Living in a Material World: Support for Natural & Alternative Materials in Living Shorelines

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Introduction

High quantities of concrete, metal, and plastic are currently used in living shorelines, resulting in adverse environmental impacts. This study aimed to identify and compare the life-cycle impacts of conventional and alternative materials.

We reviewed **96** peer-reviewed articles describing full-scale and experimental living shorelines projects where materials used were mentioned.

Materials Reviewed

	Material	Application	Ecosystem Type
Conventional	*Concrete*	• Settling surface • Breakwater • Stabilization/anchoring • Vegetation establishment	
Conventional	*Plastic*	• Settling surface • Stabilization/anchoring • Breakwater • Sediment stabilization • Vegetation establishment • Nursery structure • Site delineation	
Conventional	*Metal*	• Settling structure • Stabilization/anchoring • Breakwater	
Natural	*Natural Fiber*	• Settling surface • Stabilization/anchoring • Vegetation establishment	
Natural	*Oyster shell*	• Settling surface • Breakwater • Sediment stabilization • Vegetation establishment	
Natural	*Wood*	• Sediment stabilization • Breakwater	
Natural	*Rock*	• Settling surface • Breakwater • Sediment stabilization • Settling surface	
Reduced-Impact	*Bioplastic*	• Settling surface • Sediment stabilization • Vegetation establishment • Breakwater • Stabilization/anchoring	
Reduced-Impact	*Alternative concrete*	• Breakwater • Settling surface • Sediment stabilization[83]	

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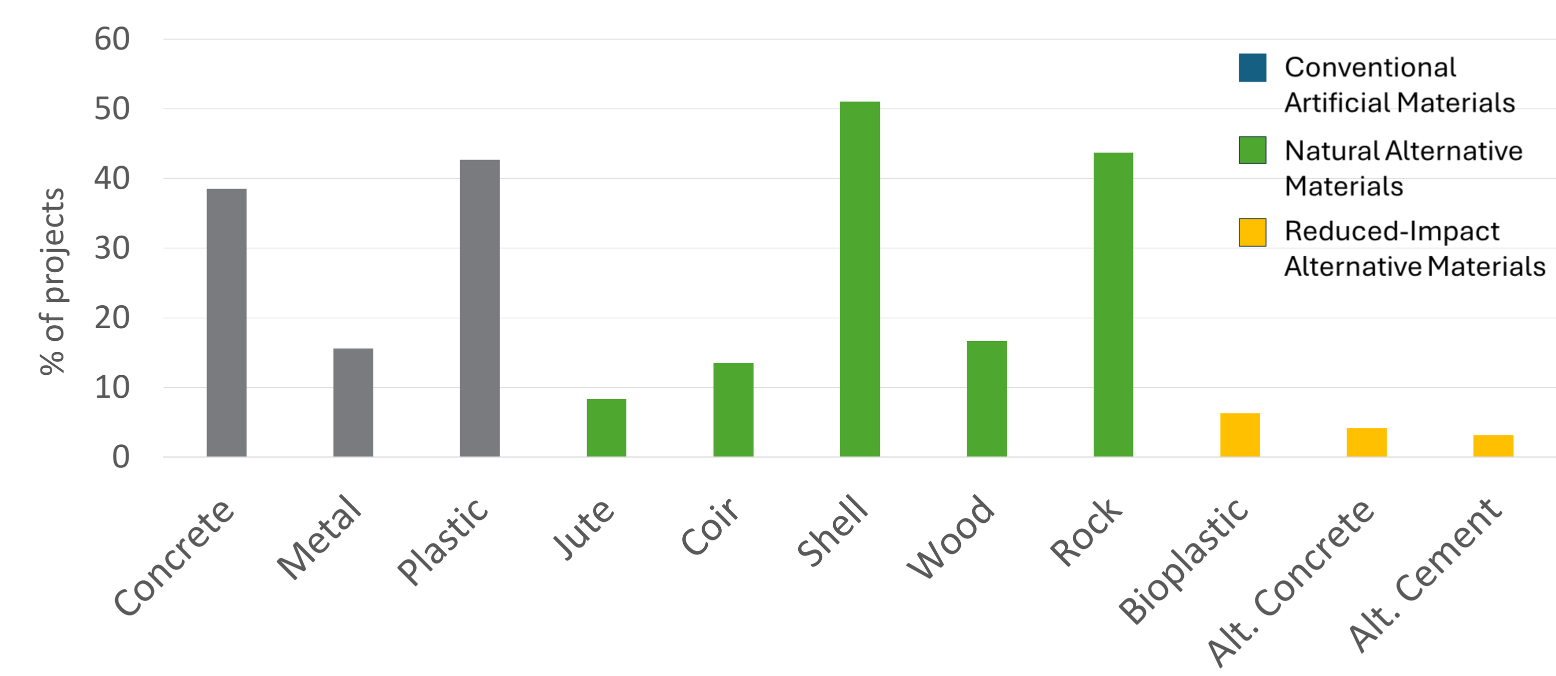
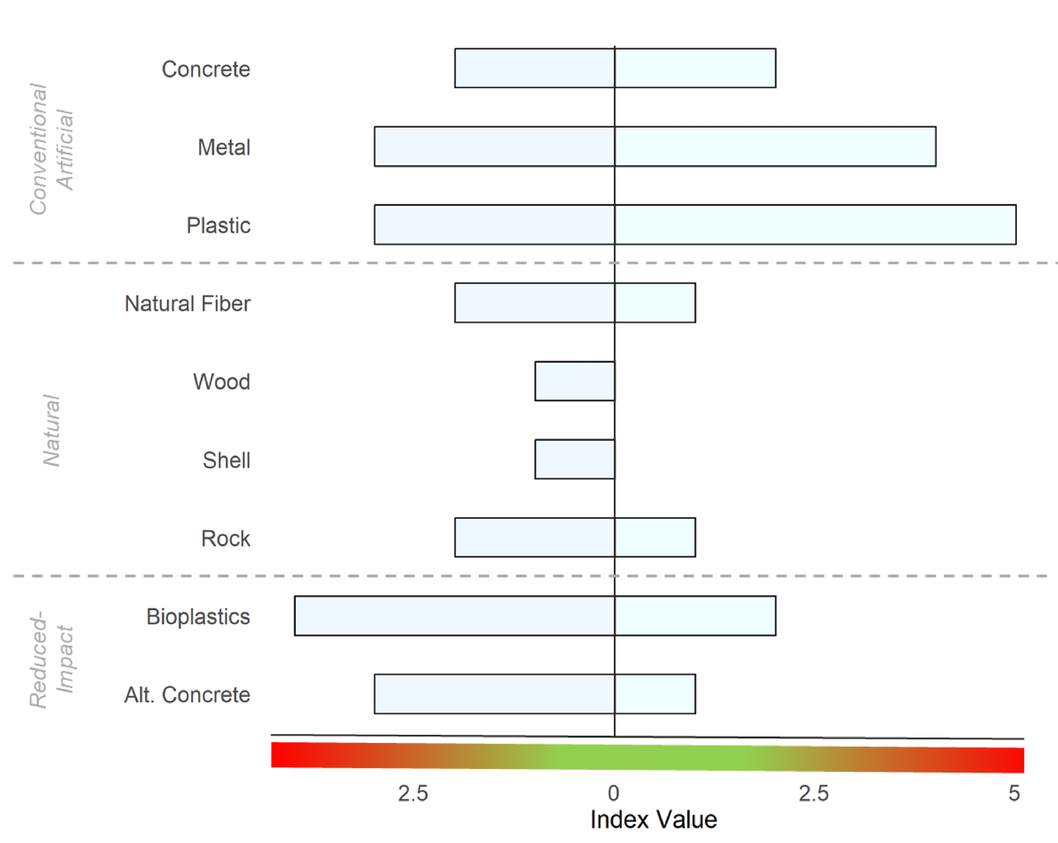
Material Prevalence



Material prevalence is presented as the proportion of studies in our review using each material.

Financial Cost vs. CO_2 Emissions



Purchase Cost Index

Cost (USD) per kg of material	Index Value
0 to 0.01	1
0.01 to 0.10	2
0.1 to 1.0	3
1.0 to 10.0	4
10.0 to 100.0	5

CO_2 Emission Index

kg CO_2 emitted per kg of material from production	Index Value
0 to 0.5	1
0.5 to 1.0	2
1.0 to 1.5	3
1.5 to 2.0	4
2.0 to 2.5	5

Additional Considerations

Lifespan

Degradation is sometimes a desirable material characteristic following foundation species establishment. However, it is dependent on environmental conditions such as wave energy and foundation species establishment rates.

Sourcing

Using local sourcing, including the use of recycled materials, most reduces impact for natural materials.

Life Cycle Impacts

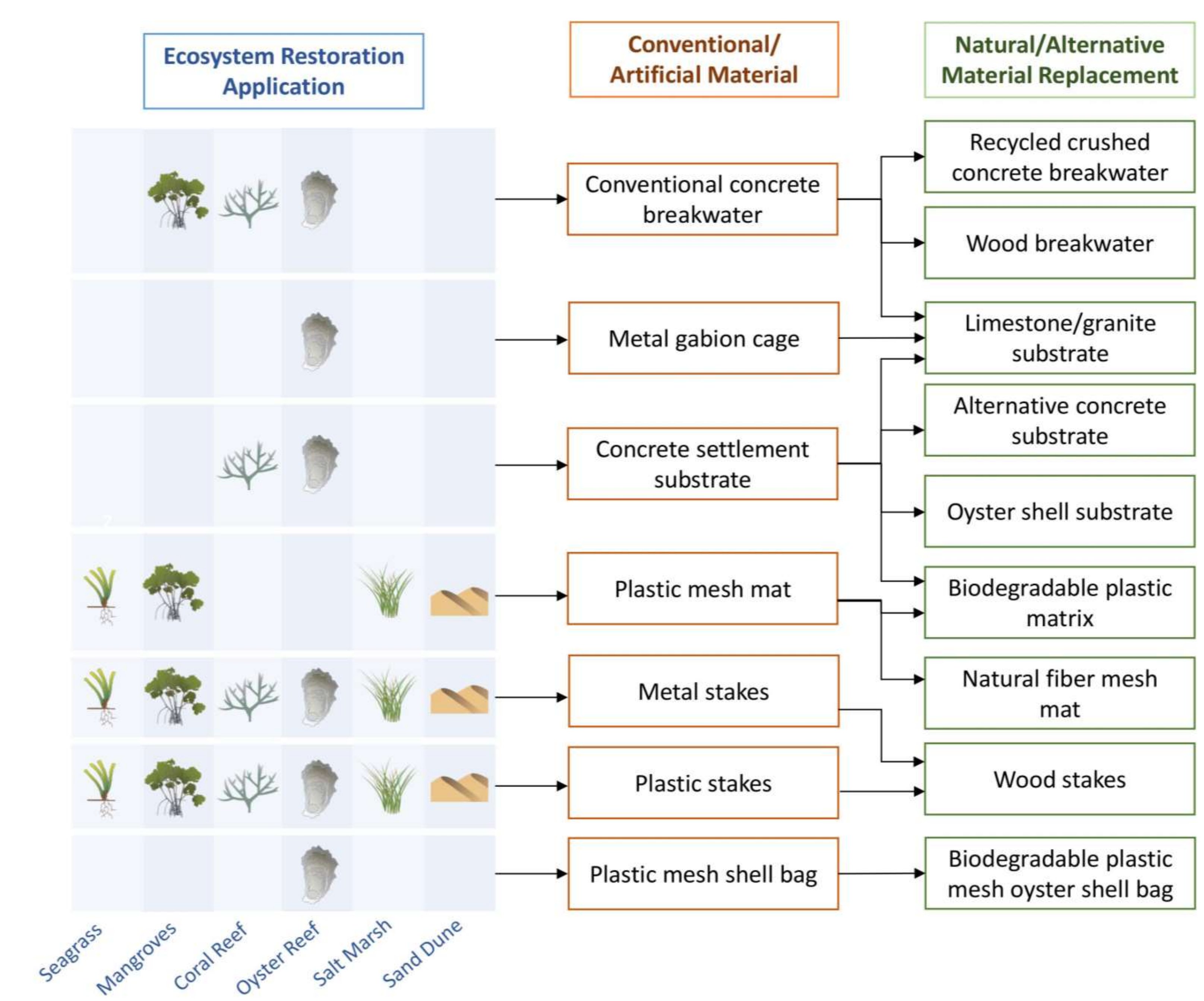
Life Cycle Stage

	Material	Production			Transportation/Deployment		Degradation	
		Resource Consumption	Waste Production	CO_2 Emission	Transportation	Deployment	Physical Impacts	Chemical Impacts
Conventional	Plastic	High Impact	High Impact	High Impact	Medium Impact	Low Impact	High Impact	Medium Impact
Conventional	Metal	High Impact	Medium Impact	High Impact	High Impact	Medium Impact	Medium Impact	Medium Impact
Conventional	Concrete	High Impact	Medium Impact	High Impact	High Impact	Medium Impact	Medium Impact	Low Impact
Reduced-Impact	Bio-based/ Biodegradable plastics	Medium Impact	High Impact	High Impact	Medium Impact	Low Impact	Medium Impact	Low Impact
Reduced-Impact	Alternative Concrete	Medium Impact	Medium Impact	Medium Impact	High Impact	Medium Impact	Medium Impact	Low Impact
Natural	Rock	High Impact	Low Impact	Low Impact	High Impact	Medium Impact	Low Impact	Low Impact
Natural	Wood	Medium Impact	Low Impact	Low Impact	Medium Impact	Medium Impact	Low Impact	Low Impact
Natural	Oyster Shell	Low Impact	Low Impact	Low Impact	Medium Impact	Medium Impact	Low Impact	Low Impact
Natural	Natural Fibers	Medium Impact	Low Impact	Low Impact	Medium Impact	Low Impact	Low Impact	Low Impact

High Impact · Medium Impact · Low Impact

Impacts are presented as the relative magnitude of adverse environmental effects from each life cycle stage.

Material Replacement



Examples of material and structure replacement approaches are presented for select ecosystem applications.