Abiotic and biotic factors contributing to invasive aquatic plant cover in southern Connecticut ponds

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Abstract

Much is known about how invasive aquatic plants affect communities they inhabit; however, few surveys have been conducted to determine the chemical, physical, and biological factors correlated with invasive aquatic plant abundances. This study took a first step toward understanding the correlations among water quality, native plant and invertebrate communities, and invasive aquatic plant abundance in small ponds. Preliminary surveys were conducted in four ponds in southern Connecticut: Colony Pond in Ansonia, Osbournedale Pond in Derby, West Campus Pond at Sacred Heart University in Fairfield, and Mondo Pond in Milford. Water quality parameters (depth, Secchi depth, nitrate, phosphate, coliform bacteria) and aquatic plant and invertebrate abundances were measured at five locations in each pond. Osbournedale pond had high invasive plant cover (53%). Colony and Mondo Pond had low invasive plant cover (2-3%). West Campus at Sacred Heart University contained no invasive plants. Principal component analysis revealed correlations between invasive plant abundance, phosphate, and coliform bacteria. Analysis of similarities (ANOSIM) showed distinct biological communities at each site, which may correspond to invasion risk. The preliminary data collected from this survey can guide future studies to predict invasive plant cover.

Introduction

The invasions of aquatic plants can be detrimental to the balance of an ecosystem's biodiversity[1] and financially devastating to the surrounding community. Invasive aquatic plants have been found clogging waterways, interrupting recreational activities such as fishing, boating, and swimming, as well as decreasing property values of lakeside communities. Invasive species are extremely difficult to eradicate once establish due to their high reproductive rates and their ability to survive in a wide variety of climates. Their high reproductive rates allows them to suffocate native plants and smother out other forms of wildlife in a relatively short amount of time. Management methods are ever evolving to work in slowing and preventing the coverage of invasive plants. This preliminary survey will aid in narrowing down factors that can contribute to invasive coverage and aims to identify factors for further investigation. This study investigated the relationship between water quality parameters, aquatic plant abundances, and invertebrate abundances in comparison to invasive plant coverage in four small southern Connecticut ponds.

Objectives:

- Determine invertebrate and aquatic plant abundances and identify similarities between locations.
- Measure water quality parameters and determine if there is a strong relationship with invasive plant between locations.
- Compare biological communities and determine if there is a strong relationship with invasive plants.

Methods

- Plant, invertebrate, and water samples were taken from Colony Pond, Mondo Pond, Osbournedale Pond, and Sacred Heart's West Campus Pond (Fig. 1).

Plant Sample Collection

- Plant samples were taken from a canoe (Fig. 2) at five locations in each pond.
- A rake was used to collect plants from a ~1-m stretch on one side of the canoe[1].This was repeated twice for every location.

Invertebrate Sample Collection

- Invertebrate samples were taken from five locations along the banks of each of the four ponds. Accessibility determined where samples were collected.
- A one minute dip net sweep was used to collect samples at each location.

Water Quality Measurement

- Water quality was measured by taking Secchi depth measurements, depth measurements, and water samples for nitrate, phosphate, and coliform bacteria. One measurement or sample was taken at each sampling location in each pond prior to collecting plant and invertebrate samples.
  - Hach Cadmium Reduction Method 8039 was conducted for nitrate concentration (https://www.hach.com/asset-get.download-en.jsa?id=7639983736)
  - Hach Ascorbic Acid Method 8048 conducted for phosphate concentration (https://www.hach.com/asset-get.dwnload-en.jsa?id=7639983835)
  - Coliscan EasyGel was used to count coliform bacteria and *E. coli* (https://www.micrologylabs.com/page/95/Instructions)

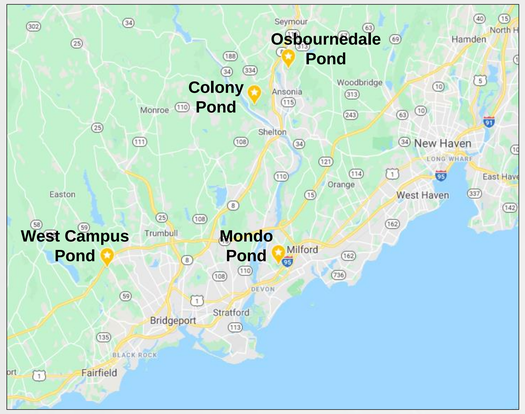

Figure 1 (above). Locations of ponds surveyed in southern Connecticut

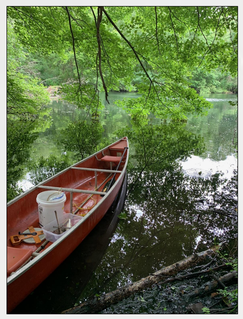

Figure 2 (left). Plant and invertebrate collection by canoe at West Campus Pond (Fairfield, CT).

Results

Table 1. Mean percent (± 1 SD) of four invasive plant species in samples from four ponds. *M. spicatum* was the most common invasive plant, with the highest cover at Osbourndale. There were no invasive plants at West Campus.

Site	Mean % *Myriophyllum spicatum* (± 1 SD)	Mean % *Ludwigia sp.* (± 1 SD)	Mean % *Najas minor* (± 1 SD)	Mean % *Potamogeton crispus* (± 1 SD)
Colony	Not Present	Not Present	16.4 ± 19.1	1.12 (present in only one sample)
Mondo	4.4 ± 2.1	Not Present	0.2 ± 0.01	Not Present
Osbournedale	53.2 ± 29.7	1.84 (present in only one sample)	Not Present	Not Present
West Campus	Not Present	Not Present	Not Present	Not Present

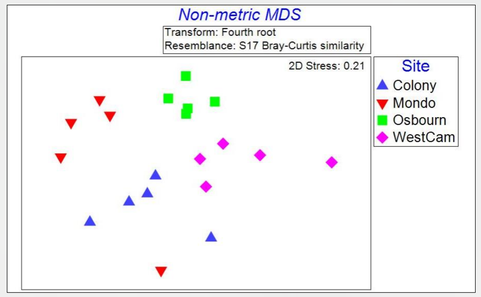

Figure 3. Non-metric multidimensional scaling (NMDS) plot of plant and invertebrate community data from four sites. Analysis of Similarity (ANOSIM) showed significant differences in the biological community at each site, with distinct communities at every site (Global R = 0.62, p =0.01).

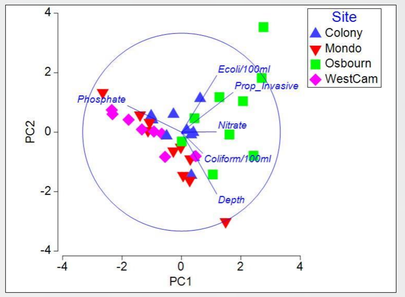

Figure 4. Principal component analysis (PCA) ordination of water quality data and proportion of invasive plants from the four sites. High invasive cover appears to be correlated with high *E. coli* and nitrate. Similarity Percentatge (SIMPER) analysis confirmed that high invasive cover was associated with high *E. coli*, high nitrate, low total coliforms, and low phosphate.

Discussion

The differences in biological communities among sites appear to be driven mainly by differences in invasive plants present from site to site (Fig. 3, Table 1). Osbournedale had high abundances of *M. spictum,* while Mondo Pond had low *M. spicatum* cover (Table 1). Colony Pond had a low abundances of *N. minor* and *P. crispus*. West Campus pond did not have any invasive plants (Table 1). Differences in water quality among sites may contribute to the differences in invasive plant cover. Mondo Pond, Colony Pond, and West Campus pond had high levels of phosphate present compared to Osbournadle (Fig. 4). Osbournedale, the site with the highest invasive plant cover (Table 1), had high levels of nitrate and *E. coli* compared to the other sites, which was supported by both PCA and SIMPER analysis (Fig. 4). Taken together, our results indicate that high *E. coli* and nitrate levels are linked to high invasive plant cover.

Conclusions

Although we did not collect data on bird abundances, we observed a large Canada goose population at Osbourndale Pond, which may explain our results. Geese could bring invasive plants in and drive up bacterial counts through defecation and travel[2]. Our data suggest waterfowl as a possible link to invasive plants, which should be explored more fully in the future. In this study, invertebrate samples were only taken at the bank of the ponds. A more detailed sampling of the entire pond may prove helpful for future endeavors. Based on our data, parameters that warrant future investigation into their potential for predicting invasive plant abundances are *E. coli* and nitrate levels in the water. Because our study sites had limited invasive plant cover, future work will expand these surveys to include additional sites.

Literature Cited

1. Capers, R.S., Selsky, R., Bugbee, G.J., White, J.C. 2009. *Botany* 87:309-314.
2. Reynolds, C. Miranda, N.A.F., & Cumming, G.S. (2015). *Diversity and Distributions* 21: 744-754.

Acknowledgements

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