

Short-term restoration dynamics of living shorelines in the Great Bay system of New Hampshire

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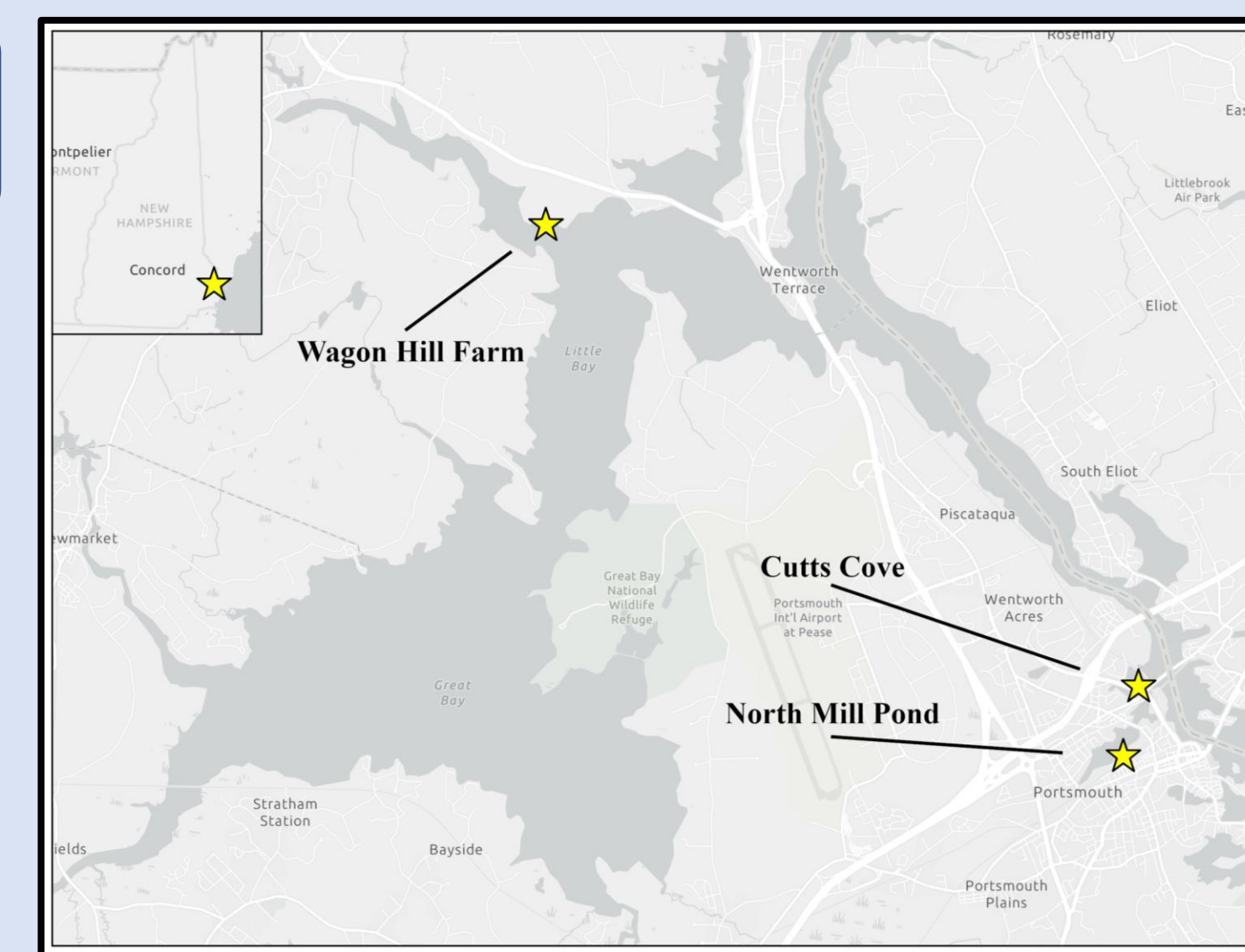
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Background

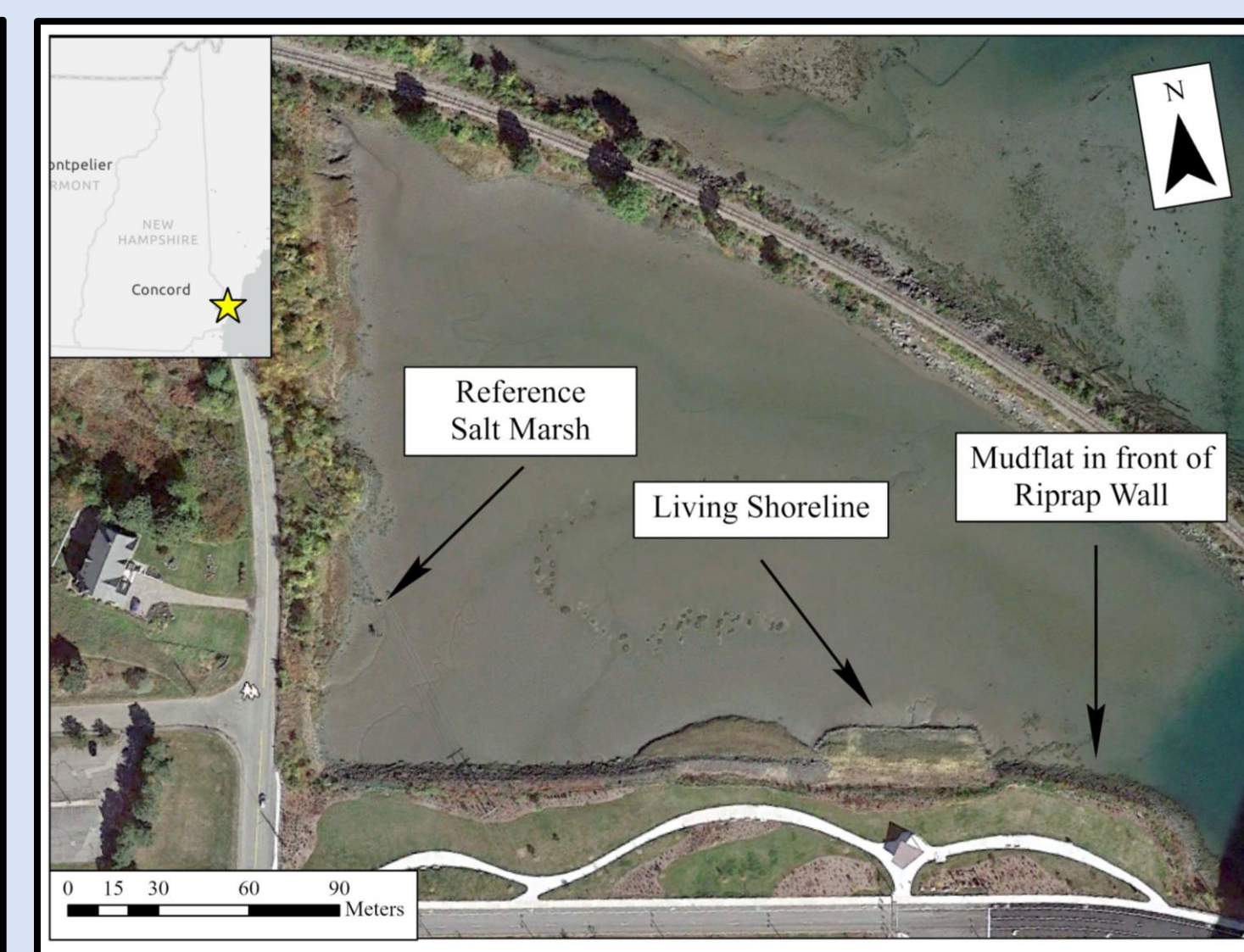
- Salt marsh degradation has led to loss of valuable ecosystem services – carbon storage¹, water filtration², and nurseries for local fisheries³
- Living shorelines (LS) is a shoreline stabilization method which pairs stone or concrete structures with ecological restoration⁴
- A common LS design is the creation of salt marsh habitat at correct tidal elevations with a 3 – 4 ft riprap sill at the seaward edge



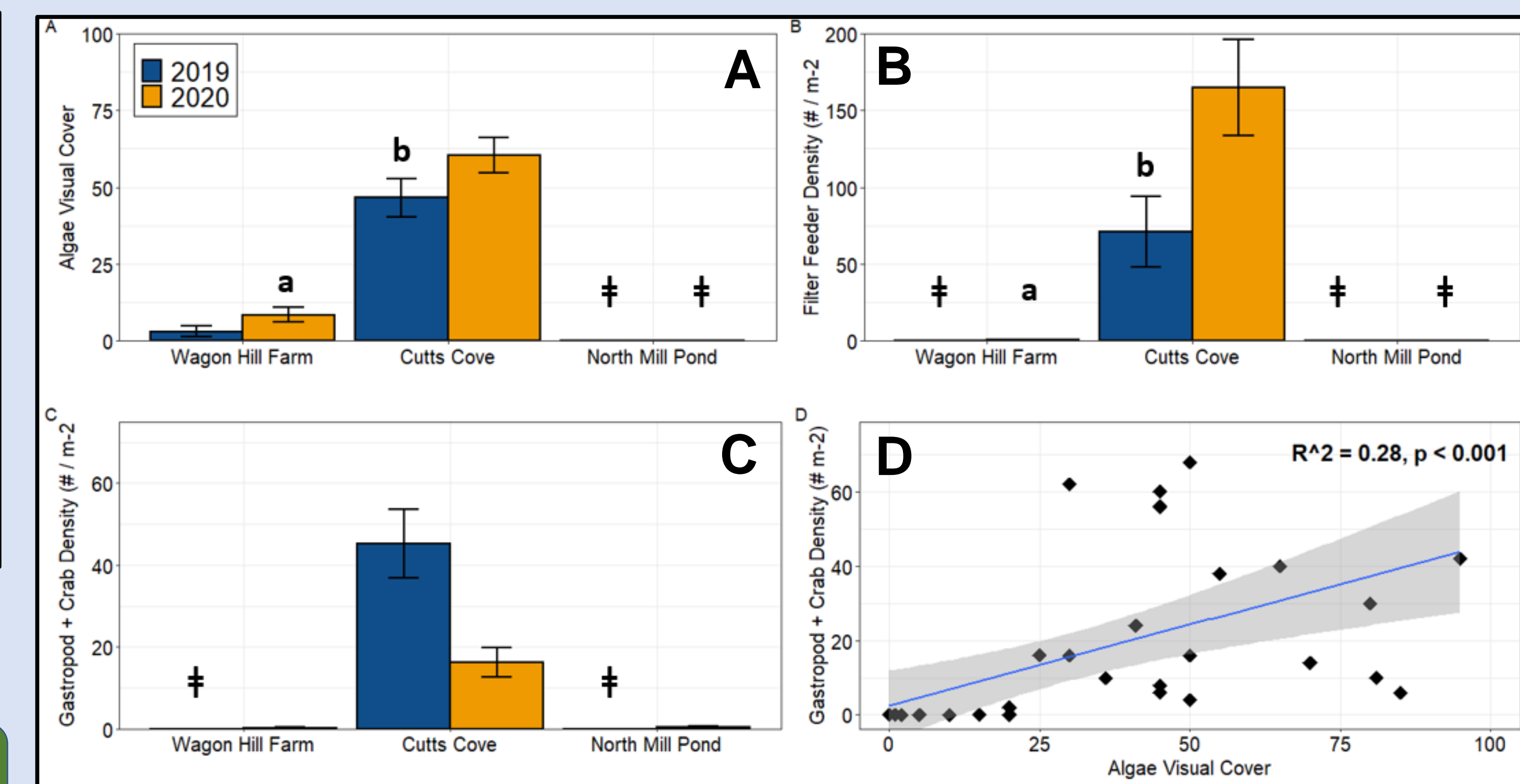
Shoreline armoring with riprap in Cutts Cove from 1980's. Armoring converted fringe salt marsh to mudflat.



Site map of three living shoreline projects in the Great Bay system of New Hampshire.

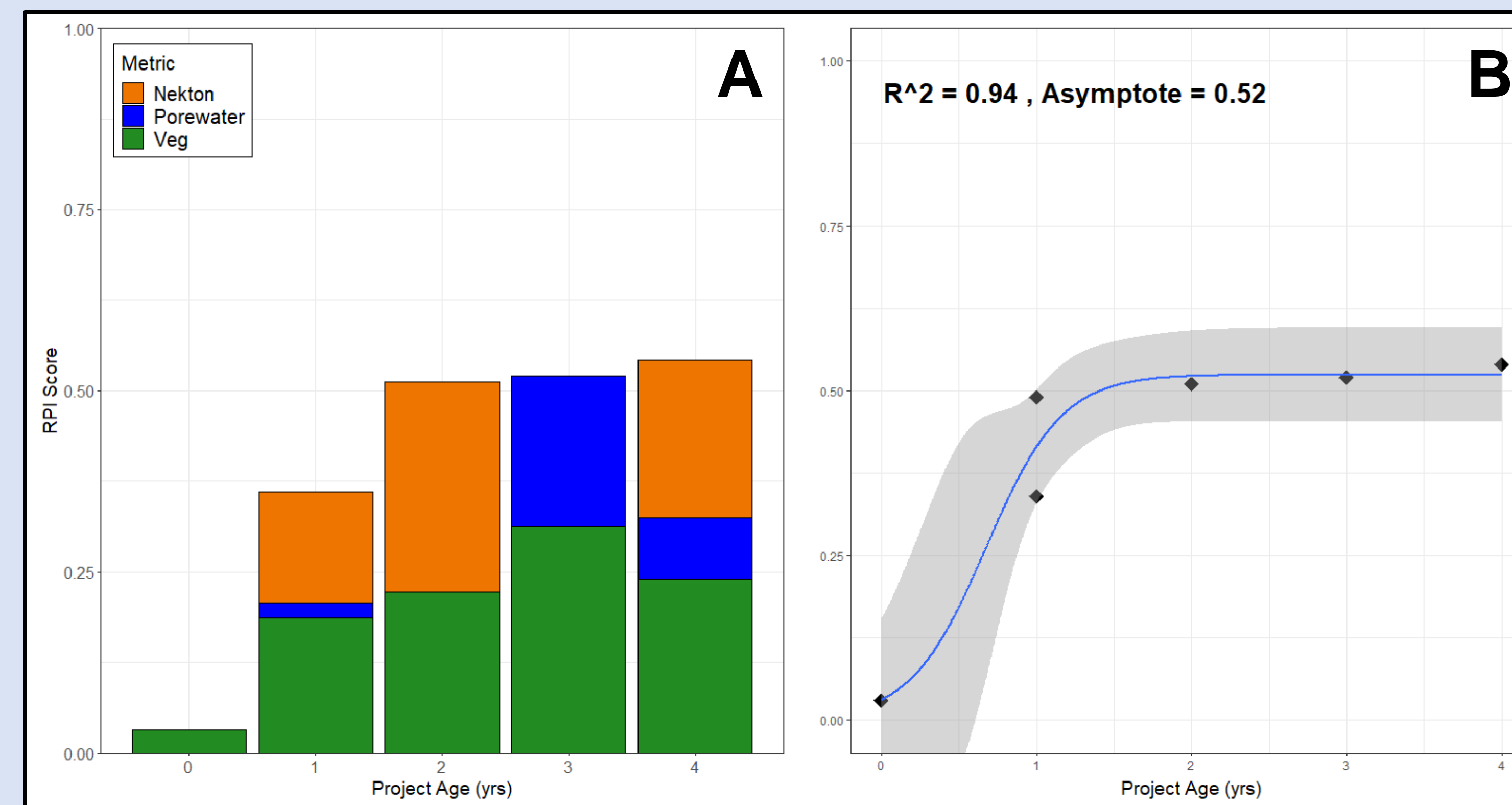


BACI design of Cutts Cove living shoreline in Portsmouth, New Hampshire. Control shoreline is a mudflat created from historic armoring.



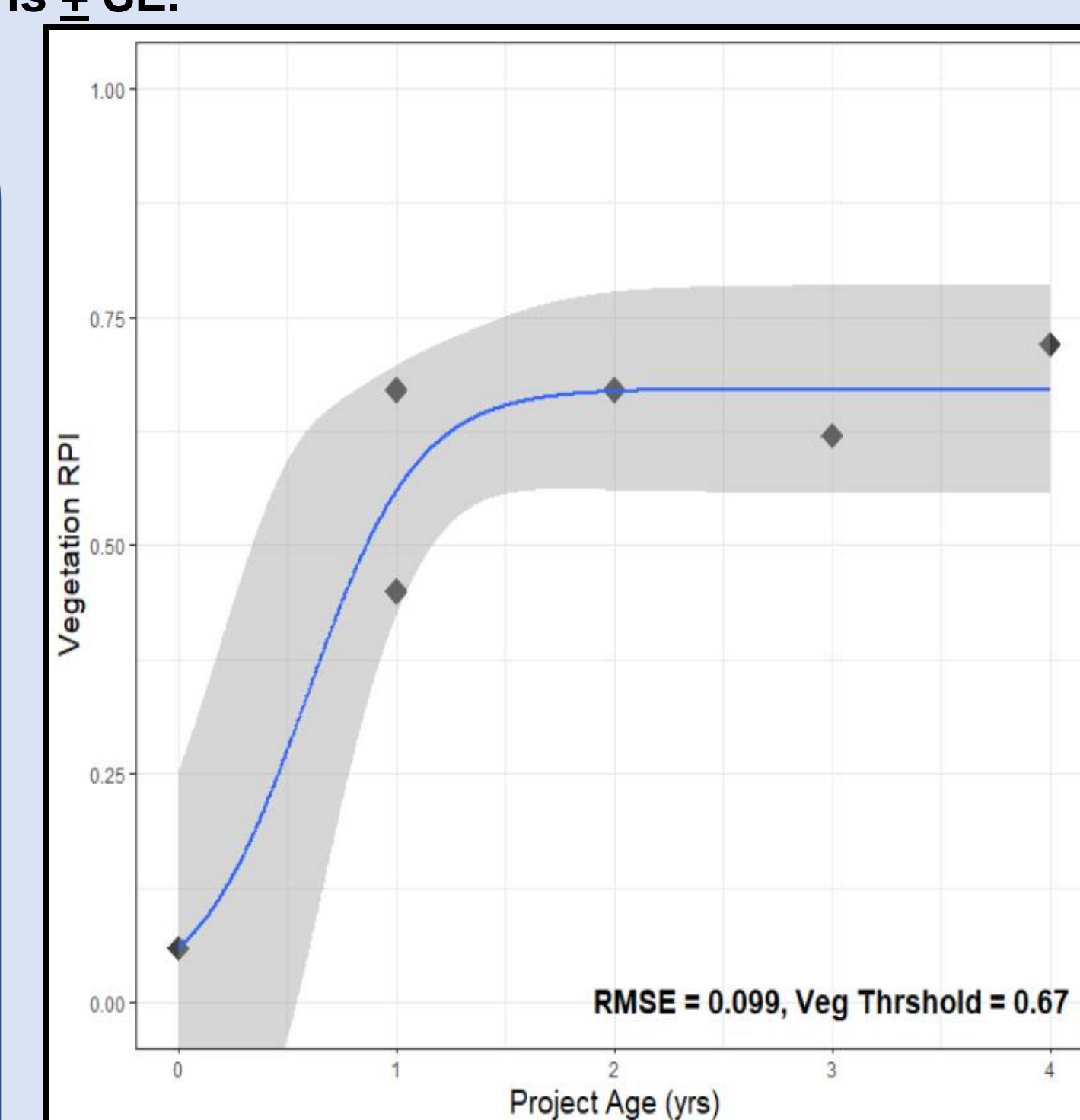
(A) Algae cover of sills of living shoreline projects in 2019 and 2020. Wagon Hill Farm and Cutts Cove have a riprap sill and North Mill Pond has a decomposed coir fiber sill. (B) Barnacle density of sills. (C) Snail and crab density of sills. (D) Linear regression of algae cover and snail and crab density on sills. Error bars are \pm SE. Letters denote Tukey's comparisons between Cutts Cove (2019) and Wagon Hill Farm (2020) when both were 1 year old.

Results

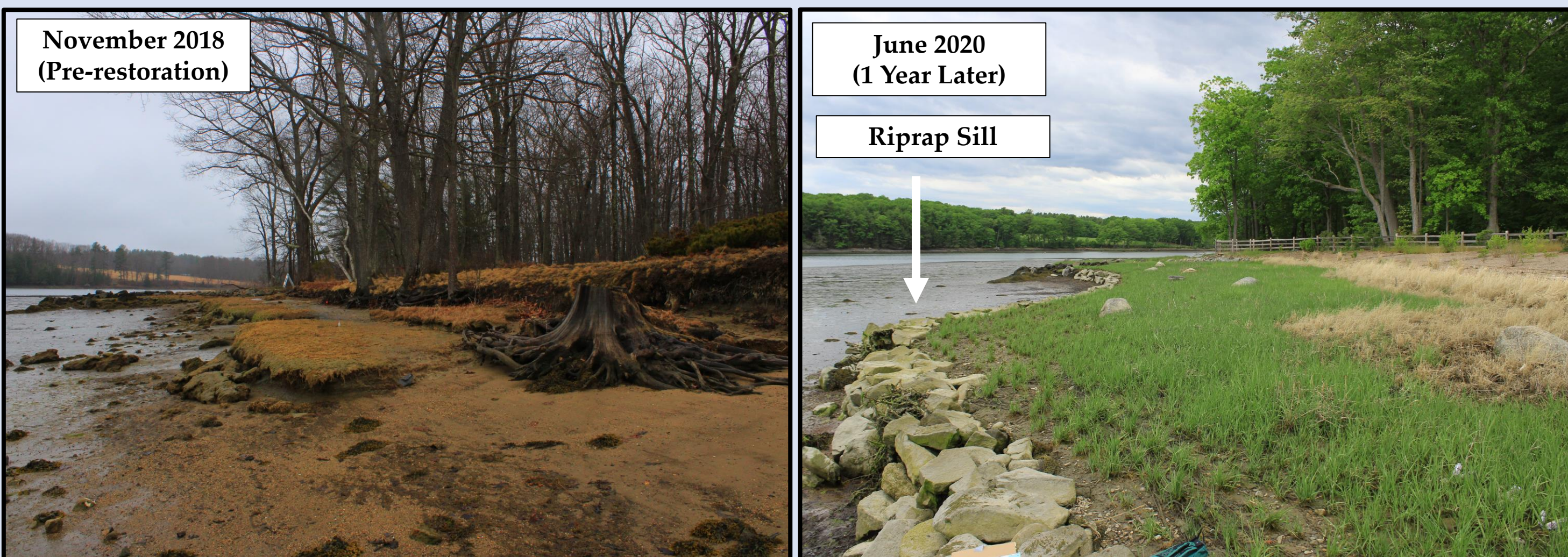


(A) Chronosequence of RPI total scores with representative contributions of nekton, porewater chemistry and vegetation. (B) Logistic regression of the total RPI score over project age (RMSE = 0.062, $R^2 = 0.94$). Living shoreline projects experienced a rapid recovery phase in 0 – 3 years and shifted to a slower, more incremental recovery post-3 years. Grey interval is \pm SE.

- LSs recovered quickly within 5 years from 0.03 to 0.54 RPI
- Vegetation and nekton recovered quickly to metric RPI scores of > 0.65
- Nekton densities were greater or similar between LS and references within 1 year
- Possible early issues to address:
 - Intense geese herbivory
 - Erosion from storm runoff
 - High *Spartina* mortality near seaward edge



Logistic regression of the unweighted vegetation metric RPI score over project age (RMSE = 0.099, $R^2 = 0.91$). Grey interval is \pm SE.



Living shoreline at Wagon Hill Farm (Durham, NH) right before construction and one year later. Photographs taken from roughly the same vantage point.

Research Objectives

- 1) Quantify the short-term trajectory of restoration progress of habitat structure, soil development, and fauna of LS projects
- 2) Document the impact of riprap sills on algae cover and invertebrate colonization

Methods

- Three LS projects monitored in 2019 and 2020 in a BACI design. Each LS paired with a local reference salt marsh and degraded shoreline.
- Vegetation, nekton, and porewater chemistry sampled at each shoreline, and invertebrates and algae cover sampled on sills.
- Progress evaluated using the Restoration Performance Index (RPI)⁵, scores ranging 0 – 1. Logistic models applied to RPI scores over chronosequence of LS project ages.

Management Implications

- 1) LSs recovered 50% of ecosystem structure and function of references within 4 years
- 2) Practitioners can expect rapid recovery within 0 – 5 years and then slower, incremental gains
- 3) Abiotic and biotic factors recover at different rates
- 4) Monitoring and adaptive management should be budgeted in the initial planning process

References

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