

Measuring the Impacts of Vegetation on Dune Erosion

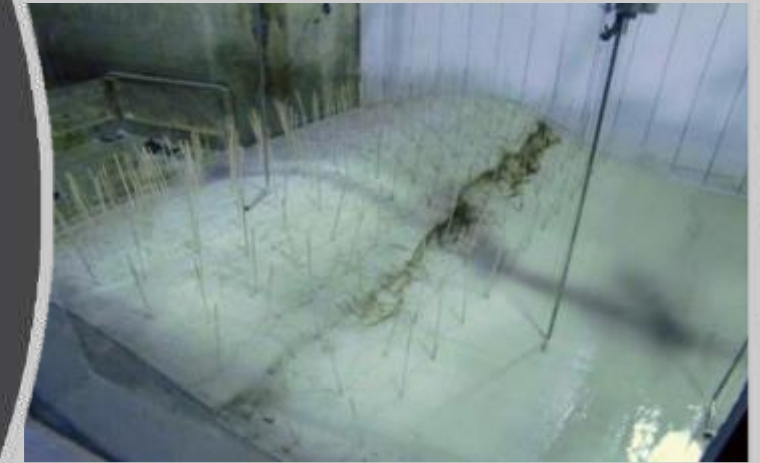
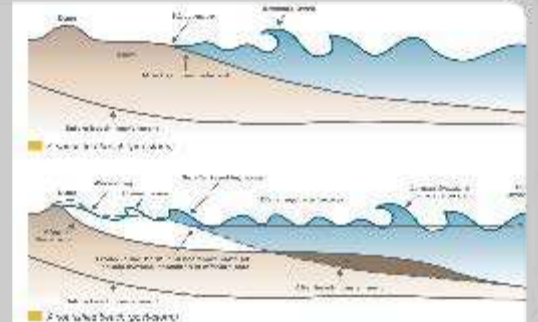
9th National Summit on Coastal and
Estuarine Restoration and Management
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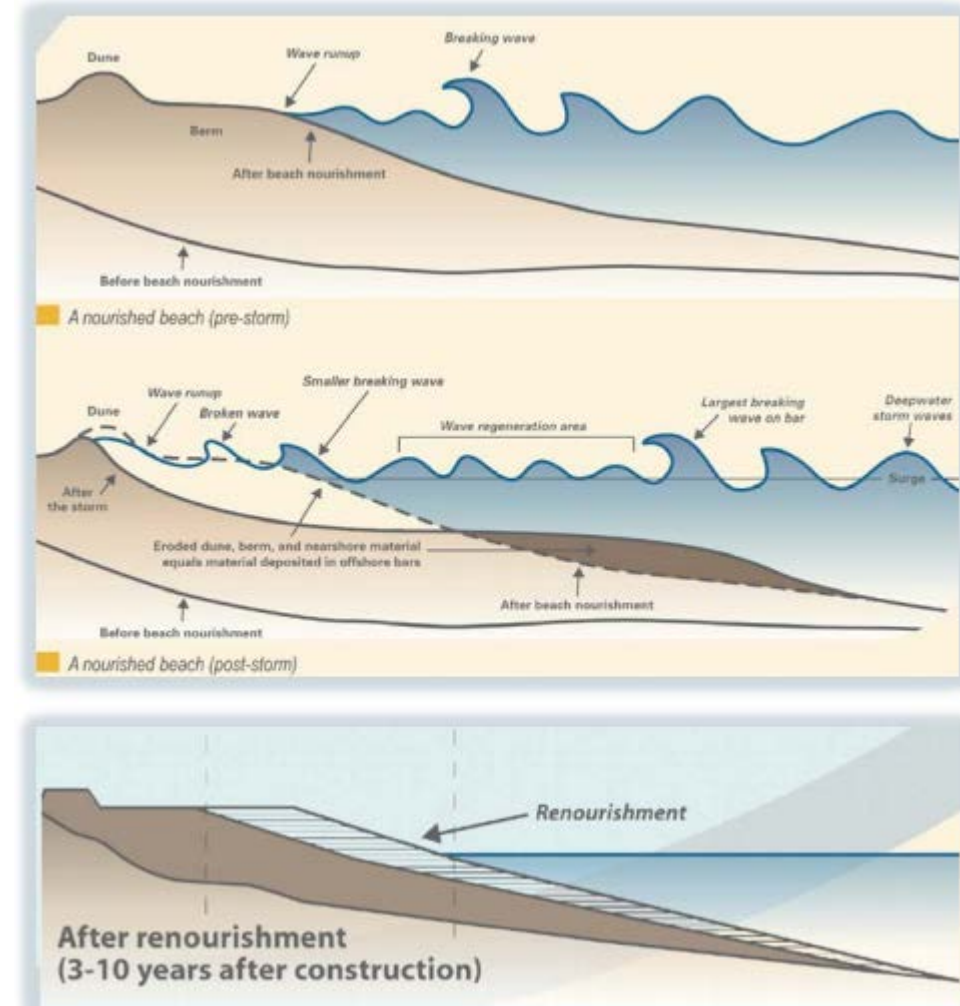


US Army Corps
of Engineers



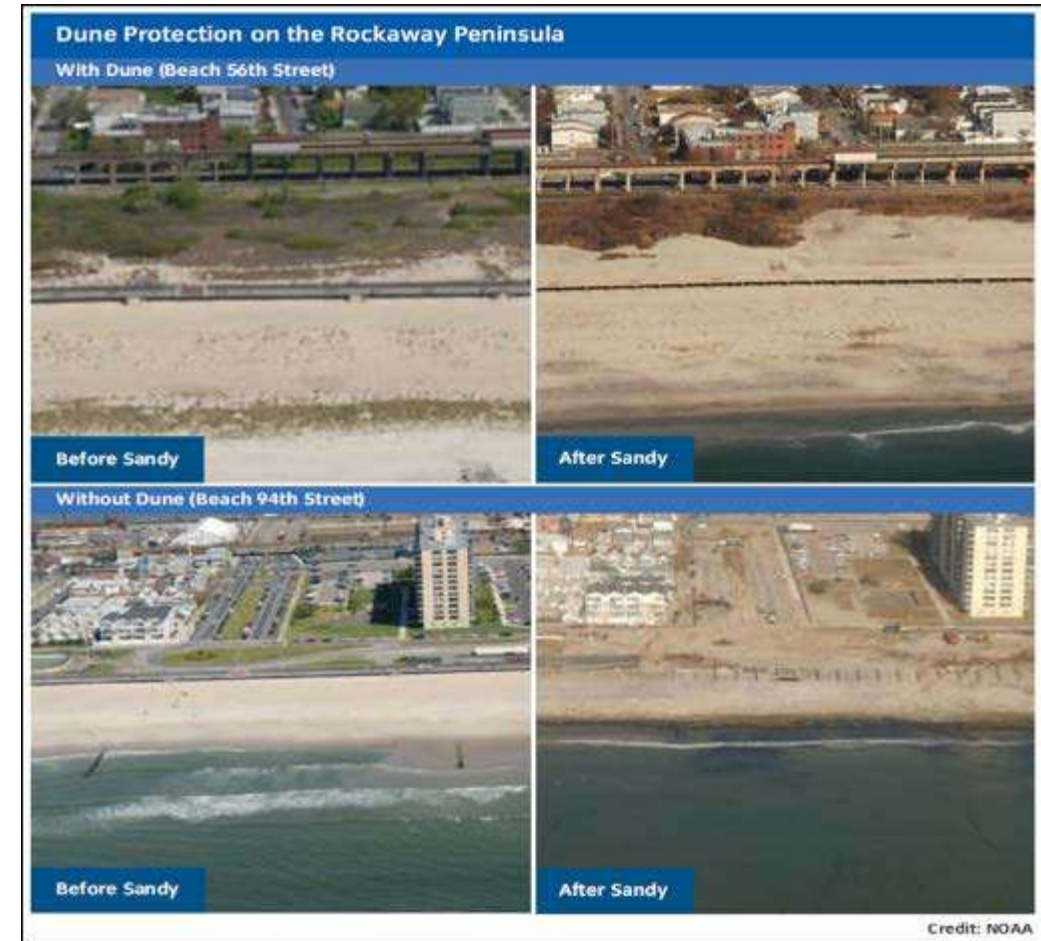
Dunes and Beach Nourishments

- Dunes are often built as part of a beach nourishment or grow following nourishment
- Dunes serve as sediment storage (engineering service) increasing coastal resilience



Coastal Dune – Storm Damage Reduction

- Observed to **provide coastal protection** during storm events
- Population has historically **encroached** into areas resulting in “coastal squeeze”
- Vulnerable coastal populations due to **increasing threats**
- Beach nourishment has been found to be **the most cost-effective, socially and environmentally suitable** way to reduce storm damages and coastal flooding (ASCE 2016)



City of New York. 2013. *planNYC: a stronger, more resilient New York*. New York, NY: The City of New York.
<http://www.nyc.gov/html/sirr/html/report/report.shtml>.



Ecosystem Services



- Beach nourishment increases habitat
- Reduces impacts from human encroachment (coastal squeeze)



Investments in Nourishments and Dunes



- 10 years approximately 1,305 dredging projects - cost of \$5.7 billion
- 250 projects involved beach nourishments - cost \$1.4 billion (currently cannot itemize dune repair or replacement)
- Numbers don't include local or state funded nourishments that do have an impact on coastal storm risk reduction
- Clear recreation benefits from nourishments



Pressing Research Needs

The Environmental Defense Fund in their 2015 publication *Performance of Natural Infrastructure and Nature-based Measures as Coastal Risk Reduction Features* identified 9 catalytic/pressing research needs.

- **What is the contribution of root/vegetation presence on dune function?**
- **Do unknowns associated with root/vegetation presence contribute to additional risk/uncertainty?**
- **What is the effect of vegetated vs. non-vegetated dunes on storm surge? Is this quantifiable?**
- **What is the role of hybrid natural, nature-based, and structural solutions, such as sea wall buried beneath a sand dune?**



Vegetation and nearshore/dune morphology control the natural resilience of sandy coastlines

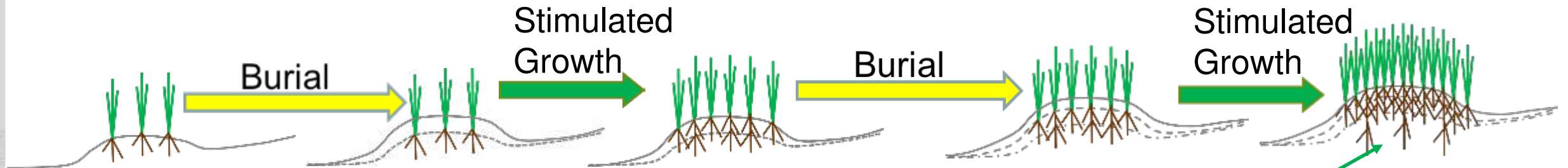


- Vegetation affects dune storm response and recovery
- Better managing our dune vegetation can improve overall coastal resilience
- Improving our dune modeling capabilities can help identify problem areas and better target beach nourishment and vegetation restoration

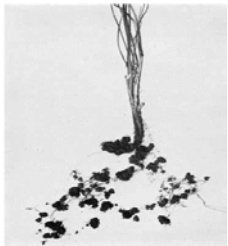


Basics of Natural Dune Growth

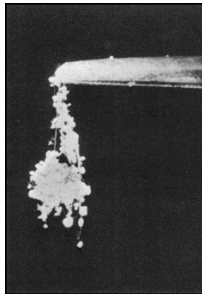
Natural System



Arbuscular Mycorrhizal [AM] Fungi



Tisdall and Oades 1982



Koske and Polson 1984



Biomass distributed throughout dune vertically

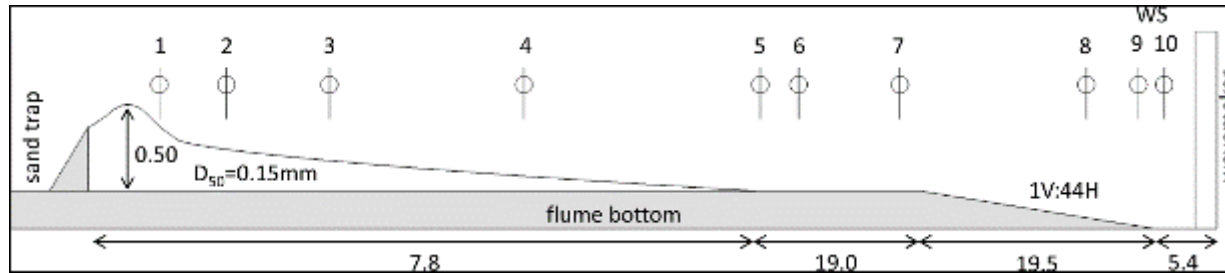


Natural Processes

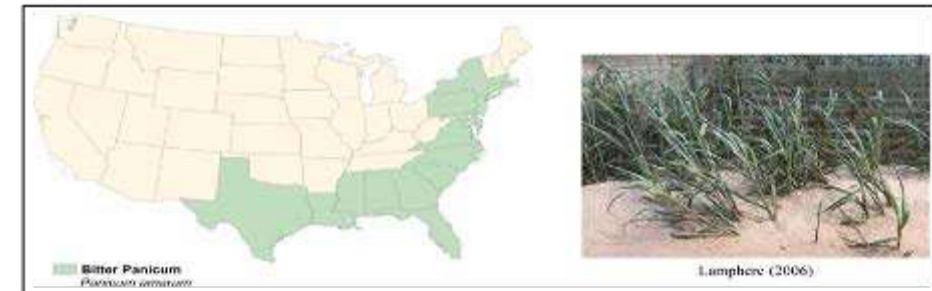
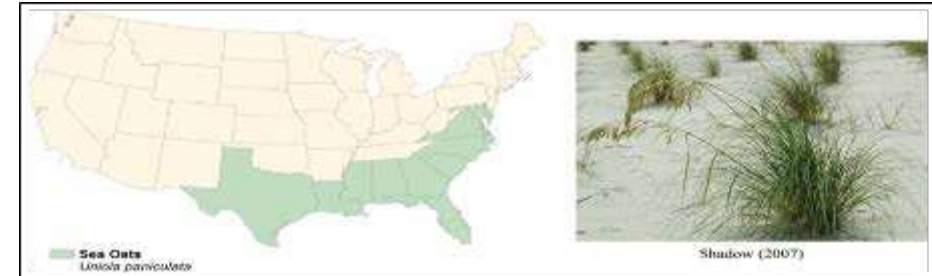


Recent Research Efforts

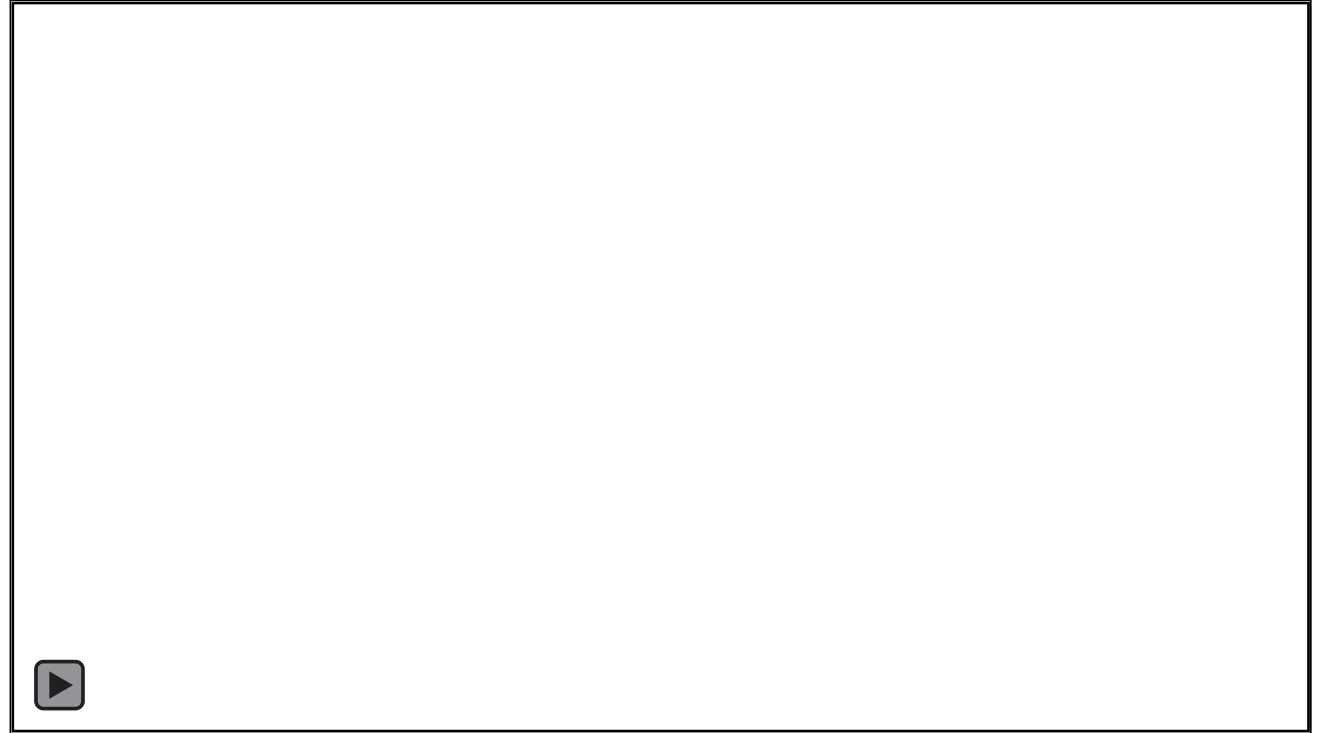
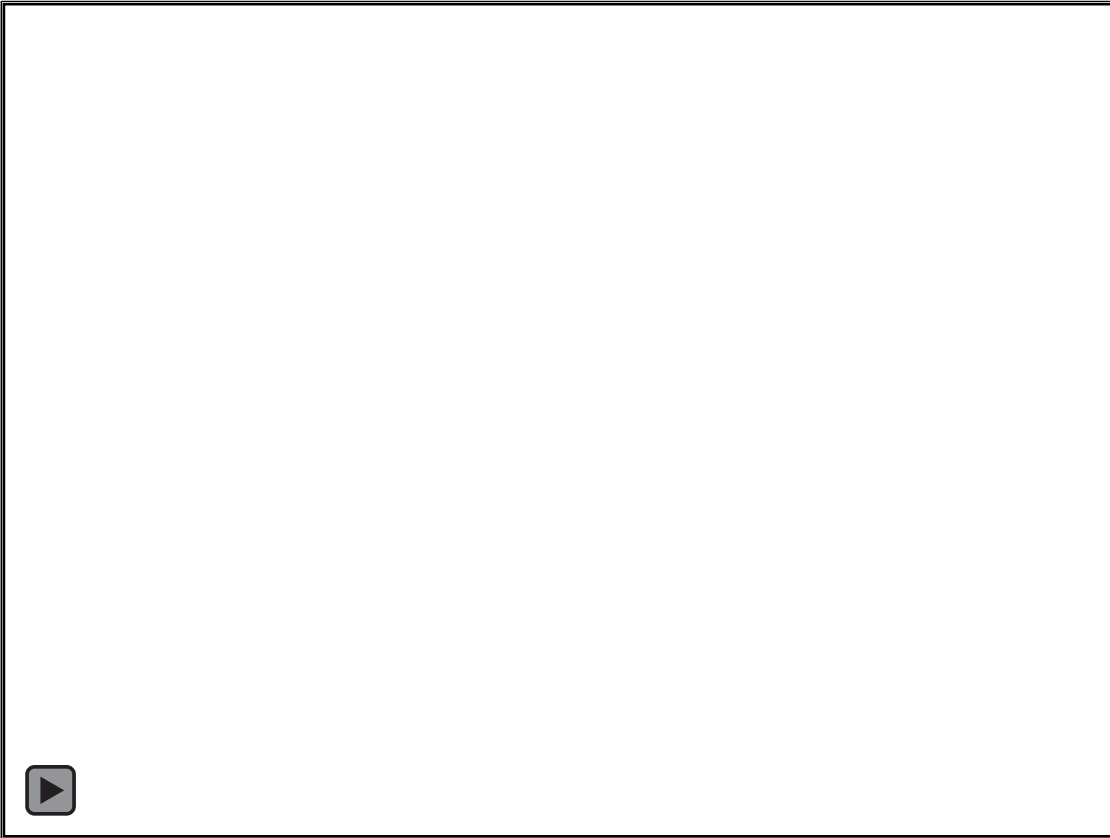
- Test the degree of **protection and reduction in erosion** afforded by biomass during events
- Provide a **quantitative dataset** that can be used to inform models and identify dune building strategies that can decrease dune erosion



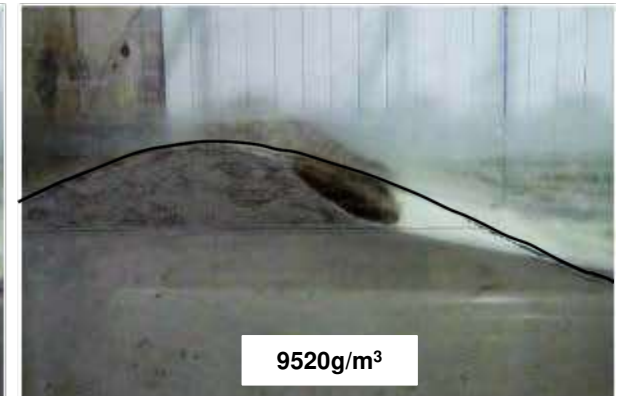
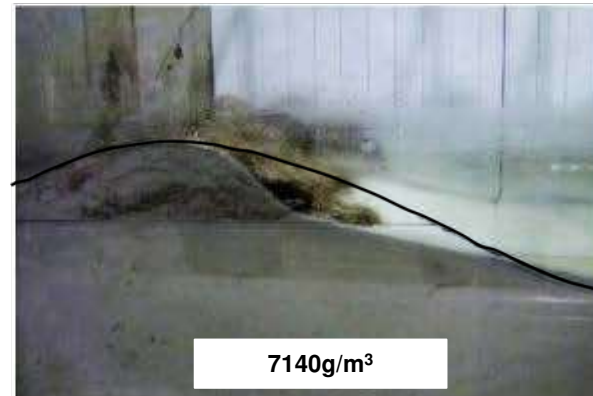
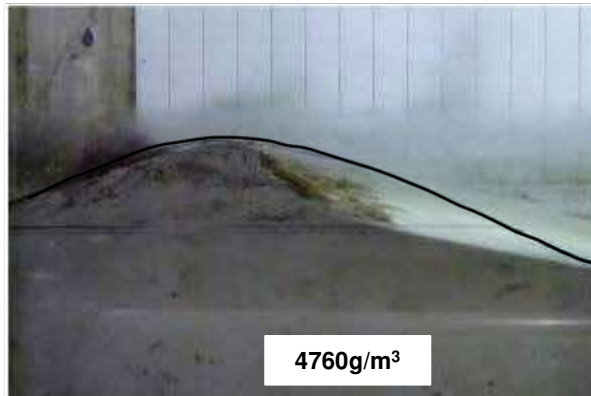
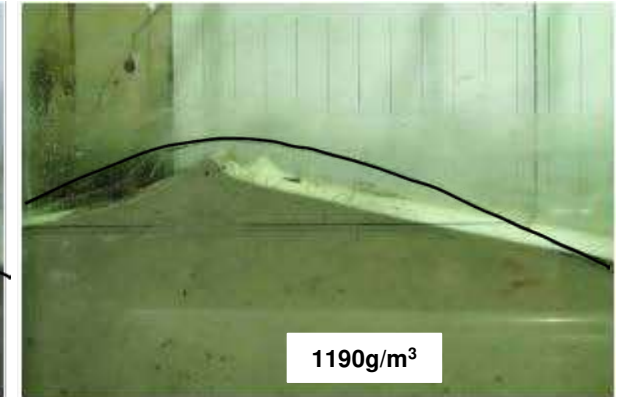
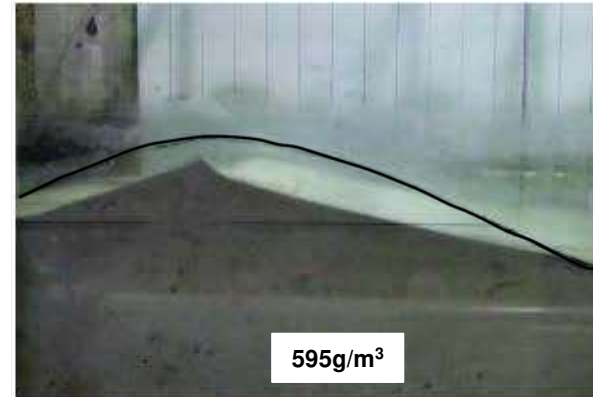
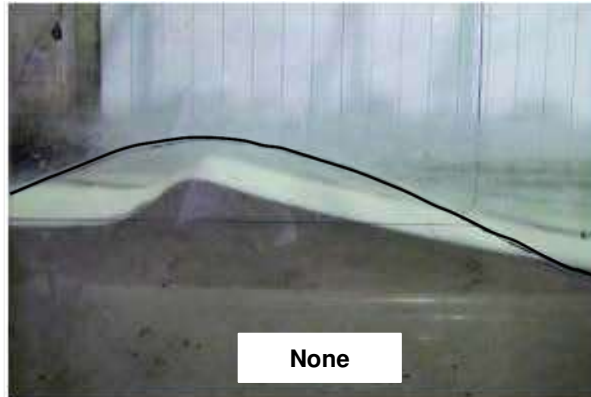
- Most pioneering dune building vegetation belongs to the Family *Poacea* (*flowering grasses*)
- **Growth stimulated due to sand burial**
- Drought and salt tolerant
- **Abundant belowground biomass**
- **Symbiotic relationship with arbuscular mycorrhizal (AM) fungi**
- Poor growth from seed – require plantings



Laboratory Model of Dune Erosion

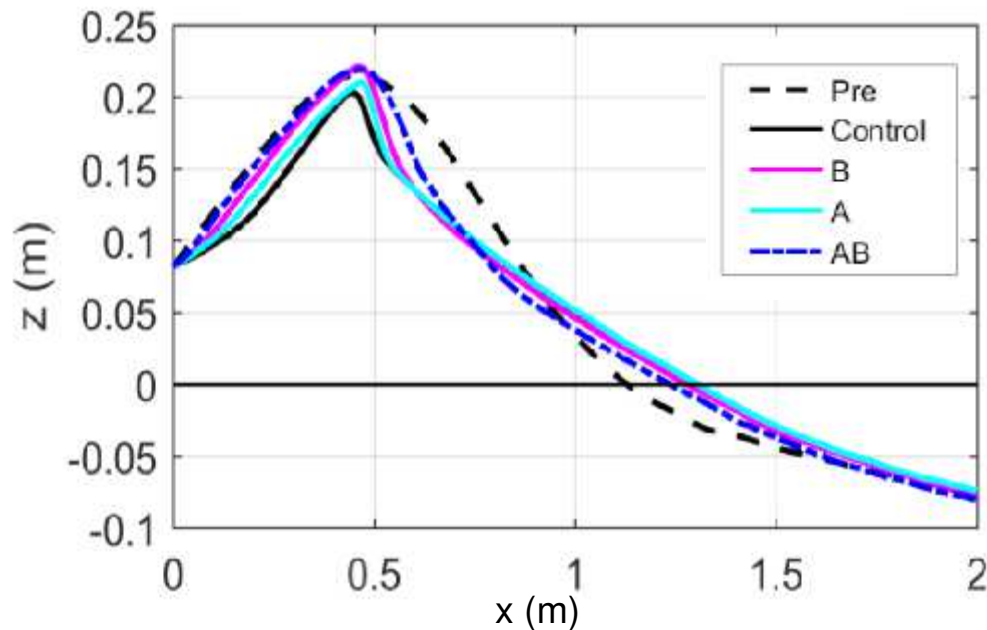


Observed Differences

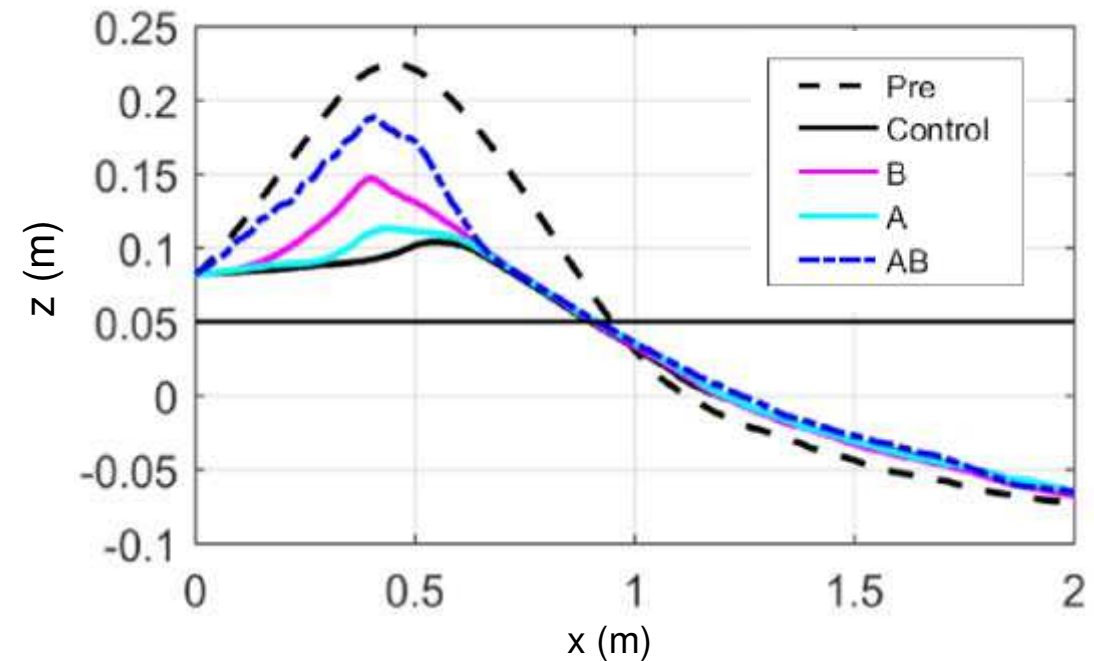


Results – Dune Profile Changes

Overwash Condition 1



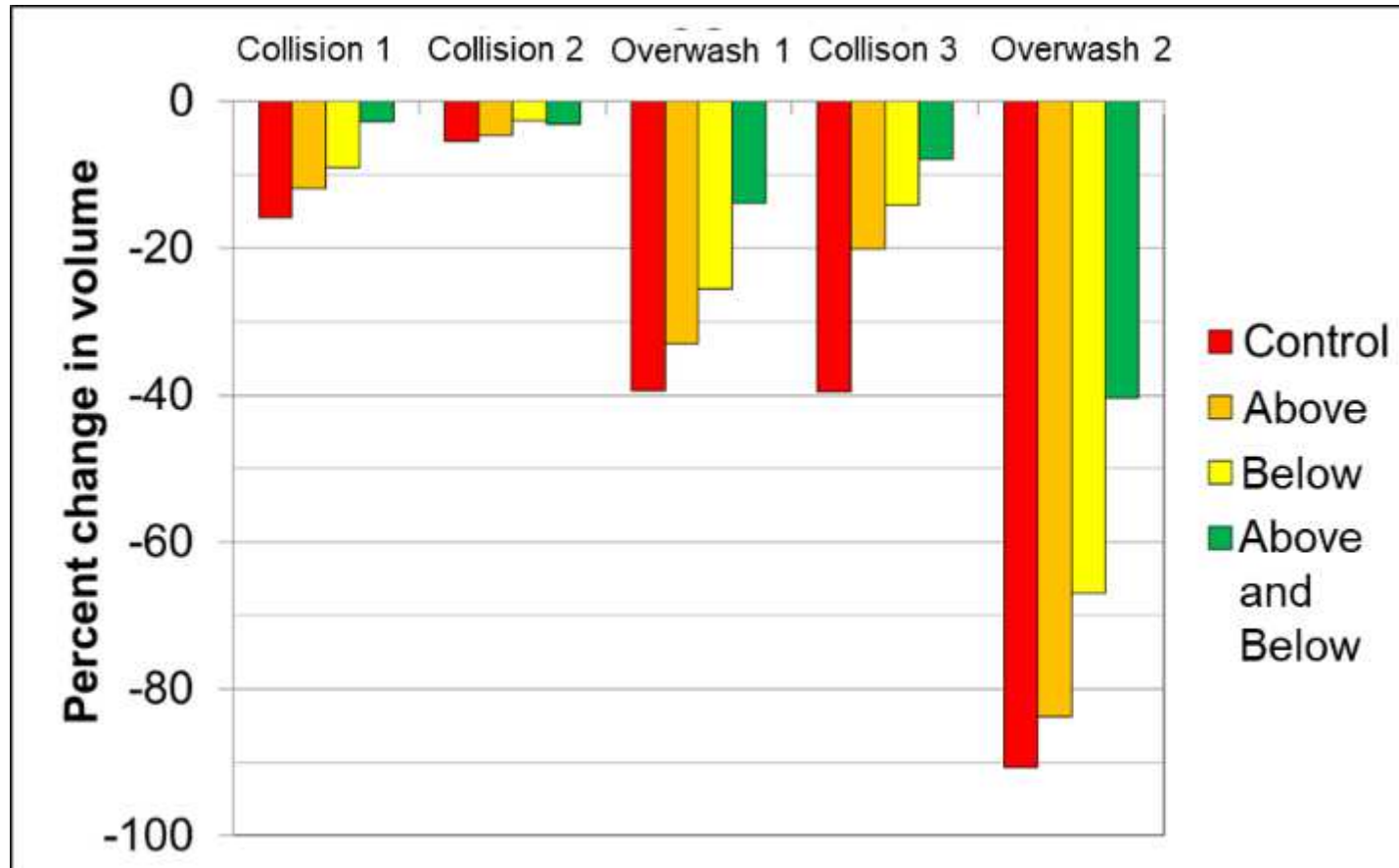
Overwash Condition 2



- Without biomass dunes suffered more erosion
- Biomass regardless of form decreased erosion
- Sediment eroded from the dunes deposited in the surf zone or deposited in the overwash



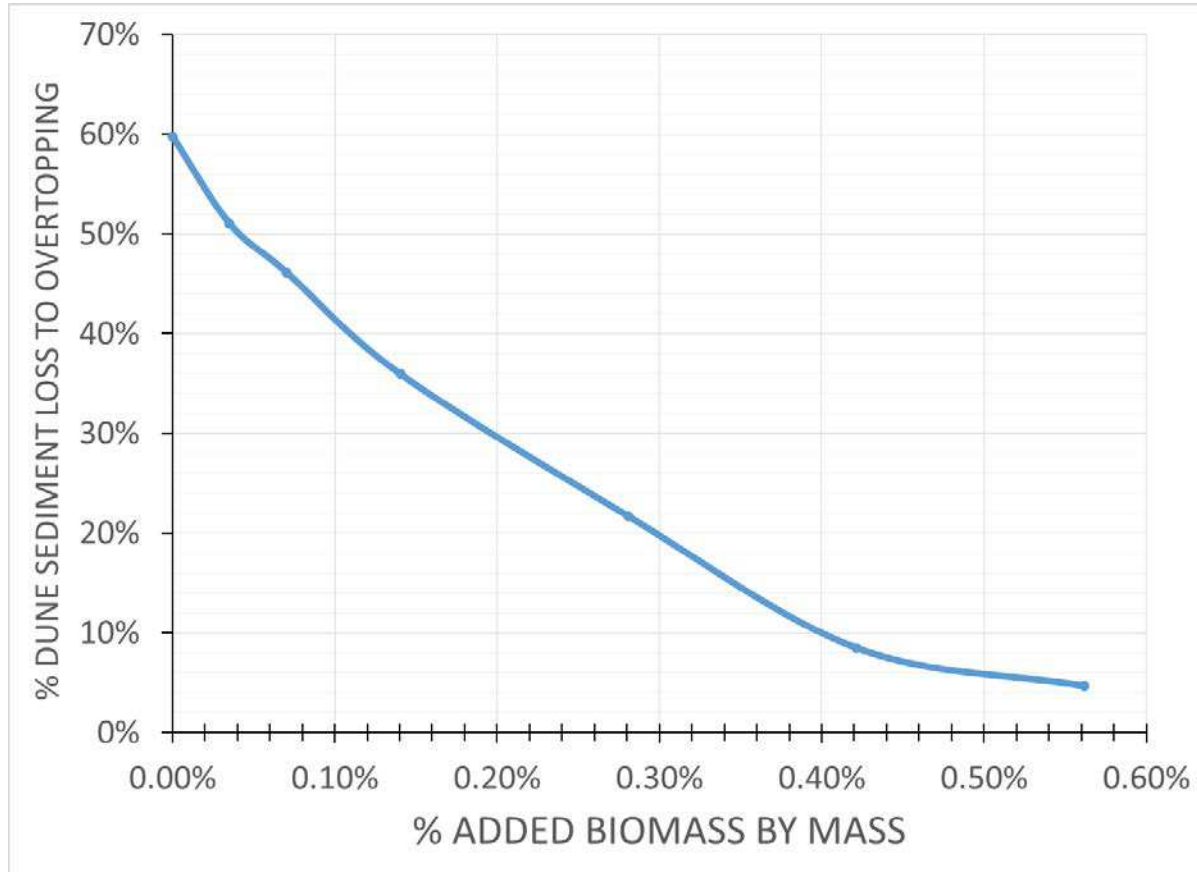
Results – Dune Volume Changes



- Result indicate that increasing dune biomass as quickly as possible to a natural level will increase dune storm performance and resiliency



How much biomass to add?

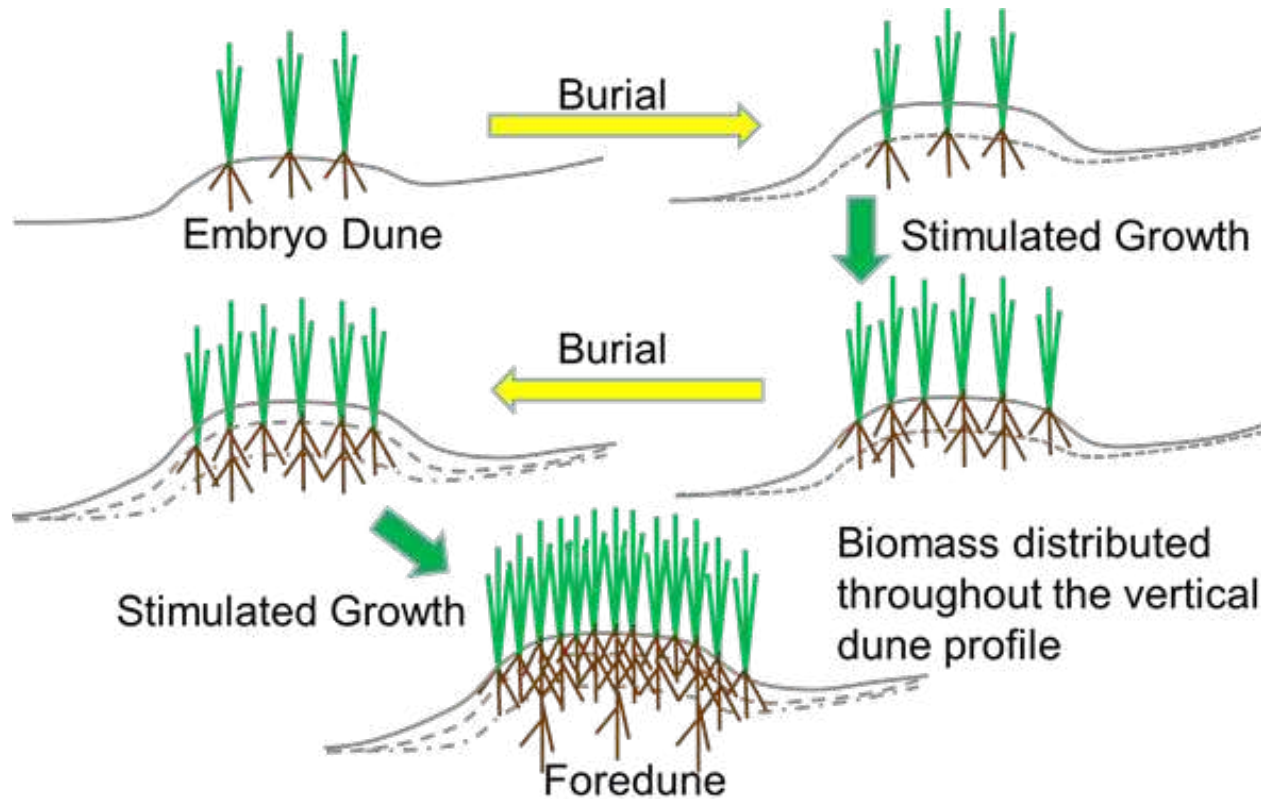


- Increasing levels of belowground biomass decreased the loss of dune material during overwash events
- What are the **practical and economical implications and limits?**

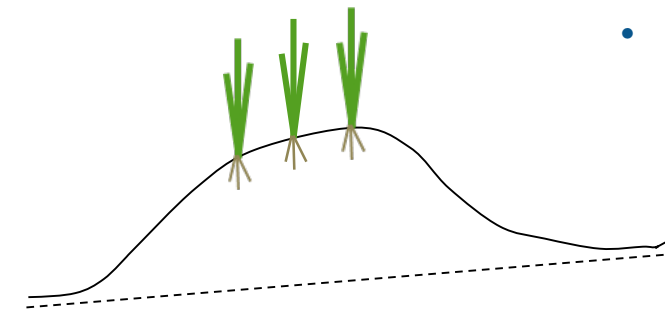


Building Better?

Natural System

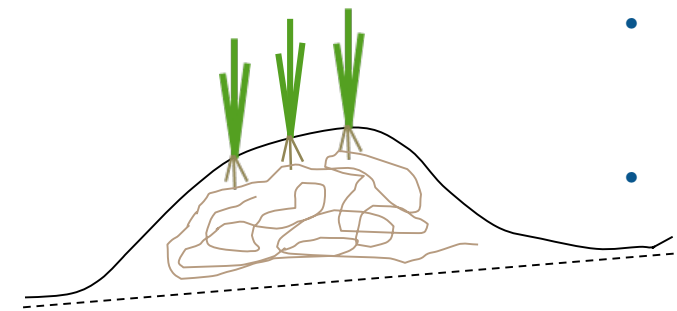


Current Construction Method



- Biomass is not distributed throughout after construction

Possible Building Method



- Biomass is artificially included in the dune
- Dune is allowed to naturally accrete



Allowing for Natural Processes

- Results show that dunes with fully integrated biomass throughout the depth will be more resistance to erosion
- These results fit well with field observations that showed:
 - Artificial dunes may not respond as natural dunes to storm processes despite being planted with native species, resulting in more rapid erosion. (Morton et al., 1994)

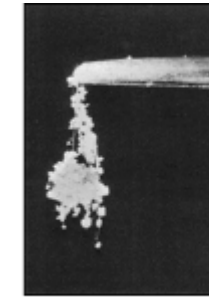


Recommendations for Future Dune Projects

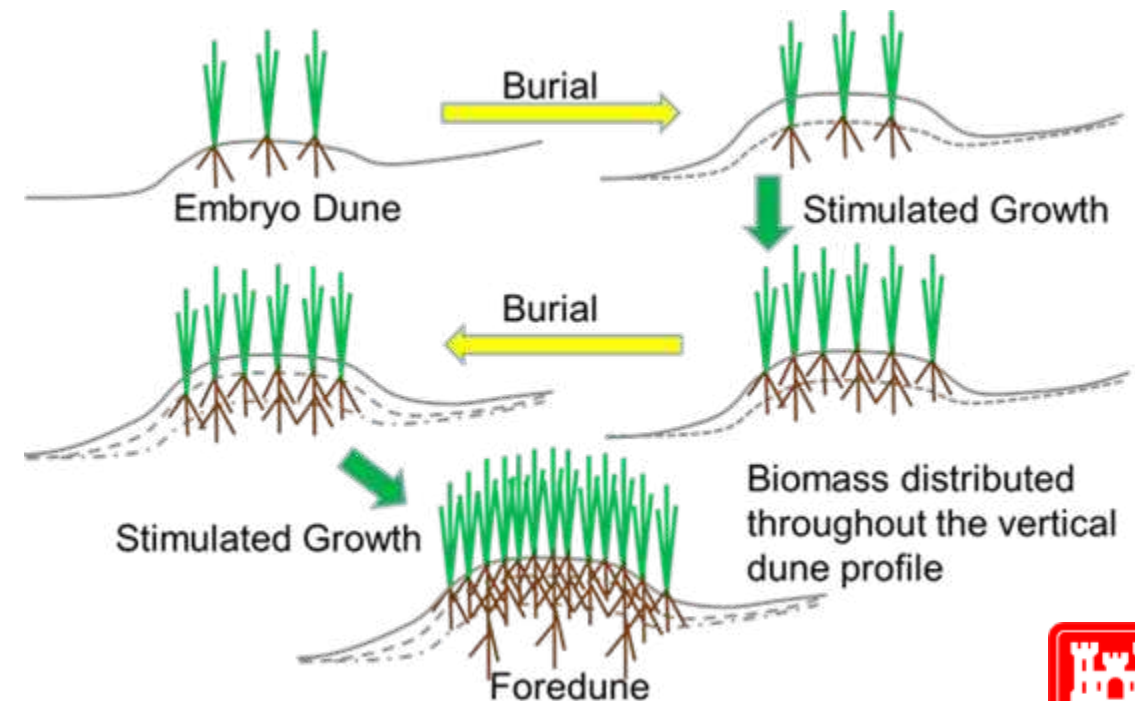
1. Track the cost of your dune construction and maintenance – Improves future decision making
2. Guarantee that plant vegetation has AM fungi present
 - Some growers use sterile growing
 - Consider inoculation/consider microbiology
3. Dredge material will not have the same microbiology or chemistry
 - May initially be too high in salinity and pH
 - Consider testing sediment before planting



Tisdall and Oades 1982



Koske and Polson 1984

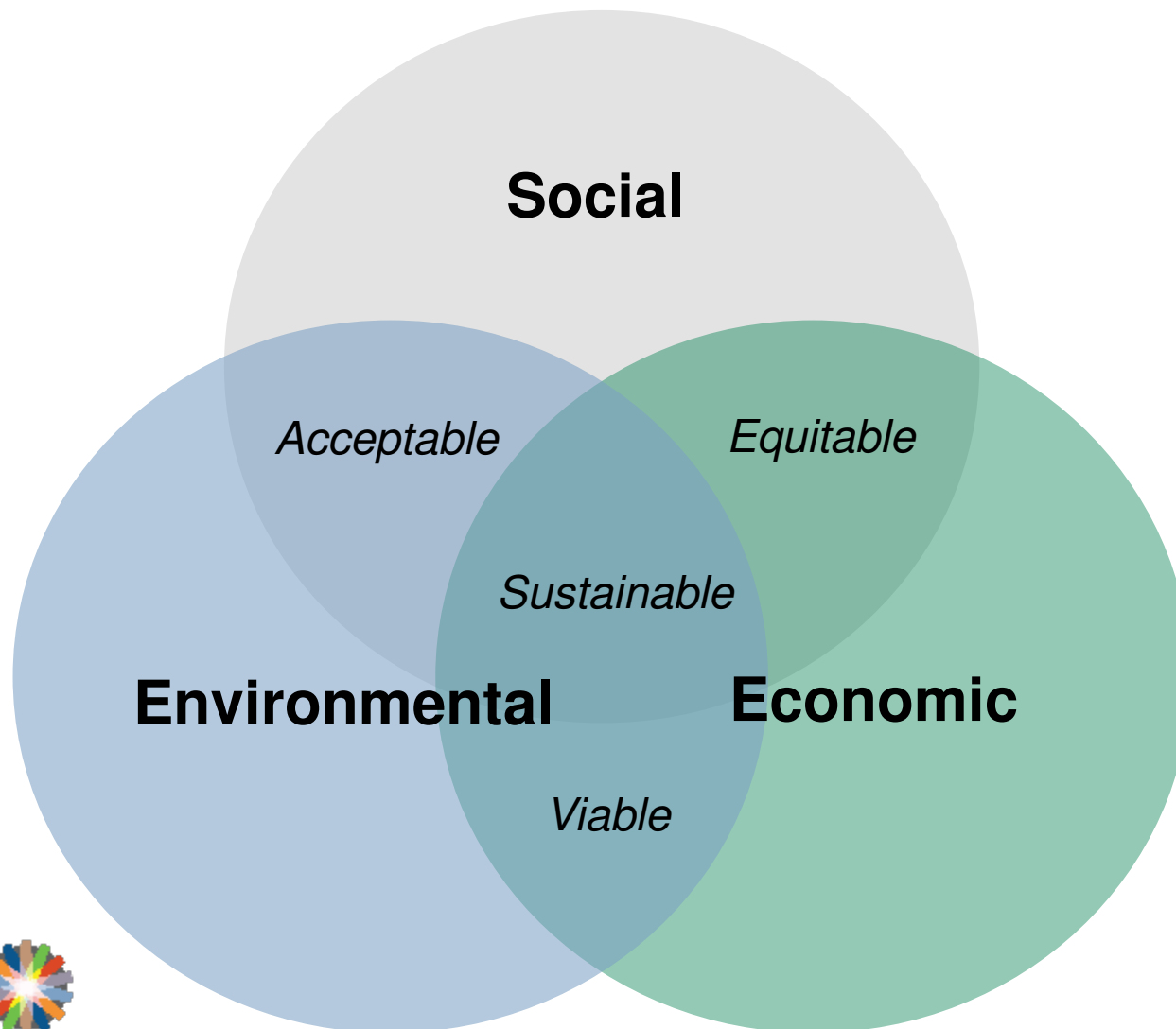


Recommendations Future Dune Projects

5. Where possible – build dunes to a lower height to allow for natural growth
 - Natural dunes have better biomass distribution – use natural processes
6. Careful and thoughtful contracting
 - Take control of the planting by guaranteeing plant survivability
 - Ask for the planting contractor to show experience/training/education/past performance
7. Biomass additions such as coir or other fibers can simulate roots, increasing erosion resistance and resulting in earlier resilience.



Dunes Triple Win



Dunes and Beach Nourishments provide one of the most sustainable methods to

1. Increase Coastal Resiliency
2. Increase Environmental Habitat
3. Provide Recreational Areas that have measurable economic impacts

- Vegetation is critical in trapping and maintaining sand during wind transport events
- Vegetation provides added benefits in reducing storm erosion
- Vegetation is key to post-storm recovery and dune re-growth

