Vermont Vernal Pool Mapping Project Maintenance

Final Performance Report to the Vermont Fish and Wildlife Department

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Introduction

Vernal pools are typically small, shallow wetlands characterized by alternating flooded and dry phases. Despite their small size and ephemeral nature, they support a rich assemblage of invertebrates and breeding amphibians, many of which are considered High and Medium priority Species of Greatest Conservation Need (SGCN) in the Vermont Wildlife Action Plan (Kart et al. 2005). The Vermont Vernal Pool Mapping Project (VPMP) was conducted from 2009 thru 2012, during which the location of 4,846 "unverified" vernal pools were mapped statewide, primarily using aerial photo interpretation. Of those, 636 (13%) were field-visited, with 54% (n=344) confirmed to be vernal pools. In addition, another 221 "new" pools were confirmed that were not previously mapped, bringing the total number of confirmed pools to 565 (Faccio et al. 2013).

This grant award was provided to maintain the VPMP database from 2013 to 2016. The primary tasks were to:

1. Seek and accept new vernal pool site reports from volunteers for data entry and mapping.
2. Provide quality control, data entry, and mapping of new field records as they are received.
3. Continue to develop a GIS layer of verified vernal pools statewide, and a database consisting of biological and physical attributes of all verified pools.

Methods

Data for field-verified pools were primarily collected on standardized field data sheets provided to volunteers by VPMP staff (see Faccio et al. 2013 for copy of data sheet). Data were then either entered into the online database directly by volunteers, or in some cases, mailed to S. Faccio who then entered the data into the online database.

Database Structure
The online database provided a consistent data entry point for field data forms filled out by volunteers and project partners when assessing a vernal pool in the field. The database was designed to mimic the field data form for easy transfer and to reduce data entry errors, while archiving the field data in a reliable, manageable, and flexible format. A few structurally important database fields are discussed below.

Coordinates
Field investigators recorded spatial coordinates for pools they visited on the field data form. The coordinates recorded can be sourced from a variety of tools, including handheld GPS of varying accuracy, online mapping tools, or scaling from paper maps. For this reason, the coordinates entered on the field data forms, and subsequently in the database should be

considered <u>advisory</u> only. For all remotely mapped pools and those received from other reliable sources, the original mapping coordinates should be used to define the pool location. The one exception to this is for NEW pools, as described below.

The database allows multiple records for a single pool, so if a pool is visited over multiple years, or by more than one investigator, all data can be retained. In order to facilitate data distribution in a concise spatial format, only a single database record can be associated with the pool location coordinates. For multiple entries, this distinction is accomplished through the QA duplicate review process described below.

Pool Types

Remotely Mapped Pools: Identified by VPmapID starting with initials of reviewer.
The majority of the pools in the database and distributed data were derived from VPMP remote mapping using color-infrared aerial photo interpretation.

Known Pools: Identified by VPmapID starting with the letters "KWN"
In addition to remote mapping of pools, VPMP gathered pool data from a wide variety of reputable sources including previous remote mapping inventories by professional biologists, State and Federal agencies, conservation organizations, land managers and educational institutions (see Faccio et al. 2013 for a list). In order to be assimilated into the remote vernal pool dataset, the data was required to include a spatial location and come from a source deemed reliable and competent by the VPMP project team. Through the course of field investigation, some KWN pools have been determined not be vernal pools, or have been found to be inaccurately mapped. KWN pools that have not received field verification are considered "Probable" pools until field confirmation is conducted.

NEW Pools: Identified by VPmapID starting with "NEW"
In addition to entering data for previously mapped pools identified during VPMP, the database had the capability to include "new" pools found in the course of field work, through local knowledge, or other means. These pools received a VPmapID starting with "NEW," followed by a unique sequential number. Because these pools had no previous mapping, this is the only case where the coordinates entered from the field data form in the database are used to define the location of pools.

NEW Pools received the same level of QA review as those database entries corresponding to previously mapped pool locations.

Pool Located/Certainty

As a general rule, indication that a pool was located, or the level of certainty was not assumed to be a fail-safe or accurate depiction of pool confirmation. Because field verification was conducted by individuals with a variety of experience and training it was found that these indicators on the field data form and in the database were not reliable as measures of a pool's verification. For example, some field investigators indicated the confirmed presence of a pool,

but photos, other notes or subsequent follow up visits reveal it was in fact a wetland with amphibian breeding habitat or a very small pool with insufficient hydroperiod most years.

Data Quality Assurance

Data quality assurance review (QA) was conducted for updated database entries on an annual basis, typically in late winter prior to the subsequent pool verification season. The QA process involved inspection of the newly received database entries. Entries were reviewed manually for complete and consistent data entry, confirmation of pool identification, and confidence in location of the pool described. In addition, pools were reviewed through batched automated spatial processes designed to identify incorrectly-entered location coordinates and duplicate entries.

QA Database Fields

QA_CODE: One of the following QA Codes were assigned to each database entry. These Codes were then used to differentiate pool status in all subsequent data exports:

- CONF- (Confirmed Pool). Assigned when an entry confirmed presence of a vernal pool and was deemed complete and accurate.
- PROB-VPMP- (Probable Pool). Assigned when an entry was inconclusive or incomplete, but indicated the likely presence of a vernal pool. Typically used for pools visited during off-season, or those with questionable hydroperiod due to field conditions.
- PROB-OTHER- (Probable from other source). This was not assigned during QA of new database entries, but indicates pool information provided by other sources assumed reliable during the original mapping process. In these entries, the VPMP data form has not been completed.
- NOT FOUND- (Pool not found at location). The pool was not located at the location anticipated. This typically resulted from a remote mapping error such as tree shadow, ledge, or other confusing photo signature.
- NOT POOL- (Location holds a feature that is not a vernal pool). Assigned when a field investigation and QA review determined the site was not a classic vernal pool, even if it had amphibian breeding habitat and indicator species, such as a seepage wetland.
- DUPLICATE- (Duplicate data entry) Assigned when multiple database entries are made for a single pool location. One of the duplicate entries received another QA_Code, and all others received are coded "DUPLICATE"
- LANDOWNER- (Landowner restrictions on data distribution). Assigned when a landowner specifically requested that information on a pool on their property NOT be made public. For the purposes of data distribution, these pools are not considered "Confirmed."
- ERROR- (Data entry error). Assigned when QA review is unable to determine the appropriate code from the list above. Typically used with incomplete or very inconsistent entries without sufficient explanation.

QA_Alt: Used for additional and/or temporary notations during the QA process.

QA_Person: Identification of QA reviewer (sometimes used inconsistently). All QA review for this project to-data has been conducted by Aaron Worthley (AW).

QA_Date: Date of QA Review

QA_Notes: Notes about QA review, justification for QA_CODE, changes made and outstanding issues encountered during the QA review.

Batch Spatial Processing

All pools were evaluated using GIS tools for correct coordinate entry. This review identified database entries where latitude/longitude coordinates were incorrectly entered by the database user, or where the pool found in the field was likely different than the location originally identified through the remote inventory. The review process involved comparing the spatial location of database entry via the coordinate fields with those of the original remote inventory point.

Any coordinate entry deemed incorrect (ie. DDM coordinates entered as DD) was corrected when possible, and/or noted in the QA comments field.

As previously mentioned, the database allows multiple record entries for a single pool. However, for effective use of the data, only one database record can be associated with each pool. Batch processing was used to identify duplicate pool entries. When multiple entries for the same unique ID were present, one was given the appropriate QA Code of "CONF", "NOT FOUND" or "NOT POOL" and all others were coded as "DUPLICATE". The entries were reviewed manually using the following parameters:

Most complete entry: When one duplicate entry had a more complete dataset, but all other information was consistent, the more complete or comprehensive data entry was assigned the Code, and all others were assigned "DUPLICATE".

More reliable field personnel: When duplicate entries disagreed on pool status or function the field reviewer was checked- entries by professional ecologists and biologists, especially the project team members were given more credence and assigned the Code, with others assigned "DUPLICATE". One exception to this is when the professional biologist visit was inconclusive due to time of year or field conditions.

KWN Pool IDs: KWN (KNOWN pools which are those provided by sources other than project partners conducting the remote pool mapping inventory) were assumed to be reasonably accurate and received automatic "PROB-OTHER" QA_Code status in the database. If VPMP field investigation found otherwise, the previous "PROB-OTHER" code was changed to "DUPLICATE" and the new entry was assigned the appropriate code.

Data Export & Distribution

Data export was conducted utilizing repeatable GIS based spatial modeling for consistency. At the conclusion of the original VPMP project in 2013, data distribution was divided into 7 distinct datasets:

1. **Confirmed Pools**- QA "CONF", confirmed previously mapped vernal pools.
2. **Eliminated Pools**- QA "NOT POOL" or "NOT FOUND", Eliminated previously mapped pools
3. **Probable Pools**- QA "PROB-OTHER" or "PROB-VPMP", Previously mapped pools assumed likely to be present based on information other than complete VPMP field investigation and data submittal.
4. **NEW Confirmed Pools**- ID NEWxxx and QA "CONF", NEW confirmed pools.
5. **NEW Eliminated Pools**- ID NEWxxx and QA "NOT POOL" or "NOT FOUND", NEW eliminated pools
6. **NEW Probable Pools**- ID NEWxxx and QA "PROB-OTHER" or "PROB-VPMP", NEW likely pools.
7. **Potential Pools**- All remotely mapped or KWN pools with no or insufficient evidence to fit into one of the above categories.

For this second data distribution (2016), some minor changes have been made. In order to simplify the available data, the pre-mapped and NEW pools were combined in all categories. Based on common use in the three intervening years since the original data distribution, "Potential" Pools were re-named "Unverified." This data release includes the following distinct 4 datasets:

1. **Confirmed Pools**- QA "CONF," confirmed, previously mapped, and NEW vernal pools.
2. **Eliminated Pools**- QA "NOT POOL" or "NOT FOUND," Eliminated, previously mapped, and NEW pools.
3. **Probable Pools**- QA "PROB-OTHER" or "PROB-VPMP," Previously mapped and NEW pools likely to be present based on information other than complete VPMP field investigation and data submittal.
4. **UnVerified Pools**- All remotely mapped or KWN pools with no, or insufficient evidence to fit into one of the above categories.

Results

During the four field seasons of this grant award (2013-2016), a total of 20 volunteers and 2 VPMP staff visited 160 pools in 39 towns, of which 71% (n=114) were confirmed to be vernal pools (Fig. 1). This does not include one confirmed pool on private property that was visited without landowner permission, and therefore does not appear as "confirmed" in the database. The 114 confirmed pools were located in 33 towns, 15 of which had no previously confirmed vernal pool records, including Shrewsbury where one volunteer confirmed 13 pools (Table 1).
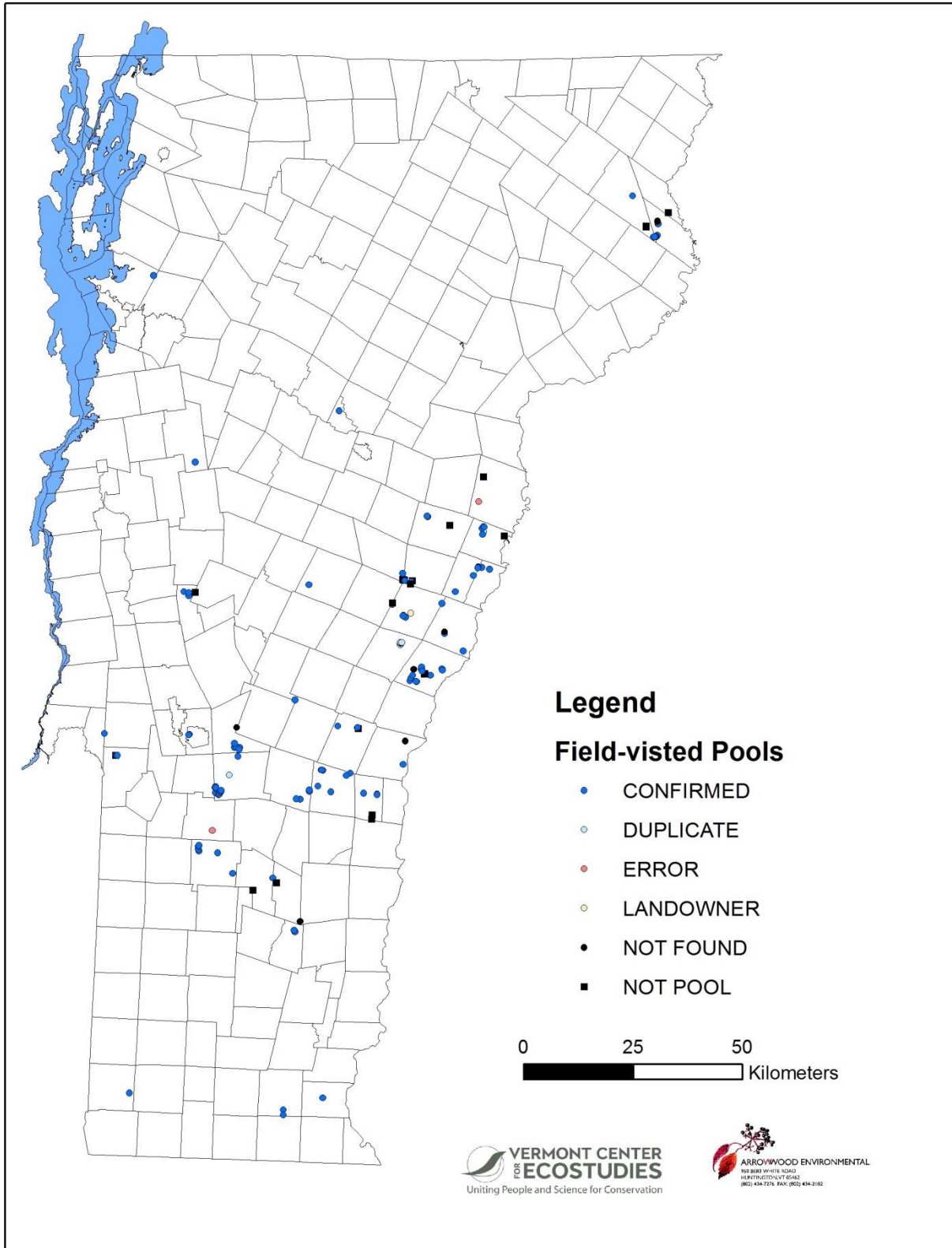
Figure 1. Distribution of 160 field-visited vernal pools in 39 towns, of which 114 were confirmed to be vernal pools during 2013-2016 field work.

Twenty-one percent of field visits resulted in pools that were either not found (n=10) or were not confirmed as vernal pools (n=23), primarily because they were other wetland types, including seeps and permanent ponds, while others were artifacts of aerial photo interpretation, such as shadows from large conifers. Nine pools were duplicate visits to sites that were field-verified previously. Three records were marked as "errors" during the QA/QC process due to discrepancies between the GPS coordinates provided by volunteers and those of the mapped pool, indicating that the observers were approximately 60m, 100m, and 300m from the mapped points.

Indicator Species

Four indicator species were detected among the 114 confirmed vernal pools—Wood Frog (*Lithobates sylvatica*), Spotted Salamander (*Ambystoma maculatum*), Jefferson Salamander (*Ambystoma jeffersonianum*), and fairy shrimp (*Eubranchipus spp.*). As expected, the most frequently detected species were Wood Frog, found in 71.1% (*n*=81) of 114 confirmed pools in 27 towns, and Spotted Salamander, found in 39.5% of confirmed pools (*n*=45) in 19 towns (Table 2). Jefferson Salamander eggs were detected in two pools in West Windsor, a town where this rare (VT S2, SC) species has been confirmed previously. Similarly, fairy shrimp were only detected in 4 pools located in Strafford, Norwich, Reading, and Castleton. No Blue-spotted Salamander populations were detected.

Similar to results reported in Faccio et al. (2013), most salamander detections (91%) were confirmed by the presence of egg masses, while the majority of Wood Frog detections (60%) were made by the presence of tadpoles. Wood Frog egg masses develop and hatch quickly compared to salamander eggs, which persist longer in pools. In addition, Wood Frog tadpoles are often the only frog larvae present in vernal pools and are relatively easy to distinguish from other anuran larvae that may be present. In many pools, confirmations of Wood Frogs involved detections of multiple life stages (e.g. eggs and larvae). Fairy shrimp presence was probably under-represented in our sample. Due to their encysted

Table 1. List of 33 towns and the number of vernal pools confirmed during 2013-2016 field work.

Town	Number of Confirmed Pools
Bennington*	1
Bradford*	5
Brattleboro*	1
Castleton*	1
Chelsea	1
Colchester*	1
Corinth*	2
Fairlee	2
Ferdinand	2
Goshen	3
Hartland	1
Maidstone*	6
Marlboro	2
Mendon	5
Montpelier	1
Mount Tabor	6
Norwich	15
Plymouth*	4
Poultney*	3
Randolph	2
Reading	9
Rutland City*	2
Shrewsbury*	13
Starksboro*	1
Stockbridge*	1
Strafford	3
Thetford	3
Vershire*	4
West Fairlee*	4
West Windsor	4
Weston	1
Windham	3
Woodstock	2
Total	**114**

* Towns with no previous vernal pool confirmations

eggs which must dry and be re-submerged before hatching, fairy shrimp occur sporadically and unpredictably from year to year (Colburn 2004). Also, their active period is relatively short (ca. 1-3 weeks), occurring in early spring and occasionally in autumn.

Volunteer Participation

At least 20 volunteers participated in field verification, submitting data from 115 field visits, representing 72% of the 160 pools visited. Of those, 74% (n=85) were confirmed vernal pools. Volunteer effort ranged widely, from submitting data for a single pool visit to as many as 39, the latter submitted by Alison Marchione, an intern with the Upper Valley Land Trust (UVLT) who coordinated with VCE to field-verify pools on UVLT properties in nine towns with permission of the landowners. Four volunteers (A. Marchione, Doug Morin, Liza McElroy, and Lucas Jackson) accounted for 74% (n=85) of all volunteer field visits, of which 73% (n=62) were field-confirmed pools. In total, volunteers contributed at least 125 hours of in-kind service, a conservative figure since several participants did not submit volunteer time sheets.

Table 2. Number (%) of confirmed vernal pools in which indicator species were detected by life stage.

	Number (%) of Pools in Which Species Detected			
	Adult	**Eggs**	**Larvae**	**Total**
Wood Frog	19 (16.7)	39 (34.2)	48 (42.1)	81 (71.1)
Spotted Salamander	0	41 (36.0)	5 (4.4)	45 (39.5)
Jefferson Salamander	0	2 (1.8)	0	2 (1.8)
Fairy Shrimp				4 (3.5)

VPMP Database: Future Management and Maintenance

Background

VPMP partners, Arrowwood Environmental and Vermont Center for Ecostudies, contracted with an outside source to design and host the VPMP online database. The database was built in SQL Server, with an ASP.net front end. With the culmination of the VPMP project contracts, the database will no longer be hosted by the subcontractor.

The partners have worked with Vermont Fish and Wildlife Department (VFWD) over the course of the VPMP Maintenance Grant period to facilitate a transfer of the database from the VPMP host to a long-term permanent option. It was determined that the IT department at the Vermont Agency of Natural Resources (ANR) was probably the most appropriate long-term host and database maintainer. The following steps were taken to support the migration of the database to ANR:

- Revisions to the VPMP Field Data Form were drafted and circulated among VPMP partners, VFWD Biologists, ANR Wetlands Division, and interested parties for review and comment.
- A final Field Data Form was established in an attempt to integrate field data collection for all future vernal pool evaluations in Vermont. This form should be

used as the basis for the new database front-end and Visit Table structure. The existing VPMP data should be appropriately assimilated into the new database.
- Copies of the existing database were provided to ANR IT in order to test replication and implementation of the VPMP database in the ANR IT environment.
- The VPMP database was replicated on ANR IT servers, and VPMP partners participated in testing and review of the database function and schema.
- Some issues were identified and attempts made to explore options to mitigate these issues (see below). Meetings occurred between VPMP Partners, VFWD, ANR IT, and ANR GIS to investigate solutions.
- ANR GIS determined they did not have a workable solution for the issues presented.

Three major issues were identified during the course of the database migration process:
1. Since the database is a technological solution, it would benefit from ongoing management and oversight by personnel that are familiar with the technology, applications and limitations of the system. However since it is also designed to record and disseminate information on a very specific ecological feature, management and oversight personnel should also be versed in vernal pool biology and data requirements. It is unclear who would be best positioned and available within ANR to take on management and oversight responsibilities.
2. ANR IT has access restrictions on their database servers making outside online entry for backend QA review and data distribution impossible. All backend data access must be done by ANR personnel, or on an ANR-owned computer used by an authorized person at a Vermont State facility with network access to the server. It is unclear if available capacity exists among existing ANR personnel to conduct regular QA and data distribution activities. Secured servers unavailable to outside access makes QA activities by outside parties considerably more difficult.
3. In order to remain relevant and useful, the migrated database will require regular oversight, QA review, and promotion. It is unclear if this can be absorbed into the workload of the existing ANR personnel involved with the project.

Recommendation for Future Management
We believe that the best way to ensure ongoing utilization of VPMP data and provide a platform for additional data collection in the future, is to maintain a new/updated VPMP database. This will lead to a more robust and valuable dataset that will provide scientists, land managers, and regulators with up to date information about vernal pool distribution in Vermont. Although hosting a new/updated vernal pool database within ANR IT may be the least expensive option in terms of outside costs, without available personnel to manage and maintain the database, internal costs are likely to be incurred. Therefore, we recommend providing a budget to an outside party who will be contractually responsible for regular management and maintenance of the database, as well as data distribution. This will likely result in the most useful long term availability and functionality of the database, ongoing data updates, and project derivatives.

Acknowledgements

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