Wisconsin Department of Natural Resources

Accuracy Assessment of Ephemeral Pond Wetlands Mapping in Southeastern Wisconsin: Wisconsin Ephemeral Ponds Project (WEPP)

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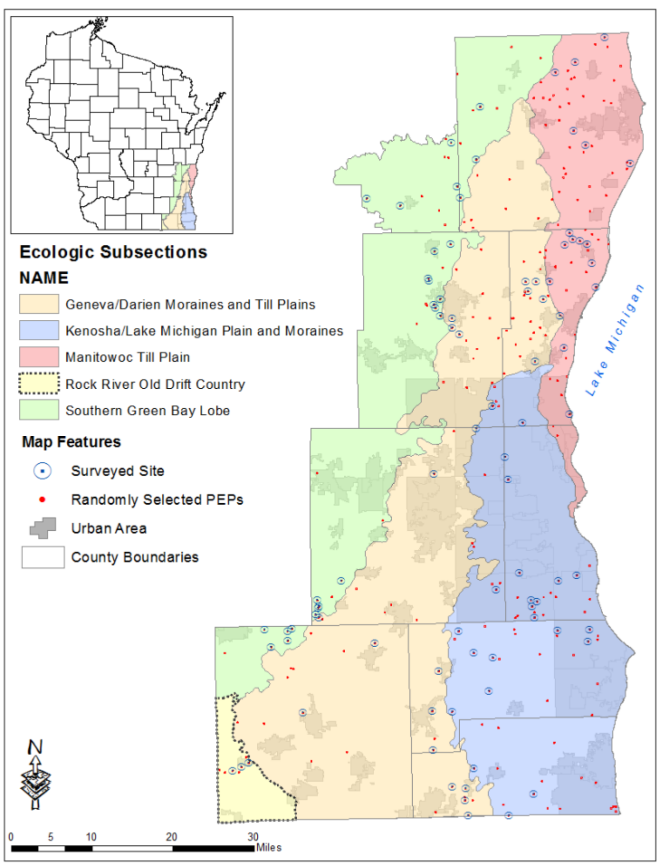

Accuracy Assessment of Ephemeral Pond Wetlands Mapping in Southeastern Wisconsin: The Wisconsin Ephemeral Ponds Project (WEPP)

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Executive Summary

Ephemeral ponds, or vernal pools, play a uniquely important ecological role. They may support unique plant communities and often provide productive amphibian and invertebrate habitat which is critically important for ducks and other water birds. Because they are often small, temporarily inundated and occurring in a forested setting, they are very difficult to map in the Wisconsin Wetland Inventory.

To improve mapping techniques and identify more ephemeral ponds in southeastern Wisconsin, the Wisconsin Ephemeral Ponds Project was initiated. Skilled photo-interpreters focused strictly on mapping ephemeral ponds, using the best available imagery and ancillary data. The project mapped 9,058 "Potential Ephemeral Ponds" or PEPs in an eight county study area in southeastern Wisconsin. The early efforts involved ground-truthing, however, it was an opportunistic effort which was not designed to provide a statistically rigorous accuracy assessment of the map product. The current study was designed and carried out in the late summer and fall of 2012 to evaluate accuracy in a statistically robust way.

The results of the early work show that the project succeeded in mapping about 25% more ephemeral ponds than were mapped as wetland by the Wisconsin Wetland Inventory in the Study Area. This current study examined both feature accuracy, the ability to distinguish ephemeral ponds from non-wetlands, and attribute accuracy, the ability to distinguish ephemeral ponds from other types of wetlands.

Feature Accuracy, relative to errors of commission, over the entire Study Area was 77%, meaning 77% of the mapped ephemeral ponds were found in the field to be at least some type of wetland. Conversely, 23% of the areas mapped as ephemeral pond were found to not be wetlands.

Feature Accuracy, relative to errors of omission, over the entire Study Area was 81%, meaning 81% of the ephemeral ponds found in the field had been mapped as at least some type of wetland. Conversely, 19% of the ephemeral ponds found in the field had been missed by the mappers and not mapped as any type of wetland. The size of the ephemeral ponds that were missed indicates that setting a minimum mapping unit of 0.03 acres would be justified for this method.

Attribute Accuracy over the entire Study Area was 73% relative to errors of commission, meaning 73% of the areas mapped as ephemeral pond wetland were correctly mapped and 27% were some other type of wetland. This is the least serious error, in that only the type of wetland was incorrectly mapped.

These accuracy statistics provide reasonable expectations for what can be achieved in future ephemeral pond mapping projects using similar methods. Compared to earlier ephemeral pond mapping projects and other wetland mapping accuracy assessment reports these results are promising. With the advent of LiDAR data to generate higher resolution topographic data, and assess vegetation the more serious mistakes can likely be reduced and errors of omission reduced.

Introduction

Ephemeral ponds, also referred to as vernal pools, are isolated wetlands that contain ponded water for part of the growing season. The ephemeral nature of these ponds is what makes them such valuable wetland habitat for concentrations of invertebrate, amphibian and bird species diversity in the landscape. They play a distinctly different ecological role from wetlands with more permanent inundation, such as marshes, and from wetlands with saturated soil such as wetland meadows. Yet because of their small size and temporary nature they are particularly difficult to map.

Background

A project to map ephemeral ponds in southeastern Wisconsin was completed in two phases between 2004 and 2010 (Bernthal et al., 2009; Bernthal et al., 2010). Over the course of the entire project, ephemeral ponds were mapped throughout eight counties: Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington and Waukesha; and the upper reaches of the Milwaukee River Basin in parts of Dodge and Fond du Lac counties. Two mapping methods were employed; traditional stereo photography interpretation and on-screen delineation with soils and topography displayed over aerial photography. During the mapping period, the mappers and other Department staff investigated known ephemeral ponds and field sites they identified as “potential ephemeral ponds” as training sites for the mappers to refine their interpretation. The final mapping product continued the use of the term “potential ephemeral pond” or PEP for sites that had not been identified solely through the two remote sensing methods. A total of 9,058 ephemeral ponds were mapped over the course of the mapping project. As sites were field-verified by Department staff they were identified as “verified ephemeral ponds” or VEPs.

After mapping was completed several field seasons were spent investigating PEPs and changing their status to VEPs as they were confirmed in the field. A citizen monitoring program was also developed that trained volunteers to make simple physical measurements and observations repeatedly from ice-off to drying of the pond (if it occurred). The goals of the program were to educate citizens about ephemeral ponds while gathering data that could be used to add to the inventory of verified ephemeral ponds. The volunteer program was inaugurated and maintained through a Partnership that included nature centers, academic institutions, University of Wisconsin-Extension, two county land conservation departments and Wisconsin Department of Natural Resources staff. Volunteers chose PEPs on public and private land and committed to monitoring them over the course of at least one field season. Volunteer data was used to make a determination that the site was either: a verified ephemeral pond, a permanent pond, another type of wetland, or a non-wetland. This opportunistic approach was carried out from 2006-2012. Over the course of six field seasons, 880 PEPs were investigated: 76 were found to be mistakes (not wetland, not a pond). Of those that were properly classed as wetland, 575 were verified to be ephemeral ponds, 11 were found to be permanent ponds, 115 were found to be some other type of wetland. For 103 PEPs the field data was inconclusive and additional field work was suggested to make a determination.

The Study Area with mapping and verification results is shown in Figure 1.

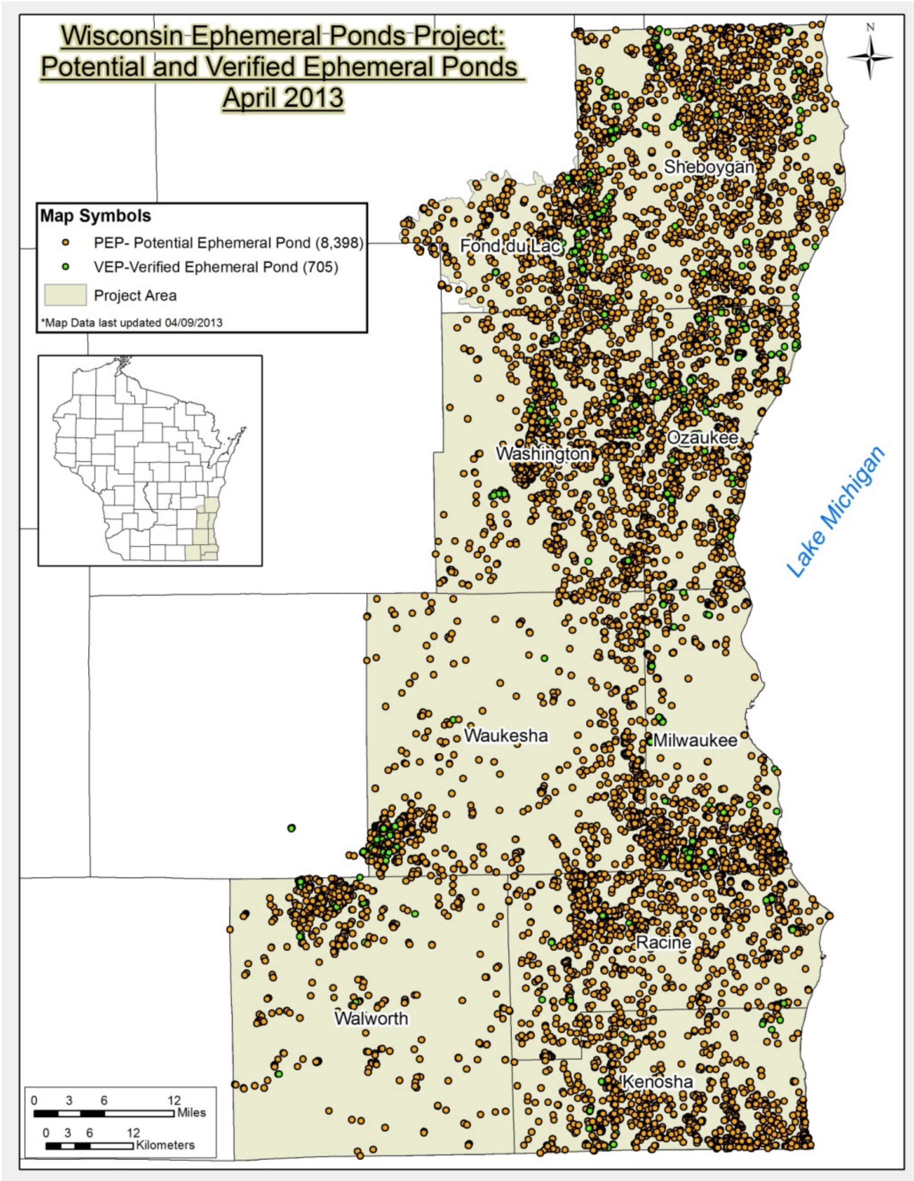

Figure 1: Potential and Verified Ephemeral Ponds in the Study Area

While this information is instructive and was very useful in adding hundreds of ponds to the registry of Verified Ephemeral Ponds, it was not gathered in a systematic, unbiased or representative fashion. Because of this, it cannot serve as a statistically valid accuracy assessment of the map product. Because site selection was opportunistic, it was biased toward publicly-owned land or property controlled by the Partners that was readily accessible, though some partners, such as the county conservation staff were able to access private land in the course of their duties. Also we did not attempt to balance skill level of the observer or amount of survey effort. Further, while the citizen monitoring protocol provided for documentation of “found” ephemeral ponds, most volunteers did not attempt to search for additional ephemeral ponds while navigating to the pond of their choice. Thus, there was no means of estimating error of omission – not mapping an existing ephemeral pond - a key statistic.

Project Goal

The purpose of this Accuracy Assessment is to conduct a statistically robust and valid study of the accuracy of the PEP mapping product for the entire project area, comparable to other assessments of wetland mapping projects. A decision was made to use a fresh selection of sites independent of previous survey efforts.

In addition to the Accuracy Assessment project funds were also used to support amphibian egg mass surveys of some of the ponds that were found to be VEPs. In the spring of 2013, the Natural Heritage Inventory program surveyed 150 VEP sites for evidence of substantial amphibian breeding activity (O'Connor, pers. comm.). As a result 99 VEPs from the project have been added to the Natural Heritage Inventory as Ephemeral Pond Natural Communities.

Study Area Description

The Study Area was selected opportunistically, based on a concentration of ephemeral ponds combined with strong interest and enthusiasm from regional WDNR staff and a variety of conservation partners for ephemeral pond ecology and conservation. Many nature centers and academic institutions participated in the project. Also, there was interest from the Southeastern Wisconsin Regional Planning Commission (SEWRPC), an agency staffed with both aerial photography interpretation and biological expertise. The combination of energy and expertise drove the formation of the Wisconsin Ephemeral Pond Partnership to carry out the mapping and volunteer monitoring projects. Eventually the Partnership mapped all of the seven counties served by SEWRPC and all of Sheboygan County. In order to cover the entire Milwaukee River Basin and the Northern Unit of the Kettle Moraine State Forest, parts of Dodge and Fond du Lac counties were also included.

In terms of land use the Study Area is strongly dominated by agriculture in its central and western parts and the string of highly urbanized areas along Lake Michigan, centered on the cities of Kenosha, Racine, Milwaukee, Port Washington, and Sheboygan. Geologically, the Study Area is dominated along the coast by lacustrine deposition from fluctuations of Glacial Lake Michigan and the Lake Michigan Lobe of the Wisconsin Glaciation reflected in the coastal till plains. The Study Area also contains the lateral moraines of the Green Bay Lobe and the inter-lobate moraines found in the Northern and Southern Units of the Kettle Moraine State Forest. In these areas the "kettle" topography made it difficult to maintain agriculture and resulted in land cover more likely to remain in forest.

There is a diversity of ways in which ponds form in the Study Area. The highly permeable substrate and sharp local relief in the kettle moraine landscapes results in a proliferation of kettle ponds of varying permanence. In the coastal plains lacustrine clay substrates produce "perched" ponds that collect surface water in small depressions in the landscape that typically dry down in the classic ephemeral pond pattern, resulting in "seasonally flooded basins" (Eggers and Reed 2011). Ponds can persist in these landscapes where agricultural drainage was too difficult to establish or failed over the years. Cut-off oxbows in floodplains also can form ponds in riverine systems, and coastal ridge and swale topography can produce highly complicated complexes with many ponds that become connected and disconnected from each other over the course of the year. In all these settings, the soils, microtopography and anthropogenic alterations at a site combine to determine whether a pond will form and how long standing water will persist. Ephemeral ponds exist along a gradient that includes very short duration pools on one end and permanent ponds on the other. In our study we included seasonally flooded basins in agricultural settings in our mapping definition as well as wooded ephemeral ponds. The small size of many ephemeral ponds, their differential appearance over the course of the year and the occurrence of many of them under forest canopy make them a wetland type that is difficult to map.

Methods

The variety of landscape settings may differentially affect our ability to map them accurately. Some settings may be more prone to “errors of omission” and others more prone to “errors of commission.” In order to detect differences in accuracy due to landscape setting the Study Area was subdivided by the Ecological Subsections mapped in the National Hierarchical Framework of Ecological Units (Cleland et al.1997). The four major Subsections were used to stratify the sampling frame. The Rock River Old Drift Subsection was combined with the adjacent Geneva/Darien Till Plains, as shown in Figure 2.

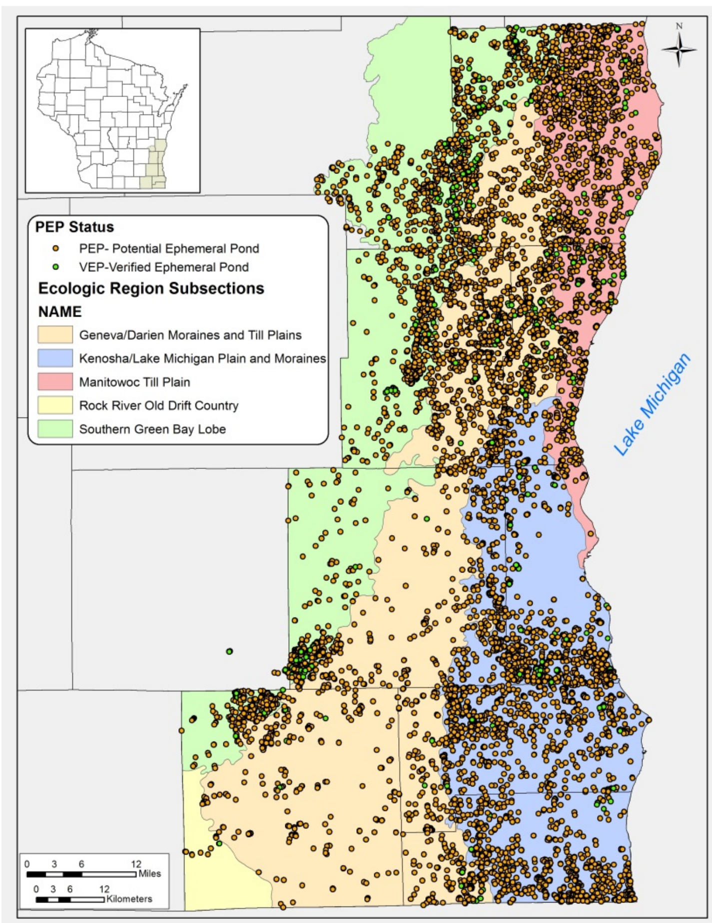

Figure 2: Study Area Potential and Verified Ephemeral Ponds by Ecological Subsection

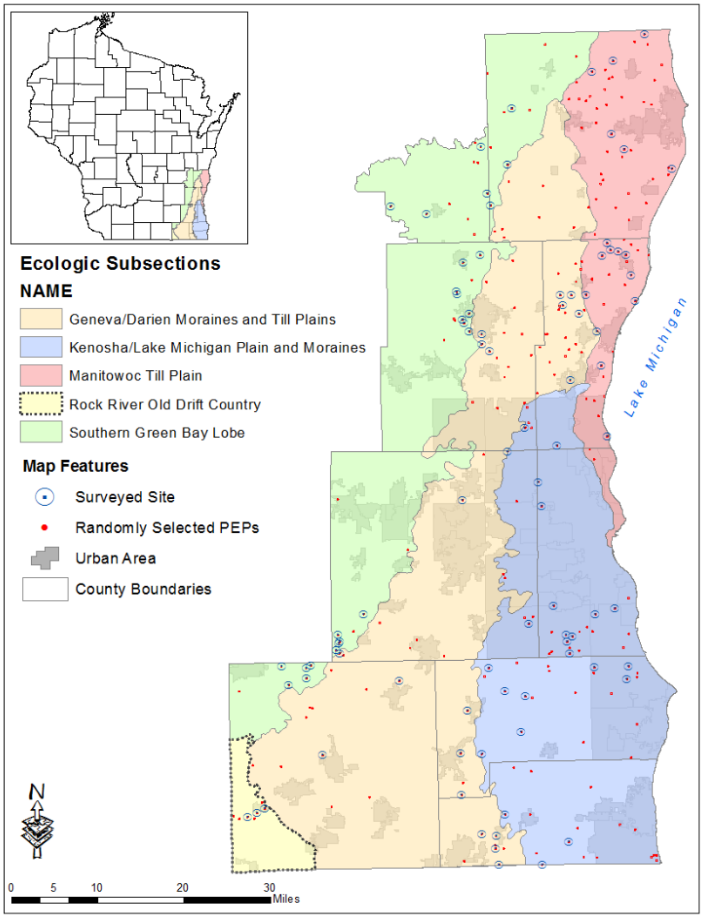

Figure 3: Study Area Ecological Subsections, Municipalities, Selected PEPs and Surveyed Sites

Sampling Design

Since 2006, the Wisconsin Ephemeral Ponds Project (WEPP) mapped approximately 9,000 potential ephemeral ponds (PEPs) in a 2 million acre project area in southeastern Wisconsin. Because of the large project area and the variety of landscapes and land uses they occur in, a random stratification sampling method was determined as the most appropriate method for selecting samples from the existing WEPP geo-database. Utilizing the National Hierarchical Framework of Ecological Units, four strata were designated, and with computer assisted randomization, an initial sample series of 50 PEPs were selected from each stratum.

In order to assess both false-positive and false-negative mapping errors, the randomly selected PEPs were converted into spatially defined search areas by generating a 150m radius buffer around the PEP centroid. This search area method, referred to as Defined Search Area (DSA) in this report, was determined to be superior to simply surveying individual features. The field surveyor searches the entire area for ephemeral ponds, allowing identification of “Missed Ephemeral Ponds” (MEPs) which can be used to calculate a percentage error of omission. The 150m radius was chosen because the entire area could be surveyed in about one hour. A larger area would require more time and increase the number of landowners involved. A smaller search radius would involve fewer additional PEPs and produce a smaller search area for identifying MEPs.

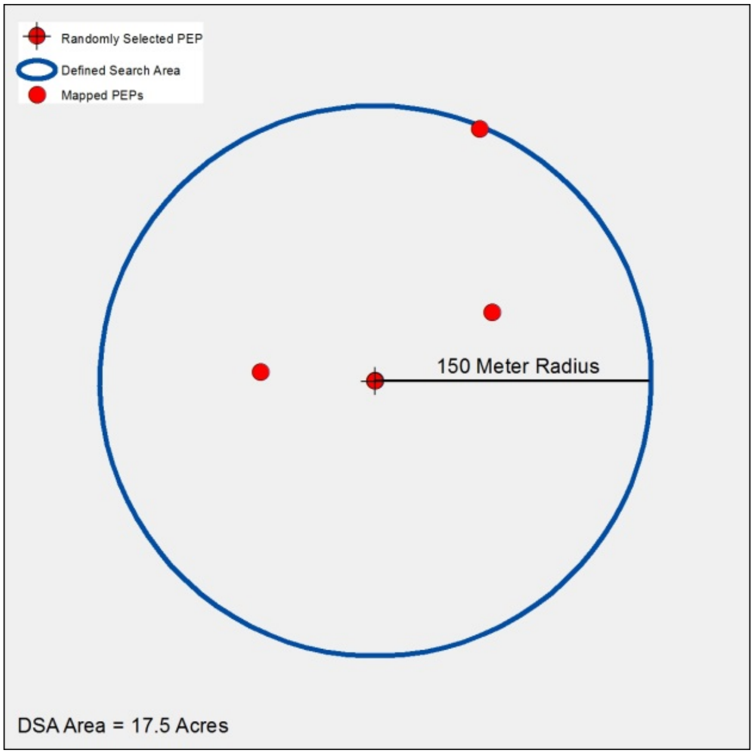

Figure 4: Defined Search Area (DSA)

The diagram on the left shows an example of a typical DSA. Note the randomly selected PEP is used as the centroid for the 150m buffer analysis. The surveyor has the opportunity to assess additional PEPs within the DSA and is provided a defined area to search for MEPs.

As opposed to single feature surveys, a DSA provides a defined and consistent survey area when searching for MEPs, allows for rapid collection of multiple data points by a single surveyor and reduces the amount of travel and time in the field. However, acquiring the required private land access from private landowners was made particularly challenging due to the highly urbanized and populated landscape of the region.

Setting a circular "doughnut" search area was considered. This would have also used the randomly selected PEP as the centroid of the search area and the 150m radius, but would have set a second, larger radius to define an outer search area limit. The defined search area would then occur between the inner and outer perimeter of the doughnut, excluding the inner circle and randomly selected PEP from the survey.

The possible statistical advantage to this approach is the collection of a better spatial sample of omitted ephemeral ponds that is not affected by the naturally occurring clustering of ephemeral ponds. It was decided however, to retain the contiguous search area in order to not limit the survey from collecting ground truth data on known mapped features. This approach would have increased the number of surveys required to accumulate enough data for statistical analysis. It would also have required more time and effort to contact and secure land access permission from private landowners and would have reduced the ability to survey in the highly developed urban areas of the project area.

To overcome difficulties acquiring private land access, a less stringent objective to survey 30 DSAs and a secondary objective to survey at least 50 PEPs per subsection, replaced an original plan for 50 DSAs per Ecological Subsection. Additional random DSAs, to account for the likelihood of access denials, were generated both prior to and throughout the assessment to reach the target number of surveys. In total, only 40% (113/273) of all generated DSAs were determined to be accessible for survey before the end of field work.

Scouting

By design, the sampling selection method did not discriminate between private and public land, however, for a DSA to be selected as suitable for assessment survey, legal land access as well as a set of quality assurance criteria had to be met before field work could begin. To strike a balance between unbiased data sampling and encourage worthwhile data collection driven surveys, a detailed but time consuming "Scouting" process occurred prior to field surveying.

The scouting process involved:

1. Property Identification and Landowner Contact
2. DSA Quality Assurance (QA) Vetting
3. DSA Selection

Property Identification and Landowner Contact

Federal privacy laws prohibit the public access to complete personal information. Because of this obstacle, landowner identification involved nine separate county tax parcel GIS data layers and 11 local and county land information web services. All desktop GIS data was dated from 2009 and was the most up to date and publicly available tax parcel data at the time of scouting. Extra care was taken to identify any discrepancies when using county web-map services using more recent data.

Loading all available ancillary data, the DSA GIS layer was overlaid on the county tax parcel data in a desktop GIS environment. A spatial intersect query was conducted to select all parcels falling within the boundary of any DSA. Because county tax parcel data is not uniform between different counties, each county's intersecting tax parcels were kept as standalone GIS layers, and each county was completely scouted before moving on to the next. This protocol also had the intended advantage of saving on computation times and outflow and inflow of property access requests and landowner contacts.

Once all intersecting tax parcels had been compiled, the land owner identification process was started. Each unique tax parcel ID was referenced against its respective county tax parcel web-service. Owner names and addresses for each relevant parcel were recorded in a master list along with spatial reference, local address, property type, and ancillary notes on possible access constraints and pre-requisites.

Property Summary	
Private	512
Public	58
All Properties	570

Table 1: Ownership of Parcels within DSAs

After scouting was completed for a county, access to private property requests were mailed to the property owners. The requests were sent with a form letter of introduction briefly explaining the significance of ephemeral ponds and the purpose for the assessment survey, a general map highlighting the owners' property, proposed DSA, and all PEPs to be targeted by the survey, and lastly, a standardized permission form and business reply envelope with a request to return to the Assessment Coordinator. The coordinator accepted replies by mail, email, and phone with the greater majority of returns via mail, and incorporated the results of the access survey to the landowner contact master list to begin the second step of the scouting process. Responses from landowners took anywhere between two days and three months, however, on average responses were returned 2-3 weeks after mailing.

Defined Search Area Quality Assurance Vetting

As land access permission requests came in, DSAs with private landowners' permission were compared against criteria designed to address potential inconsistencies in surveyed area caused by private property access constraints. Modifiable areal unit problem, a common flaw in spatial statistical analysis, was addressed by only selecting DSAs for survey that met the required criteria thus mitigating survey variance in regard to area. If at any time a DSA was determined unsuitable during the vetting process, it was flagged "discarded" in the master list and no further time was spent scouting that DSA.

Criteria and Rationale:

1. The DSA must be legally accessible by the surveyor

   Rationale - required for legality and surveyor safety [special concerns: Castle Doctrine, deer hunting season]

2. Randomly Selected PEP (DSA centroid) must be accessible by surveyor

   Rationale: required for random sampling method integrity

3. 75% of DSA must be available for survey either by direct access or within line of sight of accessible properties

   Rationale: Required to mitigate inconsistencies with MEP survey area, 75% visible area determined to be best threshold to balance consistent and worthwhile data collection while not discarding too many DSAs because the criterion was too strict.

4. The DSA cannot consist of more than 25% impervious surfaces [rare]

   Rationale: Ensure worthwhile survey data collection and spatial dataset integrity

The diagram to the right demonstrates a common scenario during DSA QA vetting. The example shows a DSA intersecting four separately owned private properties ("sliver" properties were omitted during the landowner identification process). This DSA passes criteria 1, because at least one of the property owners granted access to the surveyor. However, this DSA does not pass criteria 2. The DSA centroid and randomly selected PEP are not legally accessible and therefore the DSA would be discarded. Had this DSA passed criteria 2 it would be checked against criteria 3 and 4 in a desktop GIS environment utilizing additional orthophotos, contours, and wetlands data layers in determining suitability.

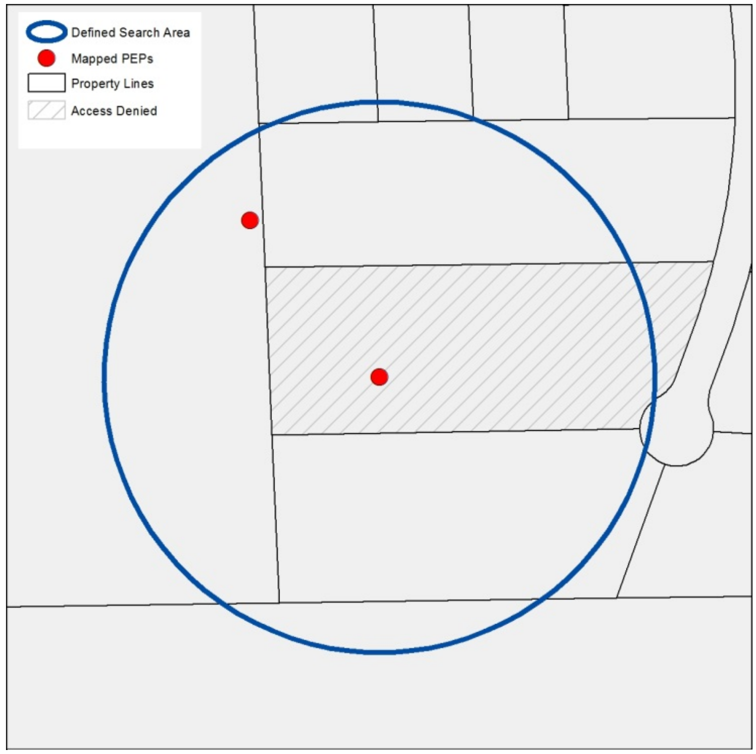

Figure 5: Example DSA Quality Assurance Vetting

Field Survey

The Accuracy Assessment utilized the WEPP monitoring data form (Appendix A), developed in earlier phases of the project for use by both professionals and trained volunteers. It provides for documentation of simple physical measures and observations that can be made on the day of the site visit. These include water depth, water temperature, estimated pond area, tree canopy cover, evidence of previous ponding, evidence of a high water mark, substrate, ground cover in the basin, connection (or lack of a connection) to other wetland and water features, disturbance and indicator animals. The "determination" section of the data form is shown in Figure 6.

10. Do you think this site is an ephemeral pond? (check one)

Yes ☐ No, and not a wetland ☐ What is the feature? ________________________________

No, but may be another type of wetland ☐ No, may be a permanent pond ☐ Not Sure ☐

Comment:

____

Figure 6: Question 10, Citizen Monitor Ephemeral Pond Data Form

The Accuracy Assessment fieldwork process begins with the surveyor navigating by GPS to the PEP at the centroid of the DSA, confirming the location, then conducting a systematic search for ephemeral ponds throughout the search area. The surveyor was supplied with a hand held Trimble Yuma GPS loaded with an aerial orthophoto, all PEPs, and the DSA boundary, along with the coordinates of the centroid PEP and all other PEPs within the DSA. Paper copies with the same information plus parcel boundaries, landowner names and contact information were also supplied for each site as well as an ample supply of the data forms.

At each mapped PEP the surveyor filled out a separate WEPP monitoring data form, and made a determination on pond status if possible. For each unmapped area that could be an ephemeral pond a separate data form was completed and a determination on pond status was made. If the area was determined to be an ephemeral pond it was considered a “Missed Ephemeral Pond” (MEP).

The field surveyors for the Accuracy Assessment were experienced biologists. They were skilled in detecting evidence of ephemeral ponds, even when water was not present. This was particularly important because of the drought conditions in Wisconsin during the summer of 2012.

The survey period ran from late August through mid-December, with a training and start-up period in mid-August. This time period was chosen so surveyors would have a high probability of being able to accurately identify ephemeral ponds in a single visit. During this time period, surveyors could observe ponds during dry-down while still being able to recognize secondary hydrology indicators.

At the beginning of the field season in mid-August, two QA/QC oriented sessions were held with the Project and Survey Coordinators, the two field surveyors and some additional staff. The purpose of these sessions was to:

- Train the surveyors on the proper use of the project GPS, particularly downloading the aerial orthophoto, and the particular capabilities of the project GPS unit for navigation and for acquiring coordinates for the centroid of ponds.
- Work on consistency between surveyors in the use of the data form and criteria for making determinations.

The surveyors worked together when possible, and worked independently when necessary. They were given a list of 7-15 DSA’s per week and the accompanying maps and data forms. The project GPS, a Trimble Yuma was used whenever possible and a backup GPS was used when necessary. The GPS was returned every other week to the Survey Coordinator who downloaded a new set of DSAs and returned the GPS to the field surveyor. Surveyors retained photocopies of completed field sheets and the originals were returned to the Survey Coordinator at the end of the field season. The Survey Coordinator then entered field data into an MS Access Field Survey database. Quality Control checks were made to search for obvious locational errors by plotting recorded locations of PEPs against the Master PEP Database. Discrepancies were reviewed with the field surveyors periodically and locations that could not be verified were discarded. Locations of MEPs, were plotted and reviewed by the Survey Coordinator and field surveyors together. Any unresolvable MEP locations were discarded.

Figure 7 shows an example of a DSA, with the actual survey results displayed. In this particular DSA there were four other mapped Potential Ephemeral Ponds (PEPs) in addition to the randomly selected PEP at the centroid that created the DSA. In this case, the surveyor confirmed all 5 mapped PEPs as Verified Ephemeral Ponds (VEPs). She also found two ephemeral ponds that had not been mapped, so these are indicated as Missed Ephemeral Ponds (MEPs).

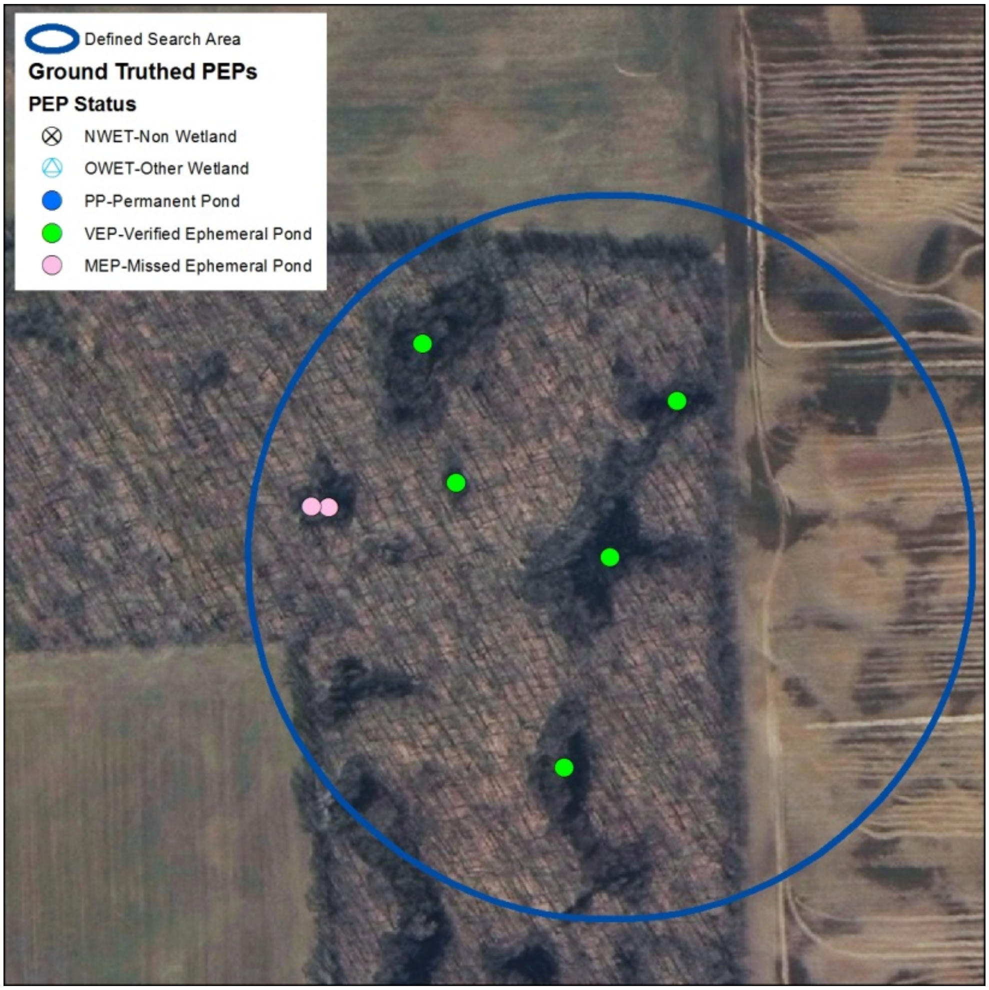

Figure 7: Example Field Survey Results

Results and Discussion

Distribution of Survey Effort

The stratification by ecological subsection was intended to ensure that the sampling was representative. Figure 8 shows the Ecological Subsections and the distribution of the randomly selected PEPs, indicating those that surveyors were able to visit.

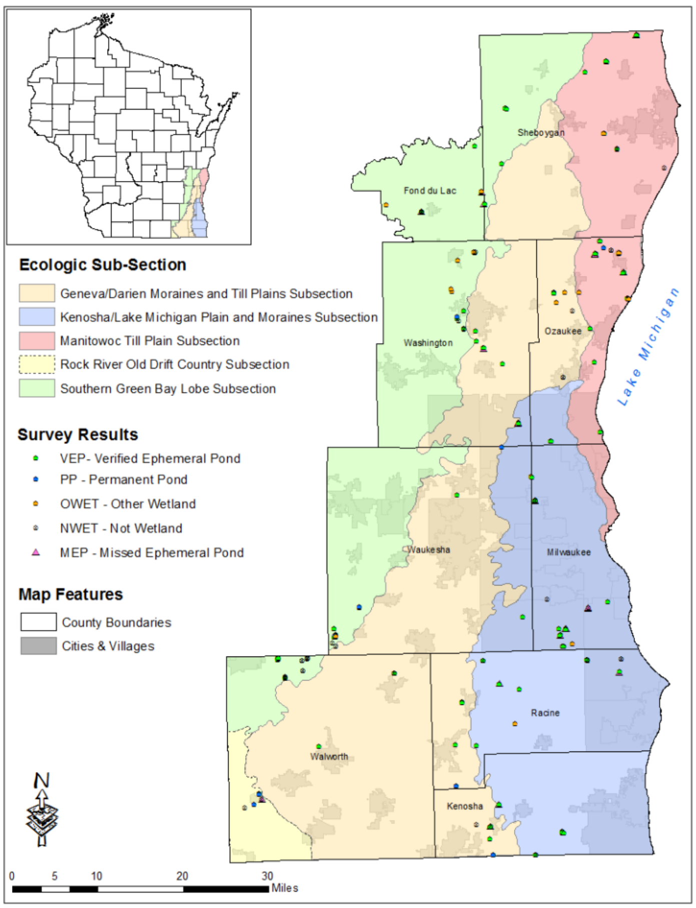

Figure 8: Survey Results

Table 2 shows the distribution of the mapped PEPs by Ecological Subsections as compared to the areal extent of each subsection. Note the percent of mapped PEPs in each subsection does not always match the areal extent. The Geneva/Darien – Rock combination has a much lower percentage of PEPs in the study area (and a lower density) than the Kenosha/Lake Michigan Till Plain, Moraines and Manitowoc Ecological Subsections. The Manitowoc Till Plain had the highest PEP density. Since ephemeral ponds tend to occur in clusters, random selection of PEPs to establish search areas appears to have resulted in a fairly close match between the amount of survey area and the PEP density of each Ecological Subsection.

Ecological Subsection	Total Acres	Percent Project Area	Mapped PEPs	PEP Density (PEP/Acre)	% of Total PEPs
Geneva/Rock	849,547	40%	2,184	.0025	24%
Kenosha	538,954	25%	2,970	.0055	33%
Manitowoc	246,148	12%	1,696	.0069	19%
S. Green Bay	503,535	24%	2,197	.0044	24%
Total	**2,138,184**	**100%**	**9,047**	**.0042**	**100%**

Table 2: Ecological Subsections: Area and PEP Distribution

Table 3 shows the surveyed acreage of each Ecological Subsection as a percent of the total surveyed area. Survey effort, in terms of percent of PEPs evaluated, was fairly evenly distributed among the Ecological Subsections of the Study Area, with Kenosha under-represented and the Southern Green Bay Lobe slightly over-represented. This is likely due to the greater clustering of ephemeral ponds in this subsection due to the predominance of irregular topography.

Ecological Subsection	Mapped PEPs	Percent of Total PEPs	Total DSAs	Acres Surveyed*	Percent of Total Surveyed Area
Geneva/Rock	2,184	24%	25	331	24%
Kenosha	2,970	33%	25	400	29%
Manitowoc	1,696	19%	16	262	19%
S Green Bay	2,197	24%	26	383	28%
Total	**9,047**	**100%**	**92**	**1,376**	**100%**

Table 3: Ecological Subsections: PEP Distribution and Survey Effort

Overall Feature and Attribute Accuracy

Wetland mapping Accuracy Assessment typically considers the wetland vs non-wetland distinction as the “feature class,” and the type of wetland as the “attribute class.” In the mapping project the goal was to identify ephemeral ponds as distinct entities. As such, the first distinction to assess for accuracy is between “wetland” and “non-wetland.” The second distinction is between “ephemeral pond” vs other types of wetlands, particularly emergent marshes, lowland hardwood swamps, wet meadows and permanent ponds. For the field surveyor this was simplified into two choices, “other wetland type" (OWET) or "permanent pond" (PP). Figure 9 shows the Feature and Attribute Accuracy decision tree and the box below defines how the terms were used in this report.

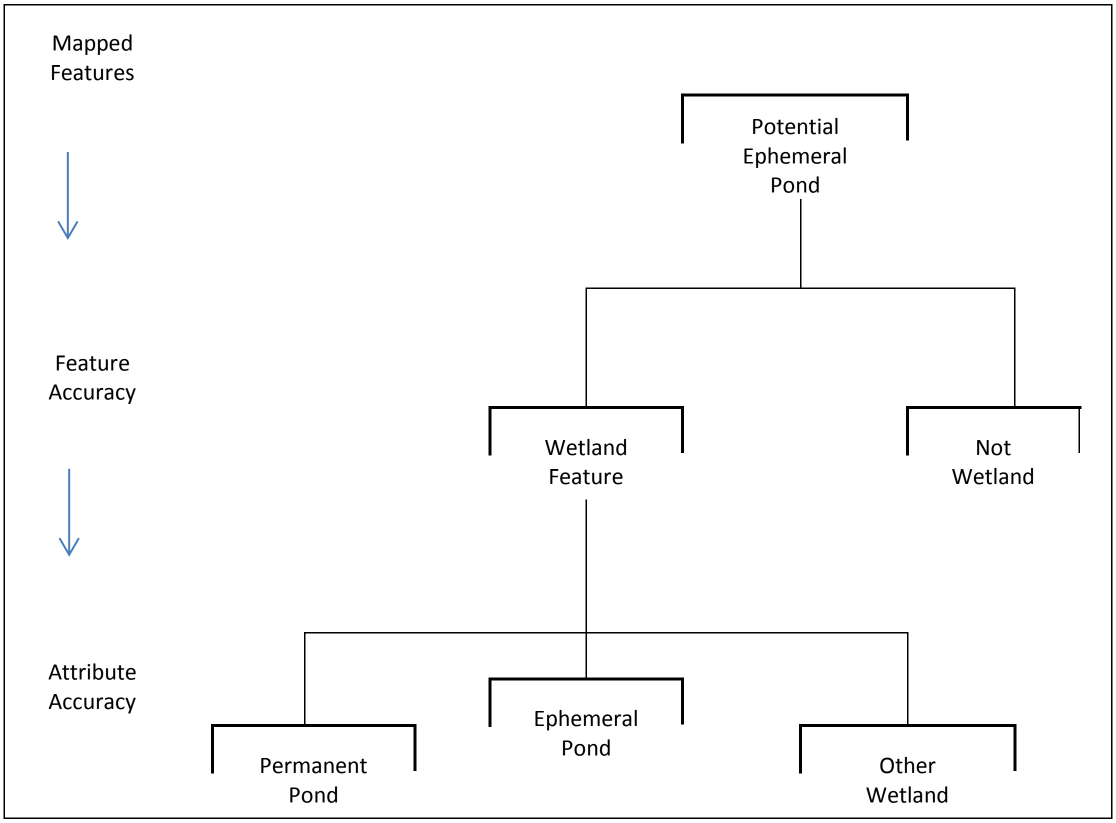

Figure 9: Feature and Attribute Accuracy Tree

Mapped Feature: As assigned by mapper, prior to Accuracy Assessment.

Feature Accuracy: Primary accuracy assessment to identify major mapping errors or features incorrectly mapped as a wetland feature (i.e. a canopy gap from fallen tree in woods, rocky debris)

Attribute Accuracy: Secondary accuracy assessment for minor errors (i.e. mapping another type of wetland as an ephemeral pond)

The raw results, error and accuracy calculations are presented in the following two tables.

	(On Ground)				
	Wetland Feature		Not Wetland	Row Total	Commission Error
(As Mapped)	Ephemeral Pond Wetland	140	43	183	23%
	Not Wetland	33	**Feature Commission Accuracy:** 140/183 = **77%**		
	Column Total	173			
	Omission Error	19%			
Feature Omission Accuracy: 140/173 = **81%**					

Table 4: Feature Accuracy Matrix

The top left cell shows 140 entities that were mapped as wetland features and verified on the ground as wetland features. In the next cell to the right are 43 entities that were mapped as wetland features but were found not to be wetland on the ground. Adding up the row provides the total sample size of 183 PEPs that were mapped and surveyed by the assessment. The percent error of commission value is derived by dividing the total errors of comission (43) by the total sample size (183).

In the cell immediately below the top left cell are 33 entities that were not mapped as wetland features prior to the accuracy assessment, but were determined to be ephemeral pond wetlands on the ground. These are “Missing Ephemeral Ponds,” or MEPs. The column total indicates there were 173 ephemeral pond wetland features found on the ground by the field surveyor (accurately mapped wetland features plus MEPs). The error of omission is derived by dividing the number of omission errors (33) by the total number of on the ground wetland features (173).

Feature Commission Accuracy and Feature Omission Accuracy are simply the inverse of the error calculations. The results show a 77% accuracy in regard to true positives (features correctly mapped as wetland features) and 82% accuracy in regard to true negatives (non- wetland features correctly left unmapped).

	(On Ground)					
		Ephemeral Pond	Other Wetland	Perm Pond	Total	Attribute Error
As Mapped	Ephemeral Pond	102	26	12	140	27%
Attribute Accuracy: 102/140 = **73%**						

Table 5: Attribute Accuracy Matrix

Table 5 illustrates attribute accuracy. Of the 140 accurately mapped wetland features, 102 were determined to be ephemeral ponds, while wetland features other than ephemeral ponds were determined to be minor mapping errors. Attribute error and accuracy values are derived from dividing the total number of attribute errors (26 Other Wetland + 12 Permanent Pond = 38) by the total sample of all mapped wetland features (140).

Feature and Attribute Accuracy within Ecological Subsections

Feature and attribute accuracy by Ecological Subsection is reported in Table 6. For feature accuracy, the two lake plain subsections, the Manitowoc Till Plains and the Kenosha/Lake Michigan Plain and Moraines, had the two highest feature accuracy rates relative to commission mistakes, at 83% and 78%. In the Southern Green Bay Lobe, the subsection with the most complex "kettle" topography, the mappers had the lowest feature accuracy rate relative to commission mistakes, incorrectly mapping areas as ephemeral ponds that weren't even wetlands. However the mappers had a very high accuracy rate, 93%, relative to omission errors, meaning they missed very few ephemeral ponds. Moving to an examination of attribute accuracy our mappers had the poorest rate in the Southern Green Bay Lobe, meaning they made the most errors in discriminating ephemeral ponds from other wetland types. These results are interesting but not definitive, as the study did not control for mapper method within subsections.

Note that in the Kenosha/Lake Michigan Plain the mappers had the poorest feature accuracy at 70%, meaning they missed the most ephemeral ponds, yet had the best attribute commission accuracy at 93%. There seems to be a trade-off between omission accuracy and commission accuracy. In areas where mappers succeeded in missing few ephemeral ponds they seemed to be more likely to map "false positives" – features that were not ephemeral ponds. Conversely, in areas where mappers successfully avoided incorrectly mapping "false positives," they were more likely to miss real ephemeral ponds. This tradeoff seemed to be strongest in the Southern Green Bay Lobe and occur within the realm of feature accuracy, but also occurred between high feature accuracy and low attribute accuracy.

	Feature Accuracy		**Attribute Accuracy**	
Ecologic Subsection	Commission	Omission	Commission	Omission
Geneva/Rock	75%	82%	63%	n/a
Kenosha	78%	70%	93%	n/a
Manitowoc	83%	78%	71%	n/a
S. Green Bay	68%	93%	64%	n/a

Table 6: Feature and Attribute Accuracy Table by Ecologic Subsection

Maximum Depth and Area Among Pond and Other Wetland Types

Maximum depth was measured and ponded basin dimensions were estimated at each documented pond. Because many basins were not ponded at the time they were surveyed, maximum water depth often had to be inferred from water marks on trees or boulders and drift lines, vegetation changes, water stained leaves and other secondary indicators. Estimated area and estimated depth for the entire dataset of wetland features were plotted as percentiles in MS Excel to characterize the distribution of area and depths for each attribute category. The bottom whisker is the minimum value for each attribute category, followed by the 25th percentile at the bottom of the box, the median at the color break, 75th percentile as the top of the box, and the upper whisker is the maximum value for that category.

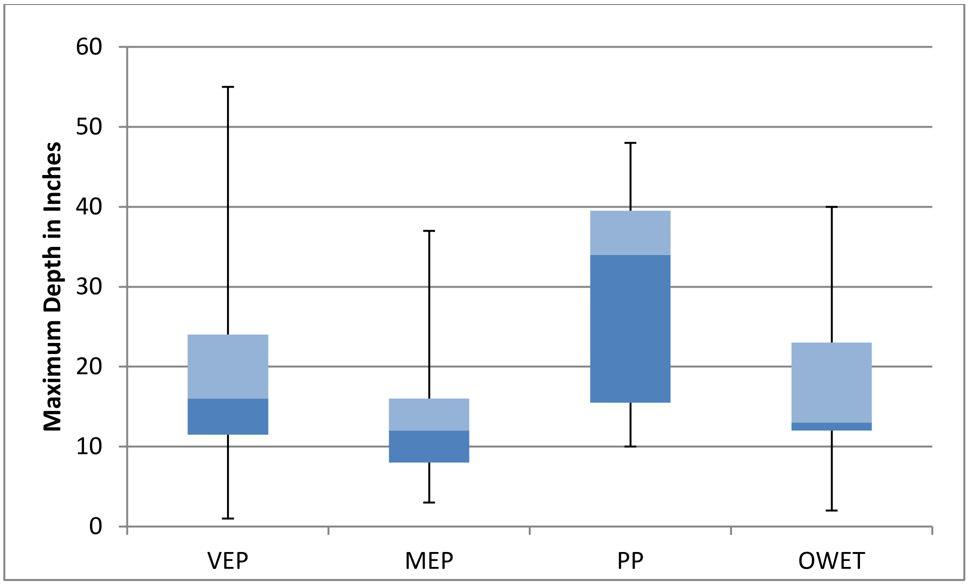

Figure 10: Pond Maximum Depth by Type

Figure 10 shows the range of average depths is generally the same, with MEPs generally being shallower and permanent ponds deeper.

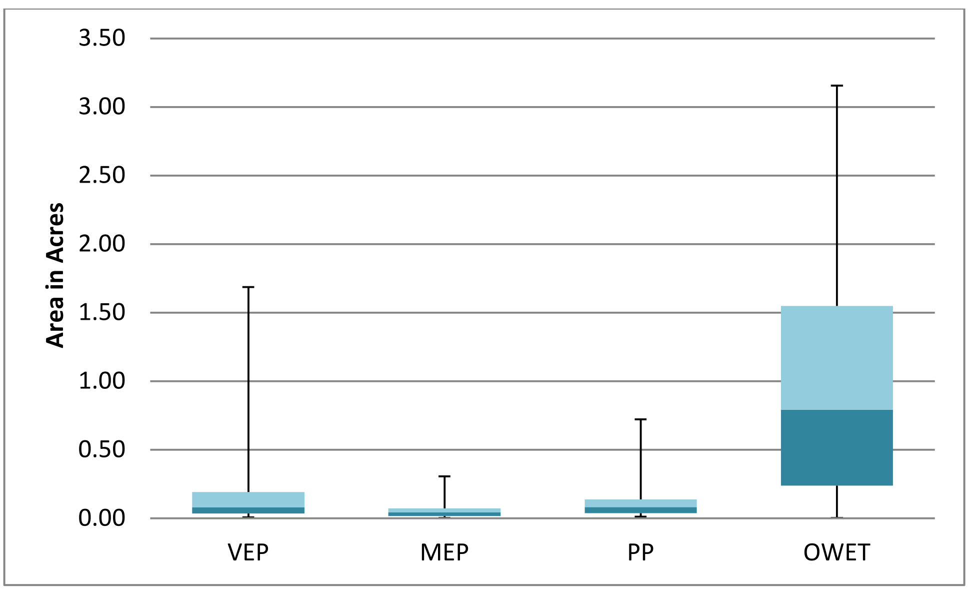

Figure 11: Pond Area by Type

Figure 11 shows that accurately mapped ephemeral ponds were commonly found to be between 0.05 acres and 0.11 acres in size with little variation. 50% of surveyed EPs were under 0.08 acres. MEPs were much smaller and even less variable in size. Permanent ponds were similar to ephemeral ponds.

Mapping Method Accuracy Comparison

Desktop vs. Stereo Pair Feature Accuracy

The accuracy data relative to the type of mapping method are presented in Tables 7 and 8. The GIS Desktop method appears to have slightly higher feature accuracy for both omission and commission error.

However, these results should be considered exploratory, not definitive, because the assignment of which method was used in which area was strictly opportunistic, with no systematic control for sources of bias.

		(On Ground)			
(As Mapped)		Wetland Feature	Not Wetland	Total	Commission Error
	Wetland Feature	74	18	92	20%
	Not wetland	13			
	Column Total	87	Desktop Feature Commission Accuracy: 74/92 = **80%**		
	Omission Error	15%			
	Desktop Feature Omission Accuracy: 74/87 = 85%				

Table 7: Desktop Feature Accuracy Matrix

		(On Ground)			
(As Mapped)		Wetland Feature	Not Wetland	Row Total	Commission Error
	Wetland Feature	63	25	88	28%
	Not as wetland	20	Stereo Pair Feature Commission Accuracy: 63/88 = **72%**		
	Column Total	83			
	Omission Error	24%			
	Stereo Pair Feature Omission Accuracy: 63/83 = 76%				

Table 8: Stereo Pair Feature Accuracy Matrix

Desktop vs. Stereo Pair Attribute Accuracy

Desktop GIS appeared to yield higher attribute accuracy than stereo pair interpretation. Again these results should be considered exploratory, not definitive due to lack of control over sources of bias.

		(On Ground)				
	Method	Ephemeral Pond	Other Wetland	Permanent Pond	Total	Attr. Error
(As Mapped)	Desktop	56	3	15	74	13%
	Stereo Pair	43	9	11	63	14%
Desktop Attribute Accuracy: 56/74 = 76%						
Stereo Pair Attribute Accuracy: 43/63 = 68%						

Table 9: Desktop and Stereo Pair Attribute Accuracy

Comparison with Wisconsin Wetland Inventory

Accuracy rates are not generally derived as part of the Wisconsin Wetland Inventory (WWI) update process. This survey's ground-truth results can be used to assess feature accuracy of the 2010 WWI for ephemeral ponds. Of the ephemeral ponds mapped and verified through the project, 73% were also mapped as wetland on the WWI and 27% were missed by the WWI. This means that the project increased the number of mapped ephemeral pond wetlands by 27%. Interestingly, the accuracy rate did not decrease when considering MEPs, meaning 73% of the ephemeral ponds that were missed by the project mappers were recorded as wetlands on the WWI. This may be due to attribute errors, the inability of the mappers to distinguish between ephemeral ponds and other wetland types. In terms of "real world" consequences this a much less serious error. Unfortunately attribute accuracy cannot be evaluated because the WWI does not have a class or a special modifier for ephemeral ponds.

Attribute	In WWI Wetlands	On Ground	Percent Mapped by WWI
VEP	74	102	73%
MEP	24	33	73%
Overall	98	135	73%

Table 10: Percent Ephemeral Ponds Mapped by Wisconsin Wetland Inventory

Ephemeral Ponds by WWI Vegetation Class

Although the WWI does not specifically map ephemeral ponds as a class, one can gain a picture of the broad vegetation type in which ponds occur by intersecting the surveyed ephemeral ponds with the WWI and examining the results by vegetation classification. The results are shown in Figure 12. In this analysis, Aquatic Bed, Flats and Open Water wetlands were included in "other" wetland types and combined into the "Emergent/Other" category because these have no woody canopy. The results indicate that forested wetland is by far the most dominant mapped vegetation type.

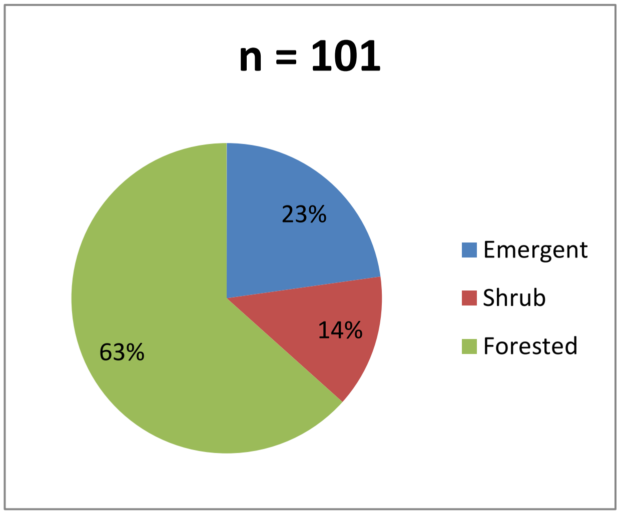

Figure 12: Wisconsin Wetland Inventory Vegetation Type of Mapped Ephemeral Ponds

Conclusions:

Minimum Map Unit

Because of the very small size of a number of surveyed ephemeral ponds, 50% were under 0.08 acre (3,485 sq. ft.), it is unlikely that ephemeral ponds mapping will be able to reach the same level of accuracy attainable for mapping other wetland types.

One important feature of any map product is a statement of the minimum map unit. For a given scale, this is the size in area below which a mapped feature can be reasonably represented. Since this project was exploratory in nature, and since ephemeral ponds were mapped as points, a minimum map unit was not set in advance. A reasonable minimum map unit could be set at the 75th percentile for MEPs, which is 0.03 acre, or 1,361 square feet (47 ft. by 47 ft.). This size is also the 25th percentile for Verified Ephemeral Ponds (VEPs). This means that 25% of the ponds that were correctly mapped would not have been captured had the mappers ignored potential ponds smaller than 0.03 acre. For future mapping projects using these methods, a reasonable minimum map unit would be 0.03 acre.

Future Ephemeral Ponds Mapping

Compared to earlier ephemeral pond mapping projects and other wetland mapping accuracy assessment reports, these results are promising. Further projects using the methods outlined in earlier WEPP project reports are justified. These results appear to support a preference for on-screen digitizing in a Desktop GIS environment over traditional stereo pair analysis, but the assessment did not rigorously control for enough sources of bias to make a definite recommendation. With the advent of LiDAR data to generate higher resolution topographic data and assess vegetation, the more serious mistakes and errors of omission can likely be reduced.

Because of the additional resources required to map ephemeral ponds, EP mapping may not be warranted in all areas of the state. Some areas may have greater concentrations of EPs where special projects to map them makes sense. Also, the WDNR Wildlife Action Plan has set priorities for certain wetland types, including EPs, in different ecological landscapes. These may be focal areas for this application.

Recommendations

Based on these results and conclusions, we make the following recommendations:

- Future projects with a special focus on mapping ephemeral ponds can be undertaken with a reasonable degree of confidence in the results. However, the small size of many ephemeral ponds and their temporary nature will always limit mapping accuracy.
- Designers of future ephemeral pond mapping projects should set a priority for which type of error is most important to avoid, as there appears to be a tradeoff between avoiding errors of commission vs. errors of omission.
- Map projects should set a minimum map unit. For a future project using similar methods, a minimum map unit of .03 acre would be reasonable.
- Adding ephemeral ponds as a special modifier in future Wisconsin Wetland Inventory updates would be justified if a separate effort were made specifically to identify them. It may make sense to keep ephemeral pond mapping as an option for areas with a special interest in their conservation rather than as a routine part of the WWI mapping protocol.
- Utilize better data sources such as topographic products derived from LiDAR data to enhance the accuracy of ephemeral ponds mapping.
- Target ecological landscapes where ephemeral ponds are a priority wetland type for ephemeral pond mapping.

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Appendix A

WEPP Data Form and Instructions

WISCONSIN EPHEMERAL PONDS PROJECT

CITIZEN MONITOR EPHEMERAL POND DATA FORM 2009

OFFICE USE

A. Observer Partner: ______________________

Name(s): ______________________

Date: ______________ Time: ________ am / pm

B. Location PEP ID: ________

County: ______________________

Township ____ N Range ____ E/W Sec ____, ____¼ ____¼ ¼

For newly observed PEPs with no PEP ID, record GPS coordinates and/or attach a map that shows the PEP location, and send a copy of the map with this form to your Partner organization.

GPS: __________ LAT __________ LON

GPS Error: _____m

Coordinate System: ☐ WGS84 ☐ Other _____

C. Property Information

Ownership (circle one): Public Private

Local Name: ______________________

Land Owner/Manager

Name: ______________________

Address: ______________________

City: ____________ State: ___ Zip: ________

Phone: ______________________

D. Historic Hydroperiod Data

☐ Dry by late spring ☐ Dry by late summer

☐ Dry by late fall ☐ Dries only in dry years

☐ Permanent water ☐ No historic data available

Data Source: ☐ Landowner Other ____________

Time Period ______________________

E. Basin Physical and Hydrologic Data

1. Does a Pond Basin (a depression that can collect water) occur here, even if no water is present today? ☐ Yes ☐ No
If No, what is this feature? ______________________

2. Is this Basin connected to another water feature?
☐ No, Basin is isolated
☐ Yes, Basin is connected to: (circle all that apply) stream / ditch / culvert / marsh / swamp / another basin

3. Approximate Basin Dimensions: Length ________ ft / m Width ________ ft / m

4. Is there any water in the Basin?
☐ Yes . . . Water depth at the deepest point in the pond: ________ in / cm
Surface water area covering the Basin (check one): < 10% ☐ 10 to 50% ☐ >50% ☐
Water Temperature, near the bottom of the pond at the deepest point ________ (circle one) C / F
☐ No . . . Soil at the deepest point in the Basin is (check one): Saturated ☐ Moist ☐ Dry ☐

5. Is there evidence that the water was deeper earlier this year? ☐ Yes ☐ No
If Yes, estimate this maximum water depth ________ in / cm
Estimate is based on: Water marks on trees, Bare soil at basin edge, Other ______________

6. Basin Ground Cover when mostly dry: (check all that apply)
Dead leaves ☐ Dead wood ☐ Live plants ☐ Bare soil ☐

7. Basin Soil Type when mostly dry: (check one)
Sandy ☐ Silt/Clay ☐ Muck/Peat ☐

8. Are Trees Present in the Basin (check one)?
No ☐ Yes, but only at the edge ☐ Yes ☐

9. Tree Canopy covering the Basin: (check one)
<10% ☐ 10 to 50% ☐ >50% ☐

10. Do you think this site is an ephemeral pond? (check one)
Yes ☐ No, and not a wetland ☐ What is the feature? ______________________
No, but may be another type of wetland ☐ No, may be a permanent pond ☐ Not Sure ☐
Comment:

F. Observed Basin Disturbance: (circle all that apply)

Filling	Sediment
Refuse	Cultivation/Livestock
Tire Ruts	Purple loosestrife
Reed canary grass	
Other ______________________	

PHOTO TAKEN: ☐ Yes ☐ No
Submit a copy of any digital photos to your Partner organization at the end of the field season. Identify each photo with the Township, Range, Section, PEP ID, photo #, and photo date and record each on the reverse side of this page.

G. Indicator Animals: (check if observed)

Anurans:	Visual	Call	Other:	Visual
Wood frog			Salamander	
Spring peeper			Fairy shrimp	
Chorus frog			Fingernail clam	
Gray tree frog			Aquatic beetle	
Leopard frog			Dragonfly	
Toad				
Green frog				
Bullfrog			Fish	

WISCONSIN EPHEMERAL PONDS PROJECT

Extension

Wisconsin Coastal Management Program

I. How to Complete your WEPP Data Form (*Use a separate field data sheet for each visit.*)

A. Observer information:
Record your data using a number 2 lead pencil, it doesn't run when wet and is easy to read when photo copied. Write the names of the people conducting the survey and the name of your local Partner organization. Be sure to include the date and time of your survey! **Fill out the form based on present observations.** You do not have to guess about past or future conditions. Fill out a separate sheet for each visit. We will use the total information from all your visits to make a status determination.

B. Location
Record the Potential Ephemeral Pond (PEP) ID noted on the map supplied by DNR. On your first site visit, complete all location information (i.e., County, and T, R, S, ¼ S & ¼ - ¼ S). The Township, Range and Section will be printed on your map. On subsequent visits only enter the PEP ID. GPS coordinates are **not** required for mapped PEPs. **For newly observed ponds that are not mapped as PEPs, record GPS coordinates** and include a map with the location. Latitude and longitude in decimal degrees to 7 places after the decimal point is preferred. If your GPS reads out degrees-decimal minutes, make sure that is noted. For decimal minutes at least 3 places after the decimal point is preferred

C. Property Information
Write down the name of the landowner for your site. You MUST obtain permission to enter any property PRIOR to conducting a survey. Permission is also required to cross private lands to gain access to a public site. On public lands contact the land manager.

D. Historic Hydroperiod Data
This is not likely to be used by citizens, however if you are very familiar with the pond, do you know when it typically goes dry? Are other data available describing when the pond has gone dry in previous years? Include the source for your information and the time period for the historic data.

E. Basin Physical and Hydrologic Data
1. Pond Basin occurrence: Is there evidence that a basin exists at this site? Typically the basin is most full early in spring. The edge of the ponded water is likely to be the same as, or very close to, the basin edge. **If no**, then describe the feature and take a photo to submit with your data sheet. *You are now finished at this site. Read section III. below "What to do with your WEPP Data" and proceed as described.*

2. Basin Connection: Walk the entire perimeter of the pond basin to determine where the basin edge is in relation to other surface water features, such as stream inlets or outlets or a larger waterbody such as an open marsh. If you circle "yes", also circle the type of waterbody the pond basin is connected to.

3. Basin Dimensions: You need only do this once. It can be early when the basin is full of ponded water by pacing parallel to the water's edge or it can be done after the pond has gone dry or is mostly dry. This is expected to be an estimate, not an exact measurement. Use your pacing skills to approximate length and width of the basin. Indicate the units used (m or ft). If the pond is an irregular shape, you may sketch it on the back of the form and show the approximate dimensions.

4. Water in the Basin: If you circle "yes", measure water depth in the deepest area (indicate units). Do not 'push' the ruler down into the substrate; instead hold it so that it rests gently on the surface of the substrate. Surface Water % Cover: If there is hardly any water left, check <10%. If there is some water but lots of the basin exposed, check 10 to 50%. If mostly water, check >50%.

Water Temperature: Collect water temperature at deepest point. Avoid disturbing the water and ground. Allow thermometer to stabilize for a minimum of 1 minute. Indicate units (C or F).

Substrate Moisture: Select "saturated" if water pools around your boot when pressing down, "moist" if the substrate is wet but does not pool around boot, and "dry" if the material feels dry to the touch.

5. Evidence of deeper water earlier: If yes, estimate maximum water depth and evidence used (e.g., water marks on trees, bare soil at basin edge, debris hanging on vegetation on basin edges, other). See diagram on back page for measuring maximum water depth.

(Continued on Back)

When the current water level is below the base of any indicator tree, or there are no trees, then get your best estimate with an "indirect measure". Like with Water Depth, approximate is fine. For Maximum Water Depth, +/- 6 inches is still helpful.

6. Ground Cover: The ground cover is the layer of plant material in the pond basin – important information about the possible food & habitat value of the pond. Record this information when the pond is mostly dry.

7. Soil type: Check the dominant soil type present in the basin. Most EP soils are mineral (silty/clay or sandy). Silty/clay forms a ribbon when rolled between your fingers; the ribbon will fall apart if sandy. If silt/clay particles are present, the soil will feel STICKY when it's wet, so you can make the ribbon, etc. Muck/Peat is very dark and has no grit when rubbed between your fingers. Muck/peat washes off your boots and hands easily. It is easiest to record this information when the pond is mostly dry.

8. Trees in Basin: Circle "yes" if live standing trees are present within the pond basin. Trees (as opposed to saplings or seedlings) have a diameter of at least 4 inches about 4 feet from the ground.

9. Tree Canopy: Collect information in late spring when leaves are full size. Stand in the middle of the pond and look up. If almost all sky, check <10%, if mostly shaded, check >50%, if part sky/part shade, check 10 to 50%.

10. Ephemeral Pond: Use the information collected during the survey to complete this section. Your comments are VERY VALUABLE, especially to explain your reasoning in "close calls". Just give us your best educated answer, and use "not sure" if you can't tell.

F. Basin Disturbance

For each disturbance type, circle disturbances observed. Add any additional disturbances observed that may be detrimental to the health of the ephemeral pond.

G. Indicator Observed

For the calling frogs and toad, check "visual" if you see the species at the site. If you make your observation by hearing its call, check "call". If you see and hear the frog or toad, place a check in both categories. For each of the other animals listed, check if you see it.

II. Top Things to Consider When Taking Photos at Your Ephemeral Ponds

- Digital camera photos preferred, but cell phone photos are OK if that's all that is available.
- It's good to take photos from the same location each time. You can mark the site with a stake wire flag or marking tape. (Asking permission will ensure it won't be removed).
- **Save each digital photo with the following naming format: Township-Range-Section-PEP ID-photo number-date (in two digit day-month-year format) The Township, Range and Section will be printed on the maps supplied.**
- Note on back of data sheet if you have taken photos and record the names of those photos.
- If you aren't sure about something, take a photo and share that with your Partner or the coordinating team.

Best to submit both digital and paper copies of photos along with your data sheets to your Partner. You can email your partner your photos, send them a CD or share a USB drive with them to make the transfer.

III. What to Do with Your WEPP Data

1. While you are still at your PEP site, double check you have completely filled out your data form.
    a. Did you include the *date and time* you monitored?
    b. Did you include (on the back) names for any photos you took while at your site?
2. Make a copy of your data form to keep.
3. Send the original to your Partner organization.

Measuring Maximum Water Depth

- Measure "Water Depth" (blue line) at deepest point
- Find high water mark on tree standing in water (green line)
- Measure vertical distance from the water surface to high-water mark indicator (brown line). Add together for Maximum Water Depth.