Interactive effects of wood traits and intertidal exposure on shipworm infestation in southeastern US estuaries

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Introduction

- Shipworms are a group of wood-boring, filter-feeding bivalves that have been present in marine environments for centuries.[1]
- They settle preferentially on wooden structures and bore holes into them with the aid of symbiotic bacteria that can digest cellulose.[2]
- Shipworms are ubiquitous in virtually all coasts and estuaries around the world.[3]
- Shipworms continue to cause millions of dollars in damages in the US and to date there is no treatment that is one hundred percent effective at preventing shipworm burrowing.[4]

Research Question

How do proximity to the sediment surface, tree species identity, branch diameter, and site interact t o mediate the intensity of shipworm infestation, measured as the density of shipworm burrows and percentage of wood volume lost to burrowing?

Hypotheses

1. The greater the distance between the top of the sediment layer and the wood, the lower the susceptibility of shipworm boring. Branches in direct contact with the sediment will have greater number of shipworms.
2. Trees with the largest diameter will be most resistant to shipworm boring and will have lost the least wood volume.
3. Laurel oak and mangrove branches will suffer less damage than crepe myrtle or sweetgum branches due to their higher wood density.

Study site

Two tidal creeks in the Matanzas River Estuary in St. Augustine, Florida, USA

- Semidiurnal tides, tidal range -0.25 to 1.25 m
- Temperature range: 8 to 23°C in winter and 22 to 33 °C in summer
- Salt marsh ecosystem, dominated by march cordgrass, *Spartina alterniflora*, with some black mangroves, *Avicennia germinans*, in the area
- Both sites had soft substrate, but Site 2 was characterized by extremely soft mud while Site 1 had more stable substrate.

Figure 1. Map of study sites in the Matanzas River Estuary.

Tree species

Figure 2. Tree species tested for susceptibility to shipworm infestation. From left to right: Laurel oak, *Quercus hemisphaerica*, Sweetgum (*Liquidambar styraciflua*), Crepe myrtle (*Lagerstroemia spp.*), Black mangrove, (*Avicennia germinans*).

Experimental Design

- Designed ladders to compare shipworm infestation rates on four tree species, at two distinct branch diameter classes, and at nine different heights above the sediment.
- Ladders were built using PVC as the side and tree branches as the rungs.
- Small diameter ladders had rungs at -10, -5, 0, 5, 10, 20, 30, 40, and 50 cm from the sediment.
- Large diameter ladders had rungs at -10, 0, 10, 20, 30, 40, and 50 cm from the sediment.
- Mangrove ladders for both diameter classes had rungs at -10, 0, 10, 20, 30 cm from the sediment due to scarcity of branches.
- Deployed 5 replicates of each species and each diameter class at 2 sites.
- Ladders were left in the field for 6 months and at the end of the study period were collected and branches were frozen for further processing.

Figure 3. Shipworm ladders before being deployed in the field.

Figure 4. Shipworm ladders in the field, immediately after installation.

Figure 5. Monitoring shipworm ladders.

Figure 6. Two replicates of shipworm ladders at Site 2.

Data Collection and Processing

- Each branch was individually tagged with site number, species name, diameter class and distance across the sediment before being frozen.
- Branches were analyzed for presence of shipworms and wood volume lost to shipworm burrows by cutting each branch in 5 cm intervals and recording the number of burrows along with their diameter and depth.
- With the dimensions of shipworm burrows, percentage of wood volume lost to burrowing was calculated by subtracting the volume of all burrows from the initial volume of each branch.

Figure 7. Staging and tagging of branches after being extracted from the field.

Figure 8. Shipworm burrows in oak branch.

Figure 9. Shipworm extracted from laurel oak branch.

Results

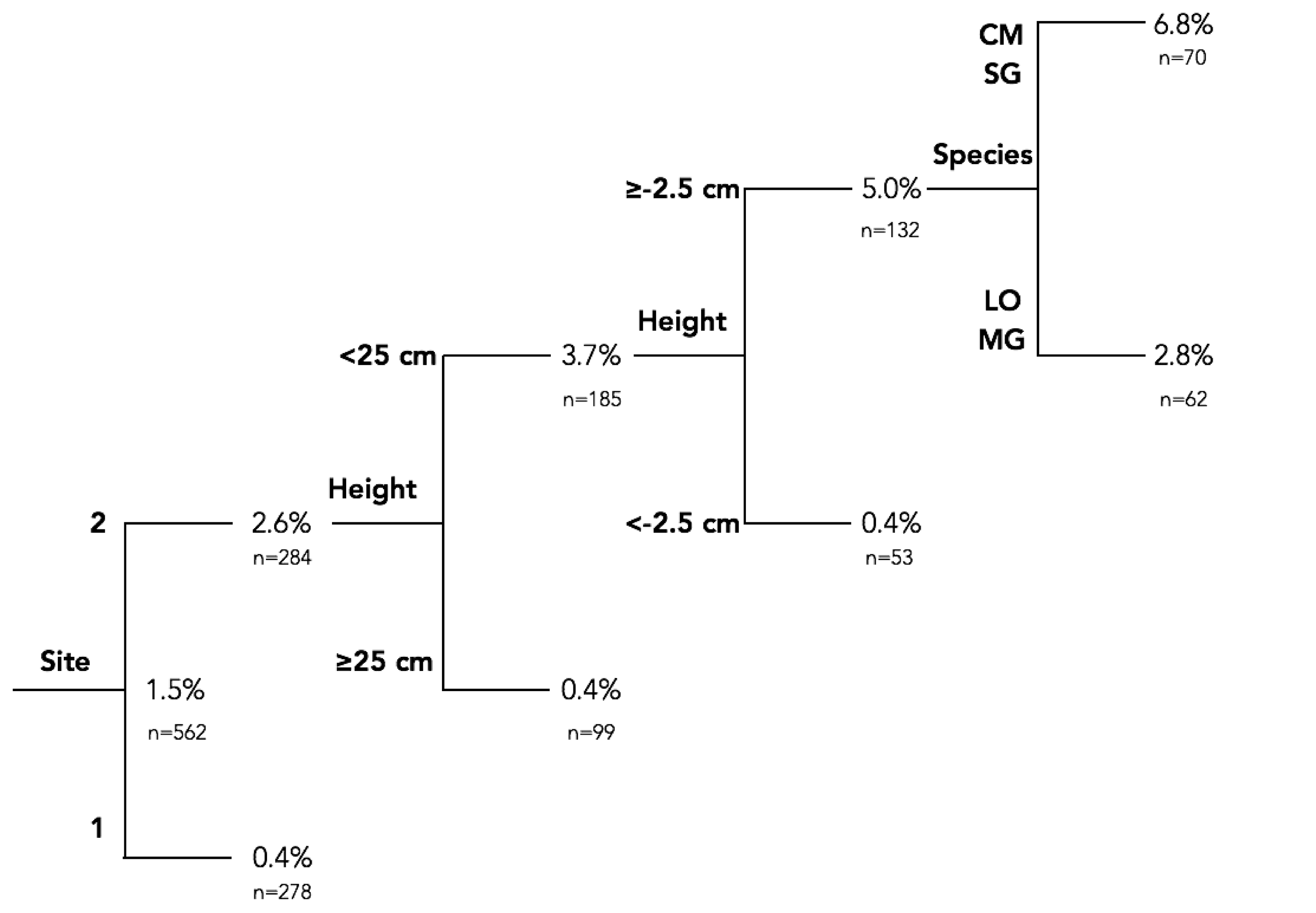

Figure 10. Regression tree made to determine percent wood volume lost by site, height, and species.

Conclusions

- There is great spatial variability in shipworm damage, meaning that life spans of wooden constructions in coastal environments will vary from site to site.
- Most shipworm damage is concentrated in the first 20 cm from the sediment, making this area particularly vulnerable in wooden constructions.
- Possibly because of their lower wood density, crepe myrtle and sweetgum are species that withstood the most damage from shipworm burrowing. Higher wood density of oak and mangrove makes it more difficult for shipworms to bore into these branches.
- There were no significant differences in shipworm damage between different diameter branches.

Applications

- Wood continues to be a construction material found in marine environments.
- Wooden structures are also used as an alternative to hardened, concrete structures when thinking of shoreline protection measures.
- Insights gained from this study can help extend the life span of wooden marine structures by determining desirable characteristics of the wood employed.
- Differences in shipworm burrowing along the water column make it possible to identify vulnerable zones that might need more maintenance.

Figure 11. Example of a wooden break wall, a shoreline protection structure constructed with crepe myrtle branches.

References

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