Wetland Mapping for
Tompkins County, New York

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Contents

INTRODUCTION

The Tompkins County Water Quality Strategy focuses on the preservation and improvement of waters within the County. As transitional zones between the land and water, wetlands are critical for maintaining water quality, providing habitat for flora and fauna, and storing stormwater by moderating the impact of heavy rain events.

In 2008, a study titled *Wetland Protections in Tompkins County: Existing Status, Gaps, and Future Needs* found that up to 19% of the wetlands in Tompkins County have no protection under existing state and federal regulations. This study was funded by a Wetland Program Development Grant from the U.S. Environmental Protection Agency, administered by the Tompkins County Soil and Water Conservation District, and overseen by the Tompkins County Water Resources Council (WRC) Wetlands Committee. In response to the findings of this study, the WRC Wetlands Committee drafted a sample wetlands protection local law, which was approved by the WRC in 2012 and presented to municipalities for adoption.

A longstanding action item of the WRC Work Plan has been to **"identify and map all wetlands that are not currently regulated by DEC or the federal government and are therefore vulnerable to disturbance and destruction from development."** A complete and current wetland map is an important tool for municipalities seeking to protect wetlands with specific laws or through the review of site plans, such as stormwater plans. The New York State Department of Environmental Conservation (NYSDEC) and the U.S. Fish and Wildlife Service (USFWS) have developed their own wetland maps and associated geospatial datasets. However, these maps can be outdated, incomplete, and inaccurate.

The NYSDEC Freshwater Wetlands Maps, created to comply with the Freshwater Wetlands Act (Article 24 of the Environmental Conservation Law), show the approximate boundaries for only state jurisdictional wetlands. State jurisdictional wetlands include all wetlands greater than 12.4 acres in extent, and smaller wetlands only if they are determined to be of considerable local value. The Freshwater Wetland Maps do not include most wetlands below 12.4 acres in size. Furthermore, according to a study on wetland trends in New York State completed for the NYSDEC, "*the state regulatory maps are outdated and it is believed that many wetlands >12.4 acres are not depicted on the regulatory maps and therefore not subject to regulatory jurisdiction*" (Huffman and Associates Inc., 2000).

The USFWS National Wetland Inventory (NWI) was created to describe all wetlands, regardless of size or type, and has been widely regarded as a valuable tool for wetland conservation. However, numerous studies have shown that these maps tend to greatly underestimate the extent and number of wetlands (Morrissey & Sweeney, 2006; Nichols, 1994; Stolt & Baker, 1995; Werner, 2004). For example, a field study in Oswego and Onondaga Counties found significant spatial inaccuracies in delineated wetland boundaries that total wetland area was underestimated by 61% (McMullen & Meacham, 1996).

The USFWS and NYSDEC have relied in large part on remote sensing and geospatial mapping technologies to develop these wetland data resources. Visual analysis of high-resolution aerial imagery has been the primary method for depicting and classifying wetlands, and today remains the most viable method for efficiently mapping wetlands across large spatial extents, such as a town, county, or broader area. For Tompkins County, the availability of better aerial imagery, high resolution elevation data (LiDAR), and oblique aerial imagery make it possible to improve on past mapping efforts. These data resources can be particularly important for developing a more complete wetland map, by helping identify the smallest wetlands not previously mapped due to limitations of historic data resources.

In 2013, the Tompkins County Soil and Water Conservation District (TCSWCD) contracted with the Cayuga Lake Watershed Network (CLWN) to perform a wetland mapping pilot study.[1] Funding for the study came from the Finger Lakes – Lake Ontario Watershed Protection Alliance (FL-LOWPA) and in-kind match from several sources. The pilot study demonstrated that a new wetland map based on the analysis of the visual analysis of the most recent high resolution aerial imagery and topographic analysis of recent LiDAR elevation data could provide substantial improvements in accuracy and completeness compared to existing wetland maps.

In 2014 and 2015, the CLWN received funding from the Park Foundation and Tompkins County to build on this pilot study and develop a new wetland map for the entire county. This report summarizes the results of this effort, including a field-based accuracy assessment, and comparison to existing wetland datasets. The geospatial data resource and maps developed through this project have been distributed and are available to all interested organizations at no cost.

THE PILOT STUDY SUMMARY

To assess the value and utility of a new wetland map for Tompkins County, a pilot study was completed using the Town of Dryden (94 mi^2) (Figure 1). In total, 5,641 acres of wetlands were mapped, equivalent to approximately 9.4% of the area of Dryden. Natural palustrine wetlands, such as bogs, swamps, vernal pools, and floodplain wetlands, accounted for 91% of the total wetland area. In total, 529 contiguous natural wetland areas were mapped.

Figure 1. Tompkins County with the boundary of Dryden outlined in red.

In comparison to previously existing wetland datasets, the total area of all wetlands mapped in the Town of Dryden pilot study wetland dataset was 2.5 times that of the NYSDEC Freshwater Wetland Maps, and 1.5 times that of the USFWS NWI dataset. Both the NWI and NYSDEC wetland datasets appeared to generally exclude the smallest and driest wetlands. The rate of omission for the NWI data for wetlands less than 1.0 acres was estimated to be over 80% when compared to the pilot study wetland data. By design, the NYSDEC Freshwater Wetland maps generally only depict wetlands over 12.4 acres in extent. Therefore, a comparison between the pilot study dataset and the NYSDEC Freshwater Wetland Maps for wetlands below 12.4 acres is not appropriate. However, the NYSDEC Freshwater Wetland Maps also appear to exclude some wetlands that exceed the 12.4 acre threshold. The Freshwater Wetland Maps for Dryden include 32 wetlands over 12.4 acres and 5 wetlands below that threshold. However, the pilot study identified 70 wetlands over 12.4 acres in size. It is important to keep in mind that differences in the datasets may be the result of a combination of factors which include the mapping methods, data sources, project purpose, actual changes in wetland extent over time, as well as mapping accuracy.

The pilot study also included a limited accuracy assessment of the new wetland data based on a field survey completed in the summer of 2007 by GBH Environmental (Ithaca, NY). The field data were originally collected for a gap analysis of wetland data for Tompkins County (Schipanski, 2008). The initial goals of the accuracy assessment were to quantify the error of omission rate, the error of

[1] The pilot study products and final report can be found here:
https://www.dropbox.com/sh/ek1k81fks7fo7xe/AAD1AwN6fq_fAkGwBZd9UmHIa?dl=0

commission rate, and the wetland boundary accuracy. However, limitations of the field survey data were discovered during the analysis. Due to the field data collection method and absence of detailed study records, the error of omission rate and wetland boundary accuracy could not be quantified. The assessment was limited to an estimate of the error of commission rate only.

Twenty-five wetlands identified in the 2007 field survey completed by GBH Environmental could be located with sufficient accuracy and confidence to be used to estimate the error of omission rate for wetland occurrence in the pilot study wetland data. The error of omission rate was determined to be 40%. Of the wetlands missed in the Dryden wetland mapping pilot study, over half were 0.4 acres or less. Although the field survey did not provide sufficient data for a more comprehensive accuracy assessment, it did suggest that the smallest wetlands would still likely be underrepresented in a new wetland map for Tompkins County, though significantly less underrepresented than in the NWI and NYSDEC Freshwater Wetland Maps datasets.

The results of the pilot study were in line with previous research on the NWI and NYSDEC wetland datasets. From the pilot study, it was concluded that 1) an updated wetland map using the methods selected for the pilot study would provide substantial improvements in accuracy and completeness compared to existing wetland maps; and 2) a more robust accuracy assessment would be a necessary component of any further wetland mapping efforts.

WETLAND MAPPING FOR TOMPKINS COUNTY

The pilot study provided sufficient justification for an expanded wetland mapping effort for Tompkins County. Beginning in 2014, the CLWN sought additional funding from Tompkins County and the Park Foundation (Ithaca, NY) to complete the project. The expanded mapping project began in 2015.

WETLAND MAPPING METHOD

Wetlands in Tompkins County were mapped by visual interpretation of high-resolution aerial imagery available at no cost from the New York State Digital Orthoimagery Program (NYSDOP) and topographic analysis of high resolution LiDAR elevation data collected in 2008 by Pictometry (Rochester, NY). The primary goal of the project was to map all wetlands in the County, regardless of size or type. The wetlands were described using the USFWS Cowardin classification for Wetlands and Deepwater Habitats (Cowardin, Carter, Golet, & LaRoe, 1979). Geospatial data processing and analyses were completed using Manifold 8.0 GIS System (Manifold Software Limited Wanchai, Hong Kong) and ArcGIS 10.1 (ESRI, Redlands, CA) where indicated. The resulting geospatial dataset will be referred to as the Tompkins County 2012 Wetlands Map, in reference to the most recent NYSDOP aerial imagery which served as a primary data resource.

Primary Data Resources

NYSDOP high resolution aerial imagery

High-resolution aerial imagery is available for the entire state of New York through the New York Statewide Digital Orthoimagery Program (NYSDOP). At the time that the project was completed, imagery from 2002 through 2013 could be downloaded as image tile sets directly from the State's website (http://:gis.ny.gov). Imagery was available for Tompkins County from 2002, 2007, and 2012 (Table 1).

Year	Type	File format	Pixel resolution	Horizontal accuracy (95% conf. level)

2002	Color-Infrared	Compressed MrSID	0.5-ft City of Ithaca 1-ft Tompkins County	+/- 4.0 ft +/- 8.0 ft
2007	Natural color	Compressed JPEG2000	0.5-ft City of Ithaca 1-ft Tompkins County	+/- 2.0 ft +/- 8.0 ft
2012	4-band (natural color and near-infrared)	Compressed GeoTIFF	0.5-ft City of Ithaca 2-ft Tompkins County	+/- 4.0 ft +/- 8.0 ft

Table 1. High resolution aerial imagery available from NYSDOP for Tompkins County.

The pilot study had confirmed that color-infrared imagery is superior for identifying and characterizing wetlands due to the particular appearance of saturated soils, stressed vegetation, and other wetland indicators in the near-infrared band. Imagery from 2002 and 2012 were downloaded, uncompressed, and mosaicked to create single contiguous images for each town. These image mosaics were subsequently converted to Enhanced Compression Wavelet (ECW) format to improve image rendering speed.

Tompkins County LiDAR elevation data

In May 2008, LiDAR data were developed by Pictometry International Corp. (Rochester, NY) for Tompkins County for the purpose of supporting FEMA's Floodplain Map Modernization Program. Data were collected by Mapping Specialists, Inc. at a nominal post spacing of 1.4 meters. The LiDAR elevation point data were classified using TerraScan software (TerraSolid Limited, Helsinki, Finland) by an automatic classification algorithm. The data have expected horizontal and vertical positional accuracy in compliance with the National Standard for Spatial Data Accuracy (NSSDA) RMSE estimation of elevation data in support of 2 ft. contour mapping products.

The LiDAR elevation data were provided for the project by the Tompkins County GIS Division in LAS binary format v1.1. The data were processed using ESRI ArcGIS 10.1 LiDAR geoprocessing tools. A "bare earth" digital elevation model (DEM) was generated. LiDAR points classified as "ground" were loaded into a File Geodatabase and a Terrain dataset was created. A raster DEM was derived from the Terrain layer using a linear sampling method with a pixel resolution of 5 ft.

Prior analysis of LiDAR-derivatives

During the pilot study, several derivatives of the LiDAR DEM were also created to aid in identification of areas with hydrologic conditions suitable for wetlands, including a slope raster and 1-ft contour lines, using Manifold 8.0 Surface Tools. Streams were derived using the FlowStreams function with a threshold of 1000 cells (equivalent to 0.57 acres).

The compound topographic index (CTI) also known as a topographic wetness index (TWI), was applied to the LiDAR DEM for the purpose of identifying possible wet areas. First, depressions in the LiDAR-derived DEM were eliminated with a "sink-filling" function using the Manifold 8.0 Surface Tools. Then, the CTI was calculated for all LiDAR DEM raster cells using the CTI equation: $\ln(a/\tan B)$ where a equals the upstream contributing area; and B equals slope.

Another aspect of LiDAR data that has been shown to be useful for wetland identification under forest canopies is the intensity of the return signal (Lang & McCarty, 2009). The intensity of the return signal is primarily a function of the reflective properties of the materials that are hit by the laser. Water tends to absorb the infrared light used by most LiDAR systems, and therefore return intensity is lower in areas that are inundated or have saturated soils. The return intensity values of LiDAR points classified as "ground" were used to generate a raster surface using the same process as described above for derivation of the "bare earth" DEM. An iterative filtering process described by Land & McCarty (2009) using an enhanced Lee filter was applied to more clearly define possible wet areas.

The LiDAR derivatives were qualitatively analyzed to determine if they would be useful in the identification of wetlands and their boundaries. The data were examined across the landscape, particularly in areas known to have wetlands, and compared to the available NYSDOP high-resolution aerial imagery. The 5-ft LiDAR DEM raster, and its immediate derivatives (1-ft contours and streams) had a very high level of spatial accuracy and detail, and aligned accurately with the high-resolution aerial imagery. Subtle changes in elevation visible in the elevation data apparently corresponded closely with wetland boundaries apparent on the imagery.

However, the CTI raster was not useful in identifying wetlands or their boundaries. Although the CTI raster identified areas which would have substantial accumulation of water, such as stream channels, CTI values for wetlands were not consistently higher or lower than neighboring upland areas. The CTI raster was not used to assist in wetland mapping.

LiDAR return intensity rasters, both the unfiltered and the enhanced Lee filtered, did not show a consistent pattern matching wetland occurrence or absence. In general, known wetland areas and upland areas could not be distinguished from one another using the return intensity data.

Although it was initially anticipated that the CTI and return intensity rasters might provide a means to classify the landscape into areas which were more likely or less likely to be wetlands using an automated process or by visual examination, none proved to be useful and there was no evidence that further processing would be productive. Therefore, neither the CTI nor the return intensity rasters were used in the wetland mapping process.

Mapping Technique

Wetlands within the county and those intersecting the county boundary were mapped by image interpretation using the NYSDOP aerial imagery and visual analysis of the LiDAR DEM and its derivatives. Wetlands were delineated primarily using the NYSDOP 2012 imagery at a scale of at least 1:1,000. If wetland boundaries were not clearly identifiable on the NYSDOP 2012 imagery, the wetland boundaries were delineated using the LiDAR-derived slope raster and 1-ft contour lines if possible. The slope raster was themed or "symbolized" to highlight flatter areas, those between 0 and 5 degrees. This themed slope layer proved to be critical for identifying previously unmapped wetlands.

Oblique aerial imagery was also examined to aid in wetland identification. Oblique aerial imagery is captured at an angle and is particularly useful for determining vegetation structure and composition. For the Tompkins County area, high resolution oblique aerial images were collected by Pictometry and available through the Microsoft Bing online map service.[2] Four oblique aerial images were available for most locations in the study area.

Other geospatial data resources that were referenced during the mapping process include the USGS National Hydrography Dataset (NHD)[3], the FEMA National Flood Hazard Layer (NFHL)[4], the 2007

[2] http://www.bing.com/maps/
[3] http://nhd.usgs.gov/
[4] https://msc.fema.gov/portal

Tompkins County Land Use and Land Cover layer[5], the NYSDEC Freshwater Wetland Maps, and the USFWS NWI.

All wetlands, regardless of size and origin, were mapped. Areas were determined to be wetland if hydrologic, topographic, and vegetative wetland indicators were all present. Hydrologic conditions supportive of wetland classification typically included visible surface water or saturated soils, which were generally more easily identified on CIR imagery. Vegetative indicators include specific vegetation types or growth forms, or specific species visible on the oblique imagery. Topographically, flatter areas, or areas at the bases of slopes were identified using the LiDAR DEM and its derivatives. Generally, areas were only classified as wetlands if there was sufficient evidence of wetland hydrology, wetland vegetation and appropriate topography, or, in the case of modified landscapes, that those conditions would exist if the area were allowed to revert to a natural state. Apparent wetland conditions on imagery from both 2002 and 2012 was considered strong evidence of wetland presence.

Wetlands were classified according to the widely-accepted Cowardin classification system developed by the USFWS for the NWI (Cowardin et al., 1979). In this hierarchical classification scheme, wetlands are organized into five main systems (Marine, Estuarine, Riverine, Lacustrine, and Palustrine), which are divided into subsystems, classes, and subclasses based on hydrologic and vegetation characteristics. In Tompkins County, all wetlands fall within the Riverine, Lacustrine, and Palustrine systems. The USFWS formal definitions of these wetland systems are provided in Appendix A. Most wetlands in Tompkins County fall within the Palustrine category, which includes small non-vegetated waterbodies up to 8 ha (20 ac) in size. The Palustrine system divided into classes based on the dominant vegetation (such as trees, shrubs, emergents, or unconsolidated bottom if vegetation is absent) which are then divided into subclasses based on other vegetation characteristics (such as deciduous, evergreen, or dead vegetation).

Further description of wetlands is accomplished by adding special modifiers that indicate specific water regimes, water chemistry, soil attributes, or landscape alterations by humans or beavers. For all wetlands classified in the Cowardin scheme, a water regime modifier is assigned. For non-tidal wetlands, the water regime modifiers include: permanently flooded, intermittently exposed, semi-permanently flooded, seasonally flooded, saturate, temporarily flooded, intermittently flooded, and artificially flooded. Optionally, wetlands can be assigned modifiers that describe modifications to wetlands. These include: excavated, impounded, diked, partly drained, farmed, and artificial.

The Federal Geographic Data Committee (FGDC) Wetland Map Standards (2009), which has endorsed the Cowardin classification system, has defined a minimum standard for completeness of the wetland classification that includes: ecological system, subsystem, class and/or subclass, water regime, and special modifiers. The wetland mapping process completed for the Tompkins County met those standards.

Many larger wetlands are comprised of distinct areas that would be classified as different wetland types in the Cowardin system. As with the NWI, wetlands were divided into multiple distinct features with appropriate classifications. Each distinct wetland feature was given a unique identification number. Wetland features belonging to contiguous wetland areas were grouped using unique "wetland complex" identification numbers to support data management and analysis tasks.

Several additional attributes of wetland features were documented. Wetlands were classified by their likely origin, either "artificial" or "natural." Also, additional hydrologic descriptors were given for specific wetland types which are not identified in the Cowardin system. For instance, some wetlands were identified as vernal pools, agricultural ponds, or on a floodplain.

[5] http://cugir.mannlib.cornell.edu/bucketinfo.jsp?id=8010

Although wetlands were mapped as carefully and accurately as possible, mapping was based solely on remote sensing data. It is important to acknowledge the limitation of this method. To document the uncertainty in the wetland classification process, some wetland features were attributed with a qualitative designation of “unlikely”, “possible”, or “probable.”

To ensure complete and thorough analysis of all parts of the study area, a 1-km by 2-km rectangular grid geospatial data layer was used to track and document progress. Each grid cell was marked as complete after thorough and systematic review.

Accuracy Assessment

Overview

A field-based accuracy assessment is an essential component of any geospatial data development project. Geospatial data are complex and there are numerous aspects of the data for which accuracy may be quantitatively determined. Two fundamental statistics which should be determined are the:

1. Error of commission rate (the rate at which areas were mapped as wetlands, but no wetlands were present; false positives); and
2. Error of omission rate (the rate at which areas were not mapped as wetlands, but wetlands were actually present; false negatives).

Beyond these basic measures, an accuracy assessment of geospatial data could also address spatial or positional accuracy, as well as the classification accuracy. For wetlands, the spatial accuracy may refer to the size, location, or shape of wetland areas; and the attribute accuracy could refer to the proper classification of the wetland type using the Cowardin classification system and other characteristics. Statistical validity is another important element of an accuracy assessment; and ideally, sample sites would be chosen at random from all potential wetland sites. However, given limited financial and human resources, a realistic sampling method and set of accuracy measurements must be selected.

For the Tompkins County 2012 Wetlands Map accuracy assessment, the goals were to estimate:

1. the error of omission rate;
2. the error of commission rate; and
3. the spatial accuracy of the wetland boundary (or edge).

The error of omission rate would be calculated as the number of wetland sites not mapped divided by the total number of wetland sites visited in the field. The error of commission rate would be calculated as the number of sites mapped as wetlands that were not actually wetlands divided by the number of mapped wetland sites. The spatial accuracy of the mapped wetland boundary was calculated based on the shortest distances between the mapped wetland boundaries and their corresponding wetland boundary locations determined by field measurements.

Site selection

To achieve a sufficient level of confidence in the wetland data, sampling target goals were 1) at least 30 wetlands to evaluate error of commission; and 2) at least 30 locations without wetlands to evaluate error of omission. Although a random selection of sample sites across Tompkins County would be statistically ideal, this sampling method would not have been feasible given limited project resources. In particular, the time and effort required to secure land access permission from private landowners and coordinate site visits would greatly exceed time and budget constraints.

To develop a set of sites representative of the diversity of wetland types and landscape conditions across the county, members of the CLWN were contacted to request access to their properties to complete field surveys. To target areas with potential natural wetlands, only members with land outside of city boundaries were selected for contact. In total, 184 members were contacted with the letter given in Appendix B.

Anticipating a limited number of positive responses from CLWN Members, the Cornell University Plantations' Natural Areas program was also approached to request permission to use Cornell's landholdings to complete the field survey. The Natural Areas program manages over 3,000 acres of land spread among nearly 60 different sites, primarily within the Towns of Dryden and Ithaca. The Natural Areas program granted access to all of their lands and provided assistance in the form of geospatial data layers delineating property boundaries and trails which could be used by the field technicians. Due to the ecological sensitivity of some sites, data provided by Cornell Plantations and the data produced by the field survey are considered confidential and only reported in this document in aggregate to support this accuracy assessment.

The Cornell Natural Areas include a wide variety of site conditions and are broadly distributed. Although the use of these sites does not provide a statistically random sample, these sites were sufficiently representative of the diversity of landscape conditions and wetland types present in the county. More than 30 of the sites were excluded from consideration due to their extreme topography and proximity to campus. Twenty-four Cornell University Natural Areas properties totaling 1,800 acres were selected for the assessment.

Field survey

A field survey method was developed by Kerry Thurston (InFocus Environmental Consulting, Syracuse, NY), an experienced wetland delineator. The goal of the field survey method was to rapidly confirm the presence of a wetland, locate its approximate boundary, and classify it according to the Cowardin classification system.

At each field site, the following process, as written by Kerry Thurston, was used to determine wetland presence or absence, and the location of the wetland boundary.

1. *Walk the project site and identify different plant communities for evaluation. These communities may be woodland, marsh, field, pond and the like. The focus will be on undisturbed areas (e.g. not actively farmed fields or landscaped lawns).*

2. *In each plant community, determine visually whether primary vegetation indicators of wetland are present. These indicators would be trees, shrubs and herbaceous plants consistent with wetlands, such as cattails, skunk cabbage, marsh marigold, willow, dogwood, speckled alder, red maple, and green ash. As necessary, use plant identification keys and the 2014 Northeast Region Plant List to identify the wetland indicator status of the most common plants in the community. If the vegetation is clearly indicative of a wetland community (such as a cattail marsh), then it is a wetland.*

3. *If the vegetation is not clearly indicative of wetland (such as a maple forest), and there are hydrology indicators present (such as water-stained leaves, moss trim lines on trees, and drift lines), examine soil properties by digging a hole at least 18 inches deep. Assess soil saturation depth, and document soil texture and the presence of redox features (for the purposes of this project, documenting soils using the Munsell color charts will not be*

conducted). If neither vegetation nor soils are indicative of wetlands, the area is not a wetland.

4. *If wetlands are present, determine whether the wetland boundary is consistent with the digitized boundary, referring to site maps provided and/or GPS/GIS positioning tools; included will be an assessment of whether the wetland boundary - as seen on the ground - is well-defined or poorly defined. Waypoints collected using portable GPS, if available, will be used with GIS to verify the location of the boundary.*

5. *Data collection forms containing a checklist of wetland indicators should be completed for each plant community observed, including the upland communities bordering the wetland. Using the information gathered, the wetland habitat can be classified using the Cowardin system (Classification of Wetlands and Deepwater Habitats of the United States, Cowardin et al., 1979).*

The field survey of CLWN member landholdings and Cornell Plantations' Natural Areas was completed by trained wetland field technicians. The field technicians were provided with hardcopy maps of all field survey sites. The maps depicted parcel boundaries, topography, roads, mapped wetland boundaries, and 2012 aerial imagery.

The wetland field technicians were also provided with a Google Nexus 7 Android tablet (ASUSTeK COMPUTER INC., Taiwan), and Garmin GLO GPS/GLONASS receiver (Garmin International, Inc., Olathe, KS) for navigation and spatial data collection purposes. Locus Map Free (Asamm Software, http://www.locusmap.eu) was used to record position information and field observations through both typed notes and geotagged images. Supporting geospatial data, including parcel boundaries, trail locations, and mapped wetland boundaries were preloaded to assist with navigation.

To guide the wetland field technicians through the wetland field survey process and document site visits, the wetland technicians completed a Field Survey Worksheet (Appendix C) for each site visited. This form is derived in part from information provided in the NYSDEC New York State Freshwater Wetlands Delineation Manual.[6] For each wetland found, at least one wetland boundary point location would be taken by GPS. For large wetlands, multiple wetland boundary locations were mapped as possible, depending on field conditions.

For each survey location, the wetland field technicians were instructed to walk the entire site if possible. For larger survey locations, the wetland field technicians were expected to cover as much area as possible by trail or transect.

Wetland field technician training

Two wetland field technicians were hired in July 2015. The field technicians were provided one day of intensive training by Kerry Thurston in wetland identification and delineation methods, including an overview of typical vegetative, hydrologic, and soil wetland indicators, training in the use of plant identification keys and wetland plants list, and an introduction to the Cowardin classification system. Instruction was provided at sites with documented wetlands and sites without documented wetlands. The field technicians also received training by Nicholas Hollingshead in the use of the tablet and GPS receiver.

[6] http://www.dec.ny.gov/docs/wildlife_pdf/wdelman.pdf

RESULTS

Accuracy Assessment

Field Survey

The response rate from the CLWN membership was low. Four individuals volunteered to have their properties included in the study. The names and locations of these sample sites have been kept confidential.

The field survey was carried out on 11 days between July 14, 2015 and October 31, 2015. The wetland field technicians visited 22 Cornell Natural Area properties and the 4 private properties of the CLWN members. These sites were located in the towns of Caroline, Dryden, Groton, Ithaca, and Lansing. The Cornell Natural Areas visited include the following sites: Bald Hill, Bluegrass Lane Natural Areas, Caroline Pinnacles, Coy Glen, Dunlop Meadow, Eames Bog, Edwards Lake Cliffs, Ellis Hollow Wetlands, Etna Fringed Gentain Area, Fall Creek Valley North and South, McDaniels, McGowan Woods and Meadow, McLean Bogs, Mitchell Street Hawthorn Thicket, Monkey Run, Palmer Woods, Ringwood, Salt Road Fen, Slim Jim Woods, South Hill Swamp, Tarr Young Preserve, and Turkey Hill Wetlands.

Error of omission

During the field survey, 65 wetland areas were found. Of these, 48 (73.8%) had been mapped for the new Tompkins County wetlands geospatial dataset. Of the 17 wetlands that were missed, four were on relatively steep slopes or at slope bases, suggesting seep type wetlands. Two of the wetlands were created by artificial impoundment, and another was at the head of an ephemeral stream. In regard to vegetation, six were predominantly grasses or emergent vegetation, four were forested, one was scrub-shrub, and four were mixed vegetation types. Five of the missed wetlands appeared to be current or former agricultural fields or pasture.

The wetlands that were not identified by the initial geospatial mapping process were revisited in the GIS and their sizes approximated if possible using field notes, GPS locations and geospatial data resources, including LiDAR derivatives and aerial imagery. Wetland extent could be approximated for 12 wetlands. The median size of these wetlands was estimated to be 0.23 acres. One of the wetlands was approximately 3.67 acres and the remaining eleven were between 0.023 and 0.46 acres. Of the 22 wetland areas identified during the field study that were less than 0.5 acres, ten (45.5%) were identified during the geospatial mapping process. Of 43 wetland areas found during the field study that were over 0.5 acres, 42 (97.7%) were mapped.

Significant portions of two other wetlands were missed in the geospatial mapping process. These include an area adjacent to a wetland classified as PSS1E and a mixed palustrine scrub-shrub/emergent vegetation area. Including these additional missed areas, based on the field survey, the error of omission rate was 29.2%. 71.8% of the wetlands in the areas covered by the field surveys were mapped.

Error of commission

Four of the areas mapped as wetlands during the geospatial mapping process were found during the field survey not to be wetlands. One of these sites was given a NWCS class of PEM1A (Palustrine Emergent, temporarily flooded), one of PSS1A (palustrine deciduous scrub/shrub, temporarily flooded), and two of PFO1A (palustrine deciduous forest, temporarily flooded). All four sites were located adjacent to large streams and would generally be considered to be within the floodplain zone. In the field, two of these areas had some hydrophytic vegetation, but did not meet the “50/20 rule” for determining plant species dominance and wetland occurrence.[7]

In addition, a significant portion of a 5.7 acre area identified during the geospatial mapping process to be a wetland was found to be non-wetland upland habitat during the field survey. This area had been given an NWCS classification of PSS1E (palustrine deciduous scrub/shrub, seasonally flooded/saturated). The remaining portion of the site was confirmed to be wetland.

Given that 48 wetland areas were confirmed by the field survey to be wetlands, the error of commission rate for the geospatial wetland mapping process was estimated to be 8.3% if only entire areas incorrectly mapped as wetlands were counted as errors or 10.4% if the additional partial area mapped in error is included.

Wetland boundary spatial accuracy

To estimate the accuracy of the wetland boundaries as delineated during the geospatial mapping process, wetland boundary locations were determined during the field survey. At each wetland, one or more point location GPS measurement was taken along the boundary. The number of GPS points collected depended on field conditions and the wetland size.

Of the 48 wetlands mapped by geospatial analysis and found during the field survey, boundary measurements were available for 44 wetlands. An average of 1.8 GPS locations were collected at each wetland, with a maximum of 4 points collected at any individual wetland. The minimum distance between each GPS location and its associated wetland’s boundary was calculated in the GIS. GPS locations within a wetland area were given negative values, which would suggest the wetland delineation was over-inclusive. These distance measures were averaged for each wetland. These average distances between GPS field locations and their associated wetlands are show in Figure 2.

Wetland boundaries as delineated by geospatial analysis were estimated to be on average located 14.7 feet inside the actual wetland area as determined by field survey GPS measurements. This suggests that the geospatial dataset underestimates wetland extent.

Wetland Classification

During the field survey, plant communities were assessed to determine whether primary vegetation indicators of wetlands were present. Plant species occurrence and dominance were recorded as necessary to address wetland criteria. Hydrologic indicators of wetlands were also noted. It was anticipated that these field observations would be useful for determining the accuracy of the NWCS (Cowardin) classification of the mapped wetlands. The field crew was also asked to provide an NWCS classification of each wetland found in the field.

However, a NWCS wetland type for each wetland observed was not consistently determined. Furthermore, the field data were not collected at a scale corresponding to the scale at which wetlands were mapped in the GIS. Generally wetland vegetation was described for small areas, but not necessarily for entire areas delineated as wetlands in the geospatial dataset. A complete vegetation survey would have been too time-consuming and beyond the scope of the accuracy assessment. Therefore, the accuracy of

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[7] As described in the 1987 *U.S. Army Corps of Engineers Wetlands Delineation Manual*, the “50/20” rule “*states that for each stratum in the plant community, dominant species are the most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50% of the total dominance measure for the stratum, plus any additional species that individually comprise 20% or more of the total dominance measure for the stratum.*”

the NWCS wetland type assigned to each wetland area could not be assessed with a reasonable level of confidence, and the analysis was excluded from the accuracy assessment.

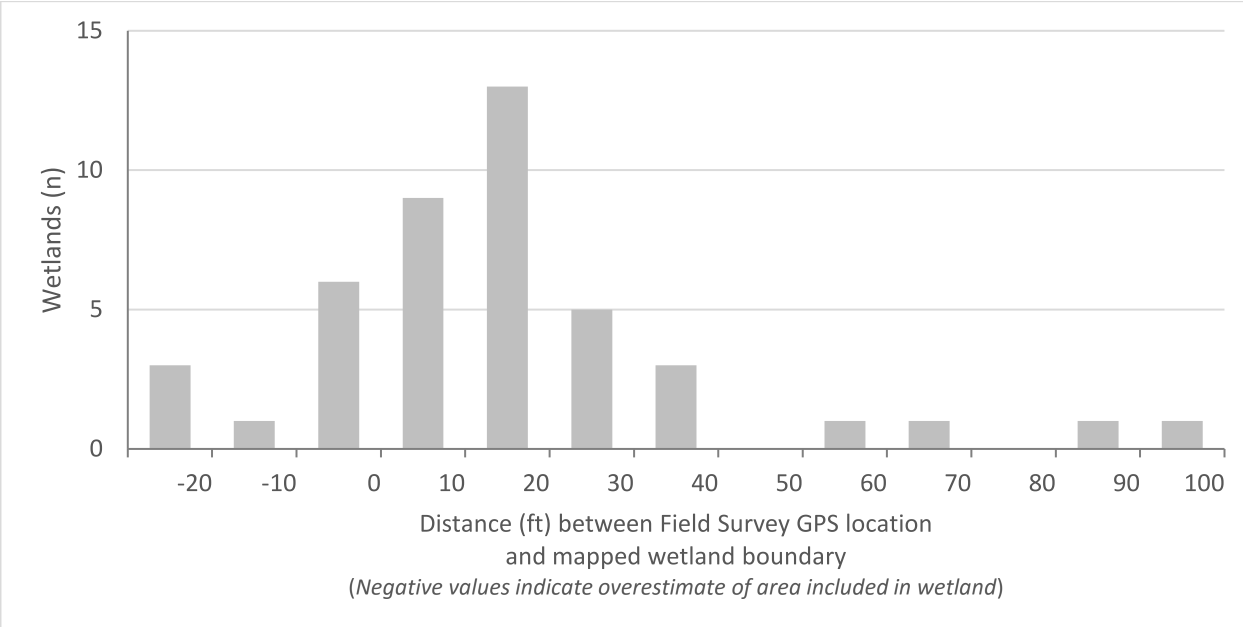

Figure 2. Wetland Boundary Accuracy

Discussion of Field Survey and Accuracy Assessment

An important requirement of any accuracy assessment is statistical validity. To assess the accuracy of the Tompkins County wetland dataset, ideally, a random sample of locations would be selected and visited to document the occurrence or absence of wetlands. However, given budget and time limitations, this would not have been feasible. Site selection is constrained by numerous factors, including landowner permission to visit field survey locations.

The solution chosen for this accuracy assessment to achieve a broad representative set of survey sites was to ask a subset of Tompkins County citizens with a higher likelihood of agreeing to participate in the field survey (CLWN membership) and to visit publicly accessible areas (Cornell Plantations' Natural Areas). Although the Natural Areas are widely distributed, they are not representative of all possible land cover and use conditions, and therefore likely introduce some bias into the accuracy assessment results. In general, wetlands in the Natural Areas appear to have fewer disturbances and more natural vegetation than wetlands throughout Tompkins County, in general. However, relying on this sample set, visiting a greater number of sites was possible, which is also important for statistical validity.

The accuracy assessment highlighted three important limitations of the new Tompkins County wetland geospatial dataset:

1. Smaller wetlands are not adequately represented. As described above, less than 50% of wetlands below 0.5 acres were identified in the field survey sites.

2. Floodplain areas are difficult to classify properly as wetland or upland. All four of the upland sites found to be misclassified as wetlands were on floodplains. All four sites were categorized in

the geospatial dataset as “temporarily flooded” indicating that the surface water is present for only brief periods during the growing season, consistent with floodplain hydrology, but the water table usually lies well below the soil surface for most of the season.

3. The new Tompkins County wetland geospatial dataset, like the USFWS National Wetlands Inventory, errs on the side of avoiding errors of commission at the cost of omitting some wetland areas that are difficult to identify. This is supported by the low error of commission rate and higher error of omission rate observed during the accuracy assessment.

Lower accuracy for wetland areas that are smaller and less frequently or consistently inundated was expected. Specifically, during the geospatial mapping process, distinguishing between floodplain areas that were flooded for sufficient duration or frequency to develop wetland characteristics and those that were not was particularly difficult due to the very subtle differences in appearance of the aerial imagery.

To assess the spatial accuracy and attribute accuracy of the wetland geospatial dataset, field wetland delineations at each wetland site would, ideally, be part of an accuracy assessment. However, wetland delineations are relatively resource intensive and were not feasible for this accuracy assessment. To develop a basic measure of the spatial accuracy of the wetland dataset, GPS point data were collected at wetland boundaries as determined in the field and compared to the wetland boundaries as mapped in the GIS. Given the spatial accuracy of the source geospatial datasets used in the mapping process, such as the NYSDOP imagery which has a horizontal accuracy 95% confidence interval of +/- 4.0 ft and +/- 8.0 ft, and the stated accuracy of the WAAS-enabled Garmin GLO GPS unit, of 3 meters, some difference between the field-based and GIS-based wetland boundary location was expected. Wetland boundaries as delineated in the GIS were 14.7 feet inside the actual wetland boundary, suggesting that wetlands in Tompkins County are, on average, larger than those delineated in the new Tompkins County wetland geospatial dataset.

The accuracy of the dataset should continue to be explored through the collection of additional field data, for instance from wetland delineation projects, and by comparison to other existing and future geospatial datasets. In particular, the spatial accuracy and characterization of the wetland should be examined further.

Wetlands Mapped

Tompkins County is 305,000 acres, excluding the large surface water areas of Cayuga Lake and the inlet. All wetlands within the county or intersecting the county boundary were mapped. Therefore, portions of some mapped wetlands extended beyond the county area. However, statistics given in this report section include only wetlands or portions of wetlands within the county. This provides a clear definition of the area being described by the statistics and is important for comparisons to NWI and NYSDEC Freshwater Wetland Maps data. In addition, wetland areas given a probability of “unlikely”, which indicates insufficient but suggestive evidence of a wetland occurring at a given location, are not included in the statistics.

In total, 15,312.5 acres of wetlands were mapped, which is approximately 5.0% of the total area of Tompkins County (Table 2). Natural Palustrine wetlands accounted for 88% of the total wetland area. Riverine and lacustrine wetlands were 0.8% and 1.4% of the total wetland extent, respectively.

In total, 3,164 natural contiguous wetland areas (wetland complexes) were mapped. The median wetland complex size was 0.5 acres and the average was 4.2 acres. The distribution of wetland complexes sizes was strongly skewed, with a large number of smaller wetlands and a small number of very large contiguous wetland areas. There were 23 wetland complexes over 100 acres each, of which two were over 500 acres each.

There were 3,950 artificially created wetlands areas mapped, totaling approximately 1,550 acres. These artificial wetland areas are primarily farm ponds, residential ponds, retention basins, and adjacent emergent vegetation areas caused by the artificial impoundment of water by man-made ponds and roads.

			Wetland area (acres)		
System	**Class**	**Subclass**	**Artificial**	**Natural**	**Total**
Lacustrine	Unconsolidated bottom		62.3	145.7	207.9
Riverine	Unconsolidated shore			115.8	115.8
Palustrine	Aquatic bed		3.5	5.1	8.6
	Emergent	Persistent	104.4	3,898.5	4,002.9
	Forested	Broad-leaved deciduous	4.0	4,204.6	4,208.6
		Needle-leaved evergreen	1.4	1,398.5	1,399.9
		Dead	3.2	92.5	95.7
	Scrub-shrub	Broad-leaved deciduous	21.6	3,603.2	3,624.9
		Needle-leaved evergreen		14.7	14.7
		Dead		16.1	16.1
	Unconsolidated bottom		1,339.4	270.0	1.609.4
	Unconsolidated shore		8.2		8.2
Palustrine Total			*1,485.7*	*13,503.1*	*14,988.8*
TOTAL			**1,547.9**	**13,764.6**	**15,312.5**

Table 2. Summary of wetlands mapped in the Tompkins County.

Comparison to USFWS NWI and NYSDEC Freshwater Wetland Maps

The USFWS NWI, the NYSDEC Freshwater Wetland Maps, and the Tompkins County 2012 Wetlands geospatial dataset have been developed for different purposes using different data resources and geospatial technologies. It is important to keep these differences in mind when using or comparing wetland maps, as some quantitative differences may reflect differences in methods rather than differences in accuracy or actual changes in wetland extent over time.

NYSDEC Freshwater Wetland Maps

The NYSDEC created the Freshwater Wetland Maps to comply with the Freshwater Wetlands Act (Article 24 of the Environmental Conservation Law). The maps show the “approximate location of the actual wetland boundary” for all wetlands subject to the jurisdiction of the law (DEC, 1997). The law defines wetlands based on the presence of certain vegetation types or specific species, or as areas that are too wet to support that vegetation (DEC, 1997). Protection under the law is provided for wetlands greater than 12.4 acres in size, or smaller wetlands determined to be of considerable local value.

The original wetland maps were completed in the 1980s using available high-resolution aerial imagery. The USGS National High Altitude Photography (NHAP) program color-infrared aerial photos were the most widely available at the time. The NYSDEC has defined a process for wetland map amendments. However, there have been no amendments submitted for Tompkins County, and the original maps were created between 1984 and 1986.[8]

[8] http://www.dec.ny.gov/docs/wildlife_pdf/wtamdfildat4.pdf

USFWS NWI Program

The USFWS NWI program was established to document the distribution and occurrence of all wetlands and deepwater habitats in the United States. Wetlands are defined by the USFWS as

> *"…lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification wetlands must have one or more of the following three attributes: (I) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year."* (Cowardin et al., 1979)

The USFWS definition of wetlands was not intended to be a regulatory definition, such as that used by the US Army Corps of Engineers to support enforcement of the Clean Water Act (Environmental Laboratory, 1987). The NWI wetland maps for the Tompkins County area were developed in the 1980s primarily by photointerpretation of USGS NHAP imagery.

Total wetland extent

Considering the differences in the purpose, intended applications, and source data, significant differences between the NYSDEC Freshwater Wetland Maps, the USFWS NWI maps, and the new Tompkins County 2012 Wetlands Map were anticipated. As shown in Table 3, the NYSDEC Freshwater Wetland Maps include approximately 37% of the wetland area depicted on the Tompkins County 2012 Wetlands Map. The NWI, which is similar to the Tompkins County 2012 Wetlands Map in terms of its purpose and methods, had 70% of the wetland area included in the Tompkins County 2012 Wetlands Map.

	NYSDEC Freshwater Wetland Maps (ac)	NWI (ac)	Tompkins County 2012 Wetlands Map (ac)
Freshwater Emergent Wetland		2,196.4	4,002.9
Freshwater Forested/Shrub Wetland		7,329.9	9,359.7
Freshwater Pond		890.1	1,618.0
Other (unconsolidated shoreline		11.6	8.2
Lake		213.4	207.9
Riverine		117.6	115.8
Total	**5,631.9**	**10,747.5**	**15,312.5**

Table 3. Total wetland area in Tompkins County as shown on NYSDEC Freshwater Wetland Maps, USFWS NWI maps, and the Tompkins County 2012 Wetlands Map.

Positional accuracy

Accurate wetland location data may be particularly important for regulatory purposes. Therefore, the degree of spatial overlap or agreement between the datasets is of interest. Due to significant advances in geospatial technologies, the recent aerial imagery and LiDAR elevation data have greatly improved positional accuracy over the imagery acquired and processed in the 1980s for the NYSDEC Freshwater Wetland Maps and the USFWS NWI. There is a high level of disagreement (a lack of overlap) between all three datasets (Table 4). Given that the Tompkins County 2012 Wetlands Map includes more wetland area, the large extent of wetland areas only in the Tompkins County 2012 Wetlands Map but not the other maps was expected.

Tompkins 2012 Wetlands Map only	Overlap	USFWS NWI only	Agreement
7207.3 ac	8,097.0 ac	2,657.6 ac	45.1%

Tompkins 2012 Wetlands Map only	Overlap	NYSDEC Freshwater Wetland Maps only	Agreement
11,553.3 ac	3,751.1 ac	1,877.5 ac	21.8%

USFWS NWI only	Overlap	NYSDEC Freshwater Wetland Maps only	Agreement
7,456.3 ac	3,298.3 ac	2,330.3 ac	25.2%

Table 4. Spatial overlap of wetland maps. Natural and artificial wetlands are included. Agreement is calculated as the area of overlap divided by the total area of both wetland maps indicated.

However, the total wetland areas in the NWI and the NYSDEC Freshwater Wetland Maps that do not overlap with the Tompkins County 2012 Wetlands Map are also quite large. Although this may be due to actual differences in analyst interpretation or changes in wetland extent over time, visual inspection of the data during the wetland mapping process suggest that positional inaccuracy accounts for a significant portion of these numbers. Further investigation of this issue was beyond the scope of this project, and would require substantial geospatial data processing and analysis.

Wetland occurrences

Wetland boundaries on the NYSDEC Freshwater Wetland Maps are more generalized and less precisely defined than the wetlands depicted in either the NWI or Tompkins County 2012 Wetlands Map, making detailed comparisons based on corresponding wetland areas more challenging or not possible. Therefore, only a general, study area-wide comparison was made (Table 5). The NYSDEC Freshwater Wetland Maps include 90 wetland areas within Tompkins County. The smallest wetland area is 5.7 acres. Because the NYSDEC Freshwater Wetland Maps only depict regulated wetlands, wetlands below 12.4 acres are generally excluded. However, it is expected that the NYSDEC Freshwater Wetland Maps would include all wetlands over 12.4 ac. Despite differences in delineation methods, it appears that the NYSDEC Freshwater Wetland Maps may not depict all wetlands that are over 12.4 ac.

Size	Tompkins County 2012 Wetlands Map (*n*)	NYSDEC Freshwater Wetland Maps (*n*)	USFWS NWI (*n*)
< 0.5 ac	1667		382
0.5 - 1.0 ac	434		203
1.0 - 2.0 ac	342		220
2.0 - 12.4 ac	525	9	537
> 12.4 ac	196	81	162
Totals	**3,164**		**1,504**

Table 5. Wetlands by size category: Natural wetlands on the Tompkins County 2012 Wetlands Map and the NYSDEC Freshwater Wetland Map.

Differences in the extent and abundance of wetlands described by the NWI, the NYSDEC Freshwater Wetlands, and the Tompkins County 2012 Wetlands Map may be attributed to a number of factors. Wetlands are not static landscape elements and changes in climate (rainfall and temperature) or hydrology (increased beaver activity, for example), may lead to actual increases in wetland extent. Furthermore, as mentioned previously, the wetland maps differ in their mapping methods and program objectives. Also, the NWI and the NYSDEC Freshwater Wetland Maps were created using imagery that is approximately 30 years old. The Tompkins County 2012 Wetlands Map was created using imagery collected as recently as 2012. Despite these factors, however, it appears that a significant portion of the difference is also due to improvements in the detection of wetlands and their boundaries associated with advancements in geospatial and remote sensing technologies.

PROJECT DELIVERABLES

The products of this mapping project are available to all government agencies and other interested parties. Contact the CLWN to obtain copies. The products available include:

1. the Tompkins County 2012 Wetlands Map geospatial dataset in ESRI Shapefile and Personal Geodatabase formats;
2. metadata describing the methods and geospatial analyses used to create the wetland geospatial dataset;
3. a set of digital maps in PDF file format; and
4. the final report summarizing the results of the mapping process including a description of the methods, accuracy assessment, and a comparison to previous wetland datasets.

Contact information:

Cayuga Lake Watershed Network
170 Main Street P.O. Box 348
Aurora, NY 13026
607-319-0475
steward@cayugalake.org
http://www.cayugalake.org/

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APPENDIX A. PALUSTRINE, LACUSTRINE, AND RIVERINE SYSTEMS IN THE USFWS COWARDIN CLASSIFICATION

Wetlands mapped in the study area were classified as Palustrine, Lacustrine, and Riverine systems in the USFWS Cowardin classification scheme for wetlands and deepwater habitats as described in this USFWS publication:

Cowardin, L., Carter, V., Golet, F., & LaRoe, E. (1979). *Classificatino of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31* (p. 131). Retrieved from http://www.fws.gov/wetlands/Documents/Classification-of-Wetlands-and-Deepwater-Habitats-of-the-United-States.pdf

The basic definitions of these systems from this report are given below.

"The <u>Palustrine System</u> includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 ‰. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than 0.5 ‰." (*p. 10*)

"The <u>Lacustrine System</u> includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 ha (20 acres). Similar wetland and deepwater habitats totaling less than 8 ha are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 2 m (6.6 feet) at low water. Lacustrine waters may be tidal or nontidal, but ocean derived salinity is always less than 0.5 ‰." (p. 9)

"The <u>Riverine System</u> includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5 ‰. A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri 1960:5)." (*p. 7*)

APPENDIX B. LANDOWNER VOLUNTEER REQUEST LETTER

(following page)

Cayuga Lake Watershed Network
170 Main Street POB 348
Aurora NY 13026
www.cayugalake.org

It takes a Network to protect a watershed!

July 9, 2015

Dear Network members and supporters in Tompkins County:

The Cayuga Lake Watershed Network is working to protect important wetlands in our watershed and we need help from all of our citizen scientists to do it!

Wetlands are critical for maintaining good water quality, which is central to the Network's mission. Wetlands also reduce flooding impacts and provide critical habitat for amphibians, migratory birds, and many rare plant species in our region.

However, our local municipalities and state agencies are making land use and management decisions using wetland maps that were created 30 years ago, and are outdated and incomplete.

With funding from the Park Foundation and Tompkins County, the Network is creating new wetland maps for Tompkins County. Using the latest modern geospatial mapping technology, the new maps will be more detailed and comprehensive than the maps that are currently used. This project will create a powerful tool that can be used by everyone - including local citizens - to protect water quality and ensure a healthy environment.

Now we need your help to complete this essential project. The final step of the project is to check the accuracy of the digital maps by visiting sites on the ground (a process called "ground-truthing").

We are interested in visiting sites that are known to have wetlands, to verify that the wetlands were mapped accurately. However, it is equally important that we visit sites without wetlands, to verify that no wetlands were erroneously mapped in those areas.

We are asking Network members and supporters to participate in this effort. If you have natural areas on your property - whether it is a swamp, a forest, or a meadow - you can volunteer your natural area to be a "ground-truth" site.

At each site our wetland field team, trained in wetland identification by Kerry Thurston of InFocus Environmental Consulting, will collect information about the plants, soil, and other features that may indicate the presence of a wetland. All information will be kept confidential and used only to assess the accuracy of the new digital wetland maps.

If you are interested in helping or have any questions, please reply to this email by July 31st to me at steward@cayugalake.org . We must complete this work by September 15.

Thank you for your continued support.

Sincerely yours,

Hilary Lambert

Hilary Lambert, Steward/Executive Director

Nicholas Hollingshead, wetlands project manager
Kerry Thurston, InFocus Environmental Consulting

APPENDIX C. FIELD SURVEY FORM

(following two page)

Site ID/Name ___________________________ **Project** Tomkins County Wetland Mapping Assessment 2015

Location/Address ____ Date ________________ Time ________________

Property Owner___________________________ **Owner Present** Y N U **Met with owner:** Y N

Hydrophytic Vegetation Assessment **Criteria Met: Yes No Maybe**

Dominant Plant Species: Species - Absolute % Cover (Status):

Canopy/Tree Stratum

1.____
2.____
3.____

Sapling/Shrub Stratum

1.____
2.____
3.____

Understory/Herb Stratum

1.____
2.____
3.____

Vegetation Criteria met by:

1. Rapid Field Test (primary): The rapid test is met if all dominant species across all strata are OBL or FACW, or a combination of the two, based on a visual assessment. (50/20 rule):
   a. FACW and wetter species are more than 50% of the total absolute percent coverage for each stratum.
   b. FACW and wetter species individually account for more than 20% of the total absolute percent coverage for each stratum.
2. Morphological Adaptations (secondary): hypertrophied lenticels, multiple trunks, adventitious or shallow roots. Observed on > 50% FACU species where indicators of hydric soil and wetland hydrology are present.

Hydrologic Indicators **Criteria Met: Yes No Maybe**

Primary Indicators (minimum of one required; check all that apply)

A. Observation of Surface Water or Saturated Soils

- ☐ Surface water
- ☐ High water table (≤12" below surface)
- ☐ Saturation (≤12" below surface)

B. Evidence of Recent Inundation

- ☐ Water marks
- ☐ Sediment deposits
- ☐ Drift lines
- ☐ Algal mat/crust
- ☐ Iron deposits (orange deposit)
- ☐ Sparsely vegetated concave surface
- ☐ Water stained leaves
- ☐ Aquatic fauna

C. Evidence of Recent Soil Saturation

- ☐ Hydrogen sulfide odor (within upper 12")
- ☐ Oxidized root channels
- ☐ Presence of reduced iron (upper 12 inches)

Secondary Indicators (minimum of two required if no primaries)

- ☐ Surface Soil Cracks
- ☐ Drainage patterns
- ☐ Moss trim lines
- ☐ Crayfish Burrows
- ☐ Stunted/Stressed plants
- ☐ Water table between 12"-24", dry season

Hydric Soil Indicators (minimum 20") **Criteria Met: Yes No Maybe**

Depth (in)	Texture	Hydric Indictors	Disturbance
☐ Test hole _________in ☐ Saturation _________in ☐ Water table _________in	☐ Rock ☐ Gravel ☐ Sand ☐ Clay ☐ Silt ☐ Loam ☐ Peat (organic)	☐ Peat/muck surface layer ≥8" thick. ☐ Dark/neutral (blackish) soil color with bright orange/reddish mottles (redox concentrations) ☐ Gray/reddish-gray matrix (redox depletions) ☐ Gleyed (neutral grey soil color, bluish to greenish grey)	☐ Fill/Waste ☐ Channels/ditches ☐ Farming/timber ☐ Industrial/Commercial ☐ Residential ☐ Impoundment ☐ Other_______________

Notes/Comments

Site ID/Name ___________________________ **Project** Tompkins County Wetland Mapping Assessment 2015

Cowardin Wetland Classification

Circle applicable descriptors in each column

System/Subsystem	Class	Subclass	Water Regime	Modifiers
☐ Palustrine (P)	☐ Unconsolidated bottom (UB) ☐ Aquatic Bed (AB) ☐ Emergent (EM) ☐ Moss-lichen (ML) ☐ Scrub-Shrub (SS) ☐ Forested (FO)	*Emergent:* ☐ Persistent ☐ Non-persistent *Forest/Scrub-Shrub:* ☐ Deciduous Broadleaf ☐ Deciduous Needleleaf ☐ Evergreen Broadleaf ☐ Evergreen Needleleaf ☐ Dead	☐ Temporarily Flooded ☐ Saturated ☐ Seasonally Flooded ☐ Season. Flood & Saturated ☐ Semi-permanently Flooded ☐ Intermittently Exposed ☐ Permanently Flooded	☐ Beaver pond ☐ Partly drained ☐ Ditched ☐ Farmed ☐ Diked/impound ☐ Artificial ☐ Spoil ☐ Excavated
☐ Riverine-Upper Perennial (R3)	Unconsolidated Shore (US)	Temporarily Flooded (A)		
☐ Not a wetland				

Tips:
Uncommon classes are greyed out.
System/Subsystem: Riverine only refers to unvegetated areas. Vegetated areas are palustrine.
Class: Unconsolidated Bottom = Pond; Aquatic Bed = Floating vegetation; Emergent = grasses (generally)
Water Regime: Temp flooded is like a floodplain; Seasonally flooded and saturated is typical wetland; Permanently flooded is generally a pond (usually associated with UB or possibly Forested-Dead);
Modifiers: Artificial refers to a purposefully artificially created wetland (not one caused by impoundment such as by a road)

GPS Data

Waypoint/Track/Photo	Description