Field-based evaluation of glass cullet as a supplementary sediment source for coastal restoration

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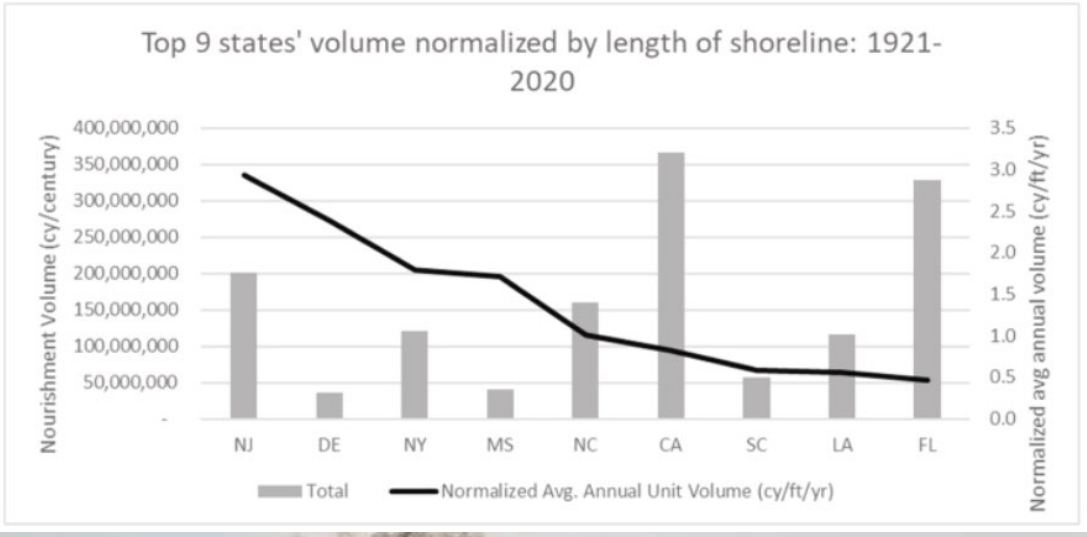
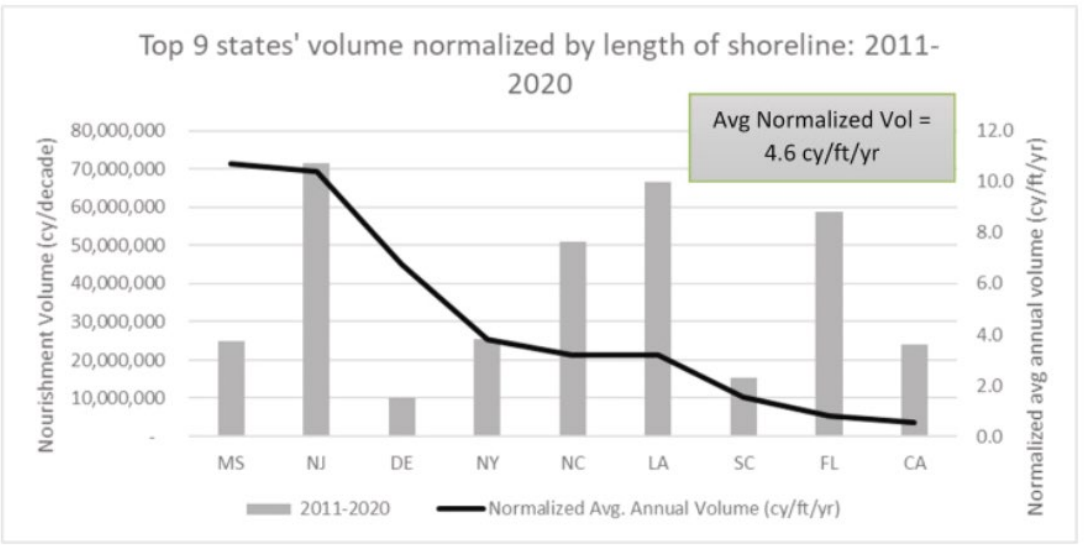
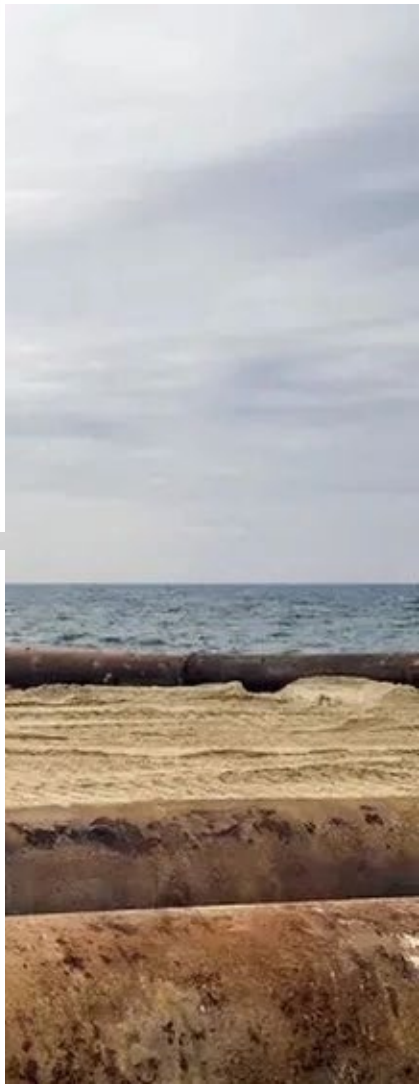
The need for sand
economic & environmental costs

MONMOUTH COUNTY, NEW JERSEY, 05.02.2024
Photo by Hector Mosley U.S. Army Corps of Engineers

The need for sand
economic & environmental costs







Elko, Nicole, et al. "A century of US beach nourishment." Ocean & Coastal Management 199 (2021): 105406.

The need for sand
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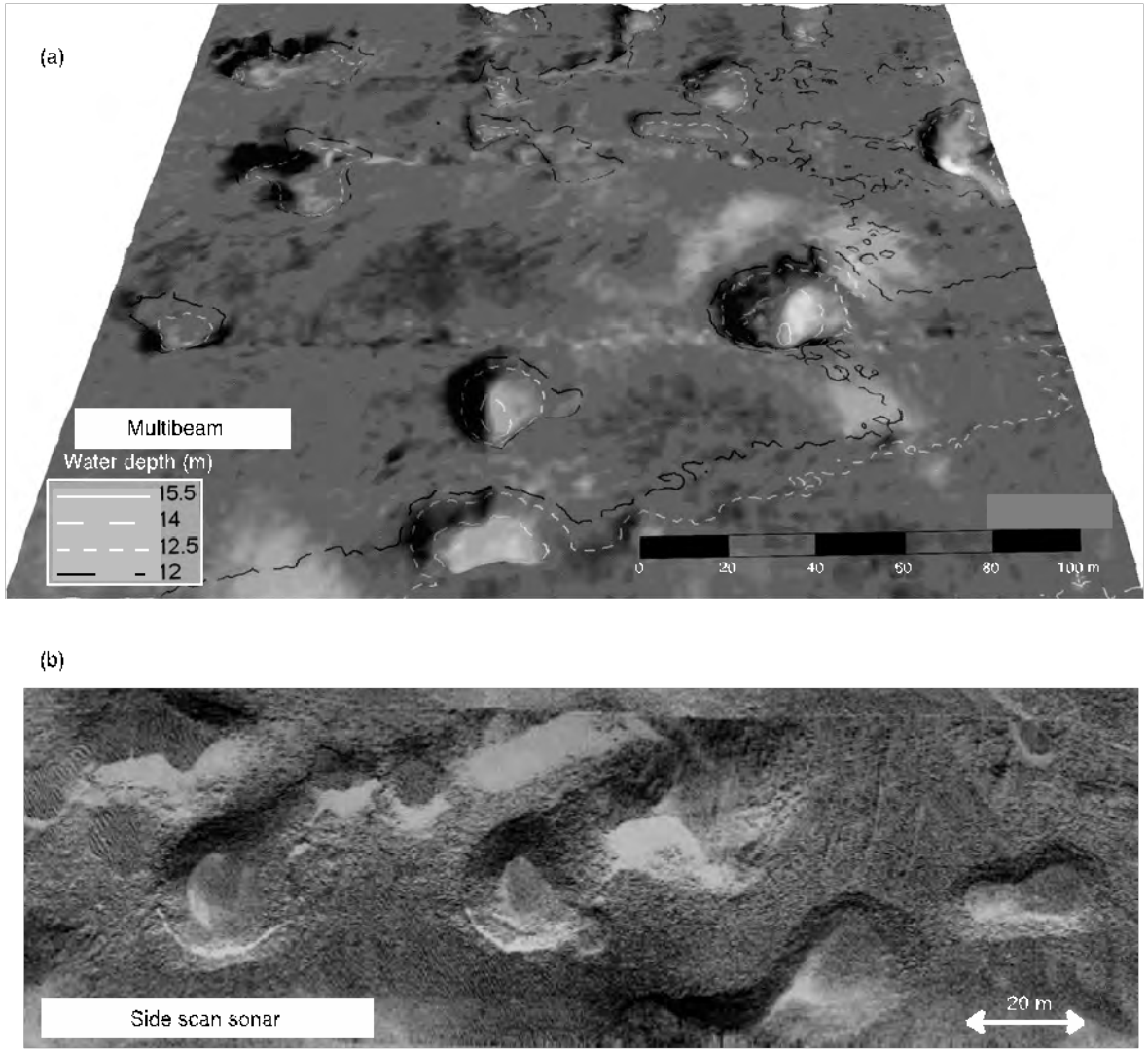


(Garel et al., 2009, *Offshore Sand and Gravel Mining*)

Glass as an alternative to sand?

crushed soda-lime-silicate container glass “cullet”

Photo of glass waste collected and processed on campus by Rowan AMMI’s Glass Education Research and Recirculation Program

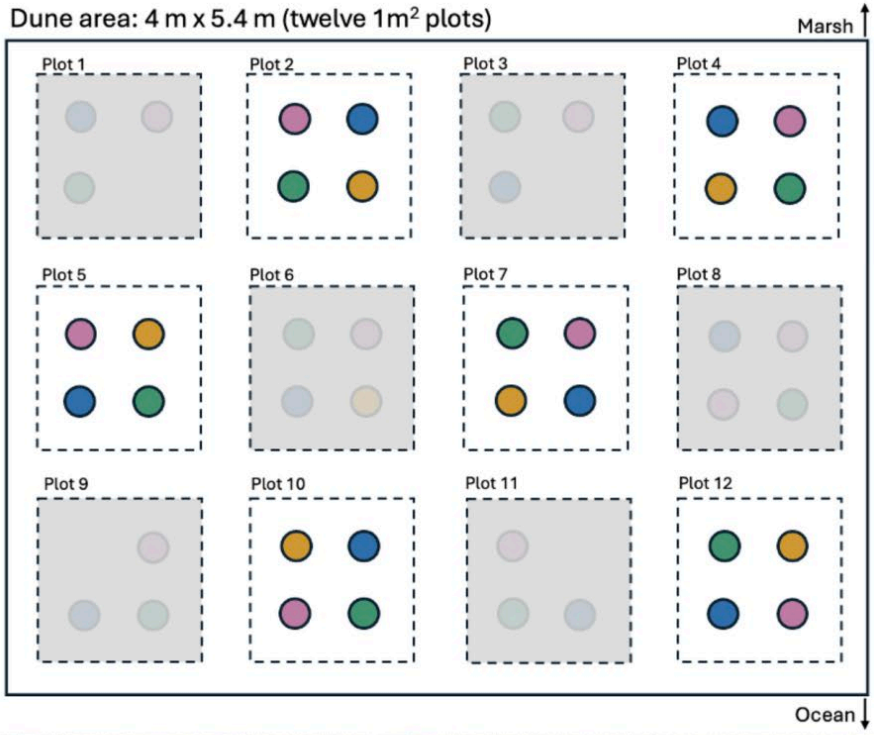
Growing dune plants in glass?

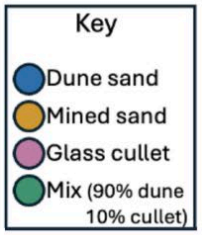
assessing the utility of cullet in dune restoration projects

Photo of glass waste collected and processed on campus by Rowan AM

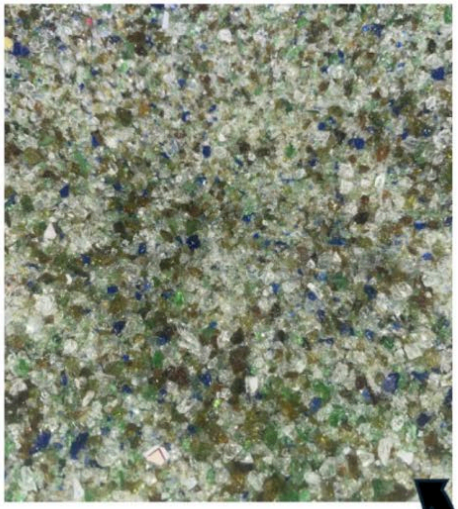
Field-based experiment

assessing the utility of cullet in dune restoration projects





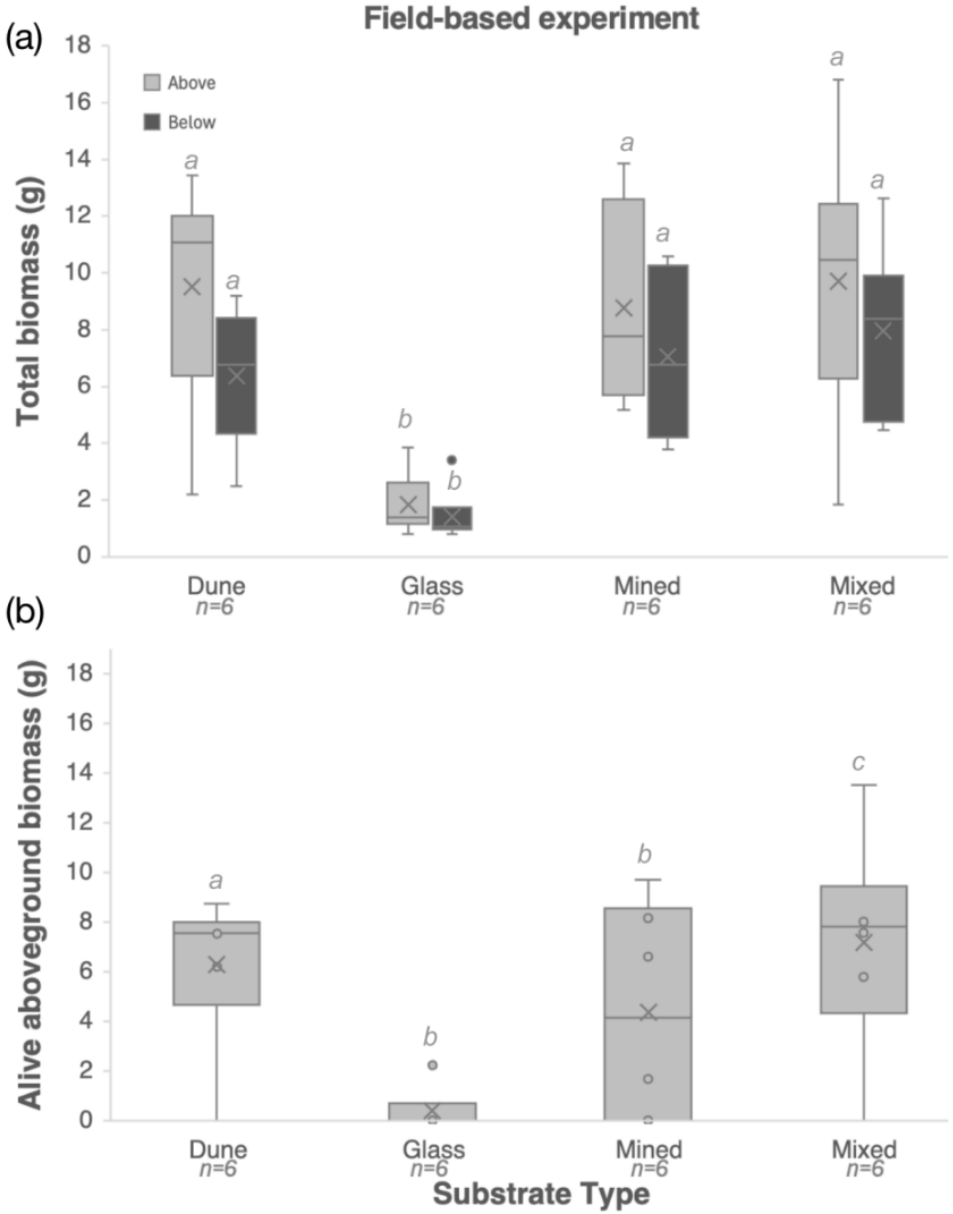
Glass cullet used (unsieved, unsorted)



Plot 4 at install showing different substrate types

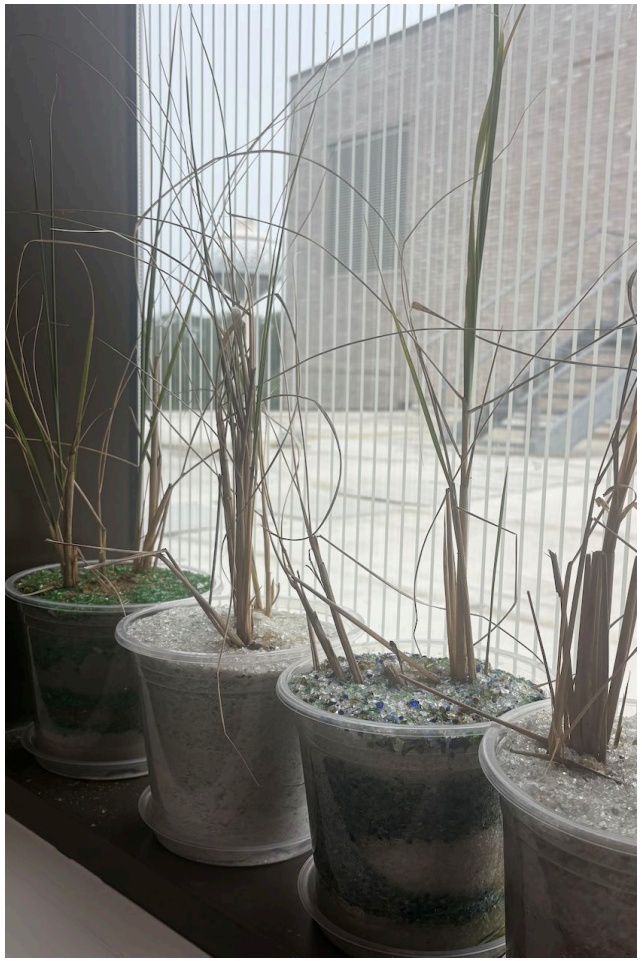
Results

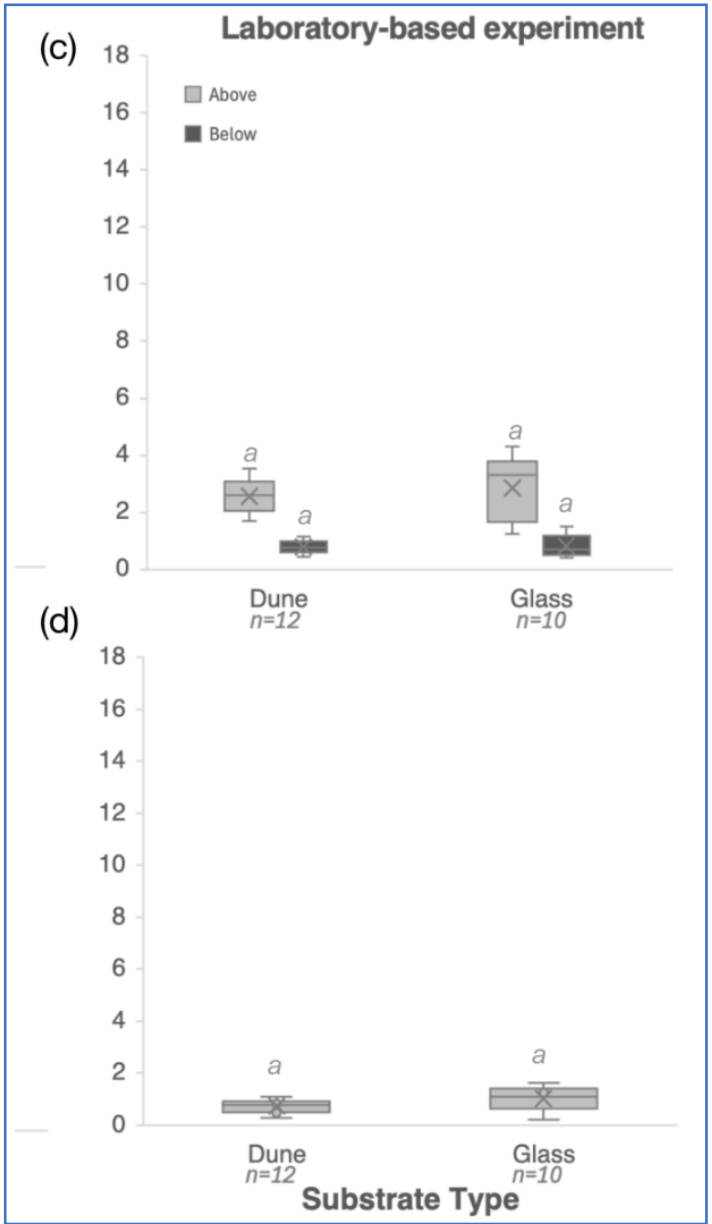
plants didn't survive in 100% cullet in the field…



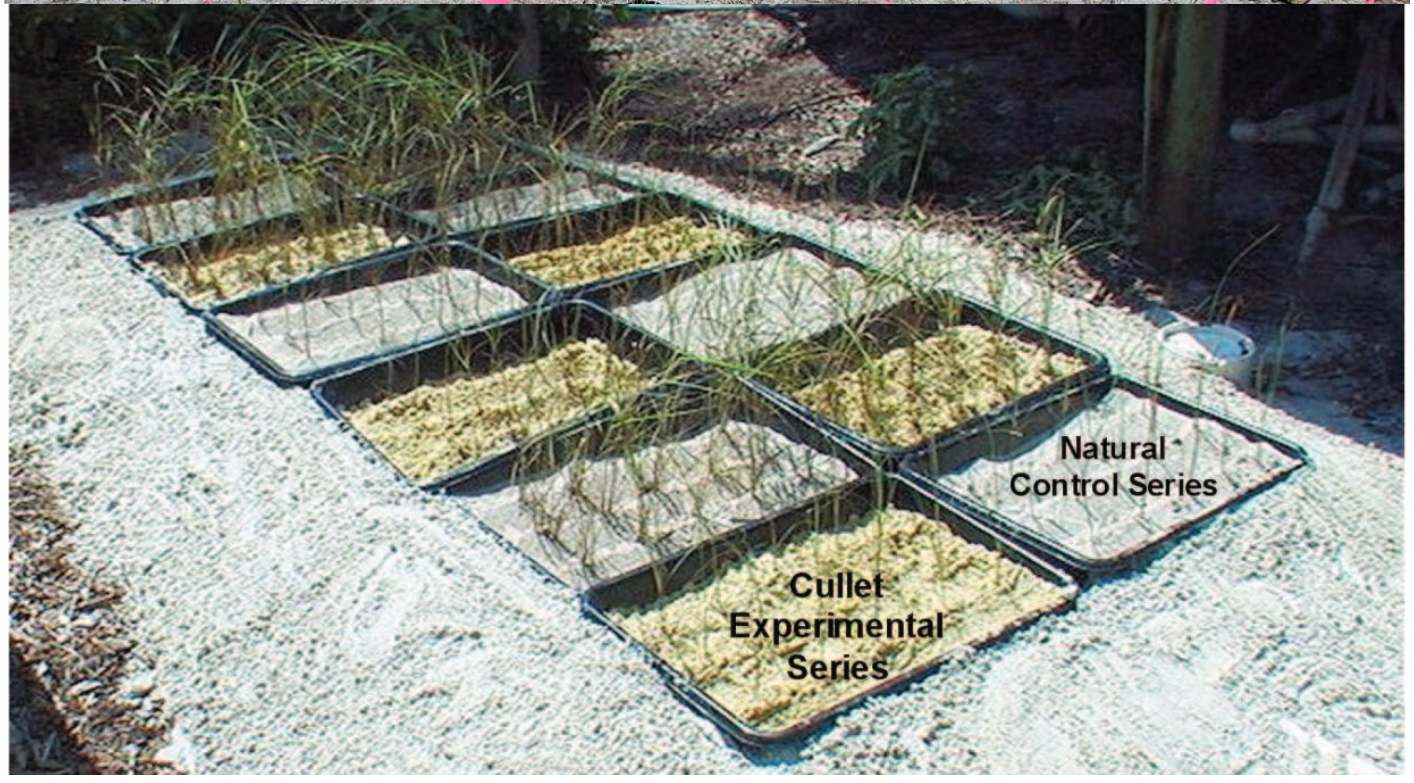
Results

…but they DID survive in 100% cullet indoors!





Why did our (field) plants die ??



Makowski, Christopher, Charles W. Finkl, and Kirt Rusenko. “Suitability of Recycled Glass Cullet as Artificial Dune Fill along Coastal Environments.” Journal of Coastal Research 289 (July 30, 2013): 772–82. https://doi.org/10.2112/12A-00012.1.

Why did our (field) plants die ??

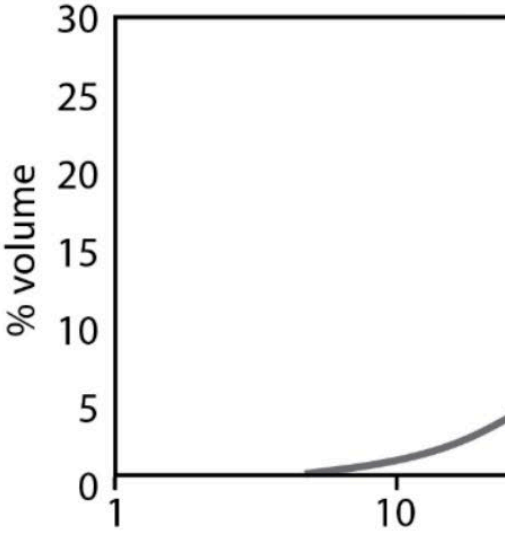
(1) physical properties of cullet that are incompatible with plant growth?

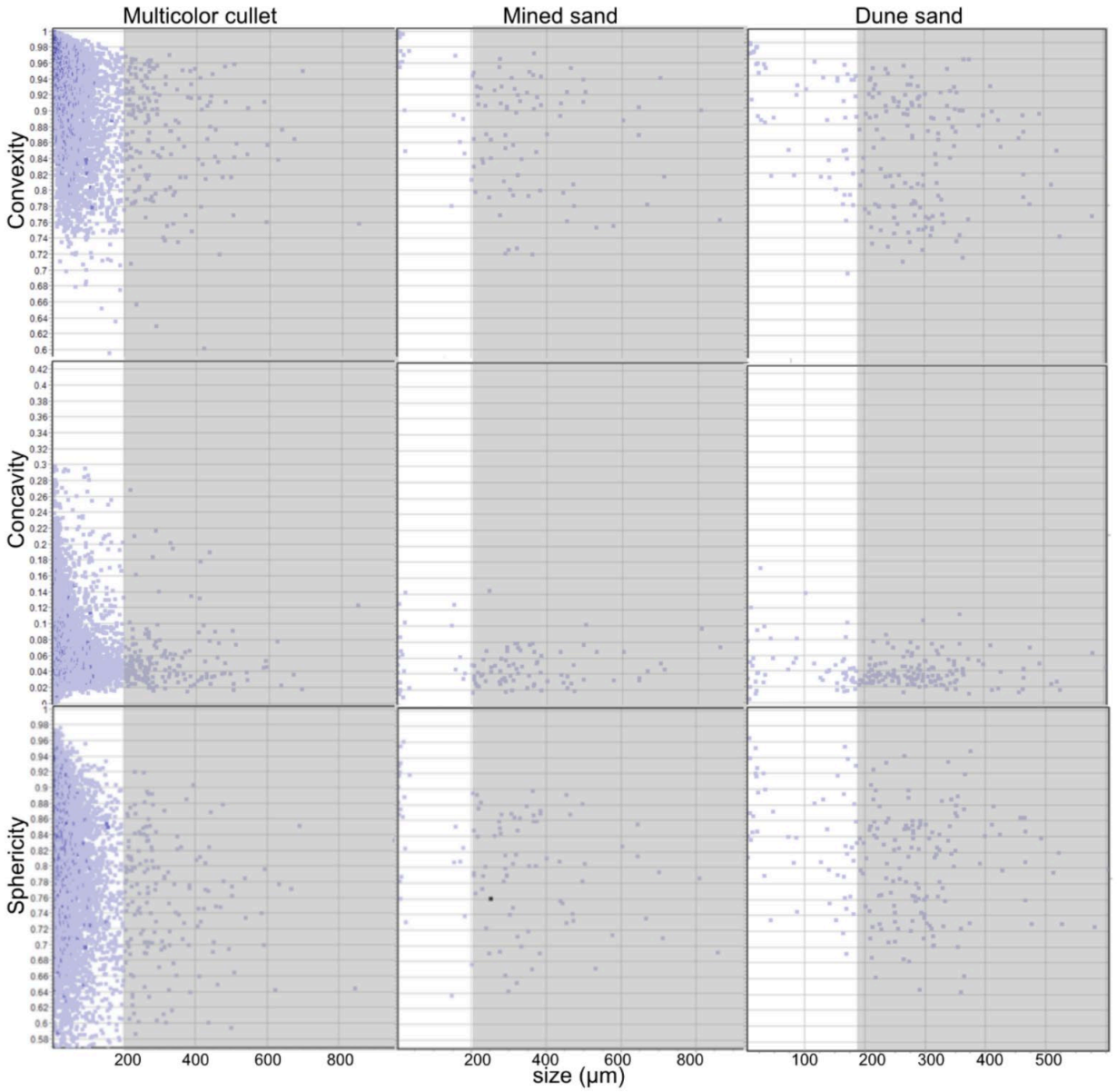
(2) chemical reactivity of cullet in certain (e.g., saline) environments?

(3) biological properties of American beachgrass incompatible with biologically-inert substrate?

Results

Physical properties: cullet very similar to sand





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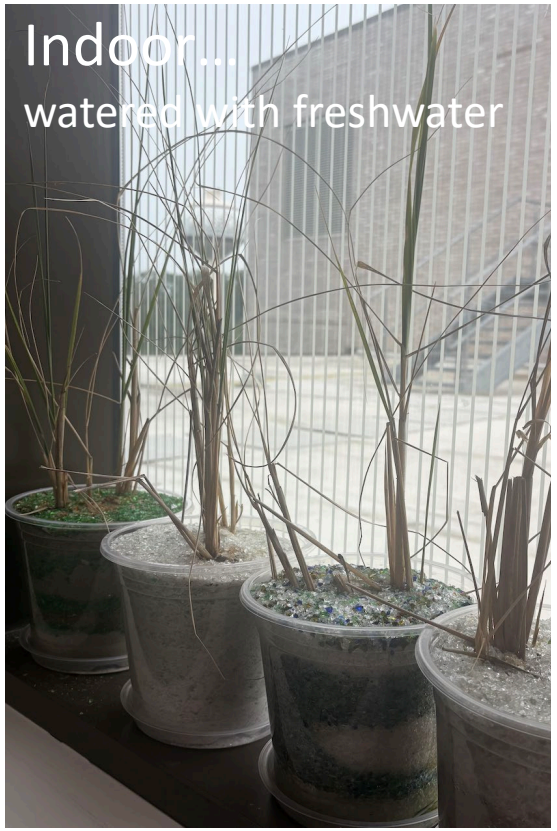
Results

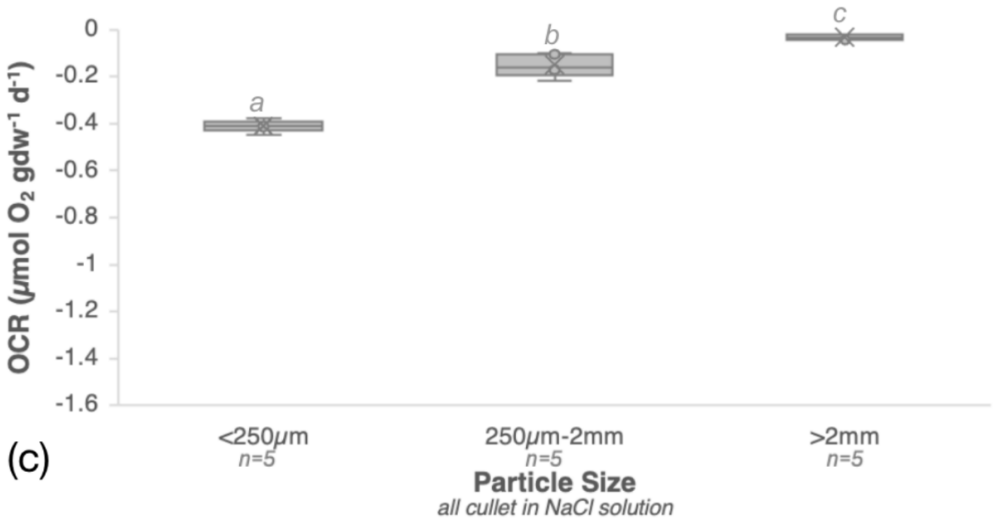
Chemical properties: substantial differences cullet vs. sand

	SiO2	Al2O3	Fe2O3	CaO	MgO	Na2O	K2O	Cr2O3	TiO2	MnO
Cullet	71.14	1.66	1.20	10.90	1.12	13.20	0.55	0.06	0.06	0.02
Dune sand	96.57	0.96	1.17	0.29	0.06	0.25	0.23	0	0.44	0.02
Mined sand	97.40	0.29	1.99	0.02	0.01	0.02	0.02	0	0.23	0.02



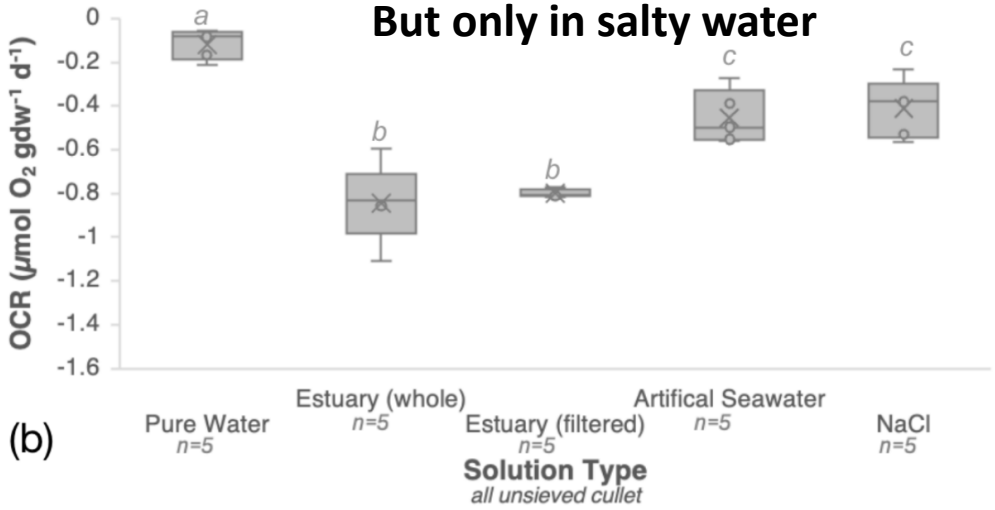
Results

Oxygen Consumption Rate incubations: Cullet chemically reactive in solutions of high ionic strength



(c)

But only in salty water



(b)

Findings (so far) & future work

- Our data support that sand-sized cullet is generally representative of natural sand (in shape) but does not support the prevailing notion that cullet is chemically inert as previously thought (cf., Finkl & Kerwin 1997), particularly when exposed to solutions of high ionic strength (e.g., saline environments).
- Further testing is required to determine the underlying cause of plant mortality when grown in cullet in saline environments. Is it this chemical reactivity that is related to plant mortality? Or something else? (e.g., biological properties)
- Small-scale, field-based experiments are recommended in advance of broad implementation of cullet in restoration projects to catch any potential unexpected environmental consequences.

Thank you!!

Pfeifer, Lily S., and Charles A. Schutte. “Field-Based Evaluation of Glass Cullet as a Supplementary Sediment Source for Coastal Restoration.” Restoration Ecology n/a, no. n/a (2025): e70142. https://doi.org/10.1111/rec.70142.

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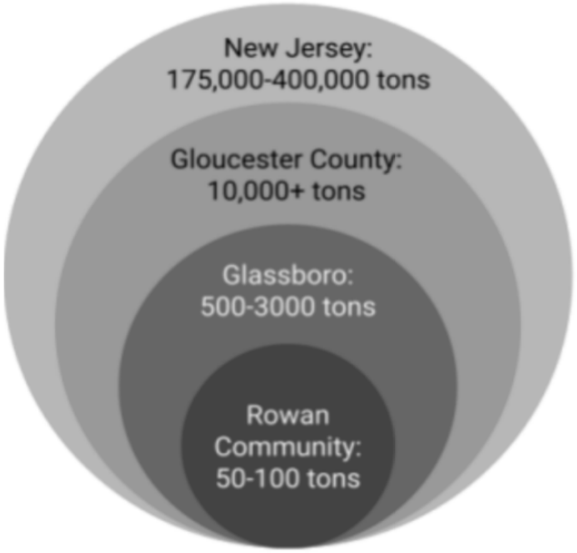
How much glass is there?



Industry	Need	~ tons/yr
Coastal restoration/dune engineering	Cullet, any color (sand-sized only?)	>100,000
Container glass manufacturing	Clear containers (whole)	>20,000
Insulation and building material manufacturing	Mixed color glass aggregate	>20,000
Medical and lab glass manufacturing	Whole container recirculation	>5,000
Food/beverage manu-facturing glass packaging	Whole container recirculation	>100