Assessing the Settlement and Distribution of Aquatic Invasive Invertebrates in the Lower Hudson River: a Lesson in Efficacy of Artificial Settlement Samplers

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Are there really 120 invaders in the Hudson River, or just zebra mussels?

The Hudson River is highly susceptible to invasion and establishment of non-native species due to increased propagule pressure from repeated human introduction, in addition to the regular disturbances attributed to tidal estuaries (Wasson et al. 2002). Aquatic invaders have the potential to alter water quality and heavily disrupt food webs; this is particularly true for invertebrates, which are a dominant group of invaders in aquatic ecosystems (Strayer 2010). Still, complete regional assessments of freshwater invasive species are lacking in the current literature and most research of invasive invertebrates has been limited to a select number of species, like the zebra mussel (Sousa et al. 2014).

To address these issues regarding current distribution knowledge and accessibility for future study in the Hudson River, we evaluated the sampling efficacy of a novel recruitment tile design for use in tidal, estuarine habitats. We predicted that the extent of both widespread and emerging invasive invertebrates would expand beyond current known infestations, to be observed by monitoring presence, absence, and percent coverage at sites along an 80-mile stretch of the Lower Hudson River.

We also investigated the feasibility of this design by addressing questions regarding the combined impact of environmental and material variables on invertebrate settlement, durability, and sustainability of the sampling equipment during two separate deployment trials. We predicted that tiles treated with a protective coating and rough surface texture would promote recruitment and significantly improve durability. We examined:

- Significance of PVC spacer size, salinity, and treatment on settlement of sessile invertebrates
- Significance of PVC spacer size, salinity, and treatment on durability

DESIGN AND DEPLOYMENT

Artificial substrate sampler sets were constructed and deployed at multiple sites (Fig. 1) along the Hudson River to encourage settlement of individuals and assess invasive invertebrate distribution. The single sampler design was adapted from samplers utilized by the USGS and Minnesota Department of Natural Resources and features 6" x 6" tiles as an artificial substrate. We used tiles made of both Masonite and balsa wood to note any potential downside of using either material, in conjunction with the treatment. Masonite is used by multiple agencies in stream invertebrate monitoring but can be difficult to source, while wood tiles can be purchased easily from retailers (USGS 2012; Flotemersch et al. 2006). The complete design can be seen in Figure 2.

Deployment sites were chosen based on the presence of a solid, foundational structure to which the sets of samplers could be affixed with nylon rope and remain at least 1 meter above the sediment, while not interfering with recreational activity.

METHODS

We conducted two separate deployment trials two test the significance of material composition on invertebrate settlement and durability:

Trial 1

In trial 1, all samplers were composed of masonite tiles and either .5" or 1" PVC spacers, as seen in Fig. 2. Seven sampler sets were deployed in early June 2020 and were left submerged for an initial settlement period of three weeks. Following this period, each set was retrieved, and each settlement tile assessed for species composition and percent coverage every two weeks until July 25, 2020. Percent cover was assessed for both sides of each tile included in the set, equating to eighteen measurements per site. Mobile species present on the exclusion cage were also noted. All sessile invasive species found were collected and euthanized at the conclusion of the experiment, while mobile species were collected and euthanized after each retrieval.

Trial 2

In trial 2, samplers were constructed using both masonite and wood tiles, which were coated in a water resistant, textured deck paint to potentially improve durability and assist with settlement by providing a rough substrate more desirable to sessile invertebrates. As in trial 1, both .5" and 1" PVC spacers were used. The second set of samplers was only deployed at five sites, as these were determined to be the most appropriate when considering site complications from trial 1. Sets were deployed in August and followed the same assessment protocol as trial 1 until the experiment concluded on September 13, 2020.

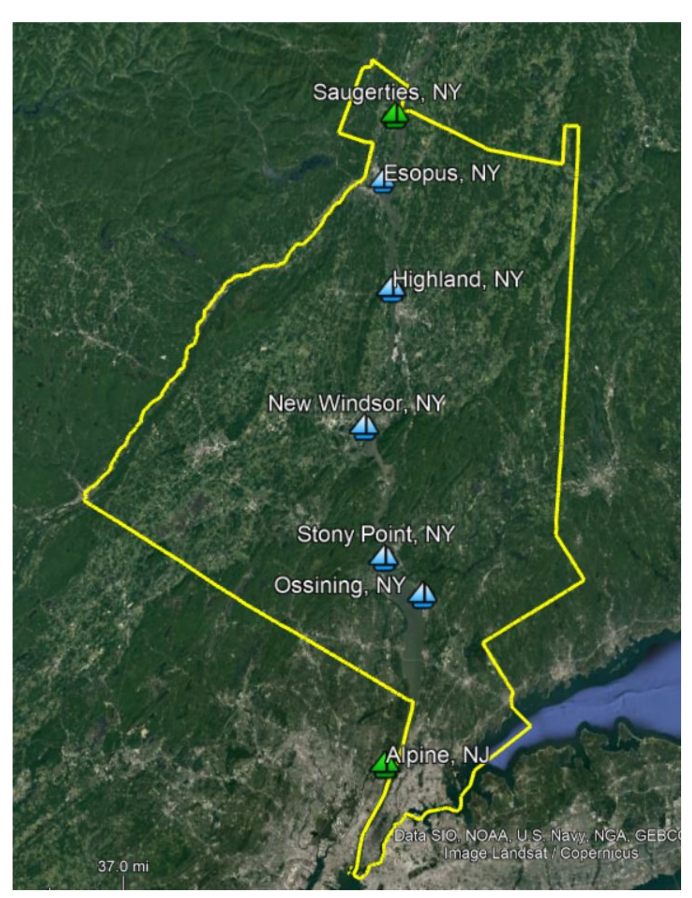


Figure 1. *Deployment of artificial substrate samplers across two trials in the Hudson River from Alpine, NJ to Saugerties, NY. Sites in green were only used for trial 1 while sites in blue were used in both trials.*

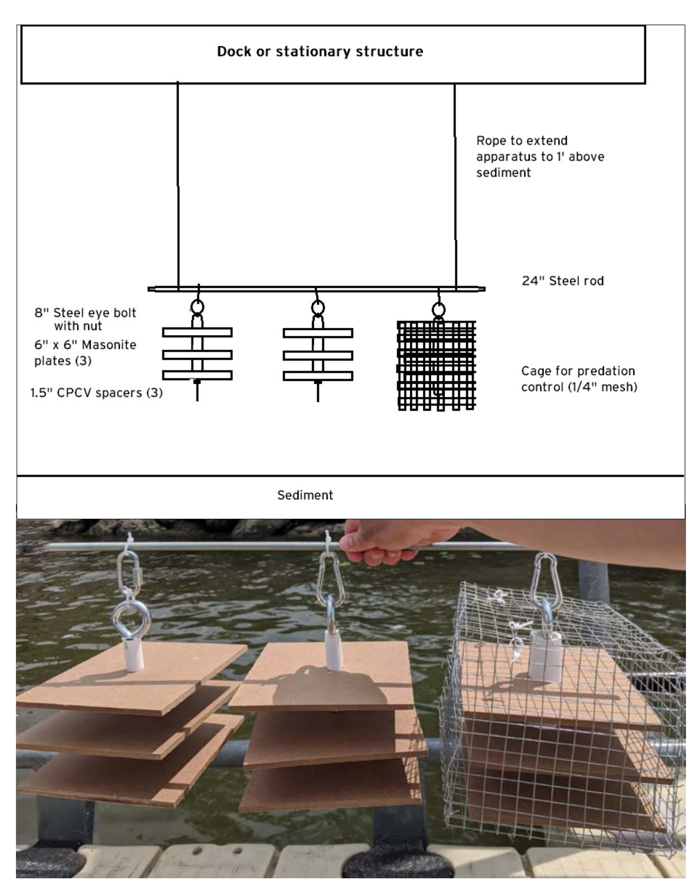
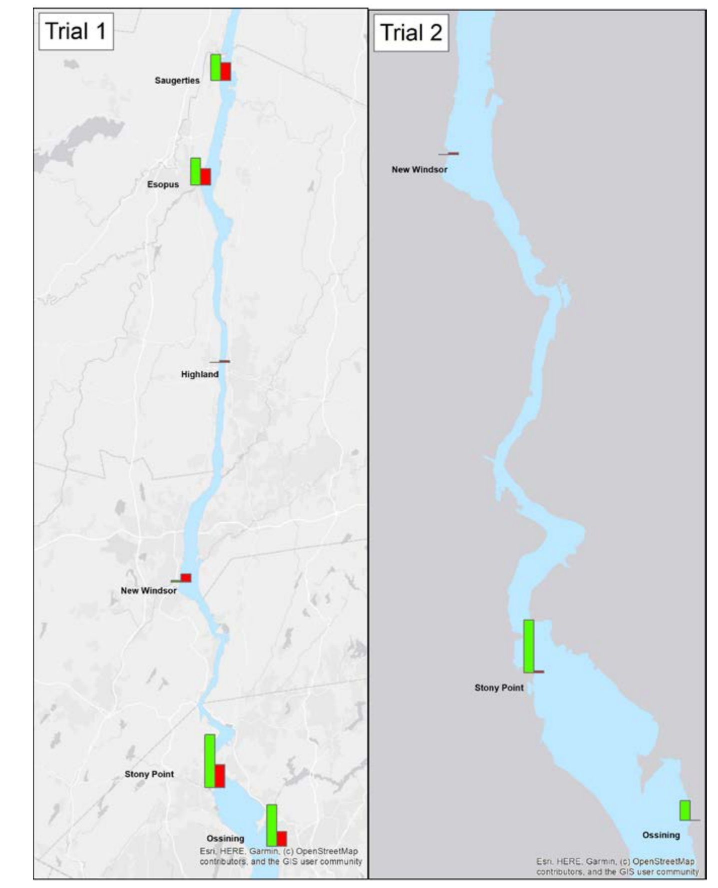


Figure 2. *Artificial substrate sampler sets of three samplers comprised of three stacked but evenly spaced tiles, with one sampler enclosed in predator exclusion cage built from .25-inch wire mesh.*

RESULTS

Distribution of Invasive Invertebrates

While most settlement observed on the samplers was of native sessile invertebrates, three invasive invertebrates were found, in total, across all sites during both trials (Fig. 3). The only sessile invasive species found was the zebra mussel (*Dreissena polymorpha*), which was observed at all locations at variable abundances. Mobile invasive species observed were mystery snail (*Cipangopaludina chinensis*) at low abundance in New Windsor, NY and Asian shore crab (*Hemigrapsus sanguineus*) at high abundance in Ossining, NY.



← ***Figure 3.*** *Highest recorded percent coverage of sessile native species (green) and invasive zebra mussel (red) during both trials. The highest native coverage ranged from 0%-65% and invasive cover ranged from 0%-28% in Trial 1, and 0%-27% and 0%-1% in Tiral 2, respectively*

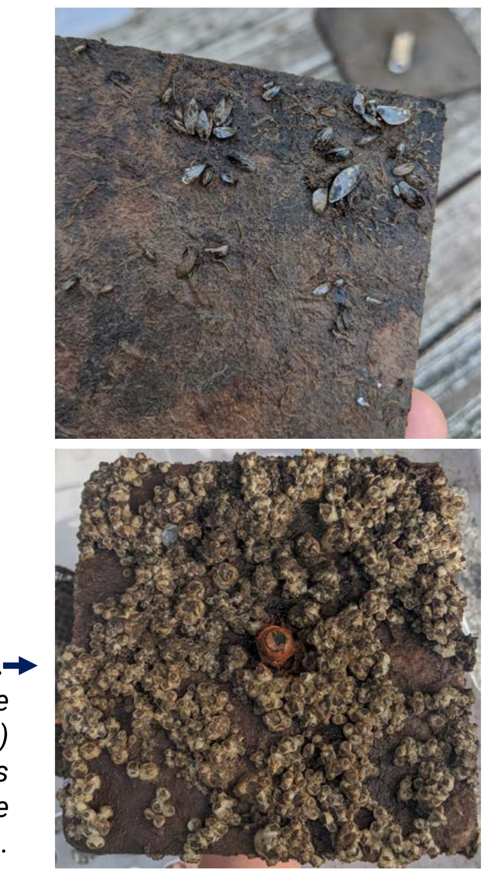


Figure 4. → *Examples of invasive zebra mussels (top) and native barnacles (bottom) coverage on tiles.*

Efficacy of Sampler Design

We used multiple linear regression to test for the effect of salinity (PSU, as a proxy for latitude), trial length (days), sampler material type (treated or untreated Masonite and/or wood) and PVC diameter (0.5" or 1" aperture) on the dependent variable, invertebrate coverage (arcsine-transformed proportion of total plate coverage).The proportion data were arcsine- transformed to satisfy normality assumptions. Our results indicate that neither trial length nor PVC diameter significantly impacted invertebrate plate coverage (p = 0.57 and 0.60, respectively) but that **salinity was marginally significant** (t-stat = 2.079, p = 0.049). Material type only approached significance at the conventionally accepted alpha = 0.05 threshold (p = 0.06) in the regression analysis. However, when we evaluated our null hypothesis that the treated plates would yield higher invertebrate recruitment than the untreated plates with a two-sample t-test, **we found that treated plates yielded significantly higher plate coverage proportions than untreated plates (t-stat = 1.71, p=0.03).**

To test for the effect of salinity, material type, and PVC diameter on durability of samplers, we used a mixed effect logistic regression that considered the loss of tiles throughout each trial as the dependent variable. We found that material type and PVC diameter had no significant effect on durability of the sampler tiles, while **salinity was found to be a significant predictor for loss of sampler tiles** (p=.006) (Fig. 5).

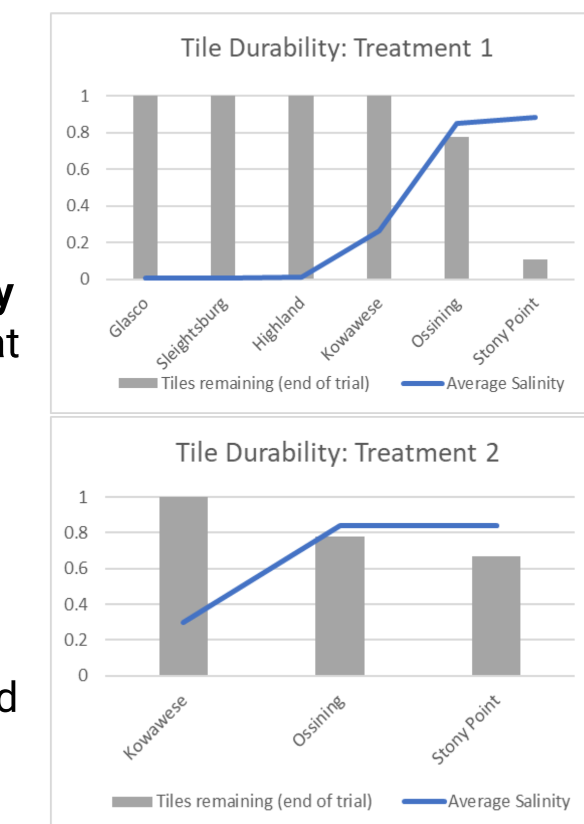


Figure 5. *Effect of salinity on tile loss during both trials. There was notable improvement on durability at Stony Point, the site with highest salinity, which went from an 90% loss in Trial 1 to a 30% loss in Trial 2.*

CONCLUSIONS AND DISCUSSION

Our analysis indicates that salinity has the most profound effect on both invertebrate settlement and durability of the sampler design. Sites closer to the mouth of Hudson yielded higher invertebrate plate coverage, while those same sites experienced higher instances of tile loss than sites with lower salinity. Treated tiles, on average, yielded higher recruitment numbers than untreated tiles. That said, because the treated tiles were set later in the season than the untreated tiles, we cannot conclusively state that the higher invertebrate yields were due to the tile treatment versus seasonal increases in invertebrate abundance. Future research will need to tease apart these two variables, with both treatments being conducted concurrently. Despite the deficiency of design durability at higher salinity, overall treated tiles were more durable and more suitable for this design (see Fig. 5), although further adjustments would still need to be made to strengthen the design if used in estuarine environments. While this was a cost-effective method and samplers can be easily built in-house, special consideration for future projects should be paid to location, as we experienced vandalism at multiple original sites.

References

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