Waterscaping Water Chestnuts: A Test of Improving Habitat for Fish

A Final Report of the Tibor T. Polgar Fellowship Program

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Abstract

Invasive species are increasingly common in the waterways of the United States. Eurasian water chestnut (*Trapa natans*) was introduced in Concord, Massachusetts in 1859. Since then it has spread throughout much of the East Coast and continues to expand westward. Because of its prolific seed bank and dense growth it is causing unsuitable conditions for submersed aquatic vegetation and fish communities alike. It has increased to the point were it may be impossible to eradicate, but we may be able to find a way to allow our native species to live along side it.

A large chestnut bed in Tivoli South Bay (Tivoli, NY) was manipulated by clearing two paths into it. In doing so we formed a smaller site (comprised of the edge of the large bed) between the clearing and an open channel in the bay. These three sites were compared to our controlled site located near Cruger Island. Our areas of interest were the dissolved oxygen concentrations and the fish communities found within each site. Dissolved oxygen concentrations were monitored with hand-held and submersible YSI multiprobes throughout the duration of the study. Fish were collected with pop nets, rotating the pop nets from site to site throughout the study.

We found that average dissolved oxygen concentrations were lower in the large bed than the other three sites. However, the most species and the highest total of fish caught were found in the large *Trapa* bed. The highest biomass was found in the edge site, which yielded the second highest amount of total fish caught. The clearing proved to hold up an increased dissolved oxygen level but yielded the fewest total fish caught and the lowest biomass.

Overall the large *Trapa* bed was still frequented by the fish community found in the bay. It is being used as protection, from aerial and aquatic predators, for the year of young and the smaller fish species. However, when the ebb tide conditions are reached the dissolved oxygen levels are to low to sustain the fish communities forcing the fish into the edges and the open water until the conditions are once again suitable.

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Introduction

Trapa natans (Eurasian water chestnut) is an invasive species that since the late 1800's has been gradually taking over back waters of the Hudson River Estuary and other aquatic systems in the northeast. *Trapa natans* grows rapidly when in season and can survive in waters from two centimeters to two meters deep.

Water chestnut is an annual, which in summer grows rapidly and can reach a length of 16-feet long. It produces two sets of leaves, one being submergent and the other emergent. The emergent leaves are triangularly shaped and toothed. These leaves grow as rosettes, producing about 20 seeds per rosette. One reason for water chestnut's success is the prolific seed bank that has built up in the sediment. The seeds may survive up to 12 years in sediment, and over time many sprout successfully.

Trapa grows densely and this has caused the displacement of some native aquatic species. The primary species that it appears to have replaced is *Vallisneria americana*, resulting in a fundamentally different plant community. *Vallisneria amaricana* contains subsurface-oxygen-producing structures. However, *Trapa natans* primarily produces oxygen on the surface, therefore it is producing little oxygen within the water column (Coote et al. 2001). Low oxygen levels prevent many fish from using the habitat, and this issue was part of the motivation for this study.

Because *Trapa natans* releases oxygen into the atmosphere and not the water column, dissolved oxygen levels tend to drop. During ebb tide conditions, dissolved oxygen levels can be depleted to hypoxic and even anoxic conditions (Caraco and Cole 2002). During ebb tide conditions, numerous small fish exited the water chestnut beds (Coote et al. 2001). This suggests that (1) water chestnut may provide refuge from predators, but (2) when oxygen declines on ebb tides, small fish are forced to leave the refuge.

In the Hudson River, water chestnut beds serve as spawning sites for *Cyprinus carpio* (carp) and also provide protection to smaller fish species such as *Etheostoma olmstedi* (tessellated darters) and *Fundulus diaphanus* (banded killifish). These vegetated areas also provide small species protection both from aerial predators and from aquatic predators such as bass and white perch. The vegetation also protects young-of-year (YOY) of larger fish until they are mature enough to enter the more open areas such as the channel and the river. Carp (*Cyprinus carpio*) larvae emigrate from South Tivoli Bay to the estuary. The bay is protecting the carp larvae until they are mature enough to be exported from the bay to the estuary (Bohne and Schmidt 1989).

The purpose of this study was to manipulate a large *Trapa* bed so that the habitat for fish would be suitable for them to remain during ebb tide conditions. Water chestnut is not easily eradicated, but perhaps may be managed to improve it as habitat for fishes. We tested one such measure, called "waterscaping" (Summerfelt 1999), in which pathways are cut into water chestnut beds. These paths would serve two purposes. The first is that they would form a smaller chestnut bed that could be monitored and compared to the larger chestnut bed. The second would be that the paths would permit more oxygenated water from outside the bed into the clearing and to the surrounding areas of the existing *Trapa*. For more comparison, a smaller *Trapa* bed at another site would also be monitored. The results found at this site would be compared to the larger bed, the smaller constructed bed, and to the cleared paths. We would be monitoring fish and water quality in and around the large *Trapa* bed, the smaller *Trapa* bed, the clearing, and the reference site. We hypothesized that the habitat found in the smaller bed and areas surrounding the clearing should begin to resemble the habitat found at the reference site.

Materials and Methods

The waterscaping manipulation was set up in Tivoli South Bay because of the high abundance of water chestnuts found in the bay. Tivoli South Bay is approximately 115ha. Of this, *Trapa natans* covers about 95% of the surface from mid-May through October (Anderson and Schmidt 1989). Tivoli South Bay is separated from the mainstream of the Hudson River by the railroad, but three railroad bridges allow tidal exchange from the bay to the river. The study site is located just south of the middle bridge, near the center edge of the bay.

The first hurdle to overcome was to remove the water chestnut. I had originally planned to have two people pull a weighted rope along the substrate, and in doing so the chestnut might be ripped at the base of the stems, but the manpower necessary was unavailable. Therefore, it was done by hand. All that was needed was a canoe and waders. When I would pull it up I would allow the water to drain and then place it into the canoe. When I would fill the canoe it would then be pulled to the shore and off loaded on the banks. I was careful to place the weeded plants at least a meter above the high tide mark seen on the rocks so that they would not be redistributed into the bay at high tide.

Following the creation of the clearing, *Trapa* on the edges needed to be held back so that it did not float back together. Two-meter tall garden posts were placed every 5m along the edge of the clearing. They were topped off with wooden dowels that were 1m in length and 7mm wide. These posts were then marked with red duct tape. The reasoning for the extension of the gardening posts was so that the site could be easily spotted if the waters were to exceed the heights of the gardening posts during flood tide.

After the posts were in place 7-mm deer fencing was then strung along the length of the clearing. The deer fencing came 33 m long and was 2 m wide. This was more than adequate to line two sides of the clearing. The fencing was cut into two symmetrical pieces