

Summer 2025 Research Project

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What are Living Shorelines?

- MD has over 3,000 miles of shoreline- the Bay is a unique resource!
- As climate change worsens, we must protect our shorelines.
- Living shorelines are a natural, adaptive method- and have been found to outperform hardened structures.

Living shorelines are effective in...



... providing protection to infrastructure from storm surges, improving water quality, habitat, aesthetic appeal, and water access!

They provide alternatives to...



... bulkheads, seawalls, breakwaters, riprap. These are considered "hardened" methods, and often require regular maintenance.

U & A has a unique method...



... "Dynamic Living Shorelines", which include stone, sand, gravel, vegetation, and wood structures.

Idea & Reasoning

Question:

How does the vegetation **community structure and productivity** of restored living shorelines compare to **unrestored** fringing marshes across three paired sites in the Severn River?

- Is there a significant difference between restored and unrestored sites?
- **Community structure and productivity** will be measured through... →

Definition:

A **fringing marsh** is a wetland that lies on the edge of a large body of water, comprising intertidal habitat between upland and open water.

**Species
Richness +
Composition**

**Total
Vegetation
Cover**

**Native vs.
Non-native
Abundance**

Hypothesis + Goals



Hypothesis

Restored living shorelines have **significantly higher** community structure metrics and vegetative productivity than adjacent unrestored fringing marshes across three paired sites in the Severn River.

Project Goals

- Examine whether the restorations are achieving **lower, comparable, or higher** vegetation metrics compared to unrestored sites with similar characteristics.
- Assess whether living shoreline sites are adequately performing, which could **inform future restoration design and monitoring** protocols.

Literature Review



Living shorelines achieve functional equivalence to natural fringe marshes across multiple ecological metrics

Isdell et al. (2021)

This study found equivalent functionality between 13 paired sites (restored paired with natural) in coastal Virginia, studying numerous metrics. **Vegetation was not evaluated in depth**, only through stem counts.



Evaluating Restored Tidal Freshwater Wetlands

Baldwin et al. (2019)

The criteria for evaluating restoration projects in tidal freshwater wetlands are hydrology, geomorphology, soil, salinity, microbes, **vegetation**, seed banks, benthics, fauna, and ecosystem functions.

Site Selection

Pair 3

Restored:

Kyle Point (Completed 2020)

Unrestored:

Sullivan's Cove Natural Area



Pair 2

Restored:

Pines on the Severn
(Completed 2010)

Unrestored:

1455 Point Way

Pair 1

Restored:

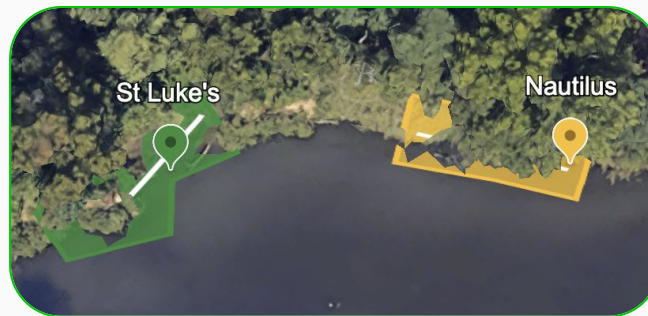
St. Luke's (Completed
2018)

Unrestored:

Nautilus Point Marina

Site Selection (1)

Pair 1



Restoration 1

St. Luke's

Fetch: 0.16km (0.1 mi)
Bank Height: 0-1.5m
Site Length: 15m



Unrestored Site 1

Nautilus Point Marina

Fetch: 0.12km (0.07 mi)
Bank Height: 0-1.5m
Site Length: 18m



Site Selection (2)



Pair 2



Restoration 2 Pines on the Severn

Fetch: 1.38km (0.86 mi)
Bank Height: 1.5-9m
Site Length: 65m

Unrestored Site 2 1455 Point Way

Fetch: 1.43km (0.89 mi)
Bank Height: 1.5-9m
Site Length: 42m



Site Selection (3)



Pair 3

Considerations

Restoration 3

Kyle Point

Fetch: 2.41km (1.5 mi)
Bank Height: 1.5-9m
Site Length: 230m

Unrestored Site 3

Sullivan's Cove

Fetch: 1.89km (1.18 mi)
Bank Height: 0-1.5m
Site Length: 65m

Finding characteristically similar sites was hindered by...

- Low resolution satellite imagery of shorelines.
- An abundance of armored shorelines in the Severn.

Methodology

Setup

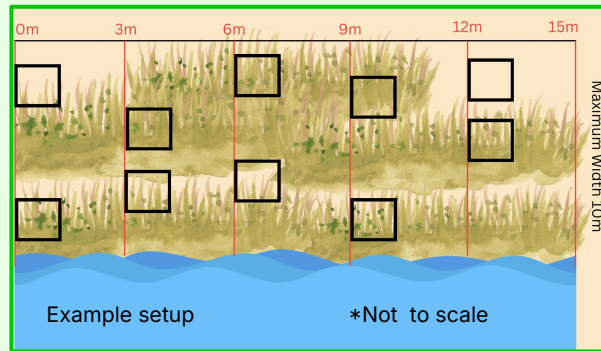
- Site divisions
- Quadrat placement randomization

Data Collected

- DO mg/L, DO%, salinity, temperature
- Tide stage
- Within quadrats:
 - Dominant substrate
 - Wrack presence
 - Marsh zone
 - Plant height variation
 - **Species observations + cover class for each species**

Field Considerations

- Unknown species
- Difficult-to-traverse sites



Protocol Specifics

6 Sites studied

1/5 Of each site length was measured

2 Random 1m x 1m quadrats per transect

3m Separation between transects

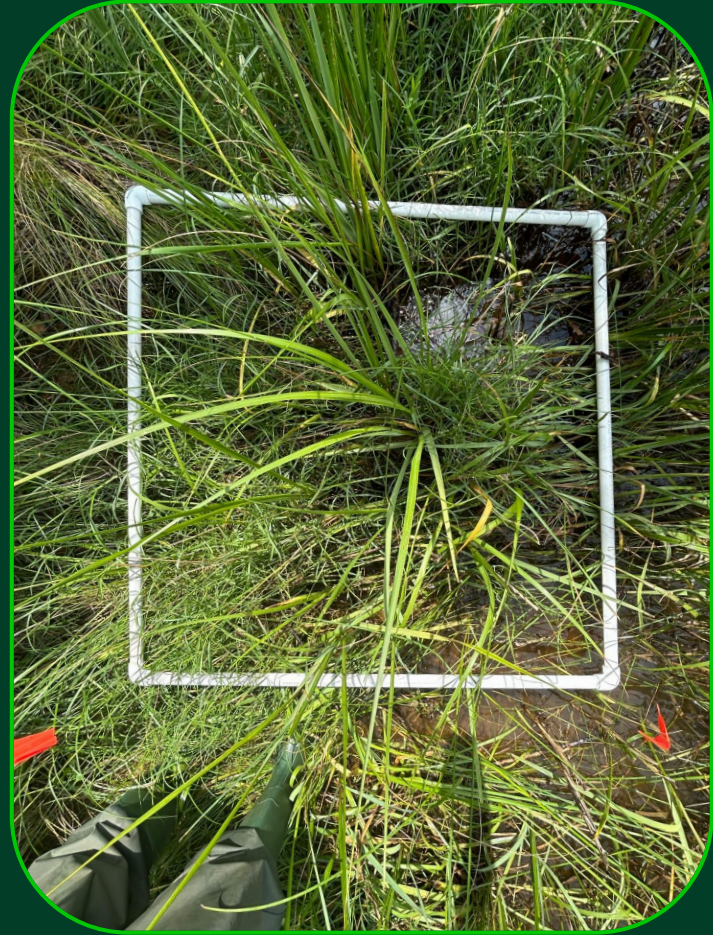
10m Maximum width measured



Observing a quadrat

Marking transect locations

Results



Total Vegetation Cover

Percent Vegetative Cover at Site



What does this mean?

Unrestored sites had higher % cover within all three pairs.

This may be a result of multiple causes:

- Living shorelines often contain **bare areas** for habitat provisioning, recreational use, and as a result of the headland + embayment system.
- Invasive species are generally **denser**, leading to higher % cover at unrestored sites (e.g., *Phragmites australis* stands).
- **Higher vegetation cover ≠ healthier**

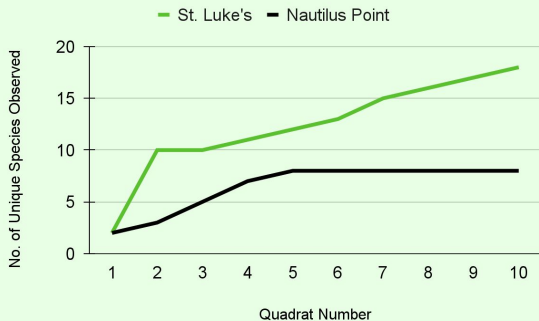
$$\text{Total Vegetation Cover} = \frac{\sum \text{Freq. of cover class} \times \text{Midpt. of cover class}}{\text{Number of quadrats at site}}$$

Species Richness

At each restoration, there were 2-6 times as many species observed as at their paired unrestored sites!

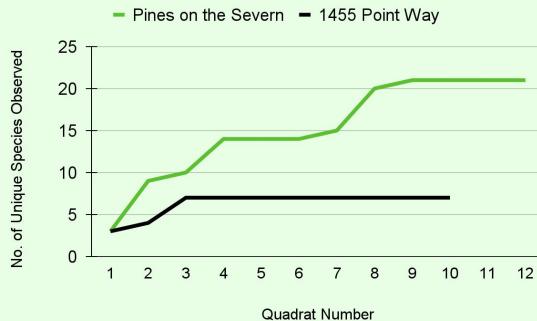
Pair 1

Restored: 18
Unrestored: 8



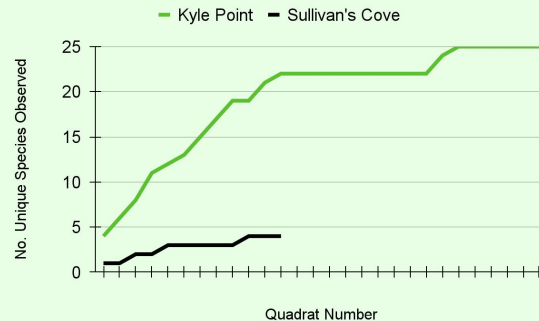
Pair 2

Restored: 21
Unrestored: 7



Pair 3

Restored: 25
Unrestored: 4

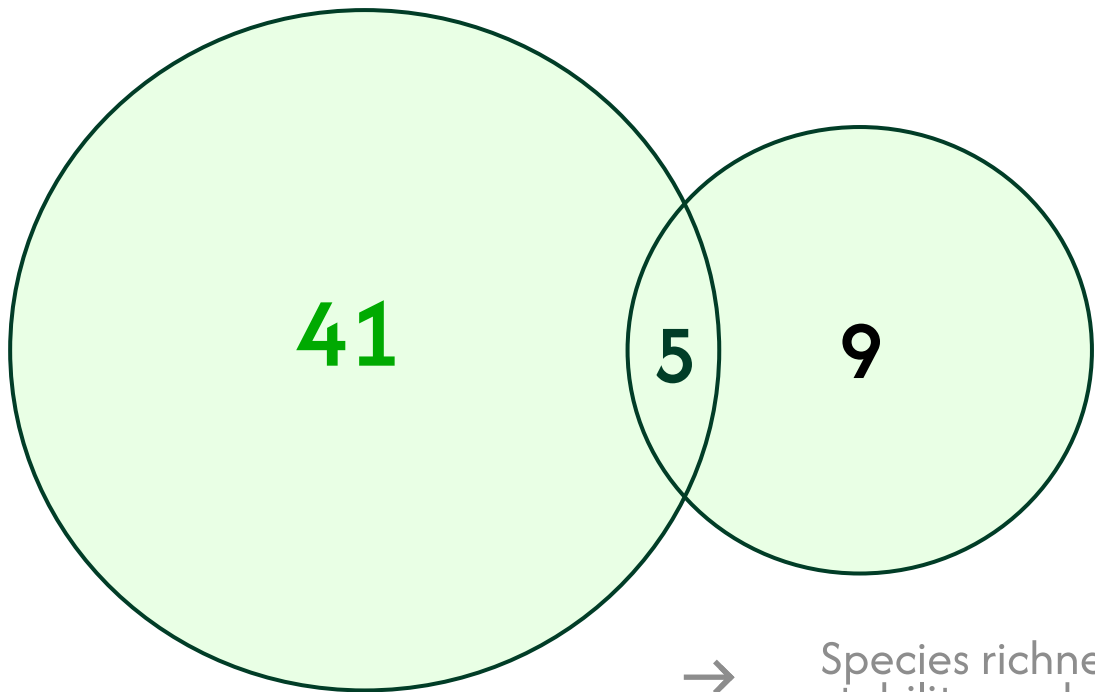


Species richness: The number of different species found in a specific area.

Species Richness

Of total species observed throughout the study period, 74.5% were found at U&A Dynamic Living Shorelines.

16.4% were found at unrestored sites.



= 55 total observed unique species

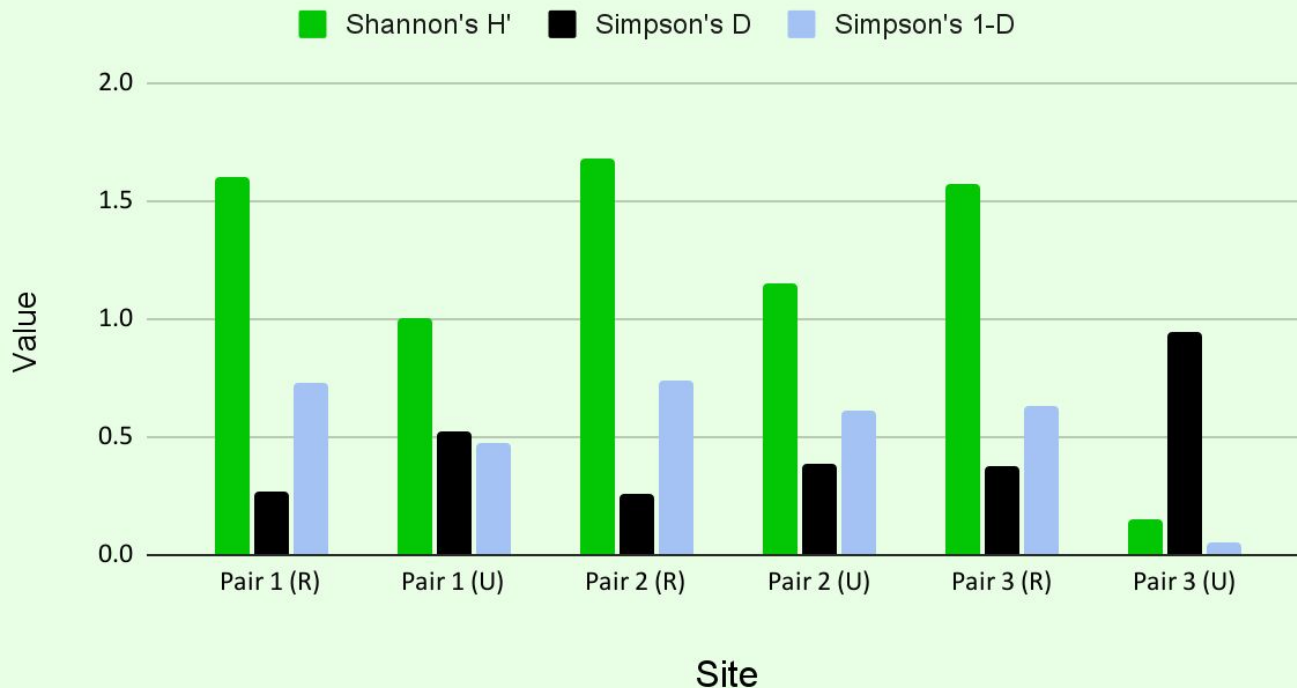


Species richness is an indicator of the function, stability, and resilience of an ecosystem.

Diversity Indices

$$H' = -\sum p_i \ln(p_i) \quad D = \sum p_i^2$$

Shannon's H', Simpson's D, and Simpson's 1-D



Shannon's Diversity Index (H')

- Higher H', more diversity (incl. richness & evenness)
- 0-1: Low diversity, 1-2: Moderate diversity

Simpson's Diversity Index (D)

- Measures species dominance
- Lower value= more diverse

Simpson's Diversity Index (1-D)

- Higher value= more diverse
- 0-0.3: Low diversity, 0.03-0.07: Moderate diversity, 0.7-1: High diversity

Species Composition

Yellow: Found at both Restored and Unrestored sites

Restored

Unrestored

Pair 1

American Sweetgum, American Three-Square Bulrush, Black Locust, Clustered Dock, **Common Reed**, False Daisy, Green Arrow Arum, Halberdleaf Tearthumb, **Marsh Elder**, Marsh Fleabane, Saltmarsh Rosemallow, **Seaside Goldenrod**, Siberian Elm, **Smooth Cordgrass**, Soft-Stemmed Bulrush, Tussock Sedge, Virginia Creeper

Common Reed, **Hedge Bindweed**, **Japanese Dodder**, **Marsh Elder**, **River Bulrush**, **Riverbank Grape**, **Saltmarsh Bulrush**, **Seaside Goldenrod**

Pair 2

American Groundnut, American Three-Square Bulrush, Bermuda Grass, Common Ragweed, Creeping Saltbush, Dog Fennel, Eastern Gamagrass, Japanese Mugwort, Pennsylvania Smartweed, Perennial Saltmarsh Aster, Porcelain-Berry, Quack Grass, Saltmarsh Hay, Saltmarsh Rosemallow, Sea Myrtle, **Seaside Goldenrod**, **Smooth Cordgrass**, Swamp Rosemallow, Sweet Autumn Clematis, Switchgrass, Virginia Wild Rye

Common Reed, **Eastern Grasswort**, **Marsh Elder**, **Seacoast Bulrush**, **Seaside Brookweed**, **Smooth Cordgrass**, **Tidal Marsh Amaranth**

Pair 3

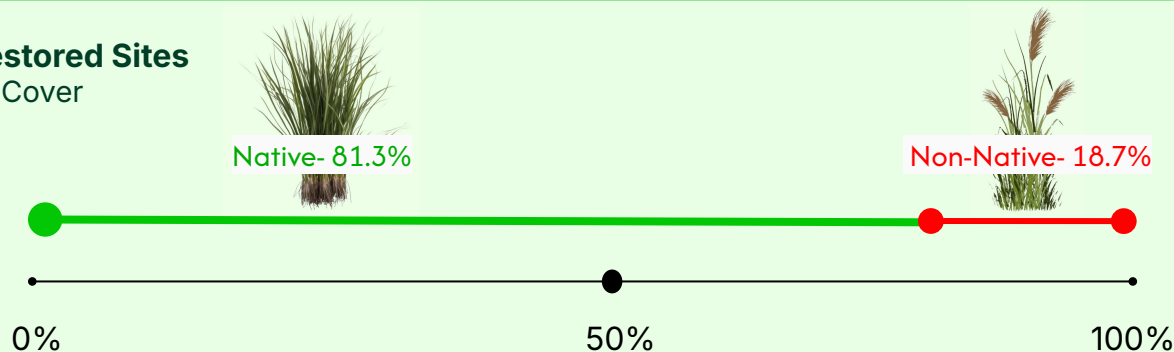
Bermuda Grass, Bitter Panicgrass, Chinese Bushclover, Clustered Dock, Common Ragweed, Common Rush, Dotted Smartweed, Giant Bristlegrass, **Hedge Bindweed**, Japanese Mugwort, Japanese Stiltgrass, **Marsh Elder**, Marsh Fleabane, Peppervine, Prairie Cordgrass, Saltmarsh Hay, Saltmarsh Rosemallow, **Seaside Goldenrod**, **Smooth Cordgrass**, Straw-colored Flatsedge, Swamp Rosemallow, Switchgrass, Tulip Poplar, White Sweet Clover

Common Reed, **Hedge Bindweed**, **Marsh Elder**, **Water Purslane**

Native & Non-Native Abundance

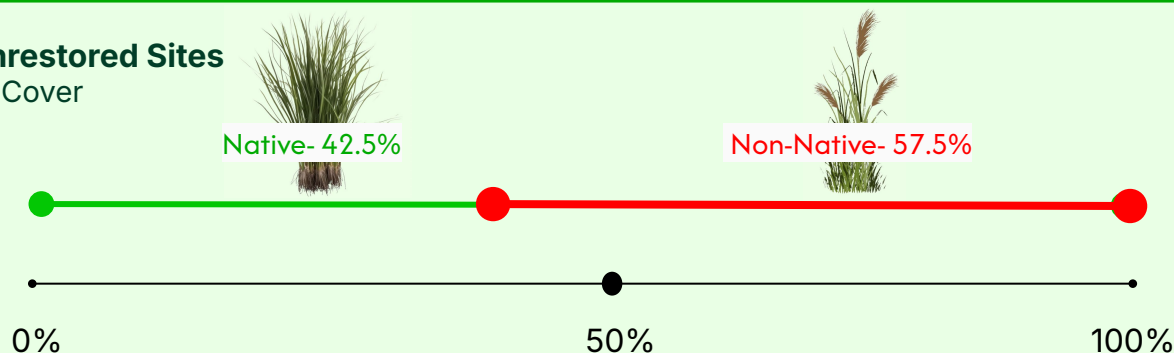
Restored Sites

% Cover



Unrestored Sites

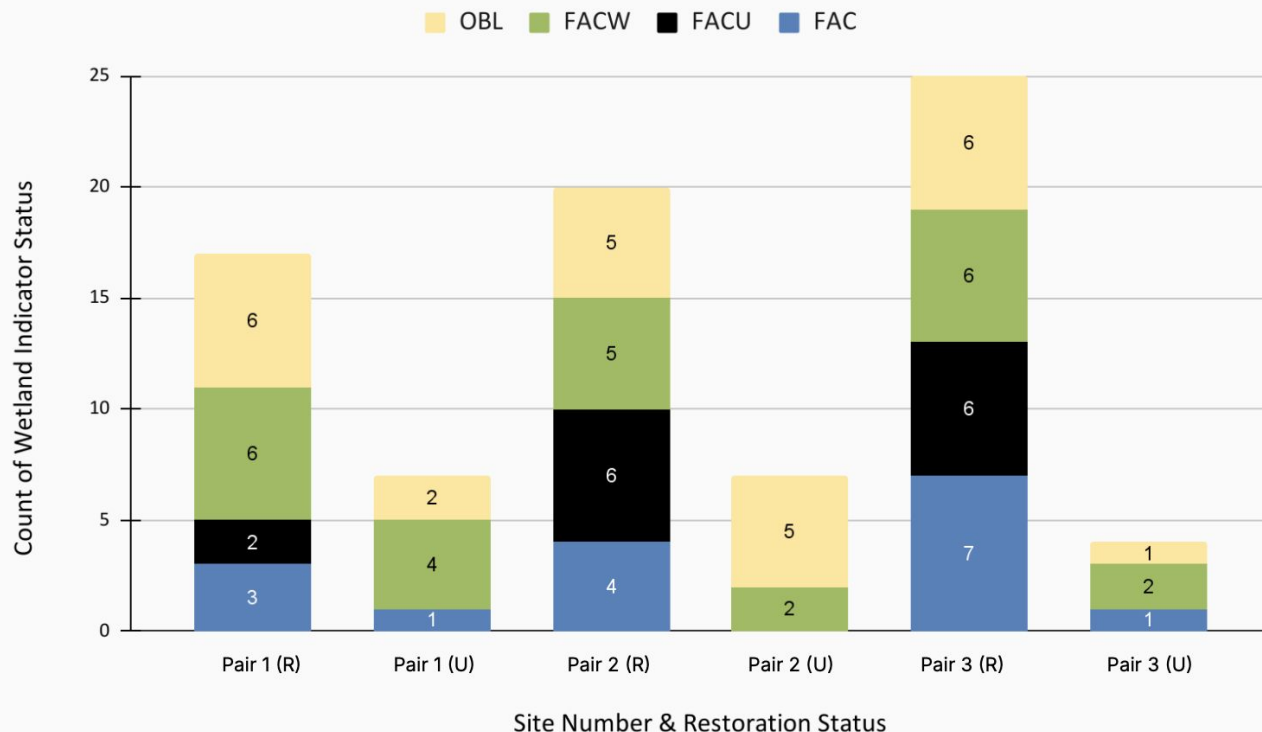
% Cover



- By **richness** (raw number of species), unrestored sites were found to have less invasive species than restored.
- By **overall species cover**, restored sites have a higher percentage of native cover than unrestored sites.
- Likewise, unrestored sites have higher incidence of invasive species.

Wetland Indicator Status

Wetland Indicator Statuses Throughout Sites



Obligate:

Almost always occurs in wetlands under natural conditions (estimated probability > 99%).

Facultative Wetland:

Usually occurs in wetlands, but occasionally found in non-wetlands.

Facultative:

Equally likely to occur in wetlands and non-wetlands.

Facultative Upland:

Usually occurs in non-wetlands, but occasionally found in wetlands.



Discussion & Conclusion



Conclusion

Total Vegetation Cover



Unrestored

Unrestored sites had higher cover at all three sites. Likely cause: density of invasive species & restoration design.

Richness



Restored

Restored sites had 2-6 times as many observed species as their unrestored partner.

Diversity + Composition



Restored

Both Shannon's and Simpson's Diversity Indices showed higher diversity at restorations through all three paired sites.

Native Cover



Restored

At restored sites, native cover was over 80%. At unrestored sites, non-native cover was over 50%.

Key Takeaways

- At points with high (>1 mile) fetch on the Severn, *P. australis* is generally the primary species that thrives without restoration.
- Higher values were found at restored sites consistently among pairs in terms of richness, diversity, variety of wetland indicator status, and native cover!
- Local restoration efforts are effectively supporting and re-establishing native plant biodiversity.
- Restored living shorelines are ecologically beneficial! Restoration projects outperformed unrestored sites across multiple metrics.



Sullivan's
Cove

Future Questions

- How do other metrics (biodiversity, soils, macroinvertebrates, etc.) stack up at restored vs. unrestored sites?
- How might U&A's Dynamic Living Shoreline method differ in prosperity versus other living shoreline designers/contractors?
- Is there any significant correlation between the increasing age of living shoreline restorations and number of native species present?



Taking water
quality
measurements

Thank you!

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