The Nature Conservancy

Memo:

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Date: December 17, 2021

Subject: **Irondequoit Bay & Lower Genesee River 2021 aquatic plant survey results**

Background

This memo reports on the methods and results of an aquatic plant survey conducted in Irondequoit Bay and Genesee River August 26 – August 28, 2021. 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. Rochester was one of three priority sites (with Oswego and Buffalo Harbor) surveyed in 2021 as part of this project 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 1,928 acres. Sample units (100 m^{-2}) were overlaid on the survey area in ArcGIS. A stratified survey design was employed for sample unit selection with grid cells in the survey area attributed as shallow (<6m) or deep (>6m) based on cell centroids overlaid on depth layers created in ArcGIS 10.8.1. Sample units (i.e. grid cells based on cell centroids) were randomly selected using the Create Spatially Balanced Point tool in ArcGIS, with 3:1 ratio of shallow to deep sites (Figure 1).

The survey was conducted August 26 – 28, 2021. 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 river/harbor 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 and deposited with the herbarium at SUNY Oswego. 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).

To quantify the effort required for high-probability nonnative species detection, estimates of the number of samples required to obtain a near-total (95%) or total (100%) census of the plant species present were derived. S95% and S100% values were calculated in the R-based web application iNext (Chao et al. 2016) using the nonparametric method proposed by Chao et al. (2014), which calculates the number of samples required to detect some proportion of the asymptotic sample-based species richness estimator, Sest.

Results

Thirty-one species (or lowest identifiable taxonomic unit) were collected from across 50 sample units (Table 1; Figure 2). Seven taxa could only be identified to genus level (*Alisma, Azolla, Chara, Potamogeton, Sagittaria, Typha,* and *Wolffia spp*.). Six species were observed in 50% or more of the sample units. Five of these common species were native, but non-native *Myriophyllum spicatum* (Eurasian watermilfoil), which was detected in 84% of the sample units, was the second most frequently encountered species in the survey. Ten species are non-native to Lake Ontario. *Nitellopsis obtusa* (Starry stonewort), *Najas minor* (brittle naiad), and *Myriophyllum spicatum x sibiricum* (hybrid watermilfoil) were detected in 40%, 36%, and 32% of sample units respectively. The other six non-native species were rarely encountered (i.e. detected in <10% of sample units). All non-native species are known to occur elsewhere in the Great Lakes basin, with the exception of *Trapa natans*, which has only been detected in Lake Ontario. *Trapa natans* was only detected in the Genesee River, where it was already known to occur. It has not yet been detected in Irondequoit Bay.

Species richness varied across the site (Figure 3). An average of seven species were detected per sample unit, and at one site 13 species were observed. At two sites no plants were detected (Figure 4). Species rich sites (>10 species) included Mayer's Marina, the vicinity of Stony Point HOA, the Irondequoit Bay Fish and Game club, Sutter's Marina, the boat ramp at Culver Rd., point adjacent to Webster Well Field, and Big Massaug Cove. Plants were more frequently detected in shallow versus deep sites (Figure 5). No plants were detected deeper than 20 ft. The average depth of sites with no plant detections was 19 ft.

The estimated total species richness (S_{est}) for the survey area from sample-based incidence data, with 95% confidence interval, is 34 [32,48], which suggests that more than 90% of the species present at the site were detected in the three-day survey (Figure 6). The species-effort relationship suggests that an additional 89 samples are needed to detect 100% of the predicted species richness at the site (Table 2). This would be equivalent to sampling about 13% of the total area. Future sampling that targets shallow sites with the highest observed richness measures, including points of entry, could help to refine the rarefaction-based estimates of total species richness and would increase confidence that the full complement of rare aquatic species, including any novel non-natives, have been detected.

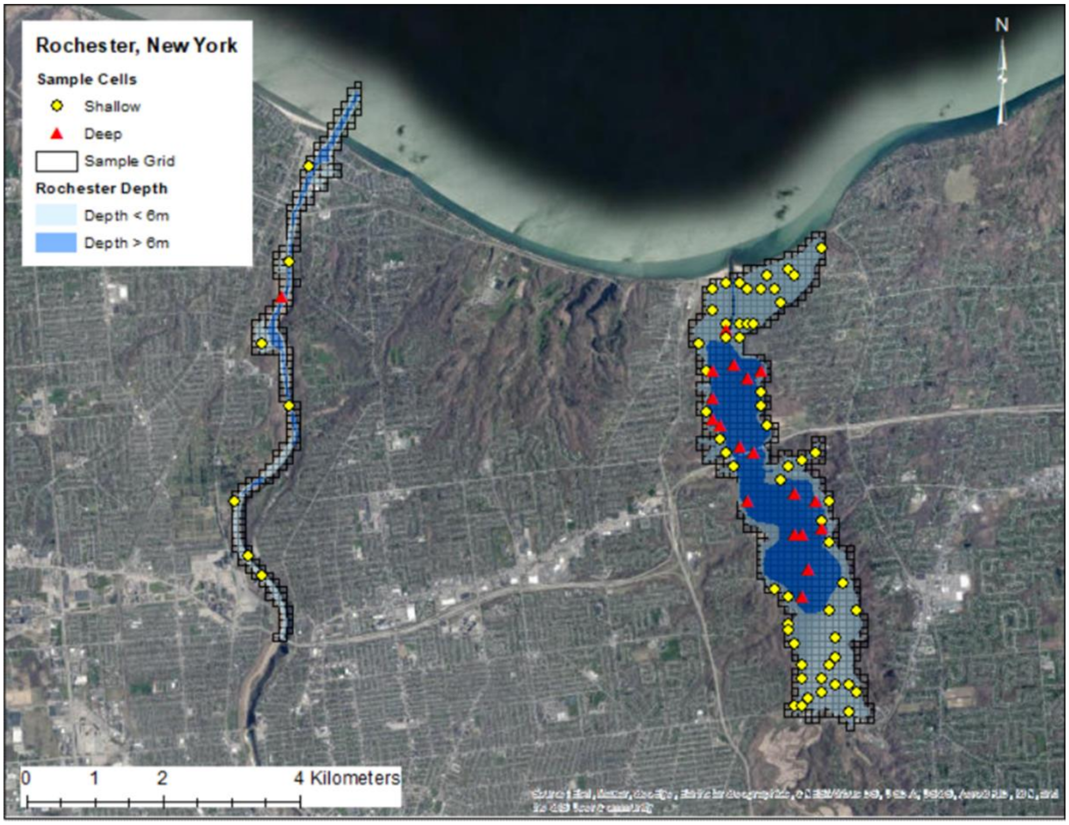

Figure 1. Survey area for Rochester showing a priori randomly selected sampling units (yellow = shallow; red = deep) overlaid on the 100m sample grid.

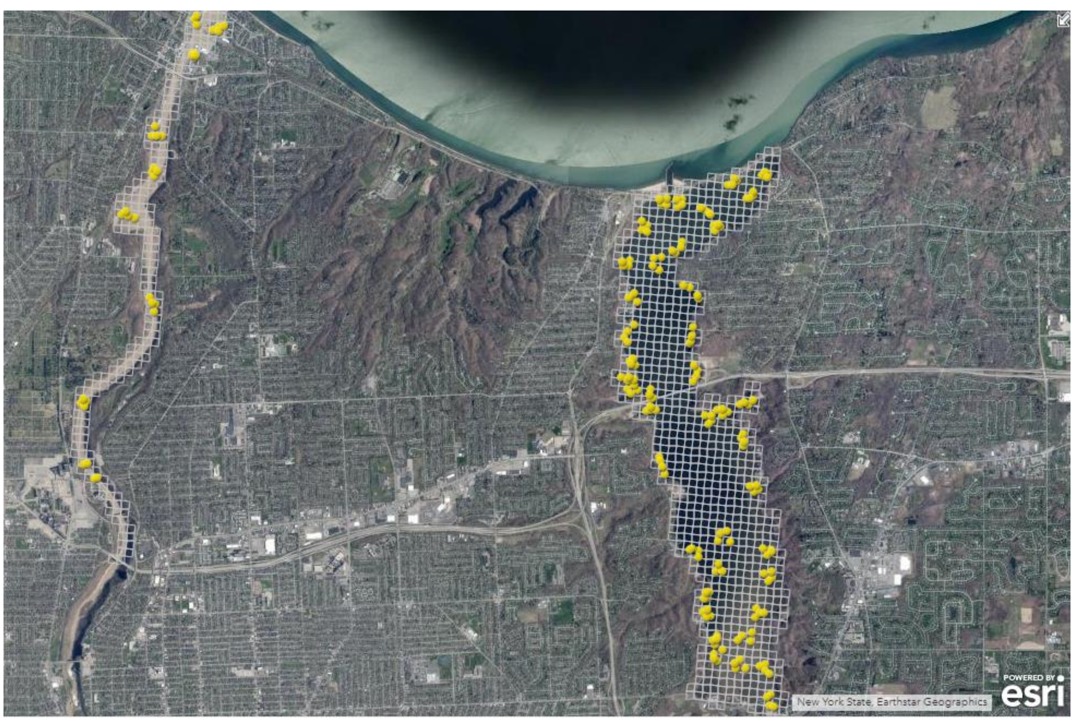

Figure 2. Survey area for Rochester showing sampling locations overlaid on the $100m^2$ grid.

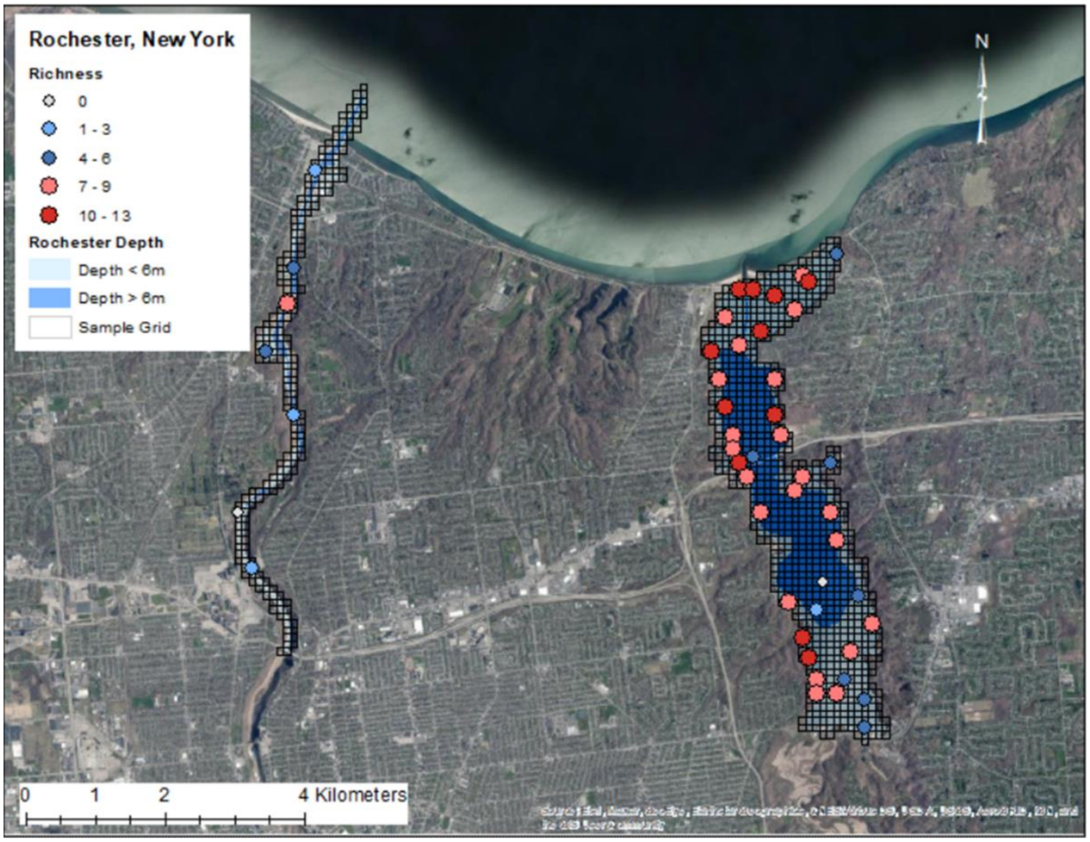

Figure 3. Species richness measures from August 2021 survey of Rochester area.

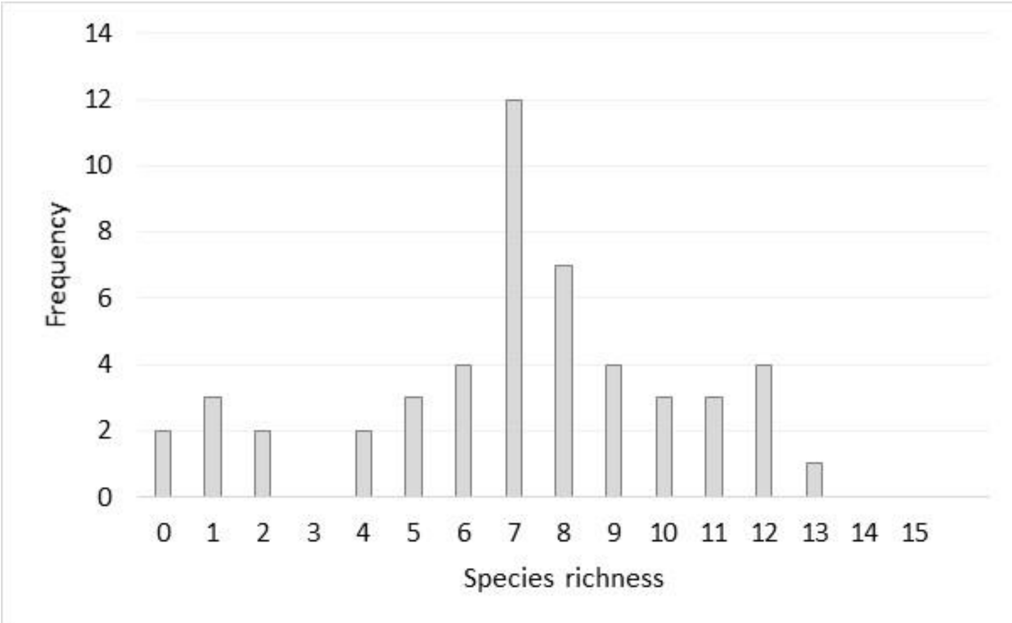

Figure 4. Frequency histogram showing species richness across sample units.

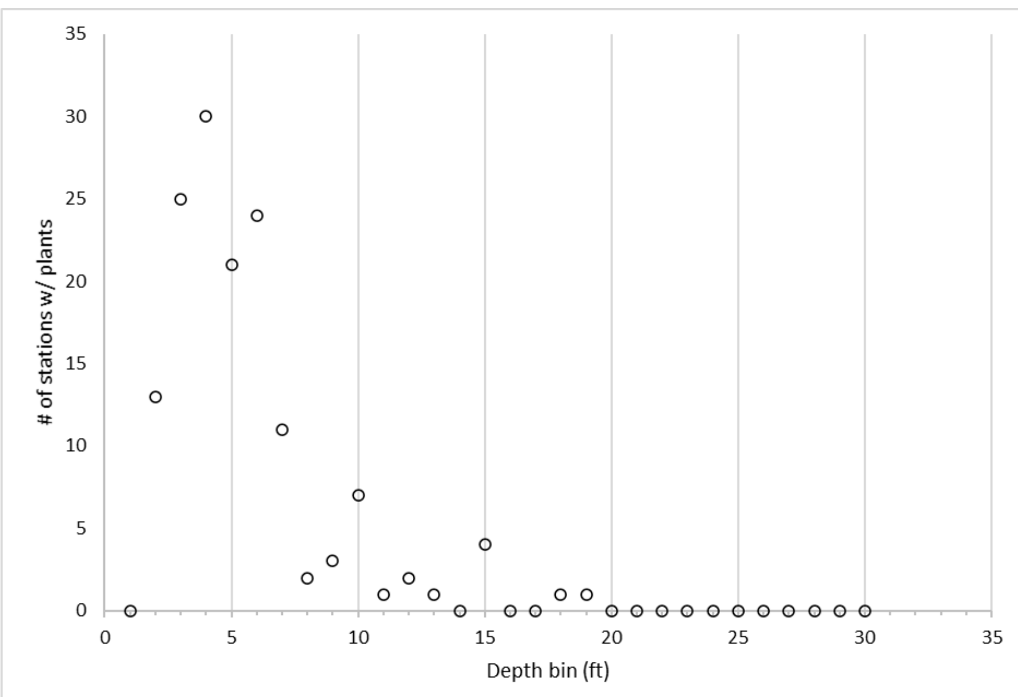

Figure 5. Scatter plot showing number of sample stations where plants were detected as a function of depth.

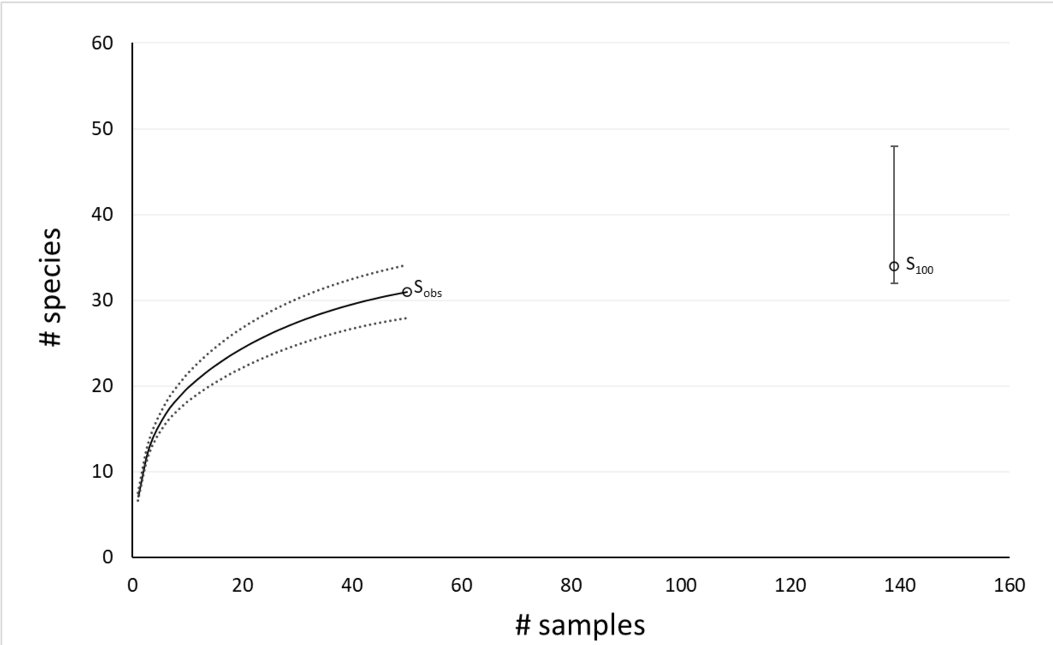

Figure 6. Species-effort curve (solid line) and its 95% confidence interval (CI; dashed lines), showing the average increase in species with each additional sample taken based on a random re-ordering of sites. The number of observed species is indicated (S_{obs}). The level of effort required to sample the estimated species total (S_{100}) is also included (error bars show 95% CI).

Table 1. Species list for Rochester (Irondequoit Bay and Lower Genesee River) aquatic plant surveys, Aug 26 – 28, 2021. (*) indicates non-native species. Occupancy is calculated as the percentage of sample units where the species was observed.

Species	**Occupancy**
Ceratophyllum demersum	86
Myriophyllum spicatum *	84
Heteranthera dubia	64
Najas guadelupensis	64
Elodea nutallii	58
Vallisneria americana	50
Nitellopsis obtusa *	40
Najas minor *	36
M. spicatum x M. sibiricum *	32
Nymphaea odorata	32
Lemna turionifera	30
Stuckenia pectinata	30
Spirodela polyrhiza	16
Potamogeton richardsonii	14
Potamogeton spp.	10
Chara spp.	8
Butomus umbellatus *	6
Potamogeton foliosus	6
Wolffia spp.	6
Hydrocharis morsus-ranae *	4
Lemna minor	4
Potamogeton nodosus	4
Trapa natans *	4
Alisma spp.	4
Azolla spp.	4
Bolboschoenus fluviatilis	2
Phragmites australis *	2
Potamogeton crispus *	2
Potamogeton pusillus	2
Typha spp. *	2
Sagittaria spp.	2

Table 2. Survey data and sampling completeness statistics for Rochester area 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. "A'ddl effort" is the additional number of sample units that would need to be sampled to detect 95% (S_{95}) or 100% (S_{100}) of the predicted total species pool.

Variable	Rochester
№ sites sampled	50
№ species detected	31
№ incidences	354
Uniques	6
Duplicates	6
S_{est} *(95% CI)*	34 (32, 48)
A'ddl effort S_{95}	0
A'ddl effort S_{100}	89

References

Chao, A., Ma, K. H.,Hsieh, T. C.and Chiu, C. H. (2015) Online Program SpadeR (Species-richnessPrediction And Diversity Estimationin R). Program and User's Guide published at http://chao.stat.nthu.edu.tw/wordpress/software_download/.

Chao, A., Ma, K. H., and Hsieh, T. C. (2016) iNEXT (iNterpolation and EXTrapolation) Online: Software for Interpolation and Extrapolation of Species Diversity. Program and User's Guide published at http://chao.stat.nthu.edu.tw/wordpress/software_download/.

Chao, A., Gotelli, N. J., Hsieh, T. C., Sander, E. L., Ma, K. H., Colwell, R. K. and Ellison, A. M. (2014). Rarefaction and extrapolation with Hill numbers: a framework for sampling and estimation in species diversity studies. *Ecological Monographs*, 84, 45–67.

Chiu, C. H., Wang, Y. T., Walther, B. A. and Chao, A. (2014). An improved nonparametric lower bound of species richness via a modified Good–Turing frequency formula.*Biometrics*,70, 671–682.

Hoffman, J. C., Schloesser, J., Trebitz, A. S., Peterson, G. S., Gutsch, M., Quinlan, H., & Kelly, J. R. (2016). Sampling Design for Early Detection of Aquatic Invasive Species in Great Lakes Ports. Fisheries, 41(1), 26-37.

Trebitz, A. S., Kelly, J. R., Hoffman, J. C., Peterson, G. S., & West, C. W. (2009). Exploiting habitat and gear patterns for efficient detection of rare and non-native benthos and fish in Great Lakes coastal ecosystems. Aquatic Invasions, 4(4), 651-667.

Tucker, A. J., Chadderton, W. L., Annis, G., Davidson, A. D., Hoffman, J., Bossenbroek, J., ... & Strakosh, T. (2020). A framework for aquatic invasive species surveillance site selection and prioritization in the US waters of the Laurentian Great Lakes. *Management of Biological Invasions* 11: 607-.