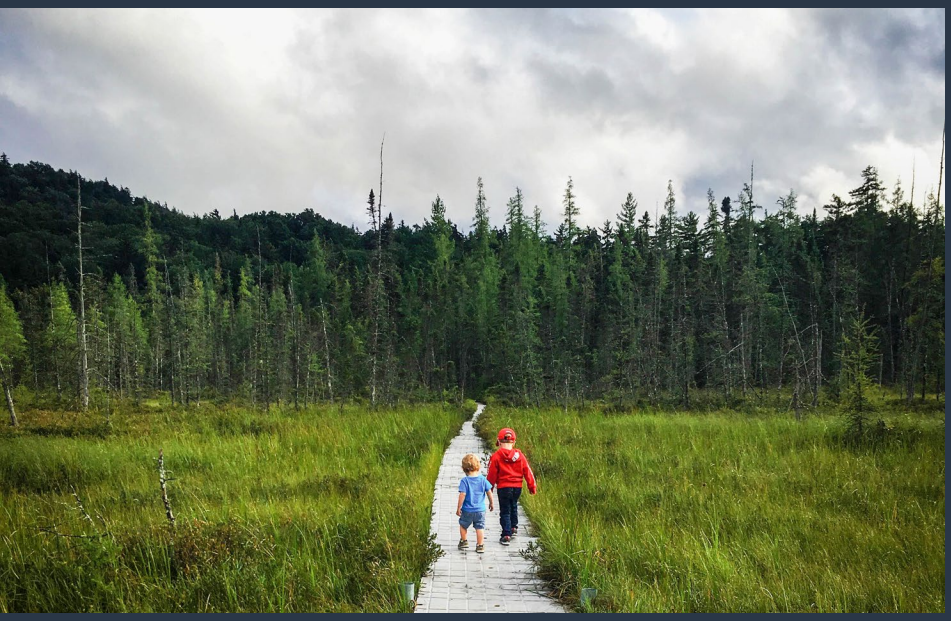
Developing methods, cultivating engagement, and creating end-user tools for wetland functional assessment

EPA Wetland Program Development Grant Final Report



New York Natural Heritage Program

A Partnership between the NYS Department of Environmental Conservation & the SUNY College of Environmental Science and Forestry

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THE NEW YORK NATURAL HERITAGE PROGRAM

The NY Natural Heritage Program is a partnership between the NYS Department of Environmental Conservation (NYS DEC) and the State University of New York College of Environmental Science and Forestry (SUNY ESF). Our mission is to facilitate conservation of rare animals, rare plants, and significant ecosystems. We accomplish this mission by combining thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resource planning, protection, and management.

NY Natural Heritage was established in 1985 and is a contract unit housed within NYS DEC's Division of Fish, Wildlife & Marine Resources. The program is staffed by more than 27 scientists and specialists with expertise in ecology, wetlands, zoology, botany, information management, spatial modeling, and geographic information systems.

NY Natural Heritage maintains New York's most comprehensive database on the status and location of rare species and natural communities. We presently monitor 182 natural community types, 870 rare plant species including mosses, and 478 rare animal species across New York, keeping track of more than 14,200 locations where these species and communities have been recorded. The database also includes detailed information on the relative rareness of each species and community, the quality of their occurrences, and descriptions of sites. The information is used by public agencies, the environmental conservation community, developers, and others to aid in land-use decisions. Our data are essential for prioritizing those species and communities in need of protection and for guiding land-use and land-management decisions where these species and communities exist.

In addition to tracking recorded locations, NY Natural Heritage has developed models of the areas around these locations important for conserving biodiversity, and models of the distribution of suitable habitat for rare species across New York State.

NY Natural Heritage has developed two notable online resources: Conservation Guides include the biology, identification, habitat, and management of many of New York's rare species and natural community types; and NY Nature Explorer lists species and communities in a specified area of interest.

NY Natural Heritage also houses iMapInvasives, an online tool for invasive species reporting and data management.

In 2014, NY Natural Heritage updated the Ecological Communities of New York State, an all-inclusive classification of natural and human-influenced communities. From 40,000-acre beech-maple mesic forests to 40-acre maritime beech forests, sea-level salt marshes to alpine meadows, our classification has become the primary source for natural community classification in New York and a fundamental reference for natural community classifications in the northeastern United States and southeastern Canada. This classification, which has been continually updated as we gather new field data, has also been incorporated into the National Vegetation Classification that is being developed and refined by NatureServe and Natural Heritage Programs throughout the United States (including New York).

NY Natural Heritage is an active participant in NatureServe – the international network of biodiversity data centers. NatureServe's network of independent data centers collects and analyzes data about the plants, animals, and ecological communities of the Western Hemisphere. Known as natural heritage programs or conservation data centers, these programs operate throughout all the United States and in Canada. These programs work with NatureServe to develop biodiversity data, maintain compatible standards for data management, and provide information about rare species and natural communities that is consistent across many geographic scales.

DEVELOPING METHODS, CULTIVATING ENGAGEMENT, AND CREATING END-USER TOOLS FOR WETLAND FUNCTIONAL ASSESSMENT

EPA Wetland Program Development Grant

Final Report

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A report prepared by the

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Cover photos (clockwise from top left): Adirondack wetland boardwalk on Ferd's Bog Trail by J. Kwiatkowski; Highbush Blueberry fruit (*Vaccinium corymbosum*) by L. Shappell; Shallow Emergent Marsh on the downstream side of a beaver dam in Lewis County by L. Shappell; and Perplexing Bumble bee (*Bombus perplexus*) on Spotted Joe-Pye Weed (*Eutrochium maculatum*) in Chautauqua County by L. Shappell

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PROJECT SUMMARY

Wetlands are a vital natural resource for people and the environment. Yet, we are lacking in ways to adequately assess wetlands with regards to their condition and function. The ability to rapidly, consistently, and accurately assess wetland condition and function is crucial for setting management priorities and prioritizing conservation actions. Our primary goal in this project is to develop and pilot a wetland functional assessment protocol that addresses functions and values protected under the NYS Freshwater Wetlands Act. Additional goals include continuing to develop our wetland rapid assessment methodology (NYRAM), building an accessible mobile application (for phones and tablets) for wetland assessment data collection, evaluate these methods with new wetland sampling in the Mohawk and Allegheny basins, and build a guide for users to help identify wetlands of potential statewide significance.

The Functional Rapid Assessment Methodology (FRAM) itemizes stressors at four spatial scales: The Survey Area (SA), a 40-meter radius around the survey point; the Field Buffer (FB), a 140-meter radius around the survey point; the whole contiguous wetland (WH) associated with the sample point; and the upslope and downslope drainage areas associated with the survey point. Wetland functions are characterized and ranked within eight broad categories, including flood control, hydrologic health, erosion control, groundwater protection, natural communities, pollution, wildlife, and values.

In 2018-2019, we sampled 31 new wetlands, adding to the 213 wetlands already sampled throughout New York State. These wetlands were stratified by urbanization and size, giving us a range of wetland condition and function quality with which to test our assessment methodology. Analysis of our functional assessment metrics in comparison to Levels 1, 2, and 3 condition metrics showed many metrics in congruence and emphasized the value and importance of evaluating these different functional groups. In this report we provide analytic details as well as case studies of a select set of wetlands to show how the metrics behave in specific ranking exercises.

We developed a data-collection app using the ODK-X software suite. A user can use the tool on a tablet or phone, offline, and then synchronize to a cloud server when online. We then upload the data to our databases for QC, storage, and analysis. We plan on maintaining this productivity enhancing toolset, with the hopes of rolling it out to partners in the future.

In order to facilitate easy identification of wetlands of potential statewide significance, we created a “quick guide” reference tool that outlines the minimum size requirement and allowable invasive species cover relative to each community and its present conservation status (S-rank). In addition, during the course of this project, the NYNHP ecology program revaluated the S-ranks of 12 nontidal palustrine communities. These updates were included in the quick guide appendix of the FRAM, and will be revised as needed to reflect changes in conservation status or benchmarks.

RESEARCH RELEVANCE

Wetland condition and function reflect flooding conditions, landscape setting (e.g., headwater or lowland), disturbance, and human-mediated stressors. Successfully balancing the need to manage and conserve our remaining wetlands and aquatic resources with upland land uses, such as forestry, and urban/exurban development requires a suite of supportive assessment tools designed for wetland permitting and monitoring in NYS. Our previous research found that wetland ecological integrity reflects anthropogenic disturbance in space and time (Shappell and Howard 2018). Factors such as adjacent upland buffer health and legacies of historical land use are reflected in the expressed wetland community we see today. Ecological degradation compromises intrinsic wetland functional capacity (water filtration, wildlife habitat, etc.), a threat that is particularly relevant for managing drinking water supplies, aquatic resources, and mitigating extreme storm events (e.g., EPA 2015).

Assessing upland integrity and wetland quality in a range of urban and rural environments is crucial for developing wetland assessment metrics for New York State (NYS). Many wetland-related functions and values depend as much on offsite characteristics such as hydrological connectivity or landscape context, as they depend on onsite characteristics such as habitat heterogeneity and hydroperiod. Habitat fragmentation and reduced natural land cover in upland buffers influences wetland structure and function (e.g., Pickett et al. 2001, Houlahan and Findlay 2004, Houlahan et al. 2006, Chu and Molano-Flores 2013). For example, interception by trees immediately reduces precipitation throughfall by more than 15% (Chapin et al. 2002). In practice, a 70% reduction in buffer canopy cover could cause a 10% increase in throughfall and potential runoff. Additionally, the importance of protecting a certain distance (buffer) between a wetland and any development for the benefit of wetland ecological condition is well documented. Our wetland condition and functional assessment methodologies therefore incorporate a range of spatial scales in the assessment process, including on-screen remote assessment as well as field data Figure 1).

One of our primary project goals aims at developing and piloting a functional assessment protocol that focuses on conserving and managing wetland resources Wetlands in New York State reflect current and historical land use - factors that strongly influence present-day wetland condition (Middleton 2003, Bruland and Richardson 2005). Wetland alterations aimed at dewatering reduce flood duration, depth and extent of flooding, making altered wetlands susceptible to invasion by competitively dominant non-native species (Ehrenfeld et al. 2003). Only select plant species possess traits that permit persistence during periods of inundation and soil anoxia (Grime 1977, Blom and Voesenek 1996, Kozlowski 2002, Magee and Kentula 2005, Toogood and Joyce 2009). Plants can therefore be one proxy for wetland condition (Euliss et al. 2004) particularly in developed landscapes where water tables have been lowered (e.g., ditching, undercut rivers) and urbanized catchments that generate “flashy” wetland hydroperiods (Findlay and Houlahan 1997, Ehrenfeld et al. 2003, Groffman et al. 2003, Grabas and Rokitnicki-Wojcik 2015).

Present-day landscape stressors can influence wetland condition and function, but legacies of past land use can play an important role, too. Historical land use/land cover data (LULC) suggests that nearly a quarter of our previously surveyed sites were actively used for cropland, pasture, or urban/exurban development (Price et al. 2007). These types of land use significantly decrease the native seed bank, alter edaphic processes, and hydrology (Middleton 2003, Bruland and Richardson 2005). Despite these past and present impacts, anthropogenically altered wetlands can maintain a diverse flora with relatively low exotic species abundance (Ehrenfeld 2005) because the physiological stressors of flooding can act as an establishment barrier to upland plant species (van

der Valk 1981, Keddy 1992, Lockwood et al. 2007). Shading in woodland environments may be an additional barrier to the colonization or dominance of understory invasive plants (Martin et al. 2009, Schramm and Ehrenfeld 2010, Stinson and Seidler 2014), whose superior competitive traits make them poorly suited for less than optimal growing conditions (Grime 1977, Davis et al. 2000; e.g., low light levels, anoxic soils). Therefore, a decrease or low proportion of hydrophytes can be an indication wetland dewatering. Similarly, dominance of generalist plant species, such as those with low coefficient of conservatism ("C") values (<4), may signal ecosystem degradation or anthropogenic disturbance (Swink and Wilhelm 1994).

New York State (NYS) needs calibration information for wetland condition and function at the urban end of the landscape spectrum to best understand the effects of development on wetland integrity. Therefore, our secondary goal focuses on expanding our dataset to better reflect NYS's urban-rural environment. To meet this goal our field sampling targets watersheds with a gradient of urbanization (hereafter referred to as development). In our previous Wetland Program Development Report, we recalibrated our wetland assessment metrics including floristic quality (Level 3), rapid wetland condition assessment (Level 2), and Landscape Condition Assessment (Level 1), and developed preliminary thresholds for identifying reference wetlands. Characterizing wetland condition is therefore crucial for understanding and mitigating potential impacts of human-mediated alterations (e.g., urbanization, invasive insects) to ecosystem structure and function.

Project Objectives

1) To develop and pilot a wetland functional assessment method that addresses functions and values that are protected under the NYS Freshwater Wetlands Act, Article 24.

2) Complete our established three-tiered assessment methods at random points within the Mohawk and Allegheny target basins. Data include vegetation plot surveys (Level 3), NYNHP's New York Rapid Assessment Method for assessing wetland condition ("NYRAM", Level 2), and generating landscape-scale metrics (Level 1, Landscape Condition Assessment Model [LCA]).

3) Research options and develop a mobile application (app) for NYRAM, our protocol for evaluating palustrine wetland ecological condition.

4) Generate a "quick guide" for users to identify wetlands of potential statewide significance because on size and native plant species' dominance.

METHODS

The established methods presented here are part of a three-tiered sampling approach (Level 1, 2, 3, Figure 28); similar methods have been employed by federal and state agencies in an effort to develop environmental monitoring protocols (Jacobs 2010, Faber-Langendoen et al. 2012, PA DEP 2014). For Level 1 (L1), the New York Natural Heritage Program (NYNHP) developed a statewide Landscape Condition Assessment (LCA) model that cumulatively depicts key anthropogenic stressors across the NYS landscape at a 30 x 30-m resolution (Figure 1; Feldmann and Howard 2013). Rapid assessment methods (RAMs) developed for Level 2 (L2) classify and catalog anthropogenic stressors using basic quantitative air photo interpretation and qualitative field surveys.

Our established New York Rapid Assessment Method (NYRAM ver. 5.3, Appendix B) provides users with a relatively quick procedure for assessing the quality and condition of NYS wetlands (Shappell et al. 2016, Shappell and Howard 2018). NYRAM field methods employ a stressor checklist that was modeled after established RAM procedures developed for Mid-Atlantic States (Jacobs 2010, PA DEP 2014). We developed new protocols for assessing wetland functions and values, as discussed below. Level 3 (L3) relevé sampling protocols modified after Peet et al. (1998) capture detailed vegetation structure and floristic biodiversity (see Appendix A for detailed methods). Below we briefly outline our established assessment protocols prior to discussing the new functional assessment method.

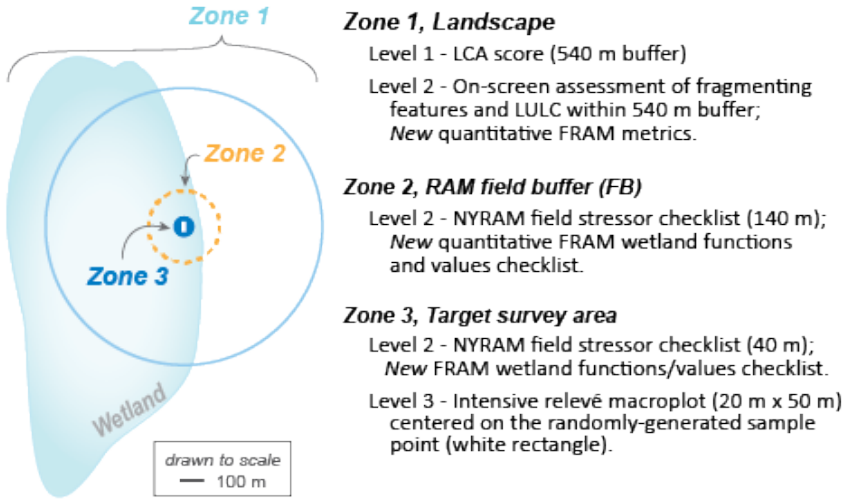


Figure 1: Schematic of our established three-tiered assessment methods and the new functional assessment method. The functional assessment method also includes factors at a broader scale during the on-screen evaluation portion of the protocols (e.g., anthropogenic development upslope, potable water resources, habitat connectivity, etc.)

Level 1 Metrics: Landscape Condition Assessment

Our previous work has demonstrated strong correlations between landscape stressors modeled in the LCA and on-the-ground floristic quality metrics (Shappell et al. 2016, Shappell and Howard 2018). Our established L1 LCA scores use zonal statistics calculations to produce a mean score based on a 540-m radius buffer (hereafter, “LCA540”) around each Level 3 site. The ArcGIS (10.3) Zonal Statistics tool produces basic descriptive statistics (mean, max, min, and variance) based on pixel scores within a defined area (polygon). Figure 2 shows our statewide LCA model developed by Feldmann and Howard (2013).

Level 2 Protocols

New York Rapid Assessment Method (NYRAM)

Our updated NYRAM version 5.3 incorporates onscreen (Part A) and field (Part B) components that broadly assess hydrology, fragmentation, vegetation composition, and water quality relative to wetland ecological condition (Appendix B). The field stressor checklist used for this method encompasses a broad range of potential stressors that may influence natural wetland structure (e.g., plant species composition) and function (e.g., ground water recharge, nutrient cycling), while providing flexibility for practitioners to document unique stressors present at their assessment site.

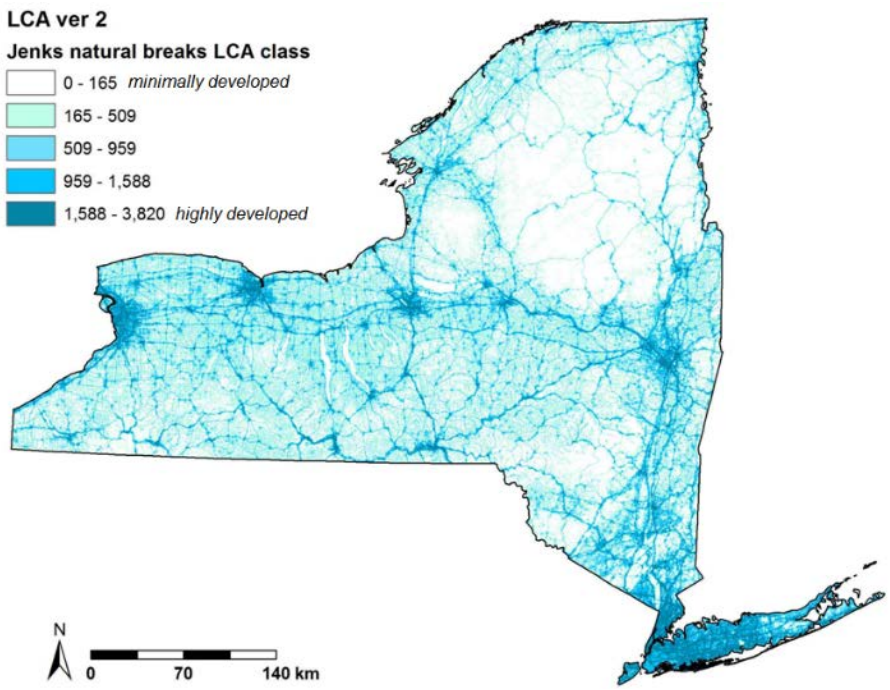


Figure 2: The landscape condition assessment (LCA) model developed by Feldmann and Howard (2012) incorporates 13 human land use input classes. White and mint green/aqua colors indicate least developed/ most natural while medium to dark blue show highly developed areas. Model resolution: 30 m x 30 m. Color categories follow Jenks (1967) natural breaks. This GIS rasterized spatial data layer may be downloaded at nynhp.org/data.

Variables are weighted and rolled into a final score with low scores indicative of minimal anthropogenic disturbance and good ecological condition (scale 0-100).

One of the goals of this project was to assess performance of our Level 2 NYRAM scores given our update to the protocol in 2018 (NYRAM ver. 5.0, Shappell and Howard 2018). Since then, our NYRAM dataset has grown by >20%, including greater coverage across NYS and along an urban-rural gradient. Our previous recalibration process relied on cross-level validation (e.g., NYRAM vs. floristic quality scores), and explored the utility of replacing the original onscreen assessment (Part A) with an automated LCA540. Using LCA scores for Part A makes the method more rapid and eliminates potential variance among observers. Field methods for NYRAM remained largely the same, presently at version 5.3, but metric recalibration, including scaling the final score to range between 1 and 100, were significant. Here we employ the automated version of the NYRAM protocol and all results will display scores from that method, presented on the 1-100 scale.

Level 3 Protocols

Our protocols are modified after the Carolina Vegetation Survey (Peet et al. 1998) approach of sampling subplots within a larger 20 x 50 m relevé macroplot. In four 10 m x 10 m subplots, we collected a complete species list by strata with percent cover and tree diameter for stems ≥10 cm DBH (Diameter at Breast Height = 1.3 m). Within the entire relevé macroplot, we recorded percent cover for all residual species not observed in the focused subplot surveys. Live and dead tree canopy basal area (m^2ha^{-1}) was calculated based on tree DBH. New field surveys completed under this project took place between June and September during 2018 and 2019.

Functional Rapid Assessment Methodology (FRAM) for palustrine nontidal wetlands in New York State (ver. 1.0)

The primary focus of this new protocol is to quantify wetland ecosystem functions and values relative to state and federal regulations. Similar to our NYRAM stressors checklist (Appendix B), users document the presence of indicators. At a minimum, as in other methods (e.g., USACE 2015 and VDEC 2019, Tiner 2011, and WVDEP 2021), the presence of an indicator signifies a function is "present". Similarly, multiple "yes" answers within a subcategory indicate a function is performing at a higher level. Indicators that a function is performing at a lower level are also noted (e.g., dewatering structures that reduce flood duration may reduce a wetland's capacity for denitrification or stormwater desynchronization).

This assessment is centered on a sample point and applied at four spatial scales, or "Evaluation Areas": sub-basin/upslope and downslope drainage areas, contiguous wetland ("contig." or "WH"), Field Buffer (FB = 140 radius around survey point), and Survey Area (SA = 40-m radius around survey point). The field portion of the form has eight broad function and value categories as outlined in Table 2 and includes >170 indicators or ranking options. Minimum ranking criteria have been created for each category using indicators relevant to the function being evaluated. Following individual category ranking, users can gain a general understanding of an evaluation area's overall functional value by combining or "rolling-up" ranks to achieve a summary score. Given the data requirements, this metric is only applicable to the SA and FB, not the contiguous wetland. Points are associated with each ranking level – more points for higher ranks – "very high" = 4 points, "high" = 3 points, "moderate" = 2 points, and "low" = 1 point. The summary roll-up score is calculated by summing all category points (Table 1), dividing by total possible points (34) and multiplying by 100. The lowest possible score is 24 and the highest is 100.

Table 1: Point assignment is simple – more points for higher ranks. All sections except hydrologic health and natural community development follow this scoring: Very High = 4 points, High = 3, Moderate = 2, and Low = 1 point. Natural Community development scoring is as follows: Excellent = 7, Very Good = 6, Good = 5, Fair = 3, Poor = 1. Hydrologic "health" scoring: None or none apparent = 4, Recovered = 3, Recovering = 2, Recent or no recovery/ongoing = 1.

Category	**Maximum points**	**% of final score**
Flood and storm water control	4	11.8%
Hydrologic "health"	4	11.8%
Erosion control	4	11.8%
Subsurface and groundwater resource protection	4	11.8%
Natural community development	7	20.7%
Pollution	3	8.7%
Wildlife	4	11.8%
Values	4	11.8%
Total possible points in the SA or FB:	**34**	**100%**

Table 2: Eight broad categories that aim to characterize wetland functions and values, as expanded upon in our Functional Rapid Assessment Method (FRAM, see Appendix). Flood/storm water control, erosion control, subsurface/groundwater resource protection, and pollution all impact surface and subsurface water quality and water resource security. Potable surface waters in NYS includes groundwater (Class GA) and surface water Classes A, A-Special, AA, and AA-Special. These classes are a priority for protection to help ensure their use as potable water sources (drinking water quality standards determined by the NYS Dept. of Health). Each category requires field observations, however we've listed relevant geospatial data that are useful and in some cases necessary to complete the assessment. These spatial data may be accessed via NYS DEC's interactive mapping services (https://www.dec.ny.gov/pubs/42937.html), the NYS GIS Data Clearing house (https://gis.ny.gov/gisdata/), and New York Natural Heritage https://www.nynhp.org/modeled-data/.

General rank category	**Rank scale** [number of options]	**General contributing factors, relevant traits, or examples**	**Relevant spatial data layers/sources (if any)**
Flood and storm water control	Low – Very High [4]	Wetland possesses characteristics associated with flood attenuation and surface water retention/dispersion (e.g., lacks a steep slope, presence of dense persistent vegetation and microtopography).	- Current aerial imagery - Topography - Digital Elevation Model
Hydrologic "health"	Recent or no recovery/ongoing – None or none apparent (undisturbed) [4]	Evidence of anthropogenic disturbance evaluated for severity of impact and level of wetland recovery (e.g., current dewatering efforts, vegetation consists primarily of ruderal plant species, or native wetland vegetation dominates and reflects the current hydroperiod, undisturbed soil profile [e.g. no evidence of tilling]).	- Current aerial imagery - Historical aerial imagery - Dams - Roads in New York State - Railroad Lines and Stations
Erosion control	Low – Very High [4]	Evidence that wetland functions as a floodplain or could receive overland flow (e.g., occurs adjacent to a stream, siltation or drift deposits are observed, woody vegetation is providing streambank stabilization)	- Current aerial imagery - Northeast Aquatic Habitat Classification System - Natural Heritage (NH) Riparian Buffers (Trees for Tribs statewide) - New York Soils, gSSURGO
Subsurface and groundwater resource protection	Low – Very High [4]	Evidence that the wetland interacts with groundwater or subsurface water resources (e.g., stable year-round water levels, occurs over a primary or principal aquifer, or potentially supports water wellheads). Potable water sources in NYS includes groundwater (Class GA).	- Unconsolidated Aquifers @250K - Upstate NY - Public Water Supply - AA and AAs Watersheds - Surficial Geology, USGS - New York Soils, gSSURGO

General rank category	**Rank scale** [number of options]	**General contributing factors, relevant traits, or examples**	**Relevant spatial data layers/sources (if any)**
Natural community development	Poor – Excellent [7]	The absence of disturbance or, if present, the severity of its impact (e.g., a forested wetland displays old growth indicators, over-browsing has led to poor seedling recruitment but invasive species cover remains low, or invasive species dominate the wetland and its hydrology has been significantly altered).	- Current aerial imagery - Historical aerial imagery
Pollution	Low – High [3]	The opportunity for a wetland to intercept pollution (e.g., it is positioned in a human-dominated landscape [>25% not natural land cover], occurs near a road/industrial property/mine/logging/etc., or has dewatering features that reduce flood retention or interception thereby potentially reducing potential functional capacity).	- Current aerial imagery - Water Quality Classifications - WI/PWL TMDL - Roads in New York State - Railroad Lines and Stations
Wildlife (includes five animal "guilds")	Low – Very High [4]	Evaluates the diversity of wildlife habitat provided by the wetland (e.g., it supports all five animal "guilds", exhibits evidence of current use by wetland species, contains +3 wetland vegetation classes). General spatial data helpful to all or several guilds are listed to the right.	- Current aerial imagery - Scenic Areas of Statewide Importance - NH Important Areas - NH Element Occurrence, Animal Screening. - Migratory Fish Runs
Birds	N/A	Observed habitat use or presence of features creating foraging, breeding or nesting habitat (e.g., water depth/duration necessary for waterbird foraging, occurs within an Important Bird Area, community structure/ species composition aligns with a species' favored habitat)	- Important Bird Area - Bird Conservation Areas - Breeding Bird Atlas - Grassland Bird Focus Areas
Mammals	N/A	Observed habitat use or presence of features creating favorable habitat (e.g., bear scat encountered, trees or snags with shaggy bark or cavities providing potential bat roosting habitat).	(see above)
Invertebrates	N/A	Observed habitat use or presence of features creating favorable habitat (e.g., Direct observation of wetland-dependent/associated invertebrates such as dragonflies or fingernail clams, floral resources present at >25% during the growing season).	- Freshwater Mussel Screening

General rank category	**Rank scale** [number of options]	**General contributing factors, relevant traits, or examples**	**Relevant spatial data layers/sources (if any)**
Amphibians and reptiles	N/A	Observed habitat use or presence of features creating favorable habitat (e.g., presence of vernal pools, general habitat features such as large rocks/logs for basking, shallow littoral zones with emergent vegetation to provide cover, etc.)	- HERP Atlas
Freshwater and marine fish	N/A	Observed habitat use or presence of features creating favorable habitat (e.g., provides general spawning, nursery, feeding, or cover habitat, or fish are directly observed within the waterbody).	- Migratory Fish Runs - Water Quality Classifications (trout streams) - Dams (may block passage)
Values (includes four value sub- categories)	Low – Very High [4]	Evaluates the general value of the wetland considering both human and natural elements (e.g., the wetland provides recreational or educational opportunities, or contains local or regionally unique features). General spatial data helpful to all or several categories are listed to the right. Data sources listed under wildlife may also apply here (e.g., bird layers for bird watching, migratory fish runs for fishing, etc.).	- Current aerial imagery - Historical aerial imagery - Trails, State and Federal - Publicly-accessible lands (NYS or municipal Parks, etc.) - Wild, Scenic, and Recreational Rivers - Scenic Byways, Rivers, and Areas of Statewide Importance
Recreation value and economic benefit	N/A	Considers features providing recreational opportunity or economic benefit (e.g., wetland occurs on public land, provides habitat for fish/wildlife/flora that can be fished/hunted/trapped/foraged, or users pay entrance fees).	- Boat Launch Sites - Public Fishing Access
Open space and aesthetics	N/A	Considers features that encourage human connection with the natural landscape (e.g., surrounding land use contrasts sharply with the wetland or it contains a diversity of plant species, including those that flower or turn vibrant colors in different seasons).	- Roads, proximity to
Education and research	N/A	Considers a wetland's ability to provide educational or research opportunities (e.g., the wetland is near a school and off-road parking if present, or developed, could accommodate a school van/bus, or has been the site of a scientific study).	- Maps showing proximity to nearby cities, towns, schools, universities, etc.

General rank category	**Rank scale** [number of options]	**General contributing factors, relevant traits, or examples**	**Relevant spatial data layers/sources (if any)**
Uniqueness	N/A	Considers wetland attributes related to public health, recreation, and habitat biodiversity (e.g., Rare, Threatened, & Endangered species are known to occur in the area, or the surrounding area is primarily urban, creating flooding/water quality concerns).	- Unique Geological Features, such as karst, seeps/springs, etc. - Archeological sites - State Historic Site - Heritage areas, NYS
Special wetlands	N/A	Considers attributes that distinguish this wetland from others or may make it deserving of more stringent protections (e.g., the wetland is an example of a rare or uncommon community type, lacks historical land use, or is a NYS DEC Class 1 wetland.	- Surficial geology - SSURGO soils (NRCS USDA)

Mobile App Development

Platform research and choice

Our task was to research different application development environments for building a mobile data collection system and then implement the most appropriate solution. Our goals were to find a system that:

- Has a large established user and development community.
- Is relatively mature in its development cycle.
- Would be available to other users (our partners) throughout the state without extra fees or costs.
- Allows for data collection and storage when not connected online.
- Allows for data synchronization to the cloud when online.
- Incorporates relational data structure.

Table 3: Data collection applications (apps) we evaluated for use.

Name	URL	Comments
Survey123	survey123.arcgis.com/	Robust but concern about partner access, use, and data sync.
wq	wq.io/	Appealing but didn't seem to have a large support community, not very mature in development cycle.
Geopaparazzi	www.geopaparazzi.org/#/	Excellent spatial capabilities but relatively simplistic data collection design and function.
Fulcrum	www.fulcrumapp.com	Robust versions require user fees.
Open Data Kit (ODK)	opendatakit.org	Large user base, no relational tables.
ODK-X	odk-x.org	Large user community, allows for relational tables (additional highlights below).

We summarize the application platforms we explored in Table 3. This list is not exhaustive and development environments available for our use continue to change over time, but the development environments we explored offered an appropriate range in functionality, accessibility, and time investment. We settled on ODK-X. ODK-X, formerly ODK-2, which has a large and active user community (https://odk-x.org/community/) with a help forum (https://forum.odk-x.org/) that we found to be particularly informative when trying to reach our goals. The extensive documentation (https://docs.odk-x.org/), software components handling all different aspects of the workflow, the regular release schedule (https://odk-x.org/software/), open-source environment (https://github.com/odk-x), and simple fact that it seems to provide all the components we were looking for made it the stand-out choice for this project.

Data entry form development

The most important, and time-consuming, part of application development was designing the data-entry form and form components to effectively match the paper form and data types. ODK-X has default settings and behavior but also allows for infinite customization as needed.

Some of the capabilities we took advantage of included:

1. Using a lookup table. We included text files (csv files) with lists, such as counties, towns, and wetland natural communities in New York and had fields that would base their drop-down values on the lists in those tables.

2. Using dependent dropdowns. After a user chooses the county they are working in, the "Town" drop-down list only includes the towns occurring within the chosen county.

3. Using related tables. There may be many surveyors at a single site. That one-to-many relationship is entered on the form following that related structure and stored in a separate table.

4. Defining custom 'choice' lists to support simpler drop-downs menus and radio-button style options.

    a) Utilizing integrated GPS fields to store location information.
    b) Defining custom calculation fields and functions that can fill in multiple fields with a single button press or calculate summary scores on demand from the user (e.g., see "Grand Score" screenshot below).
    c) Branching data-entry flow such that fields stay hidden unless a user chooses one answer, then those fields appear to allow input. One example of this is the option to select 'non-standard' plot. If the user does this, then additional fields (plot dimensions) appear for the user to fill out.
    d) Custom defined table of contents for easier navigation throughout the form.
    e) Applying constraints to disallow conflicting selections (such as "stressor present in Survey Area" and "stressor absent" both selected), a useful feature for quality control.
    f) Utilizing html formatting so text can appear italicized (scientific names), bold, larger, or smaller (headers and space-efficiency)
    g) Including images on form pages to support the question

The current design for NYRAM comes to 21 data entry screens that step the user through all the field data collection components. Screenshots of the initiation page plus five of the data collection pages are shown in Figure 3.

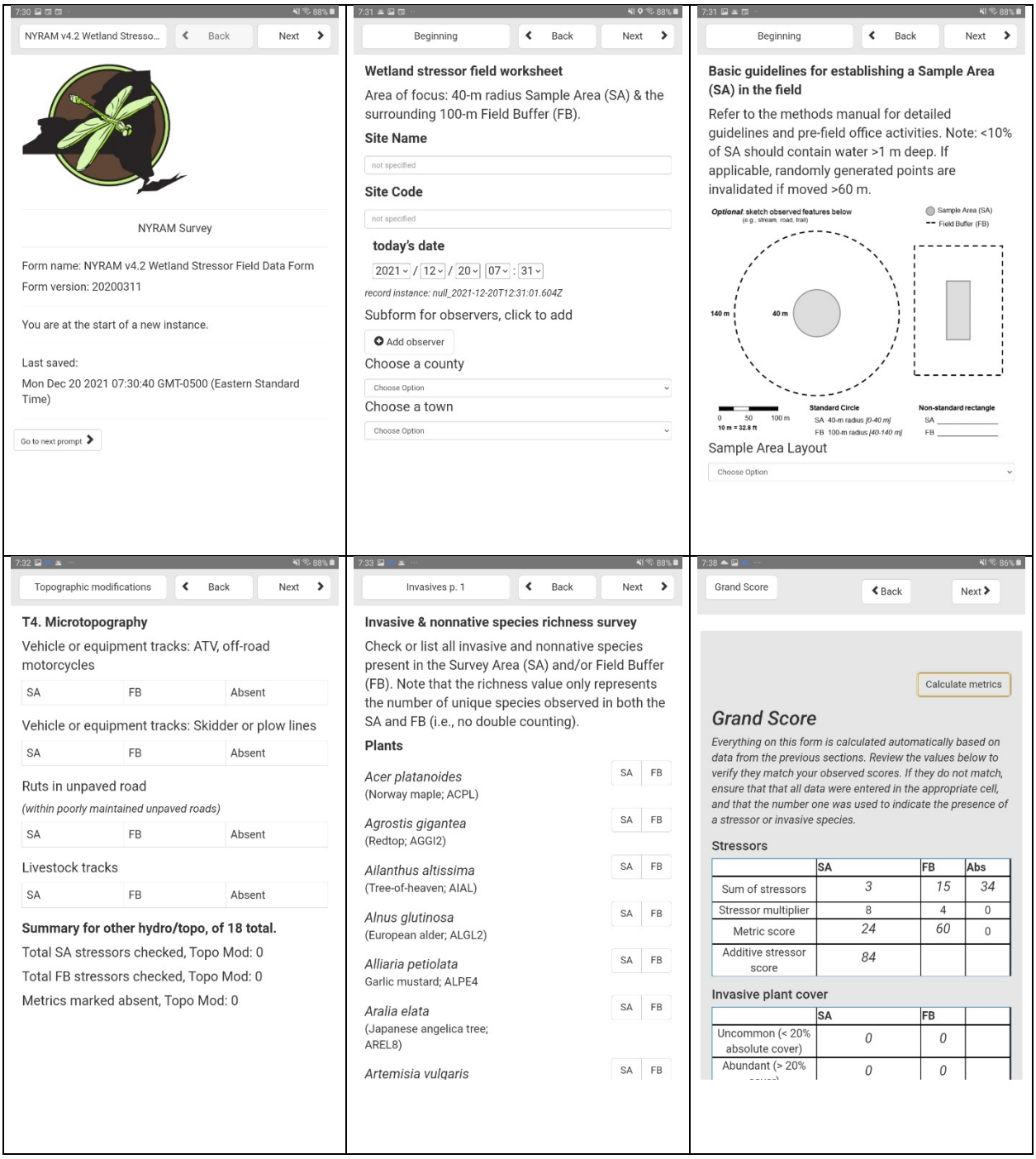


Figure 3: Sample screen shots of the NYRAM data collection forms in ODK-X.

Form dissemination, data cycle workflow

ODK-X incorporates a cloud-based data exchange system called "Sync Endpoint" (https://docs.odk-x.org/sync-endpoint/) that allows two-way communication between a user's instance of the application and data in the cloud. We installed the containerized version on the NYNHP servers and will continue to maintain that system moving forward. A user sets up the data collection system by installing three standard ODK applications ("ODK-X Services", "ODK-X Survey", "ODK-X

Tables") and then synchronizing to the server. This first synchronization installs all forms and data onto the local unit (tablet or phone).

After using the forms and collecting data, the user then synchronizes again to push all data they collected up to the server. We then download those data from the server and load them into our database, where the data undergo Quality Control, are stored long-term and are available for analyses.

User Interface

An added benefit of the ODK-X system is the ability to customize how users initiate a new survey entry and review existing records. We took advantage of this feature to add an entry point that initially looks like Figure 4.

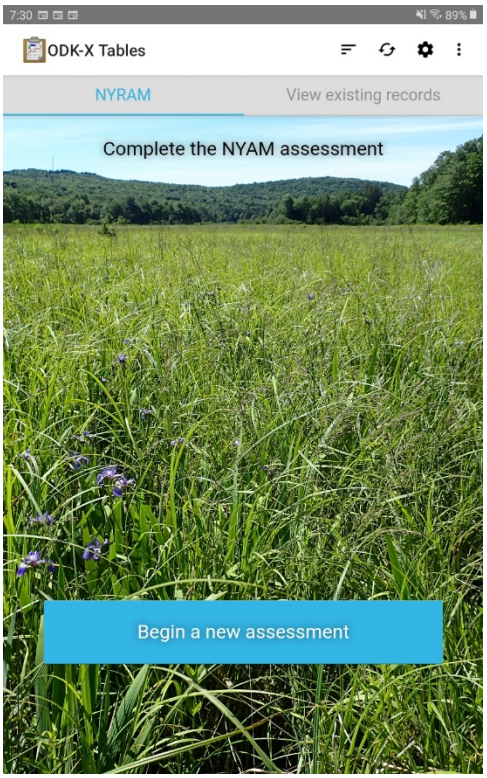


Figure 4: The start page for users. Note the "View existing records" tab, which provides users with easy access to data they have already collected.

The long-term benefit to having this launch page is that as we add more ODK-X data entry forms, they can be added to this landing page, providing clearer access to the variety of forms we can develop.

Target Basins and Site Selection

Study areas

New sample sites focused on non-tidal freshwater systems primarily within the Mohawk and Allegheny watersheds (Figure 5). Watershed selection followed NYS DEC Division of Water's established rotating assessment cycle. An additional site was sampled in the Rochester metro area at Mendon Ponds Park (Monroe County, Southeastern Lake Ontario basin) during a regional training workshop with local biologists.

Mohawk

Covering approximately 3,460 square miles, the Mohawk River Basin is divided into two sub-watersheds, the Mohawk and the Schoharie. The former consists of the Mohawk River flowing eastward from its headwaters in the southwestern Adirondack Mountains to where it meets the Hudson River in Cohoes, NY. The later receives drainage from Schoharie Creek, which reaches into the northern Catskill Mountains. Residential and agricultural land uses dominate the watershed, with much of the agriculture occurring adjacent to the mainstem of the Mohawk. Spanning over 4 ecoregions including the Adirondacks to the north and the Catskill Peaks to the south, the majority of the basin falls within the Mohawk Valley. Forest and agriculture are the dominant land covers within the watershed (50% and 25%, respectively) with wetlands comprising 6.6% (MRWC 2015).

Allegheny

Spanning approximately 1,920 square miles over the southwestern tip of New York State, the Allegheny watershed consists of 3 sub-watersheds with varying levels of anthropogenic stress. About half of the main basin is comprised of the Allegheny River sub-watershed where its namesake flows up from its headwater source in north central Pennsylvania and continues for 48 miles to the west before turning south again to exit New York. Heavily wooded and largely undeveloped, it contrasts with the sub-watersheds of French Creek and Chautauqua Lake to the west where agriculture and development are more common. Overall, forest and agriculture are the dominant land covers within the watershed (67% and 27%, respectively) with wetlands comprising about 21% of the basin, which falls within the Western Allegheny Plateau ecoregion (NYS DEC 2005).

Sample frame

Our sample frame included the following National Wetland Inventory (NWI) non-tidal, non-riverine palustrine community types: emergent (EM); broad-leaved deciduous (FO1) and needle-leaved evergreen (FO4) forested wetlands; and scrub-shrub (SS) (U.S. Fish and Wildlife Service 2015). To ensure we surveyed wetlands in urban and rural area we stratified our sample frame by Landscape Condition Assessment (LCA) score, as well as contiguous wetland size. Adjacent polygons of the target wetland types were merged prior to polygon size (ha) and mean LCA calculations in ArcGIS (ESRI 2014). Wetlands were then binned by wetland size (<12, 12-28.3, >28.3 ha) and polygon mean LCA score where the lowest bin represents wetlands that are least disturbed (LCA <80; 80-300, 300-1000, and >1000). The size bins follow the Jenks natural breaks classification method (Jenks 1967) and the LCA bins were developed following Shappell and Howard 2018. We limited our sample frame polygons to >50 and <140 m from the wetland edge, effectively producing a narrow ring in which the sample draw (points) could be placed; doing so helps ensure the LCA bin reflects the sample area (vs. the interior of a large wetland that may buffer itself).

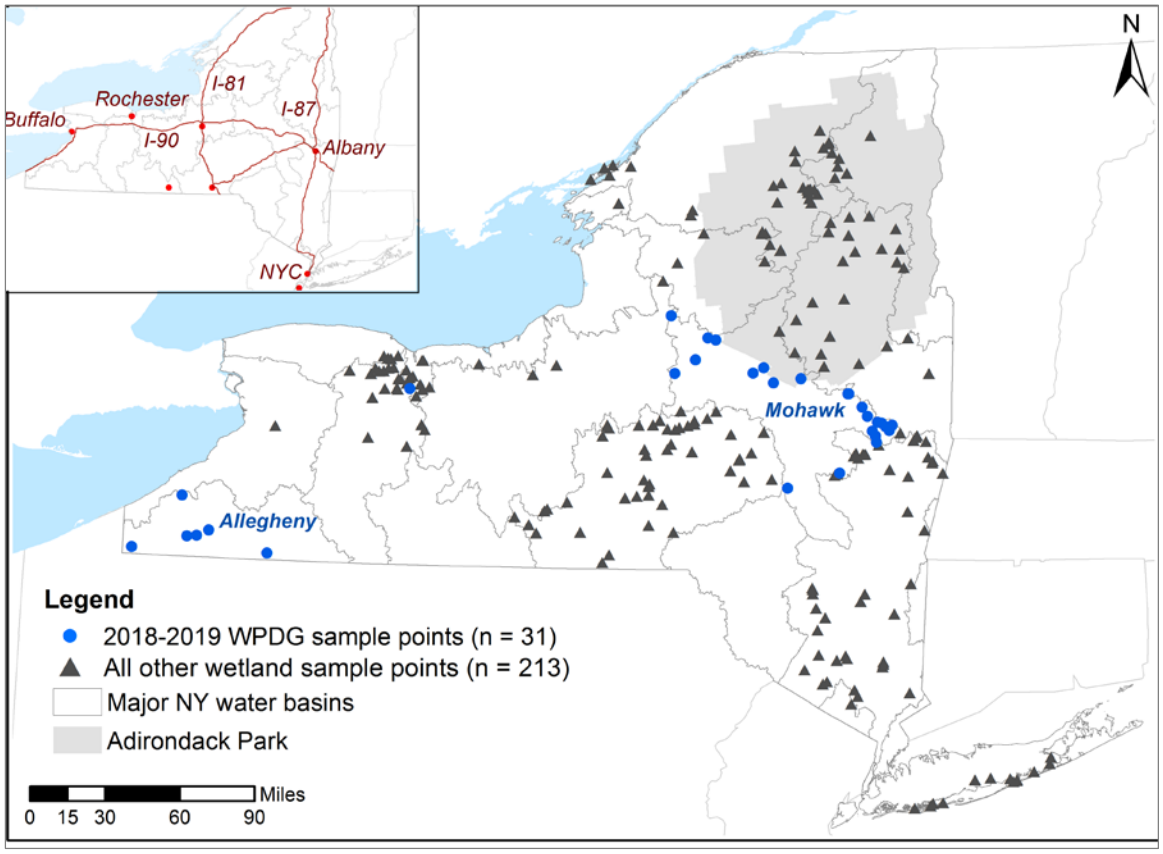


Figure 5: The Mohawk and Allegheny watersheds were targeted during this project's 2018-2019 sampling seasons. All sample sites for this project were randomly selected with the exception of one point at Mendon Ponds (Monroe County Park), south of Rochester in the Genesee watershed. We did a field training workshop at Mendon Ponds and wanted to include those data here.

Sample draw and site evaluation

We submitted the pool of potential wetlands to EPA statistician Tony Olsen to prioritize wetland site selection. The final sample pool used the Generalized Random Tessellation Stratified (GRTS) sample design (Stevens and Olsen 2004) stratified by watershed, LCA bins (per Shappell and Howard 2018) and wetland size bins (<30 ha [<74 ac], 30-70 ha, and >70 ha [>172 ac]). The GRTS method produced a spatially balanced sample draw of 30 wetlands with each wetland containing up to 11 random sample points relative to wetland size; within-wetland points were placed >40 m apart. Wetland sites and sample points were surveyed in numerical order of the sample draw with overdraw (back up) wetlands or points used when a site did not meet our evaluation criteria or we were unable to secure permission to access the land. We requested about a third of the wetlands be in the Allegheny basin because it is approximately half the size of the Mohawk basin. Because this project targeted an urban-rural gradient, sample points surrounded by agriculture (>2/3) were removed from the sample frame during preliminary site evaluation. Selected sites ranged in hydroperiod classes (sensu Cowardin et al. 1979) from seasonally flooded to permanently flooded (U.S. Fish and Wildlife Service 2015), but for safety reasons we only survey points that have ≤1 m of standing water at the time of survey.

Securing landowner access was a critical step in the site selection process. During this project 125+ access request letters were mailed to landowners in the target survey basins. Approximately one in three landowners replied to our letters, which is a relatively good response rate. Thanks to private landowners' generosity, nearly 65% of our sampled random points occurred on private land.

Statistical Analysis

Biodiversity metrics

Vascular plant nomenclature was updated prior to analyses per Werier (2017). Richness values ("S") presented here includes vascular and nonvascular plants identified to genus or species. Each species is assigned a coefficient of conservatism value ("C" value) that reflects a species' fidelity to characteristic environmental conditions in NYS (i.e., 10 = highly conservative/narrow ecological tolerance, 0 = cosmopolitan) (Swink and Wilhelm 1994). C values for a given site were averaged ("mean C": $\bar{C}$) and weighted by the proportion ("p") of cover they contributed to a given site ($\bar{C}_{wt}$, Equation 1). NYS botanists produced these C-values (reported by Ring 2016) with funds from the EPA Wetland Program Development Fund (EPA CD96294900-0). As with other studies, we have found C-value metrics perform more strongly in wetland systems than Floristic Quality Assessment Indices (e.g. Matthews et al. 2005, Miller and Wardrop 2006, Bried et al. 2013, Shappell et al. 2016, Chamberlain and Brooks 2016), so we use them exclusively, referring to them here as our floristic quality metrics.

Equation 1

$$\bar{C}_{wt} = \sum_{i=1}^{S} \frac{p_i C_i}{S}$$

Data analysis

Trends among and within indictors from each of the three levels were analyzed using correlation analysis and pairwise comparisons. Unless noted, data are presented as mean ± one standard error of the mean (SEM). Analyses were completed in SPSS (IBM Corp 2021). Scatter plot graphs were used to ensure the majority of the data points fell within the 5th and 95th percentiles or confidence intervals (correlation or regression), and that a few outliers were not driving the significant correlation trend; based on these guidelines outliers were removed prior to final analysis. Boxplot graphs presented here indicate the median line, 5th and 95th percentiles (error bars), and outliers (dots or asterisks).

A significance level of $p < 0.05$ was used for linear regression and one-way ANOVA analyses. Data that violated ANOVA assumptions were transformed or analyzed with Kruskal-Wallace (K-W) one-way analysis of variance on ranks using a significance level of $p < 0.05$. Significant pairwise differences are indicated in figures by differing letters on the boxplot or the x-axis label.

RESULTS AND DISCUSSION

This section begins by focusing on our 2018-2019 survey sites where we developed and deployed our new wetland functional assessment protocols. Wetlands in this subset of the data were distributed along an urban-rural gradient and ranged from good to very poor condition. We then discuss our efforts to identify potential wetlands of statewide significance, combing through our

database of over 200 wetlands, and the development of a "quick guide" for evaluating whether a community may be of statewide significance.

Summary of new survey sites

During the 2018 and 2019 field seasons we surveyed 24 sites in the Mohawk basin and six in Allegheny basin, with a bonus training site in the Rochester metro area (Genesee basin). Wetland size among our target basins ranged from a small, 0.5 ha urban Red maple-hardwood Swamp in Albany County (Mohawk basin) to a very large, >1800 ha, Floodplain Forest in Cattaraugus County (Allegheny basin). Final LCA540 scores reflected our desired development gradient – from a Highbush Blueberry Bog in a Wildlife Management Area (LCA540 = 26) to a Capital Region urban wetland (LCA540 = 1636; mean = 698 ± 130). The majority of our Survey Areas (60%) were in a terrene landscape setting, including terrene headwater and terrene riparian classifications as described by Tiner (2014). A third of sites were lotic, associated with flowing water; the remainder of sites were lentic (10%), associated with ponds or lakes (i.e., still or calm waters).

Forested wetlands comprised 66% of our random sample points, followed by emergent marshes/wet meadows (20%), and shrub swamps (14%). Hydroperiods ranged from permanently flooded basin marshes to seasonally saturated terrace swamps. Red Maple- and Hemlock-Hardwood Swamps (n = 5 and 5, respectively) were the most common forested community types that we surveyed. In forests hardest hit by the nonnative Emerald Ash Borer (*Agrilus planipennis*) dead ash (*Fraxinus* spp.) boles accounted for 30-70% of total stems; ash trees were present in about a third of our forested wetlands. Nonnative invasive plant richness averaged five (± 1) species per 1000 m^2 macroplot, and 10 (± 1) unique nonnative species in the SA and FB (i.e., 8 spp./5 ha/12.4 ac). Only one site lacked nonnative plants in the SA and FB. Relative cover of nonnative plants peaked at 41% in our Level 3 plot surveys, but was low throughout most of our plots (6% ± <1%). The most common nonnative plants encountered during this project were Multiflora Rose (*Rosa multiflora*, 66% of plots), Common Buckthorn (*Rhamnus cathartica*, 69%), invasive vine Bittersweet Nightshade (*Solanum dulcamara*, 62%), Purple Loosestrife (*Lythrum salicaria*, 48%), and Creeping-Jenny (*Lysimachia nummularia*, 32%).

At the subbasin scale (12-digit Hydrologic Unit Code, "HUC 12"), survey sites were distributed across 22 subbasins, averaging 9,524 ha (± 599 ha). A headwater to the Mohawk, Mine Kill, is the smallest subbasin (4,621 ha); the largest is nearly three times larger, Zimmerman Creek-Mohawk River (14,233 ha). Seven of these subbasins are positioned as headwater catchments within the larger Mohawk target basin. Relative to their subbasin size, most contiguous wetlands in this study comprised <1% of the total basin (HUC 12). Five sites accounted for 1-2% of the basin and three wetland sites covered 3-5% of their HUC 12 subbasin.

Using US EPA's Watershed Index Online (WSIO, US EPA 2021) tool we have outlined some relevant HUC-12 data in Table 4. In our surveyed subbasins developed land cover ranged from a low of 2% (SW edge of the Adirondack Park), to a high of 52% (Schenectady, NY). Hydrologically-active riparian zones comprised an average of 40% of the land area (range: 17-65%, n = 22); wetland cover was similarly high, averaging 11% (range: 3-24%). Historical wetland loss in some of these subbasins is estimated to be as high as 80%. Nearly a third of soils in these subbasins have moderate or high runoff potential, which has important implications for natural resource conservation.

Table 4: Data shown below highlights some aspects of watershed (WS) land use, land cover, and potential sources, or reflections of, anthropogenic stressors. Data are presented at the HUC12 scale where a site was surveyed for this project. Three summaries are presented for comparison: the first is an average for all of our surveyed HUC12 watersheds; second, averages for basins in the NY portion of the Allegheny watershed; and last, a summary for the entire Mohawk basin. Data source: US EPA 2021; indicator metadata in MS Excel files: https://www.epa.gov/wsio/wsio-indicator-data-library.

Basin name	HUC12 Watershed (WS) Name HUC12 code	NYNHP Site ID	Riparian Zone in WS[5]	Wetlands in WS	Wetlands Remaining in WS[6]	Tile or Ditch Drained in WS[7]	Moderate/High Runoff Potential Soils in WS	% Developed SUM
Allegheny	Outlet Tunungwant Creek HUC12: 50100010605	NYW19-A201	17%	4.6%	35%	0.1%	74%	3%
	Chadakoin River-Chautauqua Lake HUC12: 50100020207	NYW18-A185, NYW19-A117	24%	4%	19%	1.1%	36%	31%
	Upper Cassadaga Creek HUC12: 50100020303	NYW19-A197	35%	16.3%	53%	1.8%	55%	4%
	Indian Brook-Conewango Creek HUC12: 50100020406	NYW19-A173	31%	12.6%	38%	1.6%	31%	5%
	Beaver Meadow Brook-French Creek HUC12: 50100040106	NYW18-A125	28%	7.3%	24%	2.7%	28%	5%
Mohawk	Wheelers Creek-Mohawk River[1] HUC12: 20200040302	NYW19-M119	53%	12.1%	97%	1.2%	18%	8%
	Lower Ninemile Creek HUC12: 20200040306	NYW18-M102	34%	3.8%	87%	1.3%	24%	5%
	Cincinnati Creek[1] HUC12: 20200040506	NYW18-M113, NYW19-M129	40%	9.7%	100%	0.9%	44%	5%
	Spruce Creek[1] HUC12: 20200040806	NYW19-M126	46%	13%	88%	0.6%	33%	2%
	Middle East Canada Creek HUC12: 20200040807	NYW19-M110	42%	9.3%	75%	0.4%	41%	4%
	Zimmerman Creek-Mohawk River HUC12: 20200040901	NYW19-M142	43%	11.1%	100%	1.3%	53%	5%
	Peck Lake-Caroga Creek[1] HUC12: 20200040904	NYW19-M136	45%	9.3%	67%	0%	64%	4%
	North Chuctanunda Creek[1] HUC12: 20200041103	NYW18-M108-W, NYW18-M108-E	65%	23.7%	100%	1.0%	45%	10%

Table 4 *continued*

Basin	HUC12 Name HUC12 code	NYNHP Site ID	Riparian Zone	Wetland cover	Wetlands Remaining	T/D Drained	M/H Runoff Pot. Soils	% Devel. SUM
Mohawk continued	Headwaters Alplaus Kill[1] HUC12: 20200041106	NYW19-M112	63%	22.3%	100%	1.3%	56%	4%
	Indian Kill-Alplaus Kill HUC12: 20200041107	NYW19-M168	56%	20.2%	100%	0.9%	34%	19%
	Poentic Kill-Mohawk River HUC12: 20200041108	NYW19-M180	26%	4.9%	68%	0.5%	22%	51%
	Stony Creek-Mohawk River HUC12: 20200041109	NYW18-M115, -M171, NYW19-M140, -M192, -M228	48%	16.5%	82%	0.4%	33%	43%
	Shakers Creek-Mohawk River HUC12: 20200041110	NYW19-M156, NYW19-M204, NYW19-MPISP	39%	9.8%	75%	0.2%	27%	47%
	Mine Kill[1] HUC12: 20200050301	NYW19-M167	22%	2.9%	22%	0.7%	36%	6%
	Switz Kill[1] HUC12: 20200050502	NYW19-M120	34%	4.4%	43%	0.1%	55%	5%
Oswego[2]	Point Rock Creek[1] HUC12: 41402020103	NYW19-M107	66%	16.1%	100%	1.2%	12%	3%
SE Lake Ontario[3]	Headwaters Irondequoit Creek[1] HUC12: 41401010701	NYW19-MEND	39%	7.8%	16%	7.5%	11%	10%
Summary	Surveyed HUC12: Mean ± SEM (HUC 12 n = 22)		40 ± 3%	11 ± 1.3%	68 ± 7%	1.2 ± 0.3%	38 ± 4%	13 ± 3%
Allegheny[4]	NY portion of the Allegheny basin (HUC12 n = 74)		25 ± 1%	5.8 ± 0.7%	19 ± 2%	0.9 ± 0.1%	71 ± 2%	5.4 ± 0.4%
Mohawk	Mean values for <u>all</u> HUC12 in the Mohawk basin (n = 117)		34 ± 1%	6.2 ± 0.4%	62 ± 3%	1.6 ± 0.1%	55 ± 2%	7 ± 1%

[1]Is a headwater HUC12; [2]This wetland is <125 m from the Mohawk basin boundary and was included in the random sample draw and is treated here as a Mohawk Basin site (wetlands within 200 m of the basin edge were included in the random sample frame to account for mapping error). [3]2019 wetland assessment training site in the Rochester metro area (Genesee basin). [4]Portions of these HUC12 watersheds (and their data) extend beyond the NYS boarder into Pennsylvania and Ohio. [5] US EPA defines the Riparian Zone (RZ) as the corridor of land adjacent to surface waters. [6]See source metadata - in short, based on difference between Existing Vegetation Type and Environmental Site Potential geospatial grids. [7]*Minimum* estimated area (based on NHD data – see metadata).

Wetland Assessment Metrics

In the following section we summarize some highlights from each of the functional assessment categories. We cross-check the new metrics efficacy using our established three-tiered wetland assessment metrics. For example, pollution increases with increasing human land use and development, therefore we would expect wetlands with higher LCA scores to have higher pollution rankings compared to wetlands in minimally developed landscapes.

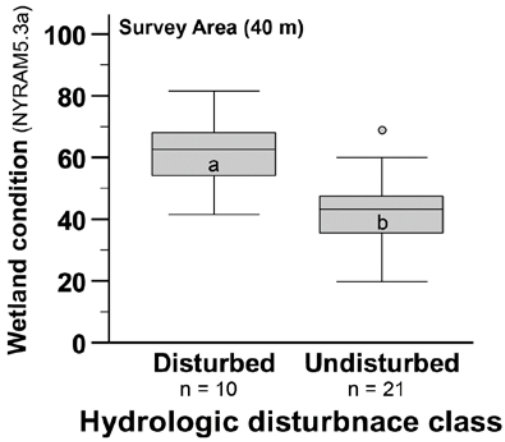


Figure 6: Wetlands lacking evidence of hydrologic disturbance in the Survey Area (SA) had significantly better ecological condition scores (i.e., *lower* scores) as measured by NYRAM (t-test: df = 29, t = 4.515, p<0.001).

Flood and Stormwater Control rating

At the contiguous wetland scale, a third of our random sites ranked "very high" for flood control, half ranked "high", four sites ranked "moderate", and one ranked "low" (site code NYW19-A173). Although the site ranking "low" was in a floodplain, the river was significantly incised reducing the potential for overbank flooding. Historically, the wetland had been cleared and ditched for agriculture; dewatering features were still present and visible during our survey. Average tree diameter aligned with what we would expect for a second growth forested floodplain (Level 3: mean DBH 23 ± 2 cm). However, Emerald Ash Borer (EAB) significantly changed the structure of this community (Figure 10). Green Ash (*Fraxinus pennsylvanica*) trees were nearly 80% of the boles in our Level 3 vegetation plot and all of them were dead due to EAB. Ash trees tended to be larger than other trees in our survey (DBH = 26 ± 1 cm), with about a third of their boles ≥30 cm DBH. Japanese Knotweed thickets lined the river's edge, thereby reducing the establishment and persistence of native woody species. All of these factors contributed to this site's "low" flood control ranking, and a "moderate" ranking for erosion control.

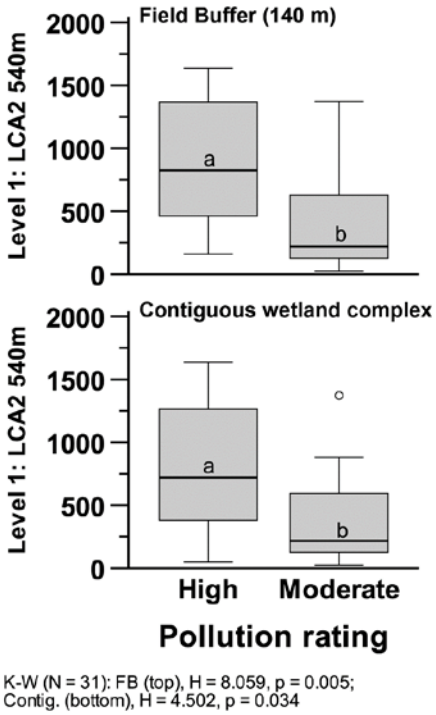


Figure 7: The highest Pollution Rating ("high") was applied to evaluation areas in more developed landscapes, as demonstrated by significantly higher LCA scores. This cross-check supports the efficacy of the functional assessment category.

Hydrologic disturbance class

Almost three quarters of our randomly-placed Survey Areas lacked evidence of hydrologic disturbance; in the Field Buffer that percentage drops to half (72% and 52%, respectively). Wetland ecological condition was significantly better in wetlands lacking evidence of hydrologic disturbance with average NYRAM

scores 20 points lower compared to sites with disturbance (NYRAM = 42.3 ± 2.5 [n = 21] vs. 62.3 ± 3.8 [n = 10], respectively; Figure 6).

Erosion control

We did not find significant trends between erosion ranking and our established three-tiered assessment metrics. Rating tended to increase with evaluation area. For example, in the Survey Area, 14% were rated as "very high" and 48% were rated as "moderate" for erosion control, but at the larger contiguous wetland scale those numbers increase/decrease nearly two-fold (30% and 20%, respectively; 50% = "high"). Level 1 landscape scores ranged from a low of 230 (minimally disturbed) to a high of 1472 (urban) for contiguous wetlands ranked "very high" for erosion control. Seven FBs were ranked "very high" for erosion control, all of which were in floodplains or riparian area (i.e., lotic or terrene headwater/riparian) where streams/rivers were not incised and dense persistent/woody native vegetation lined the watercourse (for example, see Cincinnati Creek case study below). Worth noting is that we had few lentic sites and those we did have were associated with ponds or small lakes created by beaver dams that are not subject to fetch. Our three lentic sites ranked "high" (2) and "moderate" (1) for erosion control.

Subsurface and groundwater resource protection

This function was the most ubiquitous across all wetland types. Evidence of groundwater recharge/discharge was present in 94% of our survey sites (e.g., Figure 8). Remotely, this information can be gleaned by determining if the wetland occurs over or adjacent to an unconsolidated aquifer, karst, or substrate with high porosity such as kame (see Table 2 for example spatial layers). Nearly all sites scored "very high" or "high" (90 and 3% of sites, respectively) for this functional category. The two "moderate" sites were degraded floodplain terrace sites that had no subsurface indicators in the field or during review of the spatial data (e.g., Chadakoin River Floodplain case study). During our field surveys groundwater was ranked as the SA's primary or secondary water source at 87% of sites. Nearly half of sites had overbank flooding as their primary or secondary water source (48%); none of the wetlands in our surveys for this project had precipitation as the primary water source. In rural or exurban areas private wells provide potable water to local residents – these wells draw on subsurface water resources, making them a potential groundwater resource

Figure 8: Deeper water just at the base of a hill is one indicator of toe-slope subsurface water discharge (hill is out of frame on the right). To the left of this frame the community graded into a thick permanently flooded shrub swamp with mucky soils >1 m deep and circumneutral surface water (pH = 7). Site ID = NYW19-A197.

indicator, but more importantly, reminds us that subsurface water protection is a human health and quality of life concern.

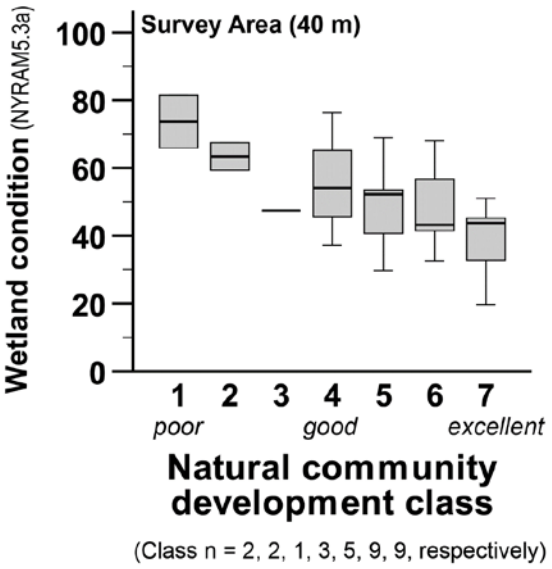


Figure 9: Minimally disturbed wetlands with higher development class scores also have better wetland condition as measured by NYRAM. That is, the highest quality Survey areas have low NYRAM scores and high community development scores.

Natural community development class

We encountered the full spectrum of community development during this project – from a *Phragmites australis* dominated marsh ("poor" development) to a pristine Black Spruce Tamarack Bog with old growth indicators ("excellent" development). Two of the primary factors contributing to lower scores include evidence of historical land use (tilling, forestry, etc.) and dominance of non-native or ruderal plants. Heterogeneity, whether horizontally in a marsh where you would expect patches of shrubs or open water and a gradient of hydrophytic forbs (heterogeneity), or in a forested wetland where vertical heterogeneity across strata signals an uneven aged native tree canopy (i.e., not even-aged second growth; see Wishing Well Case Study), and below ground, the soil profile is intact (vs. homogenized from tilling, for example). As a crosscheck, we graphed Level 2 wetland condition scores relative to an SA's natural community development class, expecting wetlands in better condition (lower NYRAM scores) would have high development class scores – a trend supported by the data (Figure 9). In our functional assessment method, categories such as habitat heterogeneity, hydrologic health/disturbances, vegetation structure, and invasive dominance are all used to inform the user's natural community development for the SA and FB. Several categories or indicators such as this one are not ranked at the contiguous wetland scale because the level of accuracy needed to confidently rank beyond the FB becomes difficult, or in some cases, nearly impossible to accurately assess.

Pollution Control rating

Wetland condition scores weren't significantly different at sites where the Pollution Control rating in the Field Buffer was "moderate" compared to sites where it was "high" (NYRAM = 42.8 ± 3.8 [n = 12] vs. 52.5 ± 3.4 [n = 19], respectively; t-test, df = 29, t = -1.848, p = 0.075). At the smaller, Survey Area scale, sample sizes were evenly split between the two pollution ratings and difference in NYRAM scores narrowed even more. Similarly, we did not see differences in our Level 1 landscape condition scores assigned for the SA. However, LCA scores were significantly higher relative to pollution ratings for the FB and contiguous wetland – a result we would expect given pollution is caused by human actions.

Figure 10: Conewango River floodplain (site ID: NYW19-A173), Chautauqua County. Green Ash once co-dominated this community that now resembles a "ghost swamp" (background). Common forbs in the foreground include Ostrich Fern (*Matteuccia struthiopteris*), Jewelweed (*Impatiens capensis*), Bay Forget-Me-Not (*Myosotis laxa*), Canada Goldenrod (*Solidago canadensis*), and non-native Creeping-Jenny. This floodplain terrace community is most similar to National Vegetation Association CEGL006147.

Wildlife

The premise of this ranking relates to the number of animal guilds present (up to five), the presence of open water, width of natural cover in the adjacent upland, and the pervasiveness, if any, of lower function indicators. As evaluation area increases, we would expect increased potential for a higher wildlife rank – that is, criteria for ranking the SA "very high" is different from that used for ranking the FB or contiguous wetland evaluation areas. A score of "very high" is awarded when habitat heterogeneity/interspersion is at least moderate, includes open water or a watercourse, has all five animal guides present, and lacks pervasive lower function indicators. The following table is a summary of Wildlife score distributions for sites surveyed during this project. Note that the majority of contiguous wetlands score "very high", as we would expect because habitat heterogeneity increases with area (e.g., see Crum Creek Headwater case study). See Figure 11 for example field observations of direct and indirect animal use.

	Wildlife rank			
Evaluation area	**Low**	**Moderate**	**High**	**Very High**
Survey Area (40 m)	6%	65%	26%	3%
Field Buffer (140 m)	3%	71%	13%	13%
Contiguous wetland		23%	13%	63%

Figure 11: Example indicators of wildlife use, clockwise from top left: recent American beaver (*Castor canadensis*) activity (NYW18-M108), North American porcupine (*Erethizon dorsatum*) climbing a tree in a hemlock-hardwood swamp (NYW19-M107); active Red-winged Blackbird (*Agelaius phoeniceus*) nest in a stand of nonnative *Phragmites* (NYW18-M108); nest built on Multiflora Rose canes, 30 cm above the surface water and approximately five meters away from open water (NYW19-A185), Green Frog (*Lithobates clamitans*) on a *Sphagnum* moss carpet and a Bumble Bee (*Bombus* sp.) ground nest built inside a mossy hummock in a Black spruce-tamarack bog (NYW19-M129).

Values

Similar to Wildlife, Values is divided into five categories, and the more categories present, the higher the score. Most relevant to conservation are the "uniqueness" and "special wetlands" categories. Example Uniqueness indicators include rare, threatened or endangered species and their habitat; migratory bird habitat; wetlands in developed landscapes; and unique geologic features (e.g., karst). A total of 11 indicators are listed in the current version. All sites in this study had at least one unique indicator in the survey area, most often that the area has habitat to potentially support a species of conservation concern, but on average sites had three indicators. The highest "special" indicator count for an SA was eight out of eleven, primarily because the wetland is in the Albany

Pine Bush Preserve which is extensively monitored by biologists and hosts several rare species. Our second highest scoring site for uniqueness is outlined in the Chautauqua Lake Outlet case study.

The Special Wetlands section focuses on natural community traits of particular conservation importance such as rare or uncommon natural communities (S-rank), forest stand age (mature, old growth), and NYS DEC Class I wetlands (seven indicators in total). On average sites had two special wetland indicators in the SA; second-growth sites tended to lack special wetland indicators in the SA (n = 3). A beautiful Black Spruce Tamarack Bog in Oneida County had the most indicators (5/6) in the SA.

Figure 12: Top: With five out of six indicators present this Black Spruce-Tamarack Bog (NYW19-M129) in Oneida County had the highest "Special Wetlands" score. A few charismatic species from this site (bottom left to right): Eastern Pondhawk (*Erythemis simplicicollis*), Showy Lady's Slipper Orchid (*Cypripedium reginae*), and Round-leaved Sundew (*Drosera rotundifolia*).

FRAM roll-up scores and validation

Wetlands in better condition (lower NYRAM scores) tended to have higher combined "roll-up" FRAM scores. That is, based on these metrics wetlands in better condition had greater function and value compared to degraded sites (Figure 13). Our functional assessment metrics for the SA and FB that are based on 8 variables detected no difference among the NYS DEC wetland classes.

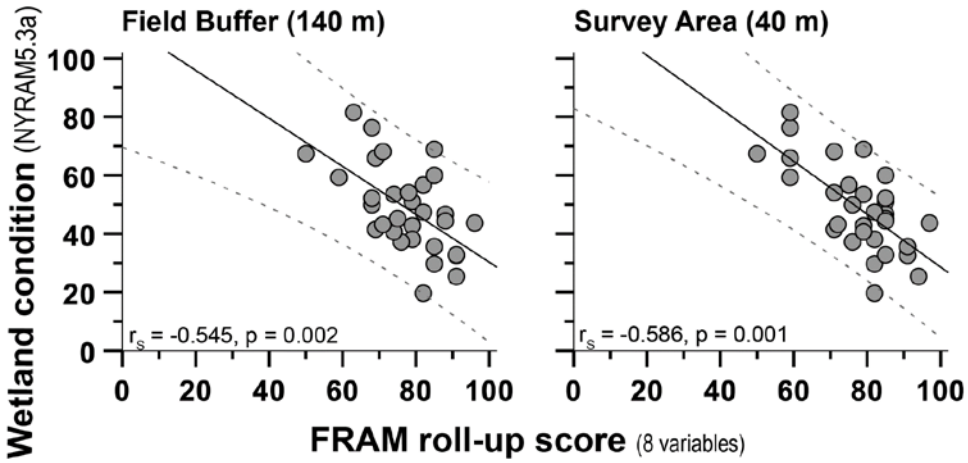


Figure 13: Based on these metrics, wetlands in better condition (low NYRAM scores) tended to have higher overall functional scoring ("FRAM roll-up). This trend was significant for both the Survey Area (SA) and Field Buffer (FB). No correlations between FRAM and floristic quality or LCA were detected. (n = 31)

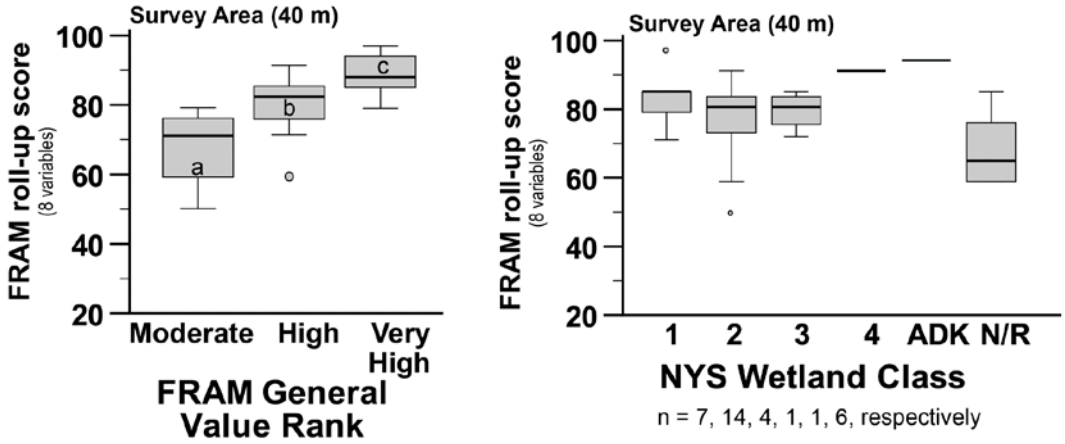


Figure 14: Left: Functions and values don't always correlate because values are inherently connected with what *humans* value. However, we see a significant trend in these metrics – wetlands with "very high" value also have higher overall function scores ($F_{2,28}$ = 9.115, p = 0.001; all pairwise p < 0.037 with LSD adjustment for multiple comparisons). This trend holds for data from the FB, too, but only "moderate" and "very high" are significantly different in pairwise comparison ($F_{2,28}$ = 5.152, p = 0.012). General Value Rank only accounts for 12% of the final score so this difference truly reflects a broader trend in the data. This trend was not observed in our established wetland assessment metrics. Right: About two-thirds of our wetland sites had assigned DEC Wetland Class ranks. Those lacking ranks include two sites in the Adirondack Park Agency's wetland jurisdiction and the remaining wetlands mapped by the National Wetlands Inventory, but not included in NYS DEC's jurisdictional wetland maps.

Theoretically we would expect Class I wetlands (deemed to be of highest conservation value per NYS wetland regulations) to score higher than Class IV. Additionally, Class I and II wetlands did not have more Special or Unique indicators compared to other classes or wetlands that aren't ranked. Interestingly, the one Class IV site we have is one of statewide significance – you can read more about it below in the Cincinnati Creek case study.

The majority of our SAs lacked evidence of hydrologic disturbance; these wetlands occur in minimally disturbed landscapes as well as urban settings (Figure 15, top). However, when looking at a finer scale metric we do see differences among these classes. Floristic quality scores were lower for wetlands with a "recovering" hydrologic health score (Figure 15, bottom), which would be expected because ruderal plant species have lower C scores. This trend was not seen when looking at the larger evaluation areas so the connection between floristic quality and hydrologic health is very localized to data collected within the Survey Area. When combined, these data highlight the potential for high quality wetlands to exist and persist in developed landscapes so long as their hydrology (among other factors) are not disturbed.

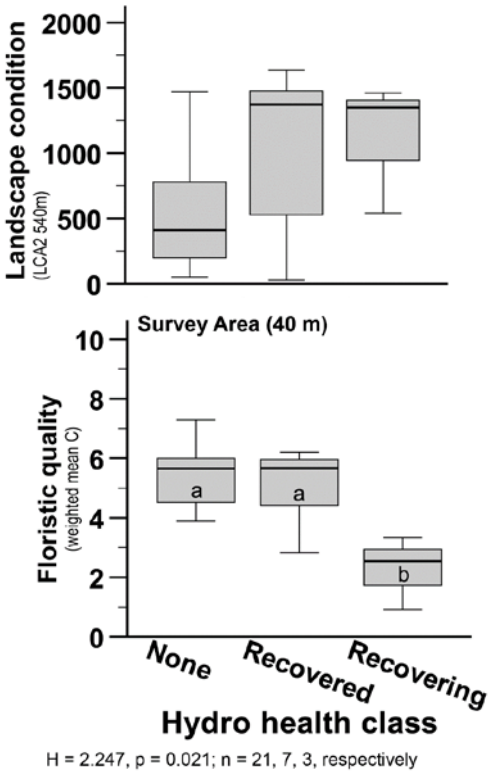


Figure 15: Top: No significant trend between LCA scores and hydrological health class (K-W: H = 4.722, p = 0.092). Bottom: Wetlands recovering from hydrologic disturbance have lower floristic quality scores (adjusted pairwise $p < 0.05$). "None" = none or none apparent. Both graphs use the same x-axis and show SA rank only.

Case Study Sites

Cincinnati Creek Wetland Complex (NYW18-M113), Oneida County, Mohawk Watershed

Cincinnati Creek meanders through the western edge of this 250+ ha wetland complex located in Oneida County, NY. Marsh flanks both sides of the creek and is dominated by graminoids and flowering plants such as Joe Pye weed (*Eutrochium maculatum*), with patches of alder (*Alnus* spp.) and willow (*Salix* spp.). Hydroperiod in the marsh

shifts from permanently flooded to seasonally flooded and permanently saturated as you move away from the stream (east or west). Silt-loam and silt-clay mineral layers lie below a well decomposed layer of muck. The marsh is flanked by a large, mature Hemlock Hardwood Swamp in excellent condition.

Ecological condition, uniqueness: We observed >95 plant species in our Level 3 vegetation plot that produced a weighted mean C score of 4.4, which is a relatively high score for this variant of marsh (Shappell and Howard 2018). A NYRAM score of 32.6 also demonstrates the wetland is in "good" condition (i.e., <38, Shappell and Howard 2018). On a five-point scale ranging from "excellent" to "poor", the ecological development was ranked "excellent", meaning it represents the best of its ecoregional type or class.

Figure 16: Cincinnati Creek Wetland Complex (NYW18-M113), Oneida County. Shallow Emergent Marsh and patches of alder Shrub Swamp flanked both side of the creek. The core of the large hemlock hardwood swamp is in excellent condition (large dark green patch), despite being fragmented in the east by an abandoned railroad, and the west by State Rt 12.

Shallow Emergent Marsh communities are ranked as uncommon in NY (S3), particularly this Sedge Wet Meadow variant (akin to NVC plant associations CEGL006412 and CEGL002257) along the shores of the creek. The Hemlock Hardwood Swamp is mature closed canopy forested wetland that is likely to contain old growth stands. Additionally, at 60+ ha (148 ac) this swamp is one of the largest documented community occurrences in NYS. All told, this wetland complex has many attributes that make it unique and of statewide-significance.

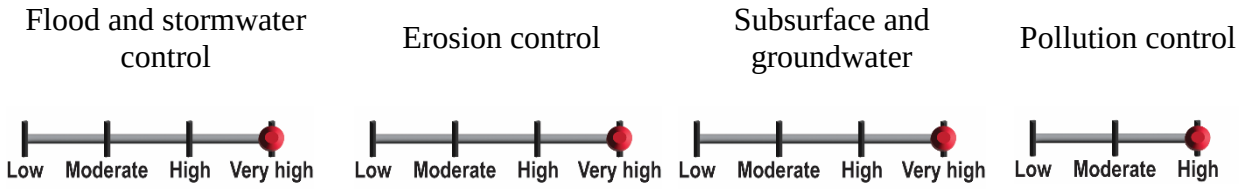
Wildlife biodiversity and habitat: The presence of a stream and wetland community heterogeneity make this a significant wetland complex for local fauna. Cincinnati Creek is a low gradient, moderately buffered transitional cool watercourse that is not listed as impaired and supports downstream habitat for Brook Trout (*Salvelinus fontinalis*; 2 km downstream). The private land owners of this wetland reported that large mammals such as Black Bear (*Ursus americanus*), White-tailed Deer (*Odocoileus virginianus*), and Eastern Coyote (*Canis latrans*) regularly move through the wetland complex. In addition to large game hunting, the owners and their neighbors use the complex to hunt migratory game birds.

Wetland communities found within the evaluation areas and beyond provide potential habitat for RT&E and SCC species including wetland associated birds such as Sedge Wren (*Cistothorus platensis*) and Least Bittern (*Ixobrychus exilis*). The abundance of flowering plants provides significant floral resources for native pollinators. Although some fragmenting features are present, aquatic connectivity seems good and natural land cover/terrestrial connectivity is good, too. Because of these factors, Wildlife Ranking in the SA was "High" and "Very High" in the contiguous wetland.

Hydrogeology, water quality, and flooding: Ground water was the primary water source in the survey area, followed by overbank flooding from Cincinnati Creek. This wetland overlays an unconsolidated mid-yield aquifer, and the local surficial geology is gravel with sand, indicating this wetland could be an important area for groundwater recharge and discharge. Residents around this wetland obtain their potable water from groundwater wells on their property, making this wetland very important for local water resources. Those same residents have septic systems, and this wetland complex occurs between them (upslope) and Cincinnati Creek, therefore the wetland likely intercepts subsurface septic leachate before it reaches the creek.

Dense persistent vegetation, high amounts of microtopography created by abundant vegetated hummocks (sedge tussocks, tree and shrub bases) contributed to this wetland's high marks in all categories associated with water resources (see below).

Water resource protection ranking for NYW18-M113:



Crum Creek Headwater Wetland Complex (NYW19-M142), Fulton County, Mohawk Watershed

Crum Creek meanders through the eastern edge of this 655+ ha wetland complex located in Fulton County, NY on its way to the Mohawk River (Figure 17). Beaver activity along this headwater stream has created a patchwork of open water and marsh communities with forested wetlands also periodically encountered, though some have been flooded. The Survey Area (SA) is permanently flooded with >75 cm of water, and in some areas, a floating mat approximately 15+ cm thick. The marsh occurs over mucky peat more than a meter deep.

We observed >85 plant species during the Level 3 vegetation survey. The community is dominated by flowering plants such as Blue Flag Iris (*Iris versicolor*) and graminoids such as Sedges (*Carex* spp.) and Bulrush (*Scirpus* spp.) with Cattail (*Typha* spp.) also having high cover (Figure 13). Nonnative Common Reed has established in a discrete southeastern portion of the SA, but species diversity in the rest of the marsh remains high. The weighted mean C score for this site was average for this community type ($\bar{C}_{wt}$, = 4.5). Level 2 rapid condition suggests the evaluation area is in "good" condition (NYRAM = 32.8), which we think accurately reflects the area's ecological health.

Figure 13 (left): Crum Creek Headwater Wetland Complex Survey Area was dominated by sedges, grasses, and Iris. As typical for this community, forb cover was high, averaging 80%, and tall (1.25 m), based on our Level 3 plot surveys.

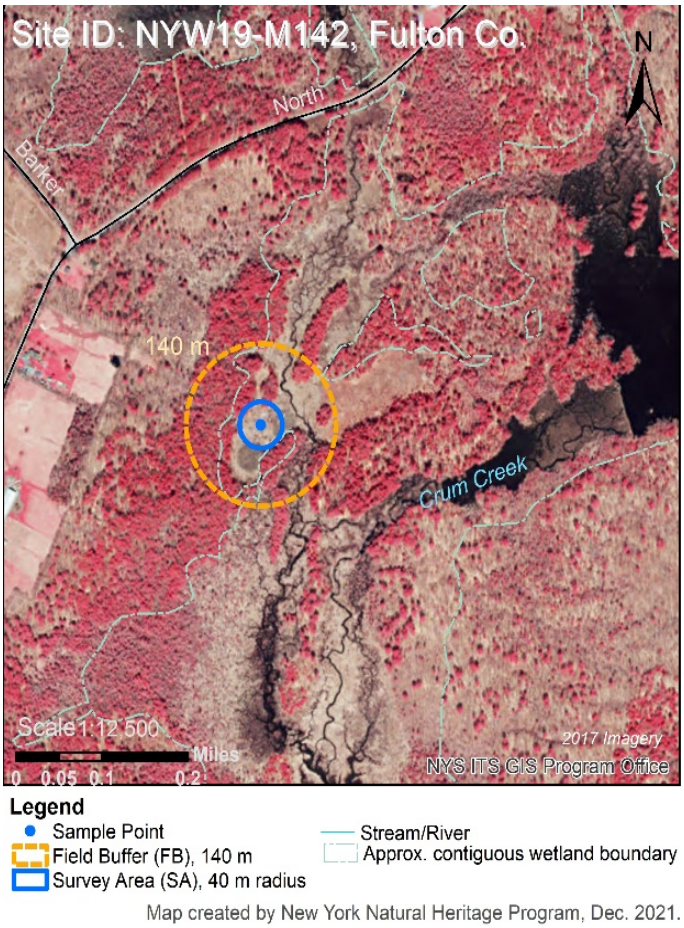
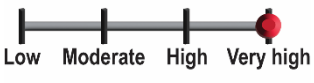


Figure 17: Our random sample point, NYW19-M142, fell in a cove of a very large and heterogeneous wetland complex along Crum Creek, a headwater stream to the Mohawk River.

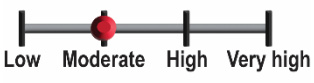
Hydrogeology, water quality, and flooding: Groundwater is the primary water source in this wetland, making it important for groundwater recharge and discharge as it overlays an unconsolidated aquifer and local surficial geology consists of coarse defined gravel with sand. As a direct headwater to the Mohawk River, an impaired waterbody, the marsh enhances water quality downstream in addition to the protection it provides its nearby rural residents who rely on wells. Dense persistent vegetation, high amounts of microtopography created by abundant vegetated hummocks (sedge tussocks, tree and shrub bases), and restricted outflow due to the beaver dam all contributed to this wetland ranking "very high" in the flood control (e.g., flood water detention) and groundwater ranking categories. Pollution treatment ranking is "moderate" for this site due to relatively few pollution sources in the local landscape. Natural buffer width averages ≥200 m around the contiguous wetland and surrounding land use is low to very low (a few sporadic residences in a predominantly

undeveloped area). In fact, development in the entire subwatershed remains proportionally low (HUC 12 % developed land = 5%).

NYW19-M142 Subsurface and Groundwater



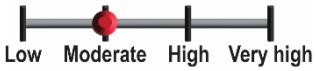
Pollution Treatment



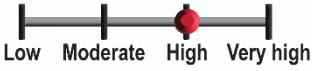
Wildlife biodiversity and habitat: The size and diversity of habitat present in this wetland complex makes it a valuable area for all five animal guilds represented in this assessment (birds, invertebrates, mammals, amphibians/reptiles, and fish). Most notably, the immediate SA and surrounding Field Buffer (FB) are potential breeding habitat for two wetland dependent species, the Sedge Wren and Least Bittern. The larger contiguous wetland area provides resting, foraging, and breeding habitat for migrating waterfowl and wading birds. The benefit of evaluating wetlands at different scales is highlighted in the wildlife ranks shown below. Moving from the smallest area, the SA, to the largest, the contiguous area or whole (WH), the increasing habitat diversity encountered in each is reflected in the corresponding rank. These methods place the SA in a landscape context and demonstrate that while the marsh itself is of value to wildlife, at each scale its value increases due to the ability to support higher species richness at that scale.

Wildlife ranking for each of the three evaluation areas for site NYW19-M142:

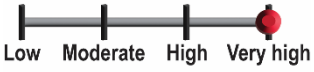
Survey Area (SA = 40 m)



Buffer (FB = 140 m)



Whole (WH = contiguous)



Wishing Well (NYW19-M192), Saratoga County, Mohawk Watershed

A mature Red Maple-Hardwood Swamp occurring in relatively small (20 ha) contiguous wetland area was sampled in Clifton Park, NY. Flanked by high density residential development to the north, south, and east and by agriculture to the west, the town-owned wetland exists as high quality greenspace in the local landscape (Figure 18). The headwater creek originating from this wetland feeds into the Stony Creek Reservoir, the largest undeveloped area in the Town of Clifton Park, which in turn empties into the Mohawk River. Silt loam mineral soils are underlain by quartz sand surficial geology. Hydroperiod in the SA is seasonally flooded while the FB is semi-permanently saturated.

The tree canopy is predominantly Red Maple (*Acer rubrum* var. *rubrum*) with Oaks (*Quercus* spp.) and Slippery Elm (*Ulmus rubra*) co-dominating. Winterberry Holly (*Ilex verticillata*) and Highbush Blueberry (*Vaccinium corybosum*) is present in the shrub layer, which had relatively low deer browse given the wetland's suburban setting. The groundlayer is a mix of vegetated patches and unvegetated hollows (Figure 19). Hydric indicators associated with these hollows such as distinct

moss lines along tree bases, the presence of fingernail clams, and leaf staining, indicate the hollows experience prolonged spring inundation that could provide habitat for vernal pool breeding amphibians.

Ferns, Skunk Cabbage (*Symplocarpus foetidus*), and Sedges dominate the herbaceous layer. All told, we observed >90 plant species during our Level 3 vegetation survey, which is nearly double the average number of plant species that we see in this community (54 ± 4 spp.). The weighted mean C score for this site was above average for this community type ($\bar{C}_{wt}$ = 5.7 vs. 4.7 ± 0.1, Shappell and Howard 2018).

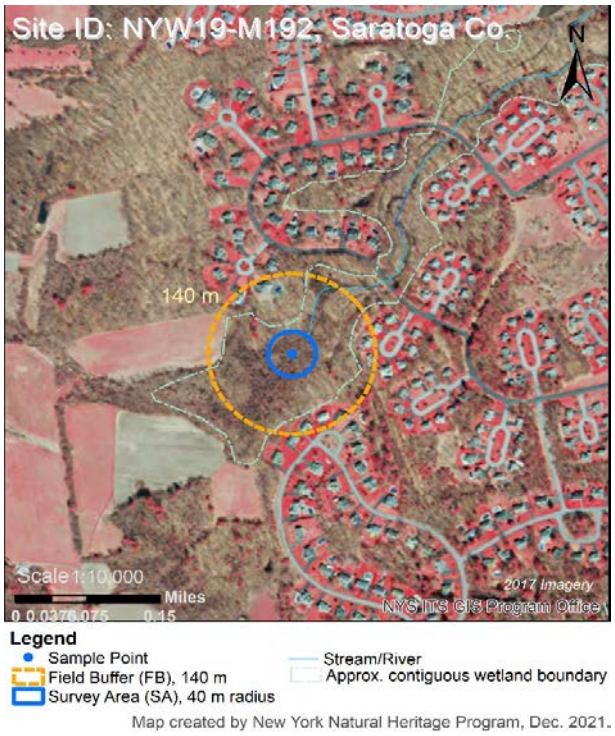


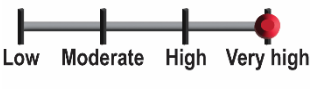
Figure 18: Wishing Well (NYW19-M192) is a suburban wetland site located in Clifton Park, NY. The wetland remains in good condition despite the recent housing developments surrounding the eastern half of the Field Buffer. Note the contiguous wetland ("WH") is not much larger than the Field Buffer.

<u>Ecological condition, uniqueness, general value</u>: The evaluation area is in "fair" condition (NYRAM = 45.2) per our Level 2 rapid condition assessment, which factors in suburban anthropogenic stressors in the adjacent area. However, ecological development in the SA was ranked "excellent" due to the absence of serious anthropogenic disturbance. The SA lacked evidence of historical land use such as signs of previous agriculture or logging; historical aerial imagery shows that the area has been forested for >70 years (i.e., natural land cover). Old growth forest stand indicators were observed such as large diameter trees (e.g., DBH of several canopy trees in the SA exceeded 50 cm, with average DBH for the plot = 35 ± 5 cm) and abundant, heavily decomposed coarse woody debris (CWD). Vertical structure of the tree canopy was also indicative of old growth stands as there were substantial emergent (25%, 30 m) and subcanopy (25%, 12 m) strata development above and below the main tree canopy layer (40%, 20 m).

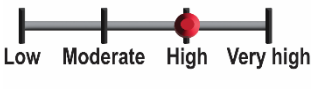
A walking path and proximity to visitors make this wetland a valuable recreation site in a suburban landscape. As demonstrated in the previous case study through wildlife ranks, this wetland highlights a gradient of General Value ranks for smaller, urban wetlands. As a result of development and agriculture, the community exists as a habitat "island", or refuge area, for wildlife and may be potential habitat for species of conservation concern. This quality, in addition to ecological integrity and recreational and aesthetic value, produced a "very high" General Value rank for the SA. Moving up in scale to include the FB, which begins to capture more disturbance from residential development and agriculture, the rank decreases slightly to "high." Finally, at the contiguous wetland scale, only a rank of "moderate" is assigned in order to reflect the degree of anthropogenic development, decrease in wildlife habitat (structural heterogeneity, area), and minimal greenspace connectivity.

General Value ranks for site NYW19-M192 are visualized below. Because our scoring system is relative to a given evaluation area's size, the General Value rank actually decreases as you go up in scale for this small suburban wetland. Only 20% of our sites ranked "very high" in the SA, so despite its relatively small stature, this wetland brings a lot of value to the local community.

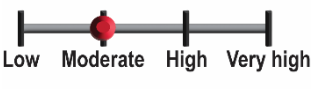
Survey Area (SA = 40 m)



Buffer (FB = 140 m)



Whole (WH = contiguous)



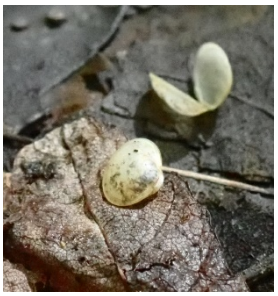


Figure 19: Top and left: Canopy and understory of the small suburban wetland site at the north end of Wishing Well Lane (NYW19-M192) located in Clifton Park, NY. The wetland had a well-developed mature hardwood canopy, potentially with old growth indicators. Forb and shrub cover averaged 30% and 10%, respectively in our Level 3 vegetation plots. Unvegetated "hollows" on the ground suggest these areas are seasonally flooded (inundated) early in the growing season. Above: Left - We often found tiny (<5 mm) fingernail clams (Sphaeriidae) in these hollows. Right – These hollows can potentially serve as breeding habitat for obligate vernal pool breeders such as Wood Frogs (*Lithobates sylvaticus*).

Hydrogeology, water quality, and flooding: As the source of a stream and its position over an unconsolidated high yield aquifer, this area is important for groundwater recharge and discharge. As a result of surrounding agriculture and development, the wetland is favorably situated to intercept runoff containing excess nutrients and sediment as well as subsurface septic leachate from nearby residents. Water quality is enhanced downstream as it also feeds a Class A trout stream and later flows into the Mohawk, and impaired river.

Chautauqua Lake Outlet (NYW19-A185), Chautauqua County, NY

The Chadakoin River, which begins at the outlet of Chautauqua Lake in Celoron, NY, flows eastward throughout Chautauqua County with its waters eventually meeting the Allegheny River by way of the major tributaries it feeds (Figure 20). We surveyed a Silver Maple-Ash Swamp situated adjacent to the lake outlet at the mouth of the Chadakoin River. Part of a 160 ha contiguous wetland area, the swamp occurs in muck soils underlain by an alluvial fan composed of silt, sand, and boulders. Hydroperiod ranges from permanently flooded near the river to semi-permanently flooded as you move upslope (north).

This forested community has a partially open canopy (~40% cover) dominated by Silver Maple (*Acer saccharinum*) with lower cover contributions by Black Ash (*Fraxinus nigra*). A well-developed, moderately abundant (~20% cover) shrub layer is present dominated by Winterberry Holly and Highbush Blueberry with Northern Spicebush (*Lindera benzoin*) and Smooth Alder (*Alnus*

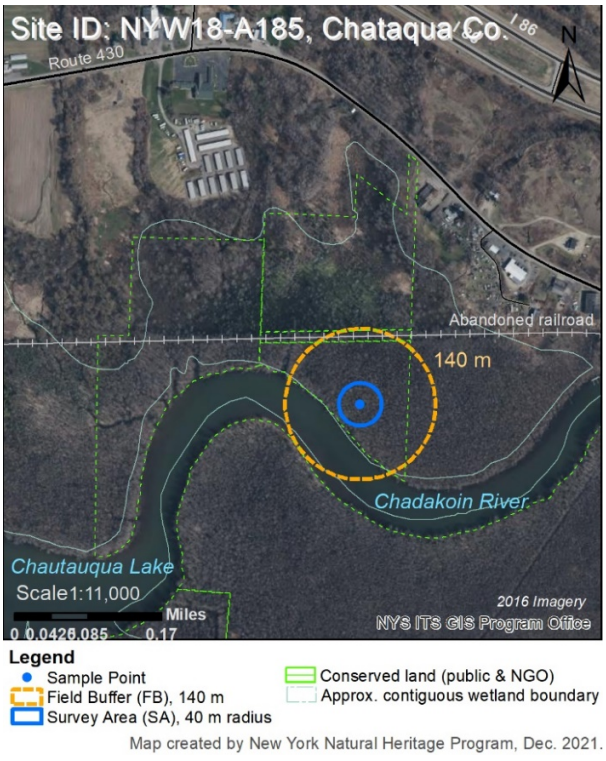


Figure 20: Left: Map of the Chautauqua Lake Outlet (NYW19-A185) survey site, Jamestown, NY. Parcels outlined in dashed green are owned by the Chautauqua Watershed Conservancy and local municipalities. Right: a view along the edge of the Field Buffer, looking south towards the river. Note the dense woody and perennial vegetation along the shoreline (mostly native).

serrulata) forming lesser components. Royal Fern (*Osmunda regalis* var. *spectabilis*) is by far the most common herbaceous species (59% cover; Figure 21). Another ~13% is comprised of graminoids, namely Sedges (~8% cover). We observed >90 total species during our Level 3 vegetation survey producing a weighted mean C score 5.9, which is above average for a Silver Maple-Ash Swamp ($\bar{C}_{wt}$ = 4.9 ± 0.3., Shappell and Howard 2018).

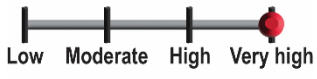
Ecological condition, water quality, and flooding: Level 2 rapid condition indicates the area is in "fair" condition (NYRAM = 43.7), reflecting the intensity of surround land use. Ecological development in the SA was ranked as "excellent" and no evidence of historical land use was observed at this scale. The absence of historical disturbance is further indicated by relatively low cover of invasive species (sum of <5% cover across all strata) despite the wetland occurring in a heavily altered landscape. An abandoned railroad falls within the northern boundary of the FB, but overall the FB's development was considered "very good to excellent". Because of its natural community, ecological condition, and size, this wetland meets NYNHP's criteria for being a wetland of statewide significance. This is a NYS DEC "Class I" wetland, the highest protection class, a protection level that is certainly supported by our data.

Pollution treatment in this wetland is ranked "high" as it occurs between the river and potential sources of pollution from high intensity land use types including row crop agriculture, a golf course, and high density development (commercial and residential). Groundwater ranks as "very high" due to the presence of an unconsolidated aquifer that the swamp overlays, field observation of toe-slope discharge, and use of wells by nearby residents. This community is an excellent example of a high-quality wetland providing flood control and erosion protection. Because of characteristics such as its position in a floodplain, predominantly woody vegetation providing bank stabilization, and high

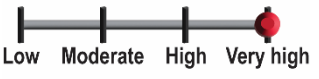
Figure 21: Co-author Laura Shappell surveying one of the vegetation plots Chautauqua Lake Outlet site (NYW19-A185). Royal fern at this site averaged >1.25 m tall. The red fruit of Winterberry Holly (upper left in photo) dotted the understory.

amounts of microtopography slowing potential overland flow, etc., this wetland ranked “very high” across all water resource categories.

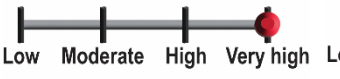
Flood and stormwater control



Erosion control



Subsurface and groundwater

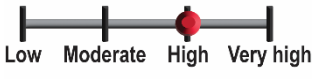


Pollution control

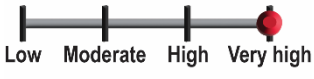
Wildlife biodiversity and habitat: Wildlife ranking ranged from “high” in the SA to “very high” in the FB and contiguous wetland due to the quality of the swamp itself coupled with the interspersion of open water encountered at larger scales. All five animal guilds were represented in the evaluation area with special value habitat recognized for birds and amphibians/reptiles. Chautauqua Lake and its outlet are designated as an Important Bird Area, identifying this wetland habitat as significant to the conservation of birds. In addition, this site falls within predicted habitat for the Pied-billed Grebe (*Podilymbus podiceps*) specifically, which is currently listed as a threatened species within NYS (S3B, S1N). Relatively recent (2018) observations of the Spiny Softshell Turtle (*Apalone spinifera*), a species of conservation concern (S2S3), have occurred nearby along the banks of the Chadakoin River.

Wildlife ranking: NYW19-A185

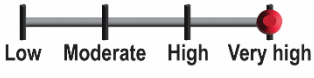
Survey Area (SA = 40 m)



Buffer (FB = 140 m)



Whole (WH = contiguous)



Uniqueness and general value: This wetland is a habitat “island” within a landscape that has been heavily developed (HUC 12 % developed land = 31%). Owned by the Chautauqua Lake Conservancy, this wetland preserve is open to the public for recreation and educational opportunities. Metal identification tags on trees in the FB suggest that this area was the site of a previous study. These qualities, in addition to its importance for threatened and imperiled species, warrant a general value rank of “very high” for all evaluation areas (SA, FB, and contiguous).

Chadakoin River Floodplain (NYW19-A117), Chautauqua County, NY

On a stretch of the Chadakoin River meandering through Falconer, NY, we sampled a floodplain forest located near where the major tributary of Cassadaga Creek and the Chadakoin converge. High density residential and commercial development exists on both sides of the river and this community exists as the only buffer between potential floodwaters and the surrounding land use. The wetland occurs in silt loam mineral soils over sand and gravel surficial geology. The hydroperiod shifts from permanently flooded to seasonally flooded as you move away from the river (northwest to southeast).

The dominant canopy species is Red Maple with Green Ash co-dominating but at lower percent cover. Overall canopy cover is low (20%), with some loss (10-15% of canopy cover) attributed to an invasive beetle, the Emerald Ash Borer. Silky Dogwood (*Cornus amomum* ssp. *amomum*) makes up the entire shrub layer, overall cover for which is moderate (~18%). The herbaceous layer is

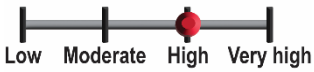
dominated by invasive and non-native species such as Japanese Knotweed (*Reynoutria japonica* var. *japonica*), Creeping-Jenny, and nearly two-meter-tall European Stinging Nettle (*Urtica dioica* ssp. *dioica*). Total non-native plant cover in our Level three survey plot was nearly 60%. The most common native herb was Jewelweed (Figure 23). We observed 60 plant species during our Level 3 vegetation survey, 78% of which are native species. However, nonnative plant dominance explains the very low weighted mean C score of 2.8. Floodplain wetlands tend to have lower floristic quality scores compared to other forested wetlands because natural disturbances driving this community tend to favor ruderal species, but this is even low for floodplains. Canopy trees were relatively small, suggesting this is not yet a mature second-growth swamp. Our previous work observed an average weighted mean C of 3.7 ± 0.3 for floodplains in our dataset (Shappell and Howard 2018).

Ecological condition, flood mitigation, and pollution: Our Level 2 rapid condition assessment produced a condition rank of "very poor" (NYRAM = 81.5), which reflects the level of anthropogenic stress and degraded status observed. Ecological development was also ranked as "poor" due to significant disturbances, such as EAB and nonnative plant dominance, that have altered the wetland community. Invasive plant species cover was consistently high throughout the evaluation area with Japanese Knotweed thickets lining the banks of the river itself and Reed Canary Grass (*Phalaris arundinacea*) forming a continuous carpet in many areas. An area in the FB where Ash dominate the forest canopy has experienced heavy dieback due to EAB, producing a veritable "ghost swamp" of standing dead trees (Figure 23, top right).

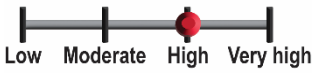
A rank of "high" for flood control was assigned acknowledging that, though degraded, the wetland occurs in an urbanized area, surrounded by development, and receives overbank flooding during high water events. The wetland did not receive a "very high" rating for flood control in part because the stream is incised in some areas and has little microtopography or water-holding edaphic/structural properties (organic soils, hollows, sloughs etc.). The latter likely reflects historical land use as much of the floodplain was cleared for agriculture prior to the 1950s. During these same flooding events, the risk of erosion is

Water resources: NYW19-A117

Flood Control



Erosion Control



Subsurface and Groundwater

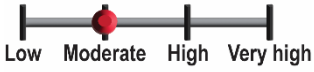


Figure 22: Top: Map of Chadakoin River Floodplain. Our survey area was a degraded second –growth floodplain forest. Bottom: Poor ecological condition prevented this wetland from scoring "very high" for flood and erosion control.

elevated, particularly in developed landscapes with low natural land cover and historically high wetland loss (Table 4). Floodplain wetlands tend to score “very high” in the erosion category, but EAB-related tree canopy loss and the dominance of Japanese Knotweed has reduced this community’s inherent capacity for erosion control, contributing to the rank of “high” this site. The scale for flood and erosion control ranges from “low” to “very high.” While a superior quality example of this community would easily score “very high,” this heavily degraded example still warrants a “high” due to its inherent functional value as a floodplain system. Pollution control was ranked as “high,” recognizing that the wetland exists as the buffer between an impaired watercourse and high density development. Groundwater was ranked as “moderate” because the wetland overlays a confined aquifer and no indicators of subsurface discharge or recharge were observed in the field.

Figure 23: Photos from our Chadakoin River Floodplain (NYW19-A117) Survey Area and Field Buffer. Clockwise from top left: Jewelweed was one of the most common native forms in our survey plot; Dead ash trees create a “ghost forest”; Blue-fronted Dancer (*Argia apicalis*), an “S3” ranked damselfly in NYS (“vulnerable”); View of the Chadakoin River in the Field Buffer – note shale stones on the left shore (wetland overlays impermeable bedrock), and Japanese knotweed thickets flowering behind the large tree on the left bank. Also note eroding banks on the right, banks dominated by nonnative plants.

Wetlands of statewide significance

We reviewed and assigned preliminary Element Occurrence ranks to >130 sites across 19 community types in our wetland database to identify wetlands that are of potential statewide significance (i.e., high quality "Element Occurrences") given each site's natural community type, size, ecologic health, and landscape condition. To assist this work and help guide others we created a "quick guide" reference tool that outlines minimum size and invasive dominance requirement relative to each community and the community's present conservation status (S-rank). This quick guide may be found as an appendix in the Functional Rapid Assessment Method datasheets at the end of this report.

During the course of this project, the NYNHP ecology program revaluated the conservation status (S-rank) of 12 nontidal palustrine communities. Ranks were revised to reflect the current science and our understanding of trends, threats, statewide distribution, and vulnerability to threats or disturbance relative to each community type. These updates were included in the quick guide, which will be revised as needed to reflect future S-rank changes.

Deciduous forested wetland types accounted for a quarter of sites reviewed. Two common deciduous forested types in our dataset are Red Maple-Hardwood and Silver Maple-Ash Swamps, both have a conservation rank of S3. Floodplain forests have the lowest S-rank (S2S3) of forested types reviewed for this task; None of the sites were in "good" or excellent" condition – all had some degree of anthropogenic disturbance and non-native plant dominance. Of the eleven Floodplain sites we evaluated, only four are in good enough condition (i.e., "fair") to be considered of statewide significance.

About half of the 22 Shallow Emergent Marsh sites evaluated were in good enough condition to meet the ecological condition requirement. Unfortunately, over 25% of marsh sites were dominated or co-dominated by non-native plants, often Phragmites. Through this evaluation process we gained a deeper understanding of the ecological condition of specific communities and the threats they face.

Table 5: Summary of Functional Assessment category rankings for all sites surveyed during this project. Each site has three evaluation areas (Eval area): Survey Area (SA = 40-m buffer around target sample point); Field Buffer (FB = 140-m radius); and Contiguous wetland boundary (Contig). Not applicable (N/A) indicates a metric does not apply to that evaluation area. The functional assessment protocol is broken into seven ranking categories as outlined in Table 2. Rankings: Very High (V. High), High, Moderate (Mod.), or Low. Unique wetlands tally (scale 0-11) and Special wetlands tally (scale 0-7) are two of five categories that contribute to the General Value score. Wildlife ranking is broken down into five animal "guilds" as well as variables that provide diverse habitat structures. Site ID is the unique identification code we use for our wetland surveys. Sites surveyed in 2018 have codes starting with NYW18*; 2019 sites = NYW19*; Mohawk basin sites have and "M" after the dash (NYW1*-M***), Allegheny sites have an "A".

Site ID	Eval. area	Flood control	Hydro. health/ disturbance	Erosion control	Ground/ subsurface H2O	Pollution treatment	Wildlife	General value	Special tally	Unique tally
NYW19-A117	SA	High	Recovered	High	Mod.	High	Mod.	High	4	1
	FB	High	Recovering	High	Mod.	High	V. High	High	3	1
	Contig	High	N/A	High	Mod.	High	V. High	High	3	1
NYW18-A125	SA	V. High	Recovered	V. High	V. High	High	High	High	1	2
	FB	Mod.	Recent/No recov.	V. High	V. High	High	High	High	1	2
	Contig	Mod.	N/A	V. High	V. High	High	V. High	High	4	2
NYW19-A173	SA	Mod.	Recovering	Mod.	High	High	Low	Mod.	3	0
	FB	Low	Recovering	Mod.	High	High	Mod.	Mod.	5	0
	Contig	Low	N/A	Mod.	High	High	Mod.	High	5	1
NYW19-A197	SA	V. High	None/None app.	Mod.	V. High	High	Mod.	High	4	2
	FB	V. High	None/None app.	High	V. High	High	Mod.	High	4	1
	Contig	V. High	N/A	High	V. High	High	V. High	High	4	1
NYW18-A185	SA	V. High	None/None app.	V. High	V. High	High	High	V. High	7	4
	FB	V. High	Recovered	V. High	V. High	High	V. High	V. High	7	3
	Contig	V. High	N/A	V. High	V. High	High	V. High	V. High	7	2
NYW19-A201	SA	V. High	None/None app.	Mod.	V. High	High	High	High	6	1
	FB	V. High	Recovered	V. High	V. High	High	V. High	V. High	6	3
	Contig	V. High	N/A	V. High	V. High	High	V. High	V. High	6	4

Site ID	Eval. area	Flood control	Hydro. health/ disturbance	Erosion control	Ground/ subsurface H2O	Pollution treatment	Wildlife	General value	Special tally	Unique tally
NYW18-M102	SA	V. High	None/None app.	Mod.	V. High	High	High	Mod.	2	1
	FB	High	Recovered	Mod.	V. High	High	Mod.	Mod.	2	1
	Contig	High	N/A	High	V. High	High	V. High	Mod.	2	1
NYW18-M108-E	SA	High	None/None app.	High	V. High	High	Mod.	Mod.	3	2
	FB	High	None/None app.	High	V. High	High	Mod.	Mod.	4	2
	Contig	High	N/A	High	V. High	High	V. High	High	6	2
NYW18-M108-W	SA	V. High	None/None app.	High	V. High	High	Mod.	High	5	1
	FB	V. High	None/None app.	High	V. High	High	Mod.	High	6	1
	Contig	V. High	N/A	High	V. High	High	V. High	High	6	2
NYW18-M113	SA	V. High	None/None app.	V. High	V. High	High	High	High	5	2
	FB	V. High	None/None app.	V. High	V. High	High	Mod.	V. High	5	4
	Contig	High	N/A	V. High	V. High	High	V. High	V. High	5	4
NYW18-M115	SA	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	V. High	8	3
	FB	V. High	Recovered	Mod.	V. High	Mod.	Mod.	High	8	1
	Contig	High	N/A	Mod.	V. High	High	V. High	High	8	1
NYW18-M171	SA	High	Recovered	Mod.	V. High	Mod.	Mod.	Mod.	3	2
	FB	High	Recovered	Mod.	V. High	Mod.	Mod.	High	3	1
	Contig	High	N/A	Mod.	V. High	Mod.	Mod.	Mod.	3	0
NYW19-M107	SA	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	High	2	4
	FB	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	High	2	2
	Contig	V. High	N/A	V. High	V. High	High	V. High	High	2	2
NYW19-M110	SA	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	High	1	4
	FB	V. High	None/None app.	High	V. High	Mod.	Mod.	High	1	4
	Contig	High	N/A	High	V. High	High	V. High	V. High	3	4

Site ID	Eval. area	Flood control	Hydro. health/ disturbance	Erosion control	Ground/ subsurface H2O	Pollution treatment	Wildlife	General value	Special tally	Unique tally
NYW19-M112	SA	High	None/None app.	High	V. High	High	High	Mod.	2	2
	FB	High	None/None app.	High	V. High	High	High	High	2	2
	Contig	High	N/A	High	V. High	High	High	Mod.	2	0
NYW19-M119	SA	V. High	Recovering	Mod.	V. High	Mod.	Mod.	Mod.	2	0
	FB	V. High	Recovered	Mod.	V. High	Mod.	Mod.	High	2	2
	Contig	High	N/A	High	V. High	High	V. High	Mod.	2	0
NYW19-M120	SA	V. High	Recovered	Mod.	V. High	Mod.	Mod.	High	2	2
	FB	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	High	2	2
	Contig	High	N/A	High	V. High	Mod.	High	High	3	1
NYW19-M126	SA	High	None/None app.	Mod.	V. High	Mod.	Mod.	Mod.	4	1
	FB	High	Recovered	Mod.	V. High	Mod.	Mod.	High	4	2
	Contig	High	N/A	Mod.	V. High	Mod.	Mod.	High	4	2
NYW19-M129	SA	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	V. High	3	5
	FB	V. High	Recovered	Mod.	V. High	Mod.	Mod.	V. High	3	4
	Contig	High	N/A	High	V. High	Mod.	V. High	High	3	2
NYW19-M136	SA	V. High	None/None app.	High	V. High	Mod.	V. High	V. High	3	3
	FB	V. High	None/None app.	High	V. High	Mod.	V. High	High	3	2
	Contig	V. High	N/A	High	V. High	Mod.	V. High	High	3	2
NYW19-M140	SA	V. High	None/None app.	High	V. High	High	High	V. High	5	3
	FB	V. High	None/None app.	High	V. High	High	Mod.	High	5	2
	Contig	High	N/A	High	V. High	High	V. High	High	5	2
NYW19-M142	SA	V. High	None/None app.	High	V. High	Mod.	Mod.	High	2	3
	FB	V. High	None/None app.	V. High	V. High	Mod.	High	High	2	2
	Contig	V. High	N/A	V. High	V. High	Mod.	V. High	High	2	2

Site ID	Eval. area	Flood control	Hydro. health/ disturbance	Erosion control	Ground/ subsurface H2O	Pollution treatment	Wildlife	General value	Special tally	Unique tally
NYW19-M156	SA	V. High	Recovering	High	V. High	High	Low	Mod.	2	0
	FB	High	Recent/No recov.	High	V. High	High	Mod.	Mod.	2	1
	Contig	Mod.	N/A	High	V. High	High	Mod.	Mod.	2	0
NYW19-M167	SA	V. High	None/None app.	High	V. High	Mod.	Mod.	High	3	2
	FB	V. High	None/None app.	V. High	V. High	Mod.	Mod.	High	2	2
	Contig	V. High	N/A	V. High	V. High	Mod.	High	High	2	2
NYW19-M168	SA	High	Recovered	High	V. High	Mod.	Mod.	High	3	2
	FB	High	Recovered	High	V. High	High	High	High	3	2
	Contig	High	N/A	High	V. High	High	High	High	3	1
NYW19-M180	SA	Low	Recovered	Mod.	V. High	Mod.	Mod.	Mod.	3	2
	FB	Mod.	Recovered	Mod.	V. High	High	Low	Mod.	3	2
	Contig	Mod.	N/A	Mod.	V. High	High	Mod.	Mod.	3	0
NYW19-M192	SA	V. High	None/None app.	Mod.	V. High	Mod.	Mod.	V. High	3	3
	FB	High	Recovered	Mod.	V. High	High	Mod.	High	3	1
	Contig	Mod.	N/A	Mod.	V. High	High	Mod.	Mod.	3	0
NYW19-M204	SA	V. High	None/None app.	V. High	V. High	High	High	High	3	1
	FB	V. High	None/None app.	V. High	V. High	High	Mod.	High	3	1
	Contig	V. High	N/A	V. High	V. High	High	V. High	V. High	7	1
NYW19-M228	SA	High	None/None app.	High	V. High	High	Mod.	High	2	2
	FB	V. High	None/None app.	V. High	V. High	High	Mod.	High	2	2
	Contig	V. High	N/A	V. High	V. High	High	V. High	Mod.	2	1
NYW19-MEND*	SA	High	None/None app.	Mod.	V. High	Mod.	Mod.	High	4	2
	FB	High	None/None app.	Mod.	V. High	Mod.	Mod.	High	4	1
	Contig	High	N/A	Mod.	V. High	Mod.	NA	N/A	x	x
NYW19-MPISP	SA	High	Recovered	Mod.	Mod.	High	Mod.	High	5	1
	FB	Mod.	Recovered	High	Mod.	High	Mod.	High	5	1
	Contig	Mod.	N/A	High	Mod.	High	Mod.	High	5	0

*NYW19-MEND is a nonrandom site at Mendon Ponds Park in the Genesee basin. The wetland is a small basin that is entirely contained within the field buffer.

CONCLUSIONS

Our new FRAM protocols developed and piloted during this project provide biologists with a science-based tool for assessing wetland functions and values. The ability to rapidly, consistently, and accurately assess wetland condition and function is crucial for setting management priorities and prioritizing conservation actions. Our new Android NYRAM Application streamlines data collection in the field and provides instant scoring results.

Our functional assessment method was designed to align with functions and values outlined in NYS' wetland protection legislation, but we did not see strong correlations between our metrics and DEC's assigned Wetland Class. We tested the efficacy of this new method relative to our established methods and found significant support across all of our three-tiered assessment metrics. For example, our scoring results suggest: a connection between wetland function and ecological condition; wetlands with higher "General Value" rankings tended to have higher function summary scores; and high-quality wetlands can persist in developed landscapes if they don't have a legacy of historical land use or modifications to their hydrology.

Our review of high-quality wetlands and natural community conservation ranking informed our new "quick guide" for identifying potentially significant wetlands based on natural community type, area, and invasive dominance. This quick guide and NYNHP's online natural community guides give land managers and conservation biologists the information they need to make informed decisions. Combined, this suite of methods produces a robust dataset that furthers our knowledge of wetland condition throughout the state, and takes an important first step towards developing a wetland functional assessment method that is tailored to New York State.

OUTREACH AND EVENTS

We involved our partners early in the development of this protocol and held several working field sessions to gain applied feedback. Due to the COVID-19 pandemic we were not able to host large group work/feedback sessions, but those of us involved felt limiting meetings to four or fewer people allowed us to go more in depth than if we had been in a large group. We met with staff from NYS DEC in Regions 4, 5, and 8, as well as staff from New York City Department of Environmental Protection, NatureServe, and former DEC permitting staff. Below is a list of presentations we gave, conferences we attended, and interactive workshops we held.

iNaturalist.org

In 2019 we began using iNaturalist.org, to post observations for our field surveys. We've found this platform is a great way to interact with the public and allows them a glimpse at some of the interesting things we see and places we visit during our surveys. These public posts are also a great way to connect with researchers interested in certain taxa or other wetland ecologists in the region. We've created a project for every survey year since 2019, added some pre-2019 photos, and created an inclusive NYNHP wetland Program "collector" style project. By creating "Observation Fields" specific to our work, such as "NY Site ID", we are able to tag and easily find/gather observations from a given survey site, wetland community type, etc. (Figure 24).

NYNHP Wetland Program "Collector" iNaturalist project (Figure 25):
https://www.inaturalist.org/projects/new-york-natural-heritage-program-wetlands-projects

2019 NYNHP Wetland Program Project observations:
https://www.inaturalist.org/projects/nynhp-wetland-program-2019

We created an iNaturalist "journal" post highlighting our favorite site form 2019, a Black Spruce-Tamarack Bog (Site ID: NYW19-M129):
https://www.inaturalist.org/journal/ny_wetlander/35356-black-spruce-tamarack-bog-wetland-complex-mohawk-watershed-headwater

2018-2011 "archive" iNaturalist observation project:
https://www.inaturalist.org/projects/nynhp-wetland-program-observation-archive-2011-2018

Figure 24: Example Observation Fields (OF) applied to an observation from site NYW19-M129. Users can easily query observations that have a specific OF or OF value.

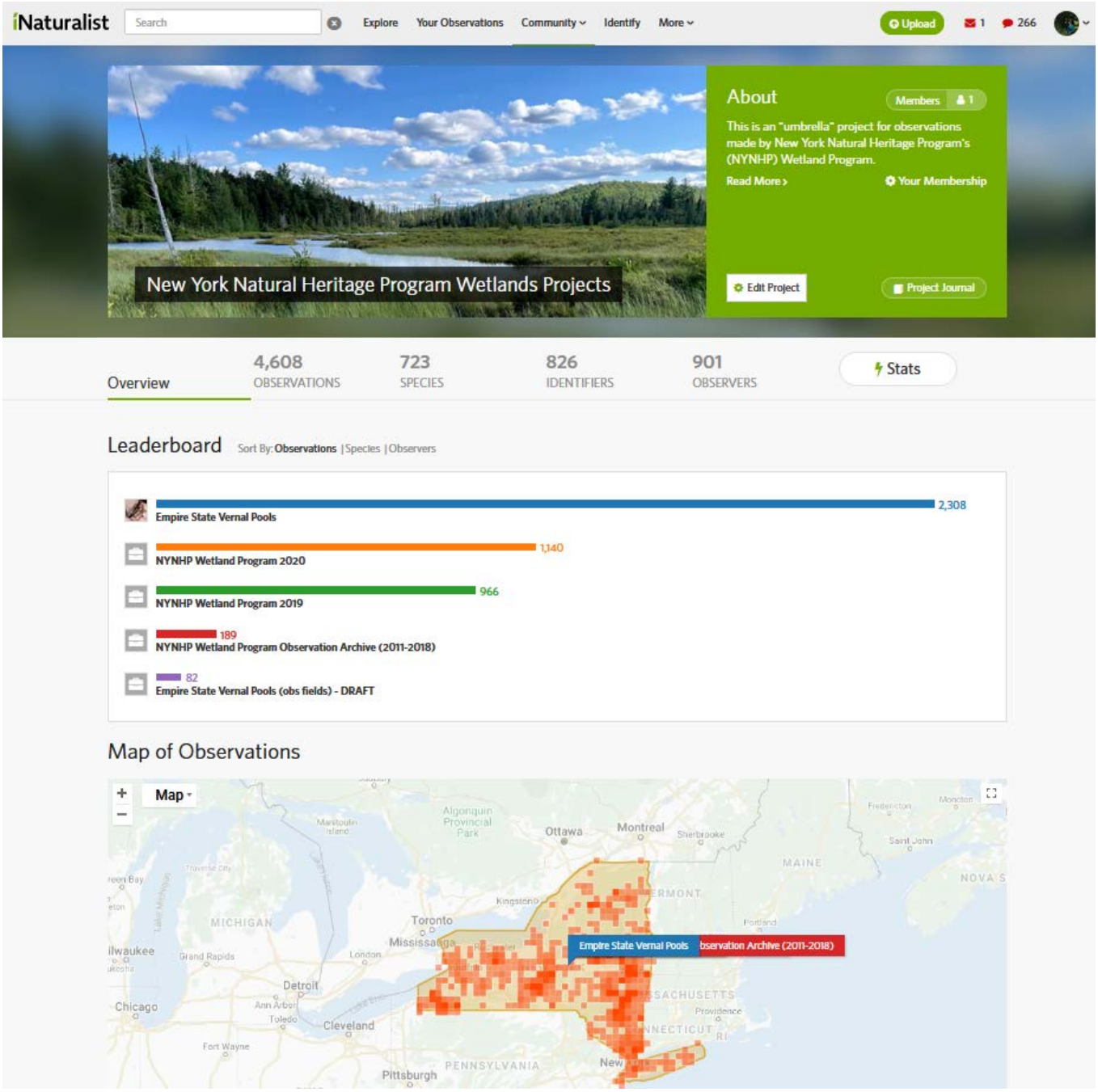


Figure 25: Screenshot of the "umbrella" project that serves as a landing page for all of our NYNHP wetland program projects. The "Empire State Vernal Pools" project is an automated datamining project that pulls in all NY observations of fauna associated with vernal pools. For all other projects listed observed need to manually add their observation to the project, which we restrict to our staff. Screenshot date: December 10, 2021.

Conferences, Presentations, and Research dissemination

Prior to 2020 conferences being canceled due to the COVID-19 pandemic we successfully submitted abstracts to the Society of Wetland Scientists and the New York State Wetlands Forum conferences.

In light of conference cancelations and academia's rapid switch to online classes during the spring of 2020, Laura Shappell reached out to several wetland ecology professors across the state to see if they would be interested in her doing a guest lecture. Dr. Shappell gave three remote guest lectures on NYNHP's wetland program and research, reaching students at SUNY Brockport, Siena College, and Finger Lakes Community College. Students were interested to see how what they have been learning in class can be applied to research that helps biologists better understand NY's wetland resources.

Society of Wetland Scientists annual conference. May 2019. Baltimore, MD. Presenter: Dr. Laura Shappell. Title: How Wide is Wide Enough? Connections Between Buffer Width, Land Use, and Wetland Condition. (A presentation on our 2018 WPDG report and future work.)

NYSWF annual conference. April 2019. Saratoga Spring, NY. Presenter: Dr. Laura Shappell. Title: How Wide is Wide Enough? Connections Between Buffer Width, Land Use, and Wetland Condition. (A presentation on our 2018 WPDG report and future work.)

SUNY ESF Guest Lecture, Wetland Management Course. March 2019. Syracuse, NY. Presenter: Dr. Laura Shappell. Introduced students to NYNHP's wetland program, assessment methods, and ongoing research.

NE/MAWWG Joint conference. November 2018. Cooperstown, NY. Dr. Laura Shappell introduced NYNHP's wetland assessment methods, results, and ongoing research to northeast and midatlantic working group members. This was also a fantastic opprotunity to network and learn from other members' efforts.

Northeast Natural Heritage Network Conference. October 2018. Western Pennsylyvaina. Dr. Laura Shappell introduced NYNHP's wetland assessment methods, results, and ongoing research to regional members of the NatureServe network.

NYSWF annual conference. April 2018. Watkins Glen, NY. Presenter: Dr. Laura Shappell. Title: A three-tiered approach to quantifying wetland condition in New York State.

NYS DEC Habitat Bureau Conference. March, 2019. Lake George, NY. Presenter: Dr. Laura Shappell. Title: A three-tiered approach to quantifying wetland condition in New York State. This presentation introduced results from our recent WPDG report (Shappell and Howard 2018), and introduced this projects objections.

Figure 26: Above, photos from our training sessions with NYC DEP in and around wetlands adjacent to the Ashokan Reservoir, Ulster County, NY.

LITERATURE CITED

Blom, C. W. P. M. and L. A. C. J. Voesenek. 1996. Flooding: the survival strategies of plants. Trends in Ecology & Evolution 11:290-295.

Bried, J. T., S. K. Jog, and J. W. Matthews. 2013. Floristic quality assessment signals human disturbance over natural variability in a wetland system. Ecological Indicators 34:260–267.

Bruland, G. L. and C. J. Richardson. 2005. Hydrologic, edaphic, and vegetative responses to microtopographic reestablishment in a restored wetland. Restoration Ecology 13:515-523.

Chamberlain, S. J., and R. P. Brooks. 2016. Testing a rapid Floristic Quality Index on headwater wetlands in central Pennsylvania, USA. Ecological Indicators 60:1142–1149.

Chapin, F. S., III, P. A. Matson and H. A. Mooney. 2002. Terrestrial water and energy balance. p. 71-96. In Principles of Terrestrial Ecosystem Ecology. 1st ed. Springer-Verlag, New York.

Chu, S., and B. Molano-Flores. 2013. Impacts of agricultural to urban land-use change on floristic quality assessment indicators in Northeastern Illinois wetlands. Urban Ecosystems 16:235–246.

Conte-Ecology, U.S. Geological Survey. 2015, November. The national hydrography dataset high resolution delineation version 2 (NHDHRDV2).

Cornell IRIS. 2018. Agricultural Districts, New York State. vector digital data, .

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services, Fish and Wildlife Service, U.S. Dept. of Interior, Washington, D.C.

Davis, M. A., J. P. Grime and K. Thompson. 2000. Fluctuating resources in plant communities: a general theory of invasibility. Journal of Ecology 88:528-534.

Edinger, G. J., T. G. Howard, and M. D. Schlesinger. 2016. Classification of Natural Areas Conservancy's Ecological Assessment Plots. New York Natural Heritage Program, Albany, NY.

Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero (editors). 2014. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY

Ehrenfeld, J. G. and J. P. Schneider. 1993. Responses of forested wetland vegetation to perturbations of water chemistry and hydrology. Wetlands 13:122-129.

Ehrenfeld, J. G., H. Bowman Cutway, R. Hamilton and E. Stander. 2003. Hydrologic description of forested wetlands in northeastern New Jersey, USA - an urban/suburban region. Wetlands 23:685-700.

Euliss, N. H., J. W. LaBaugh, L. H. Fredrickson, D. M. Mushet, M. K. Laubhan, G. A. Swanson, T. C. Winter, D. O. Rosenberry and R. D. Nelson. 2004. The wetland continuum: a conceptual framework for interpreting biological studies. Wetlands 24:448-458.

ESRI. 2014. ArcGIS Desktop: Release 10.3. Environmental Systems Research Institute, Redlands, CA.

Faber-Langendoen, D., J. Rocchio, S. Thomas, M. Kost, C. Hedge, B. Nichols, K. S. Walz, G. Kittel, S. Menard, J. Drake, and E. Muldavin. 2012. Assessment of Wetland Ecosystem Condition across Landscape Regions: A Multi-metric Approach. Part B: Ecological Integrity Assessment Protocols for Rapid Field Methods (L2). U.S. Environmental Protection Agency, Washington, DC.

Feldmann, A., and T. Howard. 2013. Landscape Condition Assessment (LCA2) for New York. New York Natural Heritage Program, Albany, NY.
Findlay, C. S. and J. Houlahan. 1997. Anthropogenic correlates of species richness in southeastern Ontario wetlands. Conservation Biology 11:1000-1009.
Genesee/Finger Lakes Regional Planning Council. 2004. The Genesee River Basin Action Strategy. Genesee/Finger Lakes Regional Planning Council, Rochester, NY.
Grabas, G. P. and D. Rokitnicki-Wojcik. 2015. Characterizing daily water-level fluctuation intensity and water quality relationships with plant communities in Lake Ontario coastal wetlands. Journal of Great Lakes Research 41:136-144.
Grime, J. P. 1977. Evidence for the existence of three primary strategies in plants and its relevance to ecological and evolutionary theory. The American Naturalist 111:1169-1194.
Groffman, P. M., D. J. Bain, L. E. Band, K. T. Belt, G. S. Brush, J. M. Grove, R. V. Pouyat, I. C. Yesilonis, and W. C. Zipperer. 2003. Down by the riverside: urban riparian ecology. Frontiers in Ecology and the Environment 1:315–321.
Homer, C. G., J. Dewitz, L. Yang, S. Jin, P. Danielson, G. Z. Xian, J. Coulston, N. Herold, J. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States – Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81:345354.
Houlahan, J. E., and C. S. Findlay. 2004. Estimating the "critical" distance at which adjacent land-use degrades wetland water and sediment quality. Landscape Ecology 19:677–690.
Houlahan, J. E., P. A. Keddy, K. Makkay, and C. S. Findlay. 2006. The effects of adjacent land use on wetland species richness and community composition. Wetlands 26:79–96.
IBM Corp. 2015. IBM SPSS Statistics for Windows. IBM Corp., Armonk, NY.
Jacobs, A. D. 2010. Delaware Rapid Assessment Procedure Version 6.0. Delaware Department of Natural Resources and Environmental Control, Dover, DE. 36 pages.
Jenks, G. F. 1967. The data model concept in statistical mapping. International Yearbook of Cartography 7:186–190.
Kozlowski, T. 2002. Physiological-ecological impacts of flooding on riparian forest ecosystems. Wetlands 22:550-561.
Lockwood, J. L., P. Cassey and T. Blackburn. 2005. The role of propagule pressure in explaining species invasions. Trends in Ecology & Evolution 20:223-228.
Magee, T. K. and M. E. Kentula. 2005. Response of wetland plant species to hydrologic conditions. Wetlands Ecology and Management 13:163-181.
Martin, P. H., C. D. Canham and P. L. Marks. 2009. Why forests appear resistant to exotic plant invasions: intentional introductions, stand dynamics, and the role of shade tolerance. Frontiers in Ecology and the Environment 7:142-149.
Matthews, J. W., P. A. Tessene, S. M. Wiesbrook, and B. W. Zercher. 2005. Effect of area and isolation on species richness and indices of Floristic Quality in Illinois, USA wetlands. Wetlands 25:607–615.
Middleton, B. A. 2003. Soil seed banks and the potential restoration of forested wetlands after farming. Journal of Applied Ecology 40:1025-1034.
Miller, S. J., and D. H. Wardrop. 2006. Adapting the floristic quality assessment index to indicate anthropogenic disturbance in central Pennsylvania wetlands. Ecological Indicators 6.
The Mohawk River Watershed Coalition. 2015. The Mohawk River Watershed Management Plan. http://mohawkriver.org/wp-content/uploads/2015/03/MohawkWatershedMgmtPlan_Mar2015_Final_r.pdf
NYS DEC. 2005. Comprehensive Wildlife Conservation Strategy for New York.

https://www.dec.ny.gov/docs/wildlife_pdf/alleghenytxt.pdf
PA DEP. 2014. Pennsylvania Wetland Condition Level 2 Rapid Assessment. Pennsylvania Department of Environmental Protection, Harrisburg, PA. 37 pages.
Peet, R. K., T. R. Wentworth, and P. S. White. 1998. The North Carolina Vegetation Survey protocol: A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262–274.
Pickett, S. T. A., M. L. Cadenasso, J. M. Grove, C. H. Nilon, R. V. Pouyat, W. C. Zipperer and R. Costanza. 2001. Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. Annual Review of Ecology and Systematics 32:127-157.
Price, C. V., N. Nakagaki, K. J. Hitt, and R. M. Clawges. 2007. Enhanced Historical Land-Use and Land-Cover Data Sets of the U.S. Geological Survey: polygon format files. U.S. Geological Survey, Reston, VA.
Ring, R. M. 2016. Coefficients of conservatism values for a Flora Quality Assessment Index of the native vascular plants of New York. New York Natural Heritage Program, Albany, NY.
Schramm, J. and J. Ehrenfeld. 2010. Leaf litter and understory canopy shade limit the establishment, growth and reproduction of Microstegium vimineum. Biological Invasions 12:3195-3204.
Shappell, L. J., A. L. Feldmann, E. A. Spencer, and T. G. Howard. 2016. New York State wetland condition assessment, EPA Wetland Program Development Grant (CD-96294200) Final Report. New York Natural Heritage Program, Albany, NY. 60 pages.
Shappell, L. J. and T. G. Howard. 2018. Supporting Actionable Decision-Making For Wetland Permitting In New York From Urban To Rural Environments. Ver. 04052019. EPA Wetland Program Development Grant. Final Report. New York Natural Heritage Program, Albany, New York.
Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262–278.
Stinson, K. A. and T. G. Seidler. 2014. Physiological constraints on the spread of Alliaria petiolata populations in Massachusetts. Ecosphere 5:art 96.
Swink, F., and G. Wilhelm. 1994. Plants of the Chicago region. Indiana Academy of Science, Indianapolis, IN.
Tarboton, D. 2016. Terrain Analysis Using Digital Elevation Models (TAUDEM).
Tiner, R. 2011. Nova Scotia Wetland Evaluation Technique. U.S. Fish and Wildlife Service.
Tiner, R. 2014. Dichotomous Keys and Mapping Codes for Wetland Landscape Position, Landform, Water Flow Path, and Waterbody Type Descriptors: Version 3.0. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. 65 pp. plus Appendices.
Toogood, S. E. and C. B. Joyce. 2009. Effects of raised water levels on wet grassland plant communities. Applied Vegetation Science 12:283-294.
US Army Corps of Engineers. 2021. NWPL Home v3.4-f9c [Online]. Available: https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html [Accessed: 03-Dec-2021].
US EPA. 2016. National Wetland Condition Assessment 2016: Field operations manual. U.S. Environmental Protection Agency, Washington D.C.
US EPA. 2021. Introduction: Watershed Index Online (WSIO) Indicator Data Tables, Area Coverage in this file: US Environmental Protection Agency Region 2 States (including NJ and NY) watershed indicator data at the HUC12 scale. Version 2.2, released August 12, 2021. U.S. Environmental Protection Agency, Washington D.C.

U.S. Fish and Wildlife Service. 2015. National Wetlands Inventory [Online]. Available: http://www.fws.gov/wetlands.
van der Valk, A. G. 1981. Succession in wetlands: a Gleasonian approach. Ecology 62:688-696.
Vermont Department of Environmental Conservation (VDEC). 2019. Vermont Wetland Evaluation Form. Version Jan. 2019. Agency of Natural Resources. Montpelier, VT.
Werier, D. 2017. Catalogue of the Vascular Plants of New York State. Memoirs of the Torrey Botanical Society 27:1–542.
West Virginia Department of Environmental Protection. 2021. User Manual for the West Virginia Wetland Rapid Assessment Method. Version 1.03. Watershed Assessment Branch, Division of Water and Wastewater Management, West Virginia Department of Environmental Protection, Charleston, WV < https://dep.wv.gov/WWE/watershed/wetland/Pages/WVWRAM.aspx>
Zar, J. H. 1999. Biostatistical analysis. Prentice Hall, Upper Saddle River, NJ.

APPENDIX A: LEVEL 3 VEGETATION SAMPLING PROTOCOLS

NYNHP Wetland Assessment

Level 3 protocols

Draft ver. 1.0

DECEMBER 2021

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Introduction

Sampling methodology and plot placement

Using plot-based sampling for vegetation study involves two broad considerations: 1) the method by which plots are placed in the study area, and 2) how the data on plant species cover are collected in the plot. Both of these factors are influenced by the objectives and requirements of the study.

Methods of plot placement can be separated into two general categories, subjective and objective. NYNHP wetland surveys conducted for EPA-funded projects primarily use objective stratified random sampling.

- **Subjective** (non-random): Plot locations are carefully chosen within each sample stand/target community so that the data from the plot represent attributes of the stand as a whole. Subjective plot placement may be used in studies whose goal is to describe or characterize vegetation for developing plant community classifications or developing detailed natural community maps, for example.
- **Objective** (random): Plots are placed either randomly or at regular intervals (i.e., systematically) across the entire study area, or alternatively the study area is divided into general units according to broad vegetation types (e.g., Cowardin et al. wetland class), groupings of dominant species, substrate types, management units, or other general criteria and plots are placed randomly or systematically within these units; the latter are examples of stratified random or stratified systematic sampling. Objective placement of plots is generally used in experimental (rather than descriptive) studies, where the goals of the study require that the data collected be treatable with probability statistics.

Our wetland program database has both objective and subjective plot data, so recording placement method is important for analysis.

Target wetland community types

Is it a wetland?

Wetlands are 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. Following Cowardin et al. (1979) classification, wetlands must have one or more of the following three attributes:

1) at least periodically, the land supports predominantly hydrophytes;

2) the substrate is predominantly undrained hydric soil;

3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (≥3 weeks).

Target wetland communities

Broadly, the target population for NYNHP's wetland assessment work is tidal and nontidal wetlands, including certain farmed wetlands not currently in crop production. The wetlands have rooted vegetation and, when present, open water **less than 1 meter deep**. Specific projects may narrow the target community specifications or adjacent land use types to meet the project's objectives (e.g., nontidal palustrine systems).

Community classification follows Edinger et al. (2014).

Evaluating random points remotely and in the field

Our site evaluation protocols follow those developed by EPA for National Wetland Condition assessment 2016, as outlined in their Site Evaluation Guidelines ("SEG"), and are briefly summarized below.

The primary purpose of site evaluation is to determine whether a random sample point selected by the random sample design ("sample draw") is a wetland in the target population for the project and is accessible and sampleable by a field crew. There are four main steps involved in this process (see SEG Figure 1):

1) Locate the sampling point on an aerial image, topographic and/or similar map and determine whether the point is within or very near (within 60 meters of) a wetland that is in the target population for the project.
2) Determine if the point is accessible.
3) Verify that the point is sampleable or can be shifted (up to 60 meters) to a nearby location that is.
4) Sample the point OR replace with an alternate point.

Vegetation plot sampling

Level 3 macroplot protocols modified after Peet et al. (1998)

When conducting objective surveys, our default macroplot orientation is North-South, or alternatively East-West. We do this for consistency and easy of set up, but occasionally sites call for non-cardinal orientation due to sampling concerns (e.g., to capture heterogeneity, fit in a narrow space, avoid open water, or a stand of poison sumac).

Plot setup

Our standard wetland assessment macroplot is 20 m x 50 m, and divided into ten 10 m x 10 m subplots AKA modules (Figure 1, left). Subplots are numbered 1-10 in a "U" pattern; in Figure 1 subplot 1 is directly below the word "plant" and subplot 10 is below the word "richness". We intensively sample four subplots, unusually following the "standard" layout (i.e., blue shaded subplots [2,3,8,9] in Figure 1, left). However, for heterogeneous sites I will randomly select intensive modules (usually using the old stopwatch start-stop method).

GPS points (n = 3): Taken at 0 m, 25 m, and 50 m of the macroplot using waypoint averaging.

Plot photos (n = 12): Main axis – taken at 0 and 50 m looking along the 50-m tape; subplot photos – photograph all subplots, preferably with the 50-m tape in view for reference. These photos are meant to capture the overall feel of the macroplot and may serve as a reference back at the office or if someone wishes to revisit the survey area.

Intensive subplots: what's measured?

Species x strata: raw percent cover is estimated for each species and unvegetated category type in each stratum (see vegetation strata section below); in a 10 m x 10 m plot 1% cover means the leaf area would fill a 1 m x 1m area. Note: Cover estimates are rounded to the nearest whole number, with <1% recorded as 0.01%. To assign Coefficient of Conservatism scores we often need a subspecies or variety level determination (e.g., ssp. or var.) per NY Flora Atlas Taxonomy.

Strata cover + height: Estimate total cover for each stratum present in the subplot, assess strata height in meters. For tree height we use a Biltmore stick. One edge of the Biltmore stick is marked with a Merritt hypsometer used to estimate tree height.

Diameter at Breast Height (at 1.3 m): The diameter of all woody stems >10 cm are recorded in cm as follows: Separate DBH measurements with a comma and note whether the tree is dead. Example: plot includes four red maple boles: one is 20 cm DBH, two multi-stemmed trunks [split below DBH] at 14 and 16 cm, and one snag at 30 cm. These data should be recorded as: 20,(14,16),30=dead. (Note: for restored sites or where tree recruitment is a concern, you may want to go down to 2.5 cm).

Litter and duff depth: representative for the plot, recorded to the nearest half centimeter, and you may optionally note the predominate leaf litter type ("maple leaves", "pine needles", "sedge leaves", etc.).

Standing water depth: deepest observed standing water depth in the subplot
Hummock hollow range (optional): we don't officially record this, but sometimes we note the range in centimeters if it is pronounced.
Coarse woody debris decomposition (optional): The highest decay class observed is noted (Decay classes follow Maser et al. 1979.). NYNHP's Wetland Ecologist, Laura Shappell began recording this in 2019, particularly for sites with CWD >30 cm in diameter.
Note: Unlike Peet et al. (1998) we do not use smaller subplots within the 10 m x 10 m modules (we've considered doing so for mosses, but haven't, yet). We do not follow Peet's soil sampling – see references below.

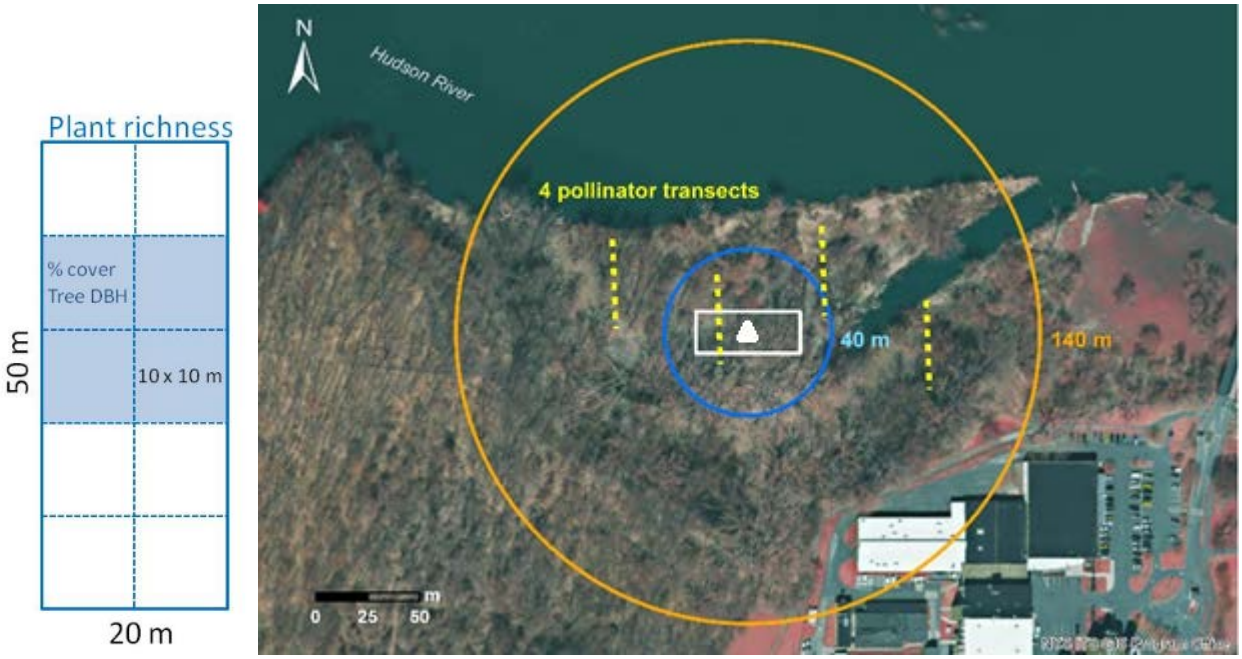

Figure 27: Left – schematic of the 20 m x 50 m macroplot. Right - Example placement of an East-West macroplot (white rectangle), centered around a random point (white triangle). That is, the point is the 25 m mark of the macroplot. At this site, 0 m is at the western end of the macroplot and 50 m is at the eastern end. Blue and orange circles represent survey areas covered during the Rapid Assessment Method survey(s). This figure also demonstrates how pollinator bowl transects may be laid when completing the intensive Empire State Native Pollinator Survey protocols (i.e., four transects within the wetland habitat); Note: pollinator transects do not need to be placed parallel no are they likely to be perfectly spaced. Pollinator sampling is not part of our standard wetland assessment sampling protocols.

Macroplot: what's measured?

Residual plant species: These are novel species not previously captured in the four intensive subplots. Percent cover should be estimated at the 20 m x 50 m macroplot scale (i.e., at 1,000 m^2, 1% = 10 m^2). Height and strata cover can be recorded for residuals, particularly if the strata is also novel. DBH is not recorded for residual tree species.

Soils: We typically just conduct soil profiles at one representative location in the macroplot. See Minnesota DNR field manual (2013, p. 15) for a good deception of **soil profile** methods along with how to use the **von Post** decomposition scale for organic soils. For each soil layer, note hydric indicators as described in the NWCA 2016 Field Operations Manual (EPA NWCA 2016, section 6.6), also briefly described by MN DNR (2013, p. 18). Additional traits described in the MN DNR manual: **Soil drainage classes** (p. 19).

General site characterization

- NYNHP ecological system (e.g., Palustrine) and wetland community name(s) per Edinger et al. 2014.
- Topographic Context (MN DNR 2013, p. 14)
- Hydroperiod (sensu Cowardin et al. 1979)
- Physiognomic group variables (MN DNR p. 30 – "woody plants" and "herbaceous plants")

Vegetation strata

Current vegetation strata codes are outlined below in Figure 2 and Table 1.

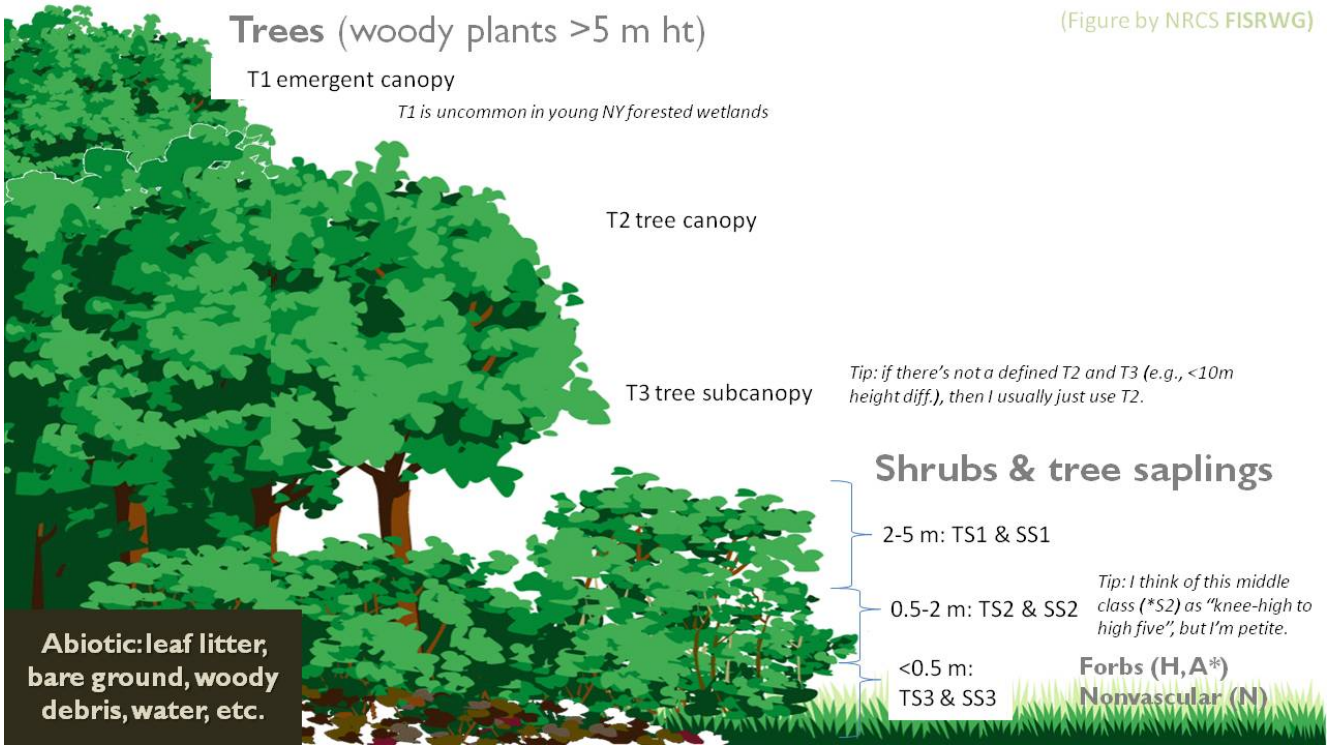

Figure 28: Schematic diagram illustrating some of the vegetation strata assessed in NYNHP's "intensive" subplots. Note: aquatic strata examples are not illustrated.

Table 6: ***Quick guide to NYNHP strata codes and unvegetated categories. Note unvegetated size classes for rocks and woody debris.***

Code	Strata/life forms			Unvegetated categories (reference)
T1	Emergent tree (>5m)	**V1**	Tall Vine/liana >5m)	Bedrock | Very large rocks >1m
T2	Tree canopy (>5m)	**V2**	Short Vine/liana <5m)	Lg rocks >10cm | Sm rocks <10cm
T3	Tree sub-canopy (>5m)	**H**	Herbaceous	Sand <2mm | Bare soil | Litter & Duff
TS1	Tall sapling (2m - 5m)	**N**	Non-vascular	Wood: CWD >7.5cm | FWD <7.5cm
TS2	Med sapling (<2m - 0.5m)	**E**	Epiphyte	Water | Wrack | Trash | Other
TS3	Short sapling (<0.5m)	**A1**	Emergent aquatic	
SS1	Tall shrub (2m - 5m)	**A2**	Floating-leaved aquatic	
SS2	Med shrub (<2 - 0.5 m)	**A3**	Submerged aquatic	
SS3	Short shrub (<0.5m)	**U**	Unvegetated (duff, soil, etc.)	

Citations:

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services, Fish and Wildlife Service, U.S. Dept. of Interior, Washington, D.C.

Edinger, G. J., D. J. Evans, S. Gebauer, T. G. Howard, D. M. Hunt, and A. M. Olivero (editors). 2014. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

Maser C., R. G. Anderson, K. Cromack, J. T. Williams, and K. W. Cummins.1979. Dead and down woody material. In 'Wildlife Habitats in Managed Forests, the Blue Mountains of Oregon and Washington'. USDA Forest Service, Agricultural Handbook 553. (Ed. J Thomas) (Washington, DC).

Minnesota Department of Natural Resources. 2013. A handbook for collecting vegetation plot data in Minnesota: The relevé method. 2nd ed. Minnesota Biological Survey, Minnesota Natural Heritage and Nongame Research Program, and Ecological Land Classification Program. Biological Report 92. St. Paul: Minnesota Department of Natural Resources.

Peet, R. K., T. R. Wentworth, and P. S. White. 1998. The North Carolina Vegetation Survey protocol: A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262–274.

U.S. EPA. 2016. National Wetland Condition Assessment 2016: Site Evaluation Guidelines. EPA-843-R-15-010. U.S. Environmental Protection Agency, Washington, DC.

APPENDIX B: NYRAM FIELD MANUAL AND DATA SHEETS

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New York State Wetland Condition Assessment

Level 2 Rapid Assessment Method
NYRAM Version 5.3, December 2021

User's Manual and Data Sheets

Developed By New York Natural Heritage Program

Laura J. Shappell, Ph.D.

New York Natural Heritage Program

A Partnership between the NYS Department of Environmental Conservation and the SUNY College of Environmental Science and Forestry

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Project scope

Method development

The New York Rapid Assessment Method (NYRAM) provides users with a relatively quick procedure for assessing the quality and condition of New York State (NYS) wetlands. Methods presented here are part of a three-tiered sampling approach (Level 1, 2, 3); similar methods have been employed by federal and state agencies in an effort to develop environmental monitoring protocols (Faber-Langendoen et al. 2012, PA DEP 2014, Jacobs 2010). For Level 1, the New York Natural Heritage Program (NYNHP) developed a statewide Landscape Condition Assessment (LCA) model that cumulatively depicts key anthropogenic stressors across the NYS landscape at a 30 x 30-m resolution. Rapid assessment methods (RAM) developed for Level 2 classify and catalog anthropogenic stressors using basic quantitative air photo interpretation and qualitative field surveys. NYRAM field methods employ a stressor checklist that was modeled after established RAM procedures developed for Mid-Atlantic States (PA DEP 2014, Jacobs 2010). At the finest scale of measurement, Level 3 relevé sampling protocols modified from those developed by Peet et al. (1998) captured vegetation structure and floristic biodiversity. Level 1 and Level 3 data were used to refine and support the Level 2 RAM presented here.

NYRAM incorporates onscreen (Part A) and field (Part B) components that broadly assess hydrology, fragmentation, vegetation composition, and water quality. The field stressor checklist encompasses a broad range of potential stressors that may influence natural wetland structure (e.g., plant species composition) and function (e.g., ground water recharge, nutrient cycling), while providing flexibility for practitioners to document unique stressors present at their assessment site.

This rapid assessment method will continue to be refined as we expand our wetland assessment dataset. Updated NYRAM versions will be posted on the New York Natural Heritage website (http://www.nynhp.org/wetlands). Please consider sharing your NYRAM data with NYNHP to help build our understanding of wetland condition in NYS.

Development of NYRAM

When developing this method, we aimed for it to be relatively quick, repeatable, and applicable to wetlands throughout NYS (Feldmann 2013, Feldmann and Spencer 2015, Shappell et al. 2016, Shappell and Howard 2018). Most of the 54 survey sites used to calibrate NYRAM ver. 4.2 fell within the Lower Hudson River and Susquehanna River watersheds; a few additional points were located in the Adirondack Park. **NYRAM ver. 5** scoring was recalibrated in 2018 based on an expanded urban-rural dataset with greater coverage across NYS (n = 140; Shappell and Howard 2018).

Following recalibration, NYRAM ver. 5 (“NYRAM5”) scores are more robust and correlate strongly with floristic quality scores (Shappell and Howard 2018). The new method provides an option to automate the onscreen assessment portion of NYRAM (“Part A”), but we’ve retained the original manual form, with updated scoring, as an option for users (NYRAM5-m). Regardless of whether users automate or manually complete Part A, the final scores are comparable (Figure 29). Users can use either the automated of manual versions of NYRAM Note: landscapes that have been recently developed or are heavily logged may not be accurately scored by the LCA model since it was developed using the 2011 National Land Cover Dataset – in these landscapes, consider using the manual option for Part A for best results.

Limitations of NYRAM

To capture subtle or short-term (<10 year) shifts in vegetation composition please consider using our floristic quality and ecological integrity metrics outlined in Shappell and Howard (2018). NYRAM was developed for non-tidal palustrine wetlands and does not include stressors unique to lacustrine, tidal, brackish, or estuarine environments (e.g., tidal flow restrictions). Caution should be used when applying NYRAM to non-target wetland systems because appropriate stressors have not been identified and evaluated during the development of this protocol. We have tested NYRAM in a handful of estuarine wetlands and it appears to perform okay, but it is not designed to capture stressors such as slumping, decreased vegetative cover, etc.

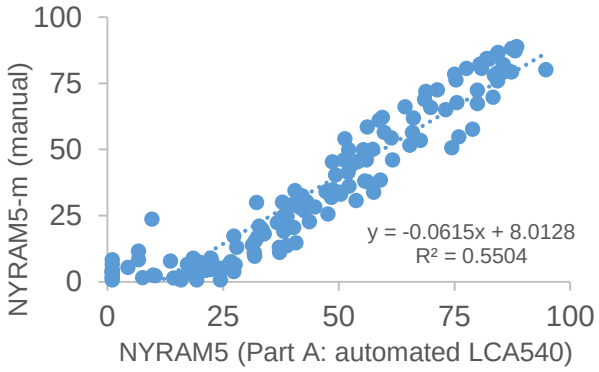


Figure 29: New for NYRAM ver. 5 users can generate a site's Part A score using a modified LCA540 metric ("automated") or complete Part A manually. Final NRAM5 scores are generally comparable between the two methods (n = 140). See sampling effort notes for exceptions.

Sampling effort

Part A: The onscreen portion of this method assesses the 540 m Landscape Buffer centered on the target Sample Area (see figure below). Following recalibration of NYRAM5, users now have the option of automating this step, using the "Zonal Statistics" tool in ArcGIS to calculate the mean (average) LCA score for a 540-m buffered area generated around the center of your Survey Area. More information about the rasterized LCA model and download information are available at nynhp.org/data. In NYRAM5-m, part A can be completed manually based on air photo interpretation using ArcGIS, Google Earth, or other air photo sources. Depending on landscape complexity and observer experience, manual completion of Part A may take 15-60 minutes. scores produced by NYRAM5 and NYRAM5-m are generally comparable with a few exceptions. The manual version should be used in areas where subtle differences in land use may not have been captured by the LCA model (e.g., silviculture or logging), or where development has occurred relatively recently (<10 years old). Tips for manually completing this portion of the assessment are outlined below.

Part B: The field portion of this method covers up to 6.15 ha (15.2 ac), including the Sample Area and surrounding 100-m radius Field Buffer that surrounds the Sample Area (i.e., 140-m out from the center point). Once at the Sample Area, a two-person team may complete the field stressor checklist in approximately 1 hour. However, sites that are difficult to traverse, such as shrub swamps or semipermanently flooded areas may take ≥2.5 hours to complete.

Overview of the NYRAM sampling design

This Level 2 rapid assessment method was designed to be suitable for a range of project needs from site assessment to establishing a reference baseline. Depending on project objectives, wetland site selection may be random, stratified random, or subjective. The Sample Area (SA) is the targeted area within a wetland that will be the focus of your NYRAM sampling. Standard sample designs focus around a 0.5 ha SA, but nonstandard layouts may vary in shape and range in size from 0.1 to 0.5 ha. The Landscape Buffer, a 540-m buffer around the center of the SA, is assessed in Part A of NYRAM

ver. 4.5 through basic air photo interpretation. The field survey assesses stressors within the SA and surrounding 100-m Field Buffer "doughnut" (Part B; Figure 30).

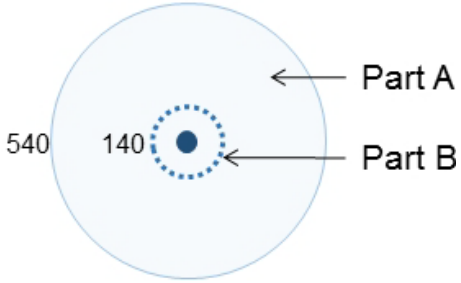


Figure 30: Schematic of the standard Level 2 rapid assessment survey design that includes Landscape Buffer stressors (Part A), and a meander field survey (Part B). Site surveys are centered on the target Survey Area (SA), a 40-m (44 yard) radius circle (0.5 ha), signified here as a dark blue circle or "doughnut hole". To ensure ≥90% of the SA land cover is wetland, linear, or small, irregularly-shaped wetlands may require non-standard SAs dimensions (e.g., 20 m x 50 m rectangle) and range in size from 0.1 ha (0.25 ac) to 0.5 ha (1.24 ac). Part B field meander surveys are conducted in the SA, and a 100-m buffer around the SA (i.e., the dash "doughnut" pictured above). Field stressor surveys therefore cover a 140-m radius area (6.15 ha/15.21 ac) around the center of the targeted survey area.

Site vetting and establishment

Sample Area

Prior to field work, try to establish an appropriate Sample Area (SA) via aerial or satellite imagery software such as ArcGIS, Google Earth (www.google.com/earth), Google Earth Pro (includes advanced functions, GIS file import: (Google Earth Pro: Importing GIS data), or via online maps (e.g., Bing Maps: www.bing.com/maps). Interactive mappers produced by the U.S. Environmental Protection Agency (EPA), U.S. Geologic Survey (USGS), U.S. Department of Agriculture (USDA) are also useful, as outlined below on page 71.

Additional mapped data such as topography, USDA NRCS SSURGO2 soils (SSURGO website), or National Wetlands Inventory maps should be consulted in tandem with the imagery. Confirm that you are viewing the most up-to-date imagery available to you - site conditions and land use can change drastically over short periods. Work through the following steps to pre-screen SAs relative to your research objectives.

1) Depending on project goals, point placement may be determined randomly, on a target wetland assemblage class (sensu Cowardin et al. 1979), or subjectively. The SA will encompass this point, ideally with the point in the center of the SA. If the SA is subjective, points may be moved to any location yielding a SA that meets the

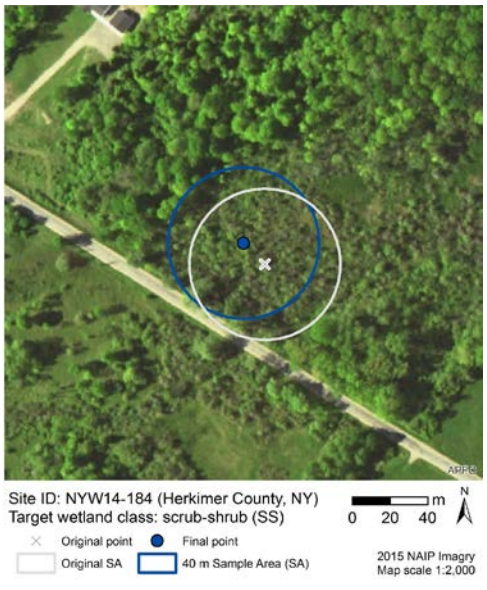


Figure 31: Sample Area around original random point included a road and some forested area (>10% non-target), so the point was moved ~15 m northwest

minimum sampleable criteria outlined below (i.e., disregard the 60-m move maximum discussed below).

2) Remote assessment of potential SA

Sample Area composition

≤10% of the total SA may include water ≥1 m deep; standing water or soft substrates that are unsafe to sample effectively; or upland systems; and if applicable, ≤10% of a non-target wetland assemblage class. **If these criteria are not met**, and you are using a random sample point, try moving the point ≤60 m (e.g., Figure 31). Point movement is only restricted to 60 m if you are following a random survey design.

SA size & shape

Standard SA: accommodates a 40-m radius plot 0.5 ha (5,025 m^2 ≈ 1.24 ac), while maintaining the above composition criteria.

Non-standard SA: if a standard SA is unworkable (e.g., small wetlands, riparian systems), alternative SA shapes and sizes (0.5-0.1 ha ≈ 0.25-1.24 ac) may be employed.

Example: Due to a railroad and non-target scrub-shrub vegetation, the example site in Figure 32 does **not** meet the standard SA criteria for size or as shape. Instead, a 20 m x 50-m rectangular non-standard SA was employed.

Figure 32: The original SA was <90% emergent, the target class for this survey, so a smaller nonstandard SA was established (0.1 ha)

Accessibility

Ownership – determine ownership using tax parcel or other government records. Private and public landowners/proprietors must grant you access to visit their property for each field-sampling event.

Physical obstructions – sketch an access route to the target wetland. Determine if non-wadeable water bodies >1 m deep or another physical obstruction would prevent you from reaching and sampling the SA within a reasonable timeframe.

3) If the SA does not meet the criteria outlined above and you are using random point placement, try moving the point within 60 m of its original location. If moving the random point does not address the issue, try selecting another random point within the wetland polygon. [Still can't establish an SA? It may be time to move on to a different random point or wetland.]

Digital resources for the field (Part B)

After the above criteria have been confirmed, save/print locator maps for each site. Include the 40-m SA (or non-standard SA polygon), as well as the 100-m radius Field Buffer (FB) that surrounds the SA (i.e., 140-m out from the center point). For example, the non-standard SA shown in Figure 32 would have a 100-m rectangular FB around the 20 m x 50 m SA (i.e., FB perimeter = 120 m x 150 m rectangle).

Additional helpful data to include with the map: site ID, target wetland boundary, topography, soils, tax parcel data, and site owner/manager contact information. If using a handheld digital device in the field, load the digital layers onto the device (e.g., point files, and SA polygon layers). Print the NYRAM 4.2 field datasheets or load an electronic version onto your field tablet. If completing Part A prior to the field survey (Part B), bringing a copy of the form with you to the field for orientation.

Part A: Onscreen assessment

This step can be conducted before or after the field assessment in Part B except when the SA is likely to be moved in the field. If the point will likely be moved, Part A should be completed following the field survey. Viewing the aerial photography in advance helps in identify potential stressors or ambiguous features that may be on the edge of the FB (e.g., an abandoned ditch), in difficult to access areas, or are otherwise likely to be overlooked in the field.

Materials & resources

Automated Part A (NYRAM5) - Landscape Condition Assessment

Generate a 540-m buffer around the center of your survey area (point) in ArcGIS using the "buffer" tool. Using the rasterized LCA data layer (download from nynhp.org/data), use the "zonal statistics as table" tool to calculate the average (mean) LCA score within your target 540-m buffer (polygon). Your zonal statistics will be exported as a table – the average (mean) LCA value is what you're looking for, this is what we use for our landscape scale "Level 1" metric referred to as "LCA540". Use the following equation to transform your LCA540 score and calculate your NYRAM5 Part A score. Note: some stressors associated with land use history such as logging may not be captured by the LCA model and in such settings, it's best to crosscheck your automated score with a manual onscreen review.

NYRAM5 Part A: $\log_{10}(\text{LCA540} + 1) \times 15$

Manual Part A (NYRAM5-m) - Aerial imagery

Use the most recent imagery that is available via ArcGIS, Google Earth, Bing Maps, or one of the interactive mappers listed below.

US EPA, "WATERS GeoViewer": epa.gov/waterdata/waters-geoviewer
Relevant content: base maps (satellite imagery from Bing Maps, topography, street maps); water quality status/permitting; rivers and streams (National Hydrography Dataset, NHD), and wetland data (National Wetlands Inventory, NWI).

USGS National Map Viewer: http://viewer.nationalmap.gov/viewer/
Relevant content: base maps (satellite, orthoimagery, topography), elevation contours, NHD including flow direction, National Land Cover Database (NLCD), protected areas (status, type, owner/manager), and wetland data (NWI). All of the data layers accessible here may be exported and viewed in ArcGIS or Google Earth.

Additional spatial data for manual onscreen assessment (optional)

Wetland, hydrography, and soils

NWI data published by US Fish & Wildlife Service (USFWS) - Interactive mapper, GIS & Google Earth data downloads: fws.gov/wetlands/

EPA WATERS data, Google Earth download - Includes NHDPlus surface water features, water quality feature: http://www.epa.gov/waterdata/viewing-waters-data-using-google-earth

USGS National Hydrography Data: nhd.usgs.gov/data.html

USDA soils:
Interactive mapper: websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

GIS data: gdg.sc.egov.usda.gov/ or via interactive downloader: ArcGIS SSURGO downloader

Transportation & recreation: New York State (NYS) roads, railroad (active and abandoned), trails (hiking, horse, and snowmobile) trail layers.

NYS GIS clearing house (general data source): gis.ny.gov/gisdata

NYS Department of Environmental Conservation (NYSDEC) State Lands Interactive Mapper: dec.ny.gov/outdoor/45478.html

NYS Google Earth file formats (.kml): dec.ny.gov/pubs/42978.html

Snowmobile trails: Private entities have made statewide snowmobile trails publicly available (e.g., JIMAPCO, Inc. jimapco.com/maproom/snowmobile/nys/)

Methods for determining % LULC type (NYRAM5-m only)

Delineate areas of interest

In ArcGIS, use the geoprocessing buffer tool to create three buffers: 40 m and 540 m around the center point (e.g., Figure 34). For consistency, use these buffers for Part A even if your final SA is not a 40-m radius circle.

In Google Earth Pro you should be able to draw in circles with a defined radius (this is a relatively new program, released in 2015, so its functionality is evolving).

Overlay a standard grid - makes photo interpretation more efficient and repeatable

In ArcGIS, apply a measured grid overlay.

In Layout View of ArcGIS 10.3 go to View > Data Frame Properties > New Grid > Measured Grid > Intervals > 50 x 50 m). If viewing a 50 x 50 m grid, the Landscape Buffer contains approximately 364 full cells. Each cell is 2500 m^2 (0.62 ac). Tip: 4 cells = 1%. 18 cells = 5%.

To make a shapefile in Data View of ArcGIS 10.3 (shown in Figure 34), open the ArcToolbox > Cartography Tools > Data Driven Pages > Grid Index features. Use the 540-m buffer layer as your input, use 50 meters as your polygon width and height (e.g., Figure 34). [Note: depending on your computing power, this process may take 1+ hours to run if using >25 points.]

In Google Earth, you can display georeferenced grids that are distributed by private entities.

For example, the Earthpoint "UTM" grid (http://www. earthpoint .us/Grids.aspx), scales the grid relative to your viewing altitude. If using this tool, make sure to measure the cell size of your grid and adjust your calculations accordingly – methods discussed here are based on a 50 m x 50 m grid.

Additional tips

Orthoimagery help identify "actively-" and "intensively-managed" agricultural land use types (i.e., hay or lawn vs. row crops). The former appears bright green early in the growing season (or red if infrared). In contrast, land used for intensive row crops appear as smooth or finely striated dull tan/brown/grey.

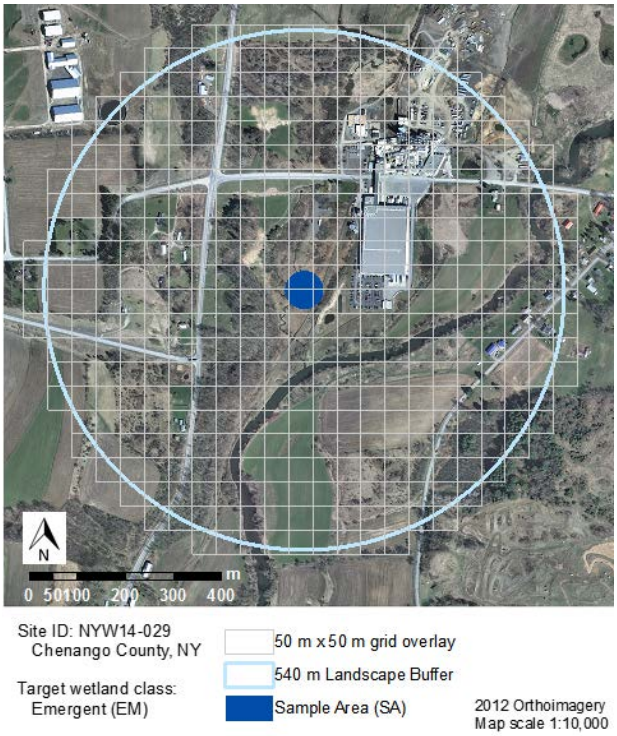


Figure 34: NYRAM5m part A assess the Landscape Buffer that extends 540 m from the center of the Sample Area. An overlay grid aids percent cover estimates of LULC types.

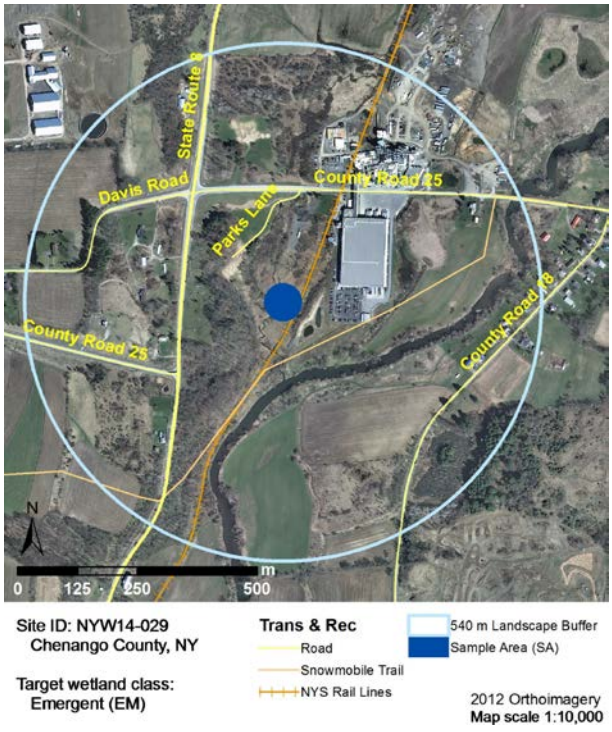


Figure 33: Fragmenting feature tally example. This site includes three categories of features: 2-lane roads, railroad, and an unpaved trail.

Worked example: Figure 34

Part A: Land Use Land Cover (LULC)

Looking forward to LULC percent cover estimates in the field manual appendix, you will see four classes of anthropogenic LULC, plus a natural cover class.

Using Figure 34 (site ID NYW14-029), we will start with the "**Impervious Surface**" cover type, which is often easiest to identify due to its clearly defined boundaries. Approximately how many cells are filled with urban or built-up land (e.g., buildings, paved roads/parking lots, industrial, residential)? For partially filled cells, such as roads and house, visually aggregate features to produce the equivalent of a "filled" cell.

Repeat this process for the remaining types:

"**Intensely managed**" such as golf courses, sand or gravel mining, warm season row crops (e.g., corn, soy), and pervious land/ponds associated with confined feeding animal operations (e.g., upper left corner of Figure 34). In this example, warm season cropland appears finely striated with a tan/brown or grey color; this pattern is best seen in spring air photos.

"**Actively managed**" types include lawn, hay, or winter wheat (all appear green in 20), vineyards, golf courses, railroads, and timber harvesting.

"**Lightly managed**" such as inactive cropland/old fields, pasture (compared to "active" cropland, pastures often occur near barns/buildings and has a more mottled texture), pine plantations (usually planted in uniform blocks), orchards.

The remaining cells should be "**Natural"** forests, wetlands, shrubland, surface water (excluding agricultural ponds), and/or barren land. Assuming the previous categories were correct, subtract the sum of those tallies from 364 to obtain the number of "**Natural**" cells.

Minor variations among observers is expected, as shown in Table 7, but these differences are marginal once the weighted percent cover scores are calculated and the total LULC score is obtained (see page 65 for weights and calculation). Total LULC scores produced form Table 7 averaged 17.6 (± 1.2).

Table 7: Variation among three independent observations for Land Use Land Cover (LULC) at site NYW14-029. Values are present as mean tallies ± standard error (n = 3). Tallies were based on the 50 m x 50-m grid overlay; percent LULC = # / 364 *100.

LULC type	cell tally (#)	LULC (%)
Impervious	44 ± 3	12 ± 1
Intense	39 ± 3	11 ± 1
Active	79 ± 10	22 ± 3
Light	37 ± 6	10 ± 2
Natural	164 ± 0	45 ± 0

Part A: fragmentation

Five fragmenting features categories are assessed and tallied. These range in magnitude from 4-lane highways to unpaved roads and trails (e.g., hiking, snowmobile, horse). Additional intermediate categories include 2-lane roads, railroads (i.e., active, abandoned, rail-to-trail), and utility line Right of Way (ROW). Continuing with the same example site (Figure 5), the Landscape Buffer includes one (1) unpaved trail (snowmobile), one (1) railroad, and five (5) continuous named roads.

NYRAM Works cited

Cowardin, L. M., V. Carter, F. C. Golet and E. T. La Roe. 1979. Classification of wetlands and deepwater habitats in the United States. Rep. FWS/OBS-79/31. U.S. Fish and Wildlife Service, Washington, DC.

Faber-Langendoen, D., J. Rocchio, S. Thomas, M. Kost, C. Hedge, B. Nichols, K. Walz, G. Kittel, S. Menard, J. Drake, and E. Muldavin. 2012. Assessment of wetland ecosystem condition across landscape regions: A multi-metric approach. Part B. Ecological Integrity Assessment protocols for rapid field methods (L2). Report nr EPA/600/R-12/021bU.S. Environmental Protection Agency Office of Research and Development, Washington, DC.

Feldmann, A. L. 2013. Quality Assurance Project Plan (QAPP): Development of wetland assessment protocols in New York. Version 2. 26. New York Natural Heritage Program, SUNY-ESF Research Foundation, Albany, NY.

Feldmann, A. L. and T. Howard. 2013. Landscape Condition Assessment (LCA2) for New York. New York Natural Heritage Program, Albany, NY. <nynhp.org/shappell>

Feldmann, A. L., and E. A. Spencer. 2015. Draft EPA wetland workflow for plot set-up, sampling and scoring NYRAM 4.1. 6. New York Natural Heritage Program, Albany, NY.

Jacobs, A. D. 2010. Delaware Rapid Assessment Procedure Version 6.0. 36 pages. Delaware Department of Natural Resources and Environmental Control, Dover, DE.

PA DEP. 2014. Pennsylvania Wetland Condition Level 2 Rapid Assessment. Report nr 310-2137-002. 37 pages. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

Peet, R. K., T. R. Wentworth, and P. S. White. 1998. A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262-274.

Shappell, L. J., Feldmann, A. L., Spencer, E. A., and Timothy G. Howard. 2016. New York State Wetland Condition Assessment. EPA Wetland Program Development Grant. Final Report. New York Natural Heritage Program, Albany, NY.

Shappell, L. J., and T. G. Howard. 2018. Supporting actionable decision making for wetland permitting in New York from urban to rural environments. EPA Wetland Program Development Grant. Final Report. New York Natural Heritage Program, Albany, NY.

WETLAND CONDITION LEVEL 2 RAPID ASSESSMENT SCORING FORMS

New York Rapid Assessment Method (Level 2) Field Worksheets

Developed by New York Natural Heritage Program
625 Broadway, 5th Floor, Albany, NY 12233-4757 (518) 402-8935 Fax (518) 402-8925 www.nynhp.org/wetlands

Part A: Onscreen rapid assessment

Area of focus: the Landscape Buffer, a 540-m buffer around the center point.
Note: If the sample point will likely be moved in the field, complete this portion after the field survey.

Site description

Observer(s) _____ Date of onscreen assessment _____

Site name _____ Site code _____

Pub. date of the imagery: _____ Sample location was determined (circle one): Randomly Subjectively

Option 1 (automated, beta ver.): Use zonal statistics in ArcGIS, calculate the mean LCA score for a 540-m buffer around the center point ("LCA540" score), and then use the calculation outlined below in Option 1.

Option 2 (manual*): Complete the following LULC and fragmenting features tables.

Please note: Although score calculations are shown below, these may be completed after field survey or in Microsoft Excel. The % LULC column should sum to 100%, and the max Total LULC score is 40.

Land Use Land Cover (LULC)

Qualitatively assess the percent area occupied by each of the following land cover types.

GIS tip: in layout view, apply a 50 x 50 m grid to the data frame. Google Earth or GIS: use the measure polygon tool to measure type area.

	% LULC		Type score
Impervious surface pavement, buildings, rock quarries	_____	x 4 =	_____
Intensely managed golf, row crops, sand/gravel mining	_____	x 4 =	_____
Actively managed lawn, timber, hay, ROW, grazing, unpaved road	_____	x 3 =	_____
Lightly managed old field, ditch, plantation, Stormwater pond	_____	x 2 =	_____
Natural forest, wetland, shrubland, water	_____	x 0 =	_____

Sum type scores = _____ ÷ 10

Total LULC score = _____

Fragmenting features

Tally the number of fragmenting features in each category found in Landscape Buffer.

GIS tip: add New York State road, railroad, hiking & snowmobile trail layers

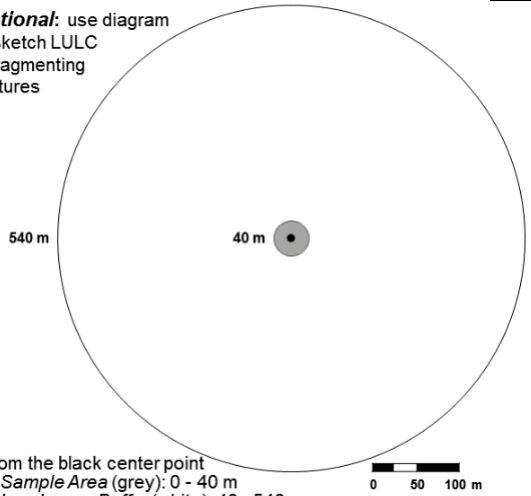
	Feature tally		Feature score
4-lane paved road 4-lanes or larger	_____	x 6 =	_____
2-lane paved road	_____	x 4 =	_____
Railroad Active or abandoned	_____	x 4 =	_____
Utility line Right-of-way (ROW)	_____	x 2 =	_____
Unpaved road/trail Grave/dirt road, hiking or snowmobile trail	_____	x 1 =	_____
Other*:	_____	x =	_____

*Select an equivalent multiplier: 1, 2, or 4

Total fragment score = _____

[sum feature scores or maximum score of 40]

Optional: use diagram to sketch LULC & fragmenting features



From the black center point
Sample Area (grey): 0 - 40 m
Landscape Buffer (white): 40 - 540 m

Option 2 (manual)

LULC + frag scores or **max of 50 pts**: _____

*Manual is suggested for landscapes with recent development within 10 years or where logging is present

Option 1 (automated, beta ver.)

$Log_{10}(LCA540 + 1) \times 15$ _____

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Part B: Wetland stressor field worksheet

Area of focus: 40-m radius Sample Area (SA) & the surrounding 100-m Field Buffer (FB)

Observers _____ Date _____

County, Town _____ Sourcecode Sarracen1a(optional) _____

Site name _____ Site code _____

UTM or Lat/Long: _____ / _____ Field point in the GPS? Yes No

Wetland community description

Target NWI wetland class (≥ 90% of SA): EM SS FO1 FO4

Optional: NYNHP/ Nature-Serve/ other comm. class _____

Optional: Landscape setting or Wetland origin (e.g., natural, created) _____

Basic guidelines for establishing a Sample Area (SA) in the field

Refer to the methods manual for detailed guidelines and pre-field office activities. Note: <10% of SA should contain water >1 m deep. If applicable, randomly generated points are invalidated if moved >60 m.

Standard, 0.5 ha (5,025 m^2; 1.24 acres)

☐ CIRCLE - 40-m radius

SA dimensions determined by (circle one):

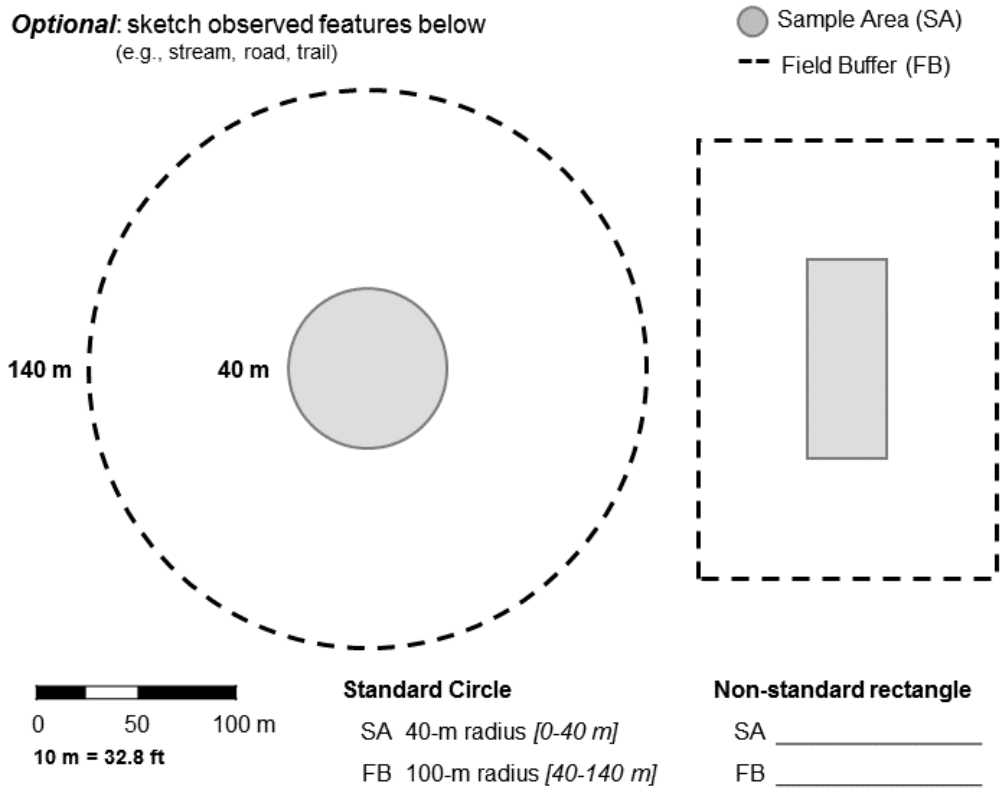
GPS tape measure visual estimate

Non-standard, 0.1-0.5 ha

☐ RECTANGLE e.g., 20 m x 50 m plot array

☐ OTHER Use space at the end of the stressor checklist to sketch SA shape

Optional: sketch observed features below (e.g., stream, road, trail)



Standard Circle

SA 40-m radius *[0-40 m]*

FB 100-m radius *[40-140 m]*

Non-standard rectangle

SA _____

FB _____

Wetland stressor checklist

Mark "X" in each applicable column if stressor is present in the Sample Area (SA), Field Buffer (FB), or absent (Abs) from both areas.

Tips: Keep an eye out for invasive species to include in the Invasive Richness Survey (pp. 7-8). Stressor sums at the bottom of each page are optional, but may be helpful when making the final checklist sum for each column.

VEGETATION ALTERATIONS

V1. Vegetation modification occurred within the past year, unless noted	SA	FB	Abs
Excessive wildlife herbivory (e.g., deer, geese, insects)			
Moderate/intense livestock grazing (>25% bare soil)			
Mowing (low intensity lawn or hay)			
Golf course or highly maintained turf (NOT typical residential lawns)			
Right-Of-Way: cleared (brush cutting, chemical, etc. assoc. with powerlines & roads)			
ROW, but no maintenance evident within past year			------
Logging within 2 years			
Annual agricultural row crops			
Plantation (conversion from natural tree species, e.g., orchards, forestry)			
V2. Invasive plant species abundance (see invasive richness list)			
Absent (circle one if applicable): SA FB Both	---- --	---- --	
Uncommon (Present, < 20% cover) – List species in the invasive survey (see end)			------
Abundant (Present, 20-75% cover) – List species in the invasive survey (see end)			------
Pervasive in SA (>75% relative cover)		---- --	
V3. Other vegetation alterations (e.g. woody debris removal)			

HYDROPERIOD MODIFICATION

H1. General hydroperiod alterations			
Ditching, tile draining, or other dewatering methods			
Stormwater inputs (e.g., source pipe, impervious surface/roads/parking lot)			
Water inflow reduced by upstream structure (dam / weir / culvert; including perpendicular road, railroad beds)			
Water outflow reduced due to impounding structure (see above examples)			
H2. Stream/riverine-specific modifiers			
Artificial levee parallel to stream (including parallel road, railroad beds)			
Channelized stream: straightened, hardened, or incised			
H3. Other indicators of hydro modification (e.g. high temperature discharge, dead/dying standing trees)			

Sum of stressor tallies for each column on this page:			

OTHER HYDRO/TOPOGRAPHIC MODIFICATIONS

T1. Development, filing, grading	SA	FB	Abs
Residential development: Low-moderate (≤2 houses/acre)			
High (>2 houses /acre)			
Commercial development (e.g., buildings, factories, parking lots)			
Other filling/grading activity (not road-related; e.g., exposed soils, dredge spoils)			
Landfill or illegal dump (excessive garbage, trash)			
T2. Material removal			
Artificial pond, dredging (not ditch-related)			
Mining/quarry (circle those present): sand gravel peat topsoil			
T3. Roads, railroads, trails			
Hiking or biking trail (well-established)			
Unpaved dirt/gravel road (established ATV, logging roads)			
Railroad (circle those present): active abandoned rail-to-trail			
Paved road: 2 lane			
4 lane or larger			
T4. Microtopography Soil surface variation <1 m in height (not pavement)			
Vehicle or equipment tracks: ATV, off-road motorcycles			
Skidder or plow lines			
History of tilling (e.g., uniform upper soil profile typical of tilled farm land)			
Livestock tracks			
H3. Other indicators of topographic modification (e.g. high temperature discharge, dead/dying standing trees)			

SEDIMENT TRANSPORT

S1. Potential sediment stressors (within <u>past year</u>, unless noted)			
Active: construction (soil disturbance for development)			
plowing (agricultural planting)			
Forestry (circle if known): clear cut, even-aged management (within 2 years)			
selective tree harvesting, salvage (within 1 year)			
Livestock grazing (intensive, ground is > 50% bare)			
Sediment deposits / plumes			

Eroding banks / slopes			
S2. Other evidence of sedimentation / movement (water consistently turbid, active mine, etc. – list if present)			
Sum of stressor tallies for each column on this page:			

EUTROPHICATION

E1. Nutrient inputs	SA	FB	Abs
Direct discharge: agri. feedlots, manure spreading/pits, fish hatcheries			
septic/sewage treatment plant			
Adjacent to intensive annual row crops			
Adjacent to intensive pasture grazing (>50% bare soil)			
Dense/moderate algal mat formation			
E2. Other evidence of contamination or toxicity (acidic drainage, fish kills, industrial point discharge, etc. – list if present)			
Sum of stressor tallies for each column on this page:			

ADDITIONAL NOTES OR SKETCH OF NON-STANDARD LAYOUT

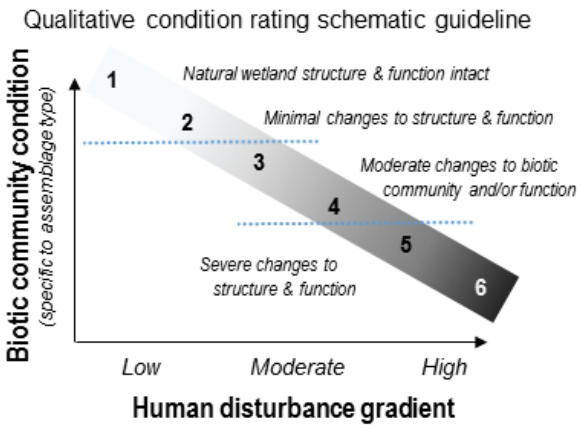
Qualitative condition rating

After completing the survey, describe overall site quality (SA + FB) as it relates to the level of human-mediated disturbance.

Circle the number that best describes the site:

Least disturbed 1 2 3 4 5 6 Highly disturbed

Ranking notes (optional):



NYRAM 5.3 - Part B

Site code: _____ Date: _____

INVASIVE & NONNATIVE SPECIES RICHNESS SURVEY

Check or list all invasive and nonnative species present in the Survey Area (SA) and/or Field Buffer (FB). Note that the richness value only represents the number of unique species observed in both the SA and FB (i.e., do not double count a species).

Plants

Scientific name	Common name	USDA code	SA	FB
Acer platanoides	Norway maple	ACPL		
Agrostis gigantea	Redtop	AGGI2		
Ailanthus altissima	Tree-of-heaven	AIAL		
Alnus glutinosa	European alder	ALGL2		
Alliaria petiolata	Garlic mustard	ALPE4		
Aralia elata	Japanese angelica tree	AREL8		
Artemisia vulgaris	Mugwort	ARVU		
Berberis thunbergii	Japanese barberry	BETH		
Butomus umbellatus	Flowering rush	BUUM		
Celastrus orbiculatus	Oriental bittersweet	CEOR7		
Centaurea stoebe	Spotted knapweed	CEST8		
Cichorium intybus	Chicory	CIIN		
***Cirsium arvense* (syn. *C. setosum, C. incanum, Serratula arvensis*)**	Canada thistle	CIAR4		
Cynanchum spp.	Swallowwort (black, pale or white)	CYNAN		
Daucus carota	Queen Anne's lace	DACA6		
Dioscorea oppositifolia	Chinese yam	DIOP		
Dioscorea polystachya	Chinese yam	N/A		
Elaeagnus umbellata	Autumn olive	ELUM		
Epipactis helleborine	Broadleaf helleborine	EPHE		
Euonymus alatus	Burning bush/Winged euonymus	EUAL13		
Frangula alnus	Glossy/smooth buckthorn	FRAL4		
Galeopsis tetrahit	Hemp-nettle	GATE2		
Glechoma hederacea	Ground ivy	GLHE2		
Glyceria maxima	Reed manna grass	GLMA3		
Heracleum mantegazzianum	Giant hogweed	HEMA17		
Hydrocharis morsus-ranae	Common frogbit	HYMO6		
Hypericum perforatum	Common St. Johnswort	HYPE		
Iris pseudacorus	Yellow iris	IRPS		
Ligustrum vulgare	European privet	LIVU		
Lonicera japonica	Japanese honeysuckle	LOJA		
Lonicera spp.	Shrub honeysuckles (nonnative)	LONIC		
Lysimachia nummularia	Creeping Jenny, moneywort	LYNU		
Lythrum salicaria	Purple loosestrife	LYSA2		
	Sum of <u>unique</u> species observed on this page			

NYRAM 5.3 - Part B

Site code: _____ Date: _____

INVASIVE & NONNATIVE SPECIES RICHNESS SURVEY

Scientific name	Common name	USDA Code	SA	FB
Microstegium vimineum	Japanese stiltgrass	MIVI		
Murdannia keisak	Marsh dewflower	MUKE		
Myosotis scorpioides	True forget-me-not	MYSC		
Myriophyllum spicatum	Eurasian water-milfoil	MYSP2		
***Persicaria hydropiper* (syn. *Polygonum hydropiper*)**	Water-pepper smartweed	PEHY6 (POHY)		
Persicaria perfoliata	Mile a minute	POPE10		
Phalaris arundinacea	Reed canarygrass	PHAR3		
Phragmites australis	Common reed	PHAU7		
Poa compressa	Canada bluegrass	POCO		
Poa trivialis	Rough bluegrass	POTR2		
Prunus avium	Sweet cherry	PRAV		
Ranunculus ficaria	Lesser celandine	RAFI		
***Reynoutria japonica* (syn. *Polygonum cuspidatum, Fallopia japonica*)**	Japanese knotweed	REJA2 (POCU6, FAJA2)		
Rhamnus cathartica	Common buckthorn	RHCA3		
Rosa multiflora	Multiflora rose	ROMU		
Rubus phoenicolasius	Wineberry	RUPH		
Salix alba	White willow	SAAL2		
Solanum dulcamara	Climbing nightshade	SODU		
Trapa natans	Water chestnut	TRNA		
Trifolium repens	White clover	TRRE3		
Tussilago farfara	Coltsfoot	TUFA		
Typha x glauca	Hybrid cattail	TYGL		
Verbascum thapsus	Common mullein	VETH		
Veronica officinalis	Common speedwell	VEOF2		

Animals & pathogens

Adelges tsugae	**Hemlock Wooly Adelgid (HWA)**		
Agrilus planipennis	Emerald Ash Borer (EAB)		
Anaplophora glabripennis	Asian Longhorned Beetle		
Cipangopaludina* spp *aquatic snails	Invasive Aquatic Snails		
***Cryptococcus fagisuga* + *Neonectria* spp.**	Beech Bark Disease		
Dendroctonus frontalis	Southern Pine Beetle		
Halyomorpha halys	Brown Marmorated Stink Bug (BMSB)		
Orconectes rusticus	Rusty Crayfish		
Lymantria dispar	Gypsy Moth (caterpillar)		
Lycorma delicatula	Spotted Lanternfly		

Additional species observed, but not listed above

NYRAM 5.3 - Part B

Site code: _____ Date: _____

INVASIVE & NONNATIVE SPECIES RICHNESS SURVEY

Sum of unique species observed on this page _____

Part B field data summary

Summarize your data and enter values into the empty spaces below.

STRESSORS

Sum tallies in the Wetland Stressor Checklist (do not include invasive richness survey data here). Use the stress multiplier to calculate the Metric Score. Stressor score = sum of the metric scores.

		SA		FB		Absent
Stressor tally sum						
Stressor Multiplier (SM)	×	8	×	4	×	0
Metric Score	=		=		=	
Stressor score						

INVASIVE PLANT COVER (%)

Where invasives are present, circle the number that corresponds to tallies indicated in section V2. Sum the values to obtain the invasive cover score. (Invasive score = zero if no invasive were observed in the SA or FB.)

Please note: All values below account for points earned when tallied in section V2 above. This scoring adjustment removes double-counting concerns for this metric, and in doing so, causes some values to be negative.

	SA	FB
Uncommon (≤ 20% absolute cover)	-4	-2
Abundant (>20% absolute cover)	8	4
Pervasive in SA (>75% relative cover)	15	---

Invasive cover score _____

INVASIVE & NONNATIVE PLANT SPECIES RICHNESS (#)

Count all unique plant, animal, & pathogen species observed in the SA & FB. If absent, write zero.

Invasive & nonnative richness _____

[1]Invasive richness for scoring is capped at 14 spp.

QUALITATIVE CONDITION RATING

Value generally describes the SA and the buffer, from least disturbed (1) to heavily disturbed (6) (see p. 6).

Condition rating _____

Part B cumulative score _____

[Part B is capped at a maximum of 70 points. If Part B>70, use 70 when calculating your final score.

Stressors score + Invasives cover score + Invasive richness[1] + Condition score.

NYRAM5 Score: _____

$$\left(\frac{\text{Part A (max 50 pts)} + \text{Part B (max 70 pts)}}{120}\right) \times 100$$

Scores range from a minimum of 1 to a maximum of 100.

Submit your NYRAM score to NYNHP's databank & see how your score stacks up: www.nynhp.org/shappell

Helpful Invasive Species References

Identification and General information

New York Invasive Species Information
www.nyis.info/
Website includes plants, animals and pathogens

Invasive plants and their native look-a-likes: an identification guide for the Mid-Atlantic
www.nybg.org/files/scientists/rnaczi/Mistaken_Identity_Final.pdf

Invasive species ID training modules by Midwest Invasive Species Info. Network
www.misin.msu.edu/training/
Website includes plants, animals, and pathogens.

A field guide to invasive plants or aquatic and wetland habitats for Michigan
http://mnfi.anr.msu.edu/invasive-species/AquaticsFieldGuide.pdf

Pennsylvania's field guide to aquatic invasive species
https://docs.wixstatic.com/ugd/bd649e_f616c128088e4a46b27b0f4a0b4f5290.pdf

Prohibited and regulated invasive plants of New York State
www.dec.ny.gov/docs/lands_forests_pdf/isprohibitedplants2.pdf

USDA National Invasive Species Information Center – Identification Resources
www.invasivespeciesinfo.gov/resources/identify.shtml
Website includes plants, animals, and pathogens.

Invasive species mapping

iMapInvasives
nyimapinvasives.org
Website includes plants, animals, and pathogens – serves as the central repository for existing locations of invasive species in New York State.

Features/tools:

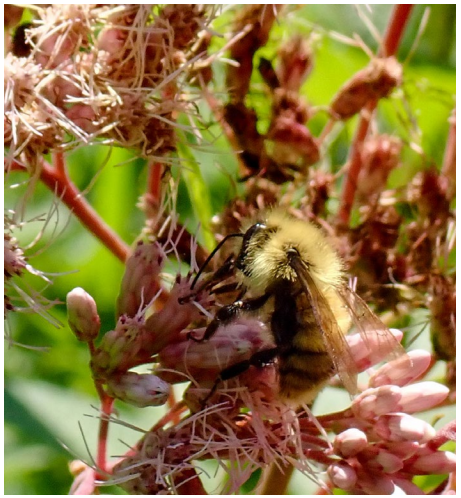
- Generate species lists by geographic, municipal, property, or jurisdictional boundaries.
- Contribute data from your field observations.
- Learn about invasive management methods.

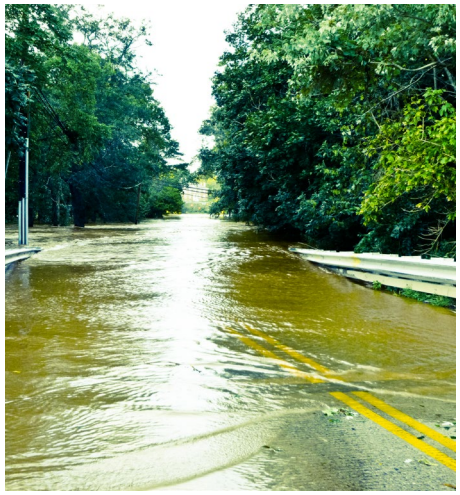
Invasive Plant Atlas of New England (IPANE)
www.eddmaps.org/ipane/Species/

APPENDIX C: FUNCTIONAL RAPID ASSESSMENT METHOD (FRAM) DATA SHEETS

Functional Rapid Assessment Methodology (FRAM)

for palustrine nontidal wetlands in New York State, *ver. 1.0*





New York Natural Heritage Program

A Partnership between the NYS Department of Environmental Conservation and the SUNY College of Environmental Science and Forestry

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Acknowledgments
Funding for this "beta" version of our functional assessment protocol was provided by US EPA Wetland Program Development Grants. Results from our first two years of piloting this method in NY's Mohawk and Allegheny basins are outlined in the following report:

> Laura J. Shappell, Lydia M. Sweeney, and Tim G. Howard. 2022. Developing methods, cultivating engagement, and creating end-user tools for wetland functional assessment. EPA Wetland Program Development Grant. Final Report. New York Natural Heritage Program (NYNHP), Albany, NY.

Special thanks to all biologists who provided feedback on this protocol, which we continue to refine in support of New York's wetland program, and to private land owners who allowed us to survey on their properties. To learn more about NYNHP's wetland program please visit nynhp.org/wetlands. You can also find us on iNaturalist.org: NYNHP Wetlands Projects.

Suggested citation: Shappell, Laura J. and Lydia M. Sweeney. 2022. Functional Rapid Assessment Methodology (FRAM) for palustrine nontidal wetlands in New York State. Version 1.0. New York Natural Heritage Program. Albany, NY.

Please note:
The FRAM method and scoring system presented here is actively being revised and has only been tested on 30 wetlands. FRAM ver 1.0 is the first published copy of this protocol, which we are actively revising and update as we gain feedback from collaborators, users, and our own field experience. Therefore, we consider this protocol and scoring to be a "beta" draft. If you're interested in providing feedback or learning about the most current version of this protocol please message Dr. Laura Shappell at laura.shappell@dec.ny.gov or ljshappe@esf.edu.

Cover photos (clockwise from far left): Adirondack wetland boardwalk on Ferd's Bog Trail by J. Kwiatkowski; Highbush Blueberry fruit (*Vaccinium corymbosum*) by L. Shappell; Shallow Emergent Marsh on the downstream side of a beaver dam in Lewis County by L. Shappell; Raritan River flooding its banks and a road following Hurricane Irene, New Brunswick, NJ by L. Shappell; and Perplexing Bumble bee (*Bombus perplexus*) on Spotted Joe-Pye Weed (*Eutrochium maculatum*) in Chautauqua County by L. Shappell

Introduction

This method is applied at three spatial scales (see figure right). The Survey Area (SA) and Field Buffer (FB) are centered on a target sample point; at least 90% of the SA should be wetland (biological definition, not jurisdictional). If needed, the SA and FB shape can be changed but the area within each Evaluation Area should match the original: SA = 0.5 (1.25 ac) ha and FB = 6.15 ha (15.2 ac).

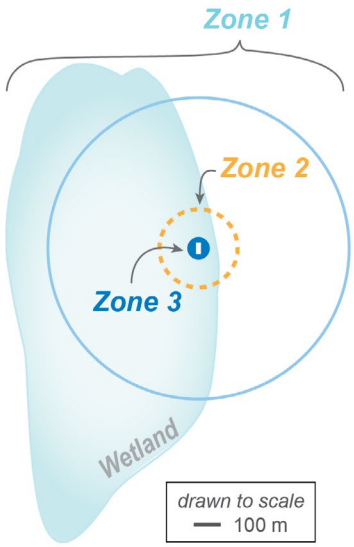
Data collection & final summary "roll-up" scoring

On-screen evaluation: Suggested spatial data layers are outlined in Shappell et al. 2022, some of these data are available via NYS DEC's Interactive Maps web-page (https://www.dec.ny.gov/pubs/42937.html).

The field portion of the form has eight broad function and value categories as outlined in Table 1 and includes >170 indicators or ranking options. Indicators relevant to each category guide the user's final ranking for that category. If an indicator has a dash through an evaluation area, it's not applicable at that scale and users should simply move on to the next check-box or field.

Category ranking: We've developed minimum guidelines for ranking, but the rater has the option to upgrade or downgrade by one degree if they think the suggested rank is not representative. When individual ranks are combined or "rolled-up" onto a summary score, users can gain a general understanding of an evaluation area's overall functional value (Table 1). Given the data requirements for this metric it is only applicable to the SA and FB, not the contiguous (WH) wetland. Points are associated with each category rank – more points for higher ranks – "very high" = 4 points, "high" = 3 points, "moderate" = 2 points, and "low" = 1 point. The summary roll-up score is calculated by summing all category points (Table 1), dividing by total possible points (34) and multiplying by 100. The lowest possible score is 24 and the highest is 100.

Table 1 (right): Points are associated with each category rank – more points for higher/better ranks. All categories but hydrologic health and natural community development follow this scoring: Very High = 4 points, High = 3, Moderate = 2, and Low = 1 point. Natural Community development scoring is as follows: Excellent = 7, Very Good = 6, Good = 5, Fair = 3, Poor = 1. Hydrologic "health" scoring: None or none apparent = 4, Recovered = 3, Recovering = 2, Recent or no recovery/ongoing = 1. The right column is a workspace for you to summarize data for this site.



Zone 1, Landscape and Contiguous wetland

On-screen evaluation - Sub-basin water quality and habitat connectivity characterization.

Contiguous/whole wetland ("contig" or "WH") - Indicator checklist (field and on-screen).

Indicators more appropriately evaluated at smaller spatial scales are excluded from this evaluation area. Similarly, some indicators are only applied at this scale.

Zone 2, RAM field buffer (FB)

Level 2 - Field indicator checklist (140 m radius).

Zone 3, Focused Survey Area (SA)

Level 2 - Field indicator checklist (40 m radius).

Level 3 (optional) - Intensive releve macroplot (20 m x 50 m) is centered on the target sample point that the SA and FB are centered around.

Category	Max points	This site
Flood and storm water control	4	
Hydrologic "health"	4	
Erosion control	4	
Subsurface and groundwater resource protection	4	
Natural community development	7	
Pollution	3	
Wildlife	4	
Values	4	
Total points in the SA or FB:	34	

Summary roll-up scores for this site: SA = _____ FB = _____

Site information and Landscape setting - remote on screen evaluation

Select all that apply.

Site name		**Site code/ID**		**Observer(s)**	
Survey date		**Sourcecode (NYNHP)**			
Natural community notes		**Latitude/UTM** (SA center point)		**Longitude/UTM**	
Major basin name (HUC 8)		**HUC 8 code**		**HUC 12 code**	
Where in the major river basin does the wetland lie?	Lower Mid Upper (circle 1)	Landscape position (based on Tiner 2014)	☐ Terrene	☐ Lentic ☐ Lotic	

Contiguous wetland size (ha or ac)

Size class (check 1)

- ☐ <30 ha (<74 ac)
- ☐ 30-70 ha (74-173 ac)
- ☐ >70 ha (>173 ac)

Is contiguous wetland *entirely* contained within the targeted Survey Area (SA)?

☐ No ☐ Yes.

Wetland associated with perennial or intermittent watercourse?

☐ **NO**. Wetland is "geographically isolated".

☐ **YES**. *Direct surface water connection present, including periodic overbank flooding or ephemeral streams.* Answer the following:

Flow determination made: ☐ In the field ☐ Aerial photo/map

Water flow path (check all that apply) ☐ Inlet ☐ Outlet ☐ Throughflow ☐ Bidirectional (perm lake/river) ☐ Tidal

Modifiers* ☐ None observed ☐ Watercourse is a ditch ☐ Restricted outlet ☐ Restricted inlet

* Includes anthropogenic restrictions to water movement such as culverts, and natural restrictions such as beaver dams.

Intensity of surrounding land use (check one)

- ☐ Very low. 2nd growth or older forest, wildlife area, etc.
- ☐ Low. Old field (>10 yrs), shrub land, young second growth forest
- ☐ Moderately high. Residential, pasture, park, new fallow field
- ☐ High. Urban, industrial, row crops, construction, clear cut forestry

Average width of natural buffer (check one)

- ☐ Undeveloped. Buffers average ≥200 m (≥656.2 ft)
- ☐ Very wide. Buffers average 100 to <200 m (328.1 to <656.2 ft)
- ☐ Wide. Buffers average 50 to <100 m (164 to <328.1 ft)
- ☐ Medium. Buffers average 25 to <50 m (82 to <164 ft)
- ☐ Narrow. Buffers average 10 to <25 m (32.8 to <82 ft)
- ☐ Very narrow. Buffers average <10 m (<32.8 ft)

On screen evaluation: sub-basin water quality and connectivity

The following apply to the contiguous wetland area and its potential to protect surface, subsurface and groundwater water resources. This portion of the assessment may be completed remotely either before or after the field survey, using digital mapping software such as ArcGIS, Google Earth, or NYS DEC's Environmental Resource Mapper (https://www.dec.ny.gov/animals/38801.html). ***Check all that apply.***

1) Water quality and water resource security: In the drainage area contributing to the wetland (upstream, upslope) there are:

- ☐ Potential sources of stormwater/wastewater/agricultural runoff
  (e.g., agriculture, impervious surface, municipal wastewater discharge etc.)
- ☐ Potential sources of excess sediments.
  Agriculture, forestry, construction, etc.
- ☐ Potential sources of excess nutrients.
  Nitrogen and/or phosphorous sources; agriculture, golf courses, septic systems, etc.
- ☐ Potential or known sources of toxicants or chemicals.
  Contaminants, pollutants, pesticides, etc.
- ☐ Highly porous upland soils or surficial geology.
  Sandy or gravel soils, karst, moraine etc.
- ☐ Sheet-flow, potential to intercept
  Contiguous wetland may intercept surface and subsurface flows that may contain pollutants and/or suspended sediments. Steep slopes, impermeable upslope/upland soils, or large amounts of impervious surface (>10%) occur upstream or upslope of the wetland (e.g., runoff to the wetland); or upslope/upstream has inadequate or limited flood storage features/capacity (natural or constructed).

2) Water quality and water resource security: Downstream or near the contiguous wetland there are:

- ☐ Water wells, known public/private wells [groundwater]
  e.g., single household or real property parcel (excluding commercial properties)
- ☐ Water wells, potential for public/private wells [groundwater]
  e.g., single household or real property parcel (excluding commercial properties)
- ☐ Water source, public/private [groundwater, subsurface, or surface]
  e.g., *Water Source Protection Area, surface drinking water supply for more than one household or parcel, includes commercial properties.*
- ☐ Groundwater or subsurface recharge or discharge
  Assumed present if contiguous wetland coincides or is near a confined or unconsolidated aquifer (high- or mid-yield unconfined), primary or sole source aquifers. (Consult NYS DEC or USGS spatial aquifer resources online.)
- ☐ Impaired or stressed waters [surface or groundwater]
  Wetland potentially contributes to the protection of surface water quality. Applies to adjacent and downstream water bodies.
- ☐ Between surface water & human land use [surface or groundwater]
  Potential point or non-point sources of sediment, nutrients, toxic substance, etc. runoff may be intercepted by the wetland, which is associated with permanent, seasonal, or ephemeral surface water such as streams, lakes, reservoirs. e.g., includes wetlands with <90% natural buffer or upslope septic tank(s).
- ☐ Valuable property/resources/recreation in/near the 100-year floodplain

3) Connectivity: The following connectivity attributes relate to habitat connectivity and heterogeneity in the local landscape. For example, being connected or near other greenspace or open water is crucial for wildlife that may use wetland resources for all or part of the year.

- ☐ Connected: Same class within 800 m (0.5 mi)
  Hydrologically connected to other wetlands of the same dominant class. (e.g., marsh site is 500 m upstream from another marsh)
- ☐ Connected: Different class w/in 1.6 km (1 mi)
  Hydrologically connected to other wetlands of a different dominant class or open water.
- ☐ No surface connection: Difference class within 400 m (1/4 mi)
  Not hydrologically connected, but other wetland classes or open water are nearby.
- ☐ Connected or not: permanent open water within 400 m (1/4 mi)
  1.2 ha (3+ ac) permanent water nearby. Includes natural and created ponds, lakes, reservoirs.

Wetland hydrology: Water source(s), Flooding depth/duration, and Open water cover.

Water source

Rank the top three water sources in the SA on a scale of 1 to 3, with "3" representing the greatest influence (Fewer than 3? Just rank 1 or 2 and add a comment). Use check-boxes to indicate all water source present in a given evaluation area. Precipitation is only ranked in the SA if it is a primary water source.

Location/Evaluation Area	SA Pres	Rank	FB	WH	= N/A Flag
Stream inflow *Typically unidirectional, includes permanent/Intermittent and ephemeral surface water*	☐		☐	☐	
Overbank flooding *Water that has escaped the banks of a river or lake, may be periodic or infrequent*	☐		☐	☐	
Perennial surface water (lake or pond)	☐		☐	☐	
Precipitation, not primary source *i.e., rain, snow, sleet, or hail that falls to the ground*	☐	----	☐	☐	
Precipitation, primary source (ombrotrophic)	☐		☐	☐	
High pH groundwater *Natural groundwater fed systems where pH typically ranges from 7.0 to 9.0. NOTE: freshwater salinization (e.g., road salt runoff) may artificially cause high pH.*	☐		☐	☐	
Other groundwater, springs/seeps *pH is circumneutral (pH typically ranges from 5.0 to <7.0) e.g., seeps, headwater, toe-slope, etc.*	☐		☐	☐	
Tidal: freshwater *Salinity <0.5 ppt, specific conductance <800 uMhos. Nanotidal: <0.3 m (≤1 ft); micro: >0.3 to <2 m (>1 ft to <6.6 ft); meso: 2 m to <4 m (6.6 ft to <13.1 ft)*	☐		☐	☐	
Tidal: estuarine or marine *Ocean-derived salts ≥0.5 ppt. Nanotidal; micro; meso.*	☐		☐	☐	

Comments/Flags:

References

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31. Washington, DC.

U.S. Army Corps of Engineers (ACOE). 2011. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Flooding duration

Select one or double check and average for each evaluation area. Hydroperiod definitions follows Cowardin et al. 1979.*

Location	Permanent	Semi-perm	Seasonal	Saturated	Flag
Survey Area (SA)	☐	☐	☐	☐	
Field Buffer (FB)	☐	☐	☐	☐	

Comments/Flags:

Maximum surface water depth

Select one per location. The Rater does not need to directly observe maximum water depth, the presence of primary and secondary hydrology indicators may be used per ACOE (2011). Less than 40 cm includes saturated wetlands. Select "upland" if <10% of the FB is wetland. *No check-box? Some indicators don't apply to all evaluation areas.*

Location	>70 cm (≥27.6 in)	40-70 cm	<40 cm (<15.7 in)	Upland	Flag
Survey Area (SA)	☐	☐	☐	----	
Field Buffer (FB)	☐	☐	☐	☐	

Comments/Flags:

Open water, mud or sand flat community cover

The following apply to wetland units associated with open water and/or mudflats where emergent and woody vegetation cover is <30% (floating and submerged aquatic veg may be >30%). *Select one per eval area.*

Location	SA	FB	WH	Flag
None observed/Not applicable	----	☐	☐	
Absent/Trace: <0.05 ha (0.12 ac) *<10% of SA; <1% of the FB or WH*	☐	☐	☐	
Low: 0.05 to <1 ha (0.12 to 2.47 ac) *≥10% of SA; 1-20% of FB*	☐	☐	☐	
Moderate: 1 to <4 ha (2.5 to 9.88 ac) *20% to <60% of FB*	----	☐	☐	
High: ≥4 ha (≥9.88 ac) *≥60% of FB. (Includes riverine and lacustrine.)*	----	☐	☐	

Comments/Flags:

Riparian or floodplain communities

The following apply to wetlands associated with open water (lakes, reservoirs, through-flowing perennial streams, or ponds. Alluvial processes are present and soils are likely Fluvaquents or Fluvents, or soils with Fluvaquentic subgroups *Select all that apply.*

- ☐ **Floodplain wetland unit**
  >10% of wetland receives overland through-flow or bidirectional surface water flow in 100-yr flood or more frequently, or major beaver influence in headwater wetlands.
- ☐ **Headwater wetland unit,** may be terrene or assoc. with streams <3 order
  Surface water is primarily unidirectional, flowing to an intermittent or perennial outlet (e.g., stream source).
- ☐ **Non-floodplain/headwater wetland unit**
  No perennial or intermittent/seasonal surface water inlet or outlet associated with the wetland. Wetland does not fringe a lake, pond, or watercourse.

None observed/Not applicable		SA ☐	FB ☐	WH ☐	
Floodplain Indicators	**Location**	**SA**	**FB**	**WH**	**Flag**
Sinuous stream present *Associated with a sinuous or diffuse low-velocity watercourse (applies to lotic systems, tends to be >first order streams)*		☐	☐	☐	
Vegetation fringing open water *≥90% of open water boundaries are fringed by a band of vegetation ≥10 m (33 ft) wide. [Also supports aquatic fauna by providing cover/refuge, shading (water temperature), terrestrial food sources (allochthonous organic inputs).]*		☐	☐	☐	
Streambank/shore stabilization, woody *Developed woody root masses stabilize streambanks against undercutting.* *(No "WH" here because unlike the above indicator, this can be difficult to discern from aerial photos/maps.)*		☐	☐	----	
Depositional environment present *E.g. sediment deposits, siltation, debris, drift deposits, flood wrack, trash, etc. Includes ephemeral streams.*		☐	☐	☐	
Floodwater drainage patterns *Backwater sloughs/ponding areas, back- channels, ephemeral streams, etc.*		☐	☐	☐	
Ice scour marks/evidence *(marks at tree bases, etc.)*		☐	☐	☐	

Comments/Flags:

General Overland Obstruction Indicators (GOOI): Surface water retention and dispersion

Select all general indicators that apply. The following indicate a wetland's capacity to obstruct or slow overland flow of surface water or desynchronize surface water flows. Obstruction may be performed at a higher level if any of the following indicators are present. The Rater may check few of the following, yet still score the function as high or moderate.
No check-box? Some indicators don't apply to all evaluation areas.

None observed/Not applicable		SA ☐	FB ☐	WH ☐	
Gen. Surface Indicators	**Location**	**SA**	**FB**	**WH**	**Flag**
Overland flow input *Wetland receives and retains flow from upslope or upstream, and/or overbank flooding.*		☐	☐	☐	
Surface water dispersion *Wetland lacks a steep slope and exists in a relatively flat area or basin.*		☐	☐	☐	
Shows signs of **variable water levels** or seasonal ponding/flooding *(Stained leaves, water lines, moss lines, etc.)*		☐	☐	----	
Lacks an outlet, or if present, has a constricted outlet (i.e., slows outflow rate)		☐	☐	☐	
Dense persistent vegetation *Herbaceous or woody zone ≥6 m (20 ft) wide, with ≥40% plant cover and occurs in a depositional environment. Applies to areas ≥10 m from open water, or lacking open water.*		☐	☐	☐	
Vegetated hummocks or tussocks *Hummocks cover >1 m^2 per 100 m^2. Including microtopography resulting from raised tree/ shrub based, sedge/fern tussocks, etc.*		☐	☐	----	
Veg. hummocks or tussocks, abundant *>25% of the wetland, includes moss hummocks. If selecting this indicator, do not select the above indicator.*		☐	☐	----	
Woody hummocks, tree or shrub bases *Includes any rooted woody vegetation.*		☐	☐	----	

Comments/Flags:

Wetland Function: Hydrology - Alterations to the wetland's hydroperiod.

Hydrological disturbances and disconnection from surface water continuum

Select all that apply. If disturbance indicators are present, related inherent wetland functions may be less effective (i.e., functional capacity reduced); these disturbances are often directly or indirectly caused by anthropogenic actions. Indicators related to a wetland's disconnection from the surface water continuum is relevant for wetlands associated with surface water (streams, waterbodies, overland flow), including permanent or ephemeral waterbodies.

None observed/Not applicable	☐	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Stormwater input *e.g., source pipe, impervious surface*	☐	☐	☐	
Artificial dewatering features *Ditches, drains, land grading, etc.*	☐	☐	☐	
Water inflow <u>reduced</u> *Barriers present between wetland and surface or subsurface water inputs (permanent or ephemeral). Examples: dam / weir / culvert; including perpendicular roads, railroad beds, and parallel features that may reduce surface or subsurface flow into the wetland (e.g., reduce toe-slope discharge).*	☐	☐	☐	
Artificial levee <u>parallel</u> to surface water *Reduction in surface water dispersion in wetland, or stream/floodplain interaction (road, railroad bed, rail trail, etc.).*	☐	☐	☐	
Stream channel banks degraded *Banks are steep, eroding, have abundant bank slides or slumps, have <50% cover of roots, or are unvegetated (excludes bedrock).*	☐	☐	☐	
Incised stream channel *Results in reduced over-bank flooding during peak/high velocity flows. (Also check above degraded indicator.)*	☐	☐	☐	
Hardened stream channel *e.g., riprap, gabions, concrete, etc.*	☐	☐	☐	
Straightened stream channel and/or moved to toeslope *(meanders eliminated).*	☐	☐	☐	
Invasive knotweed thickets *This includes Japanese knotweed (*Reynoutria japonica*), giant knotweed (*R. sachalinensis*), and bohemian knotweed hybrid (*R. ×bohemica*) present and covering >100 m² or 3 linear meters along a perennial or seasonal watercourse/ water body. These species grow/spread rapidly and decrease bank/shoreline stabilization.*	☐	☐	☐	

Hydrologic Dist. Comments/Flags:

Hydro disturbance indicators continued... *N/A*	☐	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Presence of dead forest or dead shrubs *Areas in sufficient amounts to result in diminished evapotranspiration, nutrient uptake, etc.*	☐	☐	☐	
Current use in wetland results in disturbance(s) that compromise natural wetland hydroperiod, surface water interception, groundwater discharge/recharge. *e.g., over-grazed pasture >50% bare soil; annually-tilled crops lack winter plant residue or cover crops.*	☐	☐	☐	

Hydrologic "health", general rank

Rank the wetland's current status/response to direct or indirect **<u>anthropogenic</u>** disturbance(s). Select one or double check and average. The Rater may check one or several of the possible hydrologic disturbance indicators listed above, yet still determine their impact is minimal and wetland has "recovered" or there is no apparent alteration relative to the area's overall function. Add comment if FB is >90% upland and leave those check-boxes blank.

	SA	**FB**	
None or none apparent (undisturbed)	☐	☐	
Recovered *Evidence of past disturbance, but community and hydrology has largely recovered (i.e., not dominated by ruderal plant species), native perennials that reflect the current hydroperiod.*	☐	☐	
Recovering *Wetland vegetation may be in a state of conversion (succession) due to the anthropogenic disturbance(s). Ruderal or nonnative species may be common, or if drier, greater abundance of facultative upland plants.*	☐	☐	
Recent or no recovery/ongoing *May apply to wetlands where disturbance(s) or degraded condition (e.g., dewatering structures, filling) are ongoing and extensive enough to significantly alter a wetland's natural hydroperiod.*	☐	☐	

Hydrological Health Comments/Flags:

Wetland Function: Microtopography, Flood/storm water desynchronization.

Microtopography & edaphic indicators

These structural features are important for fauna, but they may also positively influence a wetland's capacity to retain and slow surface water flows. Coarse Woody Debris (CWD) indicator: If present, only select one CWD prompt, otherwise select all that apply.

None observed/Not applicable	☐	☐	
Location	**SA**	**FB**	**Flag**
Tip-up mounds/upturned tree root wads and pits *(Different from vegetation hummocks)*	☐	☐	
Shallow flooded hollows or fish-less pools *Seasonal, semi-permanent, or permanent. May appear as sparse concave surfaces when water levels are low - often showing secondary hydric indicator(s).*	☐	☐	
Coarse woody debris/material *≥10 cm diameter, >1 m long, fully on the ground in wetland.*	☐	☐	
Coarse woody debris, abundant *>3% cover of wetland evaluation area.*	☐	☐	
Soil organic matter accumulation *≥20 cm (8 in) depth of organic soils within given evaluation area. This includes peat, muck & mucky peat.*	☐	☐	
Leaf litter and duff layer *Abundant leaf litter, bare ground typically <5%.*	☐	☐	

Comments/Flags:

Overall microtopographic complexity

In wetlands lacking a dense, movement-inhibiting shrub layer, this metric can often be quickly estimated by considering the need to pay attention to balance while walking through the wetland. Select one for each evaluation area. Add comment if FB is >90% upland and leave those check-boxes blank.

	SA	**FB**	**Flag**
Low: <3% *Most surveyors can walk freely though the wetland without looking at the ground.*	☐	☐	
Medium: 3-40% *Most must pay attention to their footing but can still move through the wetland unhindered.*	☐	☐	
High: >40% *Most need to slow down, pick their footing with care, and be mindful of their balance.*	☐	☐	

Comments/Flags:

Flood and storm water control, general rank

This is an overall score reflecting the evaluation area's capacity for flood attenuation, desynchronization and or dispersion of surface flows, and surface water storage capacity. Ranking should be informed by Rater's answers in related sections (wetland hydrology, microtopography, and disturbances). Select one per evaluation area.

Not applicable	----	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Very High *Wetland lacks a steep slope and contains micro-topography features that help slow surface water, exists in a relatively flat area, or is a basin that has flood storage potential. Minimum criteria: At least two "microtopographic indicators", "micro-topographic complexity" is medium or high; OR a floodplain or headwater wetland with at least six GOOIs and no significant Hydrologic Disturbance Indicators (HDI) present (if any).*	☐	☐	☐	
High *As "Very High", but may have minor HDI. At least four GOOIs present. Microtopography complexity may be low, and/or floodplain not in a relatively flat area, but wetland still interacts with floodwaters or receives surface or subsurface flows from adjacent upland. (e.g., may include "flashy" rivers).*	☐	☐	☐	
Moderate *At least three GOOIs, may have ≥2 HDI.*	☐	☐	☐	
Low *Three or more HDI present and strongly impacting hydrology of the evaluation present (no GOOI minimum). Note: if HDIs are limited to a certain area or wetland edge then "low" likely does not apply. For example, any of the following: Wetland occurs on a slope; receives little overland flow from uplands and none from surface water.*	☐	☐	☐	

Comments/Flags:

Wetland Function: General ranking - Erosion Control, Subsurface and groundwater.

Erosion control, general rank

Select one ranking per evaluation area. Use your answers in related sections to inform your overall ranking of the wetland's functional capacity.

	Location	SA	FB	WH	Flag
	None Applicable	----	☐	☐	
Very High	*Permanent or semi-permanent surface water present. A minimum of: 4 Floodplain Indicators, and 4 GOOIs. Hydrologic health score is "recovered" or "none apparent". **OR** is a vegetated headwater wetland with an outlet (permanent or seasonal).*	☐	☐	☐	
High	*As "Very High", but only 2-4 Floodplain Indicators and ≥3 GOOIs. Includes vegetated headwater wetlands with a surface water outlet. Hydrologic health score is "recovered" or better.*	☐	☐	☐	
Moderate	*At least* one *of the following: 2 GOOIs; 1 Interception Indicator; 1 Floodplain Indicator; or lacks an outlet but fringes a permanent pond or lake >0.8 ha (2 ac).*	☐	☐	☐	
Low	*Wetland is a narrow riparian corridor whose associated permanent stream channel is hardened or stream channel is strongly incised. Or wetland is predominately open water, has minimal natural upland buffer (<30% within 25 m), and rooted emergent wetland vegetation fringes <30% of the pond or lake edge.*	☐	☐	☐	

Comments/Flags:

Subsurface and ground water resources, field observations

Select all that apply. Only check present if observed in the field.

None observed	☐	☐	☐
Field observation: Signs of groundwater or subsurface **recharge or discharge** *(e.g., seeps, springs, toe-slope discharge, base flow levels during drought, water temperature, or water pH).*	☐	☐	☐
Field observation: **Permeable soils or rock present** *Well drained to excessively drained sands, gravels, or karst is present in the wetland or adjacent upland.*	☐	☐	☐

Comments/Flags:

Subsurface and groundwater, general rank

Select one or double check and average. Use your answers in related sections to inform your overall ranking of the wetland's functional capacity.

	Location	SA	FB	WH	Flag
	None observed/Not applicable	----	☐	☐	
Very High	*Example indicators: fairly stable year round water levels, seeps, water pH ≥6 in communities not dominated by* Sphagnum, *circumneutral plant species present (e.g., skunk cabbage, golden ragwort, buttonbush, poison sumac,* Carex lasiocarpa *etc.). Or spatial data review indicating any one of the following, occurs in or adjacent to: ground water resource protection area, unconfined aquifer, principal or primary aquifer, or potentially supports water wellheads. Note: floodplain wetlands on large rivers may meet the above criteria, but the rater may choose "high" or "moderate".*	☐	☐	☐	
High	*Example indicators: seeps, water pH ≥5 in communities not dominated by* Sphagnum, *circumneutral plant species present (skunk cabbage, golden ragwort, buttonbush, royal fern,* Carex lacustris, C. lasiocarpa *etc.)*	☐	☐	☐	
Moderate	*Does not meet the criteria for "low", but no groundwater or subsurface indicators observed.*	☐	☐	☐	
Low	*Wetland underlain by impermeable rock or fragipan and wetland lacks a surface water outlet (including ephemeral).*	☐	☐	☐	

Comments/Flags:

Wetland function: Wetland community heterogeneity/habitat diversity.

Wetland assemblage types/classes present

Check each community present within each evaluation area; only count areas ≥0.1 ha or ≥1000 m² (0.247 acres). Starting in the SA, assign a score of 0 to 3, ranking up to three types dominant in the SA (if only one type, score it as a 3). Working your way outward from the SA, note all types present in the other areas.

Location	SA	FB	WH	Flag
Not applicable	----	☐	☐	
Forested *Dominated (30%) by tall woody vegetation >6 m (20 ft). Characterized by an overstory of trees and often containing an understory of young trees and shrubs and an herbaceous layer, although the young tree/shrub and herbaceous layers can be largely missing from some types of forested wetlands.*		☐	☐	
Shrub *Dominated (≥30%) by woody vegetation <5 m (16.4 ft) tall. Plants include true shrubs, young trees, or trees/shrubs that are small or stunted b/c of environmental conditions. This class may be a successional stage or be a relatively stable plant community.*		☐	☐	
Shallow emergent marsh *Herbaceous wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses/lichens), that persists for most of the growing season in most years. Associated community names: marsh, wet meadow, sedge meadow, & herbaceous fens. Hydrology: often saturated to seasonally-flooded.*		☐	☐	
Deep emergent marsh *Often occurring next to open water, this semi-permanent to permanently-flooded wetland is dominated by erect or floating, rooted, vascular hydrophytes with persistent and non-persistent vegetation present for most of the growing season in most years. Common plants: cattail, wild rice, water or pond lily, green arrow-arum, broadleaf arrowhead, bulrush, and bladderwort.*		☐	☐	

Types/classes present, *continued*

Location	SA	FB	WH	Flag
Not applicable	----	☐	☐	
Aquatic bed Wetlands and deepwater habitats where plants grow principally on or below water surface (i.e., submergent or floating-leaved), and are the uppermost form layer with ≥30% areal coverage (e.g., PAB*, R1AB). Floating aquatic species like duckweed (*Lemna* spp., *Spirodela* spp.) are excluded from the definition of "aquatic bed."		☐	☐	
Mud, sand, or gravel flats *Equivalent to "unconsolidated bottom" (e.g., PUB3/4, R1UB3/4, E1UB3/4) described in Cowardin et al. (2016) and includes areas of wetlands characterized by exposed or shallowly inundated substrates with vegetative cover less than 30%.*		☐	☐	
Open water/deep water *Areas of permanent water generally deeper than 1 m (3.25 ft).* *[Note: Rater should default to open water if communities are identified remotely and data are not available to confirm the community is a mudflat, just document your reasoning in the comments box below.]*		☐	☐	
Upland inclusion *Per standard SA protocol, upland inclusions should comprise <10% of your target survey area, so maximum SA score for this category is 1 (i.e., for standard SA (0.5 ha), upland area should be <500 m² (0.12 ac). Here we are using an ecological definition of upland - that is, none of the three indicators: no hydric soils, plants, or hydrology.*		☐	☐	

Comments/Flags:

Wetland function: Wetland structure - Modifications, Composition.

Vegetation structure and habitat modification

Select all that apply for each evaluation area.

None observed/Not applicable	☐	☐	
Location	**SA**	**FB**	**Flag**
Excessive to moderate wildlife herbivory *E.g., deer (low seedling recruitment, visible browse line, remaining (unpalatable) plants species, etc.), geese, insects, etc.*	☐	☐	
Livestock grazing, *≥25% bare soil.*	☐	☐	
Mowing *Low intensity lawn, residential lawn, or hay.*	☐	☐	
Golf course or highly maintained turf	☐	☐	
Right-Of-Way (ROW): cleared *Brush cutting, chemical, etc. (power lines/roads)*	☐	☐	
ROW: no maintenance w/in past year	☐	☐	
Logging, *selective or clearcut within past 2 years*	☐	☐	
Annual agricultural row crops *(w/in 2yrs)*	☐	☐	
Plantation or orchard, *managed or abandoned Conversion from natural tree species.*	☐	☐	
Dumping, excessive trash	☐	☐	
Nutrient enrichment *e.g., algal bloom*	☐	☐	
Historical land use *Evidence of past use such as cut tree stumps, stone walls, skidder tracks, ditching, historical aerial imagery, etc.*	☐	☐	
Other notable habitat features or species observations *(specify):*	☐	☐	

Comments/Flags:

Invasive plant species abundance

Select one per evaluation area.

Not applicable	----	☐	
Location	**SA**	**FB**	**Flag**
Absent *None observed by Rater in area.*	☐	☐	
Uncommon *Present, <20% cover.*	☐	☐	
Abundant *Present, 20-75% cover.*	☐	☐	
Pervasive *>75% cover.*	☐	☐	

Comments/Flags:

Wetland vegetation alteration

This question evaluates the "intactness" of the natural habitat relative to the type of wetland being evaluated. Select one per evaluation area or double check and average.

Not applicable	----	☐	
Location	**SA**	**FB**	**Flag**
None or none apparent *There are no disturbances or no disturbances apparent to the Rater.*	☐	☐	
Recovered *Area appears to have recovered from past disturbances (e.g., human, beaver, fire, invasive insect such as Emerald Ash Borer).*	☐	☐	
Recovering *Recovering from past disturbance.*	☐	☐	
Recent or no recovery *Disturbance(s) recently occurred, are ongoing, and/or the wetland has not recovered from past disturbances.*	☐	☐	

Comments/Flags:

Wetland function: Wetland community development, Pollution treatment.

Natural community development, general rank

Select one per evaluation area or double check and average the points when calculating a score. If the contiguous wetland is entirely contained in the SA check "not applicable" for the FB.

Points are assigned as follows:
Excellent = 7, Very Good = 6, Good = 5, Fair = 3, Poor = 1.

	Location	SA	FB	Flag
	Not applicable	----	☐	
Excellent	*Wetland appears to represent the best of its ecoregional type or class. Forested wetlands: Old growth trees likely present, tree recruitment good in all strata.*	☐	☐	
Very good	*Very good but lacks characteristics that would make it "excellent" (e.g., a few nonnative plants or minor anthropogenic disturbances near the wetland edge).*	☐	☐	
Good	*Past or present disturbances, successional state, invasives, or other factors present. Nonnative plant cover <20%. Forested wetlands have mature canopy trees with at least some seedling recruitment.*	☐	☐	
Fair	*Moderately good example of its type/class, but because of past or present disturbances, successional state, etc. it is not "good". Seedling recruitment of native trees in forested wetland may be low due to over-browsing.*	☐	☐	
Poor	Wetland may be heavily invaded (>75% nonnative plants), have past or present land use(s) that altered hydrology and/or soils.	☐	☐	

Comments/Flags:

Pollution treatment, general rank

Select one per evaluation area. This question addresses an evaluation area's overall potential to serve as biologic and chemical oxidation basins. Human disturbances such as dewatering may reduce a wetland's potential capacity to provide this function.

"Pollution" as defined by Article 24 includes the presence in the environment of man-induced conditions or contaminants in quantities or characteristics which are or may be injurious to human, plant or wildlife, or other animal life or to property. This includes point and non-point source pollutants such as suspended solids/organic matter/sediment, road salt runoff, pesticides, agriculture pollutants (e.g., row crop amendments, animal waste, sediment, pesticide), municipal sewer overflow, septic system(s), thermal changes (e.g., discharge warm water), etc.

	Location	SA	FB	WH	Flag
	Not applicable	----	☐	☐	
High	*Wetland is in a human-dominated landscape (>25%) and is at least seasonally flooded. Primary or secondary water source is lake/pond, stream inflow, overbank flooding, or tidal.*	☐	☐	☐	
Moderate	*Does not meet the criteria for "low" or "high". Wetland may lack a surface water outlet, but is in a human-dominated landscape (>25%),* ***or*** *within 175 m (190 yards) of a road/industrial property/mine/logging,* ***or*** *wetland is riparian/floodplain and has ≥2 HDIs.*	☐	☐	☐	
Low	*For example, wetland may be saturated and lack surface water outlets; has dewatering features that significantly reduces flood duration (retention time) and/or depth. Wetland is oligotropic and precipitation is the wetland's primary water source.*	☐	☐	☐	

Comments/Flags:

Wetland function: Wildlife guilds - Birds, Invertebrates, and Mammals.

Select all that apply. Sub-guilds: Presumed present if it supports or has habitat support a given sub-guild. Many of the habitat traits important to each animal group such as wetland size, buffer width, water levels, and habitat heterogeneity are captured in other sections of this assessment.

Birds[1], *Supports or has habitat to potentially support:*

	Location	SA	FB	WH	Flag
None observed/Not applicable		☐	☐	☐	
Aquatic habitat *Water depth/duration necessary for waterbird foraging, breeding (ponds, perennial streams, etc.).*		☐	☐	☐	
Waterfowl breeding *Potentially supports 1+ breeding pair/broods.*		☐	☐	☐	
Wading bird breeding *Nest site, nest site buffer, or feeding habitat.*		☐	☐	☐	
Other migratory wetland-dependent birds *1+ pair for nesting, feeding, roosting, etc.*		☐	☐	☐	
Migrating water birds *Potential resting/feeding/roosting habitat.*		☐	☐	☐	
Birds of prey *(hawks, falcons, & owls) 1+ pair for nesting, feeding, roosting etc.*		☐	☐	☐	
Uncommon species *(RT&E, SGCN, S1-S3) 1+ breeding pair for nesting, feeding, etc.*		☐	☐	☐	
Other notable features/observations (specify).		☐	☐	☐	

Comments/Flags:

Invertebrates

	Location	SA	FB	WH	Flag
None observed/Not applicable		☐	☐	☐	
Aquatic or wetland-dependent/associated invertebrates *Mollusks, fingernail clams, crayfish, Odonates, etc.*		☐	☐	☐	
Pollinators *Supports native bees, butterflies, moths, flies, beetles, etc. Floral resources present in the spring and/or summer (>25%), or potential nesting resources present (e.g., sandy soils, woody debris/snags, or hummocks above the mean high water line).*		☐	☐	☐	
Uncommon species *(RT&E, SGCN, S1-S3)*		☐	☐	☐	

Comments/Flags:

Mammals, *Supports or has habitat to potentially support:*

	Location	SA	FB	WH	Flag
None observed/Not applicable		☐	☐	☐	
Semi-aquatic mammals *Aquatic otters, beavers, muskrat, or mink.*		☐	☐	☐	
Beaver dam/lodge, muskrat lodge *Includes active and abandoned.*		☐	☐	☐	
Medium/large mammals *Provides or has potential to provide important feeding habitat for black bear or bobcat based on regional occurrence, assessment of use, and/or proximity to contiguous natural area patch area >275 ha (≥680 ac).*		☐	☐	☐	
Other carnivores *Foxes, coyotes, wolves etc.*		☐	☐	☐	
Ungulates, White Tailed Deer		☐	☐	☐	
Ungulates, Moose		☐	☐	☐	
Bats *Potential feeding (marshes, forests, forested edges etc.) or roosting habitat (e.g., trees or snags with shaggy bark or cavities).*		☐	☐	☐	
Small terrestrial mammals *Rodentia, Insectivora, etc.*		☐	☐	☐	
Uncommon species *Habitat supports or potentially supports any RT&E, SGCN, or S1-S3 mammal.*		☐	☐	☐	
Other notable habitat features or species observations *(specify):*		☐	☐	☐	

Comments/Flags:

[1]Bird guild examples: Waterfowl: ducks, geese, swans; Wading birds: herons, egrets, bitterns, rails, sandhill crane, etc.; Migratory wetland-dependent birds: Virginia rail, common snipe, marsh wren, sedge wren, swamp sparrow, American bittern, northern water thrush, northern harrier, spruce grouse, Cerulean warbler, and loons; Other wetland-dependent migratory birds: alder flycatcher, belted kingfischer, red-headed woodpecker, etc.

Wetland function: Wildlife guilds - Amphibian, Reptile, and Fish.

Select all that apply. Many of the habitat traits important to each animal group such as wetland size, buffer width, water levels, and habitat heterogeneity are captured in other sections of this assessment.

Amphibians and reptiles

Location	SA	FB	WH	Flag
None observed/Not applicable	☐	☐	☐	
Amphibians - significant populations *Potentially supports large populations of native amphibians (common or rare species).*	☐	☐	☐	
Reptiles - significant populations *Potentially supports large populations of native reptiles (common or rare species).*	☐	☐	☐	
Vernal pool habitat *Fish-less pools may support species requiring seasonally flooded pools for breeding (includes pools within wetland complexes).*	☐	☐	☐	
General habitat *Wetland and/or adjacent watercourse provides or has potential to provide basking (large rocks/logs), breeding, feeding, or cover habitat (e.g., shallow littoral zones with emergent vegetation, physical structures such as rocks, debris dams, and hummock/hollow topography provide microhabitat).*	☐	☐	☐	
Uncommon species (RT&E, SGCN, or S1-S3) *Potentially supports breeding/nesting, buffer for a nest site, or feeding habitat.*	☐	☐	☐	
Other notable habitat features or observations (specify):	☐	☐	☐	

Comments/Flags:

NRCS: General habitat requirements of North American reptiles and amphibians https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_022220.pdf

Freshwater and marine fish

Location	SA	FB	WH	Flag
None observed/Not applicable	☐	☐	☐	
Fish present *Native fish are present (natural or stocked) in the target wetland area or adjacent watercourse or waterbody.*	☐	☐	☐	
Supports downstream fish *Wetland and adjacent tributary may not contain fish, but provides cooler water, and/or allochthonous materials/food sources to a downstream watercourse/body that does.*	----	----	☐	
General habitat *(provides or potentially does) Wetland and/or adjacent watercourse/body provides spawning, nursery, feeding, or cover habitat (e.g., assoc. with deep or shallow marshes, or seasonally flooded wetlands associated with streams and rivers.)*	☐	☐	☐	
Winter habitat *Retains some open water during winter and/or size sufficient to support fish; if riverine, defined channel present and bankfull width >15 m (>50 ft) and/or depth ≥1m (>3 ft).*	☐	☐	☐	
Brackish/estuarine/marine habitat *E.g., tidal marsh, mud flats, eelgrass beds, and/or essential fish habitat as defined by Magnuson-Stevens Fishery & Conservation Act 1996 amendments are present in or adjacent to the wetland.*	☐	☐	☐	
Uncommon species (RT&E, SGCN, or S1-S3) *Supports or potentially supports.*	☐	☐	☐	
Other notable habitat features or observations (specify):	☐	☐	☐	

Comments/Flags:

Wetland function: Wildlife. Select all that apply. Habitat traits important to each animal guild are captured in other sections of this assessment, too.

General habitat indicators (GHI)

	Location	SA	FB	WH	Flag
	None observed/Not applicable	☐	☐	☐	
	Wetland dependent animals *Evidence of use by wetland-dependent species.*	----	----	☐	
	Standing dead trees (snags) *>25 cm (10") diameter and 137 (4.5') tall*	☐	☐	☐	
	Abundant standing dead trees (snags) *≥25 cm (10") diameter and ≥1.4 m (4.5') tall, ≥3 snags/0.4 ha (1 ac). If present in a given evaluation area also check the above indicator. That is, there should be two checks.*	☐	☐	☐	
	Supports higher trophic levels *Wetland or associated surface water supports prey for higher tropic levels.*	----	----	☐	
	Fruiting plants present *≥30% total cover of flowering plants (dicots and monocots, e.g., oaks, maple, blueberry, cattail, etc.)*	☐	☐	----	
	Adjacent greenspace *≥50% surrounding land is forest, agriculture, old field, or open land within 100 m of the wetland.*	----	----	☐	
	Habitat heterogeneity *3+ wetland vegetation classes*	☐	☐	☐	
	Surface water: watercourse, pond, lake *Field observation: direct surface water connection (watercourse, lake, pond, overbank flooding, etc.).*	☐	☐	☐	
	Remote, aerial imagery observation: *If only observed remotely check here*	----	☐	☐	
	Other notable features or observations:	☐	☐	☐	

Lower functional capacity (LFI), potential indicators

Any of the following can be negated by evidence of wildlife or fish use.

	Location	SA	FB	WH	Flag
	None observed	☐	☐	☐	
	Small and isolated by development *Vegetated wetlands <5 ha (<12.4 ac), surrounding develop. limits wildlife access/use.*	----	----	☐	
	Frequent anthropogenic disturbance *Current use results in frequent cutting, mowing, herbicide treatment, etc.*	☐	☐	☐	
	Supports few wetland dependent spp. *Applies to sites where hydrology is at the drier end of the scale (saturated).*	☐	☐	----	
	Fragmentation within wetland *Roads, railroads etc. fragment what was once a contiguous wetland. Check if any fragmenting features are present in a given evaluation area.*	☐	☐	☐	
	Aquatic connectivity barrier(s) *Present in evaluation area (SA, FB) or surface water associated with the contiguous wetland (WH). Dam or culvert, beaver dam, water fall, road, etc.*	☐	☐	☐	
	Invasive plant abundance >75%, all strata *Native cover ≤25% in all strata. For example:* Phragmites *marsh should receive a check, but a floodplain forest with >25% native canopy cover does not.*	☐	☐	☐	
	Other notable features or observations:	☐	☐	☐	

Comments/Flags:

Wildlife habitat and biodiversity, general rank

Select one for each evaluation area. If wetland is entirely contained within the SA leave FB and WH blank and write a comment.

Very High. *Relatively large, w/ moderate/high interspersion (heterogeneity). Open water/mud/sand flat ranking is Low in SA or moderate/high in FB/WH, and/or permanent watercourse present and has a ≥10 m vegetated buffer. All guilds present in all eval areas. LFIs if present are not pervasive and ideally limited to the wetland edge.*	☐	☐	☐	
High. ***SA or FB: SA:*** *If LFI present, not pervasive, SA ≥4 guilds, FB and WH = 5 guilds. Typically ≥4 GHIs present.*	☐	☐	☐	
Moderate. *If LFI present, not pervasive, SA ≥3 guilds, FB and WH ≥4 guilds. Upland natural buffer tends to be ≤100m (see on-screen eval).*	☐	☐	☐	
Low. *LFI present and pervasive,* SA *≤3 guilds, FB and WH <5 guilds.*	☐	☐	☐	

Comments:

Wetland values

Recreational value considers the effectiveness of the wetland and associated watercourse to provide consumptive and non-consumptive recreational opportunities. Functional category is present and likely to be significant if any of the following are present. Select all that apply.

Recreation value and economic benefit

None observed/Not applicable	☐	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Preserved land *Property ownership allows for consumptive and non-consumptive activities and is open to the public or conservation-oriented membership group (e.g., sportsman club).*	☐	☐	☐	
Proximity to potential visitors *Potential recreation site is accessible and in, or nearby, populated cities and towns.*	☐	☐	☐	
Visible to the public, recreation/aesthetics *Whether on preserved land or viewable from the road, a scenic overlook, etc.*	☐	☐	☐	
Recreational activities, non-consumptive *Contributes to or has potential to support activities by private or public entities (e.g., hiking, boating, wildlife viewing etc.).*	☐	☐	☐	
Recreational activities, consumptive *Provides habitat for fish/wildlife/flora that can be fished/hunted/trapped/foraged under state law.*	☐	☐	☐	
Provides economic benefits *e.g., attracts visitors to local area, users pay entrance fees, hunting/fishing permits, etc.*	☐	☐	☐	

Comments/Flags:

Open space and aesthetics

None observed/Not applicable	☐	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Important open space *e.g., municipal, regional, or state plan*	----	----	☐	
Scenic river or byway proximity *Hydrologically connected to a state or federally designated scenic river or scenic byway*	☐	☐	☐	
Visible to the public, open space *Whether on preserved land or viewable from the road, a scenic overlook, etc.*	☐	☐	☐	
Aesthetics, Heterogeneity. Contains 2+ wetland classes, or is dominated by emergent marsh or open water	☐	☐	☐	
Color. Contains flowering plants, plants that turn vibrant colors in different seasons, or a diversity of vegetative species	☐	☐	☐	
Contrast. Visible surrounding land use form contrasts with wetland, appears undeveloped from viewing area and/or relatively unobstructed sight line exists through wetland.	☐	☐	☐	
Other notable values *(specify)*	☐	☐	☐	

Comments/Flags:

Education and research

None observed/Not applicable	☐	☐	☐	
Location	**SA**	**FB**	**WH**	**Flag**
Preserved land, *owned or leased* *Public or non-profit entity dedicated to education, research, and/or stewardship.*	☐	☐	☐	
Accessibility *Accessible or potentially so with the addition of trails and/or off-road parking.*	☐	☐	☐	
Group Education, *known or potential* *Within safe walking distance or short drive to schools and/or off-road parking accommodates 1+ passenger van or school bus.*	☐	☐	☐	
Scientific Research *past or present* *Known to be a study site for research.*	☐	☐	☐	

Comments/Flags:

Wetland values: Education/Research, Special wetlands, and Uniqueness.

These functions are valuable wetland attributes relative to aspects of public health, recreation, and habitat diversity. Functional category is present and likely to be significant if any of the following are present. Select all that apply.

Uniqueness

	Location	SA	FB	WH	Flag
	None observed/Not applicable	☐	☐	☐	
	Rare, Threatened, & Endangered, *known State or Federally listed species*	☐	☐	☐	
	RT&E habitat, *known or potential*	☐	☐	☐	
	Species of Conservation Concern, *known*	☐	☐	☐	
	SCC habitat, *known or potential*	☐	☐	☐	
	Historic RT&E or SCC *Last observed/documented ≥20 years ago*	☐	☐	☐	
	Migratory birds. *Significant migratory song bird/waterbird potential habitat or use.*	☐	☐	☐	
	Habitat "island" *Urban, exurban, and agriculture >25%*	☐	☐	☐	
	Urbanization/Development *Development >25%, but agriculture <25%. Urban or exurban areas should check Habitat "island" above as well as here (2 checks).*	☐	☐	☐	
	Tribal, archaeological, or historical relevance *known or potential*	☐	☐	☐	
	Wetland currently supports culturally-significant native plants *that have unique values to regional First Peoples.* *e.g., Native sweetgrass* (Anthoxanthum spp.), cattail (Typha spp.)	☐	☐	☐	
	Unusual geological feature which is an excellent representation of its type. e.g., karst map, *Comments/Flags:*	----	----	☐	

Special wetlands

A special wetland type should be marked present even if it does not apply to the entire evaluation area. See Appendix A for rare/uncommon natural community ranking specifications.

Location	SA	FB	WH	Flag
None observed/Not applicable	☐	☐	☐	
Bog or Fen	☐	☐	☐	
Rare natural community *Any other comm. ranked S1, S1S2, or S2*	☐	☐	☐	
Uncommon natural community *Any other comm. ranked S2S3 or S3*	☐	☐	☐	
Old growth forest *[e.g., ADK upland BA ~33.7 m2/ha (McGee)]*	☐	☐	☐	
Mature forested wetland *[e.g., avg canopy tree DBH >30 cm (>11.8 in)]*	☐	☐	☐	
Lacks historical land use *No evidence of historical land use w/in 75 yrs*	☐	☐	----	
NYS DEC Class I wetland *See Environmental Resource Mapper. More info on Class scoring is here Article 24.*	----	----	☐	

Comments/Flags:

Unique and Special rating summary

Summarize scores on this page in the space below. Zero means none observed. If the wetland is fully contained within the SA leave FB and WH blank and write a comment.

Location	SA	FB	WH	Flag
Uniqueness indicators tally *Scale: 0 to 11.*	___	___	___	
Special wetlands indicators tally *Scale: 0 to 7.*	___	___	___	

Comments/Flags:

SCC: Species of Conservation Concern includes NYS DEC's Species of Greatest Conservation Need & Species of Potential Conservation Need, & NYNHP S1-S3

Urban/Devel: In urban areas/clusters, or rapidly developing areas (with past 20 years), or occurs in an area where past wetland loss rates are high.

Hist. land use: historical air photos or records indicate the wetland has not been cleared, logged, farmed, or used for pasture. No field indicators observed such as rock walls, foundations, fence posts, ditches, homogeneous soil profile. If historical land use is lacking in the FB then it would automatically also be lacking in the SA.

Wetland values

Functional category is present and likely to be significant if any of the following are present. Select all that apply.

General value indicators (GVI)

Check all the apply.

Location	SA	FB	WH	Flag
None observed/Not applicable	☐	☐	☐	
Off-road public parking *presence/potential* *Within 400 m (1/4 mi) of wetland edge.*	☐	☐	☐	
Handicap accessible *For recreation, education, or stewardship.*	☐	☐	☐	
Watercourse adjacent/abutting *Potential to support valued actives.*	☐	☐	☐	
Valuable wildlife habitat	☐	☐	☐	
Wildlife/habitat enhancement efforts *e.g., bird/bat box, or stewardship (e.g., invasive plant management).*	☐	☐	☐	
Local significance *Wetland contains biological, geological, or other features that are locally rare/unique.*	☐	☐	☐	

Comments/Flags:

Potential indicators of lower functional capacity

User may mark these Lower Value Indicators (LVI) as present and still choose a general value score of high or moderate if the impact is small/localized relative to the evaluation area.

Location	SA	FB	WH	Flag
None observed/Not applicable	☐	☐	☐	
Unpleasant odors, loud noises, trash/ debris, or signs of disturbance *Noticeable from primary viewing areas.*	☐	☐	☐	
Safety/health hazards *Known hazards that could significantly reduce the utility of the wetland for recreation or education exist within the site.*	☐	☐	☐	
Wetland is small, heavily degraded, inaccessible, <u>and</u> not w/in public view	☐	☐	☐	
Other *(specify)*	☐	☐	☐	

Comments/Flags:

Value rating summary

Summarize the value scores below. Zero means none observed. The "Not applicable" check-box applies if the wetland is fully contained within the SA.

Location	SA	FB	WH
Not applicable	-----	☐	☐
Value category tally *Summarize the presence of the five value categories: Education and research, Special wetlands, Uniqueness, Recreation value and economic benefit, and Open space and aesthetics - If at least one box is checked present in a categories' evaluation area then that category should be counted as "present". Scale: 0 to 5.*	___	___	___
General value indicator tally *Two or more "general value indicators" were selected. Scale: 0 to 6.*	___	___	___

Comments:

Value score, general rank

Use answers from the detailed value categories and general value indicators to inform your overall value ranking below.

Location	SA	FB	WH	Flag
Not applicable	-----	☐	☐	
Very High, meets all of the following criteria: *All 5 value categories present (applies to SA or FB only), ≥3 Uniqueness types, and ≥3 Special wetland types.*	☐	☐	☐	
High, meets all of the following criteria: *All 5 value categories present (applies to SA or FB only), ≥3 GVI, [≥2 special wetland types OR ≥3 Uniqueness types], and LVI if present is not pervasive.*	☐	☐	☐	
Moderate *≥3 value categories present, ≥2 GVI, and ≥2 Uniqueness types, and <2 pervasive LVI(s).*	☐	☐	☐	
Low *≤3 categories OR ≥1 pervasive LVI.*	☐	☐	☐	

Comments/Flags:

Appendix A.

A quick guide to significant palustrine natural community specifications for New York State (2021)

by Laura Shappell and Greg Edinger
New York Natural Heritage Program (NYNHP)

Coarse community specifications

This guide was created to help users identify potential wetlands of statewide significance relative its natural community type and conservation status rank (S-rank). Visit our website for more information on wetland community types: https://guides.nynhp.org/. Use the minimum size and maximum invasive plant cover values below to help you quickly determine the natural community's S-rank and if your wetland area of interest meets the minimum size and invasive plant cover to be potentially significant. Many other variables are variables are factored in when NYNHP officially ranks a given community occurrence, but we use size and invasive plant dominance as part of our "first cut". Please check NYNHP's natural community guide to ensure the S-rank has not changed since this document was developed in December 2021.

NYNHP wetland communities are organized into three broad classes per Cowardin et al. (1979): palustrine emergent (PEM), palustrine scrub shrub (PSS), palustrine forested (PFO), palustrine moss-lichen (PML), palustrine rock bottom (PRB). For communities that can occur as more than one class, the alternative subclass is noted in brackets. Cowardin et al. (1979) salinity and alkalinity modifiers are applied to geographically-restricted communities.

Palustrine Emergent, unless noted		Min. size		
Natural community type	**S-rank**	**ha**	**ac**	**Inv %**
Deep Emergent Marsh	S3	8	20	<20%
Cobble Shore Wet Meadow *or 500 linear ft (150 m)*	S2	0.2	0.5	<20%
Floodplain Grassland[1]	S3	4	10	<20%
Inland Calcareous Lake Shore *or 1000 linear ft (305 m)*	S3	0.4	1.0	<20%
Patterned Peatland	S1	4	10	<10%
Pine Barrens Vernal Pond	S2	0.2	0.5	<10%
Rich Sloping Fen [PEM/PSS]	S1?	0.10	0.25	<25%
Rich Graminoid Fen	S1	0.20	0.5	<50%
Riverside Ice Meadow[1] *or 500 linear ft (150 m)*	S1	0.2	0.5	<20%
Shallow Emergent Marsh	S3	8	20	<20%
Sedge Meadow	S3	6	15	<2%

[1]Confirm hydric indicators - this community can present as wetland or terrestrial.

Scrub Shrub, unless noted		Min. size		
Natural community type	**S-rank**	**ha**	**ac**	**Inv %**
Dwarf Shrub Bog	S3	4	10	<2%
Highbush Blueberry Bog Thick	S3	4	10	<2%
Inland Poor Fen [PSS/PEM]	S3	4	10	<2%
Medium Fen [PSS/PEM]	S2S3	2	5	<5%
Perched Bog	S1	0.04	0.1	<5%
Rich Shrub Fen	S1S2	0.2	0.5	<50%
Shrub Swamp	S3S4	4	10	<15%

Forested		Min. size		
Natural community type	**S-rank**	**ha**	**ac**	**Inv %**
Black Spruce-Tamarack Bog	S3	4	10	<5%
Floodplain Forest	S2S3	4	10	<40%
Hemlock-Hardwood Swamp	S3	2	5	<5%
Inland Atlantic White Cedar Swamp	S1	0.2	0.5	<40%
Northern White Cedar Swamp	S2S3	4	10	<25%
Perched Swamp White Oak Swamp	S1S2	0.4	1	<25%
Pitch Pine-Blueberry Peat Swamp	S1	0.4	1	<5%
Red Maple-Blackgum Swamp	S2	4	10	<15%
Red Maple-Hardwood Swamp	S3S4	8	20	<10%
Red Maple-Swamp White Oak Swamp	S2	0.4	1	<30%
Red Maple-Sweetgum Swamp	S1	0.4	1	<40%
Red Maple-Tamarack Peat Swamp	S2S3	2	5	<15%
Rich Hemlock-Hardwood Peat Swamp	S2S3	2	5	<20%
Silver Maple-Ash Swamp*	S3	20	50	<10%
Spruce-Fir Swamp	S3	10	25	<2%
Vernal Pool	S3	0.008	0.02	<5%

*If Ash tree canopy has been lost due to Emerald Ash Borer this community can still be classified as a SMAS if Silver Maple canopy cover is at least 15% and, ideally, total canopy cover is >30%.

Geographically-restricted communities

Several of NYS' rare wetland communities are restricted to particular regions of the state, such as the coastal plain (Long Island and New York City Metro), Adirondack High Peaks[2], or unique geologic features. We've included the global conservation rank (G-rank) in this section because they may be Vulnerable (G3), Imperiled (G2), or Critically Imperiled (G1) on a *global* scale.

	Rank		Min. size		
Coastal Plain	**S**	**G**	**ha**	**ac**	**Inv %**
Coastal Plain Atlantic White Cedar Swamp [PFO4]	S1	G3G4	0.20	0.5?	<30%?
Coastal Plain Pond Shore [PEM1]	S2	G3G4	0.20	0.5?	<30%?
Coastal Plain Poor Fen [PEM1/PSS1]	S1	G3?	0.04	0.1?	<50%?
Pine Barrens Shrub Swamp [PSS3/1]	S3?	G5	0.40	1.0?	<30%?
Sea Level Fen [PEM1t/i]	S1	G1G2	0.40	1.0?	<30%?

	Rank		Min. size		
Non-Coastal Plain	**S**	**G**	**ha**	**ac**	**Inv %**
Alpine Sliding Fen[2] [PML1]	S1S2	G3G4	0.04	0.10?	<5%?
Inland Salt Marsh[3] [PEM18/7]	S1	G2	0.04	0.10?	<60%?
Marl Pond Shore [PRB1i/PEM1i]	S1	G3G4	0.005	0.01?	<60%?
Marl Fen[4] [PEM1i]	S1	G1	0.04	0.10?	<60%?

[2]Marl fen: Known occurrences are present in the Great Lakes Plain ecoregion and eastward to Warren County.
[3]Inland salt marsh: Great Lakes Plain

This Appendix was developed by Laura Shappell and Greg Edinger, December 2021.
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Appendix B. Newly in development as of December 2021.

Native wetland plant species used by regional First Peoples.

This draft list is in development and intended to be informative, but is by no means exhaustive. Taxonomy follows New York State Flora Atlas and regional National Wetland Plant List (NWPL) rankings by US ACOE as of December 2021. Where only a genera is listed the status applies to multiple native species. Example uses: food/medicine (f/m) or other (oth) uses such as cordage for rope/weaving, dye, building supplies, and technology.

Common name	Scientific name	NWPL	Example use codes
Balsam Fir	*Abies balsamea*	FAC	f/m, oth
Red Maple	*Acer rubrum*	FAC	f/m
Single-Vein Sweetflag	*Acorus calamus*	OBL	f/m
Speckled Alder	*Alnus incana*	FACW	f/m, oth
Eastern Serviceberry	*Amelanchier canadensi*	FAC	f/m, oth
Sweetgrass	*Anthoxanthum* spp.	FACW	oth
Groundnut	*Apios americana*	FACW	f/m
Birch	*Betula* spp.	FACU-OBL	f/m, oth
Yellow Marsh-Marigold	*Caltha palustris*	OBL	f/m
Bitter-Nut Hickory	*Carya cordiformis*	FAC	f/m, oth
Dogwood	*Cornus spp. (C. amomum, C. canadensis, C. racemosa, C. sericea)*	FAC/ FACW	f/m, oth
Common Boneset	*Eupatorium perfoliatum*	FACW	f/m, oth
Black Ash	*Fraxinus nigra*	FACW	f/m, oth
Spotted Touch-Me-Not	*Impatiens capensis*	FACW	f/m
Tamarack	*Larix Laracina*	FACW	f/m, oth
Ostrich/Fiddlehead Fern	*Matteuccia struthiopteris*	FAC	f/m
Mint	*Mentha* spp. (e.g., *M. arvensis, M. spicata, M. x piperita)*	FACW	f/m
Pond Lilly	*Nuphar* spp. (e.g., *N. advena, N. variegata)*	OBL	f/m
Sensitive Fern	*Onoclea sensibilis*	FACW	f/m, oth
Black Spruce	*Picea mariana*	FACW	f/m, oth
Swamp Oak	*Quercus bicolor*	FACW	f/m
Willow	*Salix* spp.	FACW	f/m, oth
Broad-leaved Arrowhead	*Sagittaria latifolia*	OBL	f/m, oth
Black Elder	*Sambucus nigra*	FACW	f/m, oth
Bullrush	*Schoenoplectus, Scirpus* spp.	OBL	f/m, oth
Skunk- Cabbage	*Symplocarpus foetidus*	OBL	f/m, oth
Northern White Cedar	*Thuja occidentalis*	OBL	f/m, oth
Cattail	*Typha* spp.	FACW	f/m, oth
Elm	*Ulmus americana, U. rubra*	FACW/ FAC	f/m, oth
Blueberries, Cranberry	*Vaccinium spp.* (e.g., *V. corymbosum, V. macrocarpon, V. myrtilloides, V. oxycoccos)*	FACW/ OBL	f/m
Nannyberry	*Viburnum lentago*	FAC	f/m
Wild Rice	*Zizania aquatica, Z. palustris*	OBL	f/m

References

Harriet V. Kuhnlein and Nancy J. Turne. 1991. Traditional Plant Foods of Canadian Indigenous Peoples, Volume 8: Nutrition Botany and Use. Gordon and Breach Publishers, Canada. Retrieved from <https://www.fao.org/3/ai215e/ai215e.pdf>

Native American Ethnobotany DB (website). 2021. Accessed December 2021. Retrieved from <http://naeb.brit.org/>

Prindle, T. 2021. Native Tech (website). Accessed 12/23/2021. Retrieved from <http://www.nativetech.org/>

Redish, L. and O. Lewis. 2020. Native Languages of the Americas (website). Retrieved from <http://www.native-languages.org>

Turner, N. 2019. Indigenous Peoples' Medicine in Canada. In The Canadian Encyclopedia. Retrieved from <https://www.thecanadianencyclopedia.ca/en/article/native-medicines>