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Subject: **Buffalo harbor 2022 aquatic plant survey results**

Background

This memo reports on the methods and results of an aquatic plant survey conducted in Buffalo harbor/river August 24 – August 26, 2022. The survey was undertaken as part of the Invasive Aquatic Plant Surveillance in New York Great Lakes Ports project, through a funding opportunity (F20AP00244) from US Fish and Wildlife Service (FWS) to the Oswego County Soil and Water Conservation District, on behalf of the Finger Lakes - Lake Ontario Watershed Protection Alliance (FLLOWPA) for New York State Aquatic Nuisance Species Management Plan implementation. Buffalo was one of three priority sites (with Oswego and Rochester) surveyed as part of this project across 2021-2022 and is among the highest risk sites in the Great Lakes Basin for non-native aquatic plant introduction (Tucker et al. 2020).

Methods

Survey design generally followed recommendations from Trebitz et al. (2009) and Hoffman et al. (2016), including random selection of sample sites to facilitate evaluation of detection rates and optimization of sampling efficiency. The survey area encompassed roughly 1,663 acres. Sample units (100 m^{-2}) were overlaid on the survey area in ArcGIS Pro (v2.6.3). We used a forest-based classification and regression approach to predict species richness values at the sample-unit scale for each site. Model predictions were based on a set of categorical and continuous habitat attributes associated with abiotic conditions that are known to influence plant establishment and surrogates for aquatic plant pathways of introduction, including: fetch, depth, percent littoral zone (defined as proportion of a sample unit less than 6' deep), distance to boat launches, and distance to marinas. Measures for each variable were attributed in ArcGIS for each sample unit. Probability weights based on species richness estimates were then assigned to each sample unit (e.g. 90^{th} percentile = 0.6, 80^{th} percentile = 0.5, etc.) and the Create Spatially Balanced Points tool was used to randomly select 70 sample units from across the site (Figure 1). Boat ramps were also identified and targeted for sampling during the survey.

The survey was conducted August 24 – 26, 2022. At each sample unit, plants were collected with rakes or observed visually and recorded. The rakes were double headed 14-tine rake heads attached to approximately 50 feet of 3/8" braided polypropylene rope. The survey targeted submerged, floating, and emergent taxa. All observations were from the shoreline lakeward to the maximum depth in any grid cell. The shoreline was defined as the land/water interface (i.e. the boundary between aquatic and riparian or wetland conditions). Plants were only recorded when observed in water. The location of a sample unit was occasionally adjusted away from the a priori random location selected in ArcGIS to sample adjacent areas where field observations indicated presence of macrophyte beds. In general, four evenly spaced and discrete stations were sampled within each grid cell (e.g. the four corners of the grid cell). At each station a rake was tossed 5 – 10 meters from each side of the boat (i.e. four rake tosses), allowed to sink to the bottom, and slowly retrieved. In instances where the fourth rake toss resulted in collection of a species not observed in the previous three tosses, subsequent rake tosses were made until no new species were collected.

Plants were identified to species in the field by a trained taxonomist (Erick Elgin, Michigan State University Extension). When specimens could not be identified in the field (e.g. when identification required scrutiny of morphological features under magnification) the plant was retained and identified to species (or lowest possible taxonomic group) on shore. Plant specimens were retained for vouchering. The total number of species collected at each sample location was tallied for data analysis. Water depth at each sample location was recorded from the boat mounted sonar unit. GPS coordinates, plant species observed, and water depth at each sample station were recorded electronically in the field to an iPad (connected to a Bluetooth enabled GPS receiver) using Collector for ArcGIS.

Descriptive statistics (e.g. species richness measures by site and depth) were compiled. For analysis, species richness was calculated as the aggregate from the four stations comprising each sample unit. Species richness measures were mapped in ArcGIS 10.8.1. A nonparametric estimator, iChao2, was used to estimate total species richness (S_{est}) based on sample-based plant incidence data. The iChao2 estimator uses the frequencies of species detected one, two, three, or four times to estimate the number of undetected species (Chiu et al. 2014). The S_{est} value was calculated using the R-based web application SpadeR (Chao et al. 2015).

Results

Twenty-seven species (or lowest identifiable taxonomic unit) were collected from across 44 sample units (Table 1; Figure 2). Two taxa could only be identified to genus level (*Chara and Potamogeton*). Five species were observed in 50% or more of the sample units. Four of these common species were native, but non-native *Myriophyllum spicatum* (Eurasian watermilfoil), which was detected in 59% of the sample units, was the third most frequently encountered species in the survey. Seven species are non-native to Lake Erie. *Potamogeton crispus* (curlyleaf pondweed), *Najas minor* (brittle naiad), *and Nitellopsis obtusa* (Starry stonewort) were detected in 25%, 23%, and 11% of sample units respectively. The other three non-native species were rarely encountered (i.e. detected in ≤5% of sample units). All non-native species are known to occur elsewhere in the Great Lakes basin.

Species richness varied across the site, with an average of six species detected per sample unit (Figure 3). Richness measures varied between zero and eleven species (Figure 4). Plants were more frequently detected in shallow versus deep sites and no plants were detected beyond 18 ft (Figure 5). The estimated total species richness (S_{est}) for the survey area from sample-based incidence data, with 95% confidence interval, is 43 [31,97], which suggests that about 60% of the species present at the site were detected in the three-day survey. These results suggest that the site was under-sampled (e.g. "unique species" > "duplicate species" and estimated species richness much higher than observed richness, Table 2). However, the wide confidence interval also highlights the limits of design-based knowledge, since detectability estimates are constrained by the effort exerted (e.g., it is not possible to determine whether a plant occurs at 1: 100,000 detection probability until 100,000 plants are sampled; Hoffman et al. 2016). Additional sampling would be prudent to improve the accuracy of the model-based richness estimate and to increase confidence that the full complement of aquatic species, including any new non-natives, have been detected.

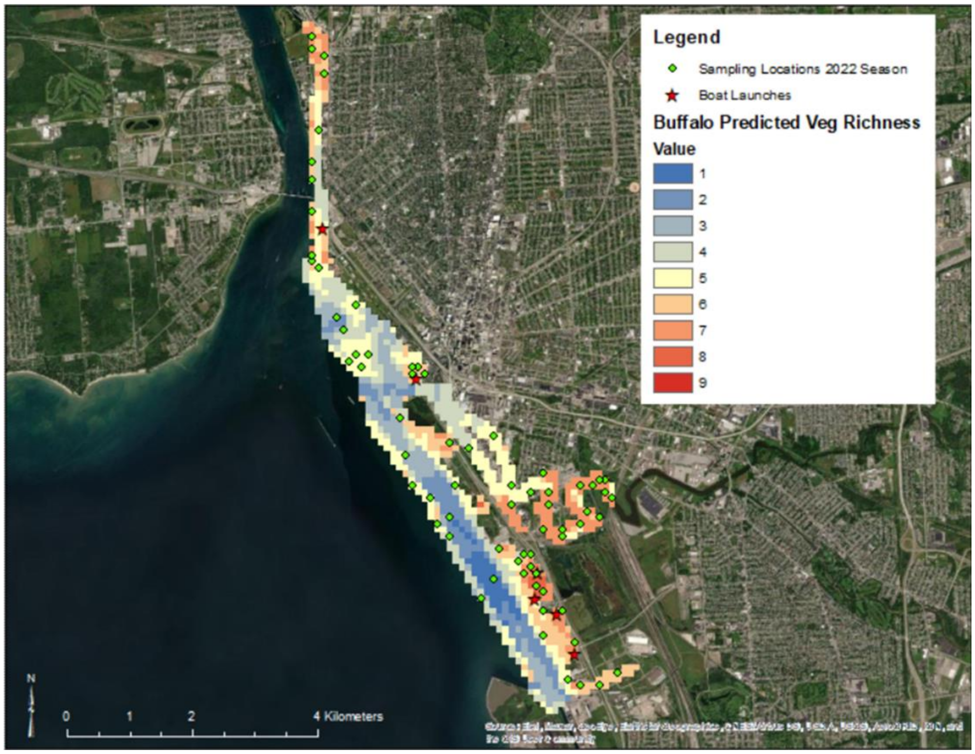

Figure 1. Survey area for Buffalo showing a priori randomly selected sampling units (green diamonds) overlaid on the modeled species richness surface at a 100m x 100m grid scale. Boat ramps are also indicated.

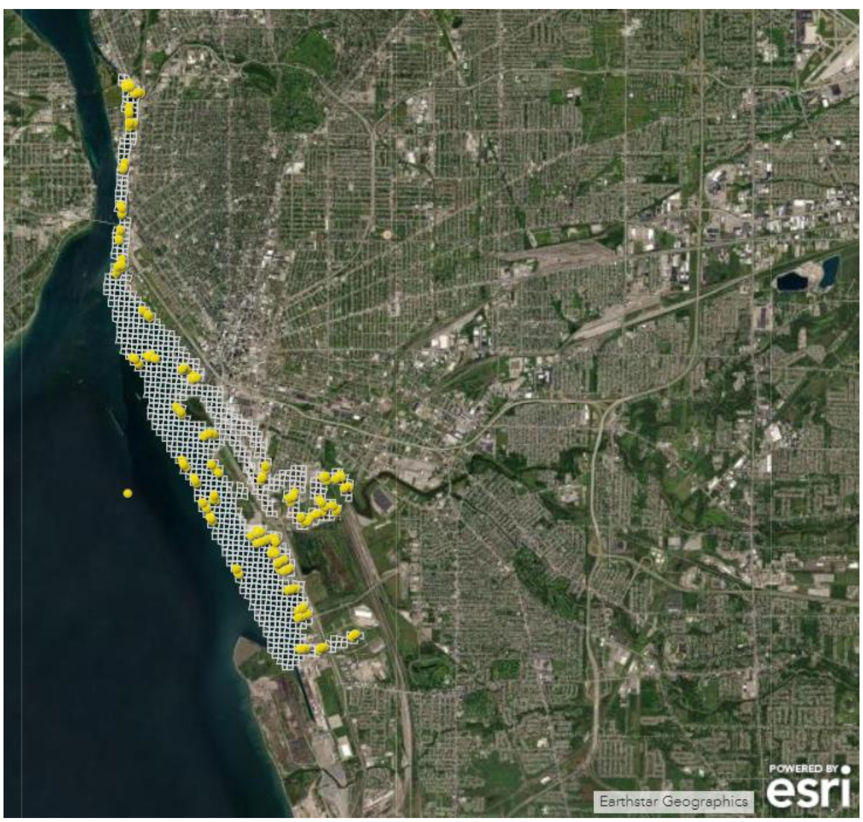

Figure 2. Survey area for Buffalo showing sampling locations overlaid on the $100m^2$ grid.

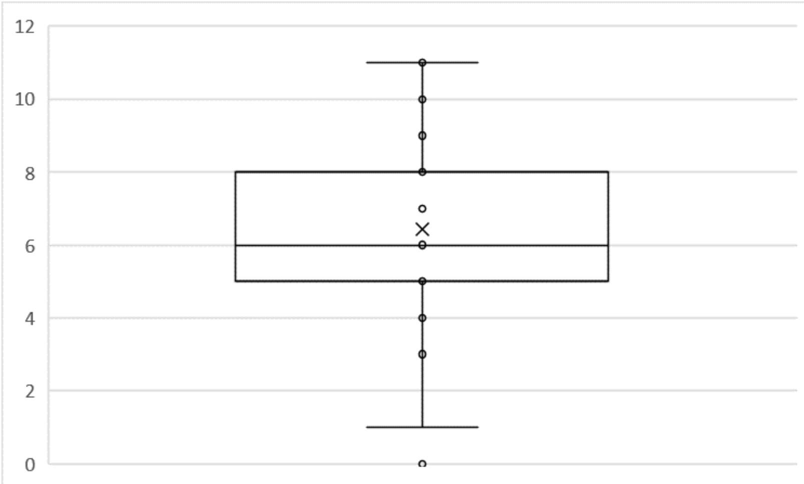

Figure 3. Box plot showing species richness measures from August 2022 survey of Buffalo harbor/river.

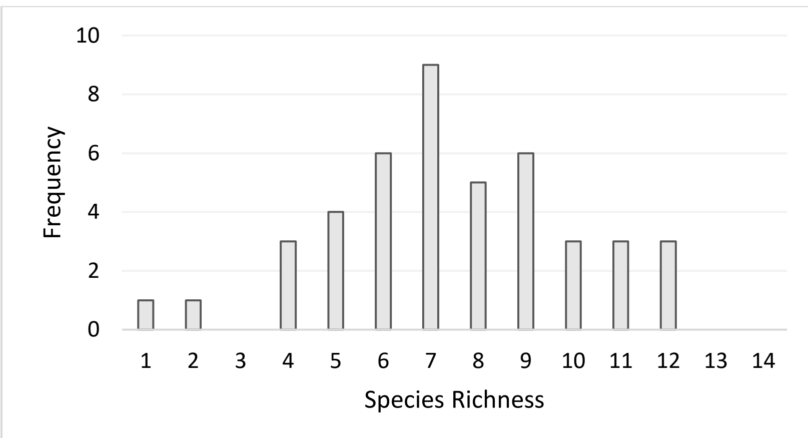

Figure 4. Frequency histogram showing species richness across sample units.

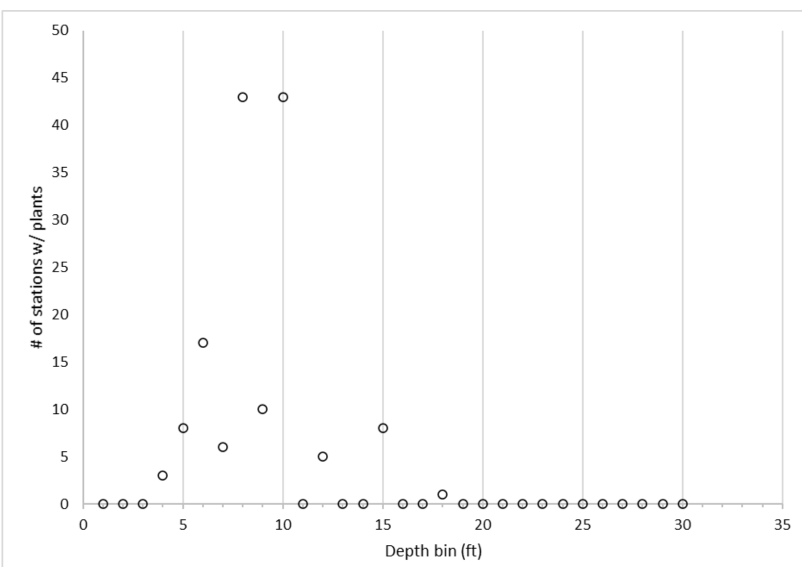

Figure 5. Scatter plot showing number of sample stations where plants were detected as a function of depth.

Table 1. Species list for Buffalo harbor/river aquatic plant surveys, Aug 24 – 26, 2022. (*) indicates non-native species. Occupancy is calculated as the percentage of sample units where the species was observed.

Species	Occupancy
Vallisneria americana	95
Ceratophyllum demersum	75
Myriophyllum spicatum*	59
Heteranthera dubia	52
Stuckenia pectinata	52
Najas flexilis	41
Potamogeton spp	41
Elodea nutallii	36
Potamogeton richardsonii	27
Potamogeton crispus*	25
Potamogeton nodosus	25
Najas minor*	23
Elodea canadensis	16
Potamogeton zosteriformis	16
Chara spp	11
Nitellopsis obtusa*	11
Potamogeton foliosus	9
Butomus umbellatus*	5
Potamogeton perfoliatus	5
Iris (psuedacorus)*	2
Lemna turionifera	2
Myriophyllum sibiricum	2
M. spicatum x M. sibiricum*	2
Nymphaea odorata	2
Pontederia cordata	2
Potamogeton pusillus	2
Spirodela polyrhiza	2

Table 2. Survey data for Buffalo harbor/river aquatic plant survey. Number of incidences is the tally of all plant detections across all sites sampled. Unique species are those species only detected in one sample unit. Duplicates were detected in exactly two sample units. S_{est} is the estimated true species richness at the site with 95% confidence interval shown.

Variable	Buffalo harbor/river
№ sites sampled	44
№ species detected	27
№ incidences	283
Uniques	8
Duplicates	2
S_{est} *(95% CI)*	43 (31, 97)

References

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