. Thus, the number of females present at a site was estimated as 0.633 times the number of egg masses. Similarly for Jefferson salamanders (*Ambystoma jeffersonianum*), Cook (1978) determined that, on average, each egg mass represented 0.30 females. Thus, the number of females present at a site was estimated as 0.30 times the number of egg masses. For wood frog egg mass counts, each egg mass represents one adult female (Crouch and Paton 2000). Because amphibians were not marked for individual identification, for the purposes of estimating an overall index of abundance, reptiles were also treated as though they had not been marked and, unless otherwise stated, numbers reported for reptile species represent capture events, not individuals.

Although the total numbers recorded for each species provide an index of abundance, it is an uncalibrated index and its relationship to actual abundance is unknown. These numbers, and their derivatives, are best viewed as indicating the order of magnitude of a species' abundance and providing a reasonably accurate representation of relative and ranked abundance within taxonomic orders. Although these numbers are of value for some inter-specific comparisons and community analysis, and are likely accurate in identifying abundant versus rare species, differences between species whose index of abundance are of the same order of magnitude may not reflect true differences in abundance.

Environmental Variables

Air and water temperature and water pH were recorded at all sampling events as appropriate. Temperatures were recorded to the nearest degree centigrade with a hand held "Enviro-Safe" thermometer. Water pH was measured with an Oakton pHTestr1 pH meter, calibrated weekly with pH 4 and pH 7 buffer solutions.

Data Management

Common and scientific names and spellings are those of the Integrated Taxonomic Information System (ITIS) at the time data were collected. Data collected during the course of this study were entered into a Microsoft Access database that is associated with this report. The original data sheets are archived with the Northeast Temperate Inventory and Monitoring Network located at Marsh-Billings-Rockefeller National Historical Park in Woodstock, Vermont. Given the low-impact nature of this study, voucher specimens of live animals were not collected. The National Park Service's Northeast Temperate Network data manager can be contacted to obtain unpublished data files produced by this study.

A Garmin III Plus Global Positioning System (GPS) unit was used to record the coordinates of each survey site (Appendix E). GPS locality data were recorded as Universal Transverse

Mercator (UTM) grid coordinates (zone 18 N) with X = x-axis or Easting, and Y = y-axis or Northing, using the NAD1983 datum.

Results

Overview of Park Herpetofauna

A total of 21 species (13 amphibians and eight reptiles) were recorded during this survey in 2001. In addition, there were a number of subsequent incidental encounters that increased the number of species currently known to be present at SARA (up to 23) or expanded the known distribution of rare species at SARA. These were: wood turtle in 2004 (pers. comm., Jacquie Tinker, SARA Ranger, 9 September 2004); eastern box turtle in 2006 (pers. comm., Jacquie Tinker, SARA Ranger, 7 July 2006); common musk turtle in Schuylerville in 2010 (pers. comm., Jacquie Tinker, SARA Ranger, 19 June 2010); and a Jefferson-blue spotted salamander complex in the Battlefield Unit in 2011 (pers. comm., Lawrence Woolbright, Sienna College, 13 April 2011). These records are not included in the results detailed below, but are incorporated into the discussion section of this report. In addition, although it occurred prior to this survey and is not treated as a current record, a spotted turtle observed by Chris Martin and David Hayes at the Schuylster Estate Unit circa 1995 (pers. comm, Chris Martin, April 7, 2011) has also been incorporated in the discussion.

Amphibians dominated the herpetofaunal community in 2001, accounting for 98.7% of the 9,921 individuals recorded. By order, anurans (frogs and toads) comprised 90.6% of all individuals recorded, salamanders 8.1%, turtles 0.4%, and snakes 0.9%. The most frequently recorded species in each order, based on total numbers of adults recorded were northern spring peeper (*Pseudacris c. crucifer*), red-spotted newt (*Notophthalmus v. viridescens*), painted turtle (*Chrysemys p. picta*), and common garter snake (*Thamnophis sirtalis*) (Table 2).

We captured target species at 37 of the 39 standardized survey sites (except Woodland 4 and Field 8), plus seven incidental encounter sites (Figures 2, 3, 4 and 5). Based on frequency of occurrence, the most widespread species in each taxonomic group were northern green frog (found at 23 or 50% of sites), eastern red-backed salamander (11, or 24% of sites), common snapping turtle (nine, or 20% of sites), and common garter snake (16, or 35% of sites, Table 3). Schuylster Estate Canal was the most species-rich site with 15 species (71% of species). Burdyl Pond accounted for the greatest number of individuals recorded (1,859 individuals or 18.7% of the total number of adults detected, Table 4 and Table 5).

By habitat, the numbers of adults recorded was greatest in wetlands (8223 or 82.9% of all individuals recorded), followed by streams/canals (1381 or 13.9% of individuals), and uplands (317 or 3.2% of individuals) (Table 2). Species richness was greatest in uplands (16 species, 76% of recorded species), followed by 15 species (71% of recorded species) in streams/canals and wetlands (Table 2). Within the seven sub-habitat categories, the numbers of adults recorded was greatest in permanent ponds (4582 or 46.2% of individuals recorded), followed by marsh (2982 or 30.1% of individuals), permanent canals (753 or 7.6% of individuals), temporary ponds (659 or 6.6% of individuals), permanent streams (628 or 6.3% of individuals), fields (178 or 1.8% of individuals), and forest (139 or 1.4% of individuals). Within the seven sub-habitat categories, although it had the lowest abundance, , species richness was greatest in forest (16 species, 76% of all species), followed by marsh (15 species, 71%), permanent streams (12 species, 62%), permanent and temporary ponds (12 species each, 57%), permanent canals (10 species, 48%), and fields (six species, 29%) (Table 3, Figure 6).

Table 2. Number of all adult amphibians and reptiles recorded in 2001 at Saratoga National Historical Park, listed by habitat category and type, and ordered by relative abundance within taxonomic group. Within-order relative abundance (RA) is the number of individuals of a species divided by total number of adults of species within each taxonomic order, expressed as a percentage.

Group	Species Common Name	Stream/Canal		Wetland		Upland			Total	Within-order RA % (Rank)
		Permanent Stream	Permanent Canal	Temporary Pond	Permanent Pond	Marsh	Field	Forest		
FROG	Northern Spring Peeper		466	520	3,026	1,815	145	5	5,977	66.49 (1)
	Gray Treefrog		5	1	798	515	1	2	1,322	14.71 (2)
	Northern Green Frog	305	84	12	272	210		28	911	10.13 (3)
	Eastern American Toad	7	161	8	3	214		3	396	4.41 (4)
	American Bullfrog	22	22	6	100	24			174	1.94 (5)
	Wood Frog	7		55	5	21		25	113	1.26 (6)
	Northern Leopard Frog	8	3	2		61		1	75	0.83 (7)
	Unidentified <i>Lithobates</i> Species				17				17	0.19 (8)
	Pickerel Frog	4							4	0.04 (9)
SALAMANDER	Red-spotted Newt	3	1	2	221	38		1	266	33.29 (1)
	Northern Two-lined Salamander	229						3	232	29.04 (2)
	Spotted Salamander			48	94	36		4	182	22.78 (3)
	Eastern Red-backed Salamander	33				5		39	77	9.64 (4)
	Jefferson/Blue Spotted Salamander Complex				30	10		2	42	5.26 (5)
TURTLE	Painted Turtle		4	1	11	6			22	50.00 (1)
	Common Snapping Turtle	1	3	1	4	12			21	47.73 (2)
	Eastern Box Turtle							1	1	2.27 (3)
SNAKE	Common Garter Snake	4	4		1	5	21	16	51	57.30 (1)
	Northern Water Snake	5		3		10			18	20.22 (2)
	Eastern Milk Snake						3	5	8	8.99 (3)
	Northern Red-bellied Snake						7	1	8	8.99 (3)
	Northern Brown Snake						1	3	4	4.49 (5)
TOTAL # OF ADULTS		628	753	659	4,582	2,982	178	139	9,921	
			1,381		8,223			317		
TOTAL # OF SPECIES			15		15			16	21	

Table 3. Distribution by habitat category and type of the 21 species of amphibians and reptiles recorded in 2001 at Saratoga National Historical Park. Ordered on total number of sites a species was recorded from, within taxonomic group. A species was considered present if reliable identification could be made from observations of egg, larval, or adult lifestages or detections via indirect means such as vocal calls were made. Frequency of Occurrence (FO) = the number of sites where a species was detected divided by the total number of sites surveyed (46). Number of localities includes both standardized survey sites (39) and incidental encounter only locations (7).

Group	Species Common Name	Stream/Canal		Wetland		Upland				FO (%)
		Permanent Stream	Permanent Canal	Temporary Pond	Permanent Pond	Marsh	Field	Forest	Total	
FROG	Northern Green Frog	8	2	2	4	4		3	23	50.0
	Wood Frog	5		2	3	3		6	19	41.3
	Northern Spring Peeper		2	3	4	4	1	5	19	41.3
	Eastern American Toad	3	2	1	2	4		3	15	32.6
	American Bullfrog	2	2	2	4	4			14	30.4
	Gray Treefrog		1	1	4	4	1	1	12	26.1
	Northern Leopard Frog	2	1	1		3		1	8	17.4
	Pickerel Frog	2							2	4.3
	Unidentified <i>Lithobates</i> Species			1	4	1			6	13.0
SALAMANDER	Eastern Red-backed Salamander	3				1		7	11	23.9
	Spotted Salamander			2	4	3		1	10	21.7
	Red-spotted Newt	1	1	1	3	2		1	9	19.6
	Northern Two-lined Salamander	6						1	7	15.2
	Jefferson Salamander				1	1		1	3	6.5
	Unidentified <i>Ambystoma</i> Species				1				1	2.2
TURTLE	Common Snapping Turtle	1	1	1	3	3			9	19.6
	Painted Turtle		2	1	3	2			8	17.4
	Eastern Box Turtle							1	1	2.2
SNAKE	Common Garter Snake	3	2		1	1	6	4	17	37.0
	Eastern Milk Snake						2	2	4	8.7
	Northern Water Snake	1		1		2			4	8.7
	Northern Red-bellied Snake						3	1	4	8.7
	Northern Brown Snake						1	2	3	6.5
	Total Number of Species	12	10	12	12	15	6	16	21	
	Total # of locations with detections / Total # of locations	8/8	4/4	4/4	6/6	4/4	8/9	10/11	44/46	95.7

Table 4. Number of adult amphibians recorded and amphibian species richness (S) at each of 39 standardized survey sites and 7 incidental encounter only locations at Saratoga National Historical Park. Frequency of occurrence (FO) is the number of locations where a species was detected, divided by the total number of locations surveyed (46). L=larvae, E=egg mass.

Site	Habitat Type	N. Spring Peeper	Gray Treefrog	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Pickereel Frog	Unidentified <i>Lithobates</i> sp.	E. American Toad	E. Red-backed Salamander	Spotted Salamander	Jefferson Salamander	N. Two-lined Salamander	Red-spotted Newt	Unidentified sp.	Total # of Adult Amphibians	% of Total Adult Amphibians	S
Standardized Survey Sites																			
Stream 1 Upper Kroma Kill	Perm. Stream			38		2		3		1				9			53	0.54	5
Stream 2 Lower Kroma Kill	Perm. Stream			32	1					5							38	0.39	3
Stream 3 Mill Creek North	Perm. Stream			13	2									9			24	0.25	3
Stream 4 Mill Creek Middle	Perm. Stream			45	2		7	1		1	3			50	3		112	1.14	8
Stream 5 American's River	Perm. Stream			3	1												4	0.04	2
Stream 6 Mil Creek South	Perm. Stream			149	1									56			206	2.10	3
Stream 8 Great Falls Creek	Perm. Stream			16			1				25			105			147	1.50	4
Canal Below Stop 10	Perm. Canal	265	5	29		5	3			91					1		399	4.08	7
Canal North of Entrance	Perm. Canal																0	0.00	0
Canal South of Entrance	Perm. Canal	201		55		17				70							343	3.50	4
Burdyl Pond	Perm. Pond	1,291	196	99		44			16	2		8			195		1,851	18.91	7
North Entrance Pond	Perm. Pond																0	0.00	0
Service Road Pond	Perm. Pond	540	194	32	1	14			L			5			11		797	8.14	7
Stop 1 Pond	Perm. Pond	569	406	93	1	31			L			14			15	L	1,129	11.53	7
Victory Woods Pond	Perm. Pond	626	2	48	3	11			1	1		67	30			E	789	8.06	8
Davidson Pond	Temp. Pond	300		10		5	2										317	3.24	4
Stop 2 Pond	Temp. Pond	39			2												41	0.42	2
Stop 8 Ponds	Temp. Pond	181	1	2	53	1				8		27			2		275	2.81	8
Beaver Marsh	Marsh	183	78	12	L	6	2			6		14			36	E	337	3.44	8
River Road Marsh	Marsh	571	106	46		1				50							774	7.91	5
Schuyler Estate Canal	Marsh	415	186	23	11	2	58			6	5	21	10		2		739	7.55	11
Vly Marsh	Marsh	646	145	129	10	15	1			152		1					1,099	11.23	8
Woodland 6	Conif. Forest										12						12	0.12	1
Victory Woods	Decid. Forest				9						2	4	2				17	0.17	4

Table 4. Number of adult amphibians recorded and amphibian species richness (S) at each of 39 standardized survey sites and 7 incidental encounter locations at Saratoga National Historical Park. Frequency of occurrence (FO) is the number of locations where a species was detected, divided by the total number of locations surveyed (46). L=larvae, E=egg mass (continued).

Site	Habitat Type	N. Spring Peeper	Gray Treefrog	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Pickereel Frog	Unidentified <i>Lithobates</i> sp.	E. American Toad	E. Red-backed Salamander	Spotted Salamander	Jefferson Salamander	N. Two-lined Salamander	Red-spotted Newt	Unidentified sp.	Total # of Adult Amphibians	% of Total Adult Amphibians	S
Woodland1	Mixed Forest	1			12					1	4						18	0.18	4
Woodland 2	Mixed Forest			3	1					1	12			1			18	0.18	5
Woodland 3	Mixed Forest	1			1						3						5	0.05	3
Woodland 4	Mixed Forest																0	0.00	0
Woodland 5	Mixed Forest	1		3	1												5	0.05	3
Woodland 7	Mixed Forest	1	2	22	1		1			1	2				1		31	0.32	8
Woodland 8	Mixed Forest	1									4						5	0.05	2
Field 1	Field																0	0.00	0
Field 2	Field																0	0.00	0
Field 3	Field																0	0.00	0
Field 4	Field																0	0.00	0
Field 5	Field																0	0.00	0
Field 6	Field	145	1														146	1.49	2
Field 7	Field																0	0.00	0
Field 8	Field																0	0.00	0
Incidental Encounter Sites																			
Entrance Rd. 1.5 mi E. of Vis. Ctr.	Mixed Forest																0	0.00	0
Woodland Stop 6 and 7	Perm. Stream			9		20					5			2			36	0.37	4
U.S. Hwy 4 West Side of Champlain Canal	Perm. Canal																0	0.00	0
Int. of Rt. 32 and Entrance Rd.	Perm. Pond																0	0.00	0
Vernal Ponds Adj. to Stream 4	Temp. Pond											21					21	0.21	1
Entrance Rd. 1.0 mi E. of Vis. Ctr.	Mixed Forest																0	0.00	0
N. of Stop 2 on Park Tour Rd.	Field																0	0.00	0
Total # of Adults		5,977	1,322	911	113	174	75	4	17	396	77	182	42	232	266	0	9,788		
Total # of Localities		19	12	23	18	14	8	2	2	15	11	10	3	7	9	0	31		
FO (%)		41.3	26.1	50.0	39.1	30.4	17.4	4.3	4.3	32.6	23.9	21.7	6.5	15.2	19.6	0.0	67.39		

Site	Habitat Type	C. Snapping Turtle	Painted Turtle	E. Box Turtle	E. Milk Snake	N. Water Snake	Common Garter Snake	Northern Brown Snake	N. Red-bellied Snake	Total # of Adult Reptiles	% of Total Adult Reptiles	SD
Standardized Survey Sites												
Stream 1 Upper Kroma Kill	Perm. Stream	1				5				6	4.51	2
Stream 2 Lower Kroma Kill	Perm. Stream						1			1	0.75	1
Stream 3 Mill Creek North	Perm. Stream						1			1	0.75	1
Stream 4 Mill Creek Middle	Perm. Stream									0	0.00	0
Stream 5 American's River	Perm. Stream									0	0.00	0
Stream 6 Mil Creek South	Perm. Stream									0	0.00	0
Stream 8 Great Falls Creek	Perm. Stream									0	0.00	0
Canal Below Stop 10	Perm. Canal	3	1				1			5	3.76	3
Canal North of Entrance	Perm. Canal		3							3	2.26	1
Canal South of Entrance	Perm. Canal									0	0.00	0
Burdyl Pond	Perm. Pond		8							8	6.02	1
North Entrance Pond	Perm. Pond	2								2	1.50	1
Service Road Pond	Perm. Pond	1	2							3	2.26	2
Stop 1 Pond	Perm. Pond		1							1	0.75	1
Victory Woods Pond	Perm. Pond						1			1	0.75	1
Davidson Pond	Temp. Pond	1	1			3				5	3.76	3
Stop 2 Pond	Temp. Pond									0	0.00	0
Stop 8 Ponds	Temp. Pond									0	0.00	0
Beaver Marsh	Marsh	2				9				11	8.27	2
River Road Marsh	Marsh									0	0.00	0
Schuyler Estate Canal	Marsh	9	3			1	5			18	13.53	4
Vly Marsh	Marsh	1	3							4	3.01	2
Woodland 6	Conif. Forest									0	0.00	0
Victory Woods	Decid. Forest									0	0.00	0

Table 5. Number of adult reptiles recorded and reptile species richness (S) at each of 39 standardized survey sites and 7 incidental encounter locations at Saratoga National Historical Park. Frequency of occurrence (FO) is the number of locations where a species was detected, divided by the total number of locations surveyed (46) (continued).

Site	Habitat Type	C. Snapping Turtle	Painted Turtle	E. Box Turtle	E. Milk Snake	N. Water Snake	Common Garter Snake	Northern Brown Snake	N. Red-bellied Snake	Total # of Adult Reptiles	% of Total Adult Reptiles	S
Woodland 1	Mixed Forest						1			1	0.75	1
Woodland 2	Mixed Forest									0	0.00	0
Woodland 3	Mixed Forest									0	0.00	0
Woodland 4	Mixed Forest									0	0.00	0
Woodland 5	Mixed Forest				4		4	2		10	7.52	3
Woodland 7	Mixed Forest						7	1	1	9	6.77	3
Woodland 8	Mixed Forest									0	0.00	0
Field 1	Field						2			2	1.50	1
Field 2	Field						1			1	0.75	1
Field 3	Field				2		2	1	3	8	6.02	4
Field 4	Field						4			4	3.01	1
Field 5	Field						4		3	7	5.26	2
Field 6	Field						8			8	6.02	1
Field 7	Field								1	1	0.75	1
Field 8	Field									0	0.00	0
Incidental Encounter Sites												
Entrance Rd. 1.5 mi E. of Vis Ctr.	Mixed Forest				1		4			5	3.76	2
Woodland Stop 6 and 7	Perm. Stream						2			2	1.50	1
U.S. Hwy 4 West Side of Champlain Canal	Perm. Canal						3			3	2.26	1
Int. of Rt. 32 and Entrance Rd.	Perm. Pond	1								1	0.75	1
Vernal Ponds Adj. to Stream 4	Temp. Pond									0	0.00	0
Entrance Rd. 1.0 mi E. of Vis. Ctr.	Mixed Forest			1						1	0.75	1
N. of Stop 2 on Park Tour Rd.	Field				1					1	0.75	1
Total # of Adults		21	22	1	8	18	51	4	8	133		
Total # of Localities		9	8	1	4	4	17	3	4	30		
FO (%)		19.6	17.4	2.2	8.7	8.7	37.0	6.5	8.7	65.2		

Saratoga National Historical Park Herpetological Survey

Salamander Species Locations

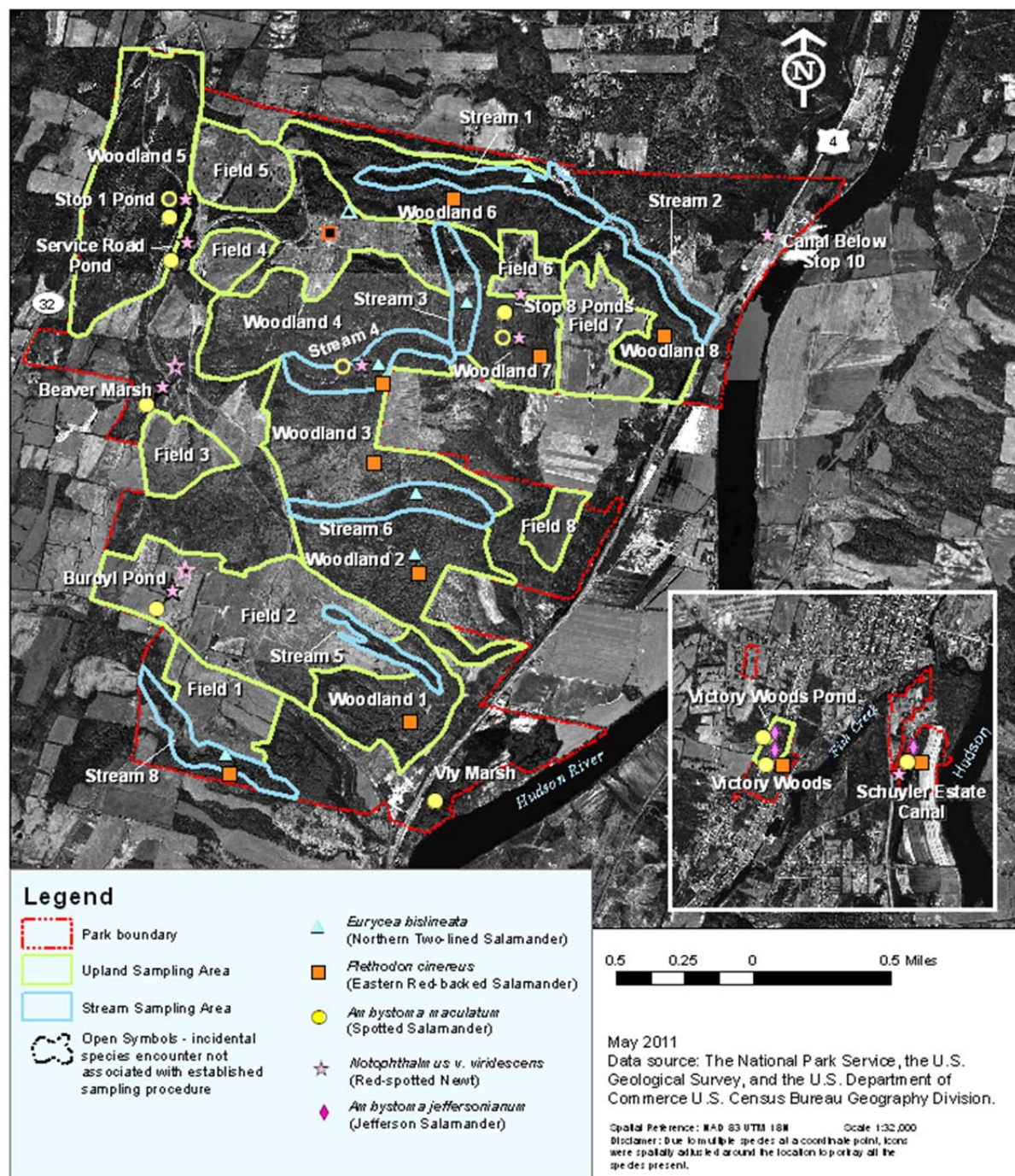


Figure 2. Location of salamander detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual.

Saratoga National Historical Park Herpetological Survey

Frog Species Locations

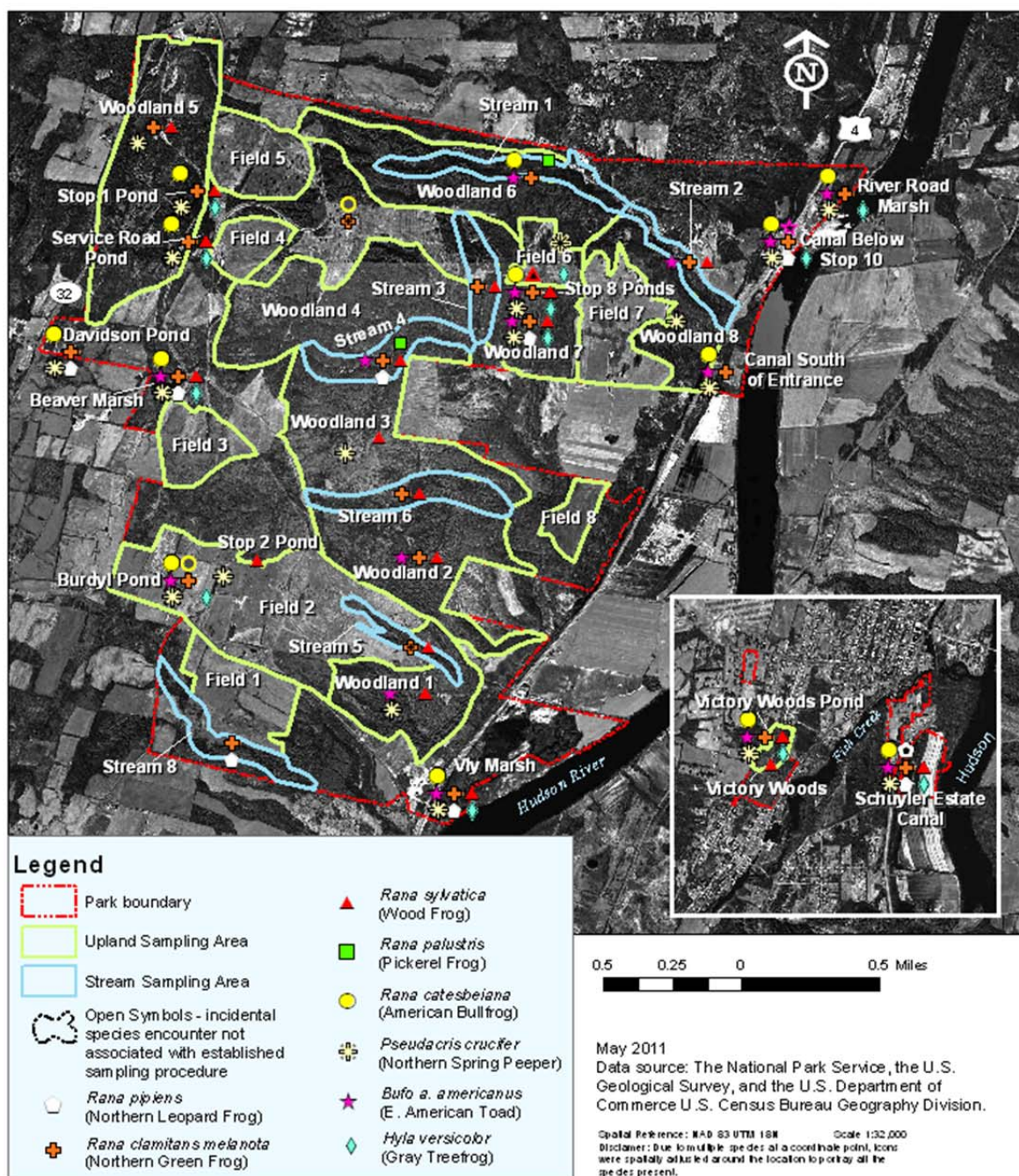


Figure 3. Location of frog and toad detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual.

Saratoga National Historical Park Herpetological Survey

Snake Species Locations

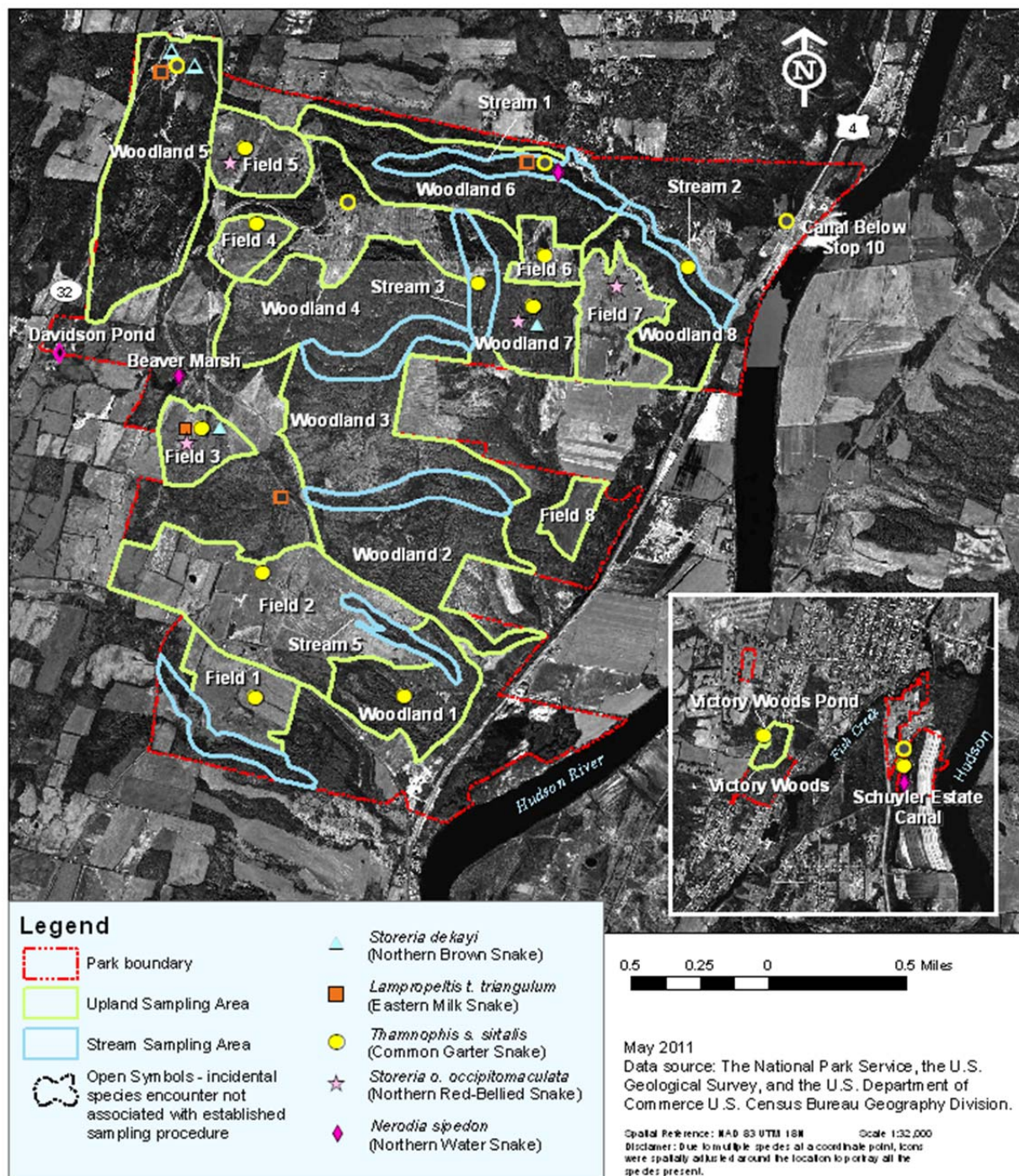


Figure 4. Location of snake detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual. Open symbol represents incidental encounter site.

Saratoga National Historical Park Herpetological Survey

Turtle Species Locations

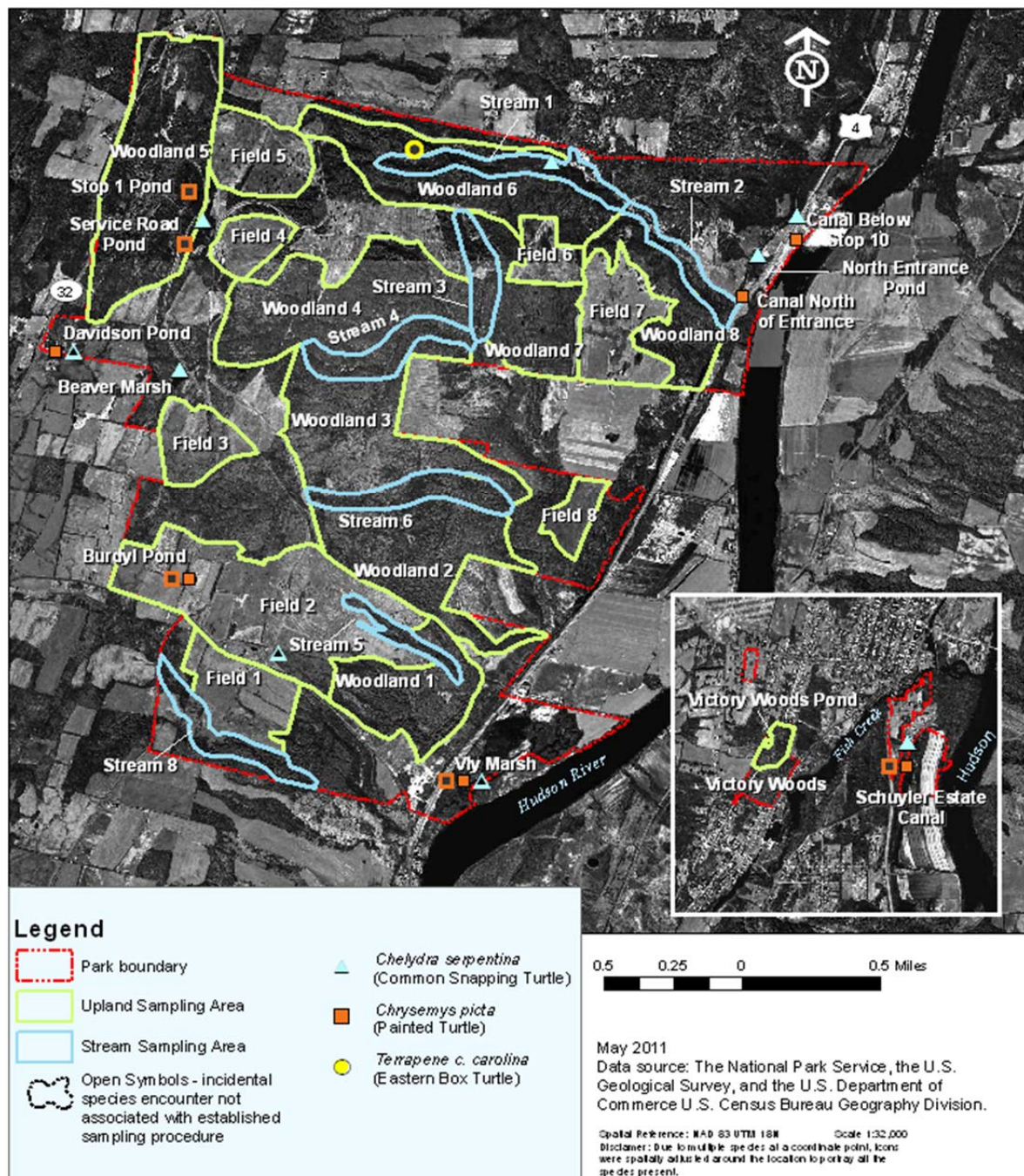


Figure 5. Location of turtle detections at Saratoga National Historical Park. Points represent central location of survey sites where a given species was recorded, not each individual. Open symbol represents incidental encounter site.

Saratoga National Historical Park Herpetological Survey

Species Richness

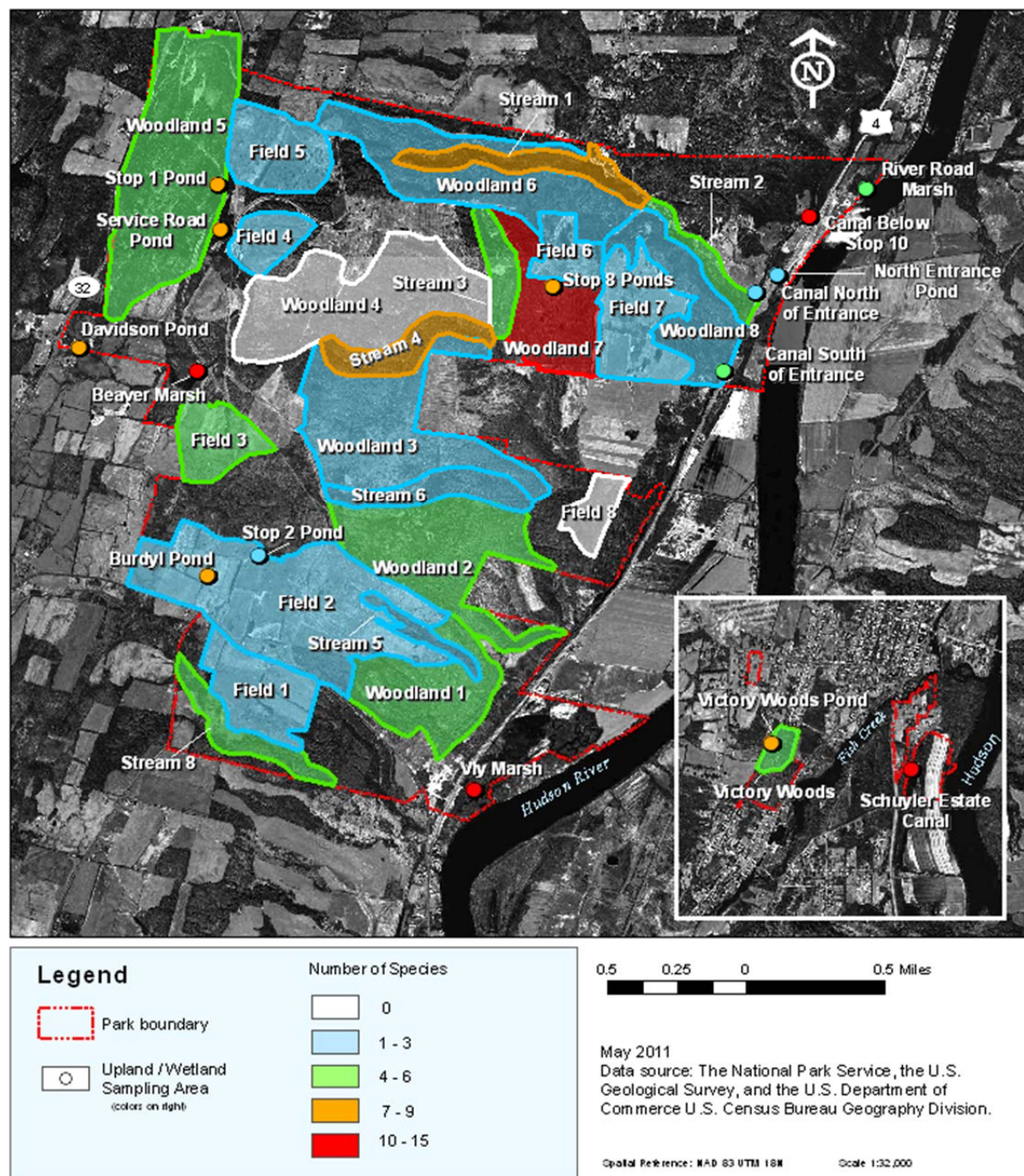


Figure 6. Species richness of areas sampled for amphibians and reptiles at Saratoga National Historical Park.

Survey Method Summaries

Of the standardized surveys, we detected the greatest number of species (14) with woodland TCS. Anuran calling surveys detected seven species, produced 61.0% of all individuals recorded, and was the most productive method for northern spring peeper, gray treefrog, northern green frog, and eastern American toad. Egg mass counts detected three species and were the most productive method for wood frog, spotted salamander, and Jefferson salamander. Stream TCS detected 12 species and was the most productive method for northern two-lined salamander and was the only method that detected pickerel frog. Field TCS detected two species, and pond TCS detected 13 species and was the most productive method for American bullfrog and northern leopard frog. Coverboard surveys detected five species and were the most productive method for common garter snake and were the only method that detected northern red-bellied snakes. Turtle trap surveys detected five species and were the most productive method for common snapping turtle and painted turtle. Minnow trap surveys detected 10 species, and were the most productive method for red-spotted newt and northern watersnake. Incidental encounters recorded 15 species and were the most productive method of capture for eastern milk snake, northern brown snake, and were the only method that detected eastern box turtle (Tables 6, 7, and 8).

Anuran Calling Surveys

Seven anuran species were heard during calling surveys at 13 sites. Northern spring peeper was the most widespread species, heard at 13 (100%) sites. Northern green frog was heard at 11 (85%) sites, eastern American toad at nine (69%) sites, gray treefrog at eight (62%) sites, American bullfrog at seven (54%) sites, and wood frog and northern leopard frog each at two (15%) sites (Table 9). Northern spring peeper was also the most abundant species (4,504 adults) based on counts or estimates of numbers calling, followed by gray treefrog (844 adults), northern green frog (370 adults), eastern American toad (268 adults), American bullfrog (50 adults), wood frog (14 adults), and northern leopard frog (three adults, Table 9). Ideally, an equal number of similarly-timed surveys at each site are desired for valid comparisons between sites. Except for one site (Stop 2 Pond), sites were surveyed five or six times each from 2 April to 12 June. Anuran calling surveys at Canal Below Stop 10 and Vly Marsh produced the most species (six each), and Burdyl Pond produced the most northern spring peepers with 1,001 adults recorded in the course of six surveys. Stop 1 Pond (five surveys) produced the most gray treefrogs (280 adults recorded), Vly Marsh produced the most northern green frogs (81 adults), and Canal Below Stop 10 produced the most eastern American toads (76 adults, Table 9).

Egg Mass Counts

We recorded spotted salamander, Jefferson salamander, and/or wood frog egg masses from five of 10 sites surveyed. Victory Woods Pond had the greatest number of spotted salamander egg masses (106 egg masses = est. 67 females), and the mean number of egg masses per pond for the five ponds where egg masses were present was 30.80 (SD $\pm$ 42.63). Jefferson salamander egg masses were only found in Victory Woods Pond (100 egg masses = est. 30 females), and wood frog egg masses were only found in Stop 8 Ponds (50 egg masses = est. 50 females, Table 10).

Table 6. Number and species richness (S) of amphibians recorded by survey method at Saratoga National Historical Park in 2001.

Species	Age Class	ACS ¹	EMC	TCS Stream	TCS Wood	TCS Field	TCS Pond	CB	TTS	MTS	IE	Total
N. Spring Peeper	A	4,504			5		1,323				145	5,977
	L									47		47
Gray Treefrog	A	844			2		469		1	4		1,320
	J					1	1					2
	L						1			3		4
N. Green Frog	A	370		293	37		187		6	15	3	911
	L						232			2,288		2,520
Wood Frog	A	14		7	25		12			3	2	63
	L						100			485		585
	E		50									50
American Bullfrog	A	50		2	20		79		3	16	4	174
	L						1			83		84
N. Leopard Frog	A	3		8	1		53			5	5	75
	L						1			4	1	6
Pickerel Frog	A			4								4
Unidentified <i>Lithobates</i> sp.	A						14				2	16
	J										1	1
	L						32			48	32	112
E.American Toad	A	268		7	3		103			15		396
	L						200			24	100	324
E. Red-backed Salamander	A			28	38		5	6				77
Spotted Salamander	A				3					42	1	46
	J				1		4					5
	L											0
	E		154								54	208 ³
Jefferson/Blue-spotted Salamander complex	A				2					10		12
	E		100									100
Unidentified <i>Ambystoma</i> sp.	L									3		3
N. Two-lined Salamander	A			229	3							232
	L			15								15
	E			29								29
Red-spotted Newt	A						15			233	13	261
	eft			3	1		1					5
	L									1		1
Unidentified sp.	E		73									73
Total # of Adult-form Amphibians		6,053	177	581	141	1	2,266	6	10	343	210	9,788
Species Richness (S)		7	3	9	12	1	10	1	3	10	8	14

1 ACS = Anuran Calling Survey, EMC = Egg Mass Count, TCS = Time-Constrained Search, CB = Coverboard, TTS = Turtle Trap Survey, MTS = Minnow Trap Survey, IE = Incidental Encounter

2 A = Adult, L = Larvae, J = Juvenile, E = Egg.

Table 7. Number and species richness (S) of adult-form reptiles recorded by survey method at Saratoga National Historical Park in 2001.

Species	TCS Stream¹	TCS Wood	TCS Field	TCS Pond	CB	TTS	MTS	IE	Total
Common Snapping Turtle	1			1		16		3	21
Painted Turtle						15		7	22
Eastern Box Turtle								1	1
Common Garter Snake	2	3	1	4	27			14	51
Eastern Milk Snake					2			6	8
Northern Water Snake	5			1			9	3	18
Northern Brown Snake		1			1			2	4
Northern Red-bellied Snake					8				8
Total # of Adults	8	4	1	6	38	31	9	36	133
S	3	2	1	3	4	2	1	7	8

¹ TCS = Time-Constrained Search, CB = Coverboard, TTS = Turtle Trap Survey, IE = Incidental Encounter

Table 8. Percentage of adult-form individuals of each amphibian and reptile species detected by each survey method at Saratoga National Historical Park. Derived from Tables 6 and 7.

Species	ACS ¹	EMC	TCS Stream	TCS Wood	TCS Field	TCS Pond	CB	TTS	MTS	IE	Total
N. Spring Peeper	75.4	0.0	0.0	0.1	0.0	22.1	0.0	0.0	0.0	2.4	5,977
Gray Treefrog	63.8	0.0	0.0	0.2	0.1	35.6	0.0	0.1	0.3	0.0	1,322
N. Green Frog	40.6	0.0	32.2	4.1	0.0	20.5	0.0	0.7	1.6	0.3	911
Wood Frog	12.4	44.2	6.2	22.1	0.0	10.6	0.0	0.0	2.7	1.8	113 ²
American Bullfrog	28.7	0.0	1.1	11.5	0.0	45.4	0.0	1.7	9.2	2.3	174
N. Leopard Frog	4.0	0.0	10.7	1.3	0.0	70.7	0.0	0.0	6.7	6.7	75
Pickerel Frog	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4
Unidentified <i>Lithobates</i> sp.	0.0	0.0	0.0	0.0	0.0	82.4	0.0	0.0	0.0	17.6	17
E. American Toad	67.7	0.0	1.8	0.8	0.0	26.0	0.0	0.0	3.8	0.0	396
E. Red-backed Salamander	0.0	0.0	36.4	49.4	0.0	6.5	7.8	0.0	0.0	0.0	77
Spotted Salamander	0.0	53.3	0.0	2.2	0.0	2.2	0.0	0.0	23.1	19.2	182 ²
Jefferson Salamander	0.0	71.4	0.0	4.8	0.0	0.0	0.0	0.0	23.8	0.0	42 ²
N. Two-lined Salamander	0.0	0.0	98.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	232
Red-spotted Newt	0.0	0.0	1.1	0.4	0.0	6.0	0.0	0.0	87.6	4.9	266
Total # of Adult-form Amphibians	6,053	177	581	141	1	2,266	6	10	343	210	9,788
% of Total Adult-form Amphibians	61.8	1.8	5.9	1.4	0.0	23.2	0.1	0.1	3.5	2.1	
C. Snapping Turtle	0.0	0.0	4.8	0.0	0.0	4.8	0.0	76.2	0.0	14.3	21
Painted Turtle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.2	0.0	31.8	22
E. Box Turtle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	1
Common Garter Snake	0.0	0.0	3.9	5.9	2.0	7.8	52.9	0.0	0.0	27.5	51
E. Milk Snake	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	75.0	8
N. Water Snake	0.0	0.0	27.8	0.0	0.0	5.6	0.0	0.0	50.0	16.7	18
N. Brown Snake	0.0	0.0	0.0	25.0	0.0	0.0	25.0	0.0	0.0	50.0	4
N. Red-bellied Snake	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	8
Total # of Adult-form Reptiles	0	0	8	4	1	6	38	31	9	36	133
% of Total Adult-form Reptiles	0.0	0.0	6.0	3.0	0.8	4.5	28.6	23.3	6.8	27.1	
S ³	7	3	12	14	2	13	5	5	10	14	21

¹ ACS = Anuran Calling Survey, EMC = Egg Mass Count, TCS = Time-Constrained Search, CB = Coverboard, TTS = Turtle Trap Survey, MTS = Minnow Trap Survey, IE = Incidental Encounter

² Number includes egg mass – adult equivalent

³ S = Herptile species richness

Table 9. Results of anuran calling surveys at 13 standardized survey sites at Saratoga National Historical Park in 2001.

Site	First Date	Last Date	# of Surveys	Northern Spring Peeper		Gray Treefrog		Northern Green Frog		Wood Frog		American Bullfrog		Northern Leopard Frog		Eastern American Toad		S ³
				CI ¹	# ²	CI	#	CI	#	CI	#	CI	#	CI	#	CI	#	
Beaver Marsh	4/3	6/12	6	3	170	2	10	1	3				1 ⁴			2	5	5
Burdyl Pond	4/2	6/12	6	3	1001	3	131	3	69			2	11 ⁴			1	1	5
Canal Below Stop 10	4/2	6/12	6	3	265	2	5	2	28			1	5	1	2	3	76	6
Canal South of Entrance	4/2	6/12	6	3	201			3	55			2	17			3	70	4
Davidson Pond	4/2	6/12	6	3	300			1	9			1	3	1	1			4
River Road Marsh	4/10	6/12	5	3	571	3	106	3	46			1	1			3	50	5
Schuyler Estate Canal	4/2	6/12	6	3	270	3	115	1	6		1 ⁴					1	5	5
Service Road Pond	4/3	6/12	6	3	250	3	116	1	6		1 ⁴							4
Stop 1 Pond	4/9	6/12	5	3	423	3	280	3	46			1	1					4
Stop 2 Pond	4/9	6/3	3	3	39					1	2							2
Stop 8 Ponds	4/9	6/12	5	2	34											2	8	2
Victory Woods Pond	4/10	6/12	5	3	480			2	21							1	1	3
Vly Marsh	4/2	6/12	6	3	500	3	81	3	81	2	10	2	11			3	52	6
Total # of Sites				13		8		11		4		8		2		9		
Total # of Adults				4,504		844		370		14		50		3		268		

¹ Highest call index recorded² Number of adult individuals detected summed across all surveys³ S = Species richness.⁴ Includes individuals that were seen, but not heard.

Table 10. Number of egg masses recorded during egg mass counts at 10 standardized survey sites at Saratoga National Historical Park in 2001.

Site	First Date	Second Date	Spotted Salamander		Jefferson /Blue-Spotted Salamander complex		Wood Frog	
			# of Egg Masses	Est. # of Females	# of Egg Masses	Est. # of Females	# of Egg Masses	Est. # of Females
Beaver Marsh	4/10	5/2	22	14				
Burdyl Pond	4/9	5/2	13	8				
Davidson Pond	4/9	5/7						
Schuyler Estate Canal	4/11	5/11						
Service Road Pond	4/9	5/2						
Stop 1 Pond	4/10	5/2						
Stop 2 Pond	4/10							
Stop 8 Ponds	4/9	5/2	11	7			50	50
Victory Woods Pond	4/10	5/2	106	67	100	30		
Vly Marsh	5/2		2	1				
		Total	154	97	100	30	50	50

Time-constrained Search

Stream TCS

We detected 12 species during TCS in seven stream sections. Stream 4 (Mill Creek Middle) had the most species detected (eight species) by this method, and Stream 6 (Mill Creek South) had the most adult individuals detected (206 adults) of any one site (Table 11 and Table 12). The northern green frog (CR = 15.43 individuals per search hour) was by far the most abundant anuran, followed by the northern leopard frog (CR = 0.42), wood frog and eastern American toad (each with a CR = 0.37), pickerel frog (CR = 0.21; the only pickerel frogs recorded during this inventory), and the American bullfrog (CR = 0.11). The northern two-lined salamander (CR = 12.05) was by far the most abundant salamander, followed by the eastern red-backed salamander (CR = 1.47) and the red-spotted newt (CR = 0.16). The snapping turtle (CR = 0.05) was the only turtle species detected by this method, and the northern water snake (CR = 0.26) was the most abundant snake, followed by the common garter snake (CR = 0.11, Table 11 and Table 12).

Woodland/Field TCS

We detected 13 species during woodland TCS in nine areas. The eastern red-backed salamander was the most widespread species, recorded in seven of nine woodland areas surveyed. This was followed by the wood frog (six areas), northern spring peeper (five areas), northern green frog and eastern American toad (each in three areas), and gray treefrog, northern leopard frog, spotted salamander, Jefferson/blue-spotted salamander, northern two-lined salamander, red-spotted newt, common garter snake, and northern brown snake (each in one area, Table 11 and Table 13). The northern green frog (CR = 1.32 individuals per search hour) was the most abundant anuran, followed by the wood frog (CR = 1.18), northern spring peeper (CR = 0.24), eastern American toad (CR = 0.14), gray treefrog (CR = 0.09), and northern leopard frog (CR = 0.05). The eastern red-backed salamander (CR = 1.56) was by far the most abundant salamander, followed by the spotted salamander (CR = 0.19), Jefferson/blue-spotted salamander (CR = 0.09), and the northern two-lined salamander and red-spotted newt (each with a CR = 0.05). There were only two snake species (common garter snake and northern brown snake) captured by this method, each with a single individual captured (CR = 0.05). Woodland #7 had the greatest species richness (nine species recorded) and also the greatest number of adults recorded (29.0% of individuals, Table 11 and Table 13).

We detected two species during field TCS in eight areas, both of which were only found at Field 6. A single gray treefrog and a single common garter snake (each with a CR = 0.63) were detected (Table 13). Overall abundance and species diversity (S) was considerably greater in woodlands (CR = 5.05, S = 13) compared to fields (CR = 0.19, S = 2, Table 13).

Pond TCS

We detected 13 species during pond TCS at eight sites. Marsh TCS recorded all 13 species, permanent pond TCS recorded eight species, and temporary pond TCS recorded three species. Gray treefrog and northern green frog were the most widespread species, each recorded at all eight sites, followed by American bullfrog and northern spring peeper (each at seven sites), eastern American toad (four sites), red-spotted newt (three sites), wood frog, northern leopard frog, common garter snake, and northern water snake (each at two sites), and eastern red-backed salamander, spotted salamander, and snapping turtle (each at one site, Table 11 and Table 14). Northern spring peeper was also the most abundant species recorded in marsh TCS (CR = 44.06

Table 11. Time constrained search effort and dates listed by habitat type at Saratoga National Historical Park in 2001.

	Site	First Date	Last Date	# of Surveys	Effort (search hours) ¹
PERMANENT STREAM	Stream 1 - Upper Kroma Kill	4/3	9/4	6	3.4
	Stream 2 - Lower Kroma Kill	4/5	9/4	6	3.0
	Stream 3 - Mill Creek North	4/2	9/4	5	1.9
	Stream 4 - Mill Creek Middle	4/2	8/3	4	3.0
	Stream 5 - American's River	4/3	8/2	4	1.3
	Stream 6 - Mill Creek South	4/3	8/2	4	4.1
	Stream 8 - Great Falls Creek	4/3	9/4	5	2.3
	Total			34	19.0
MARSH	Beaver Marsh	4/6	8/2	4	1.0
	Schuyler Estate Canal	4/6	8/11	10	4.8
	Vly Marsh	4/6	8/2	4	1.1
	Total			18	6.9
PERM. POND	Burdyl Pond	4/6	9/4	5	1.6
	Service Road Pond	4/6	8/2	4	1.2
	Stop 1 Pond	5/4	9/4	4	1.2
	Victory Woods Pond	5/2	9/4	5	1.5
	Total			18	5.5
TEMP. POND	Stop 8 Ponds	5/4	6/6	2	0.5
	Total			2	0.5
WOODLAND	Woodland 1	4/6	9/4	6	1.8
	Woodland 2	4/6	9/4	5	1.6
	Woodland 3	4/6	9/4	5	1.8
	Woodland 4	4/7	9/3	5	2.1
	Woodland 5	4/11	9/4	5	1.5
	Woodland 6	4/7	9/3	5	1.7
	Woodland 7	4/7	9/4	8	5.2
	Woodland 8	4/7	9/3	5	1.7
	Victory Woods	4/10	9/6	5	3.9
	Total			49	21.2
FIELD	Field 1	4/6	8/2	4	1.0
	Field 2	4/6	8/5	4	1.3
	Field 3	4/6	8/3	4	1.6
	Field 4	4/7	8/5	4	1.3
	Field 5	4/6	8/6	4	1.4
	Field 6	4/7	8/11	5	1.6
	Field 7	4/7	8/4	4	1.3
	Field 8	4/3	8/2	4	1.2
	Total			33	10.5

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours

Table 12. Number of amphibians and reptiles recorded during stream time-constrained search at seven standardized survey areas at Saratoga National Historical Park. The capture rate (CR) is the number of individuals divided by total search hours.

Site (Stream Segment #)	First Date	Last Date	# of Surveys	Search Hours ¹	# Individuals (CR)													Total Adults	S ²	
					Green Frog	Wood Frog	American Bullfrog	Northern Leopard Frog	Eastern American Toad	Pickereel Frog	Eastern Red-backed Salamander	Northern Two-lined Salamander			Red-spotted Newt	Common Snapping Turtle	Common Garter Snake			Northern Water Snake
					adl	adl	adl	adl	adl	adl	adl	adl	lrv	egg	eft	adl	adl			adl
1	4/3	9/4	6	3.4	38 (11.18)		2 (0.59)		1 (0.29)	3 (0.88)		9 (2.65)			1 (0.29)		5 (1.47)	59 (17.35)	7	
2	4/5	9/4	6	3.0	32 (10.67)	1 (0.33)			5 (1.67)							1 (0.33)		39 (13.00)	4	
3	4/2	9/4	5	1.9	13 (6.84)	2 (1.05)						9 (4.74)				1 (0.53)		25 (13.16)	4	
4	4/2	8/3	4	3.0	45 (15.00)	2 (0.67)		7 (2.33)	1 (0.33)	1 (0.33)	3 (1.00)	50 (16.67)	5 (1.67)	3 (1.00)				112 (37.33)	8	
5	4/3	8/2	4	1.3		1 (0.77)												1 (0.77)	1	
6	4/3	8/2	4	4.1	149 (36.34)	1 (0.24)						56 (13.66)	4 (0.98)					206 (50.24)	3	
8	4/3	9/4	5	2.3	16 (6.96)			1 (0.43)			25 (10.87)	105 (45.65)	6 (2.61)	29 (12.61)				147 (63.91)	4	
Total					293	7	2	8	7	4	28	229	15	29	3	1	2	5	589	12
CR (inds/search hour)					(15.43)	(0.37)	(0.11)	(0.42)	(0.37)	(0.21)	(1.47)	(12.05)	(0.79)	(1.53)	(0.16)	(0.05)	(0.11)	(0.26)	(31.00)	

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours.

² S = Species Richness.

Table 13. Number of amphibians and reptiles recorded during woodland and field time-constrained search at 17 standardized survey areas at Saratoga National Historical Park. The capture rate (CR) is the number of individuals divided by search hours.

Site	First Date	Last Date	# of Surveys	Search Hours ¹	# Individuals (CR)													Total	S ²
					N. Spring Peeper	Gray Treefrog	N. Green Frog	Wood Frog	N. LeopardFrog	E. American Toad	E. Red-backed Salamander	Spotted Salamander	Jefferson/blue-spotted Salamander	N. Two-lined Salamander	Red-spotted Newt	Common Garter Snake	Northern Brown Snake		
Woodland 1	4/6	9/4	6	1.8	1 (0.55)			12 (6.56)		1 (0.55)	4 (2.19)					1 (0.55)		19 (10.38)	5
Woodland 2	4/6	9/4	5	1.6			3 (1.90)	1 (0.63)		1 (0.63)	12 (7.59)			1 (0.63)				18 (11.39)	5
Woodland 3	4/6	9/4	5	1.8	1 (0.57)			1 (0.57)			2 (1.14)							4 (2.29)	3
Woodland 4	4/7	9/3	5	2.1														0 (0.00)	0
Woodland 5	4/11	9/4	5	1.5	1 (0.67)		3 (2.00)	1 (0.67)										5 (3.33)	3
Woodland 6	4/7	9/3	5	1.7							8 (4.79)							8 (4.79)	1
Woodland 7	4/7	9/4	8	5.2	1 (0.19)	2 (0.39)	22 (4.26)	1 (0.19)	1 (0.19)	1 (0.19)	1 (0.19)				1 (0.19)		1 (0.19)	31 (6.00)	9
Woodland 8	4/7	9/3	5	1.7	1 (0.60)						4 (2.40)							5 (2.99)	2
Victory Woods	4/10	9/6	5	3.9				9 (2.30)			2 (0.51)	4 (1.02)	2 (0.51)					17 (4.34)	4
Total			49	21.2	5 (0.24)	2 (0.09)	28 (1.32)	25 (1.18)	1 (0.05)	3 (0.14)	33 (1.56)	4 (0.19)	2 (0.09)	1 (0.05)	1 (0.05)	1 (0.05)	1 (0.05)	107 (5.05)	13

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours.

² S = Species richness.

Table 13. Number of amphibians and reptiles recorded during woodland and field time-constrained search at 17 standardized survey areas at Saratoga National Historical Park. The capture rate (CR) is the number of individuals divided by search hours (continued).

Site	First Date	Last Date	# of Surveys	Search Hours ¹	# Individuals (CR)														Total	S ²
					Northern Spring Peeper	Gray Treefrog	Northern Green Frog	Wood Frog	American Bullfrog	Northern Leopard Frog	Eastern American Toad	Eastern Red-backed Salamander	Spotted Salamander	Jefferson/blue-spotted Salamander	Northern Two-lined Salamander	Red-spotted Newt	Common Garter Snake	Northern Brown Snake		
Field 1	4/6	8/2	4	1.0																0
Field 2	4/6	8/5	4	1.3																0
Field 3	4/6	8/3	4	1.6																0
Field 4	4/7	8/5	4	1.3																0
Field 5	4/6	8/6	4	1.4																0
Field 6	4/7	8/11	5	1.6		1 (0.63)											1 (0.63)	2 (1.27)		2
Field 7	4/7	8/4	4	1.3																0
Field 8	4/3	8/2	4	1.2																0
Total			33	10.5	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	2
CR (inds/search hour)						(0.10)											(0.10)		(0.19)	

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours

² S = Species richness

Table 14. Number of adult-form amphibians and reptiles recorded during pond time-constrained search at eight standardized survey sites at Saratoga National Historical Park and herpetofaunal species richness (S). The capture rate (CR) is the number of individuals divided by search hours.

						# Individuals (CR)												
						Adults												
	Site	First Date	Last Date	# of Surveys	Search Hours ¹	Gray Treefrog	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Unidentified <i>Lithobates</i> sp.	E. American Toad	E. Red-backed Salamander	Spotted Salamander	Red-spotted Newt	Snapping Turtle	Common Garter Snake	N. Water Snake
MARSH	Beaver Marsh	4/6	8/2	4	1.0	4 (4.00)	5 (5.00)		2 (2.00)			1 (1.00)						
	Schuyler Estate Canal	4/6	8/11	10	4.8	2 (0.42)	13 (2.71)	10 (2.08)		53 (11.04)		1 (0.21)	5 (1.04)	4 (0.83)	1 (0.21)	1 (0.21)	3 (0.63)	1 (0.21)
	Vly Marsh	4/6	8/2	4	1.1		1 (0.91)											
	Total			18	6.9	6	19	10	2	53	0	2	5	4	1	1	3	1
	CR (inds/search hour)					(0.87)	(2.75)	(1.45)	(0.29)	(7.68)		(0.29)	(0.72)	(0.58)	(0.14)	(0.14)	(0.43)	(0.14)
PERMANENT	Burdyl Pond	4/6	9/4	5	1.6	1 (0.63)	22 (13.75)		25 (15.63)		13 (8.13)				14 (8.75)			
	Service Road Pond	4/6	8/2	4	1.2	2 (1.67)	15 (12.50)		10 (8.33)						1 (0.83)			
	Stop 1 Pond	5/4	9/4	4	1.2	3 (2.50)	18 (15.00)		26 (21.67)									
	Victory Woods Pond	5/2	9/4	5	1.5		16 (10.67)	2 (1.33)	10 (6.67)		1 (0.67)						1 (0.67)	
	Total			18	5.5	6	71	2	71	0	14	0	0	0	15	0	1	0
	CR (inds/search hour)					(1.09)	(12.91)	(0.36)	(12.91)		(2.55)				(2.73)		(0.18)	
TEMP.	Stop 8 Ponds	5/4	6/6	2	0.5		1 (2.00)											
	CR (inds/search hour)			2	0.5	0	1 (2.00)	0	0	0	0	0	0	0	0	0	0	0

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours

Table 14. Number of adult-form amphibians and reptiles recorded during pond time-constrained search at eight standardized survey sites at Saratoga National Historical Park and herpetofaunal species richness (S). The capture rate (CR) is the number of individuals divided by search hours (continued).

		# Individuals (CR)																
		Vocalization								Larvae							Total # of Adults	S
Site	First Date	Last Date	# of Surveys	Search Hours ¹	N. Spring Peeper	Gray Treefrog	N. Green Frog	American Bullfrog	E. American Toad	Gray Treefrog	Northern Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Unidentified <i>Lithobates</i> sp.	E. American Toad		
MARSH	Beaver Marsh	4/6	8/2	4	1.0	13 (13.00)	61 (61.00)	1 (1.00)			4 (4.00)			1 (1.00)		100 (100.00)	87 (87.00)	5
	Schuyler Estate Canal	4/6	8/11	10	4.8	145 (30.21)	69 (14.38)	3 (0.63)	2 (0.42)	1 (0.21)					1 (0.21)		313 (65.21)	13
	Vly Marsh	4/6	8/2	4	1.1	146 (132.73)	64 (58.18)	47 (42.73)	3 (2.73)	100 (90.91)							361 (328.18)	5
	Total			18	6.9	304	194	51	5	100	1	4	0	1	1	100	761	13
	CR (inds/search hour)					(44.06)	(28.12)	(7.39)	(0.72)	(14.49)	(0.14)	(0.58)	0	(0.14)	(0.14)	(14.49)	(110.29)	
PERMANENT	Burdyl Pond	4/6	9/4	5	1.6	290 (181.25)	62 (38.75)	7 (4.38)	1 (0.63)	1 (0.63)	106 (66.25)				15 (9.38)	100 (62.50)	436 (272.50)	7
	Service Road Pond	4/6	8/2	4	1.2	290 (241.67)	76 (63.33)	4 (3.33)			68 (56.67)		1 (0.83)		16 (13.33)		398 (331.67)	5
	Stop 1 Pond	5/4	9/4	4	1.2	146 (121.67)	123 (102.50)	25 (20.83)			54 (45.00)						341 (284.17)	4
	Victory Woods Pond	5/2	9/4	5	1.5	146 (97.33)	2 (1.33)	9 (6.00)				100 (66.67)					187 (124.67)	6
	Total			18	5.5	872	263	45	1	1	0	228	100	1	31	100	1,362	8
	CR (inds/search hour)					(158.55)	(47.82)	(8.18)	(0.18)	(0.18)	0	(41.45)	(18.18)	(0.18)	0	(5.64)	(18.18)	(247.64)
TEMP.	Stop 8 Ponds	5/4	6/6	2	0.5	147 (294.00)	1 (2.00)										149 (298.00)	3
				2	0.5	147	1	0	0	0	0	0	0	0	0	0	149	3
	CR (inds/search hour)					(294.00)	(2.00)	0	0	0	0	0	0	0	0	0	(298.00)	

¹ Note that "Search Hours" displayed in this table are rounded to one decimal place and the capture rates are calculated using the raw, non-rounded search hours.

individuals/search hour), permanent pond TCS (CR = 105.82) and temporary pond TCS (CR = 294.00, Table 11 and Table 14). Abundance (CR) of northern spring peepers was calculated from the estimated number of adult males heard (Table 14). Estimates of the number of northern spring peepers, gray treefrogs, and eastern American toads present during incidents of full chorus during pond TCS surveys are based on the average number of individuals of each species (145, 61, and 100, respectively) estimated by multiple observers during full chorus episodes of anuran calling surveys.

Coverboards

The overall capture rate of snakes was higher in fields than in woodlands, 4.81 captures/100 board checks and 1.23 respectively, whereas red-backed salamanders were only captured at woodland sites (Table 15). In eight woodland sites, a total of 648 board checks produced six eastern red-backed salamanders, seven common garter snakes, and one northern red-bellied snake. Woodland 7 was the only woodland site where multiple species were recorded (three species) and was also the site with the greatest number of individuals (nine individuals, Table 15, Appendix E). In seven field sites, a total of 624 board checks produced 20 common garter snakes, seven northern red-bellied snakes, two eastern milk snakes, and one northern brown snake. Field 3 (four species) and Field 5 (two species) were the only field sites where multiple species were recorded, and Field 3 had the greatest number of individuals (eight individuals, Table 15, Appendix E).

Although sampling was fairly evenly divided between early (April-June) and late (August-September) survey periods, 74% of snake captures occurred in the early period (Table 16). These seasonal differences in captures (28 vs. 10) were significant ($\chi^2 = 6.624$, $p = 0.01$). Similarly, sampling effort with metal versus plywood coverboards was almost equal (638 vs. 641 board checks, respectively) and although a few more snake captures were under metal coverboards, these differences were not significant ($\chi^2 = 2.231$, $p = 0.14$, Table 17, Appendix E).

Turtle Trap Surveys

Most turtles were recorded through trapping. Sixteen individual painted turtles (none of which were recaptured) and 14 individual common snapping turtles (two of which were each recaptured once) were captured using turtle traps (Table 18, Appendix F). Painted turtles were captured in marsh, permanent pond, and temporary pond habitat at seven of 12 sites (58%) and common snapping turtles were captured in marsh and permanent pond habitats at five of 12 sites (42%). Capture rate was greatest in permanent ponds for painted turtle and in marsh for snapping turtle. Based on number of individuals and captures, painted turtles were most abundant in Burdyl Pond (six unique individuals and captures) and common snapping turtles were most abundant in Schuyler Estate Canal (six unique individuals and eight captures, Table 18, Appendix F). Based on a trapping session in April 2011, in which a total of six individuals were captured, the modified Lincoln-Petersen estimate of snapping turtles present at Schuyler Estate Canal was 7 ± 3 . Capture rates were highest for painted turtles at Canal North of Entrance and at North Entrance Pond for snapping turtles, but sampling effort at these two sites was much less than all other sites (Table 18), and it is uncertain if more intensive sampling of these sites would have produced such high capture rates.

Table 15. Number of reptiles and amphibians recorded during woodland and field coverboard surveys at 15 standardized survey sites at Saratoga National Historical Park. Capture rate (CR) is the number of captures per 100 board checks. Board checks are number of boards/site, multiplied by number of site visits.

Site	Common Garter Snake	E. Milk Snake	N. Red-bellied Snake	Northern Brown Snake	E. Red-backed Salamander	# of Snakes	# of Amphib.	S ¹	Snake CR	# Boards/ Site	# of Site Visits	# of Board Checks	# of Boards with Snakes
Woodland 1									0.0	8	10	80	
Woodland 2									0.0	8	10	80	
Woodland 3					1 (1.25)		1	1	0.0	8	10	80	1
Woodland 4									0.0	8	10	80	
Woodland 5									0.0	8	10	80	
Woodland 6					4 (5.00)		4	1	0.0	8	10	80	1
Woodland 7	7 (8.75)		1 (1.25)		1 (1.25)	8	1	3	10.0	8	10	80	4
Woodland 8									0.0	8	11	88	
Woodland Total (CR)	7 (1.08)	0	1 (0.15)	0	6 (0.93)	8	6	3	1.23	64	81	648	6
Field 1	2 (2.27)					2		1	2.27	8	11	88	2
Field 2	1 (1.14)					1		1	1.14	8	11	88	1
Field 3	2 (2.27)	2 (2.27)	3 (3.41)	1 (1.14)		8		4	9.09	8	11	88	5
Field 4	4 (4.17)					4		1	4.17	8	12	96	3
Field 5	4 (4.55)		3 (3.41)			7		2	7.95	8	11	88	3
Field 6	7 (7.95)					7		1	7.95	8	11	88	3
Field 7			1 (1.14)			1		1	1.14	8	11	88	1
Field Total (CR)	20 (3.21)	2 (0.32)	7 (1.22)	1 (0.16)	0	30	0	4	4.81	56	78	624	18

¹ S = species richness

Table 16. Seasonal variation in snake captures during coverboard surveys at Saratoga National Historical Park, April to June versus August to September 2001. Board checks are the number of boards per site, multiplied by the number of site visits.

Dates	Number (%) of Board Checks	Number of Board Checks Producing Snakes	Percent of Board Checks Producing Snakes	Number (%) of Snakes
April – June	672 (53%)	21	3.1%	28 (74%)
August – September	600 (47%)	10	1.7%	10 (26%)
Total	1,272	31	2.4%	38

Table 17. Number of snakes captured under metal versus plywood during coverboard surveys at Saratoga National Historical Park in 2001.

Species	Number of New Snakes	Number of Recap Snakes	Coverboard Type			
			Metal ¹		Plywood ¹	
			# of Snakes	% of Snakes	# of Snakes	% of Snakes
Common Garter Snake	24	3	16	59%	11	41%
Eastern Milk Snake	1	1	2	100%	0	0%
Northern Red-bellied Snake	8	0	5	63%	3	37%
Northern Brown Snake	1	0	0	0%	1	100%
Total Snakes	34	4	23	61%	15	39%

Table 18. Number of unique individuals (Inds) and turtle captures (Caps) during turtle trapping at 12 standardized survey sites at Saratoga National Historical Park in 2001. Capture rate (CR) is the number of captures per 100 trap nights and S is species richness.

	Site	First Date	Last Date	# Traps	# of Trap Nights	Painted Turtle			Snapping Turtle			S
						Inds	Caps	CR	Inds	Caps	CR	
MARSH	Beaver Marsh	5/2	6/7	3	25				2	2	8.0	1
	Schuyler Estate Canal	4/2	6/8	2 to 6	64	2	2	3.1	6	8	9.4	2
	Vly Marsh	5/2	6/7	4	40	2	2	5.0				1
	Total				129	4	4	3.1	8	10	7.8	2
PERM. POND	Burdyl Pond	5/2	6/7	4	40	6	6	15.0				1
	Canal Below Stop 10	5/2	6/7	5	40	1	1	2.5	3	3	7.5	2
	Canal North of Entrance	9/3	9/7	1	4	3	3	75.0				1
	North Entrance Pond	6/4	6/7	1	4	1	1	25.0	2	2	50.0	2
	Service Road Pond	5/2	6/7	4	40				1	1	2.5	1
	Stop 1 Pond	5/2	6/7	4	40							
	Victory Woods Pond	5/2	6/7	4	40							
	Total				208	11	11	5.3	6	6	2.9	2
TEMP. POND	Davidson Pond	5/2	6/7	4	40	1	1	2.5				1
	Stop 8 Ponds	5/2	6/7	4	40							
	Total				80	1	1	1.3	0	0	0	1
	All Sites Combined	4/2	9/7	1 to 6	417	16	16	3.84	14	16	3.84	2

Minnow Trap Surveys

Eleven species were recorded using minnow traps at 10 sites. Beaver Marsh had the greatest species richness (nine species) and Burdyl Pond the most adults captured (176; CR = 255.07 captures/100 trap nights). The most abundant species was red-spotted newt (233 individuals captured, CR = 40.38) and the most widespread species was American bullfrog (captured at nine of 10 sites, Table 19).

Incidental Encounters

Sixteen species from 19 sites were recorded incidental to survey efforts conducted at standardized survey sites in 2001. Field 6 had the greatest number of individuals captured (145 individuals, all northern spring peepers), and Woodland Stop 6 and 7 had the next greatest number of individuals captured (38) and had the greatest species diversity (five species captured). Northern spring peeper was the most abundant species (145 individuals), and common garter snake was the most widespread species, being captured at six sites (Table 20).

Table 19. Number of amphibians and reptiles captured in minnow traps at 10 standardized survey sites at Saratoga National Historical Park in 2001. Capture rate (CR) is the number of captures per 100 trap nights and S is species richness.

	Site	First Date	Last Date	# of Traps	Trap Nights	Adult forms- # Captures (CR)										Total # of Adults
						Gray Treefrog	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	E. American Toad	Spotted Salamander	Jefferson/Blue-spotted Salamander	Red-spotted Newt	N. Water Snake	
MARSH	Beaver Marsh	4/2	8/6	3	55	2 (3.64)	3 (5.45)		3 (5.45)	2 (3.64)				34 (61.82)	9 (16.36)	53 (96.36)
	Schuyler Estate Canal	4/2	8/3	3	55		1 (1.82)					17 (30.91)	10 (18.18)	1 (1.82)		29 (52.73)
	Vly Marsh	4/2	6/7	3	45				1 (2.22)	1 (2.22)						2 (4.44)
	Total				155	2 (1.29)	4 (2.58)	0	4 (2.58)	3 (1.94)	0	17 (10.97)	10 (6.45)	35 (22.58)	9 (5.81)	84 (54.19)
PERM. POND	Burdyl Pond	4/2	9/6	3	69	2 (2.90)	1 (1.45)		3 (4.35)					170 (246.38)		176 (255.07)
	Canal Below Stop 10	4/2	9/6	3	69		1 (1.45)			1 (1.45)	15 (21.74)			1 (1.45)		18 (26.09)
	Service Road Pond	4/2	8/6	3	62		7 (11.29)		2 (3.23)			5 (8.06)		10 (16.13)		24 (38.71)
	Stop 1 Pond	4/10	9/6	3	57		1 (1.75)	1 (1.75)	3 (5.26)			13 (22.81)		15 (26.32)		33 (57.89)
	Victory Woods Pond	5/2	9/6	3	51			1 (1.96)	1 (1.96)							2 (3.92)
	Total				308	2 (0.65)	10 (3.25)	2 (0.65)	9 (2.92)	1 (0.32)	15 (4.87)	18 (5.84)		196 (63.64)		253 (82.14)
TEMP. POND	Davidson Pond	4/2	9/6	3	69	1 (1.45)			2 (2.90)	1 (1.45)						4 (5.80)
	Stop 8 Ponds	4/2	6/7	3	46			1 (2.17)	1 (2.17)			7 (15.22)		2 (4.35)		11 (23.91)
	Total				115	1 (0.87)		1 (0.87)	3 (2.61)	1 (0.87)		7 (6.09)		2 (1.74)		15 (13.04)
All Sites Combined		4/2	9/6		577	5 (0.87)	14 (2.43)	3 (0.52)	16 (2.77)	5 (0.87)	15 (2.60)	42 (7.28)	10 (1.73)	233 (40.38)	9 (1.56)	352 (61.01)

Table 19. Number of amphibians and reptiles captured in minnow traps at 10 standardized survey sites at Saratoga National Historical Park in 2001. Capture rate (CR) is the number of captures per 100 trap nights and S is species richness (continued).

					Larvae - # Captures (CR)												
	Site	First Date	Last Date	# of Traps	Trap Nights	N. Spring Peeper	Gray Treefrog	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Unidentified Lithobates sp.	E. American Toad	Spotted Salamander	Unidentified Ambystoma sp.	Red-spotted Newt	S
MARSH	Beaver Marsh	4/2	8/6	3	55	1 (1.82)	1 (1.82)		13 (23.64)		4 (7.27)		24 (43.64)				9
	Schuyler Estate Canal	4/2	8/3	3	55		2 (3.64)	7 (12.73)	42 (76.36)			47 (85.45)					6
	Vly Marsh	4/2	6/7	3	45			19 (42.22)	6 (13.33)	1 (2.22)							4
				Total	155	1 (0.65)	3 (1.94)	26 (16.77)	61 (39.35)	1 (0.65)	4 (2.58)	47 (30.32)	24 (15.48)	0	0	0	11
PERM. POND	Burdyl Pond	4/2	9/6	3	69			1,006 (1,457.97)		21 (30.43)						1 (1.45)	4
	Canal Below Stop 10	4/2	9/6	3	69			1 (1.45)									4
	Service Road Pond	4/2	8/6	3	60	8 (13.33)		992 (1,653.33)	3 (5.00)								6
	Stop 1 Pond	4/10	9/6	3	58	26 (44.83)		247 (425.86)								1 (1.72)	6
	Victory Woods Pond	5/2	9/6	3	51	12 (23.53)		15 (29.41)	164 (321.57)					1 (1.96)	2 (3.92)		5
				Total	307	46 (14.98)		2,261 (736.48)	167 (54.40)	21 (6.84)				1 (0.33)	3 (0.98)	1 (0.33)	9
TEMP. POND	Davidson Pond	4/2	9/6	3	69				1 (1.45)	61 (88.41)		1 (1.45)					4
	Stop 8 Ponds	4/2	6/7	3	46				257 (558.70)								4
				Total	115				258 (224.35)	61 (53.04)		1 (0.87)					6

Table 20. Number of adult-form amphibians and reptiles recorded as incidental encounters at 19 localities at Saratoga National Historical Park. S is species richness.

Site	Habitat Type	N. Spring Peeper	N. Green Frog	Wood Frog	American Bullfrog	N. Leopard Frog	Unidentified <i>Lithobates</i> sp.	E. Red-backed Salamander	Spotted Salamander	N. Two-lined Salamander	Red-spotted Newt	Snapping Turtle	Painted Turtle	E. Box Turtle	E. Milk Snake	N. Water Snake	Common Garter Snake	Northern Brown Snake	S
Standardized Survey Sites																			
Stream 5	Permanent Stream		3																1
Canal Below Stop 10	Permanent Canal																1		1
Burdyl Pond	Permanent Pond				4		3				11		2						4
Service Road Pond	Permanent Pond												2						1
Stop 1 Pond	Permanent Pond								1				1						2
Davidson Pond	Temporary Pond											1				3			2
Stop 8 Ponds	Temporary Pond			2					13										2
Beaver Marsh	Marsh									2									1
Schuyler Estate Canal	Marsh					5							1				2		3
Vly Marsh	Marsh											1	1						2
Woodland 5	Mixed Forest														4		4	2	3
Field 6	Field	145																	1
Incidental Encounter Sites																			
Woodland Stop 6 and 7	Permanent Stream		9		20			5		2							2		5
Entrance Rd. 1.5 mi E. of Vis. Ctr.	Mixed Forest														1		4		2
U.S. Hwy 4 W. Side of Champlain Canal	Permanent Canal																3		1
Int. of Rt. 32 and Entrance Rd.	Permanent Pond											1							1
Vernal Ponds Adj. to Stream 4	Temporary Pond								21										1
Entrance Rd. 1.0 mi E. of Vis. Ctr.	Mixed Forest													1					1
N. of Stop 2 on Park Tour Rd.	Field														1				1
Total # of Adults		145	12	2	24	5	3	5	35	4	11	3	7	1	6	3	16	2	
Total # of Sites		1	2	1	2	1	1	1	3	2	1	3	5	1	3	1	6	1	

Discussion

Community Analysis, Factors Affecting Species Presence and Absence, and Important Habitats

Of the 63 species of native, non-marine/estuarine amphibians and reptiles that occur in New York State, the number of species are fairly evenly divided among four of the five orders present: 18 salamander, 14 anuran, 11 turtle, 17 snake (Gibbs et al. 2007). There are also three species of lizards, but New York lies at the northern edge of lizard distribution and lizards are not a significant component of the state's herpetofauna. This relatively even community composition among the four dominant orders existed among the 39 species we considered historically present in the Hudson River Valley of Saratoga County (11 salamanders, 10 anurans, seven turtles, and 11 snakes), as well as among the 32 species we consider likely to have historically occurred at and adjacent to SARA, seven salamander 10 anuran, seven turtle, and eight snake. Of this 32 species "historic baseline", 21 species were recorded at SARA during surveys in 2001, and two additional species (stinkpot and wood turtle) have been recorded since. Thus, the 23 species (13 amphibians and 10 reptiles) currently known to occur at SARA represent 59% of the 39 species historically present in the Hudson River Valley of Saratoga County and 72% of the 32 species likely to have been historically present at SARA (Appendix A). Considering the relatively small size of SARA (1,378 ha) and the number of species that occur in this part of the state (39), the 23 current species indicates that SARA supports a fairly diverse herpetofauna for its size. Twenty two of these species occur in the Battlefield Unit, 16 in the Schuyler Estate Unit, and 10 in the Victory Woods Unit. Considering how small the Schuyler Estate Unit is compared to the Battlefield Unit, a remarkable diversity of species occurs there, although given its size and the home ranges of the species present, it is certain that for most populations there, NPS lands are just a part of the larger landscape needed to support them.

The herpetofauna of New York State is modest in species richness, ranking 29th among the 50 United States (Moriarty 2004). This partially reflects New York's northerly latitude and the negative relationship between herpetofaunal species richness and latitude in North America (Porter 1972). However, New York's size and associated habitat diversity and topographic variation, as well as its location, has resulted in a herpetofauna somewhat more diverse, consisting of species from the Atlantic coastal plain, Appalachian mountains, and the Mid-west/Great Lakes regions. In addition to total species richness being lower in northern locales, northern herpetofaunal communities tend to be dominated by amphibians, particularly in numbers of individuals. However, in New York State, the number of species of these two orders are relatively equal (Gibbs et al. 2007) and, as noted above, the same is true of the "historic baseline" and the species currently present. Thus, at the species richness level, there does not appear to have been any shifts over time in the relative number of species of amphibians and reptiles. Moreover, although amphibians numerically dominate reptiles at SARA, comprising 98.7% of all individuals recorded in this survey, this is probably not a change from historic conditions. The dominance of northern herpetofaunas such as SARA's by amphibians is because amphibians generally have lower activity temperature requirements than reptiles (Zug 1993).

Of the 32 species in the "historic baseline" for SARA, nine have not been recorded here recently. Three of these, eastern spadefoot (*Scaphiopus holbrookii*), Fowler's toad (*Anaxyrus fowleri*), and eastern hog-nosed snake (*Heterodon platirhinos*) occur in New York state primarily on the coastal plain, but extend up the Hudson River Valley, reaching their northern limit in New York

State in the vicinity of SARA (Klemens 1993, Gibbs et al. 2007). Their presence in the SARA region is tied to the Albany Pine Bush and the “greater sandplains of Albany, Schenectady, Saratoga, and Warren County”, a geological feature that has allowed these typically southern, sandy coastal plain species to extend their range this far north up the Hudson River Valley (Stewart and Rossi 1981). A fourth, the spotted turtle (*Clemmys guttata*) is another such species, although it also occurs on the Great Lake Plains south of Lake Ontario (Gibbs et al. 2007). Although these four species have recently been recorded in the region (Breisch and Ozard, in prep) and the spotted turtle was recorded at SARA circa 1995, the spadefoot toad, hog-nosed snake, and spotted turtle can be difficult to detect and have also declined to the point of being listed as Special Concern species. Thus, these four species are now rare at best at SARA, if even present.

The northern map turtle (*Graptemys geographica*) is found in large lakes and rivers (Gibbs et al. 2007) and at SARA, its occurrence would most likely be tied to the Hudson River and Fish Creek in Schuylerville. The Hudson River abuts the boundary of SARA and was not sampled in this survey, and the tributaries that flow through the Battlefield Unit are not appropriate habitat for this species. The lack of records of map turtle at SARA is likely a combination of lack of proper habitat inside the park and lack of sampling in the abutting Hudson River, where it does occur (Gibbs et al. 2007).

The remaining four species believed to “historically” occur at SARA that were not recorded during this inventory – northern spring salamander (*Gyrinophilus porphyriticus*), dusky salamander (*Desmognathus fuscus*), smooth green snake (*Liochlorophis vernalis*), and eastern ribbon snake (*Thamnophis sauritus*) – have likely been affected by landscape changes over the past few hundred years. The original forests were largely cleared during the colonial era and early 19th Century and 90% of the original forests had been cleared for agriculture by 1870 (Vana-Miller et al. 2001). These activities profoundly affect the occurrence and abundance of many amphibian and reptiles. Deforestation and conversion to agriculture leads to declines in the occurrence and abundance of stream salamanders due to increased sedimentation, higher streamflow, loss of cover and hiding spaces, and increased water temperatures (Orser and Shure 1972, Lowe and Bolger 2002, Bury 2008, Moseley et al. 2008). The spring salamander is typically found in cold headwater springs and streams in undisturbed high elevation forest (Bishop 1941, Bonin 1991). Although we cannot know if spring salamanders occurred in the streams of present-day SARA prior to deforestation, its occurrence here in the 20th century is questionable, given its habitat requirements and the impacts of deforestation. In the case of the dusky salamander, its occurrence in streams from sea level to high elevations (Klemens 1993) suggests it likely occurred on the original SARA landscape and it may have been extirpated by deforestation. Although the forests of the SARA landscape have recovered to the point where it is 57% forested (Vana-Miller et al. 2001), connectivity to other un-impacted first order streams as sources for re-colonization following forest recovery is an important factor in the presence of stream salamanders (Lowe and Bolger 2002, Grant et al. 2009). It is unlikely that the streams at SARA, which drain into the Hudson River, could be easily re-colonized. The remaining two species, smooth green snake and eastern ribbon snake, both appear to have benefited from the increase in open, early successional stage habitat that accompanied conversion of the original landscape from largely forested to largely agricultural. However, both of these species are now declining throughout the Northeast, with reforestation considered a major factor (Klemens 1993,

Gibbs et al. 2007). In addition, smooth green snake populations have been negatively impacted by pesticide use, through direct mortality and food chain effects (Klemens 1993, Ernst and Ernst 2003), and the use of pesticides on the agricultural landscape that surrounds SARA may also be a factor in its apparent decline.

In addition to the nine species discussed above, there are six additional species present in the Hudson River Valley of Saratoga County that have never been documented at or near SARA. These are the common mudpuppy (*Necturus maculosus*), Allegheny mountain dusky salamander (*Desmognathus ochrophaeus*), four-toed salamander (*Hemidactylium scutatum*), northern black racer (*Coluber constrictor*), northern ringneck snake (*Diadophis punctatus edwardsii*), and eastern rat snake (*Elaphe alleghaniensis*). The common mudpuppy occurs in the Hudson river and associated canals (Gibbs et al. 2007) and the lack of any records at SARA may be due to inadequate sampling of these water ways. The mountain dusky salamander is very similar to the spring salamander discussed above. It typically occurs at higher elevations and even if it was present in the streams of what we now know as SARA prior to deforestation, it is not likely it survived that period. For four-toed salamanders, the lack of any records, in spite of this survey and all the nighttime road surveys on rainy nights from 2001 thru 2010 suggests this species is absent. However, considering how difficult four-toed salamanders can be to find during general time-constrained search, more targeted searches in sphagnaceous wetlands in mid-spring and road searches on rainy early spring nights are needed to be more certain of its status here. The ringneck snake, although considered secretive, is relatively easy to find through active search. The fact that none have ever been recorded at SARA, in spite of all the field work here, suggests it is not present here. The apparent absence of this species at SARA is hard to explain, given that SARA appears to have plenty of woodland habitat and prey items for this widespread species, which is nowhere near its range limit. Lastly, both the black racer and eastern ratsnake are large, conspicuous snakes that have relatively high detectabilities but have never been recorded in the park. It does not seem likely that they are present. The black racer is yet another coastal plain species that ranges up the Hudson River Valley to the SARA region (Stewart and Rossi 1981). Northern black racers have declined in the Northeast due to urbanization, habitat fragmentation, and loss of open, early successional habitat to reforestation (Kjoss and Litvaitis 2001, Gibbs et al. 2007). Although the landscape at SARA is far more forested than it was in the 19th Century (Vana-Miller et al. 2001), it is still roughly 1/3 open habitat and surrounded by farmland. The effects of habitat loss and fragmentation here would not seem to be severe, but SARA is also at the northern limit of the black racer's range, and this may also be a factor in its absence here. For eastern ratsnake, its absence may reflect local extirpation due to historic deforestation and a lack of sufficient older forest and overwintering (hibernacula) habitat, as well as limitations associated with it being at the northern edge of its range.

Thus, a combination of regional factors that determine the species pool present, as well as the presence or absence of certain habitat types, plus the historic and current condition of the landscape and human activities upon it have all combined to determine which species are present at SARA. However, our knowledge of species presence and absence is far from perfect, and lack of historic data as well as issues of detectability and adequacy of sampling, complicate our ability to determine if the lack of records for certain species at SARA is due to historic absence, recent decline, inadequate sampling, or a combination of these factors. An example of this uncertainty is the 2011 record of a Jefferson/blue-spotted complex salamander in the Battlefield

Unit. Although nighttime road surveys on rainy nights had been conducted since 2001, this was the first time this species was recorded there (pers. comm, Larry Woolbright, Sienna College, April 13, 2011).

As noted above, amphibians numerically dominate the herpetofauna of SARA, highlighting the importance of wetland habitats. With exception of the eastern red-backed salamander, all of the amphibians at SARA depend on some type of wetland or stream habitat for reproduction. In addition, the snapping turtle, stinkpot, painted turtle, and northern water snake are highly aquatic, and the wood turtle and spotted turtle are semi-aquatic. In their case, wetlands provide the habitats they feed, mate, and hibernate in, although the semi-aquatic species also feed on land. Wetlands accounted for 82.9% of all adults recorded (8,223 of 9,921), with streams/canals accounting for 13.9% (1,381 of 9,921) and uplands 3.4% (317 of 9,921). However, although wetlands are critical habitats without which the majority of species would not be present at SARA, some of the numerical dominance of wetlands is due to sampling bias. More sampling took place in wetlands, and much of it occurred in spring, when otherwise terrestrial or fossorial amphibians were concentrated in breeding ponds and more readily detected than when in the uplands.

The number and variety of wetlands at a site is integral to the abundance and diversity of its herpetofauna, particularly amphibians. Semlitsch (2003) describes an ideal landscape for amphibians in which a diversity of ponds with varying hydroperiods in close proximity is available to support all the locally-occurring species. SARA has an abundance of wetlands in close proximity, with over 15 ponds, marsh, and canal sites identified at the start of this project, plus four streams in the Battlefield Unit as well as the Hudson River and Fish Creek, abutting. However, only 6% of SARA is wetland, mostly forested wetlands and small ponds. It lacks large lakes and ponds (Tiner et al. 2000). In addition, it appears that the forested vernal ponds of SARA are predominantly short hydroperiod ponds. As discussed in detail in the spotted salamander species account, the relative numbers of egg masses and naïve occupancy rate is much greater for wood frogs than spotted salamanders, and there is only one pond that supports what could be considered a viable population of spotted salamanders. From this we infer that SARA has few long hydroperiod vernal ponds. Given this, and the lack of large lakes, it appears that wetland diversity at SARA is low and long hydroperiod and permanent ponds species here are limited.

Among SARA wetland sites, total species richness was greatest at Schuyler Estate Canal, with 15 species recorded. It was an important site for northern leopard frog, Jefferson/blue-spotted salamander, spotted salamander, snapping turtle, and eastern garter snake. The total number of amphibians recorded was greatest at Burdyl Pond, accounting for 18.9% of all amphibians. Burdyl Pond was particularly important to spring peeper, grey treefrog, American bullfrog, red-spotted newt, and painted turtles. Victory Woods Pond was an important breeding site for Jefferson/blue-spotted salamander, spotted salamander, and spring peeper and Stop 8 Ponds was an important breeding site for wood frog and spotted salamander. Vly Marsh, with eight amphibian species, accounted for 38% of all American toads recorded.

At SARA, permanent and temporary ponds had identical species richness, with 12 species recorded in both pond types. However, greater numbers were recorded at permanent ponds relative to temporary ponds. After accounting for differences in sampling effort by converting to mean numbers per pond, the total number recorded in permanent ponds was 764 per pond (4,582 recorded in six ponds) and 165 per pond for temporary ponds (659 recorded in four ponds). In a Southern New Hampshire amphibian community very similar in species composition to that of SARA, larval amphibian density was greatest in long hydroperiod ponds (Babbitt et al. 2003). Thus, because amphibians dominate SARA numerically, the difference between temporary and permanent ponds in mean number of total recorded may be related to hydroperiod. However, because permanent ponds are generally much larger than temporary ponds, the greater numbers recorded at permanent ponds could also be related to pond size.

By species, the mean number per pond in permanent versus temporary ponds were: northern spring peeper, 504 versus 130; grey treefrog, 133 versus one; northern green frog, 45 versus three; wood frog, one versus 14; American bullfrog, 17 versus two eastern American toad, one versus two; red-spotted newts, 37 versus one; Jefferson/blue-spotted salamander, five versus zero; and spotted salamander, 16 versus 12. In terms of relative abundance, northern spring peepers dominated the amphibian community of both types, accounting for 66% of all captures in permanent ponds and 79% in temporary ponds. Among the remaining species, grey treefrogs and northern green frogs were the next most dominant species in permanent ponds, with a relative abundance of 17% and 6% respectively, versus 0% and 2% in temporary ponds. Red-spotted newts accounted for 5% of animals recorded in permanent ponds, versus 0% in temporary. In temporary ponds, the sub-dominant species were wood frog and spotted salamander. Wood frog and spotted salamander had a relative abundance of 8% and 7% respectively in temporary ponds, versus 0% and 2% in permanent ponds. In addition, 63% of all non-terrestrial records of wood frogs were in temporary ponds, highlighting their importance as breeding habitat for this species. Permanent streams had relatively high species richness (12 species), and notably Great Fall Creek (stream 8), Mill Creek South (stream 6), and Mill Creek Middle (stream 4) are very important habitat for northern two-lined salamanders, SARA's only species of stream salamander, accounting for 91% of all recorded.

Although freshwater wetlands and streams are critical to supporting the diversity of amphibian and reptile species found at SARA, the adjacent upland habitats are also important. Eastern red-backed salamanders are wholly terrestrial and do not breed in wetlands. Most of the amphibians found in pond and marsh habitats at SARA only use them for breeding, and spend the rest of the year in uplands, where they forage and hibernate. Thus, spotted salamander, wood frog, eastern American toad, northern spring peeper, and grey treefrog are dependent on the woodland habitats of SARA, as are red-spotted newts, which utilize this habitat for their juvenile stage (red eft). Similarly, northern leopard frogs spend much of the active season foraging in fields and meadows, usually near watercourses. In addition, all of the reptiles here depend on uplands. Except for the northern water snake, all snakes at SARA depend entirely on uplands for foraging and hibernation, as does the eastern box turtle. All turtles, whether they are aquatic species (snapping turtle, stinkpot, painted turtle, and wood turtle) or terrestrial (box turtle) require open, well-drained uplands for nesting. Thus, although amphibians and reptiles commonly utilize specific habitats for a given part of the year, their complex life cycles require the use and occupancy of a number of different habitats for breeding, foraging, dispersal, nesting, and hibernation. It is important to ensure the integrity and connectivity of all these habitats at SARA.

Species at Risk

Most of the 23 species of amphibians and reptiles currently documented at SARA are common in the Northeast (Conant and Collins 1998, Klemens 1993) and widespread in North America. From a preservation of species at risk perspective, SARA does not support significant populations of any species that are exceptionally rare such that SARA could be considered a critical site for a rare or declining species. However, several of the species known from or adjacent to SARA have experienced declines in the Northeast region and/or in New York State (Klemens 1993, Gibbs et al. 2007), and SARA provides important habitat for them. In most instances, the habitat provided by SARA is part of a larger local complex of adjacent or linked habitat areas that, in their sum total, help support local populations and maintain species richness at the town or county level. Individually these sites would not be large enough. The wood turtle and eastern box turtle are good examples. Both are species of “Special Concern” in New York State and have declined in many parts of the Northeast. Their decline in this region is due to a number of factors relating to development, habitat alteration, fragmentation and road kill, although collection for the pet trade is also a factor in their decline (Levell 2000, Mitchell and Klemens 2000, Gibbs et al. 2007). Attributes of their natural history and demography pre-dispose these two species to being vulnerable to those factors. Both species are wide-ranging as individuals, and therefore require relatively large tracts of relatively natural landscapes to sustain viable populations. Wood turtles prefer slow-moving, sandy-bottomed, mid-sized streams and unpolluted, undeveloped rivers set within large, unfragmented riparian areas (Compton et al. 2002). Box turtles need large, predominantly natural areas that are relatively road and traffic free. In addition, both are very long-lived species with delayed sexual maturity, low reproductive output, and naturally low adult mortality. Their populations cannot sustain increased mortality from human sources and pet collection (Gibbs and Amato 2000). In addition to wood and box turtles, although the only record of spotted turtle at SARA dates back to 1995, it is also a “Special Concern” species in decline due to these same factors. For the Jefferson/blue-spotted salamanders, another “Special Concern” species, the primary threats to their populations in the region are also loss, alteration, and fragmentation of habitat (Bogart and Klemens 2008). A woodland species, the extent of agriculture and roads, as well as wetland hydro-period in the Battlefield Unit may be limiting their numbers here.

Several other species currently present at SARA have experienced declines in parts of the Northeast and although they may be common here, they are of conservation concern elsewhere in the region. These include species such as northern leopard frog, grey treefrog, eastern milk snake, water snake, red-spotted newt, spotted salamander, wood frog, and pickerel frog. Where these species have declined, the factors responsible have been various aspects of urban development, habitat fragmentation, conversion of forest to agriculture, and road kill. Thus, although its landscape has been altered significantly in past centuries, a site like SARA provides a relatively large, diverse, natural landscape capable of supporting a community of amphibians and reptiles that includes species that are highly tolerant of development and disturbance, as well as species that require larger, more intact natural areas. As such, the continued habitat protection provided by the National Park Service is important in helping to maintain regional bio-diversity.

Population Trends

Determining population trends at SARA is difficult, given the lack of detailed historic data. In addition to older general works that provide no SARA-specific information, we only have

species lists from the 1980's and 1990's (NPS 1986, 1998, Lynch 1988, Troha 1995), which provide little to no information on abundance and distribution. Because these lists do not have any details or documentation via specimens or photos, their accuracy is also uncertain or doubtful in some instances, e.g. Fowler's toad, northern dusky and northern spring salamander, eastern ribbon snake. In contrast, species identification is not an issue with records from the New York State Herp Atlas (Breisch and Ozard, in prep.), but these are records from near SARA of species that could have been present at SARA. Thus, although our "historic baseline" consists almost entirely of species which likely occurred at what is now SARA at some point in the historic past, we barely have any information on their abundance in the 1980's and 1990's, let alone what their status was at the time of the park's establishment in 1938 or prior to the deforestation that occurred in the 18th and early 19th century.

For the 32 species "historic baseline", we have attempted as best as possible, to determine the current status and population trends since the 1980's. Currently, we consider three species to be abundant, nine common, seven uncommon, four rare, and nine were unrecorded (Table 21). Although status data from the 1980's is limited, it appears that 22 species are stable over this relatively short, recent time period, one species (eastern smooth green snake) has declined, and for nine species, the trend is unknown. Most of these unknown are species not currently recorded, and for seven of these nine, their historic status is also unknown.

Table 21. Historic and current status and apparent trends since the 1980's in "historic baseline" species of amphibians and reptiles at Saratoga National Historical Park.

Common Name	Historic Status	Current Status	Apparent Trend
Jefferson/Blue-spotted Salamander	uncommon	uncommon	stable
Spotted Salamander	uncommon	uncommon	stable
Red-spotted Newt	common	common	stable
Northern Dusky Salamander	unknown	not recorded	unknown
Northern Two-lined Salamander	common	common	stable
Northern Spring Salamander	unknown	not recorded	unknown
Eastern Red-backed Salamander	common	common	stable
Eastern Spadefoot Toad	unknown	not recorded	unknown
Eastern American Toad	common	common	stable
Fowler's Toad	unknown	not recorded	unknown
Gray Treefrog	abundant	abundant	stable
Northern Spring Peeper	abundant	abundant	stable
American Bullfrog	common	common	stable
Northern Green Frog	abundant	abundant	stable
Northern Leopard Frog	uncommon	uncommon	stable
Pickerel Frog	rare	rare	stable
Wood Frog	common	common	stable
Common Snapping Turtle	common	common	stable
Stinkpot	unknown	rare	unknown
Painted Turtle	common	common	stable
Northern Map Turtle	unknown	not recorded	unknown
Spotted Turtle	rare	not recorded	unknown
Wood Turtle	rare	rare	stable
Eastern Box Turtle	rare	rare	stable
Eastern Hog-nosed Snake	unknown	not recorded	unknown
Eastern Milk Snake	uncommon	uncommon	stable
Northern Water Snake	uncommon	uncommon	stable
Smooth Green Snake	rare	not recorded	decline
Northern Brown Snake	uncommon	uncommon	stable
Northern Red-bellied Snake	uncommon	uncommon	stable
Eastern Ribbon Snake	rare	not recorded	unknown
Common Garter Snake	common	common	stable

Stressors

Given its location in an agricultural landscape long affected by human activities, SARA has been and is subjected to numerous stressors, both local and global. Global stressors tend to affect large geographic areas and are often far removed from their ultimate cause or source. Global stressors include ultraviolet-B radiation and atmospherically transported pollutants such as mercury and acid rain. Stressors such as other heavy metals, chemicals found in fertilizers, herbicides, pesticides, habitat degradation, disease, road mortality, and introduced species (Dunson et al. 1992, Blaustein 1994, Blaustein et al. 1994, Pechman and Wilbur 1994, Daszak et al. 2000, Knapp and Matthews 2000) may also be widespread in their scope, but tend to be more variable across the landscape in their extent. Thus their impacts may be at either a regional or local level.

Few global stressors are known to be impacting SARA, although that may be because assessments have not yet been conducted. Mercury is transported atmospherically and often deposited far from the source. Upon entering aquatic ecosystems, particularly acidified ones, mercury is biologically and chemically converted to methylmercury, a biologically active and highly toxic form (Bank et al. 2005) that can be accumulated by aquatic organisms to the point of causing lethal or sub-lethal effects. Anthropogenically produced mercury deposition is occurring throughout the Northeast, and even aquatic systems of relatively undeveloped areas such as Acadia National Park (Bank et al. 2006) and Cape Cod National Seashore contain high levels of mercury. Because methylation of mercury increases at low pH, either naturally acidic waters or acid rain can lead to elevated concentrations of methyl mercury. This process has been linked to the decline of northern dusky salamanders at Acadia NP, and both northern green frogs and northern two-lined salamanders there also show elevated mercury levels (Bank et al. 2006, Bank et al. 2007). Given that both acid precipitation and mercury deposition occurs in the vicinity of SARA (Likens et al. 1996, Chalmers et al. 2005) it is reasonable to conclude that SARA is subjected to inputs from both of these stressors. In addition to mercury, low pH can increase the solubility of aluminum to levels toxic to amphibians (Clark and Hall 1985).

However, although rainfall in the Northeast is acidic, the calcium-rich bedrock in the SARA region buffers its waters and soils (Vana-Miller et al. 2001). Groundwater pH is neutral to mildly alkaline (pH 7.0 to 8.3) and stream pH values are similar (NPS 1997, Vana-Miller et al. 2001), suggesting that streams are unlikely to be affected by atmospheric deposition. Although there is not as much data on pond water pH at SARA, the data collected during this survey (Table 22) suggest that the ponds and marshes at SARA are fairly well buffered. Not surprisingly, temporary ponds had the lowest mean pH (6.6), but even the most acidic of them, Stop 8 ponds, had a mean pH (5.6) that was well above the low to mid pH 4 range associated with adverse effects (Sadinski and Dunson 1992). Considering that many robust populations of many of the same amphibian species as found at SARA occur in slightly acidic ponds at Cape Cod National Seashore (Cook et al. 2006b), it does not appear that there are any acid deposition/low pH related problems at SARA.

Diseases are also a global issue, with one in particular, Chytridiomycosis being linked to the decline and disappearance of amphibians. The fungus that causes it, *Batrachochytridium dendrobatidis* is believed to be native to Africa and spread globally through international trade in the mid-20th century (Weldon et al. 2004). Recent surveys suggest that chytrid fungus is widespread in the Northeast, but there is little evidence it has caused die-offs in this region. Surveys of anurans in eastern Massachusetts found chytrid fungus in two of 23 northern green

Table 22. Mean, maximum, and minimum pH values, and sample size (n) of water in SARA streams and wetlands during this survey in 2001. Habitat means are weighted averages based on combining data from all sites sampled in each habitat type.

Site	Habitat Type	Mean pH	Min pH	Max pH	n
BEAVER MARSH	Marsh	7.6	6.7	8.7	41
BURDYL POND	Permanent Pond	7.6	6.7	8.8	46
CANAL BELOW STOP 10	Permanent Canal	7.7	6.1	8.7	38
CANAL NORTH OF ENTRANCE	Permanent Canal	7.2	6.7	7.4	4
DAVIDSON POND	Permanent Pond	7.5	6.9	8.4	42
NORTH ENTRANCE POND	Permanent Pond	7.6	7.2	7.9	3
RIVER ROAD MARSH	Marsh	7.7	7.1	8.2	5
SCHUYLER HOUSE CANAL	Marsh	7.6	6.3	8.8	49
SERVICE ROAD POND	Temporary Pond	7.4	6.1	8.3	44
STOP 1 POND	Permanent Pond	7.6	6.5	8.6	40
STOP 2 POND	Temporary Pond	7.5	7.1	7.7	3
STOP 8 PONDS	Temporary Pond	5.6	4.2	8.4	35
STREAM 1	Permanent Stream	8.3	7.9	8.8	6
STREAM 2	Permanent Stream	8.3	8	8.8	6
STREAM 3	Permanent Stream	8.0	7.6	8.2	5
STREAM 4	Permanent Stream	8.0	7.5	8.2	4
STREAM 5	Permanent Stream	7.8	7.5	8	3
STREAM 6	Permanent Stream	7.9	7.8	8.2	4
STREAM 8	Permanent Stream	8.0	7.7	8.3	5
VICTORY WOODS POND	Permanent Pond	7.3	5.7	8.5	40
VLY MARSH	Marsh	7.4	6.6	8.4	34
all Marsh	Marsh	7.5	6.3	8.8	129
all Temporary Pond	Temporary Pond	6.6	4.2	8.4	82
all Permanent Pond	Permanent Pond	7.5	5.7	8.8	171
all Permanent Canal	Permanent Canal	7.7	6.1	8.7	42
all Permanent Stream	Permanent Stream	8.1	7.5	8.8	33

frogs (Longcore et al. 2007) and rates of occurrence approaching 50% were found in northern green frogs and American bullfrogs on Cape Cod, with no apparent die-offs (Tupper et al. 2011). Considering the abundance of these two species at SARA, this particular stressor does not appear to be affecting amphibians at SARA.

Pollutants could also negatively impact amphibians and reptiles at SARA. Nutrients such as nitrogen and phosphorous can cause algae blooms and mats, which can interfere with egg deposition sites. In addition, the decomposition that follows algal blooms can reduce the dissolved oxygen available in the water for amphibian larvae and alter the composition and abundance of the invertebrate communities that are food for larvae. SARA is embedded within a landscape that has been and continues to be a mix of agriculture and forest, and fertilizers and pesticides have undoubtedly been used, but the extent to which these may be a problem is uncertain. Pesticides are suspected or have been implicated in declines of the smooth green snake (Klemens 1993, Ernst and Ernst 2003) and the apparent decline of green snakes at SARA may be pesticide related. Recent assessment of SARA stream water quality shows that nitrogen (excepting NO₂) and phosphorus levels are moderate to high and are likely susceptible to increased loading from runoff higher in the watershed (Gawley *In Prep.*). These results suggest that increased nutrient levels may be a concern in stream systems, potentially affecting northern two-lined salamander populations at SARA. Unfortunately, water quality in non-stream wetlands at SARA remains largely unknown at the current time and should be a focus of future research and monitoring. Another pollutant whose impacts at SARA are unknown is Polychlorinated Biphenyls (PCB's). This contaminant is present in sediments of the Hudson River as a result of industrial activity upstream of SARA. It also is present to some extent on SARA's floodplain lands as a result of the River's periodic flooding of those lands. A full understanding of the distribution and concentration of PCB's that may be present in the soils and wetlands of the Hudson River floodplain of SARA, as well as of the ecological impacts, however, await the results of a remedial investigation that is planned to be undertaken within the next several years.

At a more local level, SARA's landscape has been manipulated over the years and by the 1870's, roughly 90% of the original forests of SARA had been cut and converted to agriculture (Vana-Miller 2001). Given what we know today about the landscape ecology of the region's amphibians and reptiles, this undoubtedly caused major changes to the amphibian and reptile community. Among pond-breeding amphibians, the majority of species present at SARA decline in abundance and/or frequency of occurrence as landscapes are converted from forest to agriculture and species richness is greatest at wetlands in forested landscape (Hecnar and M'Closkey 1998, Guerry and Hunter 2002, Herrmann et al. 2005, Gagne and Fahrig 2007, Egan and Paton 2008, Windmiller et al. 2008). Only a small number of species are positively affected, for example American toad, and others, such as green frog may be somewhat neutral. However, species also differ in their sensitivity to deforestation, with some, such as spring peeper, able to persist in small patches of forest habitat whereas other species, such as wood frog, spotted salamander, and red-spotted newt, only occurring in larger forest patches (Gibbs et al. 1998).

A number of studies have shown that the occurrence and abundance of stream salamanders declines as the nearby landscape becomes urbanized or deforested. These studies suggest that more than a narrow stream buffer of intact vegetation is needed to avoid these impacts (Willson and Dorcas 2003, Miller et al. 2007), which appear to be due to increased levels of sedimentation and higher velocity stormflow (Orser and Shure 1972). Increased sedimentation decreases the

space between rock and gravel substrate, reducing the places where adult and larval salamanders can hide from predators or avoid being washed downstream during high stormflow, which also tends to be more severe in altered watersheds (Lowe and Bolger 2002, Brannon and Purvis 2008, Barrett et al. 2010). Severe flooding can wash away cover such as leaves and logs, further reducing habitat quality (Price et al. 2010). Removal of forest canopy can also lead to increased stream water temperatures and lower dissolved oxygen, which can reduce or eliminate stream salamanders (Bury 2008). In addition, following forest recovery, connectivity to un-impacted first order streams as sources for re-colonization is an important factor in the presence of stream salamanders (Lowe and Bolger 2002, Grant et al. 2009) and it is unlikely that the streams at SARA, which drain into the Hudson River, could be easily re-colonized.

Herrmann et al. (2005) found that ponds with 60% or more adjacent forest cover had high species richness and those with less than 40% had low. Now that much of the SARA landscape has recovered to the point where roughly 60% of the park is forested (Vana-Miller 2001), the pond-breeding amphibian community appears to be reasonably complete, with species either having been able to survive the de-forestation period or been able to re-colonize. However, amphibians breeding in ponds close to fields may still be affected by deforestation. Survival rates of dispersing juvenile spotted salamanders and American toads are much lower in field than forest habitat and juvenile spotted salamanders do not survive to maturity in field habitat. Thus, breeding ponds surrounded by non-forested habitat may act as population sinks for some species (Rothermel and Semlitsch 2002, 2006). In addition, stream salamanders at SARA are currently limited to the northern two-lined salamander, a degradation tolerant species (Southerland et al. 2004). Although there is doubt that the northern spring salamander, a cold water specialist, ever occurred at SARA, the northern dusky salamander is a widespread species that was likely present originally but appears to have been unable to survive the deforestation period and is unable to re-colonize. Thus, although there has been significant recovery of most species, historic deforestation may still be exerting some effects on SARA's herpetofauna.

Invasive alien plants are another stressor at SARA. If left unchecked, they have the potential to impact structure, composition, and function of native upland and wetland ecosystems, and are one of the leading threats to biodiversity and ecological integrity (Klemens 1993, Malecki 1995, Miller et al. 2011). Recent monitoring data show that alien shrubs, particularly bush honeysuckle (*Lonicera* spp.) have invaded large areas of the park, and, based on numbers of invasive alien indicator species, SARA just narrowly missed being rated a "significant concern" for alien species (Miller et al. 2011). Additionally, just over half (53%) of wetland area at SARA consists of significantly modified wetlands, including a large percentage of impounded and/or partly drained wetlands (Tiner et al. 2000). These likely have restricted ecological functioning and may serve as habitat for non-native plant species. These wetlands may be candidates in the future for restoration of their ecological functioning. Moreover, although not an anthropogenic stressor, the lack of lake and large pond habitats (Tiner et al. 2000), and relatively few long hydro-period vernal ponds, appears to limit the abundance of species that prefer these habitat types, such as snapping and painted turtle, and spotted and Jefferson/blue-spotted salamanders.

Road kill is another significant stressor on amphibian and reptile populations, with impacts greatest on mobile species and less on those that are more sedentary (Carr and Fahrig 2001). Traffic related mortality has been shown to have a significant negative effect on amphibian density and contributes to their population declines, especially in populated areas (Fahrig et al.

1995, Gibbs and Shriver 2005). Road kill also alters the sex ratio of turtle populations near roads, as the more mobile females are disproportionately killed during nesting forays, leading to depletion of breeding females (Gibbs and Steen 2005). Road kill is suspected of contributing to widespread population declines of turtles in the United States, and has the potential to limit populations of some species (box, spotted, wood, and snapping turtles) in areas such as the Northeast (Gibbs and Shriver 2002). We did not record any road kill at SARA during this survey, but minor road kill does occur on park roadways. However, the greater concern is road kill that may be occurring on heavily travelled roadways that run through and adjacent to SARA, especially U.S. Highway 4 on the east side of SARA. Some of the most productive amphibian breeding locations at SARA are located near Highway 4, and animals migrating to and from those wetlands on rainy nights are at risk. At present there are no data on the extent of road kill on these roads and further work is needed to assess their effects on amphibian and reptile populations.

Because amphibians and reptiles utilize both aquatic and terrestrial habitats, they are important indicators of environmental quality. The semi-permeable skin of amphibians makes them more susceptible to changes in their environment than other vertebrates, and they are often among the first species to show the effects of changes in environmental conditions (Pough et al. 2004). Many reptiles tend to be long-lived and require large habitat patches to maintain viable populations, making these species sensitive to anthropogenic mortality and habitat fragmentation. The loss of keystone species and important habitats can alter the sustainability of herpetofaunal communities and the ecosystem as a whole. Although there is much evidence of amphibian and reptile declines in the northeast and SARA has and continues to be impacted by numerous stressors, it none-the-less currently supports a fairly diverse and robust amphibian and reptile community. SARA provides a relatively large and natural landscape that is a mix of forest and field habitats, with numerous wetlands and streams and canal to provide additional habitat diversity and travel corridors to maintain connectivity. The community of amphibians and reptiles here includes species that are highly tolerant of development, disturbance, and other stressors, but it also includes species that require larger, more intact natural areas for population persistence, such as wood frog, spotted salamander, red-spotted newt, box turtle, wood turtle, and milk snake.

Recommendations for Management and Future Inventory and Monitoring

Both its herpetofauna and SARA's natural resources in general have been impacted by a number of agricultural and development-related stressors. Although there has been significant recovery from many of them, stressors continue to operate at SARA and there are many ways that the NPS (staff of SARA, the Northeast Region, and the Northeast Temperate Network) can work to bring about changes that can improve the condition of SARA's natural resources and help protect them into the future.

Monitor/Prevent/Mitigate External Threats and Stressors

Although relatively large and "self-sufficient" for some amphibian and reptile species, many others that occur at SARA are far ranging, and SARA only provides a portion of the landscape area needed to support their populations. This is particularly true for species occurring at the Schuyler Estate and Victory Woods Units. Considering that the herpetofauna of SARA can be affected by activities on the adjacent landscape and in the Hudson River, to the extent possible, the park should advocate for activities in the "neighborhood" that are consistent with protection of native wildlife, including herpetofauna. Potential activities that might negatively affect amphibians and reptiles include removal of PCB contaminated soils from the Hudson River floodplain, the applications of pesticides on adjacent farms, anything that increases vehicular traffic, anything that pollutes or diminishes ground or surface waters, and anything that increases the abundance of "subsidized predators" such as raccoons, skunks, and feral cats. Considering the continued development in the region, the park should promote protection of the adjoining landscape and watershed, and become involved in ensuring that any future developments will not contribute to degradation of the park and vicinity. To do this, SARA should be involved in and comment on local and regional planning efforts to ensure that stream and river water quality is improved. Similarly, SARA should consider supporting the protection of nearby open space and natural areas by towns, private conservation groups, state and federal agencies. Whenever road or culvert replacement work is being planned in or around SARA, the park should advocate for increasing the size and capacity of culverts and bridges, and installing wildlife tunnels to increase landscape connectivity and reduce road kill (Singer and Graber 2005, MA Highways 2006).

Monitor/Prevent/Mitigate Internal Threats and Stressors

The park should take steps to ensure that the activities listed above do not take place on NPS property or are kept to a minimum. In particular, ensure that runoff from park roads and parking lots is not contributing to pollution of groundwater, streams and wetlands and bridges and culverts in the park are designed to facilitate unimpeded movement of fish and wildlife. SARA should also make sure that use of pesticides in the park conforms to NPS pesticide use policy.

Maintain Habitat Diversity

The amphibians and reptiles currently utilizing SARA collectively require a combination of woodland, field, and wetland habitat to provide for all aspects of their life cycles. Ensuring woodland health is important but concern for such health should recognize that natural woodlands contain dead and dying trees and an abundance of downed, rotting logs. Such dead snags and coarse woody debris on the ground are important habitat for many species of

amphibians and reptiles, as well as cavity nesting birds and small mammals. In open habitats associated with the cultural core of the park, as well as the historic fields, to the extent that it is possible, maintain the open habitats as native grasses and forbs mowed infrequently, rather than “lawn”. Mowing as a maintenance and habitat management tool should be used carefully to minimize direct mortality.

Minimize Direct Mortality From Mowing Operations

Most species of snakes use field and field edge habitats to bask and hunt, and turtles, both aquatic and terrestrial, use fields for nesting, which generally occurs in late May through early July. American toad and leopard frog may also use fields, especially ones near aquatic habitats. Mowing should be conducted in a way that minimizes the potential for direct mortality to these and other animals. There are a number of ways to do this, depending on how a particular area is being managed. For areas being maintained as lawn or roadside verge, it is best to mow frequently, so that the grass is close-cropped. This may make the habitat less attractive, and turtles and snakes are more easily observed by staff operating mowers and can be avoided. If grass has gotten taller, having a person walk ahead of the mower to check for turtles and chase away snakes and frogs is the safest approach.

Fields and pastures (as opposed to lawns) at SARA are maintained as part of the cultural landscape and their long term maintenance benefits many species of wildlife dependant on edge or early successional stage habitat. This includes snakes and turtles, which use fields and field edges for basking and nesting, and American toad and leopard frog, which forage in fields. Maintaining fields at SARA should be done in a way that minimizes the risk of killing amphibians and reptiles with mower blades and/or tractor wheels. First, because some fields may not need to be mowed annually to maintain them, the park should consider only mowing a portion of the field habitats in any given year. Ideally, fields should be mowed during the cold months, when animals are not active. At SARA, this is probably limited to late October and November, before snow cover sets in, or early spring, if it is not too muddy. However, in fields that are actively farmed or hayed this may not be possible. The worst times of year to mow would be late May to early July, which is generally when turtles nest, and in mid to late spring and late summer-early fall, when snakes often bask at field edges.

If mowing must occur in summer, it should be done during the hottest months (July and August). Snakes, turtles, and anurans tend to avoid open areas during times of drought and high heat intensity, making the heat of day on hot and dry days the best time to mow during the active season. Mowers with rotary blades or sickle bars are preferable to reel or flail mowers. Rotary blades and sickle bars are oriented horizontally. If these blades are set to cut at least seven inches above ground, they will safely pass over many small animals and the blades will wear more slowly. Field mowing should start in the center and spiral outward, so animals in the field are pushed out of the way of the mower slowly (MA NHESP 2009).

Minimize Direct Mortality From Vehicles

Road kill appears to be modest on the NPS roads inside the Battlefield Unit, but is likely much greater on other adjacent roads, such as US Highway 4 and Route 32. Amphibians cross roads in large numbers on rainy nights, especially in spring as they migrate to breeding ponds. Snakes often bask on roads in spring and autumn and turtles cross roads and move to open fields in late

spring and early summer to nest. Although much of the problem of road kill is beyond the park's ability to mitigate, improvements to existing bridges and culverts, and installation of additional wildlife tunnels could help improve landscape connectivity and reduce road kill (Singer and Graber 2005, Massachusetts Highways 2006). Any and all road and bridge projects in and adjacent to SARA should consider these improved designs. In addition, if observations indicate there are any road kill "hot spots" in the park, warning signs should be erected and the possibility of engineering solutions investigated.

Additional Inventory and Monitoring

Uncertainties regarding the presence/absence and status of several species remain. In some instances it is because of the rarity of species, but in others it may also be attributable to lack of sampling in the best potential habitat. The list of species for which additional information is recommended is long. In some instances, direct sampling will be necessary and is recommended. In others, sampling is probably not feasible, but additional records of occurrence may be obtained via incidental encounters by park staff. Several significant species occurrence records discussed in this report were obtained in this fashion, mostly from Ranger Jacquie Tinker. To do this, staff should be provided with this list, asked to be on the lookout for any of the species (even those for which additional sampling is recommended) and provided information on identification and what to do when they encounter them. Collection is preferable if at all possible, but photographing both dorsal and ventral surfaces will also provide documentation.

- a. Mudpuppy – sample with large entrance-diameter minnow traps in canals and mouths of tributaries to Hudson River.
- b. Jefferson/blue-spotted salamander complex – sample with minnow traps to determine genetic composition of populations at Victory Woods and Schuyler Estate Canal.
- c. Dusky salamander and other stream salamanders—sample via stream search, in uppermost reaches of streams, close to source seeps, springs etc.
- d. Four-toed salamander-sample via active search in any wetland and canal where *Sphagnum* clumps and pillows overhanging water are present, in May, when females are guarding eggs. Incidentals on road on rainy nights, capture and photograph as possible.
- e. Spadefoot toad and Fowler's toad – be on lookout for on roads, rainy nights, especially along Hudson River floodplain. Capture, photograph as possible.
- f. Stinkpot- sample for by trapping impounded Fish Creek above the Schuylerville Dam. Incidentals on road, capture and photograph as possible.
- g. Map Turtle – active search with binoculars for basking animals on shoreline of Hudson River.
- h. Wood Turtle – additional trapping for, Champlain Canal in the Battlefield Unit. Also, be on lookout for, capture, photograph when encountered.
- i. Box Turtle - be on lookout for, capture, photograph when encountered.
- j. Northern Black Racer, Northern Ringneck Snake, Black Rat Snake, Eastern Hog-nosed Snake, Smooth Green Snake, Eastern Ribbon Snake – be on lookout for live or dead specimens and capture, photograph as possible.
- k. All snakes- For terrestrial snakes, an expanded system of coverboard arrays (at least 12) established along field edges and in open wetland habitat patches, and checked

from one to three times per week from April through October would provide a better basis for determining their status here.

Although a detailed monitoring plan is beyond the scope of this inventory, anuran calling surveys, stream salamander surveys, and salamander egg mass surveys and vernal pond hydroperiod monitoring would be the most useful methods for monitoring SARA's amphibians. Long term monitoring of reptiles should include periodic trapping of aquatic turtles to estimate population size and structure, and periodic monitoring of snakes with coverboards for a season. Such long term monitoring is important to better separate natural fluctuations in populations over time from anthropogenic declines (Pechmann et al. 1991, Pechmann and Wilbur 1994). In addition, a more in-depth analysis of changes in stream, wetland and terrestrial habitat quality, as well as analysis of adjacent landscapes for each pond and stream will help to better identify potential causes of changes in the herpetofauna.

Species Accounts: Species Likely Present Historically at or Adjacent to Saratoga NHP

Jefferson – Blue-spotted Salamander and complexes (*Ambystoma jeffersonianum*, *A. laterale*, *Ambystoma jeffersonianum* x *A. laterale*)

The Jefferson and blue-spotted salamanders are two closely related species that form hybrid complexes across a portion of their range. The Jefferson salamander ranges south and southwest from Southwestern New England to Southern Indiana and Kentucky. The blue-spotted salamander ranges west across the Northeast through the Great Lakes states to Minnesota and north into Canada, up to Hudson's Bay and east through the Maritime Provinces. Across much of its range, which is limited to glaciated areas, the blue spotted salamander hybridizes with Jefferson salamanders (Klemens 1993, Petranka 1998). Hybrids of blue spotted and Jefferson salamanders have been found from Southern Canada (southern Ontario to the Maritimes) and Northern New England south through New York and New Jersey and the upper Midwestern United States (Bogart and Klemens 1997, 2008).

Hybrids exhibit a wide array of colors and patterns, making visual identification difficult. Recent work by Bogart and Klemens (1997, 2008), based on cellular and molecular techniques, indicates that hybrids occur as unisexual (nearly all female) diploid, triploid, and tetraploid individuals. Most populations are a mix of predominantly unisexual hybrids, mostly triploids, and a relatively small number of diploid, sexual individuals of one or the other species, but never both. Pure diploid populations are uncommon. Populations of hybrids are maintained by breeding between the unisexual hybrids and individuals of one of the diploid sexual species in which the unisexuals steal genetic material from the sexual sperm donors. Based on the dominant alleles and diploid sexual species present, populations in the Northeast are classified as pure diploid *A. jeffersonianum*, pure diploid *A. laterale*, *A. jeffersonianum* complex, and *A. laterale* complex. In New York State, most populations are either *A. jeffersonianum* or *A. laterale* complex, with populations of pure diploid *A. jeffersonianum* recorded from south-central New York State and pure diploid *A. laterale* only recorded from Montauk on Eastern Long Island (Bogart and Klemens 2008). Recent work by Bogart and Klemens (2008) indicates that most of the populations in East-central New York are triploid *Ambystoma jeffersonianum* – *Ambystoma laterale* (LJJ; i.e., one *laterale* allele and two *jeffersonianum* alleles) individuals.

Both Jefferson and blue-spotted salamanders are among the earliest of spring breeding amphibians and often migrate to ponds when still largely covered in ice (Bishop 1941). Female Jefferson salamanders deposit gelatinous egg masses on twigs and leaves in the pond whereas female blue-spotted salamanders scatter their eggs, attaching them singly or in small clusters to grass blades, often at the base of tussocks in their breeding wetlands. They then leave the pond and return to adjacent woodlands where they spend most of the year (Petranka 1998). Hybrid populations share the ecology and distribution of the parental (diploid) species to which they are genetically closest. In New England, *A. jeffersonianum* breed in vernal ponds and are found primarily in deciduous forests in steep terrain, whereas *A. laterale* prefer floodplain marshes and wooded swamps in low elevation woodlands and are more tolerant of habitat disturbance (Klemens 1993, Bogart and Klemens 1997).

The historic record for these two species is uncertain because of early confusion with the slimy salamander (*Plethodon glutinosus*), the relatively recent recognition of Jefferson and blue-spotted salamander as two separate species, and the even more recent recognition and understanding of the hybrid complexes (Bogart and Klemens 1997, 2008). For example, Bishop (1941) considered *Ambystoma jeffersonianum* to be geographically widespread and locally very common in some parts of New York, but he referred to it as both “Jefferson’s salamander” and “Blue-spotted salamander”. He did not list *A. laterale*. Thus, although we do not know which species or species complex they represent, we do know there are historic records from Saratoga Lake and Saratoga Springs, as well as from Albany and Rensselaer counties (Bishop 1941). The current distribution of what we now know to be two separate species complexes shows them to be widespread in New York State, but with apparent absences in some part of the state (Gibbs et al. 2007). Except for urban areas where historic populations have probably been lost, it is likely that these current distributions also reflect their historic distributions. Currently, these two species and their complexes are listed as a species of “Special Concern” in New York State.

In the recent New York Herp Atlas project, there were no records of Jefferson or Blue-spotted salamander in the four Herp Atlas quads (an area of approximately 600 km²) that overlap with SARA (Breisch and Ozard, in prep). However, there are current records for these two species and their complexes from more distant topo quads in Saratoga and nearly all adjacent counties (<http://www.dec.ny.gov/animals/44529.html>, <http://www.dec.ny.gov/animals/44527.html>, last accessed March 5, 2012). These records, which base identification of individuals only on external features (pers. comm. John Ozard, NYS DEC, September 15, 2011) show that the portion of the Hudson River Valley where SARA occurs contains individuals that have been identified as Jefferson Salamander, Blue-spotted Salamander, or as a hybrid belonging to either of the two species’ complexes. Population-scale analysis shows that SARA lies in a region where both *A. jeffersonianum* complex and *A. laterale* complex, but no pure sexual diploid populations are known to occur (Bogart and Klemens 2008).

At SARA, two individuals identified as “blue-spotted salamander” were captured in 1986 (NPS 1986). There are no known photos or any other details or descriptions. In the current survey, there were four encounters with members of this species complex. Ten adults, eight female and two of unknown sex, were captured in minnow traps at Schuyler Estate Canal on April 11, 2001. Photos of some of these individuals show a fair amount of blue spotting, some of which are large, on the flanks. The other three encounters were in Victory Woods. One hundred egg masses were recorded during egg mass counts on May 2, 2001 in Victory Woods Pond and single metamorphs were recorded during woodland time constrained search on August 4 and September 6, 2001. Photos of these metamorphs show a brown-gray individual with no blue spots or flecking. In addition, on April 11, 2011, an individual with small amounts of blue flecking was observed on the road adjacent to Stop 1 Pond. This was the first individual of this species complex recorded in the Battlefield Unit since nighttime spring road surveys began in 2001 (pers. comm., Larry Woolbright, Sienna College, April 13, 2011).

Although we do not know the genetic makeup of these individuals, this species complex occurs in all three SARA units and is therefore geographically widespread. The numbers recorded, representing an estimated 42 adults from two separate sites, Victory Woods Pond and Schuyler Estate Canal, suggest it is uncommon. Unfortunately, Victory Woods Pond was not sampled with

minnow traps in April, when adult salamanders would have been present (Table 19), so this number may be an under-estimate. Because most populations are mixes of mostly hybrids with small numbers of pure diploid sexual individuals, and visual identification is difficult because of color variation, we cannot determine which species or species complex the populations at Schuyler Estate Canal and Victory Woods Pond belong to. The female skewed sex ratio at Schuyler Estate Canal is consistent with a hybrid population (Bogart and Klemens 1997) and the heavy blue-spotting and presence in a floodplain marsh suggests this population may belong to *A. laterale* complex. Conversely, the lack of any blue flecking, and presence in a discrete, upland vernal pond suggests the population at Victory Woods Pond may belong to the *A. jeffersonianum* complex, as does the sparse blue spotting on the individual found near Stop 1 Pond. However, the only way to be certain of the taxonomic status of individuals and the populations they form is via genetic analysis of each population.

In summary, individuals of the Jefferson and Blue-spotted salamander complex have been recorded from all three units of SARA, and small populations are known to occur in Victory Woods Pond and Schuyler Estate Canal. Further effort is needed to better determine population size, and genetic analysis of individuals from these populations is needed to determine their taxonomic status.

Spotted Salamander (*Ambystoma maculatum*)

The spotted salamander is widely distributed throughout the Eastern United States and southeastern Canada (Petranka 1998) and in New England it occurs both inland and along the coastal plain, down to sea level (Klemens 1993). They occur primarily in forested landscapes and breed in vernal and semi-permanent ponds (Petranka 1998). Adults are most easily detected in early spring when they migrate on rainy nights from underground burrows to breeding ponds. Mating occurs in the ponds and females attach gelatinous egg masses to twigs and vegetation in the pond (Petranka 1998). Spotted salamanders are difficult to find once they leave the breeding ponds. Outside of the breeding season, spotted salamanders are terrestrial, primarily subterranean, and many disperse as far as 200 to 400 meters from their breeding ponds (McDonough and Paton 2007).

The spotted salamander is common and widespread in Southern New England (Klemens 1993) and is distributed statewide in New York (Gibbs et al. 2007). Historically, they were considered widespread and common in New York (DeKay 1842, Eckel and Paulmier 1902, Bishop 1941). Spotted salamanders were recorded at SARA in the 1980's (Lynch 1988, NPS 1998) but there are no data on abundance. In the recent New York Herp Atlas project, the spotted salamander was tied for the 11th most recorded native species, accounting for three of 79 (3.80%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the spotted salamander was the third most abundant of five salamanders at SARA, with a total of 182 recorded (RA =22.78%; Table 2). Although most spotted salamanders (51.6%) were encountered in permanent pond habitats, it was the second most widely distributed salamander (FO = 22%), recorded in all habitat types except permanent streams, permanent canals, and fields (Tables 2 and 3). Egg masses, recorded primarily during egg mass counts but also as incidental encounters, accounted for 72.5% of all adult equivalents recorded (each egg mass represents 0.633 females), whereas adults captured in minnow traps accounted for 23.1%

(Tables 6 and 8). The greatest numbers of spotted salamanders were recorded at Victory Woods Pond (36.8% of all recorded), but moderate numbers were also recorded at Stop 8 Ponds, Schuyler Estate Canal, and Vernal Ponds Adjacent to Stream 4 (Table 4).

Our data suggest that spotted salamanders are widespread but not particularly numerous at SARA. Compared to many other areas in the Northeast where they occur, the number of egg masses found in breeding ponds at SARA are low (see Cook et al. 2006b for review). Only Victory Woods Pond, with 106 egg masses, had egg mass counts indicative of a viable population (i.e. >104 egg masses; Windmiller 1996) whereas ponds in the Battlefield Unit had relatively few or no egg masses (Table 10). However, based on other, long term data (Woolbright, unpublished data), it turns out that April 2001 was extremely dry and the number of spotted salamander egg masses laid in Battlefield Unit vernal ponds in 2001 was relatively few, limited by lack of rainfall and low water levels (Woolbright 2001). Long term data collected from 2001 thru 2009 indicate that it was not until 2003 that the full extent of vernal ponds present at SARA were known and sampled consistently each year (Woolbright 2001, 2002, 2003, unpublished data). During the period 2001 thru 2009, when the number of ponds sampled was nine in 2001, 12 in 2002, and 25 thereafter, the mean number of egg masses/pond surveyed ranged from 2.7 in 2007 to 31.2 in 2002, with a mean of 11. In 2001 it was 6.0 egg masses/pond surveyed, the second lowest during this period. For the full complement of 25 vernal ponds, sampled from 2003 thru 2009, total egg mass counts for all ponds sampled ranged from 217 in 2003 to 596 in 2008, with a mean of 238 and a standard deviation of 183 (Woolbright, unpublished data).

These long term data show that breeding effort by spotted salamanders sometimes varied dramatically from one year to the next and that the population of spotted salamanders at SARA is far larger than 2001 data alone would suggest. Breeding effort (i.e. numbers of egg masses laid) by vernal pond breeding amphibians is positively correlated with migration season rainfall and breeding pond water levels (Pechmann et al. 1991) and population size of spotted salamanders in any given year can also vary from one year to the next as a function of the effect of hydro-period length on larval survival in preceding years, which is also affected by rainfall. However, even after taking all these factors into account, it still appears that spotted salamanders are not numerous at SARA. Only a couple of ponds appear to support significant populations, with one, Stop 8 Fern Field Pond supporting the largest breeding population of spotted salamanders in the Battlefield Unit. With an annual average of 142 egg masses and a maximum of 451 recorded in 2008, it accounted for 61% of all the spotted salamander egg masses recorded from 2001 thru 2009 (Woolbright, unpublished data).

Studies in Massachusetts have shown that, similar to wood frogs, the occurrence and abundance of spotted salamanders are negatively related to measures of urbanization such as amount of impervious surface, road length, amount of dense residential development (Clark et al. 2008) and populations decline dramatically when forest adjacent to vernal ponds are replaced by urban development (Windmiller et al. 2008). Similar negative relationships to measures of urbanization or positive relationships to amount of intact forest have been documented in Rhode Island (Skidds et al. 2007, Egan and Paton 2008). These and other studies have shown that the ideal landscape for spotted salamanders is a non-urbanized, non-fragmented, roadless, forested landscape with well drained soils and moderately hilly topography, containing relatively large

(>1000 square meter), deep (>1 m), fishless, permanent or semi-permanent ponds (Windmiller 1996, Egan and Paton 2004). Spotted salamanders are not well adapted to fragmented, urbanized landscapes (Rubbo and Kiesecker 2005), although they can persist in suburban and agricultural landscapes where forest cover exceeds ca. 30-50% (Gibbs 1998, Homan et al. 2004). Juveniles did not survive to maturity in fields, and ponds surrounded by non-forested habitats may be population sinks (Rothermel and Semlitsch 2006). In addition, the use of road de-icing salts may have negative effects on spotted salamander populations near roads via reduced embryonic and larval survival (Karraker et al. 2008).

Given that spotted salamanders and wood frogs have similar upland landscape requirements and wood frogs are common at SARA, differences in their abundance may be related to breeding pond attributes. Although both species use vernal pools, spotted salamanders are most abundant in long hydro-period vernal ponds and semi-permanent ponds, whereas wood frogs are most abundant in and dominate medium duration vernal ponds (Babbitt et al. 2003, Egan and Paton 2004). Long term egg mass count data for SARA from 2003 thru 2010 (Woolbright, unpublished data) show that total wood frog egg mass counts are much higher than spotted salamander (mean annual total of 3645 v. 238, respectively) and pond occupancy rates are consistently higher for wood frog (mean annual naïve occupancy rate =79%, range 65-88%) than spotted salamander (mean annual naïve occupancy rate =45%, range 28-58%). Taken together, these data indicate that the woodland vernal pools of SARA are far more suitable for wood frogs than spotted salamanders and suggest that hydroperiod duration in the vast majority of these ponds is generally not long enough to support large populations of spotted salamanders. Thus although spotted salamanders are widespread at SARA, their abundance appears to be limited by a lack of long hydroperiod woodland vernal pools. They are and will remain relatively uncommon.

Red-spotted Newt (*Notophthalmus v. viridescens*)

Eastern newts (*Notophthalmus viridescens*) occur throughout most of the Eastern United States and Southeast Canada, with the red-spotted newt, sub-species *viridescens*, ranging from Canada south through the Northeastern United States, down through Virginia and inland through Appalachia (Petranka 1998). The red-spotted newt has one of the most complex and variable life cycles of all North American salamanders (Roe and Grayson 2008). Adults typically occur in permanent ponds and lakes and are aquatic year round in these habitats. They can also occur in and breed successfully in long hydroperiod vernal ponds, although they achieve higher densities in permanent ponds (Herrmann et al. 2005). Following a typical aquatic embryonic and larval stage, larvae transform in their first year into a terrestrial juvenile stage known as a red eft. The eft, bright orange with red spots, may be found under logs and brush or seen moving in woodlands and grassy areas, particularly during rain (Petranka 1998). The eft may spend 2-7 years on land before returning to water and transforming into an aquatic adult, taking on the adult's green coloration and keeled tail (Healy 1974). Thus, unlike nearly all other amphibians, the red-spotted newt generally metamorphoses twice. However, in some populations such as coastal populations of Massachusetts, the red eft stage is absent or very rare (Healy 1974).

In addition to the terrestrial efts, which are the primary stage for dispersal, post-breeding adults may also leave the pond and become terrestrial (Roe and Grayson 2008). Adults left a semi-permanent pond and moved into and hibernated in an adjacent forest, mostly within 100 m of the pond (Regosin et al. 2005). Although red efts may be handled safely by humans, they have skin toxins that deter potential predators (Hurlbert 1970). This enables their conspicuous activities in

both aquatic and terrestrial habitats. The red-spotted newt is considered to be a keystone predator in temporary pond communities where the species controls insect populations and anuran species composition (Kurzava and Morin 1994).

The red-spotted newt is common to abundant in Southern New England (Klemens 1993) and occurs statewide in New York (Gibbs et al. 2007). Historically they were considered the most widespread, common, and most frequently observed salamander in the state, with several records from Saratoga County (DeKay 1842, Eckel and Paulmier 1902, Bishop 1941). Red-spotted newts have previously been recorded at SARA by a number of observers in the 1980's (NPS 1986, 1998, Lynch 1988) and Troha (1995) observed many crossing the tour road after rain. In the recent New York Herp Atlas project, red-spotted newt was tied for the 16th most recorded native species, accounting for two of 79 (2.53%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the red-spotted newt was the most abundant of five salamanders at SARA, with a total of 266 recorded (RA = 33.29%, Table 2). Although recorded in all habitat types except fields (Table 2) and moderately distributed (FO = 19.6%), the majority (83.1%) of red-spotted newts were recorded in permanent pond habitats (Tables 2 and 3). Most (87.6%) were recorded in minnow trap surveys (Tables 6 and 8). The greatest numbers of red-spotted newts were recorded at Burdyl Pond (73.3% of all recorded), but moderate numbers were also recorded at Beaver Marsh, Stop 1 Pond, and Service Road Pond (Table 4). Woolbright (2001) recorded a total of 10 red-spotted newts in two of 11 wetlands (18.2%) he surveyed using TCS, which is a method less effective at detecting newts than minnow traps (Tables 14, 19). Based on our results, the red-spotted newt appears to be common and moderately widespread at SARA.

There is a growing body of literature linking absence or decline of red-spotted newts on landscapes subjected to forest clearing, habitat fragmentation, and urbanization (Guerry and Hunter 2002, Rubbo and Kiesecker 2005, Steen and Gibbs 2005). They have been found to disappear from habitat patches when forest cover decreases below approximately 50% (Gibbs 1998) and achieve much greater densities when forest cover within 500 meters of breeding ponds exceeds 81% (Herrmann et al. 2005). In addition, clear-cut timbering may significantly affect red-spotted newt populations (Petranka et al. 1993) and repopulation may take 30-60 years (Pough et al. 1987). The high sensitivity of red-spotted newts to habitat loss and forest fragmentation may also be due to the vulnerability of red efts to road kill during their many years of long distance terrestrial movements (Gibbs 1998, Cushman 2006). Plus, adults may become terrestrial when breeding in semi-permanent or vernal ponds (Regosin et al. 2005) and also become vulnerable to road kill. Although red-spotted newts may have experienced declines during peak de-forestation in the late 19th century (Vana-Miller et al. 2001), at ca. 2/3 forested and with only moderate amounts of roads and traffic, the current landscape at SARA appears to support a population of red-spotted newts that is relatively common and stable.

Northern Dusky Salamander (*Desmognathus fuscus*)

The northern dusky salamander ranges from Southern Quebec through the Northeast, down to South Carolina via the Appalachian Mountains (Conant and Collins 1998). In the Northeast, it is widely distributed from sea-level to high elevations, but rarely found on the deep glacial deposits of the coastal plain (Klemens 1993). This streamside salamander is found under rocks and logs in the water and along the edge of cool woodland streams, springs, and seeps, particularly within

mature forests. Northern dusky salamanders are mostly nocturnal and can be observed moving over rocks along the stream edge searching for food (primarily invertebrates) on cool, moist nights between late-spring and mid-autumn (Gibbs et al. 2007). Adults often move only a few meters along a stream over many months. Females typically deposit egg clusters in a scooped out depression under rocks or logs along the edge of a stream, and will brood the eggs for a period of time before they hatch. Larval development takes place in the stream and metamorphosis occurs in 7-11 months (Petranka 1998, Gibbs et al. 2007).

Historically, northern dusky salamanders were considered one of the most common and widely distributed salamanders in New York State, found in rapid and shallow streams under stones (Eckel and Paulmier 1902, Bishop 1941). In nearby Albany County, they were considered the most common salamander (Bishop 1923a) and in Saratoga County, one was recorded in the town of Fortsville (Bishop 1941), about 9 miles north northwest of Schuylerville. One of four surveys/species lists from the 1980's and 1990's lists dusky salamander (NPS 1986, 1998, Lynch 1988, Troha 1995), but without any details, description, or known documentation. No dusky salamanders were recorded in the current survey, nor were any recorded by the New York Herp Atlas project in the four Herp Atlas quads (an area of approximately 600 km²) that overlap with SARA (Breisch and Ozard, in prep).

Although we have included the dusky salamander as a species "likely historically present at SARA" based its inclusion on an early species list (NPS 1998), and recent maps (Gibbs et al. 2007) show it ranging across the Hudson River Valley of Saratoga County, we are uncertain of its occurrence at SARA. New York State Herp Atlas distribution maps provide a finer scale of resolution and show that records for this species in Saratoga County and adjacent Washington County, on the east side of the Hudson River, are not in close proximity to the river, but rather in topo quads at higher elevation (NYSDEC 2011, <http://www.dec.ny.gov/animals/44511.html> accessed March 5, 2012). These suggest that lower elevation sites in the Hudson River Valley may currently be unsuitable for dusky salamanders.

A number of studies have shown that stream salamanders, including the northern dusky, decline in occurrence and abundance as the nearby landscape becomes urbanized or deforested. These studies suggest that more than a narrow stream buffer of intact vegetation is needed to avoid these impacts (Willson and Dorcas 2003, Miller et al. 2007), which appear to be due to increased levels of sedimentation and higher velocity stormflow (Orser and Shure 1972). Increased sedimentation decreases the interstitial space between rock and gravel substrate, reducing the places where adult and larval salamanders can hide from predators or escape from being washed downstream during high stormflow, which also tends to be more severe in these altered watersheds (Lowe and Bolger 2002, Brannon and Purvis 2008, Barrett et al. 2010). Moreover, severe flooding can wash away cover objects such as leaves and logs, further reducing habitat quality (Price et al. 2010). Thus, although Bishop (1941) noted that both dusky and two-lined salamanders were ecologically more widespread than habitat specialists such as spring salamanders, other data from the Northeast (Bonin 1991, Klemens 1993, Southerland et al. 2004) indicate that dusky salamanders are not as widespread or as tolerant of upland habitat alterations as two-lined salamanders.

Although it is not possible to know for certain if dusky salamanders were present in the streams of SARA prior to the landscape alterations of the colonial era, it is likely they were. Absent from

cold, swift Adirondack brooks, they were common in small, slowly trickling brooks in the valleys (Weber 1928). They also occur in low elevation, low gradient streams elsewhere in the Northeast (Cook, pers. obs., Klemens 1995). However, considering the impacts of deforestation on stream salamanders, it is possible they did not survive peak deforestation at SARA, when, by 1870, 90% of the forest had been cleared (Vana-Miller et al. 2001). Moreover, given the importance of connectivity to other first order streams as sources for re-colonization following forest recovery (Lowe and Bolger 2002, Grant et al. 2009), it is unlikely that the streams at SARA, which drain into the Hudson River, could be easily re-colonized following extirpation. In addition to declines due to urbanization and deforestation, dusky salamanders have also declined in protected areas of the Northeast, such as Acadia National Park, where mercury contamination appears to have driven it to near extirpation (Bank et al. 2006). However, although mercury deposition is occurring in the vicinity of SARA (Chalmers et al. 2005), with its neutral to slightly alkaline pH stream water, excessive mercury levels do not appear to be a problem here (NPS 1997).

At Saint-Gaudens NHS in Cornish NH, 115 northern two-lined and 69 dusky salamanders were recorded using the same methods and crew as at SARA (Cook et al. 2008). Similarly, 307 northern two-lined and 254 dusky salamanders were recorded at Morristown NHS (Brotherton et al. 2005b). Thus, at sites where they were present, from 0.6 to 0.8 dusky salamanders were recorded for every two-lined salamander. We recorded 232 northern-two lined in this survey and Troha (1995) observed many two-lined salamanders in Great Falls Creek without either of us finding any dusky salamanders. This strongly suggests that dusky salamanders are currently not present at SARA. We believe they were present prior to colonial-era land clearing, but there is no way to determine if they were present at the time of the park's establishment in 1938.

Northern Two-lined Salamander (*Eurycea bislineata*)

The Northern two-lined salamander (*Eurycea bislineata*) occurs throughout the Eastern United States from the Gulf of Mexico north into Quebec, Canada (Petranka 1998). This stream salamander is typically more aquatic than the northern dusky salamander, often found in the stream and splash zones of cool, swift moving streams. Females deposit eggs singly on the underside of flat rocks in streams (Petranka 1998). The northern two-lined salamander is the most widespread and abundant stream salamander in the Northeast, as well as the most urban tolerant (Klemens 1993, Gibbs et al. 2007).

The two-lined salamander is common and widespread in New York, with the exception of eastern Long Island (Gibbs et al. 2007). Historically, they were considered widespread and common in New York with several records from Saratoga County (DeKay 1842, Eckel and Paulmier 1902, Bishop 1941). Two-lined salamanders have previously been recorded at SARA by a number of observers in the 1980's (NPS 1986, 1998, Lynch 1988) and Troha (1995) found them common in "Devil's Hollow", now called Great Falls Creek. In the recent New York Herp Atlas project, the two-lined salamander was tied for the 11th most recorded native species, accounting for three of 79 (3.80%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the northern two-lined salamander was the second most abundant of five salamanders at SARA, with a total of 232 recorded (RA = 29.04%, Table 2). It was one of the least widely distributed amphibians (FO = 15%), with the majority (98.7%) recorded from

permanent stream habitats and three individuals (1.3%) in woodland habitat (Tables 2 and 3). Nearly all (98.7%) northern two-lined salamanders were recorded via stream TCS (Tables 6 and 8). The greatest numbers of northern two-lined salamanders were recorded at Stream 8-Great Fall Creek (105 or 45.3% of all recorded), with significant numbers also in Stream 6-Mill Creek South (56 or 24.1%) and Stream 4-Mill Creek Middle (50 or 21.6%; Table 4). Capture rates in these three sites were similarly high, 45.65 individuals/search hour, 13.67, and 16.67, respectively (Table 12). Both these individual capture rates, as well as the overall capture rate for SARA (12.05 inds/hr) are higher than any other park in the NETN that we surveyed. At Minuteman NHS, the capture rate for adults is 6.49 inds/hr for Elm Brook South and 3.25 inds/hr for both Elm Brook North and South combined (Cook et al. 2011a). This is comparable to capture rates at another nearby urban site, Saugus Iron Works (6.3 inds/hr)(Cook et al. 2010) and with capture rates at Saint-Gaudens NHS (SAGA) in rural New Hampshire and Acadia National Park in Maine. At SAGA's Blow-Me-Up Brook, the capture rate in 2001 (by the same field crew that surveyed SARA) was 7.74 inds/hr (Cook et al. 2008). At Acadia, the overall capture rate for adults was 2.8 inds/hr (Brotherton et al. 2005a).

Our data indicate that northern two-lined salamanders are common at SARA and the population here appears to be relatively dense. As a stream salamander, their distribution at SARA is closely tied to streams, and having been recorded from 5 of 7 stream sites sampled, they appear to be widespread within this habitat. Great Falls Creek (formerly Devil's Hollow) was "full of" two-lined salamanders and the only site at SARA that Troha (1995) consistently found them. Our results (Table 12) indicate that Great Falls Creek continues to be the prime stream for this species at SARA. Although urbanization and forest clearing in the adjacent landscape can lead to declines in stream salamanders (Willson and Dorcas 2003, Price et al. 2006), the two-lined salamander is relatively tolerant of urbanization (Klemens 1993) and some loss of forest canopy (Gibbs et al. 2007). It is generally the most widespread and abundant stream salamander, and most tolerant of habitat degradation (Southerland et al. 2004). Thus, the pre-dominantly forested landscape of SARA appears to provide high quality habitat for this species and we expect it will continue to be widespread and common.

Northern Spring Salamander (*Gyrinophilus porphyriticus*)

The northern spring salamander is a brightly colored, semi-aquatic salamander belonging to the family Plethodontidae, which lack lungs and respire through their skin. Because of its relatively large size and lack of lungs, the spring salamander is typically found in cold, clean high-relief, well oxygenated and shaded mountain seeps, springs, and streams (Markowsky 1999, Petranka and Smith 2005). Its range is largely centered along the length of the Appalachian Mountains and its foothills from Northern Georgia to Southern Maine and Quebec (Conant and Collins 1998). Larvae are aquatic, a stage that lasts an average of four years (Bishop 1941) so they can only successfully breed in permanent streams. Adults are highly aquatic, but often use terrestrial habitat adjacent to streams, primarily within 20 meters (Petranka and Smith 2005). This species is largely nocturnal in their surface activity, spending much of the daytime hours under large stones or deep beneath talus within seeps and creeks. They emerge typically on cool, wet nights to forage, primarily on earthworms, insects, and other salamanders (Gibbs et al. 2007).

The northern spring salamander is common in many creeks in central New York but is rarely found in streams in the Adirondack Mountains and does not appear to occur east of the Hudson

River south of Rensselaer County (Gibbs et al. 2007). They are rare in Southern New England, limited to elevations above 500 feet (Klemens 1993). Historically, spring salamanders were considered widespread in New York State and locally common in appropriate habitat, such as cool mountain springs and streams (Eckel and Paulmier 1902, Bishop 1941). They were common in cold mountain brooks of the Adirondacks (Weber 1928) and, near the base of the Helderberg Mountains in Albany County they were nearly as abundant as two-lined and dusky salamanders in headwater streams that originate in cold clear springs (Bishop 1923a). In Saratoga County they were recorded in the town of Wilton (Bishop 1941), about 10 miles northwest of Schuylerville. At SARA, one of four surveys/species lists from the 1980's and 1990's lists a single spring salamander (NPS 1986, 1998, Lynch 1988, Troha 1995), but without any details, description, or known documentation. No spring salamanders were recorded in the current survey, nor were any recorded by the New York Herp Atlas project in the four Herp Atlas quads (an area of approximately 600 km²) that overlap with SARA (Breisch and Ozard, in prep).

Although we have included the spring salamander as a species “likely historically present at SARA” based on the single record (NPS1986) and recent maps (Gibbs et al. 2007) show it ranging across the Hudson River Valley of Saratoga County, we doubt its occurrence at SARA. New York State Herp Atlas distribution maps provide a finer scale of resolution and show that records for this species in Saratoga County and adjacent Washington County, on the east side of the Hudson River, are not in close proximity to the river, but rather in topo quads at higher elevation (NYSDEC 2011, <http://www.dec.ny.gov/animals/44494.html>, last accessed March 5, 2011).

A number of studies have shown that stream salamanders decline in occurrence and abundance as the nearby landscape becomes urbanized or deforested. These studies suggest that more than a narrow stream buffer of intact vegetation is needed to avoid these impacts (Willson and Dorcas 2003, Miller et al. 2007), which appear to be due to increased levels of sedimentation and higher velocity stormflow (Orser and Shure 1972). Increased sedimentation decreases the interstitial space between rock and gravel substrate, reducing the places where adult and larval salamanders can hide from predators or escape from being washed downstream during high stormflow, which also tends to be more severe in altered watersheds (Lowe and Bolger 2002, Brannon and Purvis 2008, Barrett et al. 2010). Moreover, severe flooding can wash away cover objects such as leaves and logs, further reducing habitat quality (Price et al. 2010). In the northern foothills of the Adirondacks, spring salamanders were the least widespread of three stream salamander species, and were found only in streams above 190 m in mature maple-hemlock forest. This distribution was believed to be related to proximity to springs and presence of undisturbed forest (Bonin 1991). In New Hampshire headwater streams, abundance of spring salamanders was negatively affected by the presence of brook trout, recent timber harvest, and embeddedness of substrate by sediments, and positively affected by a stream's connection to another first order stream (Lowe and Bolger 2002).

It is not possible to know if spring salamanders were present in the streams of SARA prior to the landscape alterations of the colonial era. However, even if they were present, given what we know about the impacts of deforestation on spring salamanders, plus the relationships between their occurrence and undisturbed, forested, headwater streams, it is hard to imagine spring salamanders surviving peak deforestation at SARA, when, by 1870, 90% of the forests had been cleared (Vana-Miller et al. 2001). Also, given the importance of connectivity to other first order

streams as sources for re-colonization following forest recovery (Lowe and Bolger 2002, Grant et al. 2009), it is unlikely that the streams at SARA, which drain into the Hudson River, could be easily re-colonized. Finally, stream water temperatures at SARA average from 18 to 19°C, with maxima between 25 to 29°C (NPS 1997) whereas in New Hampshire headwater streams where spring salamanders occur, heat of day, summertime water temperatures were 13 to 17 °C (Lowe 2005). Although based on species from the Pacific Northwest, Bury (2008) suggested that stream temperatures above 24°C had the potential to negatively impact cold-water stream amphibians. Given this, and the differences between maximum stream water temperatures at SARA versus those in New Hampshire streams occupied by spring salamanders, it suggests that stream water temperatures may be too high for spring salamanders at SARA.

Among the region's stream salamanders, spring salamanders are more sensitive to deforestation and dependant on a narrow range of habitat conditions generally associated with undisturbed, cool, headwater streams. In the northern Adirondacks, they were the least widely distributed species followed by northern dusky salamander, and northern two-lined salamander (Bonin 1991). This pattern was also found in Maryland, where both occupancy and abundance was least for spring salamanders, greatest for two-lined, and both spring and dusky salamanders were considered intolerant of stream degradation (Southerland et al. 2004). Given all these considerations, plus the fact that the presence of the generally more widely distributed and disturbance-tolerant dusky salamanders at SARA is also questionable, our best judgment is that the northern spring salamander is not and probably never was present at SARA since its establishment as an NPS unit in 1938. Whether it was ever present on the original, pre-agrarian landscape is a question we cannot answer.

Eastern Red-backed Salamander (*Plethodon cinereus*)

The eastern red-backed salamander is a lung-less terrestrial salamander that is widespread and common throughout the Northeast, including New York State (Gibbs et al. 2007) and New England (Klemens 1993). It occurs as a number of different color morphs, with the red-striped and un-striped (or lead-backed) the two most common and widespread (Petranka 1998). They reach their greatest density in well-drained deciduous and mixed forests with well-developed leaf litter (Gibbs et al. 2007) and dominate the vertebrate biomass in some forest ecosystems (Burton and Likens 1975). However, eastern red-backed salamanders are not necessarily restricted to mature forest habitats (Klemens 1993) and at Cape Cod National Seashore, they can also be found in open habitat and under woody debris deposited by storm surge at the upper limits of salt marshes (R. Cook, pers. obs.). Because all embryonic and larval development takes place in the "aquatic" environment within the egg membrane, eastern red-backed salamanders are completely terrestrial and do not require wetlands for reproduction. This attribute, in conjunction with their small home range and limited movements, has facilitated their widespread distribution and made them one of the most urban tolerant amphibians, capable of persisting in small woodland patches in highly fragmented urban landscapes (Schlauch 1976, Gibbs 1998).

The eastern red-backed salamander currently is and historically was widespread and abundant in New York State (DeKay 1842, Eckel and Paulmier 1902, Bishop 1941, Gibbs et al. 2007), including nearby Albany County (Bishop 1923a). Red-backed salamanders have been recorded at SARA by a number of observers and appear to have been widespread and common in the 1980's and 1990's (NPS 1986, 1998, Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, the eastern red-backed salamander was tied for the 11th most recorded native

species, accounting for three of 79 (3.80%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the eastern red-backed salamander was the fourth most abundant of five salamanders at SARA, with a total of 77 recorded (RA = 9.64%; Table 2). It was the most widely distributed (FO = 24%) salamander at SARA, with half (50.6%) recorded from seven woodland sites and an additional 42.9% recorded in permanent stream habitats (Tables 2 and 3). TCS of these two habitats produced the vast majority; woodland TCS (49.4%) and stream TCS (36.4%; Table 6 and 8). Red-backed salamanders recorded in stream habitat were above the flowing water of the stream zone, in the splash or bank zones. The site with the greatest numbers recorded was Stream 8 - Great Fall Creek (Devil's Hollow) (32.5% of all recorded), and Woodland 6 and Woodland 2 each had 15.6% of the total.

Red-backed salamanders move both horizontally between forest litter and cover objects, as well as vertically into the soil and underground burrows, in response to variation in surface moisture. At high levels of surface moisture they make greater use of leaf litter, retreating to cover objects at the surface as moisture decreases. If moisture continues to decline to the point where it become dry under cover objects, they then move downward below the surface (Heatwole 1962, Jaeger 1980) and the ability to find them under cover objects dramatically decreases during long dry periods (Bishop 1941). Considering the drought conditions in 2001, this may have limited the numbers recorded in woodland habitats and led to the relatively large numbers found in stream habitats, where moisture levels in stream beds were presumably higher. Further evidence suggesting that red-backed salamanders are more common in SARA uplands is seen in other long term data. Whereas no red-backed salamanders were recorded during nighttime driving surveys in spring 2001, 2002, 2003, 2004, a "huge migration" was observed on the tour road at mile 4.8 in 2005 (Woolbright 2001, 2002, 2003, 2004, 2005).

Overall, the eastern red-backed salamander appears to be widespread and common in SARA, especially in forested habitats. Given its relatively simple habitat requirements and ability to persist even in small patches of forest (Gibbs 1998), they are likely to remain common on the mostly forested landscape of SARA.

Eastern Spadefoot Toad (*Scaphiopus h. holbrookii*)

The eastern spadefoot toad occurs along the Northeast coast, as far north as Massachusetts, and extends south into and through the southeast (Conant and Collins 1998). It is rare and localized in southern New England (Klemens 1993), although fairly common on Cape Cod (Cook 2005). In New York State it occurs on Long Island and in the Hudson River Valley (Gibbs et al. 2007). The eastern spadefoot toad is derived from ancestors that inhabited deserts in the Southwest United States, where ability to take advantage of unpredictable and infrequent rainfall events has resulted in a breeding strategy of "irrupting" after heavy rainfalls to breed in resultant puddles. Hence, spadefoot toads are able to breed in very short hydro-period wetlands and, because they spend most of their time burrowed underground, they can be common on landscapes dominated by sandy substrate, open vegetation, and an abundance of temporary ponds (Cook 2005). Because the open, sandy habitats that provide ideal habitat for spadefoot toads are easily developed (Gibbs et al. 2007), spadefoot toads have declined with urbanization (Schlauch 1976, Klemens 1993). Spadefoots are currently listed by the New York State Department of Environmental Conservation as a "Special Concern" species and only a few spadefoot toad

populations occur in New York State, either on Long Island or in the Hudson River valley in Albany and Saratoga Counties (<http://www.dec.ny.gov/animals/44629.html>, last accessed March 5, 2012).

Historically, little was known about the distribution of spadefoot toads in New York State, although they appeared to be common where they did occur (DeKay 1842, Eckel and Paulmier 1902). Ditmars (1905) considered them rare in the vicinity of New York City, but he recognized that their habits made them hard to find and they were more common than observations suggested. Spadefoots were abundant and widespread on Long Island, occurring on both glacial moraine and outwash plains (Overton 1914, 1915, Noble 1927). Their historic abundance on Long Island reflects their burrowing habits and association with sandy habitats, and the sandy nature of Long Island's glacial deposits. In his report on the toads and frogs of Albany County, Bishop (1923b) did not report spadefoots, but they were subsequently reported from the Albany Pine Bush, a sandy, pitch pine-scrub oak community about 21 miles south of SARA (Stewart and Rossi (1981). Although not found in Albany county outside of the Pine Bush, spadefoot toad was considered one of several southern species which extended their range northward up the Hudson River Valley into the "greater sand plains of Albany, Schenectady, Saratoga, and Warren counties" (Stewart and Rossi 1981).

Spadefoot toads have never been recorded at SARA, but NY State Herp Atlas records from along the Hudson River in Albany County, as well as Saratoga County records from the Quaker Springs and Gansevoort quadrangles indicate that SARA lays within their known range. Based on the recent record from the Quaker Springs quadrangle, in which a portion of SARA lies, we consider the spadefoot toad as present adjacent to SARA. Because of their irregular breeding and burrowing behaviors, spadefoot toad populations can go undetected for decades (Klemens 1993). Although there has been fairly intensive survey activity on rainy nights for the past decade on the tour roads of the Battlefield Unit without any records of spadefoot toads, spadefoots may be more likely to occur on the Hudson River floodplain, where soils are mostly sandy and well drained (USDA NRCS 2004). We would therefore, consider the spadefoot toad to be a potentially-occurring species at SARA whose status remains unknown.

Eastern American Toad (*Anaxyrus americanus*)

The eastern American toad occurs throughout most of the Eastern United States and Canada, ranging from Northern Louisiana and Southern Appalachia northward into northern Ontario and Quebec (Conant and Collins 1998). It is widespread and common throughout the Northeast (Klemens 1993, Gibbs et al. 2007), although in Southern New England and along the Atlantic coast, it occurs primarily inland, away from the more open and xeric coastal habitats, where the closely related Fowler's toad (*Anaxyrus fowleri*) predominates (Klemens 1993). The American toad is a terrestrial species that breeds in early spring in a variety of shallow aquatic habitats including temporary ditches, flooded meadows, marshes and ponds (Klemens 1993). It is easily identified in spring by its prolonged, high pitched, trilling call. American toads occur in moist upland woods and meadows and appear to be less sensitive to habitat fragmentation than many other amphibian species (Hager 1998, Kolozsvary and Swihart 1999). They are most abundant on landscapes with more pasture, deciduous and mixed forest and less evergreen forest and less urbanization, but are also found in various human-altered habitats on suburban landscapes (Gibbs et al. 2007).

Common throughout New York State except for Long Island (Gibbs et al. 2007), the American toad was historically considered common and widespread (Eckel and Paulmier 1902), including in nearby Albany County (Bishop 1923b). American toads have previously been recorded at SARA by a number of observers (NPS 1986, 1998, Lynch 1988, Troha 1995) suggesting they were fairly common in the 1980's and 1990's. In the recent New York Herp Atlas project, American toad was tied for the fourth most recorded native species, accounting for six of 79 (7.6%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the American toad was the fourth most abundant of eight anurans at SARA, with 396 recorded (RA=4.41%; Table 2). It was widespread (FO = 33%) and recorded in all habitat types except fields, highlighting this species' extensive movements and diverse habitat use (Tables 3 and 4). We recorded the grand majority (94.7%) of eastern American toads in permanent canal and marsh habitat during the breeding season, with 67.7% recorded during anuran calling surveys and 26.0% during pond TCS (Tables 6 and 8). We recorded the greatest numbers at Vly Marsh (152 or 38.4% of all recorded), but Canal Below Stop 10, Canal South of Entrance, and River Road Marsh also had large breeding choruses (Tables 4 and 9).

Based on our data, the Eastern American toads appear to be widespread and somewhat common at SARA, with important breeding sites on the Hudson River floodplain. However, other data collected that same year (Woolbright 2001) suggest that American toads were slightly more widespread and abundant at upland ponds at SARA. In addition, in 2002 and 2003, American toads in full chorus (calling index 3) were also recorded from Stop1 Pond, Stop 2 Pond, Stop 8 Fern Field Pond, and Beaver Marsh (Woolbright 2002, 2003), indicating that these wetlands situated in the uplands of SARA are also used for breeding by large numbers of American toads. Thus it would appear that American toads breed extensively throughout SARA, although it appears that they primarily occur in the Battlefield Unit.

Although originally considered a species of inland, forest-dominated landscapes (Lazell 1976), the American toad was ubiquitous on a predominantly agrarian landscape (Kolosvary and Swihart 1999). Their occurrence or abundance is greatest on landscapes dominated by agriculture and less on those dominated by urbanization or forest (Price et al. 2005, Gagne and Fahrig 2007). In northern Maine, American toad occurrence at ponds declined when adjacent forest cover exceeded ca. 2/3 (Guerry and Hunter 2002). Although American toads breed in both temporary and permanent pools (Knutson et al. 1999, Herrmann et al. 2005) and appear to be unaffected by the amount of forest cover within 100 m of breeding ponds (Eigenbrod et al. 2008), they avoid breeding in closed canopy ponds (Skelly et al. 1999). Thus, as forest succession continues in some parts of SARA, some woodland ponds may become less favorable for American toads, although beaver may help maintain the open canopy wetlands preferred by American toads. The mixed forest and agrarian landscape of SARA is and should continue to be favorable to American toads here and we expect they will remain widespread and common.

Fowler's Toad (*Anaxyrus fowleri*)

Fowler's toad is widespread in the Eastern U.S., extending from Southern New England southwest to Eastern Texas and along the Gulf Coast to the Florida panhandle (Conant and

Collins 1998). In the Northeast it is found mostly along the coastal plain, extending inland up river valleys naturally and extending inland elsewhere in response to forest clearing (Lazell 1976, Klemens 1993). Fowler's toads are primarily terrestrial, foraging and hibernating on land and migrating to wetlands to breed. They are habitat specialists found primarily in sparsely vegetated, sandy areas (Breden 1988) and breed in both permanent and temporary freshwater wetlands, avoiding those with a canopy of woody vegetation (Tupper and Cook 2008).

In New York State, Fowler's toad is most widespread and abundant on Long Island, but it also extends up the Hudson River Valley, "with concentrations in the Albany Pine Bush and Saratoga and Warren Counties" (Gibbs et al. 2007).

The historic status of Fowler's toad is uncertain because 19th century naturalists in New York (Dekay 1842, Eckel and Paulmier 1902) did not realize that American and Fowler's toad were two different species. Early accounts appear to be a composite of the two species, which naturally tended to occupy different habitat types and breed at different times. Where their ranges overlap, these differences tend to separate them locally. However, landscape changes such as colonial-era land clearing helped break down reproductive isolation between the two species and lead to hybridization (Lazell 1976). By the early 20th Century, both species were recognized. Bishop (1923b) noted the presence of Fowler's toad in Albany County and Noble (1927) indicated that Fowler's Toad were common on Long Island and elsewhere in New York and New Jersey. More recently, Fowler's toads were recorded from the Albany Pine Bush, but were not nearly as widespread and common there as the American toad (Stewart and Rossi 1981).

Although they did not find it in Albany County outside of the Pine Bush, Stewart and Rossi (1981) considered Fowler's toad one of several southern species which extended their range northward up the Hudson River Valley into the "greater sand plains of Albany, Schenectady, Saratoga, and Warren counties". Fowler's toad is listed as occurring at SARA (NPS 1998), but no details or documentation are provided. We did not record any Fowler's toads in this survey, nor have any been encountered at SARA in the course of nighttime road surveys from 2001 thru 2009 conducted by Sienna College. Given the uncertainty of the original species list, it is impossible to know if Fowler's Toad occurred at SARA in recent times. However, New York State Herp Atlas records from sites along the Hudson River both north and south of SARA (<http://www.dec.ny.gov/animals/44609.html>, last accessed March 5, 2012), show that SARA is within its current range in the Hudson River Valley and suggest the record (NPS 1998) is possible.

At Saint-Gaudens NHS in Cornish NH, along the Connecticut River, based on vocalizations, all toads encountered were American toads. However some showed some characteristics of Fowler's toad, evidence of past hybridization between the two species (Cook et al. 2008). The lack of any current records of Fowler's toad at SARA, in spite of a fair amount of survey work taking place, suggests that Fowler's toad is absent or perhaps so rare that its presence is obscured by all the American toads present. A closer look at American toads at SARA may be called for to determine if there is any evidence of hybridization between the two species.

Gray Treefrog (*Hyla versicolor*)

Gray treefrogs occur throughout most of the Eastern United States as a pair of sibling species distinguished from each other in the field only by voice (Conant and Collins 1998). The species

most well known in New York, *Hyla versicolor*, is found throughout the Northeast and Canada (Klemens 1993). The sibling species (*Hyla chrysocelis*) looks similar in appearance and occurs in New York to an unknown extent (Gibbs et al. 2007). The gray treefrog has large toe pads, orange/yellow coloration on the underside of the hind limbs, and their dorsal color ranges from gray to brown, green, light gray, to almost white depending on activity and environmental conditions (Conant and Collins 1998). Grey treefrogs live high in trees and shrubs, descending to wetlands to breed (Behler and King 1979). Because gray treefrogs breed moderately late in the season (Cook et al. 2011b), yet have larvae that metamorphose later that same year, they tend to breed in long hydro-period vernal or semi-permanent ponds. After metamorphosis, the majority of juveniles remain in close proximity (i.e., within 35 meters) to natal wetlands, but adults are more mobile and frequently make migrations of 200 meters or more between foraging grounds, overwintering sites, and breeding ponds (Johnson et al. 2007).

Gray treefrogs are abundant and widespread in Southern New England (Klemens 1993) and occur statewide in New York, with the exception of the Western Catskills (Gibbs et al. 2007). Historically they were widespread in New York (Dekay 1842) and common in Albany county (Bishop 1923b). More recently, they have also been widespread and common in SARA (Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, grey treefrog was tied for the 11th most recorded native species, accounting for three of 79 (3.8%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the gray treefrog was the second most abundant of eight anurans at SARA, with 1322 recorded (RA= 14.71%), and it was moderately distributed (FO = 26%; Tables 2 and 3). The majority of gray treefrogs were recorded in permanent pond (60.4% of total) and marsh habitat (39.0%) and when adjusted for number of sample sites, the numbers recorded in these habitat types were 133 and 129 per site sampled, respectively. Individuals were encountered in all habitat types except permanent streams, illustrating this species' diverse habitat utilization (Table 2). Most grey treefrogs were recorded during anuran calling surveys (63.8% of all individuals) and pond TCS (35.6%). The greatest numbers of gray treefrogs were recorded at Stop 1 Pond (30.7% of all recorded), but substantial numbers were also recorded at Burdyl Pond Service Road Pond, Schuyler Estate Canal, and Vly Marsh (Table 4).

Our results, as well as those of Woolbright (2001), who detected gray treefrog at 7 of 11 wetlands he surveyed at SARA and found it to be the third-most abundant anuran (RA = 4.70%) (Table 23), indicate that the gray treefrog is common and widespread at SARA. Grey treefrog populations have increased since the 1970's in Northern and West-central New York State (Gibbs et al. 2005). The occurrence and abundance of grey treefrogs is much less in urban landscapes than in rural landscapes (Rubbo and Kiesecker 2005). Among rural landscapes, a number of studies have found that grey treefrogs occur more frequently or are more abundant in natural or forested landscapes compared to agrarian landscapes (Hecnar and M'Closkey 1998, Anderson and Arruda 2006, Gagne and Fahrig 2007), but these differences were not always statistically significant. Moreover, Kolosvary and Swihart (1999) found grey treefrogs to be ubiquitous on an agricultural landscape where woodlands totaling only 16% of the landscape were restricted to riparian areas and small woodlots. Knutson et al. (1999) suggested that the

Table 23. Number of adult amphibians recorded at each of 11 wetland survey sites that overlapped between the current project (“NPS”) and survey work by Sienna College (“S”) during 2001 (Woolbright 2001) at Saratoga National Historical Park. Within order relative abundance (RA) is the number of a given species, divided by the total number individuals within each order (frogs or salamanders). Frequency of occurrence (FO) is the number of locations where a species was detected, divided by the total number of locations surveyed (11). x=recorded as present, but no quantitative data available.

Site	N. Spring Peeper		Gray Treefrog		N. Green Frog		Wood Frog		American Bullfrog		N. Leopard Frog		E. American Toad		Spotted Salamander		Red-spotted Newt	
Survey	S	NPS	S	NPS	S	NPS	S	NPS	S	NPS	S	NPS	S	NPS	S	NPS	S	NPS
Burdyl Pond	146	1,291	1	196	7	99	3	0	8	44	0	0	5	2	1	8	0	195
Service Road Pond	176	540	61	194	6	32	184	1	4	14	0	0	2	0	1	5	0	11
Stop 1 Pond	162	569	61	406	3	93	139	1	2	31	2	0	0	0	2	14	1	15
Davidson Pond	145	300	0	0	3	10	0	0	2	5	2	2	2	0	0	0	0	0
Stop 2 Pond	145	39	0	0	x	0	10	2	2	0	2	0	0	0	0	0	0	0
Stop 8 Ponds	500	181	3	1	45	2	518	53	4	1	0	0	10	8	29	27	0	2
Beaver Marsh	145	183	0	78	5	12	12	0	3	6	19	2	16	6	13	14	9	36
River Road Marsh	146	571	14	106	22	46	12	0	3	1	2	0	5	50	0	0	0	0
Vly Marsh	145	646	1	145	0	129	11	10	0	15	2	1	69	152	0	1	0	0
Canal Below Stop 10	x	265	x	5	x	29	0	0	x	5	x	3	x	91	0	0	0	1
Canal South of Entrance	x	201	0	0	0	55	0	0	0	17	x	0	x	70	0	0	0	0
Total # of Adults	1,710	4,786	141	1,131	91	507	889	67	28	139	29	8	109	379	46	69	10	260
Total # of Localities	11	11	7	8	9	10	8	5	9	10	8	4	9	7	5	6	2	6
RA (%)	57.1	68.8	4.7	17.9	3.0	6.7	29.7	1.1	0.9	1.9	1.0	0.1	3.6	3.5	82.1	21.0	17.9	79.0
FO (%)	100	100	63.6	72.7	81.8	90.9	72.7	45.5	81.8	90.9	72.7	36.4	81.8	63.6	45.5	54.5	18.2	54.5

ability of anuran populations to persist on landscapes heavily dominated by agriculture was because of their use of remnant natural habitats, rather than because croplands provided favorable habitat. Thus, the mix of forest, fields, and mixed wetlands at SARA, and its adjacent landscape of fields, forest, wetlands, and minor development would appear to be quite favorable for grey treefrogs and we expect they would remain widespread and abundant here.

Northern Spring Peeper (*Pseudacris c. crucifer*)

The spring peeper is widespread and abundant throughout the Eastern United States and Canada and breeds in a wide range of freshwater wetlands. Its unique, high-pitched breeding call is often a deafening chorus of hundreds of individuals. These loud and distinct calls, in combination with a prolonged calling season that stretches from mid-March to late-May make it the most readily detected of local anurans (Crouch and Paton 2002). Spring peepers are terrestrial outside of the breeding season, and utilize a broad range of terrestrial habitats (Gibbs et al. 2007). They tolerate human disturbance and manage to persist in many urban and suburban areas (Gibbs 1998, Zampella and Bunnell 2000), making them one of the most common and widespread frogs in Southern New England and New York (Klemens 1993, Gibbs et al. 2007).

Historically, spring peepers were common and widespread in New York state (Dekay 1842, Eckel and Paulmier 1902) and very common in the vicinity of Albany (Bishop 1923b). More recently, they have also been widespread and abundant in SARA (NPS 1986, Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, northern spring peeper was tied for the fifth most recorded native species, accounting for four of 79 (5.1%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the northern spring peeper was the most abundant of eight anurans at SARA, with a total of 5977 recorded (RA or relative abundance = 66.49%). It was tied for the second most widely distributed anuran, being found at 19 of 46 sites (FO = 41%; Tables 2 and 3). Most (81.0%) northern spring peepers were recorded in permanent pond and marsh habitats, but some were encountered in all habitat types, except permanent streams (Table 2). The greatest numbers were recorded at Burdyl Pond (21.6% of all individuals) and detected primarily via anuran calling surveys (75.4% of all individuals) and pond TCS (22.1% of all individuals; Tables 4 and 6).

Our results indicate that this species is abundant and widespread at SARA, both geographically and among habitat types. These results agree with those of Woolbright (2001), who detected northern spring peepers at all 11 wetlands he surveyed at SARA and found it to be the most abundant anuran in his survey (RA = 57.1%; Table 23). Spring peeper populations have increased since the 1970's in Northern and West-central New York State, and breeding sites where spring peepers persisted or increased had relatively less acidic soils and occurred in areas with less row crops, less developed lands, less cultivated grasses, less coniferous forest, more mixed forest, less open water, and less marsh than breeding sites where they were absent or disappeared from (Gibbs et al. 2005). The SARA landscape, dominated by forest and fields and well buffered, non-acidic wetlands shares many of these attributes. Moreover, although spring peeper abundance increases with forested area in the adjacent landscape (Herrmann et al. 2005, Eigenbrod et al. 2008), landscapes dominated by agriculture or a mix of forest and agriculture also support significantly higher abundances than urban landscapes (Gagne and Fahrig 2007). Thus SARA, dominated by forest with some field habitat and numerous wetlands, provides a

high quality landscape for spring peepers. As a generalist species able to breed successfully in a broad range of wetland types and tolerate all but the most intense urbanization, the spring peeper has been and continues to be an abundant species at SARA.

American Bullfrog (*Lithobates catesbeianus*)

The American bullfrog is widespread and common throughout much of its native range, which is “the eastern two-thirds of the United States and adjacent portions of Southern Canada and Northeastern Mexico” (Klemens 1993). It has also been introduced into many parts of the Western U.S., where it has negatively impacted native species (Adams 1999) and dramatically altered aquatic community structure (Kupferberg 1994). American bullfrogs require two or more years for their tadpoles to metamorphose, so their primary habitat requirement is a permanent, open water body with abundant emergent and shoreline vegetation (Conant and Collins 1998, Albright 1999). However, because American bullfrogs may require a few years beyond metamorphosis to reach adulthood and, in the case of males, attain a size capable of defending a breeding territory, juveniles may inhabit temporary ponds and streams and travel overland between these sites. This species is an aggressive predator and includes other frogs, young turtles, small snakes, and many invertebrates in its diet. It is adept at colonizing new habitats, especially those constructed or modified by humans (Lacki et al. 1992). Bullfrogs may increase on forested landscapes as it is altered by agriculture, urbanization, and stream impoundments (Zampella et al. 2010) and are considered relatively urban tolerant (Klemens 1993).

The American bullfrog is widespread and common throughout much of the Northeast (DeGraaf and Rudis 1983) as well as New York state (Gibbs et al. 2007). Historically it was common and widespread in New York State (Dekay 1842, Eckel and Paulmier 1902) and “abundant in the more permanent ponds” of nearby Albany county (Bishop 1923b). American bullfrogs were reported at SARA previously (Lynch 1988, Troha 1995) and in the recent New York Herp Atlas project, it was tied for the second most recorded native species, accounting for six of 79 (7.6%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the American bullfrog was the fifth most recorded anuran at SARA, with 174 recorded (RA=1.94%). It was moderately distributed, with a frequency of occurrence (30%) that approached that of some of the more abundant anurans (Tables 2 and 3). Considering that bullfrogs are top predators, well known for eating other anurans (Gibbs et al. 2007), it is not surprising that they are less numerous than related species lower on the food chain. Moreover, the majority (57.5%) of American bullfrogs were recorded from permanent pond habitats, and only six records (3.5%) were from temporary pond habitats, highlighting this species’ preference for permanent ponds (Table 2). This habitat preference is also likely a factor in American bullfrogs having a lower frequency of occurrence than anurans that breed in a broader range of pond hydroperiods. American bullfrogs were most abundant at Burdyl Pond (25.3% of all recorded) and Stop 1 Pond (17.8%), but also were recorded in moderate numbers at other permanent wetlands such as Canal South of Entrance, Vly March, Service Road Pond, and Victory Pond (Table 4). Most bullfrogs were recorded during pond TCS (45.4% of all recorded) and anuran calling surveys (28.7%) (Tables 6 and 8).

Our results, as well as those of Woolbright (2001), who recorded American bullfrog at nine of 11 sites sampled (Table 23), indicate that bullfrogs are moderately widespread and common at

SARA, given their trophic status. Bullfrogs are known to be fairly tolerant of urban landscapes (Rubbo and Kiesecker 2005), primarily because their preferred habitat, permanent ponds, are more likely to survive and often increase due to urbanization (Schlauch 1976). Besides the presence of permanent ponds, there is some evidence that bullfrogs are most abundant when the adjacent landscape is heavily (>80%) forested (Herrmann et al. 2005). However, on an agricultural landscape where woodlands totaling only 16% of the landscape were restricted to riparian areas and small woodlots, the size of the woodland patch a pond was located in did not affect bullfrog presence (Kolosvary and Swihart 1999). Moreover, in the New Jersey Pine Barrens, conversion of native forest to agriculture appears to facilitate the expansion of American bullfrogs into areas where they previously had been absent (Zampella and Bunnell 2000, Zampella et al. 2010). Thus it would appear that bullfrogs, which make limited use of non-aquatic habitats and are therefore less sensitive to the adjacent landscape than amphibians that are terrestrial outside of the breeding season, are able to persist on the mixed forest-field landscape of SARA.

Northern Green Frog (*Lithobates clamitans melanota*)

The northern green frog is common and widespread throughout the Eastern United States and Canada, using a wide range of wetland habitats (Klemens 1993). However, in northern populations, northern green frog tadpoles must overwinter in the breeding pond (Wright and Wright 1949), limiting successful reproduction to permanent and semi-permanent ponds. Although adult northern green frogs breed and forage in permanent ponds, non-breeding juveniles and dispersing adults may also be found in and along vernal ponds, streams, rivers, marshes, and on roads on rainy nights. Some adults are also known to hibernate in streams (Gibbs et al. 2007). Dorsolateral ridges extending down the back help distinguish the northern green frog from the American bullfrog in which the ridges are absent.

The northern green frog is a common and widespread species in the Northeast (DeGraaf and Rudis 1983) and is distributed statewide in New York (Gibbs et al. 2007). Historically it was common and widespread in New York State, and occurred in a broad range of wetlands (Dekay 1842, Eckel and Paulmier 1902). Green frogs were common in adjacent Albany county (Bishop 1923b) and more recently, they have also been widespread and abundant in SARA (Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, northern green frog was the most recorded native species, accounting for seven of 79 (8.9%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the northern green frog was the third most abundant of eight anurans at SARA, with 911 recorded (RA=10.13%) and it was the most widely distributed (FO = 50%; Tables 2 and 3). Northern green frogs were recorded primarily in permanent stream (33.5% of total), permanent pond (29.9%), and marsh habitats (23.1%), but, when adjusted for number of sample sites, the numbers recorded in these habitat types were 38.1, 45, and 53 per site sampled, respectively. Individuals were recorded in all habitat types except fields (Table 2). Most northern green frogs were recorded during anuran calling surveys (40.6% of all individuals) and stream TCS (32.2%)(Tables 6 and 8). The greatest numbers of northern green frogs were recorded at Stream site 6 (Mill Creek South, 16.4% of all individuals) and Vly Marsh (14.2% of all individuals), but significant numbers were recorded at many stream and wetland sites (Table 4).

Our results, as well as those of Woolbright (2001), who recorded northern green frog at nine of 11 sites sampled (Table 23), indicate that green frogs are widespread and abundant at SARA. Their predominant use of different types of permanent wetlands for breeding here is typical of this species (Herrmann et al. 2005, Gibbs et al. 2007) and their heavy use of streams highlights the importance of that habitat for dispersal and foraging, especially by non-breeding juveniles that use them until they are able to occupy and defend a territory in the breeding ponds. In addition to being positively correlated with the abundance of and proximity to permanent wetlands (Kolozvary and Swihart 1999), the occurrence and abundance of green frogs has been shown to be positively correlated with forested cover in the surrounding landscape (Guerry and Hunter 2002, Herrmann et al. 2005, Eigenbrod et al. 2008). However, in these and other studies (e.g. Hecnar and M'Closkey 1998, Gagne and Fahrig 2007) it appears that green frogs remain widespread and fairly abundant even on landscapes where forest cover has been reduced to as low as 10% and replaced by agriculture. Only in one study, in southern New Hampshire, were green frogs absent or reduced in wetlands surrounded by less than 40% forest cover (Herrmann et al. 2005). The fact that adults are highly aquatic and do not make extensive use of terrestrial habitats makes them relatively insensitive to the nature of the adjacent landscape (Gagne and Fahrig 2007). Collectively, these studies indicate that the forest-dominated landscape of SARA, with its forest, fields, and mixed wetlands, and the adjacent landscape of fields, forest, wetlands, and minor development are quite favorable for green frogs and we expect they would remain widespread and abundant here.

Northern Leopard Frog (*Lithobates pipiens*)

The northern leopard frog is found throughout most of the Northeast and Northern Midwest regions of the United States, extending southwest into Northern New Mexico and Arizona. It also ranges across the southern half of Canada, from the Maritimes west to Alberta (Conant and Collins 1998). Northern leopard frogs are frequently confused with the pickerel frog (and vice versa). Both species have distinct spots down the back, but the spots of the northern leopard frog are oval and less uniform than the two parallel rows of square spots that appear on the pickerel frog. Also, northern leopard frogs are typically greener in color and lack the bright yellow-orange coloration present on the undersurface of the hind legs of pickerel frogs. Northern leopard frogs typically occur in floodplain forest and meadows, riparian wetlands, and the edges of large lakes (Klemens 1993). They breed in both temporary and permanent ponds, particularly those with open canopies, forage extensively in open grassy habitats, and “overwinter in the muck of lake and pond bottoms” (Gibbs et al. 2007). The extensive movements associated with foraging and seasonal habitat shifts can make leopard frogs vulnerable to road kill (Carr and Fahrig 2001)

Northern leopard frogs are widespread in the lower elevations of all but Southeastern New York State and are more scattered in the mountains (Gibbs et al. 2007). Historically, they were widespread (DeKay 1842) and considered the commonest of frogs in New York State (Eckel and Paulmier 1902). They were common throughout nearby Albany County (Bishop 1923b). Leopard frogs have previously been recorded at SARA but the relatively few seen suggest they were not abundant in the 1980's and 1990's (NPS 1986, 1998, Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, Northern leopard frog was tied for the second most recorded native species, accounting for six of 79 (7.6%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the northern leopard frog was the second least abundant, with 75 individuals recorded (RA = 0.83%) and second least widely distributed (FO = 17%) of eight anurans at SARA (Tables 2 and 3). Although leopard frogs were recorded in all habitat types except permanent ponds and fields, we recorded the majority (81.33%) in marsh habitats (Table 2). We recorded most via pond TCS (70.7% of all recorded; Tables 6 and 8). Although we recorded leopard frogs from eight sites, Schuyler Estate Canal accounted for 77.3% of all leopard frogs we recorded (Table 4).

Based on our data, the northern leopard frog appears to be very uncommon at SARA, with the vast majority recorded from sites on the Hudson River floodplain. However, other data from 2001, collected at wetlands in the Battlefield Unit, suggest that leopard frogs are somewhat more common and widespread than our data alone would suggest. At 11 wetland sample sites where we recorded a total of eight individuals at four sites, Woolbright (2001) recorded 29 individuals from eight sites (Table 23). Similarly, in nighttime calling surveys in 2002, leopard frogs were detected at six of 21 sites, but two sites, River Road Marsh and Canal South of Entrance, were the only ones to have multiple detections and calling index values greater than one (Woolbright 2002). Collectively these data suggest that leopard frogs are widespread but uncommon at SARA, breeding primarily in marshes on the Hudson River Floodplain, with lesser numbers at terrace sites such as Beaver Marsh and Burdyl and Davidson Ponds.

The leopard frog is well known for its association with marshy habitats, particularly those on the floodplain of large rivers or the periphery of large lakes (Klemens 1993). The strong association of leopard frogs at SARA with wetlands on the Hudson River floodplain conforms to this, but their abundance here may be limited by the amount of marshy habitat. There are no large, marsh-fringed lakes at SARA and palustrine wetlands (marsh and wet meadows) totaled only 24 acres (14%) of mapped wetlands and 38.5 miles (23%) of linear wetlands (too narrow to map as polygons) at SARA (Tiner et al. 2000).

Leopard frogs are well known for being most abundant on landscapes where there is a fair amount of open grassland or agriculture (Guerry and Hunter 2002, Gibbs et al. 2005, Gagne and Fahrig 2007). Leopard frogs appear to have declined throughout much of New England due to farm abandonment, forest regeneration, and decreases in grassland (DeGraaf and Rudis 1983, Klemens 1993) and these processes may lead to a long term decline in New York State (Gibbs et al. 2007). The mixed forest, fields, and agriculture landscape of SARA and vicinity provides suitable adjacent uplands for leopard frog, and management of the park's cultural landscape will ensure this into the future, but the modest amount of marsh habitat will likely continue to limit their abundance here.

Pickerel Frog (*Lithobates palustris*)

The pickerel frog ranges from Southeastern Canada south through most of the Eastern United States, except for Florida and the Gulf States, westward to Eastern Texas (Conant and Collins 1998). It breeds in shallow permanent wetlands and outside of breeding season, can be found in permanent and ephemeral wetlands, streams, springs, sphagnum bogs, fields, and woodlands (Klemens 1993, Gibbs et al. 2007). This species is distinguished from the northern leopard frog by a dorsal pattern of brown squares arranged symmetrically, and the inner surfaces of the hind legs are orange or yellow (Klemens 1993).

This species is common and widespread in Southern New England (Klemens 1993) and occurs statewide in New York (Gibbs et al. 2007). Historical accounts (Dekay 1842, Eckel and Paulmier 1902) suggest that pickerel frogs were widespread and common, but not as abundant as leopard frogs (Bishop 1923b). Pickerel frogs have previously been recorded at SARA, but their presence on only one of four lists (NPS 1986, 1998, Lynch 1988, Troha 1995), suggests they were not very common here in the 1980's and 1990's. In the recent New York Herp Atlas project, pickerel frog was tied for the 16th most recorded native species, accounting for two of 79 (2.5%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, the pickerel frog was the least abundant (RA = 0.04%) and least widely distributed (FO = 4%) of eight anurans at SARA (Tables 2 and 3). A total of four individuals, all captured during Stream TCS, were recorded during this survey. Three individuals were captured at Stream 1 and one was captured at Stream 4 (Tables 4 and 6). Our data suggest the pickerel frog is rare at SARA, as does a longer term data set. From 2001 through 2006, pickerel frogs were recorded only twice, and there was no evidence of breeding (Woolbright 2001, 2002, 2003, 2004, 2005, 2006).

Reasons for the rarity of pickerel frogs at SARA are uncertain. Klemens (1993) noted that pickerel frogs are uncommon outside of Southern New England and they are ecologically replaced by leopard frogs. Although pickerel frogs and leopard frogs are similar in their use of open, non-forested landscapes outside of the breeding season, pickerel frogs differ in breeding almost exclusively in permanent ponds (Herrmann et al. 2005, Knutson et al. 1999). On an agrarian landscape, the only significant feature affecting pickerel frog presence was a strong positive relationship with wetland permanency (Kolosvary and Swihart 1999) and at Cape Cod National Seashore, pickerel frogs breed in large, permanent kettle ponds (Cook et al. 2006b) with broad perimeters of emergent marshy vegetation. Given the limited amount of open, emergent marshy habitat at SARA (discussed in the leopard frog account), it would appear that breeding habitat for pickerel frogs at SARA may be even more limited than it is for leopard frogs, which are more inclined to use temporary wetlands. Thus pickerel frogs are and will likely continue to be rare at SARA.

Wood Frog (*Lithobates sylvaticus*)

The wood frog has an extensive range that includes Appalachia, the Northeast, most of Canada, and Alaska (Conant and Collins 1998). It is widespread in New York and New England, both inland and on the coastal plain (Klemens 1993, Gibbs et al. 2007). Wood frogs are terrestrial, typically associated with forested landscapes, except during the breeding season when they breed in fishless vernal pools (Conant and Collins 1998). Breeding in early spring, the wood frog is an explosive breeder. Often a large percentage of a population migrates to ponds synchronously, laying eggs together in large floating masses. They breed in greatest abundance at vernal ponds with short to intermediate hydro-periods (Egan and Paton 2004) and equally use both closed and open canopy ponds (Skelly et al. 1999). After the breeding season, wood frogs disperse from breeding ponds, spending late spring and summer primarily in forested wetlands (Baldwin et al. 2006a). Both occurrence and abundance of wood frogs at breeding ponds has been positively linked to amount of forested wetlands nearby (Egan and Paton 2008). In autumn, wood frogs move to upland forest in close proximity to their breeding ponds to hibernate in leaf litter (Regosin et al. 2003). In the course of these seasonal movements, adults may travel up to 200-

300 meters from the breeding pond (Regosin et al. 2005, Baldwin et al. 2006a). Wood frogs are philopatric, with around 80% breeding in their pond of origin. The other 20% disperse as juveniles, travelling roughly 1.2 km, on average, from their natal pond to breed as an adult the following year in a different pond (Berven and Grudzein 1990).

The wood frog is common and widespread in Southern New England (Klemens 1993) and New York, wherever there is forested landscape (Gibbs et al. 2007). Historically it was considered widespread and common in the woods of New York State (Dekay 1842, Eckel and Paulmier 1902) including Albany County (Bishop 1923b). Wood frogs have previously been recorded at SARA and appear to have been common (NPS 1986, Lynch 1988, Troha 1995). In the recent New York Herp Atlas project, wood frog was tied for the fifth most recorded native species, accounting for four of 79 (5.1.6%) records in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) (Breisch and Ozard, in prep).

In the current survey, wood frog was sixth most recorded of eight anuran species, with a total of 113 recorded (RA = 1.26%). It was widespread (FO = 41%), which, considering the small numbers of individuals recorded (Tables 2 and 3), may be due to their extensive seasonal movements. Nearly half (48.7%) of the wood frogs we recorded were encountered in temporary pond habitats, but significant numbers were also recorded from forest (22.1%) and marsh (18.6%). We recorded more wood frogs during egg mass counts (44.3% of all adults recorded as calculated from egg mass-adult equivalents) than with other methods (Tables 6 and 8). However, egg masses were only detected at Stop 8 Ponds during standardized egg mass counts (Table 10).

Although our data suggest that wood frogs at SARA are widespread but not abundant, other data show that wood frogs are, in fact, far more numerous. Using the same methods as us, in a larger group of wetlands than we surveyed, Woolbright (2001) recorded a total of 889 wood frogs (Table 23), 771 of which were egg masses. Thus, we recorded less than 10% of the numbers recorded by Woolbright (2001). In addition, it turns out that April 2001 was extremely dry and the number of wood frog egg masses laid in 2001 was relatively few, limited by lack of rainfall and low water levels (Woolbright 2001). Long term data collected from 2001 thru 2010 indicate that it was not until 2003 that the full extent of vernal ponds present at SARA were known and sampled consistently each year (Woolbright 2001, 2002, 2003, unpublished data). During the 10 year period 2001 thru 2010, when the number of ponds sampled was 11 in 2001, 14 in 2002, and 26 thereafter, the mean number of egg masses/pond surveyed ranged from 59.8 in 2003 to 209.2 in 2008, with a mean of 136.3. In 2001 it was 69.6 egg masses/pond surveyed, the third lowest during this period. For the full complement of 26 vernal ponds, sampled from 2003 thru 2010, total egg mass counts ranged from 1555 in 2003 to 5438 in 2008, with a mean of 3562 and a standard deviation of 1384.

These long term data show that breeding effort by wood frogs sometimes varied from one year to the next by a factor of two to three and that the population of wood frogs at SARA is far larger than data from 2001 would suggest. Breeding effort (i.e. numbers of egg masses laid) by vernal pond breeding amphibians is positively correlated with migration season rainfall and breeding pond water levels (Pechmann et al. 1991) and population size of wood frogs in any given year can vary dramatically from one year to the next as a function of the effect of hydro-period length on larval survival in preceding years (Berven 1990), which is also affected by rainfall. Thus,

population size of wood frogs, like other vernal pond amphibians, can be quite variable and it appears this survey was conducted when the wood frog population at SARA was at a low. Likely contributing to this was the fact that the Northeast US had experienced a drought in 1999, with April - July cumulative rainfall the second lowest of the century (NOAA 1999), and in 2001, April was the third driest on record in the region, and the October 2000-April 2001 period ranked as the ninth driest since 1895 (NOAA 2001).

In light of these long term data (Woolbright, unpublished data), wood frogs appear to be both widespread and common at SARA. Although Rhode Island wood frogs breed primarily at ponds of short to intermediate hydroperiod (Egan and Paton 2004), wood frogs in the Adirondack Mountains of New York also breed in beaver ponds. The higher reproductive success in these semi-permanent wetlands suggests that these wetlands serve as sources for re-colonization of vernal ponds after droughts (Karraker and Gibbs 2009). Similarly, in coastal Maine, most egg masses were laid in long hydro-period vernal ponds, and these longer hydroperiod ponds may buffer regional populations during drought (Baldwin et al. 2006b). In addition to having an abundance of non-permanent wetlands of varying hydro-periods in close proximity, the occurrence and abundance of wood frogs is positively related to amount of forest adjacent to breeding ponds (Porej et al. 2004, Rubbo and Kiesecker 2005, Skidds et al. 2007, Egan and Paton 2008, Eigenbrod et al. 2008). Their abundance is greatest in forested landscapes and declines as the amount of agriculture and/or urbanization adjacent to breeding ponds increases (Herrmann et al. 2005, Gagne and Fahrig 2007). However, in rural landscapes, these declines are small until a threshold of roughly 50% to 67% de-forestation is reached (Guerry and Hunter 2002, Herrmann et al. 2005). Wood frog abundance is also negatively related to measures of urbanization such as amount of impervious surface, road length, amount of dense residential development (Clark et al. 2008) and populations can decline dramatically when forest adjacent to vernal ponds are replaced by urban development (Windmiller et al. 2008).

Although the most important landscape elements and the scale at which they operate on wood frog occurrence and abundance may vary geographically, in Rhode Island the landscape within 1000 meters of the breeding pond was most important (Egan and Paton 2008) and in eastern Massachusetts the best models explaining wood frog occurrence were based on landscape features within 1-2 km of the breeding pond (Clark et al. 2008). In northern and west-central New York State, where wood frog populations have been stable from 1970 to 2000, sites colonized by wood frogs tended to have relatively more forest and swamp habitat and less pasture, and were affected by landscape features at scales ranging from 1 to 10 km from the breeding ponds (Gibbs et al. 2005). These results indicate that wood frog populations are significantly affected by features of the landscape seemingly far from the breeding ponds, presumably because of the extensive movements made by wood frogs as they disperse from ponds or make seasonal habitat shifts. Considering the dependence of wood frogs on a forested landscape, with an abundance of vernal ponds, forested wetlands, and minimal roads, traffic, and development, it would appear that SARA, with its predominantly forested landscape with numerous and varied wetlands and stream corridors provides a relatively high quality landscape for wood frogs and we would expect it to remain common here.

Common Snapping Turtle (*Chelydra s. serpentina*)

The common snapping turtle occurs from Southern Canada, south through the mid-west and east coast, down to Florida and the Gulf of Mexico (Ernst et al. 1994). It is abundant and widespread

in New York State (Gibbs et al. 2007) and New England (Klemens 1993), and is the largest freshwater turtle in the Northeastern United States. It has a high tolerance for water pollution and tends to be among our most urban tolerant turtles (Klemens 1993). Although common snapping turtles occur in nearly all freshwater habitats and also in brackish marshes, adults tend to occur more frequently in permanent water bodies and are most abundant in shallow, muddy ones (Klemens 1993, Cook et al. 2007). Although these highly aquatic turtles are common, because they are bottom walkers more than swimmers and they bask in shallow waters along the shore of a pond or wetland rather than haul out like a painted turtle does, they are not as readily observed. Typical of all turtles, their eggs are laid on land. Female common snapping turtles must emerge from wetlands and travel overland in search of nesting areas, generally open, sandy, sparsely vegetated patches (Gibbs et al. 2007). Thus when observed by the public, they are most frequently seen crossing roads and traveling overland in late spring and early summer in search of nesting areas. Females dig nests and deposit eggs in loose sand or soil, and the hatchlings emerge in the late summer or early fall (Ernst et al. 1994).

The common snapping turtle is abundant and widespread throughout New York State, even occurring in some estuaries (Gibbs et al. 2007) and were widespread and common historically (DeKay 1842, Eckel and Paulmier 1902). Snapping turtles were previously recorded at SARA in the 1980's and 1990's (Lynch 1988, NPS 1998). In the recent New York Herp Atlas Project, snapping turtle was tied for the fifth most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for four of 79 (5.06%) records (Breisch and Ozard, in prep).

In the current survey, the snapping turtle was the second most abundant and most widespread of three turtle species at SARA, with a total of 21 recorded (RA = 47.73%) and a frequency of occurrence (FO) of 20% (Tables 2 and 3). Most snapping turtles (76.2%) were recorded in turtle trap surveys (Table 7 and 8) and all the snapping turtles we recorded were in aquatic habitats, with 12 (57.1%) in marsh, highlighting this species' highly aquatic nature (Table 2). We recorded the greatest number of snapping turtles at Schuyler Estate Canal (42.9% of all recorded), but they occurred at a number of sites both on the terrace and on the Hudson River Floodplain, in the Battlefield and Schuyler Estate Units (Table 5). Based on a trapping session in April 2001, in which a total of six individuals were captured, the modified Lincoln-Petersen estimate of snapping turtles present at Schuyler Estate Canal was 7 ± 3 . Although we recorded relatively small numbers of snapping turtles (21 total captures), the capture rate during trapping surveys at SARA was generally comparable to other NPS sites we have surveyed. For example, overall captures rates were 6.47 captures/100 trap nights at Saint-Gaudens NHS (SAGA), 4.41 at Acadia NP (ACAD), 3.84 at SARA, and 1.40 for Weir Farm NHS (WEFA) and in prime snapping turtle habitat, i.e. permanent ponds and marshes, the capture rates were 12.82 at SAGA, 5.77 at WEFA, 5.44 at ACAD, and 4.75 at SARA (Brotherton et al. 2005 a,c, Cook et al. 2008).

Because of its generalized habits, the snapping turtle is fairly tolerant of urbanization, landscape alterations, and water pollution, and readily makes use of most human-created wetlands and ponds (Schlauch 1976, Gibbs et al. 2007). Thus, the canals, ditches and farm ponds in and around SARA may provide more habitat than occurred on the original landscape. Road kill, which can seriously affect turtle populations by disproportionately killing females on nesting forays (Gibbs and Steen 2005) may occur here, but its extent and population impact are unknown. Based on this survey, the snapping turtle appears to moderately common at SARA,

with small populations found throughout the Park, primarily in permanent water bodies. Considering their longevity and ability to bio-accumulate environmental toxicants, samples from SARA snapping turtles might be useful for determining levels of PCB's in SARA wetlands adjacent to the Hudson River.

Stinkpot (*Sternotherus odoratus*)

Stinkpots occur throughout most of the Eastern United States, including New York and Southern New England, excluding higher elevations (Ernst et al. 1994, Klemens 1993). They are a highly aquatic species commonly found in slow-moving, muddy-bottomed streams and rivers, and also are abundant in weed-choked, shallow portions of small reservoirs. They are usually absent from temporary ponds and ponds and lakes not directly connected to or near riparian systems (Klemens 1993). Stinkpots are largely nocturnal, but occasionally bask during daytime hours. Because of their secretive habits, stinkpots go unnoticed in many areas, even where dense populations occur (Klemens 1993, Johnson 2009).

Although lacking in details, early accounts suggest that stinkpots were common and widespread in the ponds and ditches of New York State (DeKay 1842, Eckel and Paulmier 1902). However, we now know they occur primarily at relatively low elevations in the Great Lakes drainages, the Hudson River and many of its tributaries, and on Long Island. Stinkpots are absent from the Appalachian Plateau and the Adirondack Mountains (Gibbs et al. 2007). Stinkpots were “not uncommon in ponds and muddy streams” in Albany County (Bishop 1923c). In the recent New York Herp Atlas Project, stinkpot was tied for the 11th most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for three of 79 (3.8%) records (Breisch and Ozard, in prep). Stinkpots were recorded from three of the four topo quads that SARA lies in (Quaker Springs, Schuylerville, and Mechanicville), and have also been recorded to the north and south (<http://www.dec.ny.gov/animals/44384.html>, last accessed March 5, 2012).

In the current survey, no stinkpots were recorded at SARA, nor were any recorded here previously. However, a female stinkpot was encountered in 2010 on US Route 4 at the Broad Street bridge over Fish Creek, by the Schuyler Estate (pers. comm., J. Tinker, SARA Law Enforcement Ranger, 19 June 2010). It was heading west when found, and likely had entered the road from the Schuyler Estate Unit. Considering the date, June 19th, this female was likely on a nesting foray. It may have nested on the grounds of the Schuyler Estate and was returning back towards the impounded Fish Creek, but this is speculation.

It is difficult to be certain of the status of stinkpots at SARA. The lack of records suggests they are rare at SARA yet they often go unnoticed in areas where they are common. Stinkpots are common in tributaries of the Hudson River further south in Hyde Park, NY, particularly in impounded sections (Klemens et al. 1992). The impoundment of Fish Creek above the Schuylerville Dam, across from the Schuyler Estate, as well as the canals along the Hudson River floodplain appear to be good habitat for them. In addition, recent data from a site in Palmer Massachusetts, on an agrarian-residential landscape similar to that of the SARA area, show that stinkpots can be very numerous on such landscapes (Johnson 2009). Perhaps SARA is so close to the species' northern limits that climate is constraining their numbers. Although outside of SARA, a survey for stinkpots in the impoundment above Schuylerville dam might be the best way to determine if stinkpots are truly rare in this area, or just appear to be.

Painted Turtle (*Chrysemys picta*)

The painted turtle is the only North American turtle whose range extends across the continent, from Southern Canada down through the Pacific Northwest, Midwest, and the Northeast coast to Louisiana, Georgia, and the Carolinas (Ernst et al. 1994). There are four subspecies, with English names that describe each subspecies' distribution. The eastern painted turtle has an unmarked yellow plastron and the seams of the central and lateral carapace scutes are aligned, while the midland painted turtle has a variable dark marking on the plastron and alternating seams on the carapacial scutes (Ernst et al. 1994). Hybrid painted turtles are intermediate in these characters and are highly variable both within and among populations. In the Northeast and New England, the eastern painted turtle (*C. p. picta*) and the midland painted turtle (*C. p. marginata*) intergrade, forming a hybrid swarm (Pough and Pough 1968), and it is best referred to simply as "painted turtle".

In addition to a wide geographic distribution, painted turtles are widespread ecologically, occurring in a broad range of freshwater habitats, including vernal ponds. However, they prefer permanent, shallow, standing or slow-moving water bodies with soft bottoms and an abundance of aquatic vegetation (Ernst et al. 1994, Cook et al. 2007, Gibbs et al. 2007). Painted turtles are highly aquatic, feeding and hibernating in ponds. However, they lay their eggs on land and, as with all aquatic turtles, adult females must leave the relative safety of the wetland and travel overland to patches of open habitat with well drained soils to nest. Nesting areas near ponds minimize the distance females must travel on nesting forays and their vulnerability to road kill on landscapes where females must cross roads to reach nesting areas (Baldwin et al. 2004).

The painted turtle is distributed statewide in New York and is likely the most abundant turtle in the state (Gibbs et al. 2007). Because of their abundance and habit of basking on rocks, logs, and clumps of vegetation, they are the region's most familiar and conspicuous turtle (Klemens 1993). Historically, DeKay (1842) considered them widespread and second only to spotted turtles in abundance. Eckel and Paulmier (1902) considered them very common throughout New York. Painted turtles have previously been recorded at SARA by a number of observers in the 1980's and 1990's (Lynch 1988, Troha 1995, NPS 1998) and appear to have been common, especially in the Champlain Canal. In the recent New York Herp Atlas Project, painted turtle was tied for the fifth most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for 4 of 79 (5.06%) records (Breisch and Ozard, in prep).

In the current survey, painted turtle was the most abundant and second most widespread of three turtle species at SARA, with a total of 22 recorded (RA = 50.00%) and a frequency of occurrence (FO) of 17% (Tables 2 and 3). Most painted turtles (68.2%) were recorded in turtle trap surveys (Tables 7 and 8) and all the painted turtles we recorded were in aquatic habitats, with 15 (68.2%) in permanent pond or canal (Table 2). We recorded the greatest number of painted turtles at Burdyl Pond (36.4% of all recorded), but they occurred at numerous sites both on the terrace and on the Hudson River Floodplain, in the Battlefield and Schuyler Estate Units (Table 5). Although widespread at SARA, painted turtles appear to be only moderately common. The capture rate here is lower than other NPS sites we have surveyed. For example, overall capture rates were 18.23 captures/100 trap nights at Saint-Gaudens NHS (SAGA), 13.00 at Cape Cod National Seashore (CACO), 6.31 at Acadia NP (ACAD), 3.84 at SARA, and 3.49 at Weir Farm NHS (WEFA). In prime painted turtle habitat, i.e. permanent ponds and marshes, the

capture rates were 35.90 at SAGA, 19.35 at CACO, 12.50 at WEFA, 6.31 at ACAD, and 4.45 at SARA (Brotherton et al. 2005 a,c, Cook et al. 2007, 2008). Moreover, the rates for CACO are for unique individuals, not all captures (which include recaptures) and are an underestimate of the capture rate used in the other comparisons. Regardless, these capture rates suggest that the numbers of painted turtles at SARA are relatively low.

Because of its generalized habits, the painted turtle is fairly tolerant of urbanization, landscape alterations, and water pollution, and readily makes use of most human-created wetlands and ponds (Schlauch 1976, Gibbs et al. 2007). Thus, the canals, ditches and farm ponds in and around SARA may provide more habitat than occurred on the original landscape. Road kill, which can seriously affect turtle populations by disproportionately killing females on nesting forays (Gibbs and Steen 2005) likely occurs here, but its extent and population impact are unknown. Based on this survey, the painted turtle appears to be moderately common at SARA, with small populations found throughout the Park, primarily in permanent water bodies. However, the lack of large lakes and ponds at SARA likely limits their numbers.

Northern Map Turtle (*Graptemys geographica*)

The northern map turtle is primarily a Midwestern species found in the upper Mississippi River and Ohio River that extends its range east and north via the Great Lakes and St. Lawrence River into southern Quebec, Lake Champlain, and the Hudson River Valley, with isolated populations also present in the Delaware and Susquehanna rivers (Ernst et al. 1994). Map turtles typically occur in large bodies of water such as lakes and rivers, preferring slow moving, soft bottomed sections with abundant basking sites. A variety of basking sites are used, e.g. logs, rocks, muskrat lodges, and sandbars, preferably isolated from shore (Gibbs et al. 2007). Map turtles are diurnal, foraging in morning and late afternoon and basking at midday. They are extremely wary while basking and because they tend to bask in groups, when one dives into the water the others follow (Ernst et al. 1994). Females are larger than males and their diets differ, with females eating large snails, freshwater clams and crayfish and the smaller males eating aquatic insects, small snails and crustaceans. Females nest from late May to early July, in open soft, sandy soil sites near lake and river shorelines (Gibbs et al. 2007).

Naturalists of the 19th and early 20th centuries considered the map turtle “not uncommon” in the Great Lakes region of western New York State (DeKay 1842, Eckel and Paulmier 1902) but apparently were unaware of their presence elsewhere in the state. Bishop (1923c) does not mention them among the species found in Albany County, but their presence in Lake Champlain was known to mid-19th century naturalists in Vermont (Babcock 1919). Currently in New York, map turtles occur along Lake Ontario, the St. Lawrence River, the Lake Champlain and Hudson River Valleys, the Niagara River and possibly the Delaware (Gibbs et al. 2007).

In the recent New York Herp Atlas Project, map turtles were recorded from the Quaker Springs quad at Stillwater, and elsewhere in Saratoga County from Malta, Saratoga Springs and Half Moon (Breisch and Ozard, in prep). These records, as well as additional Herp Atlas records to the north and south of SARA (<http://www.dec.ny.gov/animals/44407.html>, last accessed March 5, 2012) indicate the SARA lies within the range of the common map turtle and they are likely present in the Hudson River adjacent to SARA. However, map turtles have never been recorded at SARA or included on any SARA species list. There were no map turtles recorded in the current survey, but little effort was made looking for them. Because the boundary of SARA stops

at the bank of the Hudson River, there is little actual map turtle habitat at SARA. But it is possible they are using downed trees and rocks along the Hudson River shore to bask and may also use adjacent fields to nest. Apparently, there is a state-owned parcel of land along the river that abuts SARA south of Vly Marsh that is used for turtle nesting (pers. comm., Chris Martin, September 19, 2011). This area and other sections of shoreline should be kept under observation to determine if map turtles in the Hudson River are making use of SARA.

Spotted Turtle (*Clemmys guttata*)

A small semi-aquatic turtle with distinct yellow spots on a black carapace, the spotted turtle occurs along the Atlantic coastal plain, from Maine to Florida, including lower elevation areas of Southern New England (Klemens 1993), and westward into Ohio, Indiana, Illinois, Michigan, and Southeastern Canada (Ernst et al. 1994). Spotted turtles are widespread and occur in a broad range of shallow habitats, both freshwater and slightly saline, including marshes, bogs, red maple swamps, ditches, vernal pools, and small streams (Klemens 1993, Graham 1995). They are considered semi-aquatic, because they may spend a lot of time on land when temporary wetlands dry (Ernst et al. 1994). In the Northeast, spotted turtles typically shift habitats seasonally. They overwinter in bogs and swamps and then shift to vernal pools to take advantage of a seasonal abundance of food. When vernal pools dry up, they may move to uplands and aestivate or return to the wetlands they hibernated in (Gibbs et al. 2007).

Early accounts from New York and New England considered spotted turtles to be widespread and very common, at least as numerous as painted turtles (DeKay 1842, Eckel and Paulmier 1902, Babcock 1919). We now know that their distribution is limited by elevation and they are only widespread below 700 feet (Klemens 1993) and they have declined in numbers to the point they are now listed as a Species of Special Concern in New York State. Currently, spotted turtles occur throughout lower elevation regions of the state including the Great Lakes Plain south of Lake Ontario and east of Lake Erie, the lower Hudson River Valley, and on Long Island. They are also abundant in some areas east of Lake Ontario in Oswego, Lewis, and Jefferson counties (Gibbs et al. 2007). Spotted turtles are rare in the Albany Pine Bush and elsewhere near Albany, and are one of several “southern” species that extend north up the Hudson River Valley via the “greater sand plains of Albany, Schenectady, Saratoga, and Warren counties” (Stewart and Rossi 1981). A spotted turtle was recorded at SARA near the Schuyler Estate Canal in the mid-1990’s (C. Martin and D. Hayes, SARA and Roosevelt-Vanderbilt National Historic Sites Natural Resource Managers, 1995-1998) and in the recent New York State Herp Atlas, spotted turtles were recorded in the Quaker Springs topo quad and several others along the Hudson River, both north and south of SARA (<http://www.dec.ny.gov/animals/44388.html>, last accessed March 5, 2012).

We did not record any spotted turtles in the current survey nor have there been any subsequent records. Thus the record from the mid-1990’s is the only one for this species at SARA and they are very rare here. Spotted turtles have declined throughout their range due to habitat fragmentation, wetland drainage, suburban development, invasive wetland plants, road mortality, collection for the pet trade, and increases in predator populations (Levell 2000, Lewis et al. 2004). However, the current landscape of the Battlefield Unit of SARA is relatively undeveloped and unfragmented, and it is uncertain what impact any of these factors may be having here. A number of studies have highlighted the importance of forested swamp habitats to spotted turtles, as well as their movements to vernal ponds from them in the spring (Graham 1995, Joyal et al.

2001). Although SARA has numerous vernal ponds, swamps, marshes, and canals, and forested wetlands comprise 68% of wetland area, total wetland area is only 175.9 acres (71.2 ha) (Tiner et al. 2000). Moreover, half of the wetland acreage is on the Hudson River floodplain whereas the vernal ponds, typically used in spring and early summer, are up on the terrace, a kilometer or more away. Spotted turtles are capable of making such movements, but doing so here poses risks such as from road kill and farm machinery. Although it is not possible to know, the rarity of spotted turtles at SARA may be because it is at the limits of its distribution, because there is not enough of the right wetland types in close proximity, or some combination of these plus other factors mentioned above.

Wood Turtle (*Gleptemys insculpta*)

The wood turtle occurs in Southeastern Canada, the Northeast United States and northern regions of the Midwestern United States (Conant and Collins 1998). In the Northeast it is largely absent from coastal and pine barren habitats (Klemens 1993). It is a semi-aquatic stream-dependant species, spending the majority of the fall and winter months hibernating in deep pools, under overhanging root mass or logs. In Massachusetts it prefers slow moving, mid-sized streams with sandy bottoms and heavily vegetated banks (MA NHESP 2007). After emerging from hibernation it spends the spring in and along the stream, but may move into adjacent terrestrial habitats in the summer months to nest and feed (Ernst et al. 1994). Although their diet is varied, it mostly eats animal material including earthworms, snails and slugs, insects, amphibians (tadpoles and adults), mice, and even carrion (Ernst 2001, Walde et al. 2003). Wood turtles are capable of long-distance movements, which generally follow stream and river courses (Castellano et al. 2009). Of particular interest, unlike most turtles, wood turtles have genetic sex determination (Ewert and Nelson 1991).

Although lacking in details, early accounts suggest that wood turtles were common and widespread in New York State (DeKay 1842, Eckel and Paulmier 1902). Noble (1927) however, correctly noted their absence from Long Island, whereas they were “very common in the vicinity of Albany in open woods and meadows” (Bishop 1923c) and “fairly common” in the Adirondacks (Weber 1928). Currently, although widely scattered throughout the state, wood turtles are most common in the Hudson River Valley (Gibbs et al. 2007). Wood turtles have previously been recorded at SARA (NPS 1998), including one on the entrance road on 27 May 1987 and another near the canal below Stop 9 on 25 May 1988 (Lynch 1988). In the recent New York Herp Atlas Project, wood turtle was tied for the 16th most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for two of 79 (2.53%) records (Breisch and Ozard, in prep). There were four other records elsewhere in Saratoga County and several across the Hudson River in Washington County (<http://www.dec.ny.gov/animals/44399.html>, last accessed September 19, 2011), suggesting that wood turtles are widespread in this area. There were no wood turtles recorded in the current survey, but one was photographed on August 28, 2004 crossing mowed lawn at Tour Stop 9, Battlefield Unit, just after a passing rain storm (pers. comm., J. Tinker, SARA Law Enforcement Ranger, 28 August 2004). Thus, two of three SARA-specific records of this species have been near Stop 9, above the Champlain Canal.

Wood turtles are a Species of Special Concern in New York State. Threats include dam construction, agriculture, hay mowing, development of stream banks, road kill, pet collection,

and inflated rates of predation in suburban and urban areas (Gibbs et al. 2007, MA NHESP 2007, Castellano et al. 2009). Exacerbating some of these threats is the fact that, similar to box turtles, demographic traits such as delayed sexual maturity, high adult survival, and low survival of nests and young make populations of wood turtles very sensitive to increased mortality from human sources (MA NHESP 2007). Although a number of these stressors, such as road kill and agricultural activity, are present at SARA, the primary reason for the rarity of wood turtles at SARA may be habitat related. Given their preference for slow-moving, sandy bottomed mid-sized streams and their need for unpolluted, undeveloped rivers set within large, unfragmented riparian areas to support viable populations (Compton et al. 2002) it may be that the canals and small streams of SARA do not provide enough high quality habitat for them. The few records of wood turtle at SARA suggest they are using the Champlain canal and more intensive trapping in the canal may be needed to better determine their status in the Battlefield Unit. Moreover, Fish Creek appears to be the type of mid-sized stream favored by wood turtles and the Victory Woods and Schuyler Estate Units may be small parts of a much larger landscape used by wood turtles in that watershed.

Eastern Box Turtle (*Terrapene c. carolina*)

Eastern box turtles occur from Georgia and Northern Alabama and Mississippi, northward into Southern Illinois and eastward (Conant and Collins 1998). In the Northeast and New England, box turtles are largely restricted to the coastal plain and major river valleys and do not extend far into northern New England (Klemens 1993). Box turtles hibernate by burrowing down into the soil and winter mortality may be the most significant natural cause of adult mortality (Ernst et al. 1994). Thus, in the Northeast where box turtles are at their northern range limit, their distribution and abundance correlates with well drained, sandy soils. The two areas of highest box turtle density in the Northeast, Long Island (Klemens 1993) and Cape Cod (Erb 2011) are sandy glacial deposits, ideal for burrowing, where cold winter temperatures are moderated by ocean warming.

The eastern box turtle is a terrestrial species that typically occurs in areas that are a mix of woodland and open habitat. Habitat diversity provides the ability to shift habitats seasonally in response to changes in temperature and humidity (Reagan 1974), and, as with all turtles, well drained open habitats provide nesting sites. This long-lived species is known to live more than a century (Graham and Hutchison 1969). Eastern box turtles are frequently found foraging following spring and summer rains, and they will feed on slugs, fruits, vegetation and carrion. The terrestrial nature of box turtles results in their being more widely dispersed across the landscape than aquatic amphibians and reptiles. They often engage in seasonal movements for nesting, hibernation, or feeding, and some individuals are transients that do not establish home ranges (Dodd 2001). All this movement across the landscape places box turtles at relatively greater risk of becoming road kill (Gibbs and Shriver 2002) or being collected for a pet in urban areas, which, in conjunction with their late maturity and low rate of reproduction, make their populations unable to sustain the heavy adult mortality typical in urban areas. Thus, box turtle populations do not fare well on the highly fragmented landscapes found in urban and suburban areas (Schlauch 1976, Mitchell and Klemens 2000) and are declining in many parts of their range (Dodd 2001).

Historically, box turtles were considered common everywhere in New York State (DeKay 1842, Eckel and Paulmier 1902), although Noble (1927) noted they were very common on Long Island

and “not rare” elsewhere. Currently in New York, box turtles are most commonly encountered in the Hudson River Valley and are still locally common in many parts of Eastern Long Island, even as they have declined on Western Long Island due to urbanization (Schlauch 1976, Gibbs et al. 2007). They are also scattered throughout the Appalachian Plateau and spotty in Central and Western New York, most likely the result of released pets but possibly remnant populations of a species once far more widely distributed than today (Gibbs et al. 2007). Although common in the mid-19th Century, box turtles are now rare in Albany County, found only in the Albany Pine Bush (Stewart and Rossi 1981). Box turtles have previously been recorded at SARA (Lynch 1988, NPS 1998) and in the recent New York Herp Atlas Project, there were three records of box turtles from Saratoga County, including one from Northumberland, just north of Schuylerville and one from Half Moon, south of the Battlefield Unit (Breisch and Ozard, in prep). These Northern Hudson River Valley populations occur in an area described as the “greater sand plains of Albany, Schenectady, Saratoga, and Warren counties” and represent an isolated northern range extension for a group of southern species, including the eastern box turtle, which reach their northern limits in New York State there (Stewart and Rossi 1981).

In the current survey, a single eastern box turtle was recorded (RA = 2.27%, FO = 2%) as an incidental encounter on the Entrance Road 1.0 miles east of the Visitor Center (Tables 2, 3, and 5). In addition, one was photographed near Tour Stop 3, American River Fortifications on July 17, 2006 by SARA Ranger Jacquie Tinker (pers. comm., Chris Martin, SARA, July 21, 2006). The scarcity of records suggests that although present at SARA, the Eastern box turtle is rare here, particularly considering the extent to which SARA staff patrol the park. In contrast, at Cape Cod National Seashore, where box turtles are common, there are, on average, over 50 box turtle incidental encounters recorded per year (R. Cook, unpublished data).

The Eastern box turtle is a Species of Special Concern in New York State, where its decline is the result of urbanization, habitat fragmentation, and road kill (Gibbs et al. 2007). They are generalists in terms of the habitat they occur in, as long as it is a mix of woody and herbaceous types, but they are specialists in requiring relatively large habitat patches to sustain a population. The mix of forest and field at SARA, with relatively modest amounts of roads and residential development, appears to provide a large patch of quality habitat for box turtles. Their rarity here is likely because SARA is at the northern limit of their distribution and their numbers may be constrained by winter kill.

Eastern Hog-nosed Snake (*Heterodon platirhinos*)

The eastern hog-nosed snake occurs throughout most of the Central and Eastern U.S. and into Southern Canada (Ernst and Ernst 2003). In the Northeast, hog-nosed snakes occur primarily on the coastal plain of Southern New York and Southern New England, and extend inland via major river valleys such as the Hudson, Housatonic, Connecticut, and Merrimack. Their occurrence is generally linked to the presence of sandy habitat: it prefers sandy, well-drained soils in woodlands, fields, and on barrier beaches (Klemens 1993, Ernst and Ernst 2003, Gibbs et al. 2007). Areas underlain by sandy glacial deposits, such as Cape Cod and Long Island, have long been associated with hog-nosed snakes (Lazell 1976).

Hog-nosed snakes have a number of specialized attributes that make them both readily identifiable and especially vulnerable. Their upturned rostral scale at the tip of the snout and their

defensive behaviors are unique among local species. When threatened, the eastern hog-nosed snake will puff up and hiss loudly, flatten the head into a “hood”, and sometimes attempt to strike with a closed mouth. The snake will regurgitate its last meal, turn on its back with its mouth open, and feign death. Although harmless to humans, this behavior often leads people to kill hog-nosed snakes, thinking they are a threat. Consequently, hog-nosed snakes do not survive urbanization nor co-exist with humans very well (Murphy 1950, Kieran 1959). In addition, hog-nosed snakes feed almost exclusively on toads and their distribution and abundance is greatly influenced by variation in toad abundance.

Historically, DeKay (1842) considered hog-nosed snakes common in the southern parts of the state, essentially the lower Hudson River Valley, the New York City Region, and Long Island, where it was particularly abundant (Eckel and Paulmier, 1902, Engelhardt et al. 1915, Noble 1927). Bishop (1923c) considered them common in what is now known as the Albany Pine Bush, whereas they were not reported from the Adirondacks (Weber 1928). Currently, the eastern hog-nosed snake is a Species of Special Concern in New York, with most populations found in the Southeastern region of the state and Long Island. It extends up the Hudson River Valley into Southern Warren County, with a small population still extant in the Albany Pine Bush (Gibbs et al. 2007). These northern Hudson River Valley populations occur in an area described as the “greater sand plains of Albany, Schenectady, Saratoga, and Warren counties” and represent an isolated northern range extension for a group of southern species, including the hog-nosed snake, which reach their northern limits in New York State there (Stewart and Rossi 1981).

The hog-nosed snake has never been listed as occurring at or been recorded from SARA. However, in the recent New York Herp Atlas project, hog-nosed snake was tied for the fifth most recorded native species in the four Herp Atlas quads that include SARA (an area of approximately 600 km²) accounting for four of 79 (5.06%) records (Breisch and Ozard, in prep). These and seven additional records of hog-nosed snake elsewhere in Saratoga County, mostly to the north and south of SARA (<http://www.dec.ny.gov/animals/44670.html>, last accessed March 5, 2012) show that SARA lies within the current local range of this species.

In the current survey, there were no records of hog-nosed snake, nor have there been any subsequently, but this species can be difficult to detect due to its burrowing habits. SARA seemingly provides appropriate habitat, particularly with its population of American toads. However, all of the significant toad breeding sites at SARA, as well as the sandy soils, are on the Hudson River floodplain (Table 4), whereas most of our time and sampling effort (e.g. coverboards and upland TCS) was focused on the terrace above. Most park staff activity is also focused there. Thus, it is possible that hog-nosed snakes may exist at SARA as a rare, undetected species that occurs in a section of the park that is less frequented by park staff.

Eastern Milk Snake (*Lampropeltis t. triangulum*)

The eastern milk snake is a subspecies of the milk snake, which is one of the most widespread species of snakes, ranging from the East and Mid-western U.S.A. down to Ecuador in South America (Ernst and Ernst 2003). The eastern milk snake occurs from Northern Georgia and Alabama northward to Wisconsin and through the Northeastern states into Southern Canada (Conant and Collins 1998). Identifying characters include a “Y” shaped, cream-colored patch on the nape and a black and white checkerboard pattern on the belly (Conant and Collins 1998).

Eastern milk snakes are widespread in the Northeast U.S. and occur both inland and along the coast in habitats ranging from woods, meadows, bogs, streams, and farmland. It is a secretive species most active at night. They are frequently associated with old farm fields, dilapidated structures, and trash piles, and thrive in such human altered habitats (Klemens, 1993, Gibbs et al., 2007). In Southern New England, the eastern milk snake is second in abundance to the common garter snake, occurring in most state parks, forests, game management areas, and private sanctuaries (Klemens 1993).

Historically, the eastern milk snake was considered widespread in New York State, generally common but variable in abundance (DeKay 1842, Eckel and Paulmier 1902). They were common in Albany County (Bishop 1923c) but apparently uncommon in the Adirondacks (Weber 1928). The milk snake remains widespread in New York and is known from every county, but it appears to be absent at higher elevations of the Adirondack Park (Gibbs et al. 2007). Milk snakes have previously been recorded at SARA (Lynch 1988, NPS 1998), but the records provide no sense of their abundance. In the recent New York Herp Atlas Project, milk snake was tied for the 16th most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for two of 79 (2.5%) records (Breisch and Ozard, in prep).

In the current survey, the eastern milk snake was tied for third most abundant and second most widespread of five snake species at SARA, with a total of 8 recorded (RA = 8.99%) and a frequency of occurrence (FO) of 9% (Tables 2 and 3). We recorded six (75.0%) as incidental encounters and two (25.0%) during coverboard surveys (Tables 7 and 8). All the milk snakes we recorded were in upland habitats, with five (62.5%) in woodlands and three (37.5%) in field (Table 2). We recorded half of all milk snakes from Woodland 5 (4 captures), and two from Field 3 (Table 5).

In most of the surveys we have conducted at sites where they were present, the capture rate of milk snakes under coverboards has been relatively low. The coverboard capture rate at SARA (0.16 captures/100 coverboard checks) falls towards the low end of this range, i.e., Saint-Gaudens NHS (0.0), Cape Cod National Seashore (0.08), Acadia National Park (0.10), Gateway NRA – Floyd Bennett Field (0.27), Minuteman NHS (0.28), Morristown NHS (.037), and Gateway NRA- Ruler's Bar Hassock (1.25), (Brotherton et al. 2005a,b, Cook et al. 2008, 2011a, Cook, unpublished data). However, 75% of all milk snake captures at SARA and 89% at ACAD were incidental encounters, so coverboard capture rates may not be the best index of abundance for milk snakes. Taking these factors into consideration, our sense is that milk snakes are uncommon at SARA, although more targeted searches or surveys in fields, woodlands, and around old buildings, stonewalls and hedgerows may find more of them than we did.

As a species with a large home range, milk snakes are vulnerable to impacts from habitat fragmentation and road kill, and have declined in urban areas (Klemens 1993, Kjos and Litvaitis 2001, Ernst and Ernst 2003). In addition, given their association with agrarian landscapes, they may also be declining as abandoned farms return to native forest (Gibbs et al. 2007). Intense urbanization is not at issue in and adjacent to SARA and the landscape is a mix of forest and field that will remain so as the cultural landscape is maintained through fire and mowing. Given this, milk snakes should continue to be an uncommon and secretive species here.

Northern Water Snake (*Nerodia s. sipedon*)

The northern water snake is a sub-species of water snake that occurs from the Northeast United States and Southeast Canada westward into the Mid-west (Conant and Collins 1998). In New York and New England, the northern water snake is widespread and common, occurring both along the coastal plain and inland, although it does not range into high elevations (Klemens 1993, Gibbs et al. 2007). Northern water snakes are primarily aquatic and occur in a broad range of freshwater wetlands, provided they contain an abundance of cover and food, primarily fish and secondarily amphibians (Ernst and Ernst 2003). They are frequently observed basking on the shore, on rocks, and on branches overhanging the water and occasionally enter brackish water (Conant and Collins 1998, Ernst and Ernst 2003). Similar to the brown snake and garter snake, northern water snakes give birth to live young rather than laying eggs.

Historically, the northern water snake was considered widespread and common to abundant in the ponds and streams of New York State (DeKay 1842, Eckel and Paulmier 1902). They were very common in Albany County (Bishop 1923c) but apparently uncommon in the Adirondacks (Weber 1928). The northern water snake remains common throughout most of the state, but is absent from the Northwestern Adirondacks and the St. Lawrence River valley east of the Oswegatchie River (Gibbs et al. 2007). Water snakes have previously been recorded at SARA (Lynch 1988, NPS 1998), but the records provide no sense of their abundance. In the recent New York Herp Atlas Project, northern water snake was tied for the 16th most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for two of 79 (2.5%) records (Breisch and Ozard, in prep).

In the current survey, the northern water snake was tied for second most abundant and most widespread of five snake species at SARA, with a total of 18 recorded (RA = 20.22%) and a frequency of occurrence (FO) of 9% (Tables 2 and 3). Water snakes were primarily recorded in minnow trap surveys (50.0% of all recorded) and stream time-constrained search (27.8%; Tables 7 and 8). All the water snakes we recorded were in aquatic habitats, with 55.6% in marsh (Table 2). We recorded common water snakes in Beaver Marsh (9 captures), Stream 1 – Upper Kroma Kill (5), Davidson Pond (3), and Schuyler Estate Canal (1) (Table 5).

The results of this survey suggest that the water snake is uncommon but geographically widespread at SARA, occurring both on the terrace and the Hudson River floodplain, in the Battlefield and Schuyler Estate Units. However, it is limited primarily to wetland habitats, which is in keeping with its highly aquatic nature. Although SARA lacks large freshwater bodies that could potentially support large populations, it has an abundance of smaller sites, and many streams and canals that provide additional habitat and connectivity between them. Its sedentary nature, tendency to stay in wetlands, live birth and relatively high fecundity (Gibbs et al 2007) allow it to persist on landscapes with moderate levels of human presence such as SARA, and we expect it will remain an uncommon but widespread species here.

Smooth Green Snake (*Liochlorophis vernalis*)

The smooth green snake occurs primarily from Southern Canada through the Northeastern and upper Mid-western United States with many scattered disjunct populations further west (Conant and Collins 1998). It occurs throughout most of New York State (Gibbs et al. 2007) and New England, although in New England it is now most common in coastal areas (Klemens 1993).

Smooth green snakes occur in a variety of open, un-forested habitats and open woodlands, and feed exclusively on arthropods such as spiders and various insects (Klemens 1993, Ernst and Ernst 2003).

Historically, the smooth green snake was considered widespread and common in New York State (DeKay 1842, Eckel and Paulmier 1902). Bishop (1923c) considered them uncommon in Albany County, but they were common in grassy fields in the Adirondacks (Weber 1928). Currently, the smooth green snake is found throughout New York State in appropriate habitat, except for parts of St. Lawrence County (Gibbs et al. 2007). There is a single record of this species at SARA, a road killed specimen found near the Wilkinson Trail (Troha 1995). In the recent New York Herp Atlas Project, there were no records of smooth green snake from the four topo quads that include SARA (an area of approximately 600 km²), and only one for all of Saratoga County (Breisch and Ozard, in prep).

We did not record any smooth green snakes in the current survey. Where present, smooth green snakes are often found under coverboards or during search of open, grassy habitats (Brotherton et al. 2005a, Cook, pers. obs.). The lack of any recent records at SARA suggests they are rare, if present at all. In New England, smooth green snakes are believed to have expanded in distribution and abundance due to agricultural clearing during colonial times, but have been in a general decline during the second half of the 20th Century (Mirick 2009). Part of this decline is a return to their pre-colonial status, as woodlands returned following agricultural abandonment in the 19th century. However, considering the amount of open grassy field habitat present at and around SARA, it is hard to ascribe their rarity or absence here to a lack of grassy habitat. Urban and suburban development and pesticides, which affect them directly and by eliminating their arthropod prey, are also factors in their decline (Klemens 1993). Although we will never know, it seems more likely that some of these factors have contributed to a decline of smooth green snakes in the vicinity of SARA.

Northern Brown Snake (*Storeria d. dekayi*)

The brown snake is a species that ranges throughout most of the Eastern United States and into Eastern Mexico (Ernst and Ernst 2003). The sub-species found in Massachusetts, the northern brown snake, occurs from South Carolina northward into central New England, Southern Canada, and westward to lower Michigan and Ohio (Conant and Collins 1998). It is widespread throughout New York and New England and occurs in a broad range of habitats, from woodlands to grasslands and other open, disturbed habitats, where they feed primarily on worms and slug (Klemens 1993, Gibbs et al. 2007). The brown snake is another live bearing species well known for its urban tolerance and reaches very high densities in some urban habitat patches (Schlauch 1976). Its specific name “*dekayi*” honors early New York naturalist, James E. DeKay whose historic work is cited throughout this report.

Although recognized by DeKay (1842) as occurring in New York State, it was not until later in the 19th Century that the northern brown snake was known to be fairly common and widespread, including the New York City region (Ditmars 1896, Eckel and Paulmier 1902). In Albany County, brown snakes were more common than the closely related northern red-bellied snakes (Bishop 1923c), whereas in the Adirondacks, the red-bellied snake was locally common and the brown snake rare (Weber 1928). A similar relationship was found in the Connecticut River Valley of Massachusetts, where brown snakes were common in the city of Northampton, on the

valley floor, and red-bellied snakes occurred nearby in higher elevation forests (Dunn 1930). Currently, the brown snake is distributed throughout New York State, although there are few records from the northwestern Adirondack Mountains and the eastern St. Lawrence River valley (Gibbs et al. 2007). Northern brown snakes have previously been recorded at SARA from the entrance road (Lynch 1988, NPS 1998), but these records provide no sense of their abundance. In the recent New York Herp Atlas Project, there was a single record of northern brown snake in the four topo quads that include SARA (an area of approximately 600 km²), accounting for 1.27% of 79 records, plus two other records elsewhere in Saratoga County (Breisch and Ozard, in prep).

In the current survey, the northern brown was the least abundant and least widespread of five snake species at SARA, with a total of four captures (RA = 4.49%) and a frequency of occurrence (FO) of 7% (Tables 2 and 3). Two of the four captures were incidental encounters near park facilities and the remaining two were via coverboard surveys and woodland TCS (Tables 7 and 8). All the northern brown snakes we recorded were in upland habitats, with three (75.0%) in woodland habitat and one (25.0%) in field, highlighting this species' terrestrial nature (Table 2). Two of the four captures were in Woodland 5, with one each at Woodland 7 and Field 3 (Table 5). The results of this survey suggest that northern brown snakes are uncommon at SARA and their distribution is limited to upland habitats. We only recorded them in the Battlefield Unit but they may also occur in the Victory Woods and Schuler House Units. Considering that three of four brown snakes were recorded via incidental encounters and coverboards, and we did not sample either of these two units with coverboards or spend much time in them, it is possible their presence in these other two park units went undetected. The Schuyler Estate Unit, with the disturbance of the adjacent highway department maintenance yard, is worth additional sampling effort.

As discussed above, based on elevation, we would have expected northern brown snakes to be more common than northern red-bellied at SARA. However, where these two species overlap, relative abundance may be a reflection of the extent of human development and disturbance, with brown snakes most common at disturbed, suburban sites and red-bellied snakes more common in undeveloped, forested areas (Klemens 1993, Willson and Dorcas 2004). Thus, the relatively large, undisturbed forested areas of SARA may favor red-bellied snakes. Considering that SARA is about 2/3 forested and expected to remain so, we would expect that northern brown snakes will remain a fairly uncommon species at the Battlefield Unit.

Northern Red-bellied Snake (*Storeria o. occipitomaculata*)

The northern red-bellied snake is widely distributed over most of the Eastern U.S., extending north into Southern Canada (Ernst and Ernst 2003). In Southern New England, they are more frequently found in upland areas than at low elevation sites near the coast. In these uplands, red-bellied snake tends to replace northern brown snake, except in disturbed habitats (Klemens 1993). In Massachusetts, red-bellied snakes can be locally abundant at some sites and absent from seemingly similar ones nearby (Mirick 2009). A "secretive" species, the northern red-bellied snake is most commonly found in moist woodlands under rocks, logs, and other cover. It is active during all times of the day and evening in spring and fall, but is more nocturnal in summer. The northern red-bellied snake feeds primarily on worms and soft-bodied insects but especially prefers slugs and snails and occasionally consumes small frogs and salamanders. This

species gives birth to live young rather than laying eggs (Ernst and Ernst 2003, Gibbs et al. 2007).

The occurrence of northern red-bellied snake in New York State was unknown to DeKay (1842), but by the end of the 19th Century it was considered fairly common and widespread, except for the New York City – Long Island region (Ditmars 1896, Eckel and Paulmier 1902). In Albany County, they were less common than the closely related northern brown snakes (Bishop 1923c) whereas in the Adirondacks, the red-bellied snake was locally common and the brown snake rare (Weber 1928). A similar relationship was found in the Connecticut River Valley of Massachusetts, where red-bellied snakes occurred at high elevations and brown snakes were common on the valley floor (Dunn 1930). Currently, northern red-bellied snakes are distributed throughout New York State, except for New York City and Long Island (Gibbs et al. 2007). Northern red-bellied snakes have previously been recorded at SARA from the woods near the visitor center (Lynch 1988, NPS 1998), but the records provide no sense of their abundance. In the recent New York Herp Atlas Project, there was a single record of northern red-bellied snake in the four topo quads that include SARA (an area of approximately 600 km²), accounting for 1.27% of 79 records, and four other records elsewhere in Saratoga County (Breisch and Ozard, in prep).

In the current survey, the northern red-bellied snake was tied for third most abundant and second most widespread of five snake species at SARA, with a total of eight captures (RA = 8.99%) and a frequency of occurrence (FO) of 9% (Tables 2 and 3). We recorded all eight during coverboard surveys (Tables 7, 8, 15). All the northern red-bellied snakes we recorded were in upland habitats, with seven (87.5%) in field and one (12.5%) in forest (Table 2). There were three northern red-bellied snakes recorded in Field 3 and Field 5, and Woodland 7 and Field 7 each had one (Table 5). The results of this survey suggest that northern red-bellied snakes are uncommon at SARA, although their secretive habits often make them appear to be less common than they actually are (Gibbs et al. 2007). As expected for this species, we found them in uplands and although most were recorded in fields, the coverboard arrays in those fields were deployed along the forest edge (Figure 1). Although we only recorded red-bellied snakes from the Battlefield Unit, we did not sample the Schuyler Estate or Victory Woods Units with coverboards, the only method that detected this species. Given this, coverboard surveys in those two units are needed to better determine this species' geographic extent at SARA.

Given the historic observations discussed above (Bishop 1923c, Weber 1928, Dunn 1930), and more recent ones from Southern New England indicating that this species occurs primarily at forested upland sites above 500 ft elevation (Klemens 1993) and SARA lies below that elevation, we would have expected northern brown snakes to be more common than northern red-bellied. However, where these two species overlap, relative abundance may be a reflection of the extent of human development and disturbance, with brown snakes most common at disturbed, suburban sites and red-bellied snakes more common in undeveloped, forested areas (Klemens 1993, Willson and Dorcas 2004). Thus, the relatively large, undisturbed forested areas of SARA may favor red-bellied snakes, although they are none-the-less fairly uncommon. Considering that SARA is about 2/3 forested and expected to remain so, we would expect red-bellied snakes to remain uncommon at SARA.

Eastern Ribbon Snake (*Thamnophis s. sauritis*)

As a species, the eastern ribbon snake (*Thamnophis sauritis*) ranges throughout most of the eastern United States, except for Appalachia (Ernst and Ernst 2003). The sub-species eastern ribbon snake (*T. s. sauritis*) occurs primarily from Southern New England and Southeastern New York state southward through South Carolina and then west into Mississippi and up the Mississippi River valley into Southern Illinois (Conant and Collins 1998). Ribbon snakes feed primarily on amphibians, especially frogs, and are mostly found in freshwater wetlands, particularly grassy or shrubby ones with an open canopy that allows them to bask (Gibbs et al. 2007). They are closely related to, and look very similar to garter snakes, and specimens must be captured and examined carefully to identify correctly (Klemens 1993). On Cape Cod, ribbon snakes are often observed in the course of spring fieldwork in open freshwater wetlands (Cook, pers. obs.).

Historically, the ribbon snake was considered widespread and common in New York State, although accounts differ regarding their abundance relative to garter snakes (DeKay 1842, Eckel and Paulmier 1902). Bishop (1923c) does not list ribbon snake as occurring in Albany County, but considered the garter snake very common. Stewart and Rossi (1981) report the same in the 1970's. Similarly, ribbon snakes were rare in the Adirondacks, whereas garter snakes were common and widespread (Weber 1928). Currently, the eastern ribbon snake has a very spotty distribution across New York, with a large gap in the Adirondack Mountains and also the southwest corner of the state (Gibbs et al. 2007).

Eastern ribbon snake is listed as occurring at SARA (NPS 1998) but no detail or documentation is provided. We did not record any ribbon snakes, nor are there any subsequent records. In the recent New York Herp Atlas Project, there were no records of eastern ribbon snake from the four topo quads that include SARA (an area of approximately 600 km²), and three for all of Saratoga County (Breisch and Ozard, in prep). However, these include records from the Troy North and Gansevoort topo quads, in the Hudson River Valley to the south and north of SARA respectively, which show that SARA lies within the current local range of this species.

Populations of ribbon snakes are declining over much of their range due to habitat loss and road kill (Ernst and Ernst 2003). Because they are habitat specialists tied to freshwater swamps, marshes, and vernal ponds with an abundance of anurans, and these habitats are often the first to disappear during urbanization, ribbon snakes have disappeared in urban areas (Schlauch 1976). An additional factor in their decline in Southern New England may be loss of open wetlands to successional "reforestation" (Klemens 1993). Given the uncertainty of the original species list (NPS 1998), it is impossible to know if ribbon snake occurred at SARA in recent times, but the records discussed above show it is plausible. The lack of current records suggests it is no longer present at SARA or rare at best. Reasons for this rarity are unclear; urbanization impacts and lack of wetlands and amphibian prey are not likely factors but forest succession is occurring and may be reducing basking habitat for them.

Common Garter Snake (*Thamnophis sirtalis*)

The common garter snake is a species that ranges throughout the United States, except for Texas and the southwest, and all of Southern Canada (Ernst and Ernst 2003). The subspecies found at SARA, also known as the common garter snake, occurs primarily east of the Mississippi River

from Florida northward into New York and Southern New England and also into Canada (Conant and Collins 1998). In New York and Southern New England, common garter snakes are widespread and common, both inland and along the coast, and are the most conspicuous and well known snake in this area (Klemens 1993, Gibbs et al. 2007). Common garter snakes are ubiquitous in New England, found in a variety of habitats including meadows, marshes, woodlands, and cultivated and developed areas (Behler and King 1979). They are relatively urban tolerant because of their generalized food and habitat needs (Schlauch 1976), live birth of young, and ability to persist in relatively small habitat patches. They can, however, decline in areas subject to intense urbanization (Ziminski 1970, Schlauch 1978).

Historically, the common garter snake was considered widespread and common in New York State, ranging from sea level to the summits of the Catskills and Adirondacks (DeKay 1842, Eckel and Paulmier 1902). It remains common and widely distributed, except at the highest elevations (i.e., over 900 meters) of the Adirondack Mountains (Gibbs et al. 2007). Garter snakes were recorded at SARA by a number of observers in the 1980's and 1990's (Lynch 1988, Troha 1995, NPS 1998) and appear to have been widespread and common. In the recent New York Herp Atlas Project, common garter snake was tied for the fifth most recorded native species in the four topo quads that include SARA (an area of approximately 600 km²), accounting for four of 79 (5.06%) records (Breisch and Ozard, in prep).

In the current survey, the common garter snake was the most abundant and widespread of five snake species at SARA, with a total of 51 recorded (RA = 57.30%) and a frequency of occurrence (FO) of 37% (Tables 2 and 3). Garter snakes were primarily recorded in coverboard surveys (52.9% of all recorded) and incidental encounters (27.5%; Tables 7 and 8). The majority of garter snakes recorded (72.5%) were in upland habitats, i.e., field (41.2%) and forest (31.4%), but they were recorded in all habitat types except for temporary pond (Table 2). We recorded the greatest number of garter snakes at Field 6 (8 captures), Woodland 7 (7) and Schuyler Estate Canal (5), and they also occurred in moderate numbers at numerous sites both on the terrace and on the Hudson River Floodplain, in the Battlefield, Victory Woods, and Schuyler Estate Units (Table 5).

The overall capture rate at SARA (2.12 captures/100 cover board checks) falls in the middle of the range of values obtained at other sites we have surveyed with coverboards that support populations of garter snake; i.e. Cape Cod National Seashore (0.01), Gateway NRA – Breezy Point District (0.44), Gateway NRA – Great Kills (0.66), Gateway NRA – Floyd Bennett Field (0.81), Saint-Gaudens NHS (0.85), Weir Farms NHS (1.20), Gateway NRA- Ruler's Bar Hassock (2.24), Acadia National Park (2.60), Morristown NHS (3.12), Saugus Iron Works (3.8), and Minuteman NHS (4.42) (Brotherton et al. 2005a,b,c, Cook et al. 2008, 2010, 2011a, Cook, unpublished data).

Results from this survey indicate the common garter snake is a common and widespread species at SARA and, based on a comparison of capture rates, the population here appears to be relatively robust. Considering how ecologically broad, adaptable, and urban tolerant common garter snakes, SARA provides a comparatively large, un-fragmented, and diverse landscape and we expect they will remain common here.

Species Present in Hudson River Valley of Saratoga County but Never Recorded at or near Saratoga NHP

Common Mudpuppy (*Necturus maculosus*)

The common mudpuppy is a strictly aquatic salamander that is neotenic, retaining external gills as an adult. The common mudpuppy is widespread in the Mississippi and Ohio River drainages of the Mid-West, as far south as Northern Mississippi, and it extends into the Northeast via Lakes Erie and Ontario, the Saint Lawrence River and Lake Champlain (Conant and Collins 1998, Gibbs et al. 2007). In New York State, mudpuppies also occur in the Mohawk, Allegheny, and Hudson Rivers and their connected waterways and canals (Gibbs et al. 2007). Although early authors speculated that mudpuppy dispersed east from Lake Erie via the Erie Canal (DeKay 1842) and was therefore not native to the Hudson River, it is now believed the Mudpuppy moved east via the Mohawk River and is native to the Hudson River drainage (Schmidt et al. 2004). Records for the mudpuppy in the Hudson River extend as far south as Poughkeepsie in Dutchess County (Bishop 1941).

Historically, the mudpuppy was common in the Hudson River and its tributaries at Albany, as well as in the Mohawk River (Bishop 1923a). Although there are no records of the mudpuppy at SARA, it was documented historically at Crescent on the Mohawk River in Saratoga County (Bishop 1941) and there are current records on the Hudson River both north and south of SARA (<http://www.dec.ny.gov/animals/44533.html>, last accessed March 5, 2012). Thus, SARA clearly is within both the historic and current range of the mudpuppy. Given the presence of remnants of the Champlain canal and well as other ditches, canals, and tributaries that communicate with the Hudson, such as portions of Fish Creek by the Schuyler Estate Unit, its current occurrence at SARA is possible. Mudpuppies were not specifically targeted in this survey. We sampled two potential mudpuppy sites (Canal Below Stop 10 and Schuyler Estate Canal) with minnow traps but the entrance funnel diameter of these traps may be too small for adult mudpuppy (pers. comm., Al Richmond, UMass, Amherst, January 15, 2008). Mudpuppies have been found in the mouth of a number of small tributaries of the Hudson River south of Albany using a fisheries electro-shocker (Schmidt et al. 2004). Thus, the mudpuppy should be considered a potentially-occurring species whose status at SARA is still uncertain. Targeted surveys, using either electro-shockers or specialized funnel traps are recommended in canals, ditches, and stream and river mouths along the Hudson River.

Four-toed Salamander (*Hemidactylium scutatum*)

The four-toed salamander ranges over Eastern North America from Nova Scotia and Southern Ontario south to Louisiana and the Florida panhandle, but it is far more continuously distributed in the northern portion of this range (Conant and Collins 1998). It ranges across Southern New York and Southern New England, into Southern Vermont and New Hampshire, and extends north along the coast into Maine (Petranka 1998). The four-toed salamander gets its common name because it has four toes on each hind foot instead of the five most salamanders have. It is a small terrestrial salamander typically found in woodlands adjacent to sphagnaceous wetlands, which serve as nesting sites. Females typically mate in the fall and migrate to nesting wetlands in early spring, while the males remain in the woodlands. Females are frequently found in spring in sphagnum moss “cliffs” overhanging standing water, where they deposit their eggs, often communally, and remain with them until hatching occurs. Upon hatching, the larvae wiggle

down through the moist sphagnum and drop into the water below, where they undergo a typical aquatic larval stage and metamorphose in about six weeks (Petranka 1998). This species is known for its propensity to autotomize the tail from the constriction at its base (other local salamanders autotomize only portions of the tail) often with little provocation by potential predators (Bishop 1941). The separated tail continues to undulate, distracting the predator while the salamander escapes (Gibbs et al. 2007).

Four-toed salamanders are considered difficult to find, even in localities where they are relatively common (Burgason 1999). Where they occur, they can be found by nighttime road searches on rainy nights in early spring and they are relatively easy to find by searching through sphagnum hummocks in wetlands for nesting females in mid-spring (Cook et al. 2006a). Conversely they are infrequently found under cover objects, even ones adjacent to wetlands where they nest (Cook, unpublished data). Thus, 19th century naturalists in New York did not list this species (DeKay 1842) or merely speculated that it occurred in New York State (Eckel and Paulmier 1902). However, there were in fact several records of four-toed salamander in New York State in the 19th century and Bishop (1941) considered it “generally distributed throughout the state in suitable situations”. However, it does have a spotty distribution across New York, and appears to be absent in some central and northern regions of the state (Gibbs et al. 2007). Relevant to SARA, four-toed salamanders were historically recorded from Altamont and Voorheesville in Albany County (Bishop 1923a) and they occur along the Hudson River from Lake George south through Coxsackie to New York City (Bishop 1941).

Although it has never been recorded at or adjacent to SARA, four-toed salamanders have recently been recorded from western Saratoga County, as well as the adjacent counties to the north, south, and east (<http://www.dec.ny.gov/animals/44501.html>, last accessed March 5, 2012). Thus SARA lies within its known range. The lack of any records during this survey, and in the course of nighttime road surveys on rainy nights from 2001 thru 2010, suggests that four-toed salamanders may not be present at SARA. However, considering how difficult this species can be to find during general time-constrained search and how they superficially resemble red-backed salamanders, more targeted searches in sphagnaceous wetlands in mid-spring and road searches on rainy early spring nights are needed to be more certain of its status here.

Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*)

The Allegheny mountain dusky salamander ranges from Northern New York State southward through Northern New Jersey and all but Southeastern Pennsylvania, continuing south into Northern Georgia and Alabama via the Appalachian mountains (Conant and Collins 1998). They are most often found in mixed deciduous forests that contain streams and seeps. More terrestrial than northern dusky salamanders, Allegheny mountain dusky salamanders may often be found under logs or stones on the forest floor far from water, but in winter they retreat under mosses and rocks at springs, small streams, and seeps (Gibbs et al. 2007). Adult mountain dusky salamanders are nocturnal, feeding on earthworms, snails and arthropods. Mating and egg laying may occur in spring or autumn, with eggs deposited in small grapelike clusters in hollow depressions beneath logs and stumps embedded in the mud of seeps or streams (Petranka 1998). The aquatic larvae may take from 1-10 months to metamorphose into terrestrial juveniles (Gibbs et al. 2007).

Historically in New York State, the Allegheny mountain dusky salamander initially was unrecognized by DeKay (1842) but subsequently noted as present in the Adirondacks and Catskills (Eckel and Paulmier 1902). Its presence in Albany County was considered provisional by Bishop (1923a), who was unsure how to tell it apart from the dusky salamander (*D. fuscus*), whereas in the Adirondacks, it was considered more plentiful than the dusky salamander, and common on higher slopes mostly between 1000 and 2000 feet elevation (Weber 1928). Eventually, it was considered common where it occurred, which, in addition to the Catskills and Adirondacks, also included the Finger Lakes region and Allegheny Plateau (Bishop 1941). Currently, the Allegheny mountain dusky salamander can be found in brooks and streams throughout upstate New York, except the St. Lawrence River plain, areas east of the lower Hudson River, and Long Island (Gibbs et al. 2007).

Although it has never been recorded at or adjacent to SARA, recent maps (Gibbs et al. 2007) show it ranges across the Hudson River valley in the vicinity of SARA. However, New York State Herp Atlas distribution maps provide a finer scale of resolution and show that records for this species in Saratoga County and adjacent Washington County, on the east side of the Hudson River, are not in close proximity to the river, but rather in topo quads at higher elevations (<http://www.dec.ny.gov/animals/44509.html>, last accessed March 5, 2012). These suggest that lower elevation sites in the Hudson River Valley may currently be unsuitable for Allegheny mountain dusky salamanders. \

A number of studies have shown that the occurrence and abundance of stream salamanders, declines as the nearby landscape becomes urbanized or deforested. These studies suggest that more than a narrow stream buffer of intact vegetation is needed to avoid these impacts (Willson and Dorcas 2003, Miller et al. 2007), which appear to be due to increased levels of sedimentation and higher velocity stormflow (Orser and Shure 1972). Increased sedimentation decreases the interstitial space between rock and gravel substrate, reducing the places where adult and larval salamanders can hide from predators or escape from being washed downstream during high stormflow, which also tends to be more severe in altered watersheds (Lowe and Bolger 2002, Brannon and Purvis 2008, Barrett et al. 2010). Moreover, severe flooding can wash away cover objects such as leaves and logs, further reducing habitat quality (Price et al. 2010).

It is not possible to know if Allegheny mountain dusky salamanders were present in the streams of SARA prior to the landscape alterations of the colonial era. However, even if they were present, given what we know about the impacts of deforestation on stream salamanders, plus the association of Allegheny mountain dusky salamanders with higher elevation forested habitats (Weber 1928, Petranka 1998), it is hard to imagine they survived peak deforestation at SARA, when, by 1870, 90% of the forests had been cleared (Vana-Miller et al. 2001). Considering the importance of connectivity to other first order streams as sources for re-colonization following forest recovery (Lowe and Bolger 2002, Grant et al. 2009), it is unlikely that the streams at SARA, which drain into the Hudson River, could be easily re-colonized. Finally, stream water temperatures at SARA, which average from 18 to 19°C, with maxima between 25 to 29°C (NPS 1997), may be too high. Although based on species from the Pacific Northwest, Bury (2008) suggested that stream temperatures above 24°C had the potential to negatively impact cold-water stream amphibians.

Bishop (1941) noted that Northern dusky salamanders are more widespread and occur at sites where the mountain dusky salamander is absent whereas Weber (1928) noted that the mountain dusky salamander is more abundant than the Northern dusky in the Adirondack mountains. In Maryland, where the mountain dusky is considered sensitive to stream degradation, the order of occurrence of stream salamanders was northern two-lined (88.2%), northern dusky (43.4%), mountain dusky (21.0%), and northern spring (13.2%) (Southerland et al. 2004). Collectively, these observations suggest that the mountain dusky is more restricted in the habitat conditions it occurs in and occurs at higher elevation sites than the Northern dusky. Given all these considerations, plus the fact that the presence of the more widely distributed and disturbance-tolerant dusky salamander at SARA is also questionable, our best judgment is that the Allegheny mountain dusky salamander is not and probably never was present at SARA at the time of its establishment as an NPS unit in 1938. Whether it was ever present on the original, pre-agrarian landscape is a question we cannot answer.

Northern Ringneck Snake (*Diadophis punctatus edwardsii*)

As a species, the ringneck snake (*Diadophis punctatus*) ranges throughout the Northeast United States and Southern Canada southward through the mid-west and south-central states and northward along the Pacific coast (Ernst and Ernst 2003). The northern sub-species occupies the Northeastern and Appalachian Mountain portion of that range (Conant and Collins 1998), is widespread in New York State, and often abundant as well (Gibbs et al. 2007). In Southern New England, ringneck snakes occur from sea level to mountaintops (Klemens 1993). The northern ringneck snake is a small, inconspicuous, primarily nocturnal species, typically found in moist woodlands with abundant cover where it feeds on small salamanders, especially eastern red-backed salamanders and worms (Conant and Collins 1998, Ernst and Ernst 2003).

Historically, the northern ringneck snake was considered widespread and common in New York State, but rarely seen without searching for it under cover objects (DeKay 1842, Eckel and Paulmier 1902). Bishop (1923c) considered them uncommon in Albany County and Weber (1928) did not report them from the Adirondacks. Currently, the northern ringneck snake occurs throughout New York State, but they are rare or absent from the Adirondacks northward and along the Southern Lake Ontario floodplain (Gibbs et al. 2007). The ringneck snake has never been listed as occurring at or been recorded from SARA. In the recent New York Herp Atlas Project, there was one record of ringneck snake from the Schuylerville topo quad, although it was from Washington County, east of the Hudson River (Breisch and Ozard, in prep). This and other current records of ringneck snake (<http://www.dec.ny.gov/animals/44667.html>, last accessed March 5, 2012) show that SARA lies within the current local range of this species.

In the current survey, there were no records of ringneck snake, nor were there any subsequently. Although widespread, there is a lot of geographic variation in the abundance of ringneck snakes and they can be very rare in some areas (Klemens 1993). Their apparent absence at SARA is hard to explain, given that SARA appears to have plenty of woodland habitat and prey for this widespread species, which is nowhere near its range limit. It is unlikely that colonial era deforestation eliminated this species from SARA. On outer Cape Cod, where similar deforestation occurred, it is the most frequently recorded species under coverboards (1.21 captures/100 coverboard checks) (R. Cook, unpublished data). In addition, both at Cape Cod National Seashore and at Saint-Gaudens NHS, ringneck snakes have been detected when

neonates wandered into buildings in late summer through small gaps under doors (Cook et al. 2008). Thus, although considered a secretive species, in our experience, where they are present, active search and/or attentiveness usually leads to their detection. The fact that none have ever been recorded at SARA, in spite of all the field work here, suggests the ringneck snake is not present.

Northern Black Racer (*Coluber c. constrictor*)

The northern black racer is subspecies of the eastern racer (*Coluber constrictor*), which is widespread throughout most of the United States, except for the desert Southwest (Ernst and Ernst 2003). The northern black racer occurs from the Southern Appalachian Mountains northward, extending to the coastal plain in the mid-Atlantic states and into Southern New York and New England (Conant and Collins 1998). It is widespread in Southern New York and Southern New England, occurring primarily at relatively low elevations along the coast and in river valleys (Klemens 1993, Gibbs et al. 2007).

Black racers occur primarily in landscapes with open habitats and are a large, conspicuous, diurnal species with a large home range. It is found in open, dry woodlands, fields, grasslands, along the borders of wetlands, and on barrier islands (Ernst and Ernst 2003, Kjos and Litvaitis 2001). Large sheets of corrugated sheet metal and plywood are a favorite cover type of this species, along with other debris at the edge of woodlands (Klemens 1993). Juvenile northern black racers have distinct gray/brown or reddish/brown patterning down their bluish/gray back that disappears as they mature. Adults are satiny black in color with a white throat patch and can reach five to six feet in length (Conant and Collins 1998). An opportunistic feeder, the racer diet includes a variety of animals such as shrews, voles, birds, small turtles, lizards, anurans, salamanders, and snakes (Ernst and Ernst 2003).

Historically, the account of DeKay (1842) suggests that black racers were common and widespread in New York State, but provides no specific details. It does, however, note the positive relationship between black racer abundance and agricultural expansion. By the early 20th Century, black racers in New York State were known to occur primarily in the southern part of the state, such as the lower Hudson River Valley, the New York City Region, and Long Island, where they were very common along the sandy south shore (Eckel and Paulmier 1902, Engelhardt et al. 1915, Noble 1927). Bishop (1923c) noted their presence in Albany County, whereas they were not reported from the Adirondacks (Weber 1928). They were rare in the Albany Pine Bush and elsewhere in Albany County in the 1970's (Stewart and Rossi 1981). These northern Hudson River Valley records occur in an area described as the "greater sand plains of Albany, Schenectady, Saratoga, and Warren counties" and represent an isolated northern range extension for a group of southern species, including the black racer, which reach their northern limits in New York State there (Stewart and Rossi 1981). Currently, the northern black racer is largely restricted to the Southern half of New York State, a few counties in Western New York, and on Long Island (Gibbs et al. 2007). However, a few recent records indicate it still ranges northward into Saratoga and Warren Counties (<http://www.dec.ny.gov/animals/44656.html>, last accessed March 5, 2012).

The black racer has never been listed as occurring at, nor has it ever been recorded from SARA. In the recent New York State Herp Atlas Project, it was not recorded from any of the four topo

quads that SARA lies in, but it was recorded from the town of Wilton, 10 miles northwest of Schuylerville (Breisch and Ozard, in prep). Thus, the black racer is present in Saratoga County but apparently very rare. Considering how conspicuous this species is, the lack of any records of black racer at SARA strongly suggest it does not occur here. Northern black racers have declined in the Northeast due to urbanization, habitat fragmentation, and loss of open, early successional habitat to reforestation (Kjoss and Litvaitis 2001, Gibbs et al. 2007). Although the landscape at SARA is far more forested than it was in the 19th century (Vana-Miller et al. 2001), it is still roughly 1/3 open habitat and surrounded by farmland. The effects of habitat loss and fragmentation here would not seem to be severe, but SARA is also at the northern limit of the black racer's range, and this may also be a factor in its absence here.

Eastern Ratsnake (*Elaphe alleghaniensis*)

The eastern ratsnake has a wide distribution in the Eastern United States, extending from the Gulf Coast and Florida as far north as Southern Wisconsin and eastward through Southern Michigan, Central New York and Southwestern New England (Ernst and Ernst 2003). It is a large, mostly black snake with a black-and-white checkered belly, though young individuals are much more boldly patterned than the adults with a series of light, almost white blotches. The eastern ratsnake attains the greatest length of any native New York reptile with individuals up to 101 inches (256 cm) total length reported (Gibbs et al. 2007). Eastern ratsnakes are commonly found in woodlands or the edges of forests and fields, especially where rocky outcrops occur. Eastern ratsnakes typically avoid human detection where they exist due to their excellent climbing ability and their propensity to spend much of their time up in trees (Durner and Gates 1993). Eastern ratsnakes use communal hibernacula, which typically are south-facing openings of rocky outcrops and talus slopes, though they will also hibernate in unused wells and basements of homes and buildings. Up to 50 individual ratsnakes may be found in a single hibernacula, and they will commonly share such hibernacula with other snake species including timber rattlesnakes (*Crotalus horridus*), northern black racers, eastern milk snakes, northern water snakes, and common garter snakes (Gibbs et al. 2007).

Dekay (1842) noted the presence of eastern ratsnake in New York State and, although not much is mentioned regarding distribution, his comments suggest it was common where it occurred. Early 20th Century accounts detail a distribution through the south central part of the state and the lower Hudson River Valley (Ditmars 1896, Eckel and Paulmier 1902, Noble 1927). Bishop (1923c) did not record eastern ratsnake in Albany County and nor did Weber (1928) from the Adirondacks. They were rare in the Albany Pine Bush in the 1950's but not recorded in the 1970's (Stewart and Rossi 1981). These latter records occur in an area described as the "greater sand plains of Albany, Schenectady, Saratoga, and Warren counties" and represent a northern range extension for a group of southern species, including the eastern ratsnake, which reach their northern limits in New York State there (Stewart and Rossi 1981). Eastern ratsnakes are found south of the Tug Hill Plateau and Adirondack Mountains in New York and as far north as Lake George. An apparent disjunct population exists in Jefferson and St. Lawrence counties in northwestern New York (Gibbs et al. 2007).

In the recent New York Herp Atlas Project, there was one record of eastern ratsnake from the Schuylerville topo quad, although it was from Washington County, east of the Hudson River. There was also a record from Wilton, 10 miles northwest of Schuylerville (Breisch and Ozard, in

prep). These and other nearby records (<http://www.dec.ny.gov/animals/44650.html>, last accessed March 5, 2012) indicate that SARA lies within the current local range of this species, but suggest it is rare in Saratoga County. We did not record the eastern ratsnake at SARA, nor has it ever been recorded here. The lack of any records of eastern ratsnake at SARA strongly suggests it does not occur here. This may reflect local extirpation due to historic deforestation and a lack of sufficient older forest and overwintering (hibernacula) habitat, as well as limitations associated with it being at the northern edge of its range.

Literature Cited

- Adams, M.J. 1999. Correlated factors in amphibian decline: exotic species and habitat change in western Washington. *Journal of Wildlife Management* 63:1162-1171.
- Albright, J. 1999. Bullfrog. In: Hunter, M. L., A. J. K Calhoun., and M. McCollough. *Maine Amphibians and Reptiles*. The University of Maine Press, Orono, ME. pp. 90-93
- Anderson, L.R. and Arruda, J.A. 2006. Land use and anuran biodiversity in southeast Kansas USA. *Amphibian and Reptile Conservation* 4:46-59.
- Babbitt, K.J., M.J. Baber, and T.L Tarr, 2003. Patterns of larval amphibian distribution along a wetland gradient. *Canadian Journal of Zoology* 81:1539-1552.
- Babcock, H.L. 1919. The Turtles of New England. *Memoirs of the Boston Society of Natural History* 8(3):325-431.
- Baldwin, E.A., M.N. Marchand, and J.A. Litvitis. 2004. Terrestrial habitat use by nesting painted turtles in landscapes with different levels of fragmentation. *Northeastern Naturalist* 11: 41-48.
- Baldwin, R.F., A.J.K. Calhoun, and P.G. DeMaynadier. 2006a. Conservation planning for amphibian species with complex habitat requirements: A case study using movements and habitat selection of the Wood Frog *Rana sylvatica*. *Journal of Herpetology* 40:442-453.
- Baldwin, R.F., A.J.K. Calhoun, and P.G. deMaynadier. 2006b. The significance of hydroperiod and stand maturity for pool-breeding amphibians in forested landscapes. *Canadian Journal of Zoology* 84: 1604-1615.
- Bank, M.S., C.S. Loftin, and R.E. Jung. 2005. Mercury bioaccumulation in northern two-lined salamanders from streams in the northeastern United States. *Ecotoxicology* 14:181-191.
- Bank, M.S., J.B. Crocker, S. Davis, D K. Brotherton, R. Cook, J. Behler, and B. Connery. 2006. Population decline of northern dusky salamanders at Acadia National Park, Maine, USA. *Biological Conservation* 130:230-238.
- Bank, M. S., J. Crocker, B. Connery, and A. Amirbahman. 2007. Mercury bioaccumulation in green frog (*Rana clamitans*) and bullfrog (*Rana catesbeiana*) from Acadia National Park, Maine, USA. *Environmental Toxicology and Chemistry* 26:118-125.
- Barrett, K., B.S. Helms, C. Guyer, and J.E. Schoonover. 2010. Linking process to pattern: Causes of stream-breeding amphibian decline in urbanized watersheds. *Biological Conservation* 143:1998-2005.

- Berven, K.A. 1990. Factors affecting population fluctuation in larval and adult stages of the woodfrog (*Rana sylvatica*). *Ecology* 71:1599-1608.
- Berven, K.A. and T.A. Grudzien. 1990. Dispersal in the wood frog (*Rana sylvatica*): implications for genetic population structure. *Evolution* 44:2047-2056.
- Behler, J.L. and F.W. King. 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York, 719 pp.
- Bishop, S.C. 1923a. Notes on the herpetology of Albany County. New York. *Copeia* 118:64-68.
- Bishop, S.C. 1923b. Notes on the herpetology of Albany County. New York. II. *Copeia* 120:83-84.
- Bishop, S.C. 1923c. Notes on the herpetology of Albany County. New York. III. The snakes and turtles. *Copeia* 125:117-120.
- Bishop, S.C. 1941. Salamanders of New York. New York State Museum Bulletin. 324:1-365.
- Blaustein, A.R. 1994. Chicken little or Nero's fiddle? A perspective on declining amphibian populations. *Herpetologica* 50:85-97.
- Blaustein, A. ., P.D. Hoffman, D.G. Hokit, J. . Kiesecker, S.C. Walls, and J.B. Hays. 1994. UV repair and resistance to solar UV-B in amphibian eggs: a link to population declines? *Proceedings of the National Academy of Sciences*. 91:1791-1795.
- Bogart, J.P. and M.W. Klemens. 1997. Hybrids and genetic interactions of mole salamanders (*Ambystoma jeffersonianum* and *A. laterale*) (Amphibia: Caudata) in New York and New England. *American Museum Novitates* 3218:1-78.
- Bogart, J.P. and M.W. Klemens. 2008. Additional distributional records of *Ambystoma laterale*, *A. jeffersonianum* (Amphibia: Caudata) and their unisexual kleptogens in northeastern North America. *American Museum Novitates* 3627:1-58.
- Bonin, J. 1991. Effect of forest age on woodland salamanders and the habitat and status of stream salamanders in southwestern Quebec. unpublished MS Thesis. McGill University, Montreal, Quebec.
- Brannon, M.P. and B.A. Purvis. 2008. Effects of sedimentation on the diversity of salamanders in a southern Appalachian headwater stream. *Journal of the North Carolina Academy of Science* 124:18-22.
- Breden, F. 1988. The natural history and ecology of Fowler's toad, *Bufo woodhousei fowleri* (Amphibia: Bufonidae) in the Indiana Dunes National Lakeshore. *Fieldiana Zoology* 49:1-16.

- Breisch, A.R. and J.W. Ozard. in prep. The New York State Amphibian and Reptile Atlas 1990-1999. New York State Department of Environmental Conservation.
- Brotherton, D.K., J.L. Behler, and R.P. Cook. 2005a. Acadia National Park Amphibian and Reptile Inventory March-September 2001. Technical Report NPS/NER/NRTR-2005/007. National Park Service, Woodstock, VT.
- Brotherton, D.K., J.L. Behler, and R.P. Cook. 2005b. Morristown National Historic Park Amphibian and Reptile Inventory March-September 2000. Technical Report NPS/NER/NRTR-2005/013. National Park Service, Woodstock, VT.
- Brotherton, D.K., J.L. Behler, and R.P. Cook. 2005c. Weir Farm National Historic Site Amphibian and Reptile Inventory March-September 2000. Technical Report NPS/NER/NRTR-2005/029. National Park Service, Boston, MA.
- Burgason, B.N. 1999. Four-toed salamander. In: Hunter, M. L., A. J. K Calhoun, and M. McCollough. Maine Amphibians and Reptiles. The University of Maine Press, Orono, ME. pp. 62-65.
- Burton, T.M. and G. E. Likens. 1975. Salamander populations and biomass in the Hubbard Brook Experimental Forest, New Hampshire. *Copeia* 1975:541-546.
- Bury, R.B. 2008. Low thermal tolerances of stream amphibians in the Pacific Northwest: implications for riparian and forest management. *Applied Herpetology* 5:63-74.
- Bury, R.B. and M.G. Raphael. 1983. Inventory methods for amphibians and reptiles. In J. F. Bell and T. Atterbury (eds.), *Renewable Resources Inventories for Monitoring Changes and Trends*, pp. 416-419. Oregon State University, Corvallis, Oregon.
- Cagle, F.R. 1939. A system of marking turtles for future identification. *Copeia* 1939:170-173.
- Carr, L.W. and L. Fahrig. 2001. Effect of road traffic on two amphibian species of differing vagility. *Conservation Biology* 15: 1071-1078.
- Castellano, C.M., J.L. Behler, and G. Amato. 2009. Genetic diversity and population genetic structure of the Wood Turtle (*Glyptemys insculpta*) at Delaware Water Gap National Recreation Area, USA. *Conservation Genetics* 10:1783-1788.
- Chalmers, A., M.A. Nilles, D.P. Krabbenhoft, and E. Prestbo. 2005. Analysis of mercury wet-deposition data collected with a newly designed sampler, Boston, Massachusetts Metropolitan Area, 2002–04: U.S. Geological Survey Open-File Report 2005–1368, 17 p.
- Clark, K.L. and R.J. Hall. 1985. Effects of elevated hydrogen ion and aluminum concentrations on the survival of amphibians embryos and larvae. *Canadian Journal of Zoology* 63: 116-123.

- Clark, P.J., J.M. Redd, B.G. Tavernia, B.S. Windmiller, and J.V. Regosin. 2008. Urbanization effects on spotted salamander and wood frog presence and abundance. *Urban Herpetology*. J.C. Mitchell, R.E. Jung Brown and B. Bartholomew, editors. *Herpetological Conservation* 3:67-75. Society for the Study of Amphibians and Reptiles.
- Compton, B.W., J.M. Rhymer, and M.M. McCollough. 2002. Habitat selection by wood turtles (*Clemmys insculpta*): An application of paired logistic regression. *Ecology* 83:833-843.
- Conant, R. and J.T. Collins. 1998. *A Field Guide to Reptile and Amphibians: Eastern and Central North America*. 3rd Edition Expanded. Boston: Houghton Mifflin Co.
- Congdon, J.D., Breitenbach, G.L., van Loben Sels, R.C., and D. W. Tinkle. 1987. Reproduction and nesting ecology of snapping turtles (*Chelydra serpentina*) in southeastern Michigan. *Herpetologica* 43:39-54.
- Congdon, J. D., S. W. Gotte, and R.W. McDiarmid. 1992. Ontogenetic changes in habitat use by juvenile turtles, *Chelydra serpentina* and *Chrysemys picta*. *Canadian Field Naturalist* 106:241-248.
- Cook, R.P. 1978. Effects of acid precipitation on embryonic mortality of spotted salamanders (*Ambystoma maculatum*) and Jefferson salamanders (*Ambystoma jeffersonianum*) in the Connecticut Valley of Massachusetts. MS Thesis, University of Massachusetts, Amherst.
- Cook, R.P. 2005. Monitoring leads to enhanced protection of spadefoot toads at Cape Cod National Seashore. *Park Science* 23(2):10-11.
- Cook, R.P. and K.M. Boland. 2005. A comparison of approaches to counting egg masses of spotted salamander (*Ambystoma maculatum*). *Herpetological Review* (36):272-274.
- Cook, R.P., J. Portnoy, D. Murphy, M. Schult, A. Goodstine, and L. Bratz. 2006a. Preliminary report on the distribution and abundance of four-toed salamanders (*Hemidactylium scutatum*) at Cape Cod National Seashore, with emphasis on the Herring River drainage. Technical Report, Long-term Coastal Ecosystem Monitoring Program, Cape Cod National Seashore, Wellfleet, MA.
- Cook, R.P., M. Schult, A. Goodstine, and G. Radik. 2006b. Monitoring of pond breeding amphibians at Cape Cod National Seashore, 2005. Technical Report, Long-term Coastal Ecosystem Monitoring Program, Cape Cod National Seashore, Wellfleet, MA.
- Cook, R.P., K.M. Boland, S J. Kot, J. Borgmeyer, and M. Schult. 2007. Inventory of Freshwater Turtles at Cape Cod National Seashore with Recommendations for Long-Term Monitoring. Technical Report NPS/NER/NRTR-2007/091. National Park Service. Boston, MA.

- Cook, R.P., D.K. Brotherton, and J.L. Behler. 2008. Saint-Gaudens National Historical Site Amphibian and Reptile Inventory: March-September 2001. Technical Report NPS/NER/NRTR-2008/120. National Park Service. Boston, MA.
- Cook, R.P., D.K. Brotherton, and J.L. Behler. 2010. Saugus Iron Works National Historic Site amphibian and reptile inventory: March – September 2001. Natural Resource Report NPS/NETN/NRR—2010/248. National Park Service. Fort Collins, Colorado.
- Cook, R.P., D.K. Brotherton, B. Timm, and J.L. Behler. 2011a. Minuteman National Historic Site Amphibian and Reptile Inventory: March-September 2001. Technical Report NPS/NETN/NRTR—2011/505. National Park Service, Fort Collins, Colorado.
- Cook, R.P., T. Tupper, P.W.C. Paton, and B. Timm. 2011b. Effects of temperature and temporal factors on anuran detection probabilities at Cape Cod National Seashore: Implications for Long-Term Monitoring. *Herpetological Conservation and Biology* 6(2):25-39.
- Crouch, W.B. and P.W.C. Paton. 2000. Using egg mass counts to monitor wood frog populations. *Wildlife Society Bulletin* 28:895-901.
- Crouch, W.B. and P.W.C. Paton. 2002. Assessing the use of call surveys to monitor breeding anurans in Rhode Island. *Journal of Herpetology* 36:185-192.
- Cushman, S.A. 2006. Effects of habitat loss and fragmentation on amphibians: A review and prospectus. *Biological Conservation* 128:231-240.
- Daszak, P., L. Berger, A.A. Cunningham, A.D. Hyatt, D.E. Green, and R. Speare. 2000. Emerging Infectious Diseases and Amphibian Population Declines. *Center for Disease Control*. Vol. 5, No. 6.
- DeGraaf, R.M. and D.D. Rudis. 1983. Amphibians and reptiles of New England: habitats and natural history. The University of Massachusetts Press, Amherst. 85pp.
- DeKay, J.E. 1842. Zoology of New York or the New-York Fauna; Part III. Reptiles and Amphibia. Albany, NY.
- Ditmars, R.L. 1896. The snakes found within fifty miles of New York City. Abstract of Proceedings of the Linnaean Society of New York 8:9-24.
- Ditmars, R.L. 1905. The batrachians of the vicinity of New York City. Guide Leaflet Series No. 20, American Museum of Natural History. New York, NY.
- Dodd, C.K. 2001. North American Box Turtles: A Natural History. Norman, Univ. of Oklahoma Press. 256pp.
- Dunn, E.R. 1930. Reptiles and amphibians of Northampton and vicinity. *Bulletin of the Boston Society of Natural History* 57:3-8.

- Dunson, W.A., R.L. Wyman, and E.S. Corbett. 1992. A symposium on amphibian declines and habitat acidification. *Journal of Herpetology* 26:349-352.
- Durner, G.M. and J.E. Gates. 1993. Spatial ecology of black rat snakes on Remington Farms, Maryland. *Journal of Wildlife Management* 57:812-826.
- Eckel, E.C. and F.C. Paulmier. 1902. Catalogue of New York Reptiles and Batrachians. New York State Museum Bulletin 51:355-414.
- Egan, R.S. and P.W.C. Paton. 2004. Within-pond parameters affecting oviposition by wood frogs and spotted salamanders. *Wetlands* 24(1):1-13.
- Egan, R.S. and P.W.C. Paton. 2008. Multiple scale habitat characteristics of pond-breeding amphibians across a rural-urban gradient. *Urban Herpetology*. J.C. Mitchell, R.E. Jung Brown and B. Bartholomew, editors *Herpetological Conservation* 3:53-65. Society for the Study of Amphibians and Reptiles.
- Eigenbrod, F., S.J. Hecnar, and L. Fahrig. 2008. The relative effects of road traffic and forest cover on anuran populations. *Biological Conservation* 141:35-46.
- Engelhardt, G.P., J.T. Nichols, R. Latham, and R.C. Murphy. 1915. Long Island snakes. *Copeia* 17:1-4.
- Erb, L. 2011. Eastern Box Turtle Conservation Plan For Massachusetts. Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program. Westborough, MA.
- Ernst, C.H. 2001. Some ecological parameters of the wood turtle, *Clemmys insculpta*, in southeastern Pennsylvania, U.S.A. *Herpetological Bulletin*:85:2-11.
- Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington D. C. 578pp.
- Ernst, C.H. and E.M. Ernst. 2003. *Snakes of the United States and Canada*. Smithsonian Institution Press, Washington D. C. 668pp.
- Ewert, M.A. and C.E. Nelson. 1991. Sex determination in turtles: diverse patterns and some possible adaptive values. *Copeia* 1991:50-69.
- Fahrig, L., J.H. Pedlar, S.E. Pope, P.D. Taylor, and J.F. Wegner. 1995. Effect of road traffic on amphibian density. *Biological Conservation* 73:177-182.
- Gagne, S.A. and L. Fahrig. 2007. Effect of landscape context on anuran communities in breeding ponds in the National Capital Region, Canada. *Landscape Ecology* 22:205-215.

- Gawley, W. G. *In Prep.* Northeast Temperate Network Water Quality Report, 2006-2009. Natural Resource Report NPS/NETN/NRR—2011/XXX. National Park Service, Fort Collins, Colorado.
- Gibbs, J. P. 1998. Distribution of woodland amphibians along a forest fragmentation gradient. *Landscape Ecology* 13:263-268.
- Gibbs, J.P. and G.D. Amato. 2000. Genetics and demography in turtle conservation. In: *Turtle Conservation*, p. 207-217. Klemens, M.W., Ed, Smithsonian Institution Press. Washington, DC
- Gibbs, J.P. and W.G. Shriver. 2002. Estimating the effects of road mortality on turtle populations. *Conservation Biology* 16:1647-1652.
- Gibbs, J.P. and W.G. Shriver. 2005. Can road mortality limit populations of pool-breeding amphibians? *Wetlands Ecology and Management* 13:281-289.
- Gibbs, J.P. and D.A. Steen. 2005. Trends in sex ratios of turtles in the United States: Implications of road mortality. *Conservation Biology* 19:552-556.
- Gibbs, J.P., K.K. Whiteleather, and F.W. Schueler. 2005. Changes in frog and toad populations over 30 years in New York State. *Ecological Applications* 15:1148-1157.
- Gibbs, J.P., A.R. Breisch, P.K. Ducey, G. Johnson, J.L Behler, and R.C. Bothner. 2007. *The amphibians and reptiles of New York State*. Oxford University Press, NY.
- Graham, T.E. 1995. Habitat use and population parameters of the spotted turtle, *Clemmys guttata*, a species of special concern in Massachusetts. *Chelonian Conservation and Biology*. 1: 207-214.
- Graham, T.E. and V.H. Hutchison. 1969. Centenarian box turtles. *International Turtle and Tortoise Society Journal*. 3(3):25-29.
- Grant, B. W., A. D. Tucker, J. E. Lovich, A. M. Mills, P. M. Dixon and J. W. Gibbons. 1992. The use of coverboards in estimating patterns of reptile and amphibian biodiversity. In D. R. McCullough and R. H. Barrett (eds.). *Wildlife 2001: Populations*, pp. 379-403. Elsevier Science Publication, Inc. London, England.
- Grant, E.H.C., L.E. Green, and W.H. Lowe. 2009. Salamander occupancy in headwater stream networks. *Freshwater Biology* 54:1370-1378.
- Guerry, A.D. and M.L. Hunter, Jr. 2002. Amphibian distributions in a landscape of forests and agriculture: an examination of landscape composition and configuration. *Conservation Biology* 16: 45-754.

- Hager, H.A. 1998. Area-sensitivity of reptiles and amphibians: are there indicator species for habitat fragmentation? *Ecoscience* 5:139-147.
- Harless, M. and H. Morlock. 1989. *Turtles: Perspectives and Research*. Robert E. Krieger Publishing Company, Inc. Malabar, Florida. 695pp.
- Heath, R., F. Mack, and J. Tannenbaum. 1963. Ground-water studies in Saratoga County, New York. Bulletin GW-49, New York Department of Conservation, Water Resources Commission, Albany.
- Healy, W.R. 1974. Population consequences of alternative life histories in *Notophthalmus v. viridescens*. *Copeia* 1974:221-229.
- Heatwole, H. 1962. Environmental factors influencing local distribution and activity of the salamander, *Plethodon cinereus*. *Ecology* 43:460-472.
- Hecnar, S.J. and R.T. M'Closkey. 1998. Species richness patterns of amphibians in southwestern Ontario ponds. *Journal of Biogeography* 25:763-772.
- Herrmann, H.L., K.J. Babbitt, M.J. Baber, and R.G. Congalton. 2005. Effects of landscape characteristics on amphibian distribution in a forest-dominated landscape. *Biological Conservation* 123: 139-149.
- Heyer, R. W., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, M.S. Foster. 1994. *Measuring and Monitoring Biological Diversity – Standard Methods for Amphibians*. Smithsonian Institution Press, Washington D.C.
- Homan, R. N., B.S. Windmiller, and J.M. Reed. 2004. Critical thresholds associated with habitat loss for two vernal pool-breeding amphibians. *Ecological Applications* 14:1547-1553.
- Hurlbert, S.H. 1970. Predator responses to the vermilion-spotted newt (*Notophthalmus viridescens*) *Journal of Herpetology* 4:47-55.
- Jaeger, R.G. 1980. Microhabitats of a terrestrial forest salamander. *Copeia* 1980:265-268.
- Johnson, J.R., J.H. Knouft, and R.D. Semlitsch. 2007. Sex and seasonal differences in the spatial terrestrial distribution of gray treefrog (*Hyla versicolor*) populations. *Biological Conservation* 140:250-258.
- Johnson, L.M. 2009. Reproductive ecology, demography, and causes of mortality in a population of eastern musk turtle, *Sternotherus odoratus* (Latreille), in central Massachusetts. MS thesis, Antioch University of New England.
- Joyal, L.A., M. McCollough, and M.L. Hunter. 2001. Landscape ecology approaches to wetland species conservation: a case study of two turtle species in Southern Maine. *Conservation Biology* 15:1755-1762.

- Karraker, N.E. and J.P. Gibbs. 2009. Amphibian production in forested landscapes in relation to wetland hydroperiod: A case study of vernal pools and beaver ponds. *Biological Conservation* 142: 2293-2302.
- Karraker, N.E., J.P. Gibbs, J.R. Vonesh. 2008. Impacts of road deicing salt on the demography of vernal pool-breeding amphibians. *Ecological Applications*. 18:724-734.
- Kieran, J. 1959. *Natural History of New York City*. Houghton-Mifflin Co. Boston, MA.
- Kjoss, V.A. and J.A. Litvaitis. 2001. Community structure of snakes in a human-dominated landscape. *Biological Conservation* 98: 285-292.
- Klemens, M.W. 1993. Amphibians and reptiles of Connecticut and adjacent regions. *State Geological and Natural History Survey of Connecticut, Bulletin 112*. 318 pp.
- Klemens, M.W. 1995. New distributional records of amphibians and reptiles from New Hampshire. *Herpetological Review* 26(1):49.
- Klemens, M.W., R.P. Cook, and D. Hayes. 1992. Herpetofauna of Roosevelt-Vanderbilt National Historic Sites, Hyde Park, New York, with emphasis on Blanding's Turtle (*Emydoidea blandingi*). Technical Report NPS/NAROSS/NRTR-92/08. National Park Service, Boston, MA.
- Knapp, R.A. and K.R. Matthews. 2000. Non-native fish introductions and the decline of the Mountain Yellow-legged Frog from within protected areas. *Conservation Biology* 14:428-438.
- Knutson, M.G., J.R. Saur, D.A. Olsen, M.J. Mossman, L.M. Hemesath, and M.J. Lannoo. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin, USA. *Conservation Biology* 13:1437-1446.
- Kolozsvary, M.B. and R.K. Swihart. 1999. Habitat fragmentation and the distribution of amphibians: patch and landscape correlates in farmland. *Canadian Journal of Zoology* 77:1288-1299.
- Kupferberg, S. 1994. Bullfrogs (*Rana catesbeiana*) invade a northern California watershed: impact on native frogs and hydrologic factors affecting establishment. *American Zoologist* 34:8A.
- Kurzava, L.M. and P.J. Morin. 1994. Consequences and causes of geographic variation in the body size of a keystone predator, *Notophthalmus viridescens*. *Oecologia* 99:221-280.
- Lacki, M.J., J.W. Hummer, and H.J. Webster. 1992. Mine-drainage treatment wetland as habitat for herpetofaunal wildlife. *Environmental Management* 16:513-520.

- Lazell, J.D. 1976. This Broken Archipelago: Cape Cod and the islands, amphibians and reptiles. Demeter Press (Quadrangle: The New York Times Book Co.), New York, NY.
- Levell, J.P. 2000. Commercial exploitation of Blanding's turtle, *Emydoidea blandingii*, and the wood turtle, *Clemmys insculpta*, for the live animal trade. Chelonian Conservation and Biology 3:665-674.
- Lewis, T.L., J.M. Ullmer, and J.L. Mazza. 2004. Threats to spotted turtle (*Clemmys guttata*) habitat in Ohio. The Ohio Journal of Science 104:65-71.
- Likens, G.E., C.T. Driscoll, and D.C. Buso. 1996. Long-term effects of acid rain: Response and recovery of a forest ecosystem. Science 272 (5259):244-246.
- Longcore, J.R., J.E. Longcore, A.P. Pessier, and W.A. Halteman. 2007. Chytridiomycosis widespread in anurans of Northeastern United States. Journal of Wildlife Management 71:435-442.
- Lowe, W.H. 2005. Factors affecting stage-specific distribution in the stream salamander *Gyrinophilus porphyriticus*. Herpetologica 61:135-144,
- Lowe, W.H. and D.T. Bolger. 2002. Local and landscape-scale predictors of salamander abundance in New Hampshire headwater streams. Conservation Biology 16:183-193.
- Lynch, P. 1988. List of amphibians and reptiles observed in Saratoga National Historical Park 1987-1988. Unpublished, in Saratoga National Historical Park files.
- MA Highways. 2006. Wildlife Accommodation. Massachusetts Highway Department Project Development and Design Guidebook. Chapter 14. Massachusetts Executive Office of Transportation. Boston, MA.
http://www.mhd.state.ma.us/downloads/designGuide/CH_14.pdf, last accessed March 5, 2012.
- MA NHESP 2007. Wood Turtle *Glyptemys insculpta*. Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program. Westborough, MA.
- MA NHESP 2009. Draft mowing advisory guidelines in turtle habitat: pastures, successional fields, and hayfields. Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program. Westborough, MA.
http://www.mass.gov/dfwele/dfw/nhesp/conservation/pdf/mowing_guidelines.pdf.
Link checked on March 5, 2012.
- Malecki, R. 1995. Purple loosestrife. Pages 458-459 in E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (eds). Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. National Biological Survey, Washington, D. C.

- Markowsky, J.K. 1999. Spring salamander. In: Hunter, M.L., A.J. K Calhoun, and M. McCollough. 1999. Maine Amphibians and Reptiles. The University of Maine Press, Orono, ME. pp. 59-61.
- McDonough, C. and P.W.C. Paton. 2007. Salamander dispersal across a forested landscape fragmented by a golf course. *Journal of Wildlife Management* 71:1163-1169.
- Menkens, G.E. Jr. and S.H. Anderson. 1988. Estimation of small-mammal population size. *Ecology* 69:1952-1959.
- Miller, J.E., G.R. Hess, and C.E. Moorman. 2007. Southern two-lined salamanders in urbanizing watersheds. *Urban Ecosystems* 10:73-85.
- Miller, K.M., B.R. Mitchell, G L. Tierney, and J S. Wheeler. 2011. Northeast Temperate Network forest health monitoring report: 2010. Natural Resource Report NPS/NETN/NRR—2011/399. National Park Service, Fort Collins, Colorado.
- Mirick, P.G. 2009. Field guide to the Reptiles of Massachusetts. Editor. *Massachusetts Wildlife* 59(2):4-45.
- Mitchell, J.C. and M.W. Klemens. 2000. Primary and secondary effects of habitat alteration. In: *Turtle Conservation*, p. 5-32. Klemens, M.W., Ed, Smithsonian Institution Press. Washington, DC.
- Moriarty, J.J. 2004. Amphibian and reptile diversity and distribution in the United States. <http://cggee.hamline.edu/frogs/science/StateA&R.pdf> , last accessed March 5, 2012.
- Moseley, K.R., W.M. Ford, J.W. Edwards, and T.M. Schuler. 2008. Long-term partial cutting impacts on *Desmognathus* salamander abundance in West Virginia headwater streams. *Forest Ecology and Management* 254:300-307.
- Murphy, R.C. 1950. August on Fire Island Beach. Science Guide No. 134, American Museum of Natural History, New York, NY.
- NPS. 1986. List of mammals and amphibians captured in 1986. Unpublished, in Saratoga National Historical Park files.
- NPS. 1997. Baseline water quality data inventory and analysis: Saratoga National Historic Park. Technical Report NPS/NRWRD/NRTR-97/96. National Park Service, Washington, DC.
- NPS. 1998. Unpublished species list for Saratoga National Historical Park based on the legacy NPFauna database developed by the National Park Service between 1985 and 1998. The species database has been replaced by the NPSpecies data application.

- Nelson, G.L. and B.M. Graves. 2004. Anuran population monitoring: Comparison of the North American amphibian monitoring program's calling index with mark-recapture estimates for *Rana clamitans*. *Journal of Herpetology* 38: 355-359.
- NOAA 1999. National Climatic Data Center, State of the Climate: Drought for July 1999, published online August 1999, retrieved on August 20, 2011 from <http://www.ncdc.noaa.gov/sotc/drought/1999/7>.
- NOAA 2001. National Climatic Data Center, State of the Climate: Drought for April 2001, published online May 2001, retrieved on August 20, 2011 from <http://www.ncdc.noaa.gov/sotc/drought/2001/4>
- Noble, G.K. 1927. Distributional list of the reptiles and amphibians of the New York City region. Guide Leaflet Series No.69, American Museum of Natural History, NY. 16 pp.
- Orser, P.N. and D.J. Shure. 1972. Effects of urbanization on the salamander *Desmognathus fuscus fuscus*. *Ecology* 53:1148-1154.
- Overton, F. 1914. Long Island flora and fauna III: the frogs and toads (Order Salientia). Museum of the Brooklyn Institute of Arts and Science, Science Bulletin 2(3):21-40.
- Overton, F. 1915. Late-breeding spadefoot toads, etc. *Copeia* 24:52-53.
- Pechmann, J.H.K., and H.W. Wilbur. 1994. Putting declining amphibian populations in perspective: natural fluctuations and human impacts. *Herpetologica* 50:65-84.
- Pechmann, J.H.K., Scott, D., Semlitsch, R.D., Caldwell, J.P., Vitt, L.J., and J.W. Gibbons. 1991. Declining amphibian populations: the problem of separating human impacts from natural fluctuations. *Science* 253:892-895.
- Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D. C. 587 pp.
- Petranka, J.W., M.E. Eldridge, and K.E. Haley. 1993. Effects of timber harvesting on southern Appalachian salamanders. *Conservation Biology* 7:363-370.
- Petranka, J.W. and C.K. Smith. 2005. A functional analysis of streamside habitat use by southern Appalachian salamanders: implications for riparian management. *Forest Ecology and Management*. 210:443-454.
- Porej, D., M. Micacchion, and T.E. Hetherington. 2004. Core terrestrial habitat for conservation of local populations of salamanders and wood frogs in agricultural landscapes. *Biological Conservation* 120:399-409.
- Porter, K. R. 1972. *Herpetology*. Saunders Publishing, Philadelphia, PA.

- Pough, F.H., R.M. Andrews, J.E. Cadle, M.L. Crump, A.H. Savitsky, and K.D. Wells. 2004. Herpetology. Prentice Hall, Upper Saddle River, NJ.
- Pough, F.H. and M.B. Pough 1968. The systematic status of painted turtles (*Chrysemys*) in the northeastern United States. *Copeia* 1968:612-618.
- Pough, F.H., E.M. Smith, D.H. Rhodes, and A. Collazo. 1987. The abundance of salamanders in forest stands with different histories of disturbance. *Forest Ecology and Management* 20:1-9.
- Price, S.J., D.R. Marks, R.W. Howe, J.M. Hanowski, and G.J. Niemi. 2005. The importance of spatial scale for conservation and assessment of anuran populations in coastal wetlands of the western Great Lakes, USA. *Landscape Ecology* 20:441-454.
- Price, S.J., M.E. Dorcas, A.L. Gallant, R.W. Klaver, and J.D. Willson. 2006. Three decades of urbanization: estimating the impact of land-cover change on stream salamander populations. *Biological Conservation* 133: 436-441.
- Price, S.J., K.R. Cecala, R.A. Brown, and M.E. Dorcas. 2010. Effects of urbanization on occupancy of stream salamanders. *Conservation Biology* 25:547-555.
- Reagan D.P. 1974. Habitat selection in the three-toed box turtle, *Terrapene carolina triunguis*. *Copeia* 1974: 512-527.
- Regosin, J.V., B.S. Windmiller, and J.M.Reed. 2003. Terrestrial habitat use and winter densities of the wood frog (*Rana sylvatica*). *Journal of Herpetology* 37:390-394.
- Regosin, J.V., B.S. Windmiller, R.N. Homan, and J.M.Reed. 2005. Variation in terrestrial habitat use by four pool-breeding amphibian species. *Journal of Wildlife Management* 69(4):1481-1493.
- Roe, A.W. and K.L.Grayson. 2008. Terrestrial movements and habitat use of juvenile and emigrating adult Eastern red-spotted newts, *Notophthalmus viridescens*. *Journal of Herpetology* 42(1):22-30.
- Rothermal, B.B. and R.D. Semlitsch. 2002. An experimental investigation of landscape resistance of forest versus old-field habitats to emigrating juvenile amphibians. *Conservation Biology* 16:1324-1332.
- Rothermal, B.B. and R.D. Semlitsch. 2006. Consequences of forest fragmentation for juvenile survival in spotted (*Ambystoma maculatum*) and marbled (*Ambystoma opacum*) salamanders. *Canadian Journal of Zoology* 84:797-807.
- Rubbo, M.J. and J.M. Kiesecker. 2005. Amphibian breeding distribution in an urbanized landscape. *Conservation Biology* 19:504-511.

- Sadinski, W.J. and W.A. Dunson. 1992. A multilevel study of effects of low pH on amphibians of temporary ponds. *Journal of Herpetology* 26: 413-422.
- Schlauch, F.C. 1976. City snakes, suburban salamanders. *Natural History* 85:46-53.
- Schlauch, F.C. 1978. New methodologies for measuring species status and their application to the herpetofauna of a suburban region. *Engelhardtia* 6: 30-41.
- Schmidt, R.E., T.W. Hunsinger, T. Coote, E. Griffin-Noyes and E. Kiviat. 2004. Mudpuppy (*Necturus maculosus*) in the tidal Hudson River, with comments on its status as native. *Northeastern Naturalist* 11:179-188.
- Semlitsch, R.D. 2003. Conservation of pond breeding amphibians. In: R.D. Semlitsch (ed.) *Amphibian Conservation*, pp. 8-23. Smithsonian Institution Press, Washington, DC.
- Singler A. and B. Graber. 2005. editors. *Massachusetts Stream Crossing Handbook*. Massachusetts Riverway Program. Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Fish and Game, Boston, MA.
- Skelly, D.K., E.A. Werner, and S.A. Cortwright. 1999. Long-term distributional dynamics of a Michigan amphibian assemblage. *Ecology* 80:2326-2337.
- Skidds, D.E., F.C. Golet, P.W.C. Paton, and J.C. Mitchell. 2007. Habitat correlates of reproductive effort in wood frogs and spotted salamanders in an urbanizing watershed. *Journal of Herpetology* 41:439-450.
- Southerland, M.T., R.E. Jung, D.P. Baxter, I.C. Chellman, G. Mercurio, and J.H. Volstad. 2004. Stream salamanders as indicators of stream quality in Maryland, USA. *Applied Herpetology* 2:23-46.
- Steen, D.A. and J.P. Gibbs. 2005. Potential influence of the terrestrial landscape on the distribution of pond-breeding eastern newts, *Notophthalmus viridescens*. *Applied Herpetology* 2:425-428
- Stewart, M.M. and J. Rossi. 1981. The Albany Pine Bush: a northern outpost for southern species of amphibians and reptiles in New York. *The American Midland Naturalist* 106:282-292.
- Thomson, W.L., G.C. White, and C. Gowan. 1998. *Monitoring Vertebrate Populations*. Academic Press, San Diego, CA.
- Tiner, R.W., I.K. Huber, G.S. Smith, and M.J. Starr. 2000. *Wetlands Inventory of Saratoga National Historical Park*. Produced for the U. S. National Park Service. FWS-14-16-0009-01-1807. U. S. Fish and Wildlife Service National Wetlands Inventory Northeast Region, Hadley, Massachusetts.

- Troha, T. 1995. List of amphibians and reptiles observed in Saratoga National Historic Park. Unpublished, in Saratoga National Historic Park files.
- Tupper, T.A. and R.P. Cook. 2008. Habitat variables influencing breeding effort in northern clade *Bufo fowleri*: Implications for conservation. *Applied Herpetology* 5:101-119.
- Tupper, T.A., J.W. Streicher, S.E. Greenspan, B.C. Timm, and R.P. Cook. 2011. Detection of *Batrachochytridium dendrobatidis* in Anurans of Cape Cod National Seashore, Barnstable County, Massachusetts, USA. *Herpetological Review* 42(1):62-65.
- USDA NRCS 2004. Soil survey of Saratoga County, New York. United States Department of Agriculture, Natural Resources Conservation Service.
- Vana-Miller, D., C. Martin, & L. White. 2001. Water Resources Management Plan – Saratoga National Historical Park, New York. 70pp.
- Walde, A.D., J.R. Bider, C. Daigle, D. Masse, J.C. Bourgeois, J. Jutras, and R. D. Titman. 2003. Ecological aspects of a wood turtle, *Glyptemys insculpta*, population at the northern limit of its range in Quebec. *Canadian Field-Naturalist* 117:377-388.
- Weber, J.A. 1928. Herpetological observations in the Adirondack Mountains, New York. *Copeia* 169:106-112.
- Weldon, C., L.H. duPreez, A.D. Hyatt, M. Reinhold, and R. Speare. 2004. Origin of the amphibian chytrid fungus. *Emerging Infectious Diseases* 10:2100-2105.
- Willson, J.D. and M.E. Dorcas. 2003. Effects of habitat disturbance on stream salamanders: implications for buffer zones and watershed management. *Conservation Biology* 17: 763-771.
- Willson, J.D. and M.E. Dorcas. 2004. Aspects of the ecology of small fossorial snakes in the western piedmont of North Carolina. *Southeastern Naturalist* 3:1-12.
- Windmiller, B. 1996. The pond, the forest, and the city: spotted salamander ecology and conservation in a human-dominated landscape. Ph.D. Dissertation, Tufts University, Boston, Massachusetts.
- Windmiller, B., R.N. Homan, J.V. Regosin, L.A. Willitts, D.L. Wells, and J.M. Reed. 2008. Breeding amphibian population declines following loss of upland forest habitat around vernal pools in Massachusetts, USA. *Urban Herpetology*. J.C. Mitchell, R.E. Jung Brown and B. Bartholomew, editors *Herpetological Conservation* 3:41-51. Society for the Study of Amphibians and Reptiles.
- Woolbright, L. 2001-2006. The amphibian community of the Saratoga National Historical Park. Study # SARA-00002. Unpublished annual reports in park service files.

- Wright, A.H. and A.A. Wright. 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Associates. Ithaca, New York.
- Zampella, R.A. and J.F. Bunnell. 2000. The distribution of anurans in two river systems of a coastal plain watershed. *Journal of Herpetology* 34:210-221.
- Zampella, R.A., J.F. Bunnell, K.J. Laidig, and N.A. Procopio III. 2010. Aquatic degradation in shallow coastal plain lakes: Gradients of thresholds? *Ecological Indicators* 10:303-310.
- Ziminski, S.W. 1970. Notes on the decline of snakes at the Long Island Village of Hempstead and its vicinities. *Engelhardtia* 3: 2.
- Zug, G. 1993. *Herpetology, an Introductory Biology of Amphibians and Reptiles*. Academic Press, San Diego, CA.

Appendix A. Historic and current records of amphibians and reptiles at Saratoga National Historical Park and vicinity as follows: 1=NPS 1986; 2=Lynch 1988; 3=Troha 1995; 4=pers. comm. Chris Martin 2011; 5=current survey 2001; 6=pers. comm. Larry Woolbright 2011; 7=Woolbright 2001; 8=Woolbright 2002; 9=Woolbright 2005; 10=pers. comm. Jacquie Tinker 2010; 11=pers. comm. Jacquie Tinker 2004; 12=pers. comm. Jacquie Tinker 2006; 13=composite of prior surveys; 14=Gibbs et al. 2007.

	NP Fauna	1986- 1988	1995	NY Herp Atlas	Current	Historic Baseline SARA ¹³	Hudson Valley Saratoga County ¹⁴
Salamander Species							
Common Mudpuppy							X
Jefferson Salamander		X ¹			X ^{5,6}	X	X
Blue-spotted Salamander							X
Spotted Salamander	X	X ²		X	X ^{5,7}	X	X
Red-spotted Newt	X	X ^{1,2}	X ³	X	X ^{5,7}	X	X
Northern Dusky Salamander	X					X	X
Allegheny Dusky Salamander							X
Northern Two-lined Salamander	X	X ^{1,2}	X ³	X	X ^{5,8}	X	X
Spring Salamander		X ¹				X	X
Eastern Red-backed Salamander	X	X ^{1,2}	X ³	X	X ^{5,9}	X	X
Four-toed Salamander							X
Salamander Subtotals	5	6	3	4	5	7	11
Anuran Species							
Eastern Spadefoot Toad				X		X	X
Eastern American Toad	X	X ^{1,2}	X ³	X	X ^{5,7}	X	X
Fowler's Toad	X					X	X
Gray Treefrog	X	X ²	X ³	X	X ^{5,7}	X	X
Northern Spring Peeper	X	X ^{1,2}	X ³	X	X ^{5,7}	X	X
American Bullfrog	X		X ³	X	X ^{5,7}	X	X
Northern Green Frog	X	X ²	X ³	X	X ^{5,7}	X	X
Northern Leopard Frog	X	X ²	X ³	X	X ^{5,7}	X	X
Pickerel Frog	X			X	X ⁵	X	X
Wood Frog	X	X ^{1,2}	X ³	X	X ^{5,7}	X	X
Anuran Subtotals:	9	6	7	9	8	10	10
Turtle Species							
Common Snapping Turtle	X			X	X ⁵	X	X
Stinkpot				X	X ¹⁰	X	X
Painted Turtle	X	X ²	X ³	X	X ⁵	X	X
Northern Map Turtle				X		X	X
Spotted Turtle			X ⁴	X		X	X
Wood Turtle	X	X ²		X	X ¹¹	X	X
Eastern Box Turtle	X	X ²		X	X ^{5, 12}	X	X
Turtle Subtotals:	4	3	2	7	5	7	7

Appendix A. Historic and current records of amphibians and reptiles at Saratoga National Historical Park and vicinity (continued).

	NP Fauna	1986- 1988	1995	NY Herp Atlas	Current	Historic Baseline SARA ¹³	Hudson Valley Saratoga County ¹⁴
Snake Species							
Northern Black Racer							X
Northern Ringneck Snake							X
Black Rat Snake							X
Eastern Hog-nosed Snake				X		X	X
Eastern Milk Snake	X	X ²		X	X ⁵	X	X
Northern Water Snake	X	X ²		X	X ⁵	X	X
Smooth Green Snake			X ³			X	X
Northern Brown Snake	X	X ²		X	X ⁵	X	X
Northern Red-bellied Snake	X	X ²		X	X ⁵	X	X
Eastern Ribbon Snake	X					X	X
Common Garter Snake	X	X ²	X ³	X	X ⁵	X	X
Snake Subtotals:	6	5	2	6	5	8	11
Total # Species	24	20	14	26	23	32	39

Appendix B. Habitat categories and types surveyed at Saratoga National Historical Park.

Habitat Category	Habitat Type	Description
STREAM	Permanent Stream	Narrow (<3m wide), flowing body of water.
WETLAND	Marsh	Body of water without well-defined borders, supporting abundant vegetation such as deciduous trees (i.e., Red Maple [<i>Acer rubrum</i>]), shrubs (i.e., Buttonbush [<i>Cephalanthus occidentalis</i>]), and emergent, herbaceous vegetation (i.e., Soft Rush [<i>Juncus effusus</i>]; sedges [<i>Carex</i> spp.]). Water is usually shallow (<1m) and substrate mucky.
	Temporary Pond	Open or closed canopy body of water that holds water for part of the year, drying during late summer months, and is void of fish. Identified by water stained leaves and buttressed tree trunks (i.e., Pin Oak [<i>Quercus palustris</i>]; Black Gum [<i>Nyssa sylvatica</i>]). Invertebrates present include fairy shrimp, predacious diving beetles, copepods, cladocerans, and caddisfly larvae.
	Permanent Pond	Open body of water (<2 ha), holds water the entire year, and fish are usually present. Borders of the pond are well defined.
	Permanent Canal	Typically located along the floodplain of a large river, running parallel to a river. Connected through small channels or entirely separated from the river.
UPLAND	Deciduous Forest	Forest dominated by deciduous trees (i.e., oak [<i>Quercus</i> spp.]; maple [<i>Acer</i> spp.]; birch [<i>Betula</i> spp.]).
	Coniferous Forest	Forest dominated by softwood or coniferous species like hemlock (<i>Tsuga canadensis</i>) and pine (<i>Pinus</i> spp.).
	Mixed Forest	Forest with hardwood or deciduous species, such as oak (<i>Quercus</i> spp.), maple (<i>Acer</i> spp.), and birch (<i>Betula</i> spp.), as well as softwood or coniferous species like hemlock (<i>Tsuga canadensis</i>) and pine (<i>Pinus</i> spp.).
	Field (grass/forbs)	Open area dominated by grasses and sedges

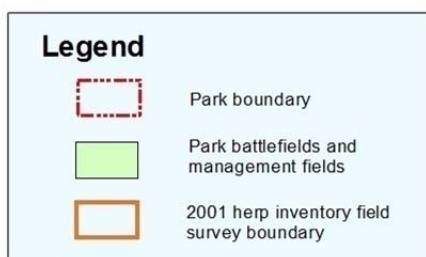
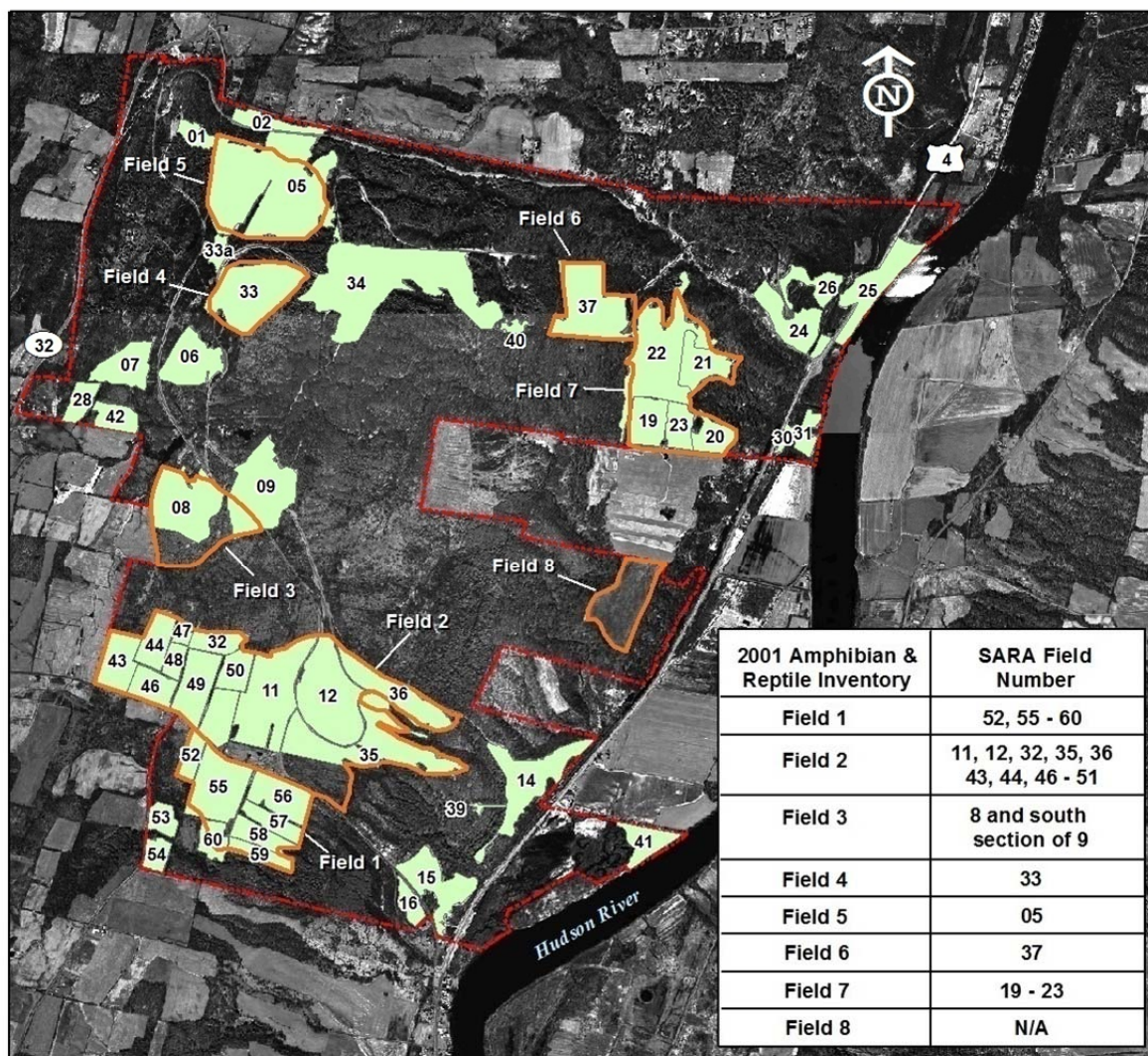
Appendix C. Coordinates for 39 standardized amphibian and reptile survey sites and 7 incidental encounter (IE) localities at Saratoga NHP. For streams and coverboards (CB), the pair of coordinates are start and end points of linear features. For fields and ponds, the single point is a central point in what is actually a polygon feature.

Site	Survey Method	UTM X	UTM Y	UTM X	UTM Y
Stream 1	TCS Stream	612699	4762388	612377	4762640
Stream 2	TCS Stream	613321	4761825	612840	4762220
Stream 3	TCS Stream	611844	4761599	611748	4762345
Stream 4	TCS Stream	611296	4761429	610826	4761554
Stream 5	TCS Stream	611742	4769612	611066	4760090
Stream 6	TCS Stream	611576	4760809	610835	4760676
Stream 8	TCS Stream	610847	4758971	609980	4759701
Canal Below Stop 10	ACS, TTS, MTS	613658	4762279		
Canal North of Entrance	TTS	613346	4761842		
Canal South of Entrance	ACS	612580	4762499		
Burdyl Pond	ACS, EMC, TCS Pond, TTS, MTS	610166	4760187		
North Entrance Pond	TTS	613477	4761943		
Service Road Pond	ACS, EMC, TCS Pond, TTS, MTS	610237	4762208		
Stop 1 Pond	ACS, EMC, TCS Pond, TTS, MTS	610226	4762468		
Victory Woods Pond	ACS, EMC, TCS Pond, TTS, MTS	614590	4772237		
Davidson Pond	ACS, EMC, TTS, MTS	609419	4761519		
Stop 2 Pond	ACS, EMC	610457	4760308		
Stop 8 Ponds	ACS, EMC, TCS Pond, TTS, MTS	612171	4761874		
Beaver Marsh	ACS, EMC, TCS Pond, TTS, MTS	610107	4761384		
River Road Marsh	ACS	613987	4762445		
Schuyler Estate Canal	ACS, EMC, TCS Pond, TTS, MTS	615411	4772061		
Vly Marsh	ACS, EMC, TCS Pond, TTS, MTS	611899	4772160		
Woodland 6	TCS Woodland, CB	611306	4762548	611339	4762567
Victory Woods	TCS Woodland	614552	4772353	614590	4772237
Woodland 1	TCS Woodland, CB	611030	4759671	611019	4759635
Woodland 2	TCS Woodland, CB	611017	610963	4760357	4760365
Woodland 3	TCS Woodland, CB	610800	4761395	610814	4761374
Woodland 4	TCS Woodland, CB	611264	4762080	611298	4762059
Woodland 5	TCS Woodland, CB	610139	4762259	610169	4762298
Woodland 7	TCS Woodland	612237	4761861	612230	4761814
Woodland 8	TCS Woodland, CB	612797	4762060	612822	4762025
Field 1	TCS Field, CB	610553	4759496	610599	4759472
Field 2	TCS Field, CB	610585	4760266	610617	4760302
Field 3	TCS Field, CB	610381	4761006	610392	4760954
Field 4	TCS Field, CB	610571	4762287	610526	4762287
Field 5	TCS Field, CB	610278	4762593	610284	4762644
Field 6	TCS Field, CB	612304	4762123	612354	4762135
Field 7	TCS Field, CB	612758	4761986	612772	4761938
Field 8	TCS Field	611278	4760845	611247	4760946
Entrance Rd. 1.5 mi E. of Vis. Ctr.	IE	612580	4762499		
Woodland Stop 6 and 7	IE	611096	4762284		
U.S. Hwy 4 W. Side of Champlain Canal	IE				
Int. of Rt. 32 and Entrance Rd.	IE	610581	4759760		
Vernal Ponds Adj. to Stream 4	IE	611281	4761414		
Entrance Rd. 1.0 mi E. of Vis. Ctr.	IE	611477	4762793		
N. of Stop 2 on Park Tour Rd.	IE	610811	4760565		

Appendix D. Crosswalk map for fields sites at Saratoga NHP.

Saratoga National Historical Park Herpetological Survey

Field Number Crosswalk



0.5 0.25 0 0.5 Miles

May 2011

Data source: The National Park Service, the U.S. Geological Survey, and the U.S. Department of Commerce U.S. Census Bureau Geography Division.

Purpose: To provide a crosswalk between field numbering systems used by the park and during the 2001 amphibian and reptile inventory described in this study.

Spatial Reference: NAD 83 UTM 18N.

Scale 1:32,000

Appendix E. Summary of measurements for snakes captured at Saratoga National Historical Park.

Species	Date	Location	Board #	Type	SVL (mm)	TL (mm)	Sex
Eastern Milk Snake	8/31	Entrance Rd. 1.5 mi E. of Vis. Ctr.	-	-	-	-	Unknown
	9/3	Field 3	83	Metal	388	439	Unknown
	9/5	Field 3	83	Metal	-	-	Recapture
	6/5	N. of Stop 2 on Park Tour Rd.	-	-	687	794	Unknown
	4/22	Woodland 5	-	-	-	-	Unknown
	5/30	Woodland 5	-	-	-	-	Unknown
	6/19	Woodland 5	-	-	-	-	Unknown
Northern Water Snake	8/27	Woodland 5	-	-	-	-	Unknown
	8/2	Beaver Marsh	-	-	520	681	Male
	8/2	Beaver Marsh	-	-	316	424	Unknown
	8/2	Beaver Marsh	-	-	487	652	Female
	8/2	Beaver Marsh	-	-	502	641	Female
	8/2	Beaver Marsh	-	-	257	331	Female
	8/2	Beaver Marsh	-	-	424	532	Female
	8/2	Beaver Marsh	-	-	379	502	Male
	8/2	Beaver Marsh	-	-	314	419	Female
	8/5	Beaver Marsh	-	-	735	958	Female
	4/9	Davidson Pond	-	-	-	-	Unknown
	6/7	Davidson Pond	-	-	856	1015	Female
	9/6	Davidson Pond	-	-	417	548	Female
		Schuyler Estate					
	5/2	Canal	-	-	-	-	Unknown
	5/11	Stream 1	-	-	-	-	Unknown
	5/11	Stream 1	-	-	554	745	Unknown
	6/6	Stream 1	-	-	-	-	Unknown
Northern Brown Snake	8/3	Stream 1	-	-	269	356	Unknown
	8/3	Stream 1	-	-	225	261	Unknown
	6/12	Field 3	88	Wood	224	302	Male
	4/11	Woodland 5	-	-	286	355	Unknown
	5/1	Woodland 5	-	-	-	-	Unknown
Northern Red-bellied Snake	4/7	Woodland 7	-	-	-	-	Unknown
	5/5	Field 3	83	Metal	223	265	Unknown
	5/5	Field 3	85	Metal	210	275	Female
	5/11	Field 3	81	Metal	245	306	Unknown
	5/2	Field 5	100	Wood	234	281	Unknown
	5/11	Field 5	104	Metal	185	237	Unknown
	9/5	Field 5	104	Wood	137	165	Unknown
	6/13	Field 7	115	Metal	-	-	Unknown
Common Garter Snake	5/11	Woodland 7	50	Wood	144	170	Unknown
	5/4	Canal Below Stop 10	-	-	496	590	Female
	8/31	Entrance Rd. 1.5 mi E. of Vis. Ctr.	-	-	-	-	Unknown
	8/31	Entrance Rd. 1.5 mi E. of Vis. Ctr.	-	-	-	-	Unknown
	8/31	Entrance Rd. 1.5 mi E. of Vis. Ctr.	-	-	-	-	Unknown

Appendix E. Summary of measurements for snakes captured at Saratoga NHP (continued).

Species	Date	Location	Board #	Type	SVL (mm)	TL (mm)	Sex
Common Garter Snake	8/31	Entrance Rd. 1.5 mi E. of Vis. Ctr.	-	-	-	-	Unknown
	5/12	Field 1	69	Metal	471	532	Male
	8/11	Field 1	70	Wood	447	550	Female
	5/5	Field 2	73	Metal	209	259	Unknown
	6/4	Field 3	87	Metal	-	-	Recapture
	6/12	Field 3	87	Metal	-	-	Unknown
	5/2	Field 4	95	Metal	368	485	Unknown
	8/5	Field 4	93	Metal	443	551	Male
	8/11	Field 4	95	Metal	448	554	Female
	8/11	Field 4	91	Metal	443	552	Unknown
	5/2	Field 5	103	Metal	165	186	Unknown
	5/2	Field 5	100	Wood	161	211	Unknown
	5/11	Field 5	104	Wood	-	-	Recapture
	6/6	Field 5	103	Metal	201	259	Unknown
	5/11	Field 6	112	Wood	188	238	Unknown
	6/6	Field 6	109	Metal	-	-	Unknown
	6/13	Field 6	109	Metal	235	274	Unknown
	6/13	Field 6	109	Metal	436	568	Female
	8/1	Field 6	109	Metal	482	605	Female
	8/4	Field 6	109	Metal	-	-	Unknown
	8/11	Field 6	111	Metal	-	-	Unknown
	8/11	Field 6	-	-	743	924	Female
	5/3	Schuyler Estate Canal	-	-	459	580	Male
	6/12	Schuyler Estate Canal	-	-	-	-	Unknown
	8/2	Schuyler Estate Canal	-	-	149	192	Unknown
	8/6	Schuyler Estate Canal	-	-	141	186	Unknown
	8/6	Schuyler Estate Canal	-	-	134	172	Unknown
	6/6	Stream 2	-	-	325	402	Female
	9/4	Stream 3	-	-	165	211	Unknown
	4/27	U.S. Hwy 4 W. Side of Champlain Canal	-	-	-	-	Unknown
	4/27	U.S. Hwy 4 W. Side of Champlain Canal	-	-	-	-	Unknown
	4/27	U.S. Hwy 4 W. Side of Champlain Canal	-	-	-	-	Unknown
	5/2	Victory Woods Pond	-	-	-	-	Unknown
	8/5	Woodland 1	-	-	425	519	Male
	4/10	Woodland 5	-	-	570	700	Unknown
	4/10	Woodland 5	-	-	392	504	Unknown
	4/10	Woodland 5	-	-	415	535	Unknown
	4/11	Woodland 5	-	-	408	510	Unknown
	5/3	Woodland 7	54	Wood	151	185	Unknown
	5/11	Woodland 7	50	Wood	160	204	Unknown
	5/11	Woodland 7	50	Wood	152	192	Unknown
	5/11	Woodland 7	50	Wood	154	196	Unknown
	6/5	Woodland 7	49	Metal	167	213	Unknown
	6/5	Woodland 7	54	Wood	-	-	Recapture
	6/5	Woodland 7	54	Wood	252	358	Unknown
	5/11	Woodland Stop 6 and 7	-	-	482	593	Female
	8/7	Woodland Stop 6 and 7	-	-	342	429	Male

Appendix F. Summary of measurements for turtles captured at Saratoga National Historical Park.

Species	Site	Date	Sex	Notch Code	CL (mm) ¹	CW (mm) ²	PL (mm) ³	PW (mm) ⁴	Wt (g) ⁵
Painted Turtle	Burdyl Pond	4/9	Unknown	R1	15	10	14	9	400
	Burdyl Pond	4/9	Unknown	R2	11	9	10	7	170
	Burdyl Pond	5/4	Female	R2+3	142	105	134	88	388
	Burdyl Pond	5/6	Unknown	R2+4	75	56	71	51	79
	Burdyl Pond	6/2	Male	R1+8	132	112	122	80	385
	Burdyl Pond	6/2	Female	R2+8	172	112	153	98	570
	Burdyl Pond	6/6	Female	R3+8	167	122	159	96	535
	Burdyl Pond	6/6	Unknown	R1+3+8	79	65	68	50	80
	Canal Below Stop 10	5/5	Male	R1+2+3	139	114	128	83	340
	Canal North of Entrance	9/3	Male	R2+3+8	141	98	128	86	363
	Canal North of Entrance	9/3	Unknown	R4+8	86	71	77	58	100
	Canal North of Entrance	9/3	Unknown	R1+3+8	89	72	83	53	110
	Davidson Pond	5/3	Female	R3	165	122	154	95	575
	Schuyler Estate Canal	5/5	Unknown	R1+4	73	65	65	51	59
	Schuyler Estate Canal	5/6	Male	R8	134	96	117	76	277
	Schuyler Estate Canal	8/3	Unknown	R3+8	54	50	44	38	23
	Service Road Pond	6/4	Unknown	-	-	-	-	-	-
	Service Road Pond	8/1	Unknown	-	-	-	-	-	-
	Stop 1 Pond	6/4	Female	R1+2+8	151	121	146	89	515
	Vly Marsh	5/2	Female	R1+2	128	96	117	76	275
	Vly Marsh	5/4	Unknown	R1+3	111	90	102	69	195
	Vly Marsh	6/3	Female	-	-	-	-	-	-
Common Snapping Turtle	Beaver Marsh	5/2	Unknown	R1	155	125	115	110	780
	Beaver Marsh	5/2	Male	R10	192	169	139	145	2500
	Canal Below Stop 10	5/4	Male	L10	306	260	216	228	2500
	Canal Below Stop 10	5/6	Male	R11	-	-	-	-	-
	Canal Below Stop 10	6/4	Male	R9+11	348	279	259	247	2500
	Davidson Pond	6/5	Unknown	L8+R9	132	98	90	88	442
	Int. of Rt. 32 and Entrance Rd.	6/13	Unknown	-	380	255	0	0	2500
	North Entrance Pond	6/4	Unknown	L8	54	50	38	42	44
	North Entrance Pond	6/4	Male	L8+R8	358	287	269	280	2500

¹ CL = carapace length

² CW = carapace width

³ PL = plastron length

⁴ PW = plastron width

⁵ Wt = weight

Appendix F. Summary of measurements for turtles captured at Saratoga NHP (continued).

Species	Site	Date	Sex	Notch Code	CL (mm) ¹	CW (mm) ²	PL (mm) ³	PW (mm) ⁴	Wt (g) ⁵
Common Snapping Turtle	Schuyler Estate Canal	5/2	Male	R8+9	308	252	228	232	2500
	Schuyler Estate Canal	5/2	Female	R8	352	306	270	279	2500
	Schuyler Estate Canal	5/2	Male	R9	342	304	252	264	2500
	Schuyler Estate Canal	5/5	Male	R9+10	340	285	253	251	2500
	Schuyler Estate Canal	5/5	Recapture	R9	-	-	-	-	-
	Schuyler Estate Canal	5/5	Female	R8+10	291	239	229	225	2500
	Schuyler Estate Canal	5/5	Recapture	R8	-	-	-	-	-
	Schuyler Estate Canal	5/6	Female	R8+11	326	293	235	263	2500
	Schuyler Estate Canal	5/11	Unknown	-	-	-	-	-	-
	Service Road Pond	5/5	Unknown	R2	93	79	61	70	221
	Stream 1	5/11	Unknown	-	-	-	-	-	-
Eastern Box Turtle	Vly Marsh	6/11	Unknown	-	-	-	-	-	-
	Entrance Rd. 1.0 mi E. of Vis. Ctr.	10/10	Unknown	-	-	-	-	-	-

¹ CL = carapace length

² CW = carapace width

³ PL = plastron length

⁴ PW = plastron width

⁵ Wt = weigh

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov