Biological Inventory of Amphibians at the Hartford Town Forest and Hurricane Forest Wildlife Refuge, Hartford, Vermont

Final Report
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Eastern Red-backed Salamander, Hartford Town Forest

Submitted by:

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Background

The Hartford Town Forest (HTF) is a 423-acre parcel that abuts the 142-acre Hurricane Forest Wildlife Refuge (HFWR) (Figure 1). Both parcels are almost entirely forested, primarily consisting of Mesic Red Oak-Northern Hardwood Forest and Hemlock-Northern Hardwood Forest communities (Thompson and Sorenson 2000). Collectively the parcels contain Wright Reservoir, two former reservoirs (the Upper and Lower Hurricane reservoirs) recently converted to small ponds, a variety of seeps, seasonal and permanent streams, two vernal pools, several miles of recreational trails that take advantage of the varied topography, and diverse wildlife habitats. The Hartford Parks and Recreation Commission oversees the HFWR, with its recreation and wildlife protection focus, while the Hartford Conservation Commission (HCC) manages the larger, more remote HTF. Elevations in the study area range from 640 feet at the eastern boundary near Wright Reservoir to 1,312 feet at the summit of Neals Hill.

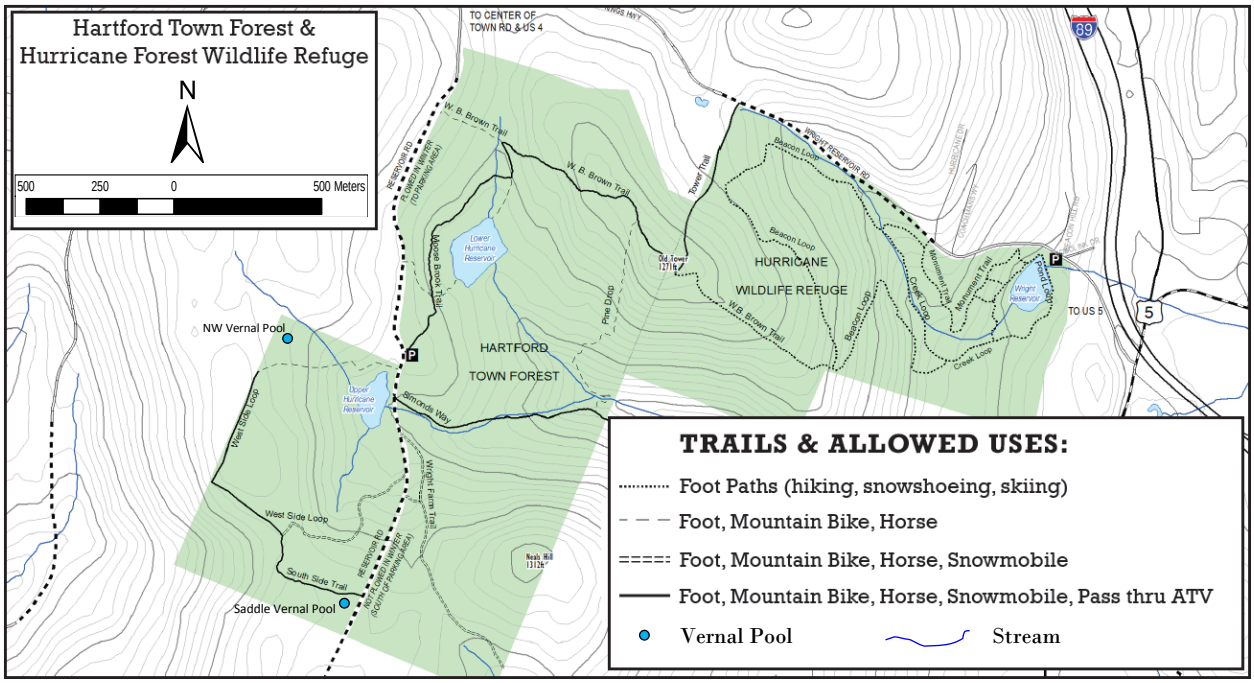

Figure 1. Hartford Town Forest and Hurricane Forest Wildlife Refuge. The Upper and Lower Hurricane Reservoirs were recently drained and converted to small ponds.

Objective

The objective of this study was to conduct a "rapid assessment" inventory of the amphibian population within the HTF and HFWR, in order to determine the diversity of amphibian species present and identify any sensitive and/or critical habitats that may be incorporated into forest management and/or recreation plans. It is important to note that due to the short duration of this study and limited field-time, any species *not* detected can only be presumed absent.

Methods

A variety of survey methods were used to inventory amphibians. Visual encounter surveys were used along streams, around vernal pools, ponds, seeps, and forest stands to search for frogs and

salamanders, as well as their egg masses and larvae. In addition, a single unbaited minnow trap was placed in each vernal pool overnight to survey adult pool-breeding salamanders. Minnow traps were secured such that the top of the trap was above the surface of the water, providing an air space for salamanders to gulp air if necessary. Traps were deployed in the afternoon and checked first thing the following morning. During each visit to the study area, encounters of other faunal groups were recorded and are listed in Appendix A.

Results

A total of seven visits to the study area were made during 2010 (7, 8, 9 Apr., 13, 27 May, and 22, 29 June) for a total of 27.5 survey-hours. Twelve amphibian species (7 frogs, 5 salamanders) were encountered (Table 1). While none of the species encountered are considered rare in the state, the Vermont Fish and Wildlife Department lists the Spotted Salamander as a "medium priority" Species of Greatest Conservation Need in the Vermont Wildlife Action Plan (Kart et al. 2005).

Table 1. Species of amphibians encountered at Hartford Town Forest and Hurricane Forest Wildlife Refuge during 2010 field surveys.

Species	Notes on Distribution and Relative Abundance within Study Area
Salamanders	
Spotted Salamander *(Ambystoma maculatum)*	Several metapopulations exist; breeds in both vernal pools and small numbers in Upper and Lower Hurricane Ponds; locally common.
Northern Dusky Salamander *(Desmognathus fuscus)*	Breeding populations in all streams and adjacent seeps; uncommon to locally common.
Northern Two-lined Salamander *(Eurycea bislineata)*	Breeding population in all streams and adjacent seeps; common.
Eastern Newt *(Notophthalmus viridescens)*	Found in both vernal pools, and all 3 reservoirs; breeding likely restricted to Wright Reservoir and Upper and Lower Ponds; common.
Eastern Red-backed Salamander *(Plethodon cinereus)*	Widely distributed; most abundant in hardwood/mixed stands and around vernal pools, seeps, and streams; abundant.
Frogs	
American Toad *(Anaxyrus americanus)*	Breeding populations in Upper and Lower Hurricane Ponds and Wright Reservoir; common.
Spring Peeper *(Pseudacris crucifer)*	Breeding populations in Upper and Lower Hurricane Ponds and Wright Reservoir; common.
Grey Treefrog *(Hyla versicolor)*	Breeding population in Lower Hurricane Pond and possibly Wright Reservoir; uncommon.
American Bullfrog *(Lithobates catesbiana)*	Breeding population in Wright Reservoir, and possibly in Upper and Lower Hurricane Ponds; locally common.
Green Frog *(Lithobates clamitans)*	Breeding populations in Upper and Lower Hurricane Ponds and Wright Reservoir; common
Pickerel Frog *(Lithobates palustris)*	Breeding population in Wright Reservoir, and likely in Upper and Lower Hurricane Ponds; locally common.
Wood Frog *(Lithobates sylvatica)*	Breeding populations in both vernal pools; could breed in Upper and Lower Hurricane Ponds; widely distributed; locally common.

Woodland Vernal Pools

The Hartford Town Forest has two woodland vernal pools (Figure 1), both of which support significant breeding populations of Wood Frogs and Spotted Salamanders. Eastern Newts were also seen in both pools, but these observations do not appear to represent breeding populations.

Saddle Vernal Pool

The Saddle Pool is located in a broad saddle at the southern end of the town forest near the junctions of Reservoir Rd. and the South Side Trail at an elevation of 1,250 feet (Figures 1 & 2). This relatively large (~15 x 35 m), but shallow (~15 cm) woodland pool is embedded in a shrub swamp which grades into a seep at the south end. The primary amphibian breeding habitat is located at the north end of the wetland near the South Side Trail. Small pockets of suitable breeding habitat can also be found scattered throughout the wetland. Significant populations of both Wood Frog and Spotted Salamander use this pool for breeding.

On 7 Apr., a large mat of Wood Frog eggs was present near the west edge of the pool. Although salamander spermatophores were visible on the pool bottom, no salamander egg masses were found. A single minnow trap was placed in the deepest section of the pool at 1600 hours. The trap was removed from the pool the following day at 0815, capturing a total of 65 Spotted Salamanders (Figure 2). All salamanders captured were male, and most were 12-15 cm in total length, although a few were in the 18-20 cm range.

On 13 May the pool was visited again to count egg masses. Poor visibility resulting from the high tannin content of the pool and surface film on the water precluded an accurate count of all egg masses, but an estimate was obtained. Approximately 100 to 150 Spotted Salamander egg masses and 150 to 200 Wood Frog egg masses were present. Many Wood Frog eggs had already hatched, while the salamander eggs were in various stages, ranging from freshly laid to nearly hatched.

On 8 Apr., 45 minutes were spent searching unsuccessfully for breeding Four-toed Salamanders by turning logs and moss mats among the hummocks of the Saddle Pool shrub swamp. Four-toed Salamanders lay eggs in deep, *sphagnum* moss mats just above the water of vernal pools, swamps, and other fishless wetlands. Adult females remain with their eggs until hatching, at which time the larvae drop into the water (Petranka 1998). The Saddle Pool provides only marginal habitat for the uncommon Four-toed Salamander, since most of the moss mats are shallow, not deep *sphagnum*.

NW Vernal Pool

The NW Vernal Pool is located in a broad saddle in the NW corner of the town forest at an elevation of 1,210 feet (Figures 1 & 2). Approximately 10 x 25 m in size, with a maximum depth of 30 to 45 cm, this pool has an ephemeral inlet at its west end from a seep that drains into the stream feeding the Upper Hurricane Reservoir. Significant populations of both Wood Frog and Spotted Salamander also use this woodland pool for breeding.

The NW Pool was first visited on 8 Apr., when 12 Wood Frog and 6 Spotted Salamander egg masses were present, in addition to many spermatophores. A single minnow trap was placed near the center of the pool and checked on 9 Apr. at 0815. A total of 11 Spotted Salamanders

Figure 2. Clockwise from top-left: View of Saddle Vernal Pool; Large mat of Wood Frog eggs in Saddle Pool; 65 male Spotted Salamanders captured in minnow trap at Saddle Pool; View of NW Vernal Pool; Spotted Salamander eggs in NW Pool; Spotted Salamander eggs in Saddle Pool.

(9 male, 2 female) and 1 Eastern Newt were captured. Fifteen newly deposited salamander egg masses were also present.

The NW Pool was visited again on 13 May, when approximately 74 Wood Frog egg masses were counted, most of which had recently hatched or were in the process of hatching. In addition, 63 Spotted Salamander egg masses were counted, some of which were close to hatching while others had been deposited in the last few days.

Permanent Ponds

During the past year, the Upper and Lower Hurricane Reservoirs were drained and have been, or are in the process of being, converted into small ponds. Also, within the basin of the old Upper Hurricane Reservoir, there is a small ephemeral depression just north of the newly created pond, which collects water and provides limited habitat for pool-breeding amphibians. The two newly-created ponds, along with Wright Reservoir (Figure 1), provide important breeding habitat for amphibians adapted to reproducing in permanent ponds with predatory fish populations, including Green Frog, Bullfrog, Pickerel Frog, American Toad, Spring Peeper, Grey Treefrog, and Eastern Newt.

Upper Hurricane Pools
Two small pools exist in the former basin of the Upper Hurricane Reservoir (Figure 3). One was created during May 2010 by grading the breached dam to form a small impoundment that is fed by a permanent stream. The other is a small (~1.5 x 6 m), ephemeral depression about 20 m north of the first pool. Both are in the open basin of the former reservoir, and do not occur beneath a forest canopy. Therefore, they lack the annual input of leaf litter that is a critical component of the food web in woodland vernal pools. It is likely that these pools will provide limited breeding habitat for small numbers of some pool-breeding species, including American Toad, Green Frog, Spring Peeper (which were heard calling from the site on 7 Apr. 2010), and possibly Pickerel Frog, Wood Frog, and Spotted Salamander.

Both pools were visited on 27 May, shortly after the excavators completed work grading the dam. Adult Green Frogs and Eastern Newts were present in the newly created pool, while the shallow ephemeral pool nearby hosted many Eastern Newts feeding on recently hatched American Toad tadpoles. In addition, Spotted Salamander larvae and several Green Frog tadpoles from last year, some of which had just metamorphosed and still possessed their tails, were present in the smaller pool (Figure 3).

Lower Hurricane Pool
The Lower Hurricane Reservoir was mostly drained by removing a section of pipe on the overflow, reducing the open water to a small pool approximately 15 x 20 m and about 1.5-2 m deep (Figure 4). Future plans for this impoundment include removing the dam and creating a small pond (M. Osborn, personal communication). Because the Lower Hurricane Reservoir is fed by a permanent stream which currently supports a population of minnows (probably Creek Chub (*Semotilus atromaculatus*)), it is likely that the new pond will also support predaceous fish, reducing its value to vernal pool-breeding amphibians (Wood Frog and Spotted Salamander), but providing important habitat for pond-breeding species such as Green Frog, Bullfrog, Pickerel Frog, American Toad, Grey Treefrog, Spring Peeper, and Eastern Newts.

Figure 3. Clockwise from top-left: View of both pools in basin of former Upper Hurricane Reservoir; Close-up view of newly-created pool with breached dam in background; Close-up view of small, ephemeral pool; Newly metamorphosed Green Frog in ephemeral pool; Spotted Salamander larvae in ephemeral pool; Newly hatched American Toad tadpoles in ephemeral pool.

The Lower pool was visited on 13 and 27 May. On the first visit, several hundred newly-hatched American Toad tadpoles were present and being actively depredated by an abundant Eastern Newt population (Figure 4). In addition, approximately 12 Spotted Salamander egg masses were observed in relatively deep water (~1 m). On the latter visit, a pair of American Toads were observed in amplexus (mating posture), along with 3 large clumps of toad eggs and hundreds of tadpoles, as well as several Green Frogs, while a Spring Peeper was found in the basin of the former reservoir (Figure 4). In addition, an adult Northern Two-lined Salamander was found under a rock near the edge of the pool and Grey Treefrogs were heard calling from the area around the pool, possibly from the trees along the dike or from the rocks of the dike southeast of the pool. It is likely that Grey Treefrogs use this pool for breeding as well.

Wright Reservoir
Occupying 3 acres, Wright Reservoir is located in the northeast corner of the HFWR, in close proximity to White River Junction (Figure 1). Supporting a population of Largemouth Bass (*Micropterus salmoides*), it is a popular and easily accessible fishing spot. It also provides excellent habitat for several frog species, particularly American Bullfrog, Green Frog, Pickerel Frog and Spring Peeper. In addition, Grey Treefrog may also breed in the marshy southern edge of the impoundment.

Stream Salamander Habitat

With three permanent streams and several small ephemeral streams, the study area provides excellent habitat for streamside salamanders. Of the three species of stream salamanders found in Vermont, both Northern Dusky and Northern Two-lined salamanders were found in all three permanent streams. The Spring Salamander (*Gyrinophilus porphyriticus*), which requires well-oxygenated, cold streams, was not encountered during field surveys. Although the presumed absence of this large stream salamander is not unusual given that it is primarily found in first-order mountain headwater streams, suitable habitat appears to be present in the study area, particularly in the stream draining Lower Hurricane Reservoir. This gravel-bed stream with minimal siltation descends through a mixed hemlock/northern hardwood forest with abundant seeps, plunge pools, and partially submerged rocks and logs which provide salamanders with cover and egg attachment sites. In addition, it is the only stream in the study area without impacts from a parallel trail or road (Figures 1 and 6).

Stream searches were conducted on 7 April, 13, 27 May, and 29 June, for a total of 8.5 survey-hours. Numerous Northern Dusky and Northern Two-lined salamanders were found in all stream searches. During a search of the Lower Hurricane Reservoir stream on 13 May, a clutch of Northern Two-lined Salamander eggs containing 62 embryos were found on the underside of a partially submerged rock, measuring approximately 30 x 55 cm (Figure 5). Salamander larvae of various age classes were also observed during stream searches.

Forested Habitat

The vast majority of the study area contains forested upland habitat, consisting primarily of Mesic Red Oak-Northern Hardwood Forest and Hemlock-Northern Hardwood Forest. These

Figure 4. Clockwise from top-left: View of Lower Hurricane Reservoir pool after draining; American Toads in amplexus; recently-hatched American Toad tadpoles and strings of eggs; Eastern Newt feeding on American Toad tadpoles; adult male Green Frog; Spring Peeper found in former basin of Lower Hurricane Reservoir.

Figure 5. Clockwise from top-left: View of Lower Hurricane Reservoir stream and rock (with dip net) where salamander eggs were found; Northern Two-lined Salamander eggs attached to underside of rock, Lower Hurricane Reservoir stream; Adult Two-lined Salamander; Adult Northern Dusky Salamander, Upper Hurricane Reservoir stream

forested uplands provide important year-round habitat for the Eastern Red-backed Salamander, as well as non-breeding and over-wintering habitat for several other amphibians, including Spotted Salamander, Red Eft (terrestrial stage of the Eastern Newt), Wood Frog, Spring Peeper, Grey Treefrog, and American Toad.

Eastern Red-backed Salamander
Probably the most abundant amphibian in the study area (see cover photo), the completely terrestrial Red-backed Salamander deposits small, grapelike egg clusters beneath or within rotting logs and other cavities in forested habitat. Lacking a free-living larval stage, the hatchlings resemble miniature versions of the adults (Petranka 1998).

Although systematic surveys for Red-backed Salamanders were not conducted during this study, opportunistic searches were conducted by turning cover objects in a variety of habitats, during which many individuals of all size classes were frequently encountered. Red-backs are widely distributed in the both the HTF and HFWR, and appear especially abundant in moist soils found adjacent to seeps, vernal pools, and streams. They were encountered less frequently in drier uplands, particularly around the forested edges of the old tower field, in saturated soils, and in White Pine stands, possibly due to acidic soils.

Management Recommendations

The most sensitive amphibian habitats in the study area, and those that should be considered in management or recreation plans, include the two vernal pools and the forest surrounding them, and all streams and associated seeps.

Vernal Pools and Amphibian Life Zones
Vernal pool breeders found in the study area (Spotted Salamander and Wood Frog) spend the majority of their lives in forested habitat, generally within about 200 m of their breeding pools (the amphibian "life zone"), and avoid open, non-forest habitat (Faccio 2003, Baldwin et al. 2006). While the pools are vital to maintaining breeding populations of vernal pool fauna, the surrounding forested habitats are equally important. Any management plan that focuses only on protecting the pool itself may fail to maintain viable amphibian breeding populations, therefore, identifying and protecting critical terrestrial habitat should be a priority (Marsh and Trenham 2001).

In identifying critical terrestrial habitat, it is important to consider amphibian metapopulation dynamics. A metapopulation is a set of local populations among which gene flow, extinction, and colonization may occur (Semlitsch 2000). Amphibian aggregations at individual breeding pools rarely represent distinct (closed) populations. Instead, regular dispersal between pools commonly occurs, particularly during the juvenile stage.

The vernal pools at the HTF likely represent two metapopulations of Spotted Salamander and Wood Frog. Therefore, conservation of these amphibian assemblages would be best-achieved by considering the two pools and the forest stand between them as the management unit, rather than managing each pool individually. This will ensure that a suitable dispersal corridor exists between the pools helping to maintain metapopulation source-sink dynamics. This is especially

critical given the fact that both pools are close to the edge of the town forest property (< 80 m) and the amphibian life zones extend onto privately-owned land that may be developed or managed without consideration of wildlife habitat values or knowledge that a vernal pool exists nearby.

Specific Management Recommendations

The following management guidelines are recommended within the amphibian life zone around each vernal pool and in the forest block between the two pools (Figure 6).

1) Avoid timber harvests within 75 m of vernal pools.
2) Maintain a minimum average of >75% canopy cover of trees at least 30 feet tall within 200 m of vernal pools.
3) Consider maintaining the same canopy cover as above in the forest block between the two vernal pools to provide a dispersal corridor.
4) Protect the forest floor by:
    a) Harvesting only when the ground is completely frozen;
    b) Avoiding the creation of ruts;
    c) Minimizing soil compaction and scarification;
    d) Maintaining closure of Reservoir Road south of the HTF parking area between 15 March and 1 June, and consider gating the road during this period.
5) Encourage coarse woody debris (cwd) on the forest floor by:
    a) Allowing fallen limbs, trees, logs, and other cwd to remain undisturbed;
    b) Leaving large diameter snags and den trees for future recruitment of cwd.
6) Contact adjacent landowners to:
    a) Inform them about the amphibian life zones that extend onto their property;
    b) Encourage them to incorporate vernal pool wildlife habitat values in their forest management plans.

Stream Riparian Zones

Many species of wildlife depend on riparian habitats for various life-history functions (e.g. breeding, foraging, dispersing, over-wintering, etc.). The three permanent streams in the study area, along with their associated seeps, provide critical breeding habitat for populations of Northern Two-lined and Northern Dusky salamanders. They may also serve as important overwintering habitat for Green Frog (Lamoureux and Madison 1999) and possibly other frog species, as well as dispersal corridors for a wide variety of amphibians. In addition, adult stream salamanders, as well as red-backed salamanders, utilize forested habitat adjacent to streams for foraging. Maintenance of a well-shaded riparian zone with abundant coarse woody debris and leaf litter that is free from excessive erosion is required for the persistence of these amphibian populations.

Often when riparian buffer zones are defined, they are based on criteria that protect water quality alone and do not consider impacts to semiaquatic species such as stream salamanders. Stream salamanders are highly dependent upon specific microclimates that are maintained by riparian forests and can be significantly influenced by edge effects. Many researchers have investigated the effects of riparian buffer zones on ecosystem processes. While most of these studies indicate

that a minimum buffer width of 30 m is necessary to avoid significant impacts on riparian environments, buffers up to 100 m are often recommended. Rudolph and Dickson (1990) found that reptile and amphibian populations were significantly lower in stream side habitats with narrow buffer widths (≤30 m) than those with wider buffer strips due to changes in air, soil, and water temperatures, relative humidity, and soil moisture resulting from increased solar penetration. In their review of riparian forestry impacts on amphibian populations, Olson et al. (2007) suggested buffers of 40–100 m, while Crawford and Semlitsch (2007) recommended a riparian buffer for stream salamanders of 77 m, consisting of a 27 m core terrestrial habitat zone (which contains 95% of the stream salamander assemblage), plus an additional 50 m to buffer edge effects.

Specific Management Recommendations

With the exception of the former Upper and Lower Hurricane Reservoir basins, the streams at the HTF and HFWR primarily pass through closed canopy forest stands. Maintenance of these well-shaded environments is critical to the health of the stream communities. At a minimum, a 60 m buffer on either side of each stream should be maintained (Figure 6), within which the following management guidelines are recommended.

1) Avoid timber harvests and herbicide/pesticide use.
2) Encourage coarse woody debris (cwd) on the forest floor by:
   a) Allowing fallen limbs, trees, and other cwd to remain;
   b) Leaving large diameter snags and den trees to serve as future cwd recruitment;
3) Avoid activities that will increase erosion and sedimentation of stream channels (e.g., new trail construction, etc.).
4) Divert trail drainage and water bars away from the riparian zone.
5) Take appropriate steps to eliminate siltation and erosion when removing the Lower Hurricane Reservoir dam. The stream reach below this dam is relatively free from disturbance and provides the best breeding habitat for stream salamanders in the study area.

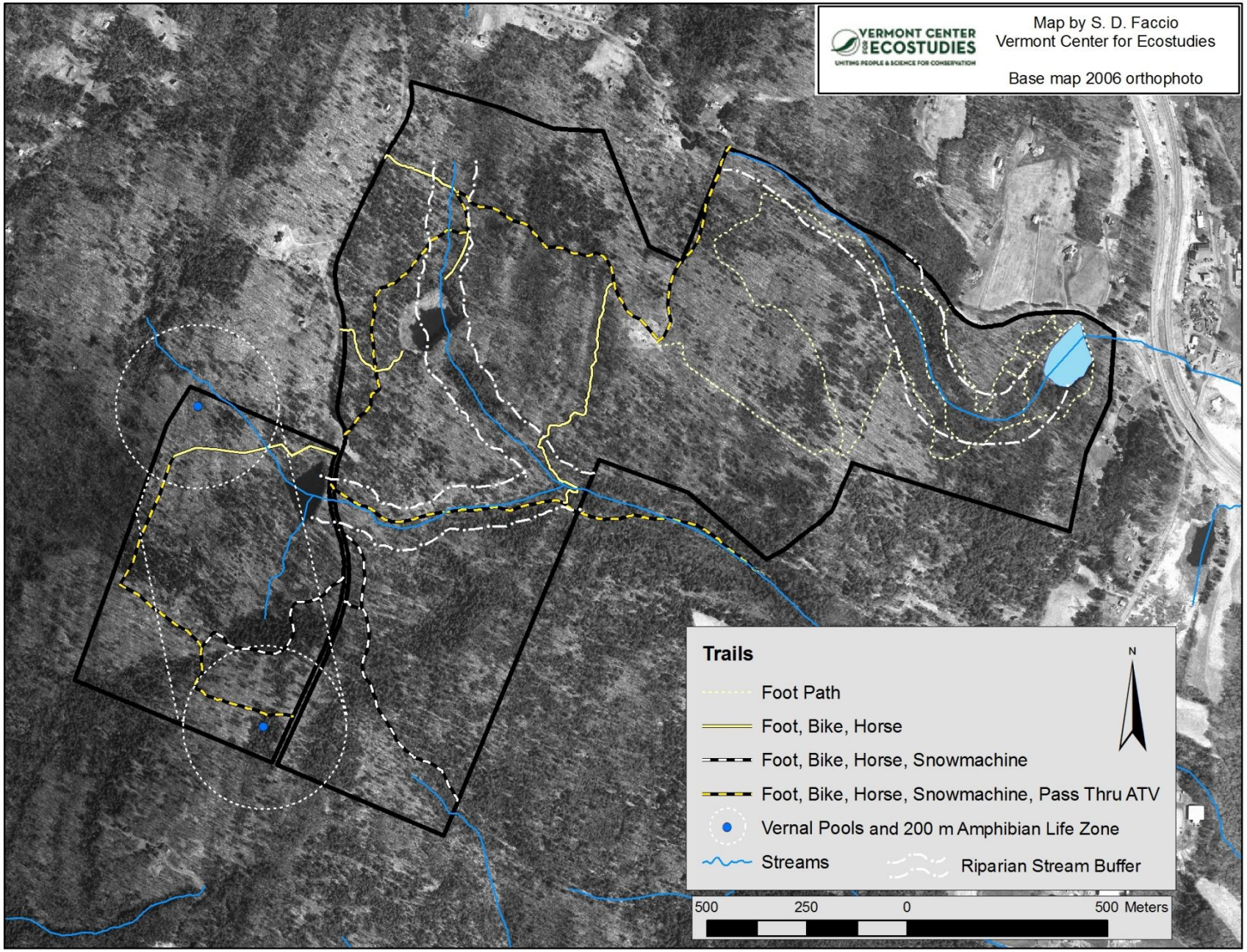

Figure 6. Recommended buffers and amphibian life zones around vernal pools and streams at Hartford Town Forest and Hurricane Forest Wildlife Refuge, Hartford, Vermont.

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Appendix A. List of birds and reptiles detected during field work at Hartford Town Forest and Hurricane Forest Wildlife Refuge. Species listed in taxonomic order.

Species	7-Apr-10	8-Apr-10	13-May-10	27-May-10	22-Jun-10
Birds					
American Kestrel	X				
Barred Owl			X		
Ruby-throated Hummingbird					X
Yellow-bellied Sapsucker			X	X	
Hairy Woodpecker			X		
Yellow-shafted Flicker					X
Pileated Woodpecker			X		
Eastern Wood-Pewee				X	X
Eastern Phoebe		X			
Great Crested Flycatcher				X	X
Blue-headed Vireo				X	
Red-eyed Vireo			X	X	X
American Crow		X			X
Black-capped Chickadee			X		
Tufted Titmouse					X
White-breasted Nuthatch					X
Brown Creeper	X		X	X	
Veery				X	X
Hermit Thrush		X		X	
American Robin		X	X	X	X
Black-throated Blue Warbler			X	X	
Yellow-rumped Warbler			X	X	
Black-throated Green Warbler			X	X	X
Blackburnian Warbler			X	X	X
Pine Warbler		X			
American Redstart			X		
Ovenbird			X	X	
Common Yellowthroat				X	
Scarlet Tanager			X	X	X
Song Sparrow				X	
Swamp Sparrow				X	
Dark-eyed Junco		X		X	
Rose-breasted Grosbeak			X	X	
Indigo Bunting					X
Red-winged Blackbird					X
Common Grackle					X
Brown-headed Cowbird				X	
Reptiles					
Eastern Garter Snake				X	
Painted Turtle					X