



# Microinvertebrate distribution on Merrymeeting Bay, a freshwater, tidal ecosystem

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## Introduction

Aquatic microinvertebrates are a large, heterogeneous group of organisms that constitute a critical trophic level within the benthic food web. In Merrymeeting Bay, this group primarily includes crustaceans—chief among them cladocerans, copepods, and ostracods (Fig. 1)—but also includes insects, various types of worms, and rotifers. These organisms are generally primary consumers that feed on aquatic vegetation and associated periphytic algae (Diehl 1992). They are, in turn, eaten by secondary consumers such as fish. Microinvertebrate abundance and distribution, therefore, is an indicator of food-web health (Paukert and Willis 2003). I use these invertebrate-collection data to determine the spatial structure of the Merrymeeting Bay food web and assess its potential for recovery.

As most of the benthic food web literature is based on lentic systems (i.e. Paukert and Willis 2003; Scheffer 1993), it is important to establish that these patterns also hold true for Merrymeeting Bay. Unlike most still-water systems, Merrymeeting Bay has strong current from the Androscoggin and Kennebec rivers as well as tidal inflow and outflow. The bay also has areas with shallow, slowly moving water, which makes it not quite a lotic system, either. The main pattern I attempt to establish is that microinvertebrates are strongly associated with submerged aquatic vegetation (SAV) beds, as is widely established in lake systems (i.e. Diehl 1992; Ali 2007; Rennie 2005).

Secondly, I use collection data to illustrate the spatial distribution of macroinvertebrates across the bay. Ultimately, I attempt to correlate these patterns with relevant habitat variables such as water quality, turbidity, amount of vegetation, current strength, depth at low tide, substrate composition, and density of predators. Lastly, I will examine the food-web effects of transplanted vegetation and whether recently added beds act as effective habitat for microinvertebrates.

## Methods

### Site Description

Merrymeeting Bay is an inland bay formed at the confluence of the Kennebec and Androscoggin Rivers, among other minor tributaries. Although it is freshwater and 30 km from the Atlantic Ocean, the bay is also tidal. This combination of tidal influences and freshwater, as well as its size, makes the Merrymeeting Bay ecosystem unique among estuary systems north of Chesapeake Bay (Lichter et al 2006).

Four sites were chosen within the bay for study. The Androscoggin River site is the least sheltered of the sites, with coarse sand and the least turbidity. It has the fastest current and most closely resembles a lotic-type system. The Bald Head Point site is relatively protected with a moderate current and depth at low tide. The Butler Cove site is well protected and has an especially large amount of surrounding vegetation. The Cathance Flat site has the lowest depth at low tide and is fed primarily by the Cathance river, one of the smaller sources for the bay.

Two one-meter-square plots were transplanted with *Valisneria spiralis* at each site, one within an existing vegetation bed (vegetated treatment) and one in open water (unvegetated treatment). Sample areas included vegetated and unvegetated plots and, later, inside and outside unvegetated plots. Two methods of sampling were used.

### Light Traps

Light traps, or funnel traps, are a common and accepted way to sample aquatic invertebrates (NOAA 1997). They consist of a soda bottle with its top removed and inverted to form an inward-pointing funnel. These bottles are then secured to wooden stakes and staked 9" off the bottom. One white, long lasting glow stick is placed in each bottle. This light source attracts invertebrates by exploiting the animals' positive phototaxis. After two full tidal cycles, traps are removed and their contents filtered using a 125um funnel net. Samples are then taken back to lab where 10ml of the sample is removed and replaced with 91% isopropyl alcohol to halt predation. 1ml subsamples are then placed on a Wildco 1ml counting slide and organisms are classified broadly and counted. Typically classification stops at order.

### Sweep Net

Areas are swept with 125um funnel net using three passes over a meter-long transect. Samples are then dealt with in the same fashion as the light traps, above.

### Sediment Analysis

Sediment cores of 10cm were collected from each site, dried at 65°F for 5 days, sieved, and weighed. All sediment passing through the 2mm sieve was considered silt and clay. Percent composition was calculated for each site and grain-size category.

### Other environmental Analyses

Total suspended solids, percent cover, depth at low tide, turbidity, salinity, and chlorophyll were measured using various protocols not listed here (see posters by Drew Trafton and Ross Cowman).

### Statistical Analyses

Statistical analysis was only possible for certain groupings of data; each set of samples was considered differently and therefore N=1 for each plot. Comparisons of vegetated versus unvegetated, for example, allowed for the grouping of multiple data and thus lent itself to statistical analysis. Statistical tests were performed and graphs were created using SPSS v.10 for Windows.

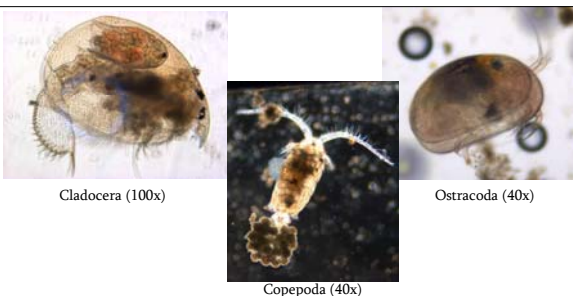


Fig. 1. The most commonly observed microinvertebrates of Merrymeeting Bay. From left, order Cladocera (water fleas), superorder Copepoda, and class Ostracoda. Micrographs by James Anderson.

## Abstract

Aquatic microinvertebrates are a large, heterogeneous group of organisms that constitute a critical trophic level within the benthic food web. In this study, I sample these creatures to determine the spatial structure of the Merrymeeting Bay food web and assess its potential for recovery after centuries of human impact. Specifically, I attempt to establish the relationship between these invertebrates and submerged aquatic vegetation. I examine which variables predict invertebrate abundance, and I try to predict the upper-trophic-level effects of transplanted vegetation. Invertebrates were sampled using two methods, identified under bright-field microscopy, and counted according to general taxonomy. There was no reliable trend observed with microinvertebrates and vegetation. The strongest relationship between invertebrate abundance and any variable was with substrate percent silt and clay. Evidence also exists for the success of transplanted vegetation in the invertebrate trophic level.

### Effect of vegetation on invertebrate distribution

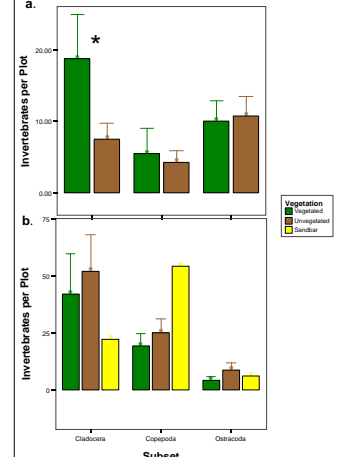


Fig. 2. Number of invertebrates per plots found in vegetated versus unvegetated plots in two occasions. Clusters represent phylogenetic classifications; bars represent means; error bars represent standard error; N=1 for sandbar; N=4 for all others.

### Effect of site on invertebrate distribution

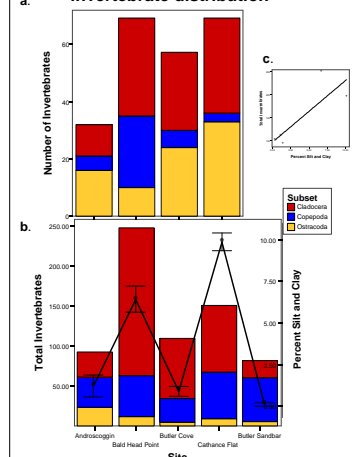


Fig. 3. Number of invertebrates from both plots found at each site in two occasions. Stacked bars represent phylogenetic classifications; bars represent sums. (b) Line graph represents the mean percent of silt and clay found in sediment from each respective site; error bars represent standard error; N=2. (c) Percent silt and clay vs. total invertebrates.

### Viability of food web within transplanted plots

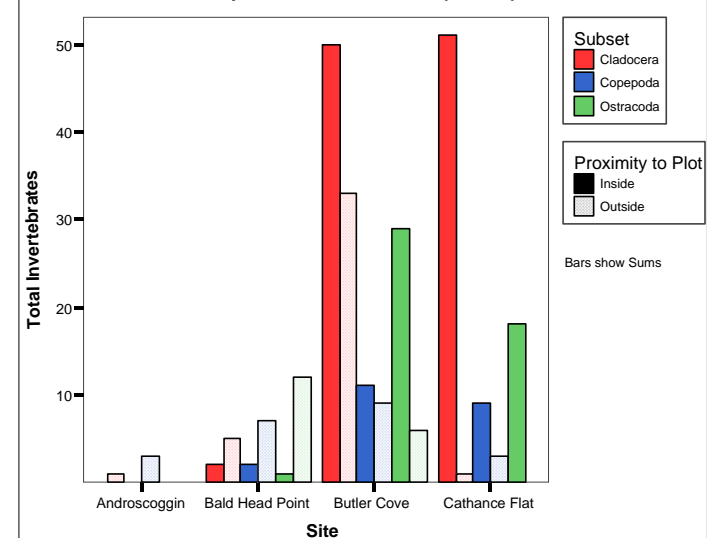


Fig. 4. Total number of invertebrates inside and outside of transplanted, unvegetated plots. More invertebrates—across all taxonomic classifications—were collected inside than outside of plots at Butler Cove and the Cathance Flats. This trend was reversed at Bald Head Point and at the Androscoggin site. Clusters represent sites; colors represent taxonomic classifications; bars represent sums.

## Results

### Effect of Vegetation

The first set of samples (Fig. 2a) shows no significant difference between vegetated and unvegetated plots, although it is very close to significant for cladocerans (independent-sample t-test;  $p > 0.318$ ;  $p = 0.082$ ). The second set (Fig. 2b) shows a conflicting trend—more invertebrates in unvegetated than vegetated plots—although none of these differences are significant (independent-samples t-test;  $p > 0.145$ ).

### Effect of Site

The two set of samples (Fig. 3) show a similar trend and that trend corresponds loosely to the percent of silt and clay found in sediment collected from each respective site. The two variables are not quite significantly correlated (Fig. 3c) linear regression;  $r^2 = 0.695$ ;  $p = 0.079$ .

### Effect of Transplants

In Butler Cove and the Cathance Flats, more invertebrates were found inside than outside of the transplanted plots (Fig. 4). This trend was reversed at Bald Head Point and at the Androscoggin site. The difference of invertebrates between the overall mean of samples from inside and outside (graph not shown) was not significant (independent-samples t-test;  $p = 0.404$ ).

## Discussion

My results do not show that invertebrates are more likely to be found in vegetated versus unvegetated habitat, as expected. In this way, Merrymeeting Bay in fact diverges from the vast majority of literature on shallow lakes (i.e. Diehl 1992; Ali et al 2007). There are a number of plausible reasons for this difference.

First, Merrymeeting Bay is fundamentally different because it is tidal. This tidal current, along with that of the Kennebec and Androscoggin Rivers, makes Merrymeeting Bay a relatively lotic habitat. This possibility is supported by the observation that generally fewer invertebrates are found at the Androscoggin and Butler Sandbar sites, the two sites with the strongest current.

Another possibility is that the areas we chose for plots were not far enough away from each other to measure any difference. In most cases, plots were within 10m of each other to minimize compounding site variables. Unvegetated plots, while not within a bed of vegetation, were rather located just outside of one. Especially considering the strong currents in the bay, it is possible being located nearby vegetation caused the same effect on invertebrate populations as being directly inside the vegetation beds.

Sampling at the Butler Sandbar was an attempt to quantify this effect. The problem with this sampling, however, was that there were many differences at this site beside simply vegetation. The sandbar site is the shallowest of all the sites, has one of the strongest currents, and its substrate composition is mostly sand and very little silt and clay. For these reasons, the sandbar forms a more-than-imperfect comparison with unvegetated plots. What's more, the sandbar counts are not necessarily lower than those of unvegetated plots (Fig. 2b).

There is some limited evidence that the transplanted plots represent a better habitat for microinvertebrates than open water. At two sites, Butler Cove and Cathance Flat, there were many more invertebrates found inside the plot than outside (Fig. 4). These data suggest that a broader scale transplant effort may have measurable and immediate impacts on the upper trophic levels, at least as far as invertebrates.

Perhaps the strongest relationship this study reveals is the effect of substrate composition, particularly the percent of silt and clay, on invertebrate populations (Fig. 3b). Percent silt and clay is in effect an analog for turbidity. Thus, it seems that invertebrates are found more often at turbid sites than clear sites. If we accept this correlation at face value, then it stands in contrast to our expectations that the benthic food web is stronger in areas of low turbidity. What may be a compounding factor, however, is that swift water sites are generally less turbid than areas of slow or stagnant water. Thus, we cannot say that a given site—all else equal—would have fewer invertebrates if its turbidity were lowered.

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