Assessing the individual and combined effects of invasive crabs on macrofaunal community structure in Nova Scotia, Canada

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I. Introduction

- The European green crab, native to the Northeast Atlantic[1], and the Asian shore crab, native to East Asia[2], are two invasive species co-occurring in the Northwest Atlantic (USA and Canada).
- Both species were introduced through larvae inadvertently pumped into ship ballast water and released overseas[3].
- The green crab has been established since 1817[4], whereas the shore crab's introduction is more recent (Fig. 1). the shore crab's expansion into Nova Scotia was suspected due to climate change.
- Both crabs prey on ecologically and economically important organisms (e.g., soft-shelled clams[8,9], blue mussels[10], and macrofaunal invertebrates[11,12])

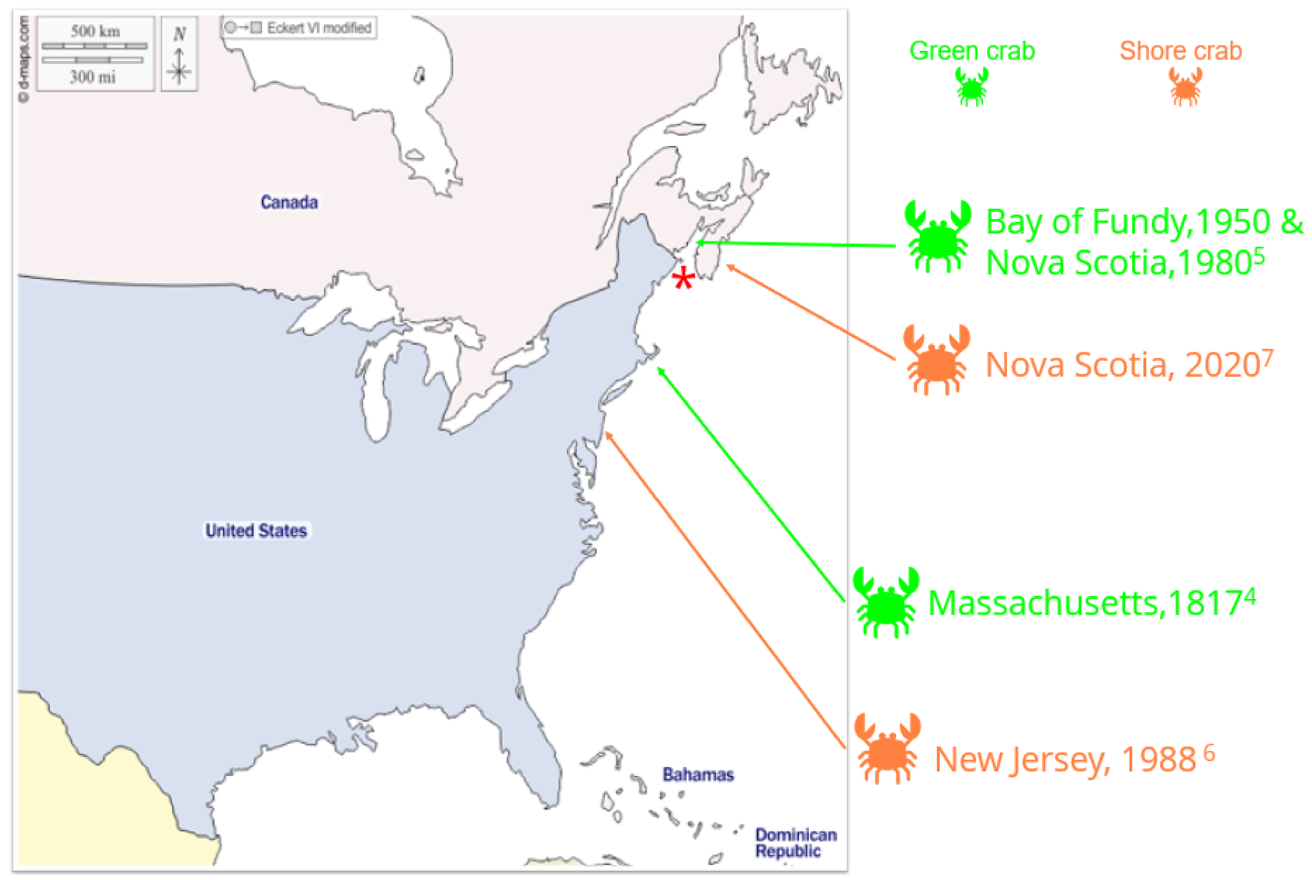


Fig 1. Invasion history of European green crabs and Asian shore crabs.
* = Study area in St. Mary's Bay, Nova Scotia (44°29'03"N 65°58'08"W).

II. Significance

Macrofauna: invertebrates >500µm

- Food for important species such as common sole[13] and sturgeon[14].
- Oxygenate benthic environment, increasing nutrient cycling[15].
- Indicator species for environmental monitoring[16].

Knowledge gaps

- Limited study on co-invasion effects[17].
- Previous studies have focused on species-level effects rather than community-level effects of crabs.
- Multiple predator effects[18,19] : total effects are not equal to the sum of individual predator effects.

Examples of macrofauna. From left to right: Amphipod, Isopod, Polychaetes

European green crab *(Carcinus maenas)* Listed in top 100 worst invasive species[1].

Asian shore crab *(Hemigrapsus sanguineus)* Have been exceeding green crab population by tenfold in Maine[20].

Objective: To examine the impact of these two co-occurring invasive crabs on the benthic macrofaunal community structure.

Hypothesis 1: Feeding and foraging by crabs negatively affect macrofauna community structure (e.g., taxon richness and abundance).

Hypothesis 2: The presence of another crab will alter the effect on the macrofaunal community.

Hypothesis 3: The presence of conspecifics (same species) vs. heterospecifics (different species) affect macrofaunal community structure differently.

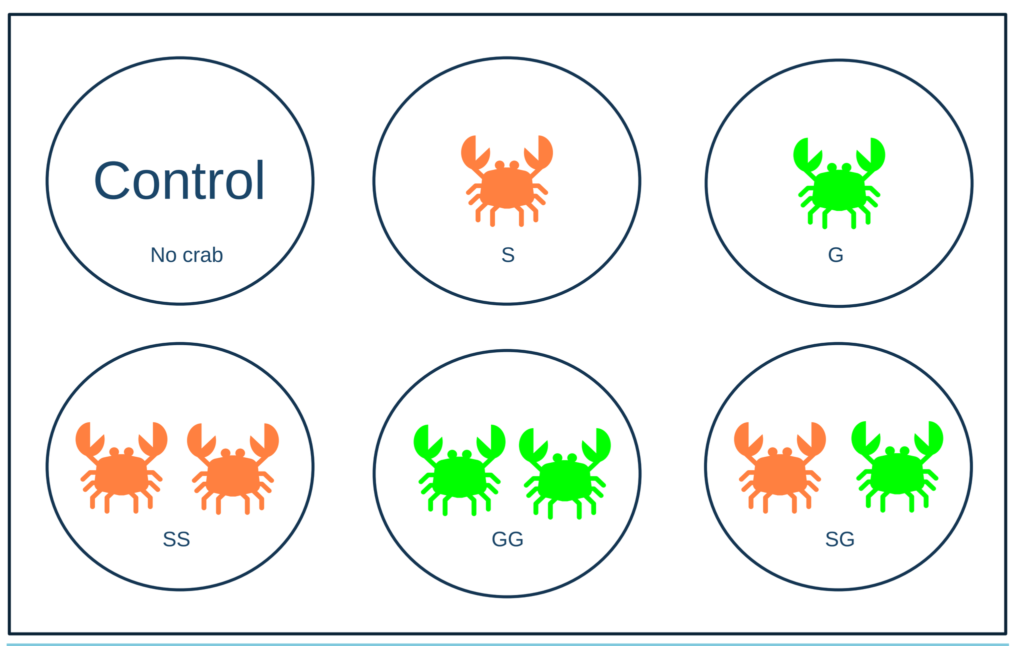


Fig 2. Illustration of the experimental setups (S: shore crab, G; green crab, SS: two shore crabs; GG: two green crabs, SG: a shore and a green crab). Location of each treatment were placed randomly.

Experimental set-up (left). Shore crab in a treatment (right)

Methodology

1. Collected macrofauna using a 3cm deep cup cored into intertidal sediments.
2. Place 24-hour unfed crabs into the experimental cups.
3. Left to feed for 3 days. Recorded temperature and replaced any molted crabs (n=4) daily.
4. Removed crabs and fixed macrofauna in 4% buffered formalin, then in 70% ethanol with Rose Bengal dye.

❖ Design included five crab treatments and two controls (i.e., experimental no crab present and ambient sediment that was fixed directly after collection in the field), Fig. 2 (ambient not shown).

Data analysis

Hypothesis 1

Principle Coordinates Analysis (PCO) in PRIMER 7.0 and ordination diagram based on Bray Curtis similarity comparing macrofaunal community structure among samples/treatments.

Hypothesis 2 and 3

Conducted univariate statics in Jamovi between alone vs. paired crab treatments (planned comparisons: S vs. SS; G vs. GG, S vs. SG; G vs.SG) to examine differences in community measures (i.e., species/taxon richness, evenness, Shannon diversity, and total macrofaunal abundance) and major taxonomic groups. When data were normal or could be normalized through transformation (i.e., square root or log), a t-test was conducted. Otherwise, a Mann-Whitney U test was used.

Hypothesis 3

Using the same metrics as stated in hypothesis 2, we use to conduct ANOVA analysis for SS, GG, SG

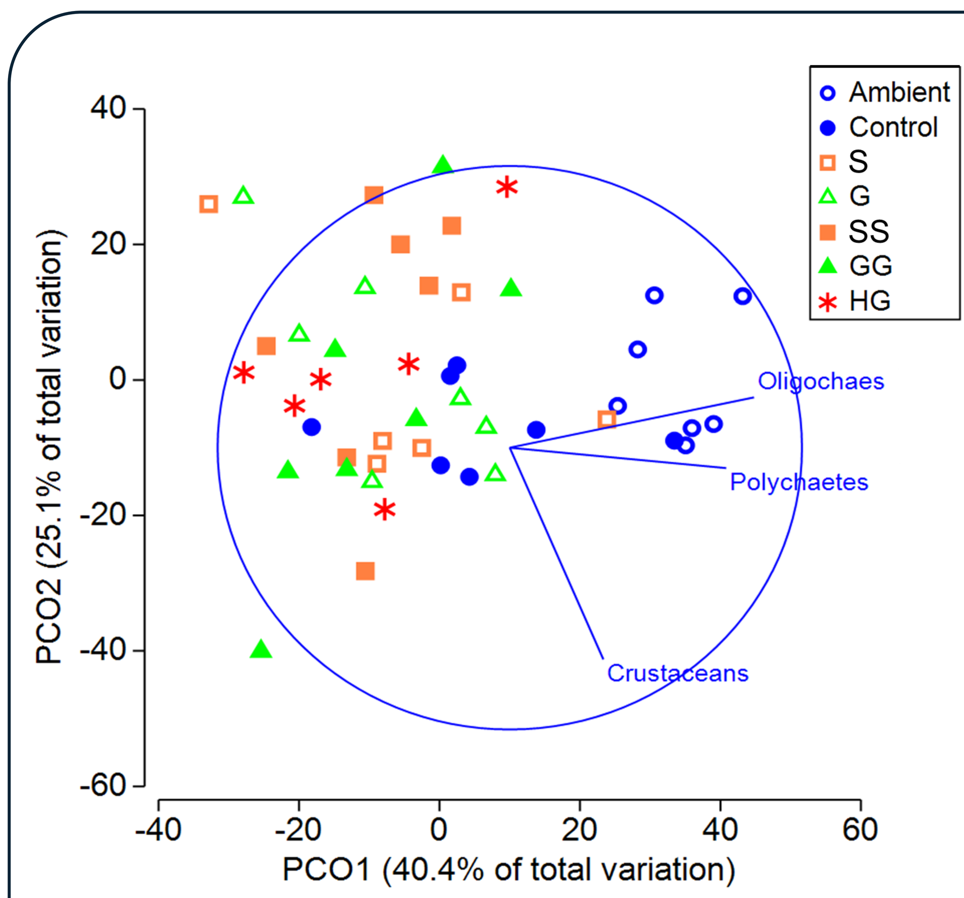
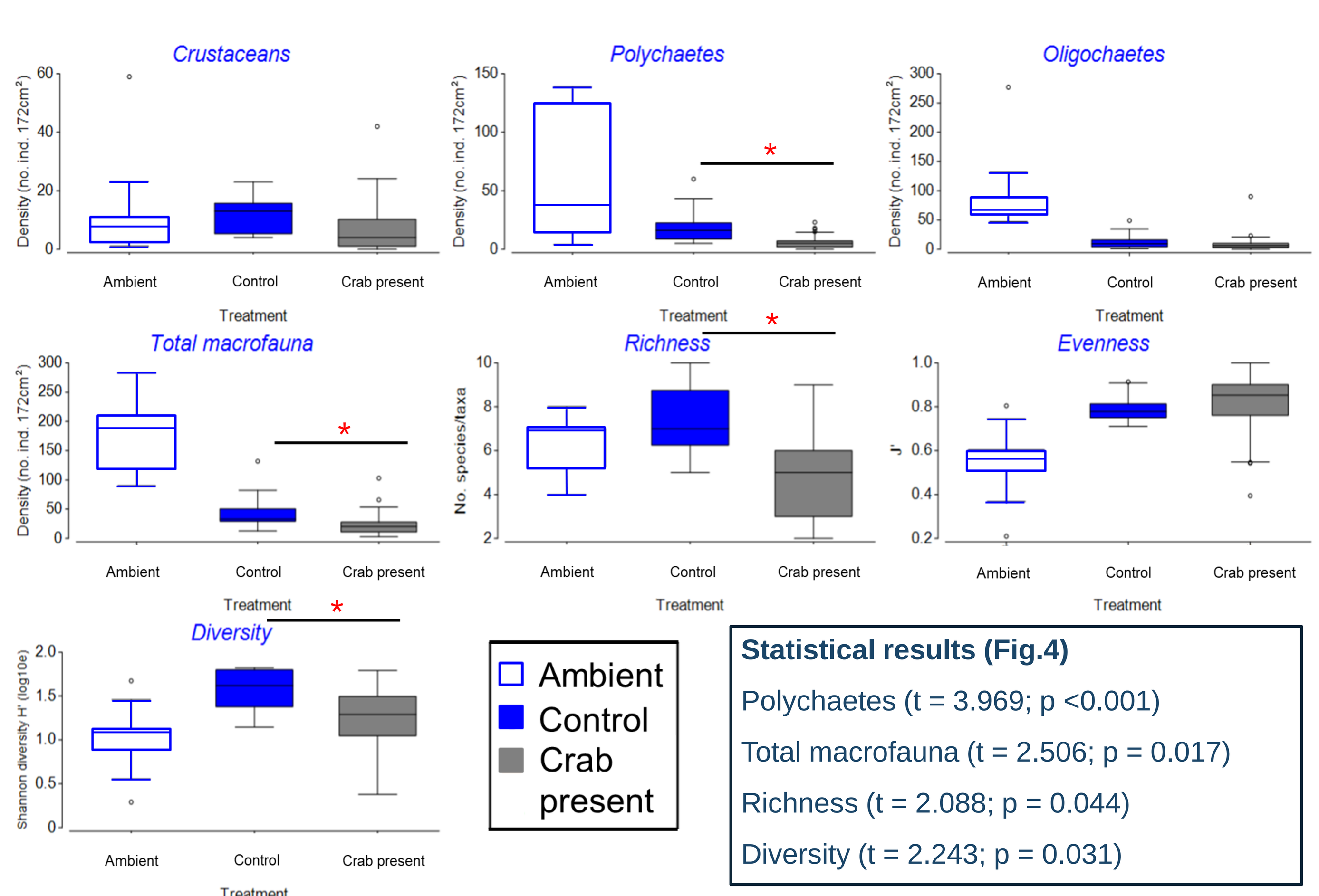


Fig 3. Principal Coordinate Analysis comparing macrofaunal community in each treatment. Vectors show major taxonomic groupings that contributed to the observed dissimilarity between treatments. Each treatment (Ambient, Control, SS, G, GG) was replicated with *n* = 7, while S and SG treatment had *n* = 6.



Statistical results (Fig.4)

Polychaetes (t = 3.969; p <0.001)

Total macrofauna (t = 2.506; p = 0.017)

Richness (t = 2.088; p = 0.044)

Diversity (t = 2.243; p = 0.031)

Fig 4. Box plots (median, quartiles and ranges) of community metrics and taxon abundance for ambient (*n* = 7), control (*n*=7), and Crab-present treatments (*n* = 33). * = significant differences (t-test, p < 0.05).

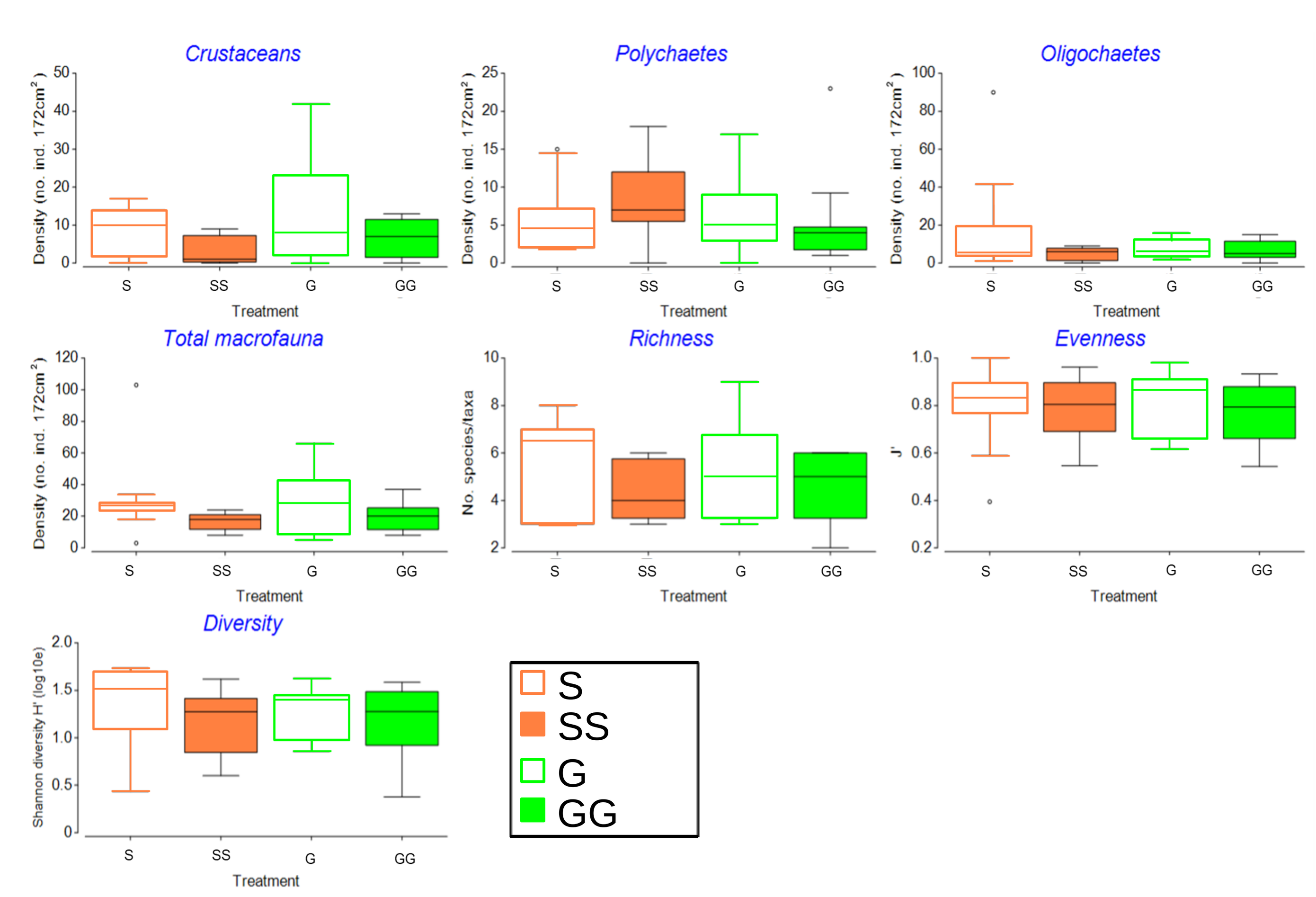


Fig 5. Box plots of community metrics and taxon abundance for crab alone vs. paired treatments (S, SS, G, GG; *n* = 6-7) As (Note that H vs. GH; G vs. GH were also not significantly different among these community measures).

Key takeaways

- Multivariate analyses showed that differences among samples were mainly driven by variations in the abundance of Crustaceans, Polychaetes, and Oligochaetes (Fig 3.). The ambient sediment community was clearly different from the community present in all other treatments. No clear groupings were found for the other treatments.
- The presence of crabs significantly reduced species/taxon richness, diversity, total macrofaunal abundance and the abundance of polychaetes (Fig. 4.)
- Crabs when alone or together had a similar effect on macrofaunal community (Fig 5.).
- Heterospecific and conspecific pairings did not alter crab impacts on the macrofauna community. (Note that the data for heterospecific pairings was not plotted in this poster)

Acknowledgement

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References