

Mare Brook Macroinvertebrate Enclosure Study

Introduction

This study investigated the absence of healthy macroinvertebrate communities in the Mare Brook watershed in Brunswick, Maine. The primary question regarding the absence of these communities is whether there are problems with the stream water (e.g., toxins in the water) or the physical habitat (e.g., toxins in the substrate) that are potentially suppressing macroinvertebrates in this watershed. To address this issue, the study was designed to provide consistent physical habitat among stream locations thereby isolating the stream water as the single variable between sites. This was done through the construction of in-stream enclosures which provided standardized habitat conditions (Figure 1). The chambers were stocked with a known quantity of macroinvertebrates so that survivorship among sites could be compared.



Figure 1. In-stream chambers used to standardize physical habitat conditions between sites. The chambers are filled with cobble-sized rocks to provide suitable macroinvertebrate habitat. They have mesh openings on all sides to allow water to flow through the enclosure. The black pipe on the top of the chamber allows access for a water quality probe to monitor conditions inside the enclosure.

Sites were established in two locations of Mare Brook and one location in a reference stream for comparison. The purpose of deploying chambers in a reference stream is to provide an expected level of survivorship for an unimpaired stream, as we would assume some mortality due only to the mayflies being located inside the chamber. Fifteen chambers were deployed so that five chambers could be placed in each of three sites: two locations in the Mare Brook watershed – Mare Brook along Richards Drive (ME DEP monitoring station S-1064) and Merriconeag Stream below Purinton Crossing (S-330) – and a reference stream in Bowdoin (East Branch Cathance River, S-859). This particular reference stream was chosen due to its proximity to Brunswick and the two test sites, a similar sandy habitat to Mare Brook, and its unimpaired water quality. This stream was found to meet its Class B aquatic life use standard the last time a Maine DEP macroinvertebrate assessment was completed there in 2013.

The chambers were made from 11" x 14" x 3.5" plastic boxes. Holes were cut along each side of the boxes to maximize the flow of stream water through them. The holes were covered with window screen (inside) and ¼" hardware cloth (outside) to keep macroinvertebrates inside and strengthen the chambers. A tube was attached through the lid so that a water quality meter could be lowered inside to monitor in-chamber water quality conditions (Figure 1).

The Study

Study organisms – A particular genus of mayfly (*MacCaffertium*; Figure 2) was chosen to stock inside the chambers due to their commonness in Class B streams in Maine and their known ubiquity at a particular stream location (Douglas Brook in Gorham, ME). All of the mayflies used in the study were collected on the morning of deployment (Figure 3). They were kept alive during transport to the study sites in a bucket of cool water with a running aquarium aerator.



Figure 2. The mayfly (genus: *MacCaffertium*) used in the study.



Figure 3. Collecting mayflies at the study stream.

Chamber Deployment - Chambers were deployed at all three sites on August 5th, 2016. They were left in the stream for seven days and were retrieved on August 12th, 2016. This was a hot dry week with daily air temperatures near 85°F. A negligible amount of rain fell in the area during the deployment period (0.09" on August 10th). Five chambers were deployed at each of the three sites (Figure 4), all with 10 mayflies in each. Daily water quality measurements (water temperature, dissolved oxygen and specific conductivity) were recorded to check for variation between stream conditions and chamber conditions (Table 1). Electronic datasondes were also deployed at each site to record continuous dissolved oxygen and temperature data (Figure 5).

Merriconeag Stream below Purinton Crossing (S-330)



Mare Brook along Richards Drive (S-1064)



Reference Stream: East Branch Cathance River (S-859)



Figure 3. Placement of chambers at each of the three site locations.

Table 1. Summary data (averages for the week of deployment) from daily water quality checks on stream sites and chambers.

Site		Water Temperature (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)
<i>Purinton Ave. - Merriconeag Stream</i>	Chamber Avg.	21.33	5.45	220.94
	Stream Avg.	21.28	6.42	223.80
	Chamber - Stream Difference	0.05	-0.97	-2.86
	Chamber - Stream Difference (%)	0.2%	-16.3%	-1.3%
<i>Richards Ave. - Mare Brook</i>	Chamber Avg.	17.31	6.44	261.16
	Stream Avg.	17.44	7.97	241.92
	Chamber - Stream Difference	-0.13	-1.53	19.24
	Chamber - Stream Difference (%)	-0.78%	-21.28%	7.65%
<i>Reference Site: East Branch Cathance River</i>	Chamber Avg.	19.18	1.118	43.95
	Stream Avg.	19.18	1.864	72.64
	Chamber - Stream Difference	0.00	-0.75	-28.69
	Chamber - Stream Difference (%)	0.0%	-50.0%	-49.2%

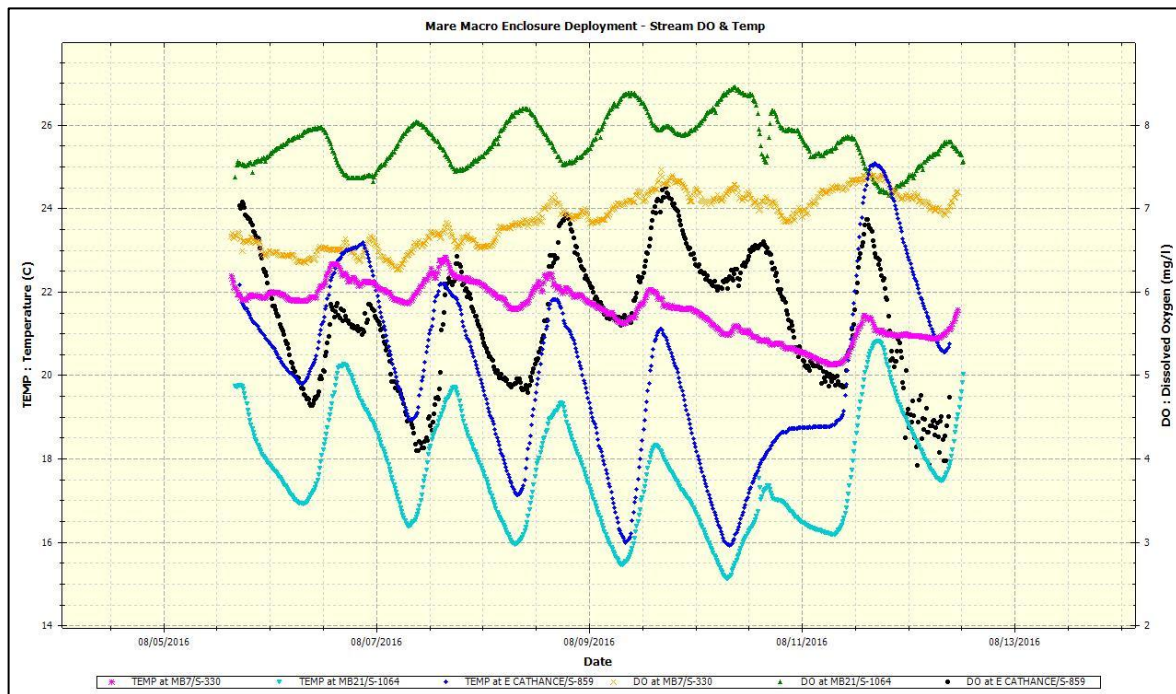


Figure 4. Continuous water temperature and dissolved oxygen data for each of the three sites.

Results

Chambers were retrieved on August 12th, 2016 and the mayflies inside were enumerated as living, dead or missing. If partial mayflies were found, only parts with heads were counted. Table 2 lists the data obtained from each chamber.

Table 2. Mayfly survivorship data from the two sites in the Mare Brook watershed and the reference stream.
 *The tube on chamber #8 from Mare Brook became loose during deployment, so this chamber was not tallied in the final results.

Site	Chamber #	# Live	# Dead	# Missing	% Survivorship of remaining mayflies	% Survivorship of original number of mayflies
<i>Merriconeag Stream - Purinton Ave.</i>	7	0	0	10	--	0
	4	0	2	8	0	0
	13	0	9	1	0	0
	11	0	1	9	0	0
	9	0	2	8	0	0
	Average	0	2.8	7.2	0	0
<i>Mare Brook - Richards Ave.</i>	8*	--	--	--	--	--
	10	4	2	4	67	40
	3	3	0	7	100	30
	4	0	0	10	--	--
	14	4	1	5	80	40
	Average	2.8	0.8	6.5	82.2	36.7
<i>Reference Stream East Branch Cathance River</i>	6	0	5	5	0	0
	12	0	8	2	0	0
	16	0	3	7	0	0
	15	0	6	4	0	0
	5	0	10	0	0	0
	Average	0	6.4	3.6	0	0

Site Discussions

Merriconeag Stream - Purinton Ave.

No live mayflies were found in any of the five chambers. On average, only 2.8 dead mayflies were recovered from each, indicating a substantial loss of mayflies from these chambers. Planarian flatworms (Figure 5) were abundant inside these chambers upon retrieval; the flat worms were likely scavenging and/or predating upon mayflies which could explain the low numbers recovered. Mayfly parts were not as abundant as in the reference stream chamber, providing further evidence that predation or scavenging was occurring. These results make it unclear how many mayflies potentially died due to stream conditions alone. Dissolved oxygen was slightly lower in the chambers relative to stream but not enough to cause concern.

Mare Brook - Richards Ave.

Some survivorship was observed at this site: 36.7% of original 10 mayflies were still alive at retrieval, while 82.2% of mayflies remaining in the chamber were still alive). In these chambers, Isopods were found to be abundant. As in the Merriconeag Stream chambers, there is high likelihood that the isopods were scavenging on mayfly bodies and parts since there were almost no signs of dead or decomposing mayflies in these chambers. Dissolved oxygen was slightly lower in the chambers relative to stream but not enough to cause concern.

Reference Stream - East Branch Cathance River

This site met Maine Class B standards for aquatic life use in 2013 and showed a healthy macroinvertebrate community. However, the water and dissolved oxygen levels were critically low during the chamber deployment period. The sonde at this site showed the DO ranging from ~4 to ~7 mg/L, but the meter used to check the stream and inside the chambers daily showed an average of 1.8 mg/L (stream) and 1.1 mg/L (chamber). These dissolved oxygen levels are critically low - too low for gilled organisms like mayflies to survive. No surviving mayflies were found inside the chambers, but many body parts were recovered. This indicates that the organisms died in the chamber and were decomposing - as opposed to being scavenged or predated upon. Since no mayflies survived in the reference chamber, comparisons to the reference condition are not possible in this study.



Figure 5. Tubellaria flatworms (genus *Planaria*) were found in abundance in the Merriconeag Stream chambers. Planarians are known to eat living and dead animals, and may be the reason so few mayflies (or mayfly parts) were recovered from these chambers.



Figure 5. Isopoda (a crustacean that can be found in fresh or salt water, also on land) were found in abundance in the Mare Brook chambers. Isopods are known to eat living and dead animals, and may be the reason so few mayflies (or mayfly parts) were recovered from these chambers.

Discussion

It appears that the stream water in Mare Brook will not kill moderately sensitive macroinvertebrates within one week. It is difficult to draw further or stronger conclusions from this study, since extenuating circumstances complicate the results.

Our deployment week for the study coincided with extremely low flow and water level conditions. It is difficult to determine the extent that these stream conditions affected the chambers, but it seems that it did at least affect the reference stream. The purpose of deploying chambers in a reference stream is to provide an expected level of survivorship for an unimpaired stream, as we would assume some mortality due only to the mayflies being located inside the chamber. Dissolved oxygen was critically low in the reference stream, which likely contributed to the 0% survivorship in the reference chambers. With these results, it's not possible to compare the survivorship of the mayflies in the Mare Brook chambers to what is expected.

The invasion of other taxa (flatworms in Merriconeag Stream and Isopoda in Mare Brook) into the chambers makes it difficult to determine if mayfly death or disappearance was due to stream conditions or predation, or both. The intent to keep mayflies inside, other animals outside, and water flowing freely through the chambers is difficult to implement. There has been success with this chamber and study design before, but Isopods and flatworms were not observed to be an issue in the previous study streams.

In a similar study involving these chambers in 2013, Douglas Brook in Gorham (where the mayflies for the present study were collected) was used as the reference stream. In that study, the survivorship in the reference chambers was 67%, with only 2 mayflies missing from 3 chambers. Applying this value to the current study, survivorship in the reference stream is roughly double than that of the Mare Brook chambers (36.7%).