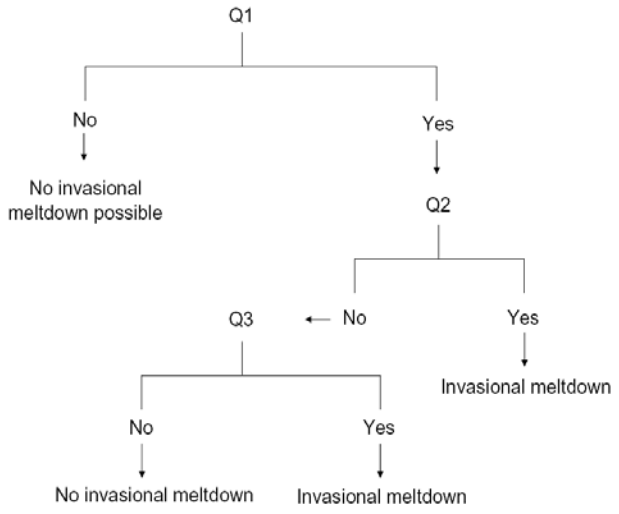
Apple snails reduce native plant abundance and facilitate alligator weed invasion

Invaded habitats often contain multiple exotic species which may reflect positive biotic interactions among exotic species. The invasional meltdown hypothesis proposes that exotic species increase the success of other exotic species, often those on different trophic levels, resulting in a highly invaded habitat. To fully understand the causes and effects of multi-trophic invasions, biotic interactions among exotic species must be considered

Figure 1



In a 16-week mesocosm experiment I investigated whether multiple invaders influence each other's invasion success and impacts more specifically whether there was mutual facilitation between an exotic plant (*Althernanthera philoxeroides* – alligator weed) and an exotic herbivore (*Pomacea insularum* – island apple snail) consistent with an invasional meltdown. Using invasive plants and invertebrates in freshwater ecosystems, I addressed the following questions: Q1) Does the presence of exotic herbivorous snails increase the success of exotic plants invading native plant communities? Q2) Does the presence of exotic plants in a native plant community increase the success of exotic snails? Q3) Is exotic snail performance higher in exotic plant communities vs. native plant communities? (not tested in this field experiment)

Experimental design

Forty freshwater wetland communities were established in summer 2010 and were subjected to single (snails or plants), successive (snails then plants or plants then snails), or simultaneous invasions (snails and plants), or were left as uninvaded controls in late spring 2011. I collected data on native plant biomass and diversity, alligator weed biomass, native snail abundance, and apple snail size and abundance.

Results

Reductions in native plant biomass and diversity versus controls were greater for communities only invaded by apple snails compared to those only invaded by alligator weed ($F_{5, 34} = 11.745$, $p < 0.0001$; and $F_{5, 34} = 14.322$, $p < 0.0001$, respectively; Fig. 2). Apple snails fed preferentially on native plants so that even though they significantly reduced alligator weed biomass, they significantly increased the proportion of plant mass that was alligator weed ($F_{2, 17} = 9.526$, $p = 0.0017$; $F_{2, 17} = 3.916$, $p = 0.0399$, respectively; Fig. 3; Fig. 1 - Q1="yes"). Apple snail growth and fitness were all independent of the presence of alligator weed ($F_{2, 17} = 1.780$, $p = 0.1987$, and $F_{2, 17} = 0.017$; $p = 0.9830$, respectively; Fig. 4; Fig. 1 - Q2="no").

Discussion

Reductions in native plant biomass and diversity for communities invaded by apple snails compared to those only invaded by alligator weed suggests that exotic herbivores have greater impacts on these native wetland plant communities than do exotic plants. Apple snails preferentially feeding on native plants and the increase in the proportion of plant mass that was alligator weed suggests that apple snails may facilitate invasions by exotic plants in these ecosystems. This study showed that apple snails directly damage wetland ecosystems by consuming native plants and indirectly damaging such ecosystems by providing opportunities for exotic plants to invade. However, I did not find mutual facilitation between the exotic plant and herbivore species as predicted by the invasional meltdown hypothesis.

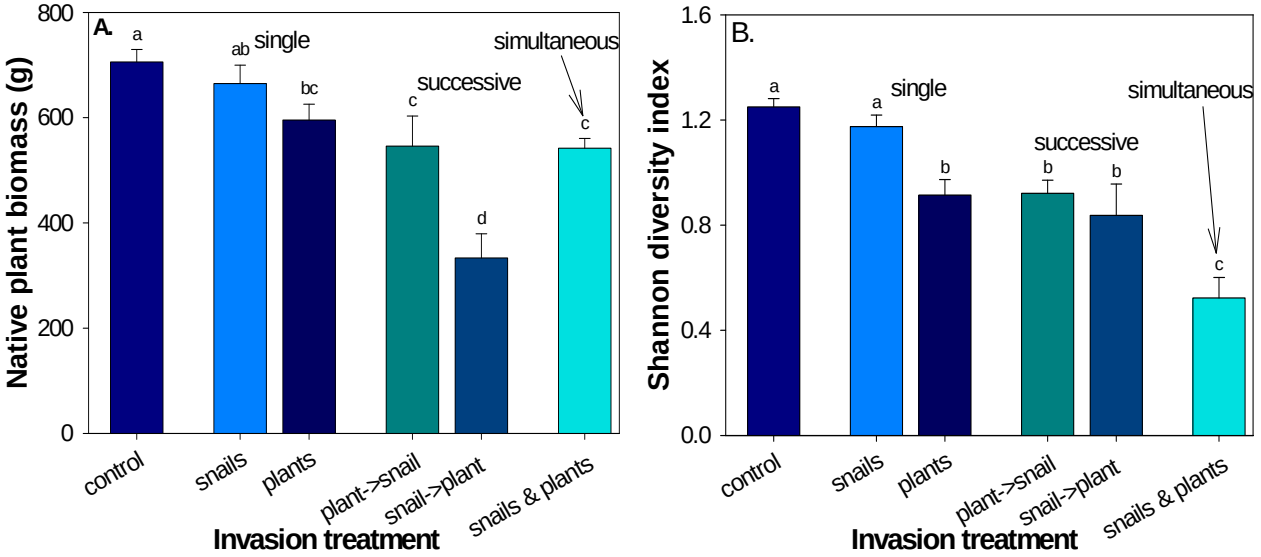


Figure 2: A) Native plant biomass in each invasion treatment and B) Shannon diversity index for each invasion treatment. Means + 1 s.e. Letters indicate treatments that were not significantly different in post-hoc tests.

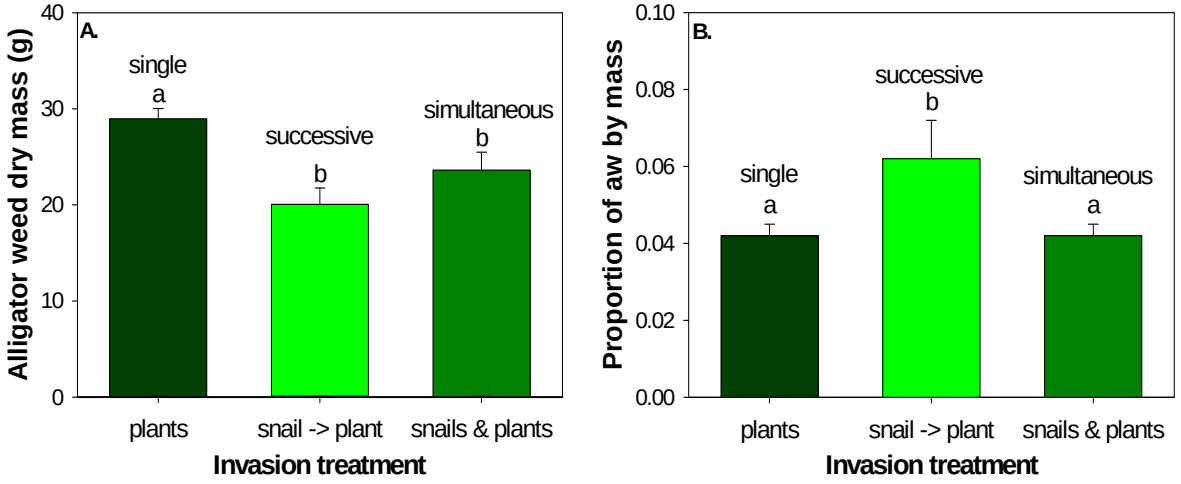


Figure 3: A) Alligator weed biomass and B) Proportion of alligator weed by mass in each treatment that included exotic plants. Means + 1 s.e. Letters indicate treatments that were not significantly different in post-hoc tests.

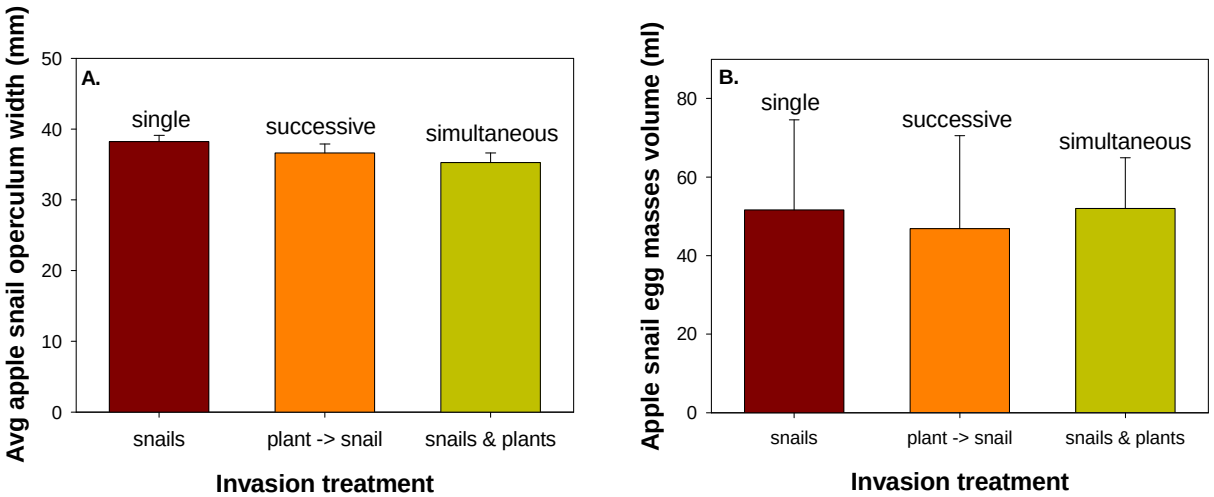


Figure 4: A) Adult apple snail average operculum width and B) Apple snail total egg mass volume in each treatment that included exotic snails. Means + 1 s.e.