

2016 VERNAL POOL FIELD VERIFICATION PROJECT
for the
CITY OF MONTPELIER, VERMONT



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EXECUTIVE SUMMARY

This report contains the results of a 2016 Vernal Pool Field Verification Project (Project), conducted on behalf of the Montpelier Conservation Commission (MCC), for the City of Montpelier (City). This Project, undertaken during the second week of June, 2016, includes, as its primary product, an updated map (Appendix I) of the known locations of vernal pools in the City.

The intent of the Project was not to map Montpelier's vernal pools in their entirety. Rather, the focus of this effort was on field-verifying 'potential' vernal pools formerly identified in *A Natural Community Inventory of the City of Montpelier, Vermont* (Inventory) (Engstrom and DeLeo 2007) completed for the City. Other vernal pools, not identified in the Inventory, were also field-surveyed. These included additional, potential vernal pools known to members of the MCC, as well as vernal pools discovered by the Project consultant, while conducting expanded searches on select parcels.

Verification of a vernal pool was based primarily on evidence of breeding amphibians regionally associated with local, vernal pool habitats. Other criteria used included the absence of both a permanent inlet stream to a pool and a viable population of fish.

Through a field verification process, a total of 14 vernal pools, either potential (3 pools) or confirmed (11 pools), were identified in this Project. Of the six potential vernal pools originally identified in the Inventory, 5 were confirmed. Additional field work, conducted in the future, would most certainly identify additional vernal pools in the City.

INTRODUCTION

In 2015 the MCC began the process of updating a Natural Resources Inventory (NRI) Map, for the City. The NRI Map's primary purpose is to serve as a land use planning tool in support of the collective efforts of residents, property owners, the City, and other stakeholders in making informed land use management decisions that contribute to the long-term conservation of Montpelier's natural resources.

Among the natural resources identified on the NRI Map are vernal pools, which can be defined as "having four distinctive features: surface water isolation, periodic drying, small size and shallow depth, and support of a characteristic biological community" (Brown and Jung 2005). These unique, ephemeral wetlands typically occur in shallow depressions on the landscape, which fill with water from spring rains, snowmelt, and groundwater, but, in most years, dry up during the summer months. An important ecological component of the City's woodland environments, vernal pools support an array of organisms uniquely adapted to the temporary nature of these wetland habitats, including spotted salamanders (*Ambystoma maculatum*), wood frogs (*Lithobates sylvaticus*), fairy shrimp (Order Anostraca) and fingernail clams (Family Sphaeriidae) (see Figure 1). Amongst vernal pool-dependent species found in Vermont are those listed by the VT Department of Fish and Wildlife as Species of Greatest Conservation Need, including the aforementioned spotted salamander (Vermont Wildlife Action Plan Team 2015).

Yet, despite their ecological significance, "Vernal pools and the wildlife that use them face many problems, including direct loss of pools, degradation of pool quality, and alteration of the surrounding upland habitat that is critical for many amphibians non-breeding life stages" (Vermont Wildlife Action Plan Team 2015). In order to protect vernal pools from the aforementioned threats, a critical first step is identifying locations where they occur on the landscape.

While the aforementioned 2007 Inventory was underway, six potential vernal pools were identified in the fall of the year. The Inventory's final report stated that these potential pools "must be assessed

during the spring and early summer to determine their significance as breeding habitat for amphibians” (Engstrom and DeLeo 2007), which is a principal criterion, under the Vermont Wetland Rules, used in identifying a wetland as a vernal pool. While other amphibian species breed in local vernal pool habitats, evidence of breeding by the aforementioned wood frogs and/or spotted salamanders is, in particular, a key regional indicator of the presence of a vernal pool. Evidence of breeding by these two amphibian species includes, but is not limited to, the presence of breeding adults, their egg masses, or hatched larvae.

A primary objective of this Project was to conduct the fieldwork necessary to determine whether the six potential vernal pools, originally identified in the Inventory, were, indeed, vernal pools. The consultant for this Project was also tasked with field-surveying vernal pools that were:

1. Identified as potential pools, by members of the MCC, at additional locations in Montpelier.
2. Encountered in the field, while verification of other pools was being conducted.
3. Brought to the attention of the MCC or the consultant during this Project.

The MCC entered into this Project with the understanding that the lack of any substantial snowpack, coupled with relatively sparse spring rains, could result in some vernal pools having dried-up before the field work for this Project was undertaken, during the second week of June, 2016. However, it was felt that the effort would be worthwhile, because the majority of the vernal pools, investigated by the Project’s consultant, were expected to be still holding water and supporting wood frogs in the larval stage and/or spotted salamanders in the egg and larval stage. Further justification for undertaking this Project was the MCC’s commitment to maintaining an NRI Map that is as up-to-date as possible, including the locations of vernal pools in Montpelier.

A special thanks to the landowners who allowed the Project’s consultant access to their properties. This initiative would not have been possible without their generous cooperation (Note: Each participating landowner was offered a copy of this report, with a reference to the vernal pool(s) surveyed on their respective parcel(s)). Thanks also to the Montpelier Conservation Commission for their sponsorship and support of this Project, in particular MCC members James Brady, Emily Byrne, Charlie Hohn, John Jose, and Page Guertin. James Brady provided latitude/longitude coordinate information for vernal pools identified in the 2007 Inventory and contributed to updating the map of vernal pools found in the City. Emily Byrne, Charlie Hohn, and Page Guertin all contributed to editing this report. In addition to coordinating this Project, John Jose also provided information regarding additional, potential vernal pools in Montpelier. He also contributed to this report and provided supplementary images to support photo-documentation of select pools. Thanks also to Dan Currier, Central Vermont Regional Planning Commission, for providing an updated map of the City’s vernal pools, based on the work completed in this Project. Lastly, thanks to the City of Montpelier for financial and administrative support.

The consultant for this Project, Dr. Steven P. Brady, is a field biologist and evolutionary ecologist with expertise in amphibian ecology and vernal pool systems. As a master’s student (Yale University, M.E.SC. 2007), his research focused on 1) wetland bird community composition across an urban to rural gradient, and 2) the evolutionary dynamics of wood frogs across a forest canopy gradient in vernal pools. His dissertation research (Yale University, Ph.D. 2013) and recent postdoctoral experience (Dartmouth College, 2014-2015) focused on the effects of roads and runoff (especially road salt) on wood frogs and spotted salamanders. Throughout this work, Dr. Brady typically logged 60-100 days working in the field in vernal pools each year, collecting, analyzing, and reporting data on vernal pool species and habitats. Over the past ten years, during his graduate and postdoctoral work, Dr. Brady visited and surveyed over 300 vernal pools throughout Vermont, New Hampshire, Connecticut, Rhode Island, and New York.

Figure 1. Images of select, vernal pool-dependent species



Spotted Salamander (*Ambystoma maculatum*)



Fingernail Clams (on U.S. quarter) (Family Sphaeriidae)



Fairy Shrimp (Order Anostraca)



Wood Frogs (*Lithobates sylvaticus*)

Images courtesy of John Jose

METHODS

Identifying property owners to contact for permission to survey

Landowner information was identified for vernal pools located on private property, so that permission to survey could be obtained. A combination of ArcMap (ArcGIS v10.2) and the Montpelier, VT interactive GIS website (iGIS: <http://montpelier.interactivegis.com/>) was used to identify the parcels and property owners for each vernal pool. First, ArcMap was used to create a shapefile feature layer comprising the locations of the vernal pools. Coordinates of vernal pools were provided by John Jose and James Brady, both members of the MCC. A layer called 'VTPARCELS_Montpelier2014.shp' (hereafter 'VTPARCELS') was then added, which was downloaded from the Vermont Center for Open Data (<http://vcgi.vermont.gov/opendata>). This layer was located within the data layer called 'CadastralParcels_VTPARCELS' at the following link: http://maps.vcgi.vermont.gov/gisdata/vcgi/packaged_zips/CadastralParcels_VTPARCELS/VTPARCELS_Montpelier2014.zip.

Using ArcMap, the specific parcel containing each pool was identified. This information was contained in the attributes of the VTPARCELS in the 'parcelnum' field. This parcel number was then used to search the Montpelier, VT iGIS website (accessed via 'Guest Access'). Once the parcel was found, the property owner information (i.e. owner name and address) was gleaned using the 'identify' tool.

Property owners were then contacted to request permission to survey their vernal pools. Contact was made by a combination of in-person visits to the property and/or email. At the request of the property owner, an official letter from the MCC explaining the Project and requesting that the landowner allow the consultant access to their property, was provided (Appendix II).

Vernal pool survey/documentation techniques

In each vernal pool, an 8 x 11 inch, handheld dip net was used to survey for larvae of the wood frog and Ambystomatid salamanders (primarily the spotted salamander). Specifically, larvae were dipped for, while wading throughout the pools, ensuring that different sections of the pool were covered. In vernal pools where few or no larvae were detected, the entirety of the pool was dipped. In vernal pools where wood frog and/or spotted salamander larvae were quickly detected, a minimum of two minutes of survey was conducted. For all surveys, effort was recorded as the amount of time spent dipping in order to provide an estimate of relative density across pools.

Specimens of wood frog and spotted salamander larvae were collected at each site in which they were detected during the survey. Specifically, one or two individuals of each species were preserved in 70% ethanol. These specimens will be held by MCC member John Jose, in the event that additional documentation is needed, at some future date, to demonstrate the presence of a vernal pool.

Visual surveys were also conducted for spotted salamander egg masses (wood frog eggs had hatched and masses had disintegrated, prior to the Project taking place). Any evidence of breeding by wood frogs (i.e. the presence of larvae) or spotted salamanders (i.e. the presence of larvae and/or egg masses) was photo-documented. Of note is the photo documentation of a 'candidate' egg mass of the *Ambystoma jeffersonianum* complex detected in VP1005.

For a subset of surveyed potential pools, supplemental images that provide evidence of wood frog and/or spotted salamander breeding activity that occurred either in previous years or in the spring of 2016, but prior to the Project taking place, are included in Appendix III. These photos are clearly labeled

and include the date taken and name of the person that took the images, so as to distinguish them from those taken during this Project. The purpose of these supplemental photos is to demonstrate that a pool (e.g. VP1006), surveyed by the consultant during the course of the Project and found to be dry, supported wood frog and/or spotted salamander breeding in at least one, previous year. Supplemental photos are also included for select pools (e.g. VP1007, VP1008, and VP1014), which were found to be supporting breeding activity by wood frogs and/or spotted salamanders during the course of the Project. For these pools, supplemental photos are added to further strengthen documentation of breeding by these amphibian species.

Searching for new, additional vernal pools

In addition to surveying the potential vernal pools identified by the Inventory and potential pools identified by members of the MCC, time was spent searching for new pools in areas where the landscape appeared especially conducive to supporting vernal pool habitat. During these searches, wooded landscapes, adjacent to pools identified in the Inventory, were walked in a switchback pattern to search for vernal pools, focusing on locations that might be expected to contain pools, such as micro-depressions and the off-flows from saturated terrain.

RESULTS

The following provides a brief description of the vernal pools surveyed, in terms of their broader location and surrounding habitat, as well as the major findings with respect to the presence of vernal pool species. Vernal pools found on public property are described in the context of the property on which they are located (e.g. 'Hubbard Park Pools'). In order to protect the privacy of landowners, vernal pools located on privately-held parcels are simply listed as occurring on private property. Photos of each pool and the amphibian species detected there can be found in Appendix III. Detailed findings from each pool are reported below (Table 1).

The full suite of data collected from this Project is provided separately in a spreadsheet entitled PoolSurveyData_MCC_2016.

VP1001 and VP1007

Two pools located in the lowlands near the North Branch Winooski River were surveyed. While VP1001 was situated between a large parcel of privately held forested land and the River, VP1007 was located adjacent to housing development and mixed deciduous/coniferous woodlands. VP1001 was nearly dry with no evidence of vernal pool species present. VP1007 is a large pool with both spotted salamander and wood frog larvae present.

VP1002

The surrounding context was large, contiguous forestlands for this pool, which was located relatively far from the nearest road. Both spotted salamanders (egg masses and larvae) and wood frog larvae were present. The area between this pool and the nearest road, located downslope of the pool, was searched extensively; however, no new pools were detected.

VP1006, VP1008, and VP1012-VP1014

A group of five pools was surveyed within the Hubbard Park property. These pools are generally situated in mixed deciduous and coniferous forest. Although the landscape surrounding these pools is largely forested, each pool lies adjacent to either a hiking trail or in one case both a hiking trail/gravel road and

parking/recreation area (VP1008, near the Park's 'New Shelter'). Given the protected nature of Hubbard Park and the presence of relatively large, contiguous forest patches, the terrestrial landscape across this region appears to provide well-connected habitat. Yet, given the distance between these pools and the relatively small amphibian populations that appear to occupy them, additional pools may exist nearby that help support the populations in the pools surveyed here.

VP1003-VP1005, VP1009-VP1011

Three pools (VP1003-VP1005), reported by the Inventory, are situated on a large, privately held parcel in the extreme, northern terminus of the City. Given that this landscape appeared especially conducive to hosting vernal pools, considerable time was spent searching for new pools. This extra effort yielded two, new, confirmed vernal pools and one potential, but dry, pool (VP1009-VP1011). This landscape held the highest density of vernal pools surveyed in this Project.

Summation of Results (Refer also to Tables 2 and 3)

Through a field verification process, this Project identified a total of 14 vernal pools, either 'potential' (3 pools) or confirmed (11 pools). Ten of the 11 confirmed pools provided evidence of breeding by wood frogs and/or spotted salamanders. The remaining pool (VP1006) was dry but confirmed by an image, provided by MCC member John Jose, of a wood frog egg mass deposited in this pool in 2015 (see Appendix III).

Of the 14 total pools identified, 5 pools (1 potential and 4 confirmed) are located on public property in the City (Hubbard Park). The remaining 9 pools (2 potential and 7 confirmed) are located on privately-held parcels.

From the subset of 6 sites originally identified in the Inventory as holding potential vernal pools, 5 were confirmed, while one pool (VP1001) was found to be almost dry and supporting no evidence of amphibian breeding. However, the area where this pool is located is known by members of the MCC to provide vernal pool habitat, which supports wood frogs during this species's breeding season. As such, this area will be re-surveyed in the spring of 2017.

Of note is a cluster of vernal pools (VP1003 - VP1005 and VP1009 - VP1011), which includes 5 confirmed and 1 potential pool, located on privately held parcels in the extreme, northern portion of the City.

In terms of species composition of vernal pool amphibians found in field-verified vernal pools, of the 10 pools confirmed through evidence of spotted salamander and/or wood frog breeding during the Project, 2 pools held only wood frog larvae, 4 pools showed evidence of only spotted salamander breeding (eggs and/or larvae), while the remaining 4 field-confirmed pools supported both spotted salamanders (eggs and/or larvae) and wood frog larvae. Additionally, a total of 6 pools held wood frog larvae and a total of 8 pools supported spotted salamander larvae and/or egg masses. Also, of note is a 'candidate' egg mass of the *Ambystoma jeffersonianum* complex detected in VP1005.

Table 1. Summary of key findings for vernal pools surveyed.

Pools are identified by a uniquely assigned '2016 ID'. Pools newly discovered during this Project are indicated by an asterisk (e.g. VP1010*). For the 'potential' pools previously identified by Engstrom and DeLeo (2007), the formerly used '2007 ID' is also provided (see "2016 ID (2007 ID) Survey Date)" in table). Bank-full depth (see "Depth (in.)" in table) and bank-full area (see "Area (ft²)" in table) are also shown. A simple, visual-based approximation of the percentage of overhead canopy that is closed off due to forest cover is provided (see "Canopy" in table). Vernal pool species detected are shown here along with the developmental stage (E = embryo, L = larva, A = adult) and the number of individuals and/or egg masses detected. The species listed here include the spotted salamander (*Ambystoma maculatum* = 'Amma'), the blue-spotted/Jefferson complex (*A. laterale*/*A. jeffersonianum* = 'Amla/je'), and the wood frog (*Lithobates sylvaticus* = 'Lisy') (see "Vernal pool spp." in table). A brief summary of the overall impression of the pool is also provided, as well as a general characterization of contiguous woodlands and surrounding land uses (see "Comments" in table).

2016 ID [2007 ID] Survey date	Depth (in.)	Area (ft²)	Canopy	Vernal pool spp.	Comments
VP1001 [115] 6/9/16	10	71	70	None	Situated in primarily mixed deciduous forest, the edge of which lies adjacent to the North Branch of the Winooski River, on private property. Pool was essentially dry with a small collection of water (~ 2 x 3 ft.) located at z-max. No sign of vernal pool amphibian species present. However, the basin had the appearance of a vernal pool with respect to saturated ground, darkened leaf matter, and a lack of vegetation. MCC member John Jose reported hearing wood frogs vocalizing in this area in the spring of 2015 and 2016. In addition, in the spring of 2016, MCC member Asa Richardson-Skinder observed what appeared to be two vernal pools in this area. He provided a photograph from one of these pools of an egg mass that had the appearance of a wood frog egg mass. Recommend that this area be resurveyed, at a future date, during the breeding season for target amphibian species.

VP1002 [198] 6/12/16	27	220	85	Amma E. (2) Amma L. (1) Lisy L. (71)	Situated in heavily forested context, comprised primarily of mature hemlock and located far from development, on private property. Pool with limited emergent vegetation. Relatively high density of wood frog larvae present. Pool located far away from any disturbed habitats, well upslope of the nearest road and situated on a large parcel of land.
VP1003 [225] 6/10/16	16	137	45	Amma E. (23) Lisy L. (42)	Situated in heavily forested context and located relatively far from development, on private property. Canopy characterized primarily by hemlock, some birch and maple with some emergent sedge and fern occurring in pool. Several spotted salamander egg masses and wood frog larvae were observed.
VP1004 [227] 6/10/16	15	47	50	Amma E. (2)	Situated in heavily forested context and located relatively far from development, on private property. Canopy characterized by mixed deciduous/coniferous species (primarily hemlock, spruce, maple) with some emergent sedge and fern occurring in pool.
VP1005 [229] 6/10/16	12	408	75	Amma E. (11) Amla/je E. (1)	Situated in heavily forested context and located relatively far from development on private property. Canopy predominated by conifers (primarily hemlock, some spruce) with limited emergent vegetation occurring in pool.
VP1006 [295] 6/9/16	12	0	85	None (but see Appendix III for prior documentation of wood frog breeding in a previous year).	Pool was dry. However, it presented the distinct appearance of a vernal pool, in terms of saturated ground, darkened leaf matter, and lack of vegetation. This potential pool occurs very near to where the property boundaries of a private parcel and City Park property meet. Photo documentation of wood frog presence in a prior year is included in Appendix III.

VP1007 [NA] 6/14/16	28	481	35	Amma L. (5) Lisy L. (25) (Also, see Appendix III for supplementary images provided as additional documentation of wood frog breeding in April, 2016).	Situated adjacent to a combination of housing development, forest, and larger wetland complex, on private property. Compared to other pools surveyed in this Project, this pool has a relatively high macroinvertebrate and amphibian species diversity and a high density of both wood frogs and spotted salamanders. Due to the turbidity of the water, it was not possible to complete a survey of total spotted salamander egg masses present.
VP1008 [NA] 6/9/16	24	1414	45	Amma E. (9) Amma L. (1) (Also, see Appendix III for prior documentation of wood frog breeding and supplementary image provided for evidence of spotted salamander breeding in prior years).	Relatively large pool situated next to a main hiking trail/gravel road at Hubbard Park. Water was turbid with sediment, presumably from dogs entering and disturbing the water. Salamander egg masses appeared healthy. No wood frog larvae were detected. However, MCC member John Jose reported wood frog egg masses present in this pool earlier this spring, but it appeared the egg masses disintegrated before any significant hatching of embryos occurred, resulting in very low production of this species in this pool for this breeding season. Photo documentation of wood frog and spotted salamander presence in prior years is included in Appendix III.
VP1009* [NA] 6/10/16	12	236	50	Amma E. (3) Amma L. (3)	Relatively open canopy pool with emergent fern and sedge occurring in pool. Located on private property. Canopy was mixed conifer and deciduous, comprised of spruce, hemlock, and maple.
VP1010* (NA) 6/14/16	12	0	95	None	Small, closed-canopy potential pool. Canopy was mixed, consisting of hemlock, beech, and maple. Located on private property. Recommend that this pool be resurveyed, at a future date, during the breeding season for target amphibian species.
VP1011* (NA) 6/14/16	13	107	50	Amma E. (4) Lisy L. (1)	Pool with some emergent sedge and fern, on private property.

					Hemlock and maple canopy fairly open.
VP1012 (NA) 6/12/16	10	20	50	Lisy L. (5)	Small pocket of water connected to very large wetland complex in Hubbard Park. Larger wetland is characterized by open canopy with dense emergent fern vegetation. Many such pockets may exist in this wetland complex in wetter years and earlier in the season. Recommend that the wetland complex be resurveyed, at a future date, during the breeding season for target amphibian species.
VP1013 (NA) 6/12/16	10	28	30	None	Small potential pool, partially dry but holding water, in close proximity to complex described for VP1012 in Hubbard Park. No species detected, but may attract breeding adults. Recommend that this pool be resurveyed, at a future date, during the breeding season for target amphibian species.
VP1014 (NA) 6/12/16	16	31	50	Lisy L. (9) (Also, see Appendix III for supplementary image provided for documentation of wood frog breeding in a prior year).	Similar to VP1012, this pool is a relatively small pocket of water connected to a larger wetland complex in Hubbard Park. Larger wetland is characterized by open canopy with dense emergent fern vegetation. Many such pockets may exist in this wetland complex in wetter years and earlier in the season. Recommend that the wetland complex be resurveyed, at a future date, during the breeding season for target amphibian species. Photo documentation of wood frog presence in prior year is included in Appendix III.

Table 2. Confirmed vs. potential vernal pools (2007 Inventory (Engstrom and DeLeo) and new pools) and landowner status (public vs. private land) of confirmed pools

Vernal Pool	2007 Inventory Vernal Pools		New Vernal Pools		Confirmed Vernal Pools: Public/Private Land	
	Unconfirmed	Confirmed	Confirmed	Potential	Public	Private
VP1001*	X					
VP1002		X				X
VP1003		X				X
VP1004		X				X
VP1005		X				X
VP1006**		X			X	
VP1007			X			X
VP1008			X		X	
VP1009			X			X
VP1010***				X		
VP1011			X			X
VP1012			X		X	
VP1013*				X		
VP1014			X		X	
TOTAL	1	5	6	2	4	7
TOTAL CONFIRMED POOLS: 11						

*Potential pool with only a small collection of water remaining. No evidence of breeding amphibians detected.

**Dry when surveyed, but confirmed via images, from 2015, providing proof of wood frog breeding.

***Potential, but dry, pool.

Table 3. Evidence of wood frog and Ambystoma salamander breeding (by species and life stage) and collected specimens

Vernal Pool	Evidence of Wood Frog and Ambystoma Salamander Breeding					Collected Specimens		
	Wood Frog Larvae	Spotted Salamander Larvae and/or Egg Masses	Wood Frog and Spotted Salamander	'Candidate' Jefferson Salamander Complex Egg Mass	Supplementary Image(s) Provided	Wood Frog Larvae	Spotted Salamander Larvae	Spotted Salamander Egg
VP1001*								
VP1002	X	X	X			2	1	
VP1003	X	X	X			2		
VP1004		X						
VP1005		X		X				
VP1006**					X			
VP1007	X	X	X		X	2	1	
VP1008		X			X		1	2
VP1009		X					1	
VP1010***								
VP1011	X	X	X			1		
VP1012	X					1		
VP1013*								
VP1014	X				X	2		
TOTAL	6	8	4	1	4			

*Potential pool with only a small collection of water remaining. No evidence of breeding amphibians detected.

**Dry when surveyed, but confirmed via images, from 2015, providing proof of wood frog breeding.

***Potential, but dry, pool.

DISCUSSION

Two important considerations in interpreting these findings are 1) the extremely cold spring temperatures and 2) the time of year of the Project. First, the numerous sub-freezing events that occurred this past spring, presumably after many wood frogs had bred, may have killed a substantial portion of wood frog embryos, as well as some of the spotted salamander embryos. This might explain the absence of wood frogs in many of the pools. Secondly, surveys at this time of year, after all wood frog embryos and some spotted salamander embryos have hatched, make detection less likely compared to the early spring when eggs are first laid and are highly conspicuous and readily identifiable as to the amphibian species that deposited them.

In one vernal pool (VP1005), a candidate "*Ambystoma jeffersonianum* complex" egg mass was detected. This complex comprises various hybridizations of the blue spotted salamander (*Ambystoma laterale*) and the Jefferson salamander (*Ambystoma jeffersonianum*). This egg mass is referred to as a 'candidate' because of the uncertainty in positively distinguishing it from *A. maculatum*. This difficulty arises in part because of their similarity in appearance and in part because no other such egg masses were detected. Distinguishing between the egg masses of the *Ambystoma jeffersonianum* complex and *A. maculatum* is typically tractable earlier in the season when they are not yet infused with visible algal growth. However, this egg mass presented the classic appearance of an *Ambystoma jeffersonianum* complex egg mass, namely, a relatively smaller egg mass with many 'pearly white', inviable eggs.

REFERENCES

Brown, L.J. and R.E. Jung. 2005. *An Introduction to Mid-Atlantic Seasonal Pools*, EPA/903/B-05/001. United States Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Ft. Meade, Maryland.

Engstrom, Brett and John DeLeo. 2007. *A Natural Community Inventory of the City of Montpelier, Vermont*. Marshfield, Vermont.

Vermont Wildlife Action Plan Team. 2015. *Vermont Wildlife Action Plan 2015*. Vermont Fish & Wildlife Department. Montpelier, VT. <http://www.vtfishandwildlife.com>.

Appendix I: Updated map of vernal pools in Montpelier – Provided separately as 11” x 18” “Montpelier, Vermont Vernal Pools Map”

Appendix II: Letter requesting landowner permission to survey pools



City of Montpelier, Vermont *"The Smallest Capital City in the United States"*

CONSERVATION COMMISSION:

Geoff Beyer, Parks Liaison	Ben Eastwood	John Jose
James Brady	John Fox	Asa Richardson-Skinder, Official Youth Member
Emily Byrne	Charles Hohn	Roy Schiff, Chair

June 8, 2016

Dear Montpelier Property Owner:

The Montpelier Conservation Commission is in the process of completing an updated Natural Resource Inventory Map, which will support Montpelier residents in making informed land use decisions. Among the natural resources identified on the map are vernal pools - unique wetlands that fill with water from spring rains and snowmelt, but frequently dry up during the summer months.

These seasonal pools are an important ecological component of the City's woodland environments, supporting a unique and fascinating array of creatures, including spotted salamanders, wood frogs, fairy shrimp and fingernail clams. In addition to the pools themselves, it is necessary to have intact, surrounding woodlands for these animals to survive.

A "Natural Community Inventory", conducted in 2005, identified a small number of potential vernal pools in Montpelier, but we were unable to confirm them at that time. The authors of the Inventory recommended that these pools be revisited during the breeding season, which occurs from spring through early summer for the spotted salamanders and wood frogs, two species that are recognized as key indicators of the presence of a vernal pool.

The Conservation Commission has enlisted an ecological consultant, Dr. Steven P. Brady, to conduct this field work. Based on the findings of the Inventory, it appears that one of these pools may exist on your property. If you are willing to grant Dr. Brady access to your property, to confirm whether or not a vernal pool does exist, it will greatly benefit our efforts to properly map Montpelier's vernal pools.

Please note that if a vernal pool is identified on your property, it does not mean that land development and other land uses will be prevented from occurring. Instead, knowing a vernal pool is on your property will enable you to enact land use management practices to help provide for the long term viability of the vernal pool and the wildlife that depends on it.

Please feel free to contact John Jose of the Conservation Commission at 570-445-0173 or jjose@ptd.net, if you have any questions or concerns. Your support is greatly appreciated.

Sincerely,

John Jose, Commission Member
On behalf of the Montpelier Conservation Commission

Appendix III: Photos of vernal pools and vernal pool amphibian species detected there.

All images by Steven Brady, unless otherwise noted.

VP1001

Overview of dry, potential pool.



VP1002

Top: Pool overview (top left and right). Middle: Wood frog larva (left) and spotted salamander egg mass (right). Bottom: Spotted salamander egg mass with late stage embryos visible.



VP 1003

Pool overview (top left, top right). Spotted salamander egg masses (bottom left and right).



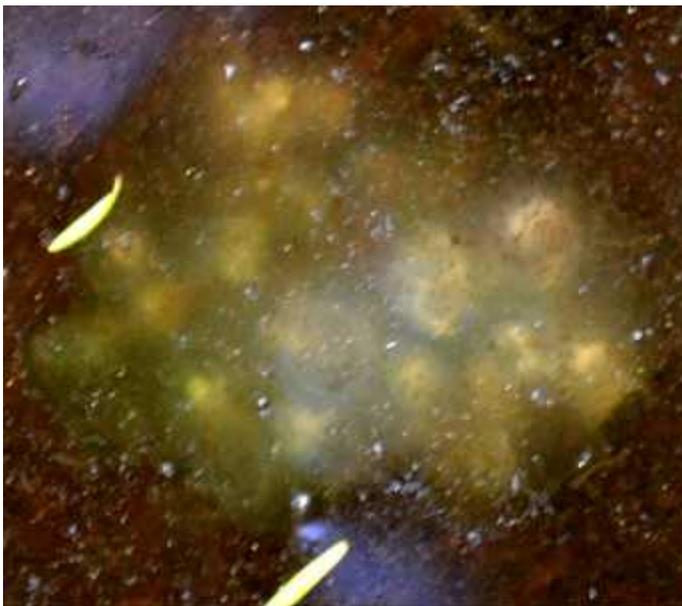
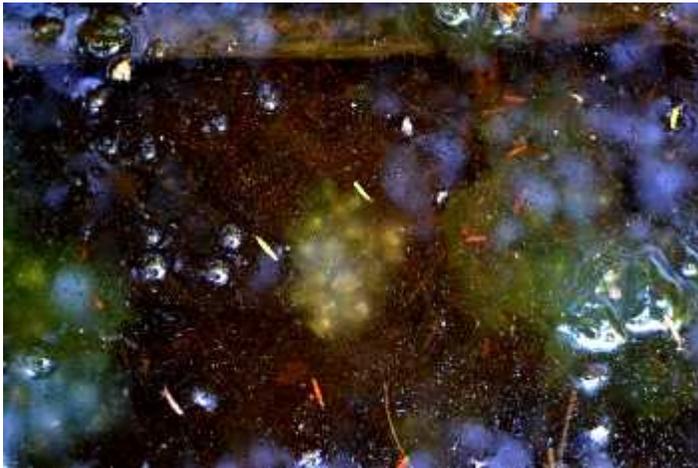
VP1004

Pool overview (left) and spotted salamander egg mass jelly (appears as though embryos have already hatched) (right).



VP1005

Pool Overview (top left, top right). Spotted salamander egg masses are shown on the left and right side of the middle photo. The central egg mass in this photo (shown cropped and enlarged in bottom photo) is that of the candidate *Ambystoma jeffersonianum* complex egg mass.



VP1006

Overview of dry, potential pool.



VP1006 Supplementary photo documentation

Pool overview (top) and wood frog egg mass (bottom). Photos by Sandy Johnson Sabin (top) and John Jose (bottom). May 2, 2015.



VP1007

Pool overview (top left, top right). Wood frog larvae pictured on dip net (bottom).



VP1007 Supplementary photo documentation

Wood frog egg mass (left) and breeding wood frogs (right). Photos by John Jose. April 14, 2016.



VP1008

Pool overview (top left, top right). Spotted salamander egg mass in dip net (bottom).



VP1008 Supplementary photo documentation

Spotted salamander larvae (left) wood frog egg mass (right). Image on left, October 12, 2015. Image on right, April 20, 2013. Photos by John Jose.



VP1009

Pool overview (left). Spotted salamander egg mass with late stage embryos visible (right).



VP1010

Dry potential pool overview



VP1011

Pool overview (top left). Post-hatch spotted salamander egg masses in pool (top right) and in dip net (middle). Wood frog larva in dip net (bottom).



VP1012

Pool overview (top left, top right). Wood frog larva in dip net (bottom).



VP1013

Potential pool overview.



VP1014

Pool overview (left) and larval wood frog in dip net (top right)



VP1014 Supplementary photo documentation.

Wood frog egg mass. Photo by John Jose. April 26, 2013.

