STANDING CROP OF FISHES IN WATER CELERY BEDS IN THE TIDAL HUDSON RIVER

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ABSTRACT

Quantitative sampling with a pop net in water celery (*Vallisneria americana*) and water-chestnut (*Trapa natans*) beds in the tidal Hudson River showed that fish species composition was very different in beds of the two plant species. The fish community in *Vallisneria* is dominated by tessellated darters and spottail shiners while fourspine sticklebacks and young of the year carp predominate in *Trapa* beds.

Standing crop (g wet weight/m^2) of fishes was not significantly different between the two plant communities or between years within the *Trapa* beds. Standing crop values ranged from 0.3-7.1 g wet weight/m^2 in *Vallisneria* and 0.6-10.4 g wet weight/m^2 in *Trapa* beds.

The differences in species composition may signal significant changes that the expansion of *Trapa* has caused in the Hudson River fish community. An increase in abundance of carp (*Cyprinus carpio*) and a decrease in tessellated darters (*Etheostoma olmstedi*) and spottail shiners (*Notropis hudsonius*) should be searched for in other data sets to test this hypothesis.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES PAGE

INTRODUCTION

In early February, 1991, the Hudson River Foundation organized a discussion among several Hudson River environmental groups, agencies, and individuals. The problem under discussion was the perceived decline of a number of Hudson River fishes (primarily bait species) and invertebrates reported by commercial fishermen in the upper Hudson. This decline was reported to have begun in the late 1970s (Waldman, 1991).

It isn't clear whether a single system-wide cause is at work or whether more than one environmental change might be implicated in the observed declines. Several alterations to the Hudson were correlated with the fish population declines. The commercial fishermen noted the increase in sewage treatment plant discharges directly into the Hudson that occurred about 1980 and expressed concern about the effects of residual chlorine. Representatives of the Department of Environmental Conservation (DEC) discussed the improvement in water quality in the upper Hudson and suggested that an increase in predators could have caused the decrease in prey organisms observed. Data sets from the various sampling programs designed to monitor the striped bass and shad populations (DEC) and to monitor fish

populations in the vicinity of power plants (Consolidated Edison) did not necessarily support the hypothesis that a decline occurred.

One of us (RES) proposed that the spread of water-chestnut (*Trapa natans*) might explain the decline in some species of fishes. Spraying to control *Trapa* stopped in the Hudson in 1975, 4-5 years prior to the perceived decline in baitfishes. After spraying ceased, water-chestnut expanded dramatically. Although greater densities and diversities of larval fishes were found in *Trapa* beds (Schmidt and Kiviat, 1988) compared to other submerged aquatic vegetation (SAVs), juvenile and adult populations of fishes in *Trapa* are depauperate (Pelczarski and Schmidt, 1991) compared to the populations in marshes not dominated by this exotic plant (Schmidt, 1986; Rod and Sramek, 1986).

During various studies on Tivoli North Bay, substantial numbers of fishes of several species were collected from water celery (*Vallisneria americana*) beds (RES, pers. obs.). *Vallisneria* is a native submersed aquatic plant that we think has been displaced in many areas by the recent spread of *Trapa*. Our hypothesis is that the adult and juvenile fish community in *Vallisneria* is denser and more diverse than the community observed in *Trapa* and therefore *Trapa* has

caused a decrease in the populations of some fish species.

MATERIALS AND METHODS

The *Vallisneria* bed that we selected for investigation lies in the main Hudson estuary between Magdalen Island and Tivoli North Bay (RM 99) and extends south towards Cruger Island (Fig. 1). This plant bed is easily accessible by canoe and is less than 1 mile from the *Trapa* bed in Tivoli South Bay that has been studied intensively (Fig. 1). *Myriophyllum spicatum* and *Potamogeton* sp. were also present in the *Vallisneria* bed, but these plants were scattered and comprised a small percentage of the plant biomass.

The pop net that Pelczarski and Schmidt (1991) used in the Tivoli South Bay *Trapa* bed is a reliable quantitative fish sampling device. Similar nets have been used in other SAV communities (Dewey et al., 1989; Killgore et al., 1989; and Serafy et al., 1988), including *Vallisneria*. We modified the net that Pelczarski and Schmidt (1991) described by making it smaller and heavier. Our net was a seven-foot square and we weighted the bottom of the net with three lengths of 3/8 inch reinforcement rod in each piece of plastic pipe. All the other aspects of the net were as described by Pelczarski and Schmidt (1991).

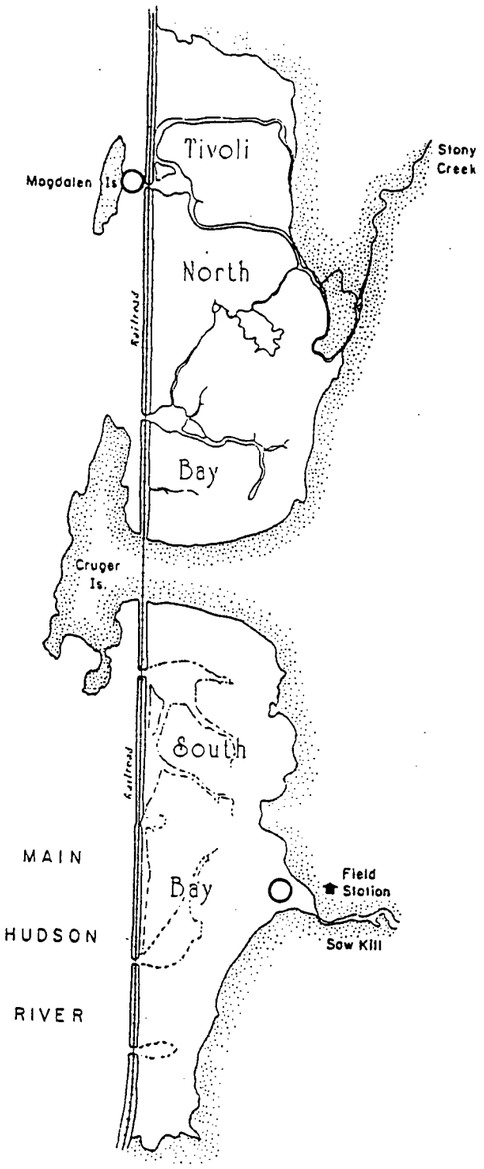

Figure 1. Map of the Tivoli Bays, Hudson River, New York showing areas sampled with pop nets. The *Vallisneria* beds are indicated by the northern circle and the *Trapa* beds are the southern circle.

The pop net was deployed at or near high tide. It was left undisturbed for several hours and then popped when the tide was about half maximum. At low tide, the *Vallisneria* bed was too shallow to effectively use the pop net. When the net was popped, we removed fishes from the net with a 10 ft X 4 ft seine made of the same mesh as the pop net (Ace 3/16 inch knotless nylon mesh). We seined within the net until five consecutive hauls caught no fish.

Fishes were identified, measured (total length) to the nearest millimeter, and weighed (wet weight) to the nearest 0.5 g on a triple beam balance with a magnetic stop. These data were collected in the field and fishes were released.

We collected fishes in the *Vallisneria* with the same 10 ft seine that we used in the pop net while the pop net was deployed. It quickly became obvious that seining in these plants could not be quantified. Since seining sometimes collects species that are not seen in pop nets (Dewey et al., 1989), we continued to seine and kept track of species and numbers collected.

We also sampled fishes from the *Trapa* bed in Tivoli South Bay to verify that the fish fauna had not changed since the study in the previous year (Pelczarski and Schmidt, 1991). We used the slightly larger net that

Pelczarski and Schmidt (1991) constructed in the *Trapa* bed, in the same place and with the same methods that they described. Fishes were processed as described above.

Numbers of fishes were converted to densities and wet weights to standing crops by dividing by the area sampled. An ANOVA was done to test the hypothesis that the standing crops of fishes in the *Vallisneria*, *Trapa* in 1991, and *Trapa* in 1990 were not significantly different.

RESULTS

Ten species of fishes were collected in the *Vallisneria* beds, eight in the pop net and an additional two in the seine (Table 1). Before starting this project, we observed redbreast sunfish (*Lepomis aurita*) and a cutlips minnow (*Exoglossum maxillingua*) in the area, the latter being uncommon in the main Hudson estuary.

The two most abundant species, tessellated darters (*Etheostoma olmstedi*) and spottail shiners (*Notropis hudsonius*), comprised 75% of the individuals collected in pop nets (Table 1). An additional 18% were juvenile anadromous clupeids. The most commonly collected species in the seines was white perch (*Morone americana*- 44% of the total individuals).

Table 1. Fishes collected and relative abundances in *Vallisneria* beds in the Hudson River. Numbers are percentages of the total number of fishes collected arranged in descending order of abundance in the pop net collections.

Species	Pop Net	Seine
Tessellated darter (*Etheostoma olmstedi*)	53.0	12.8
Spottail shiner (*Notropis hudsonius*)	22.3	10.3
Alewife (*Alosa pseudoharengus*)	10.0	5.1
Blueback herring (*Alosa aestivalis*)	7.7	-
Fourspine stickleback (*Apeltes quadracus*)	2.3	2.3
White perch (*Morone americana*)	2.3	43.6
American eel (*Anguilla rostrata*)	1.5	2.3
Pumpkinseed (*Lepomis gibbosa*)	0.8	12.8
Banded killifish (*Fundulus diaphanus*)	-	7.7
Carp (*Cyprinus carpio*)	-	2.3
	99.9	99.2
Total Number Collected	134	39

Although the species composition of seine collections and the ranks based on abundance were different than that of pop net collections, many fewer individuals were taken in the seines (Table 1). A seine haul that covered five times the area of a pop net sample would often contain only two or three fishes. This observation indicates the high degree of ineffeciency of pulling even a small seine through dense growths. Typically, the lead line rides up and rolls, thus making the seine very ineffective at catching fishes. We do not believe that the seining data provide an accurate representation of the fish community, however they do document the presence of banded killifish and carp in the *Vallisneria* beds (Table 1). Also, we occasionally seined in water deeper than we sampled with the pop net, thus differences in the fish community may be due to habitat differences sampled by the different gear.

Schmidt (1986) categorized tessellated darters and spottail shiners (along with white perch and banded killifish) as dominant species in the Tivoli North Bay marsh. This marsh is adjacent to our sampling site and may strongly affect the species composition of the *Vallisneria* beds. Banded killifish appear to be marsh surface feeders (Richard and Schmidt, 1986) and therefore we would not

expect to see many out in the main estuary. The scarcity of white perch in our pop net samples remains unexplained. It would be interesting to sample a *Vallisneria* bed that is not adjacent to a marsh to determine if the marsh inhabitants are generally distributed in the beds or our samples were primarily reflecting the proximity of the marsh.

The species composition in *Vallisneria* is very different from the community described by pop net samples in *Trapa* beds in Tivoli South Bay (Table 2). *Trapa* beds are dominated by fourspine sticklebacks and carp, species only seen in small numbers in *Vallisneria* (Table 1). The species composition in *Trapa* beds was the same in 1990 and 1991 (Table 2).

Standing crops of fishes in *Vallisneria* ranged from 0.03-7.1 grams wet weight per square meter with a mean of 3.5. There were no obvious trends in these values over the study period (Fig. 1). There were no significant differences ($F_{(2,14)} = 0.08$) among the mean standing crops for the *Vallisneria* bed, the *Trapa* samples we took (3.23-4.92 g wet weight/m^2, mean = 4.08, n = 2), and the *Trapa* samples taken in 1990 (0.6-10.4 g wet weight/m^2, mean = 3.14, n = 7-Pelczarski and Schmidt, 1991).

Table 2. Fishes collected by pop net and relative abundances in *Trapa* beds in Tivoli South Bay, Hudson River. Numbers are percentages of the total fishes collected. The 1990 data are from Pelczarski and Schmidt (1991).

Species	1990	1991
Fourspine stickleback (*Apeltes quadracus*)	75.3	64.0
Carp (*Cyprinus carpio*)	18.5	29.0
Banded killifish (*Fundulus diaphanus*)	2.5	1.3
Tessellated darter (*Etheostoma olmstedi*)	2.2	-
Spottail shiner (*Notropis hudsonius*)	0.7	-
American eel (*Anguilla rostrata*)	0.4	-
White perch (*Morone americana*)	0.4	-
Rock bass (*Ambloplites rupestris*)	-	4.0
Goldfish (*Carassius auratus*)	-	1.3
Golden shiner (*Notemigonus crysoleucas*)	-	1.3
	100.0	100.9
Total Number Collected	275	75

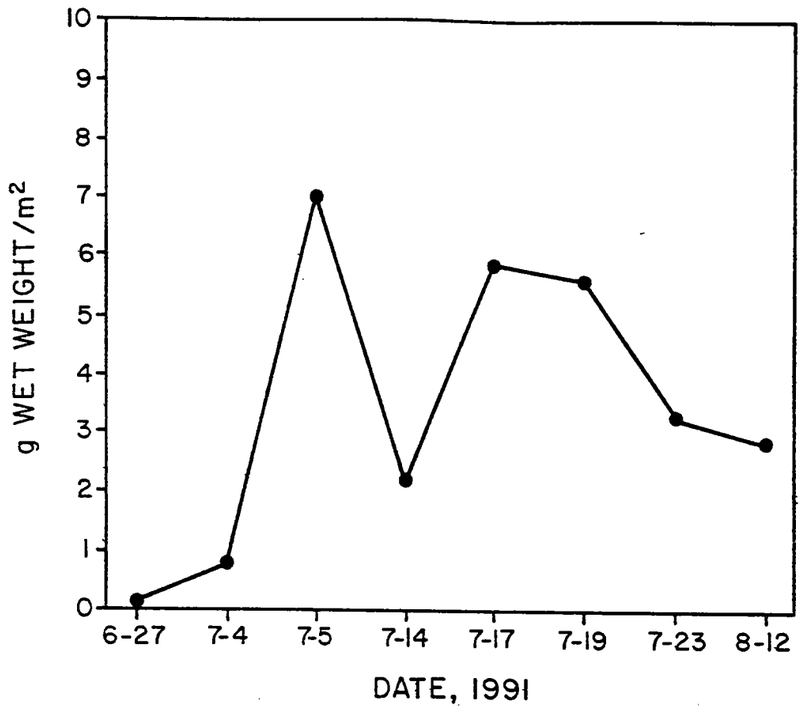

Figure 2. Standing crop of fishes in *Vallisneria* beds in the Hudson River, New York, 1991. Fishes were collected by pop net.

DISCUSSION

The differences seen in fish species composition between *Vallisneria* and *Trapa* communities may indicate changes in the Hudson River fish population caused by *Trapa* expansion. Muenscher (1937) indicated that *Vallisneria* was part of the plant community present in the protected shallows prior to *Trapa* introduction. If the present *Vallisneria* fish community is representative of the fish

community present in the protected shallows before *Trapa* invaded, then *Trapa* has caused a significant change in recent years. The tessellated darter/spottail shiner community has been replaced by fourspine stickleback and carp.

It is difficult to predict what changes would be observable as a result of this shift in plant communities, however. There have been very few studies done on any of the four species of fishes mentioned above and, in particular, there are almost no data available on carp in the Hudson. We would predict that carp populations should have increased since *Trapa* became common, but we doubt that there is a data base available adequate to test this prediction.

In terms of the effect *Trapa* may have had on the perceived decline of baitfishes in the upper Hudson, this study was too limited to be definitive. Spottail shiners would be included as a bait species and could have declined because of *Trapa* expansion, but our study says little about other species, like *Fundulus diaphanus*, that apparently have declined as well. More sampling effort needs to be done in the shallow habitats in order to address this problem.

There is one other possible explanation for the differences in community structure observed in this study. The statements we made above are based on the assumption that fishes sampled in *Vallisneria* are present because of the plants, but it is possible that other environmental differences are more important to the fishes. The *Vallisneria* bed we sampled (typical of *Vallisneria* in the Hudson today) had a substantial current during ebb and flow of the tide. *Trapa* beds in Tivoli South Bay have currents <0.01 m/sec (Schmidt and Kiviat, 1988). Perhaps the fish community we observed in the *Vallisneria* are simply more tolerant of current and were never found in the quiet backwaters that *Trapa* prefers. We cannot resolve this particular problem by sampling in the Hudson. We know of no substantial *Vallisneria* bed that does not exist in a current because all of the quiet backwaters are now dominated by *Trapa*. Sampling *Vallisneria* in other tidal freshwaters where *Trapa* is absent might answer the question - perhaps in the Connecticut or Delaware River estuaries.

Few comparative data exist with which to compare our standing crop data. Serafy et al. (1989) measured fish biomass at 5.0-8.5 g wet weight/m^2 in *Vallisneria* in the tidal Susquehanna River. We converted their data from dry

weight using their formula. Their values were slightly higher than ours but within the range of values we observed. This comparison suggests that the pop nets are sampling *Vallisneria* in the same way in both places. Serafy et al. (1989) collected pumpkinseeds (*Lepomis gibbosa*), inland silversides (*Menidia beryllina*), and banded killifish (*Fundulus diaphanus*) as the most abundant species, a very different species composition than we observed in the Hudson. We do not know the reason for the differences in species composition between their study and ours.

RECOMMENDATIONS

We think these preliminary data are interesting enough to suggest that more intensive studies be done. Comparing fish communities in *Trapa* with other SAVs throughout the Hudson estuary and among several river systems may elucidate the changes caused by *Trapa*.

Further design modifications to the pop net are warrented. Transporting the assembled net was difficult. A design like Serafy, et al. (1989) would reduce the logistics of using this otherwise superb sampling device.

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