The Effect of Native and Invasive Aquatic Plant Species on Water Quality in the Hudson River

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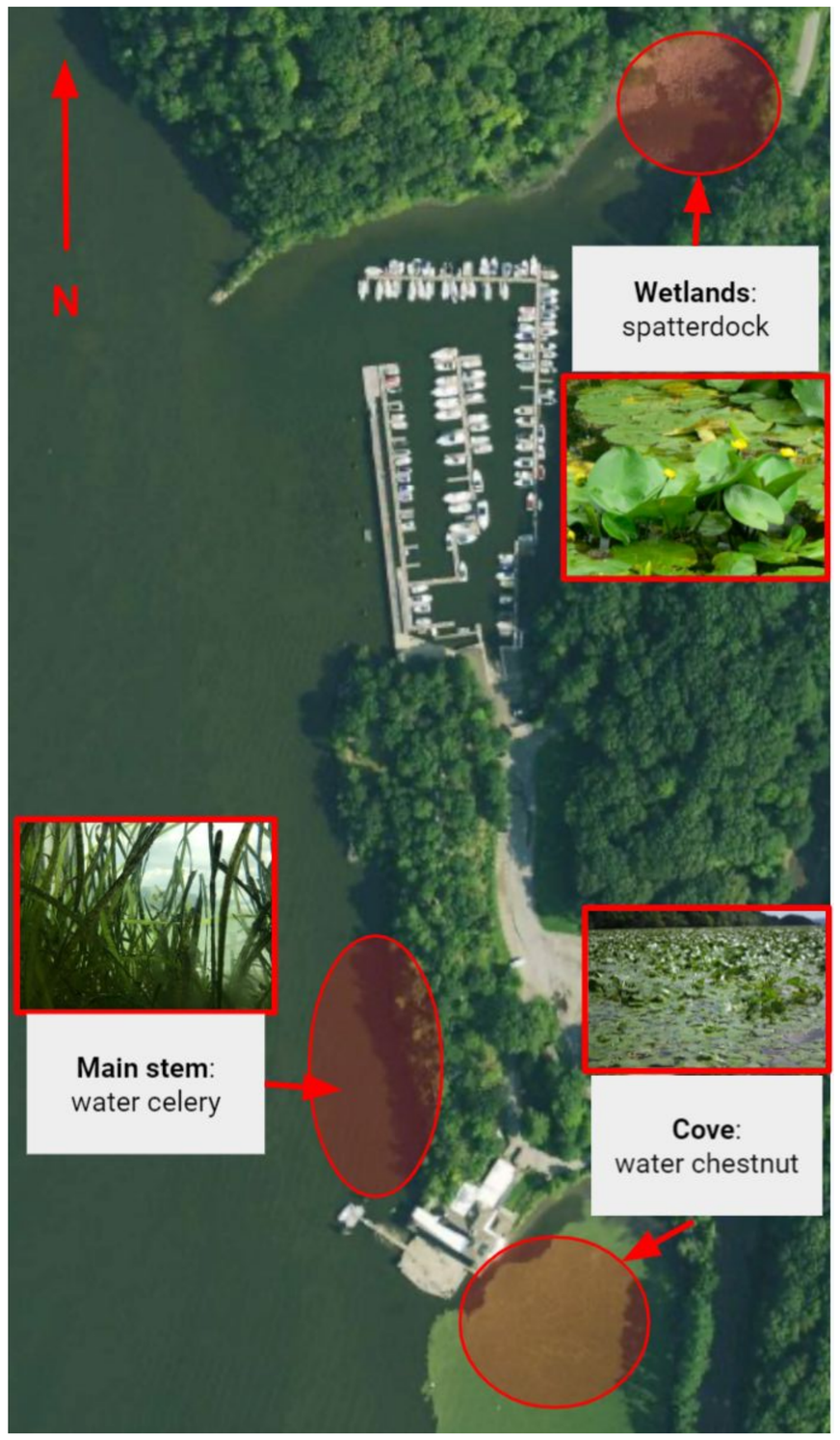

Introduction

Water chestnut (*Trapa natans*) is a surface aquatic plant that is native to Asia. It was introduced to the Hudson River in the nineteenth century and quickly proliferated as an invasive species. Water chestnuts reproduce rapidly, creating dense coverage on the surface of the water. This is a threat to native submerged aquatic vegetation present in the river as they will not be able to attain sufficient sunlight required to undergo photosynthesis. Unlike most native plants, water chestnut does not supply dissolved oxygen (DO) into the water. Instead, oxygen is released through the topical structure of the plant whilst the roots release methane directly into the water. In contrast, many native species such as water celery (*Vallisneria americana*) and spatterdock (*Nuphar advena*) release oxygen into the water as a byproduct of photosynthesis. Water celery undergoes photosynthesis and provides DO, and this DO provides the surrounding aquatic inhabitants oxygen to survive. Water celery is also a nursery for many fish species and serves as food for many waterfowl (such as *Patrick landewe*), while the dense roots and leaf cover of the water chestnut do not foster a suitable environment for native species. We conducted a field study to determine whether further water quality damage has occurred due to the invasive plant species' arrival. We hypothesized that if invasive water chestnuts (*Trapa natans*) are present, then all water quality parameters are lower relative to native aquatic vegetation such as spatterdock and water celery.

Methods & Materials

To begin testing water quality we visited three unique habitats: the SAV bed, the cove, the tidal wetlands, using a deep section of the Hudson River as a control. Each habitat has a unique set of vegetation that affects the water quality of different sections of the Hudson. The SAV bed's major form of vegetation is water celery (*Vallisneria americana*); the cove's major form of vegetation is water chestnut (*Trapa natans*); the tidal wetlands major form of vegetation is spatterdock (*Nuphar advena*), the deep section of the Hudson River lacks any vegetation. We visited each habitat at near low & high tide. During low tide, half the group entered both the water chestnut and water celery beds in waders and collected the pH, dissolved oxygen, percent saturation, turbidity, air temperature & water temperature using Vernier LabQuest 2, the Hach Dissolved Oxygen & pH kits, and a turbidity tube. The other half of the group visited the spatterdock beds using canoes and collected the aforementioned water quality data using YSI probes & turbidity tubes. At high tide, a small group of 2-4 members canoed out to all three habitats and used YSI probes and turbidity tube one day, and for all other days the Vernier LabQuest 2 & the turbidity tubes was used to collect water quality data. One day the group journeyed out on the Sloop Clearwater to collect water quality data using the Vernier LabQuest 2, YSI probes, Hach Dissolved Oxygen & pH test kits, & turbidity tubes.

Person entering data	Date	Time of Sample	Weather	Tides	Site	GPS location	Water Temperature (°C)	pH	Dissolved Oxygen (mg/L)	% Saturation	Turbidity (cm)
Angela	7/12/2021	11:38:00 AM	Cloudy, post-rain	Low	Spatterdock	41* 50' 16" N, 73* 56' 18" W	18.80	7.50	7.20	78.0	High
Brandon	7/12/2021	11:17:00 AM	Drizzling	Low	Water Celery	41*49'55"N 73*56'32"W	24.50	5.68	6.75	80.0	63.0
Anagha	7/12/2021	12:00:00 PM	Drizzling	Low	Water Chestnut	41*49'55" N 73*56'30" W	23.20	10.70			22.0
Anagha	7/13/2021	11:00:00 AM	Cloudy	Low	Spatterdock	41*51'11"N 73*56'27"W	20.40	7.00	7.30	79.6	71.0
Anagha	7/13/2021	11:45:00 AM	Cloudy	Low	Water Chestnut	41*49'55" N 73*56'30"W	23.30	6.99	6.60	92.3	25.1
Anagha	7/13/2021	11:20:00 AM	Cloudy	Low	Water Celery	41*49'56" N 73*56'32" W	23.70	6.98	8.60	97.4	38.0
Mya, Angela	7/13/2021	2:20:00 PM	Cloudy	High	Spatterdock	41* 50' 11"N 73* 56' 27"W	24.00	7.00	6.40	72.3	101.0
Mya	7/13/2021	2:40:00 PM	Cloudy	High	Water Celery	41* 47' 56"N 73* 56' 32"W	23.50	7.00	5.70	66.2	66.0
Mya	7/13/2021	2:54:00 PM	Cloudy	High	Water Chestnut	41* 49' 54"N 73* 56' 30"W	23.45	6.50	4.30	51.5	75.0
Mya	7/14/2021	10:40:00 AM	50% cloudy	Low	Water Chestnut	41*49' 54"N 73* 56' 30"W	22.90	6.50	3.80	30.3	35.0
Mya	7/14/2021	10:40:00 AM	50% cloudy	Low	Water Chestnut	41* 59' 54"N 73* 56' 30"W	23.45	6.50	4.00	51.3	27.0
Anagha	7/14/2021	10:50:00 AM	50% cloudy	Low	Spatterdock	41*47'56" N 73*56'32" W	22.80	6.91	6.70	80.0	35.0
Anagha	7/14/2021	11:30:00 AM	50% cloudy	Low	Water Celery	41*49'60"N 73*56'33" W	24.20	6.90	7.40	92.0	53.2
Anagha	7/14/2021	2:10:00 PM	50% cloudy, light breeze	High	Spatterdock	41*50'11"N 73*56'27" W	26.90	6.53	7.50	98.8	88.3
Anagha	7/14/2021	2:28:00 PM	50% cloudy, light breeze	High	Water Celery	41*49'60"N 73*56'33" W	24.30	6.80	7.00	93.0	53.2
Anagha	7/14/2021	2:37:00 PM	50% cloudy, light breeze	High	Water Chestnut	41*49'53"N 73*56'32"W	24.20	13.80	6.18	75	65.0
Anagha	7/15/2021	11:30:00 AM	Hot, Sunny	Low	Control	41*42'47"N 73*56'45"W	24.50	8.00	5.55	68.6	60.2

Results

Figure 1 displays the dissolved oxygen of the control, spatterdock, water celery, and water chestnut locations. The Water chestnut habitat showed relatively low DO levels with a low overall mean. Spatterdock and water celery habitats showed higher DO levels than both the water chestnut habitat and control location.

Figure 2 displays the turbidity of the same locations at high and low tides. A higher turbidity indicates a higher clarity of water and a low turbidity indicates a lower clarity of water. The control shows the average turbidity of the Hudson River. The turbidity recorded at the spatterdock location has the highest clarity at high tide and an average clarity at low tide. The turbidity at the water celery location is similar to the control at both high and low tide. The water chestnut location shows higher clarity at high tide and a low clarity at low tide.

Results regarding pH, water temperature and percent saturation showed no significant results, which leads us to believe that the species observed have no significant effect on these parameters.

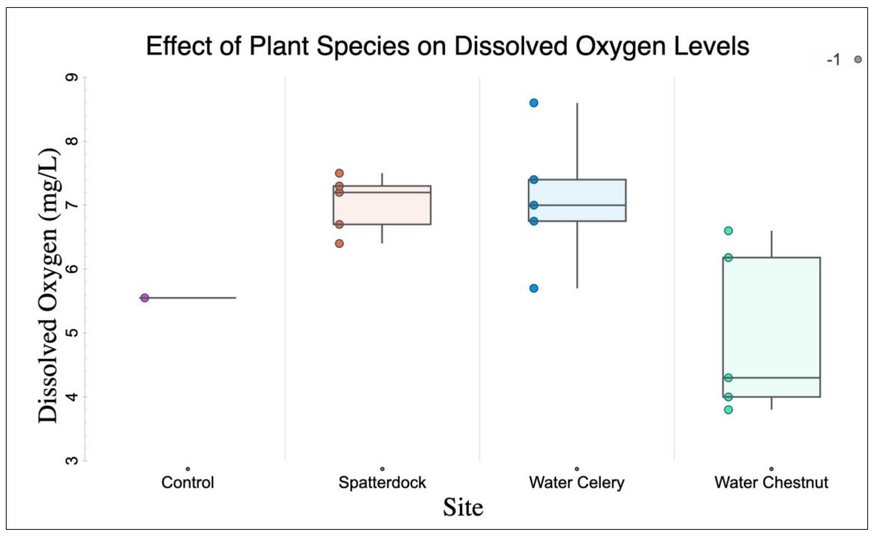

Figure 1

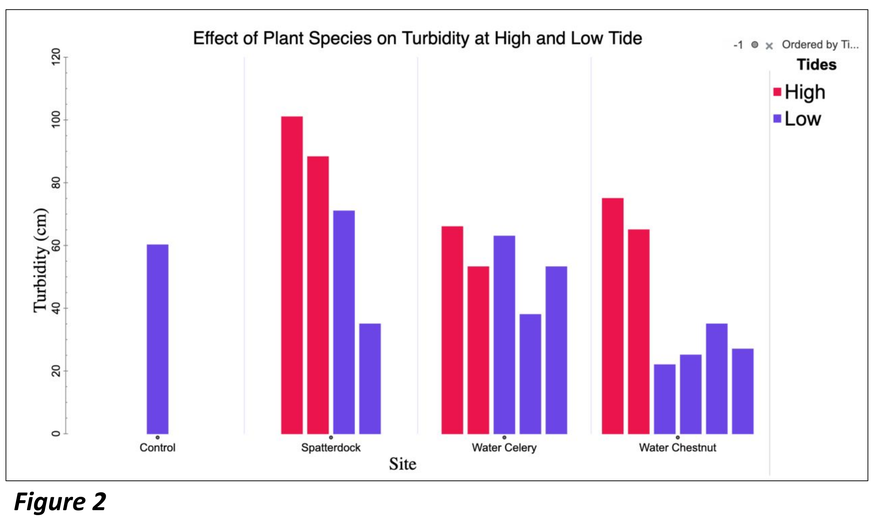

Figure 2

Discussion

Our results show that DO levels were lower on average in the water chestnut habitat than in the control (mid-Hudson River), water celery, and spatterdock habitats. We believe that the plant releases oxygen into the atmosphere rather than the water, as its photosynthetic leaves are located on the surface. Therefore, the plant structure and metabolism, in conjunction with the low water circulation in the cove habitat, decrease DO levels of the water. These results align with existing research and literature on the effects of water chestnuts on dissolved oxygen. At lower tides, the water chestnut habitat was found to have lower clarity. This may be a result of our collection method: as we waded to collect our sample, we likely disturbed the sediment, lowering the clarity of the sample. We also found a similar trend with the spatterdock habitat. When we canoed into the habitat to collect data at low tide, the paddles also disrupted the sediment. However, there is a possibility that the spatterdock and extensive root systems of the water chestnut trapped sediment as the tide receded, causing higher turbidity. If this research were to be repeated, to reduce the human interference on turbidity, we would suggest waiting for the sediments to settle after wading or canoeing out to the sample site.

References

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