The Doherty Coastal Studies Research Fellowship

Introduction

The Merrymeeting Bay ecosystem and human settlements around it have long been ecologically and economically intertwined, especially regarding the anadromous fish that use the ecosystem as a nursery habitat. Before European settlement, Native Americans utilized the enormous populations of various species of fish, and thus the previously vegetated plots would yield greater CPUEs than the completely unvegetated Sand Bar site. Essentially, both categories of fish would benefit from a large-scale transplant of Submerged Aquatic vegetation into Merrymeeting Bay.

Methods

Size Description

Merrymeeting Bay is a freshwater, tidal ecosystem located approximately 30 kilometers inland from Maine’s midcoast. It is formed by the confluence of six rivers, the Kennebec, Androscoggin, Eastern, Muddy, Cathance, and the Abbequasset. The Kennebec and the Androscoggin rivers are the second and third largest in Maine, respectively. Thus, approximately one-third of the area of Maine drains into Merrymeeting Bay. High levels of nutrients drain into the bay from its tributary rivers, making it an unusually productive ecosystem. Merrymeeting Bay is well mixed and very shallow, with expansive mudflats exposed at low tide. Wild rice covers these mudflats, providing an ideal forage habitat for ducks and other waterfowl. The ecosystem has historically supported an abundance of other biodiversity, but centuries of intense disturbance have left it severely altered. Since the ratification of the Clean Water Act in 1972, there is evidence of some recovery, though Merrymeeting Bay remains a degraded ecosystem.

Transplant

Four sites were chosen across the bay and at each site two square plots were marked with wooden stakes, one of which was densely vegetated, the other devoid of SAV. Thirty F. californica (Figure 1) were planted in each plot in early June, and their mortality was monitored throughout the month of July.

Fish Survey

At each plot, standard minnow traps were suspended from stakes approximately 10 cm above the substrate. Stakes were placed just inside the edge of the plot and traps were oriented with the predominate flow of the tide. An addition trap was placed on a submerged sandbar, onto which no vegetation was transplanted and no vegetation was present within 5 meters of the minnow trap. Number of fish caught per day in the trap was measured as Catch per Unit Effort (CPUE). Statistical analysis was performed using SPSS version 12.1.4 for Windows.

Results

No significant difference was found between the Catch per Unit Effort during the entire study period in the previously vegetated and the previously unvegetated plots (P=0.047, Figure 1). However, this was not consistent throughout the study period. Before the median day of the study period (July 1, 2008), the previously vegetated plots had a significantly lower CPUE than the previously vegetated plots (P=0.002). After the median date, data gathered indicated that there was no significant difference between the previously vegetated and unvegetated plots (P=0.652).

Also, data gathered during the entirety of the study show that a significantly higher CPUE was observed in the previously vegetated plots than the Sand Bar plot (P=0.029). However, when data gathered throughout the summer at the previously unvegetated plots were compared, no significant difference was found. This indicates that it is also possible transplants were not utilized by the resident and juvenile anadromous fish (Figure 4).

The data gathered in this study provides an excellent direction in which to proceed with the restoration of Merrymeeting Bay. The aggregated human disturbance of centuries of overfishing, pollution and dam building have caused a shift in the stable state of the Merrymeeting Bay ecosystem from a benthic-based to pelagic based ecosystem, characterized by high turbidity levels and low oxygen concentrations. This shift had a negative impact on SAV beds and fish populations. By artificially recolonizing the Bay with SAV, it may be possible to cause a shift back to the original stable state, and restoring the historically high productivity levels. However, there is doubt as to whether transplanted SAV can provide a suitable microhabitat for resident and anadromous fish. The CPUE difference at the previously vegetated site and combined average CPUE of the previously unvegetated sites, indicating that it is also possible that transplanted SAV are not utilized.

Discussion

The results from this study both support and cast doubt on my initial hypothesis. Based on previous studies on the relationship between resident and anadromous fish and Submerged Aquatic vegetation, it is expected that plots of SAV provide an important microhabitat for both varieties of fish, and thus the previously vegetated plots would yield higher CPUEs than previously unvegetated plots, due to higher vegetation densities (Orth and Heck, 1980). However, I also hypothesized that all transplanted plots would yield greater CPUEs than the completely unvegetated Sand Bar site. Essentially, both categories of fish would benefit from a large-scale transplant of Submerged Aquatic vegetation into Merrymeeting Bay.

The data show that, initially, the data from the previously vegetated plots did not indicate that the transplant was being utilized by resident and anadromous juvenile fish and there was little evidence that the transplanted plots were serving as foraging and predator avoidance areas (Figure 2). But as the median date of the study period, approximately one month after the transplant, the data indicate that the previously vegetated plots were utilized to the same extent as the previously unvegetated plots (Figure 3).

A probable cause of these observations is transplant shock. When plants are transferred into a new environment, there is considerable dieback in the leaves, and some mortality. This effectively reduces the density of the vegetation of the plot and thus it makes it a less ideal habitat for resident and juvenile anadromous fish. Perhaps after the transplanted plots were able to recover from the shock of transplant (i.e. after July 1, 2008), the density within the plots became sufficient enough to support some upper trophic level organisms.

However, when data gathered throughout the summer at the previously unvegetated and the completely unvegetated Sand Bar plot were compared, no significant difference was found. This indicates that it is also possible transplants were not utilized by the resident and juvenile anadromous fish (Figure 4).

The data gathered in this study provides an excellent direction in which to proceed with the restoration of Merrymeeting Bay. The aggregated human disturbance of centuries of overfishing, pollution and dam building have caused a shift in the stable state of the Merrymeeting Bay ecosystem from a benthic-based to pelagic based ecosystem, characterized by high turbidity levels and low oxygen concentrations. This shift had a negative impact on SAV beds and fish populations. By artificially recolonizing the Bay with SAV, it may be possible to cause a shift back to the original stable state, and restoring the historically high productivity levels. However, there is doubt as to whether transplanted SAV can provide a suitable microhabitat for resident and anadromous fish. This precludes the CPUE difference at the Sand Bar plot and combined average CPUE of the previously vegetated sites, indicating that it is also possible that transplanted SAV are not utilized.

Thus, more studies are needed to determine whether a large-scale recolonization of the bay will benefit the bay and if it is worthwhile the considerable economic investment. It will be important to monitor the regeneration of the transplanted SAV following this winter, and verify that the plants are able to survive the winter. Also, controlled studies that investigate the changes in water quality parameters and fish behavior associated with different densities of SAV would further inform restoration efforts.

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Literature Cited


Anadromic and Resident Fish Distributions and Trophic Web Structure in Merrymeeting Bay, Maine.

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Figure 1. Total Catch per Unit Effort for the Previously Vegetated and Previously Unvegetated plots from study sites before July 1, 2008. Unvegetated plots yielded significantly less CPUE than the Vegetated plots (P=0.002). Error bars represent standard error of the mean.

Figure 2. Total Catch per Unit Effort for the Previously Vegetated and Previously Unvegetated plots from study sites after July 1, 2008. Unvegetated plots yielded significantly less CPUE than the Vegetated plots (P=0.002). Error bars represent standard error of the mean.

Figure 3. Total Catch per Unit Effort for the Previously Vegetated and Previously Unvegetated plots from study sites after July 1, 2008. Unvegetated plots yielded significantly less CPUE than the Vegetated plots (P=0.002). Error bars represent standard error of the mean.

Figure 4. Total Catch per Unit Effort for the Previously Vegetated and Previously Unvegetated plots from study sites after July 1, 2008. Unvegetated plots yielded significantly less CPUE than the Vegetated plots (P=0.002). Error bars represent standard error of the mean.