

## The contrasting differences in zooplankton community composition and abundance between aquaculture (mussel farm) and control sites in the Havre-aux-Maisons lagoon, QC.



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### Abstract

Relegated to the benthos, the blue mussel, *Mytilus edulis*, is confined to consuming resources available in the water above substrates. However, aquaculture manipulates the distribution of mussels and renders the resources of the water column available to mussels. With the identification of mussels as significant consumers of zooplankton, the presence of mussels in the water column suggests aquaculture could have an impact on the abundance and composition of zooplankton. The Havre-aux-Maisons Lagoon in the Magdalen Islands, QC has supported mussel aquaculture for over a quarter century. Water samples were obtained from farm and control sites in the lagoon in August 2010 to characterize the differences in zooplankton composition and abundance. Data indicates substantial differences between farm and reference sites. Multivariate analyses revealed significant differences in community composition between farm and reference sites (ANOSIM,  $p < 0.05$ ), whereas estimates of abundances indicated a significant reduction in zooplankton abundance in farm sites (t-test,  $p < 0.05$ ). While the mechanism for the observed differences remains unknown, the results suggest the presence of mussels in the water column can alter the structure and abundance of zooplankton communities.

### Introduction

Blue mussels, *Mytilus edulis*, purported specialized microphagous filter feeders, have the capacity to consume zooplankton. Feeding experiments indicate the blue mussel can accept zooplankton, and several zooplankton taxa have been detected in the stomach contents of mussels obtained in the field<sup>1</sup>. Subsequent experiments have confirmed mussel predation on zooplankton<sup>2,3</sup>. However, the natural distribution of mussels limits interactions between mussels and zooplankton. Mussels are benthic organisms confined to filtering water above the substrate<sup>4</sup>. Yet when distributions overlap, predation can manifest. Water above mussel

beds, where zooplankton and mussels can interface, contains significantly less zooplankton than water above bare sea floor where mussels are absent<sup>5</sup>. Turbulence has been shown to generate predation through increased encounter rate. Zooplankton are driven towards mussel beds during periods of high turbulence, which enhances predation<sup>6,7</sup>. Anthropogenic intervention, however, facilitates the greatest interaction. Long-line mussel aquaculture fully superimposes mussel and zooplankton distributions. Mussels are suspended in the water column, consequently rendering zooplankton available to mussels<sup>8</sup>. The aquaculture mussel configuration facilitates intraguild predation, where a competitor can fall prey to a

heterospecific competitor. The blue mussel and zooplankton are designated the intraguild predator and prey, respectively with phytoplankton as the common resource. The manifestation of intraguild predation can have a negative effect on the intraguild prey subjected to both competition and predation<sup>9</sup>.

In this paper, aquaculture sites (farm) and reference sites are used to determine the impact of mussel aquaculture on the zooplankton community. We hypothesize that the presence of mussels in the water column will subject zooplankton to increased predation and generate decreased densities. Due to the selectivity of the mussel siphon and variability in prey vulnerability we also expected changes in community composition and tested our data for taxonomic differences between farm and reference sites.

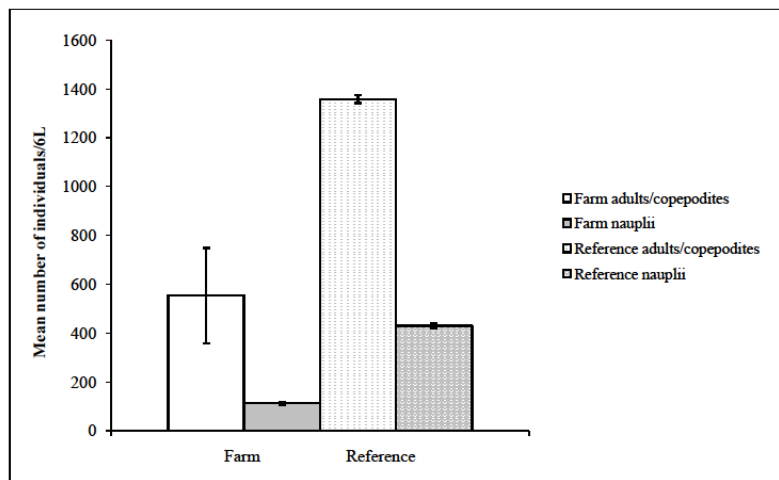
### Field methods

Samples were obtained from the Havre-aux-Maison Lagoon in the Magdalen Islands, QC. The Havre-aux-Maison Lagoon has supported mussel aquaculture for over a quarter century<sup>10</sup>. In conjunction with an associated project 1.2m x 0.76m cylindrical fiberglass mesocosms were inserted into farm and reference sediments. The mesocosm were fitted with sampling ports that facilitated the

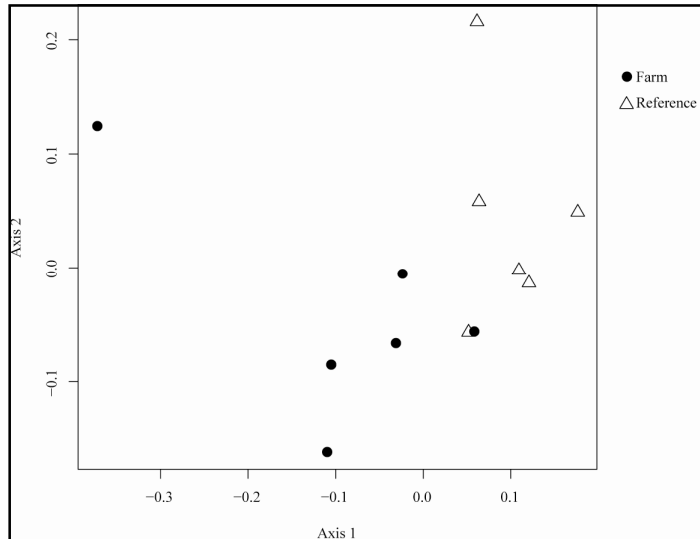
removal of water samples. Twelve mesocosms were deployed - six in farm and six in reference sites. The farm was delineated from MAPAQ (Ministère de l'Agriculture Pêcheries et Alimentation) GPS coordinates. Reference sites were located outside the boundaries of the farm. Farm and reference mesocosms were arranged in a paired block design to decrease the abiotic variability between treatments. 6L water samples were removed from each mesocosm following the installation of the mesocosms to characterize the zooplankton community. Water samples were filtered through 45mm nitex mesh and preserved in 95% ethanol. Individuals were identified to genus or species where available.

### Statistical methods

A two-dimensional Principal Coordinates Analysis (PCoA) ordination was produced with a Bray-Curtis resemblance measure from the site × taxa data. Each life stage was treated as a separate variable in the analysis. An ANOSIM procedure was subsequently applied to test for differences between farm and reference sites as a function of community composition. A t-test was applied to abundance data to test for differences between farm and reference sites. Abundance data was analyzed for adults/copepodites and nauplii separately to test for the presence of size selectivity.



**Figure 1. Mean number of individuals detected in each 6L water sample in farm and reference sites, separated by life stage. Error bars denote  $\pm 1$  SE.**



**Figure 2. Two-dimensional, PCoA ordination of farm (solid circle) and reference (triangle) sites using a Bray-Curtis resemblance measure.**

## Results

Mussels exact an effect on both zooplankton abundance and community composition. A total of 29 taxa were detected in water samples. However, seven taxa were only present in the reference sites, while there were no taxa specific to only farm sites. Abundance data indicates significantly less zooplankton in the farm sites for both adults/copepodites ( $p = 0.005$ ) and nauplii ( $p = 0.04$  t-test; Fig. 1). The analysis of community composition data also indicated differences between the community that constitutes the farm sites and reference sites. The PCoA ordination demonstrated clustering within farm and reference sites (Fig. 2). ANSOIM procedure confirmed the differences between sites ( $p = 0.01$ ).

## Discussion and Conclusion

Transplanting mussels to the water column subjects zooplankton to predation and competition – processes absent in reference sites. Lower zooplankton densities and differences in composition demonstrate the different pressures on zooplankton in experimental farm vs. reference sites. The significant difference in both adults/copepodites and nauplii suggests which suggests both categories are affected by the presence of mussels. We plan further experimentation to investigate the relative importance of predation and competition in this aquaculture-based intraguild predation food

web. The results from the Havre-aux-Maison lagoon are consistent with results from Ría de Vigo, Spain and Bantry Bay, Ireland where samples from the disparate aquaculture sites demonstrated that mussels can have a deleterious effect on zooplankton through increased competition and predation<sup>11,12</sup>.

This paper demonstrates one detectible impact of mussel aquaculture on the surrounding plankton community. The implications of mussel aquaculture on the pelagic compared to the benthic ecosystem system are relatively unknown<sup>13</sup>. Greater understanding of this system in an ecological context is necessary to secure the continual production of mussels as an aquaculture product.

## Acknowledgements

We thank Karine Nantel, The AQUAMAN Team, MAPAQ, SODIM and Réseau Aquaculture Québec. This project was funded through an NSERC Strategic Grant to GFF and three others.

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