Recycled Glass Cullet as an Alternative Aggregate for Dredged Sediments in Coastal Replenishment*

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Abstract

The altering of the continental shelf by dredging causes excess amounts of erosion putting coastal environments at a higher risk of exposure to coastal processes. As an alternative to dredging, recycled glass has been considered for use as a feasible and environmentally friendly material for coastal replenishment. Studies have shown that the use of recycled glass cullet possesses the same physical and chemical properties as natural quartz sand, which is the most common type of sand found on beaches. A field study conducted in coastal Mississippi (Ocean Springs and Biloxi) in which changes in beach elevation and variations in depth of the top layer of sand were monitored. Sand samples were also collected and analyzed showing that the size of the sand grains were comparable in size to the glass cullet. A comparative cost estimate shows glass cullet is a feasible option for an alternative aggregate for beach replenishment. The use of analytical spectral data (ASD) shows the compositional differences between glass cullet and the natural sediment, and can allow for advanced tracking of the alternative aggregate. Possible outlets for this study, once completed, are the U.S. Army Corps of Engineers, local and state governments along the Gulf Coast, as well as small island countries.

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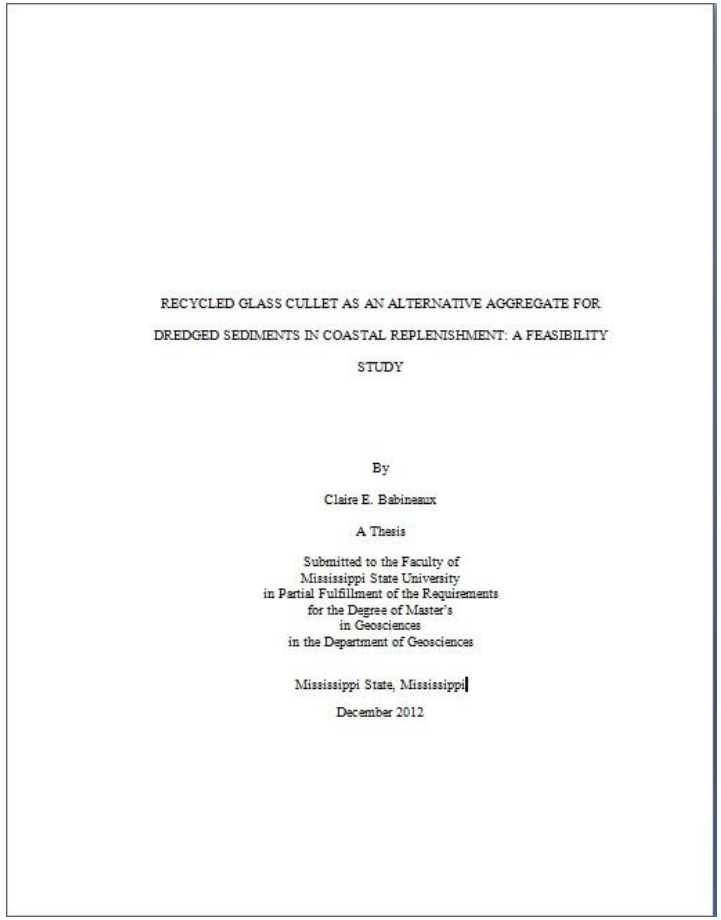
Why am I here today?

- LA and Gulf Coast knows a lot of coastal erosion
- Beach replenishment projects are a common practice in the mitigation efforts of coastal erosion
- Master's Thesis



RECYCLED GLASS CULLET AS AN ALTERNATIVE AGGREGATE FOR DREDGED SEDIMENTS IN COASTAL REPLENISHMENT: A FEASIBILITY STUDY

By

Claire E. Babineaux

A Thesis

Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master's
in Geosciences
in the Department of Geosciences

Mississippi State, Mississippi

December 2012

Important terms

- GTR
  - Golden Triangle Region
- Cullet
  - crushed recycled glass from pebble to clay size grains
- ASD
  - Analytical spectral data
    - Uses the reflectance of the material
- CBA
  - Cost benefit analysis

Background

- Recycling problem GTR
  - BluBox Recycling
    - No longer recycling glass
    - No market…no profit

- Pilot study
  - Super Bulldog Weekend
    - Home football game
    - Bulldog Bash!!
    - Excess amount of people
    - Excess amount of glass

Background

- Cullet and beach sand are comparable based on general physical characteristics (Kerwin, 1997; Makowski & Rusenko, 2007)
- Biota (macro and micro) are not affected by cullet in a system (Makowski et al, 2008)
- Cullet is a suitable dune-fill material (Makowski et al, 2013)

Makowski & Rusenko, 2007

Makowski et al, 2013

www.nps.gov

Background

- Is there a public concern?
  - Yes…
- Statutes preventing use of cullet on beaches
  - Safety (the recycling process abrades the surfaces of the grains)
  - Opposition to change, biases for using natural aggregates, cost, and regulations
  - Building codes and specifications
  - Toxins in colored glass
- But, what about natural occurrences?

“Accidental” occurrences

- Glass Beach, CA (Photo Credit: B. Kirkland)

“Accidental” occurrences

- Glass Beach, CA (Photo Credit: B. Kirkland

Research questions

- Is it ecologically viable alternative?
- Do we recycle enough for beach replenishment?
- Is it an economically viable alternative?
  - Is distance a factor?
- Will the general public accept a glass beach?

http://www.aeconline.org/recycling/materials/others/glass

Field Sites

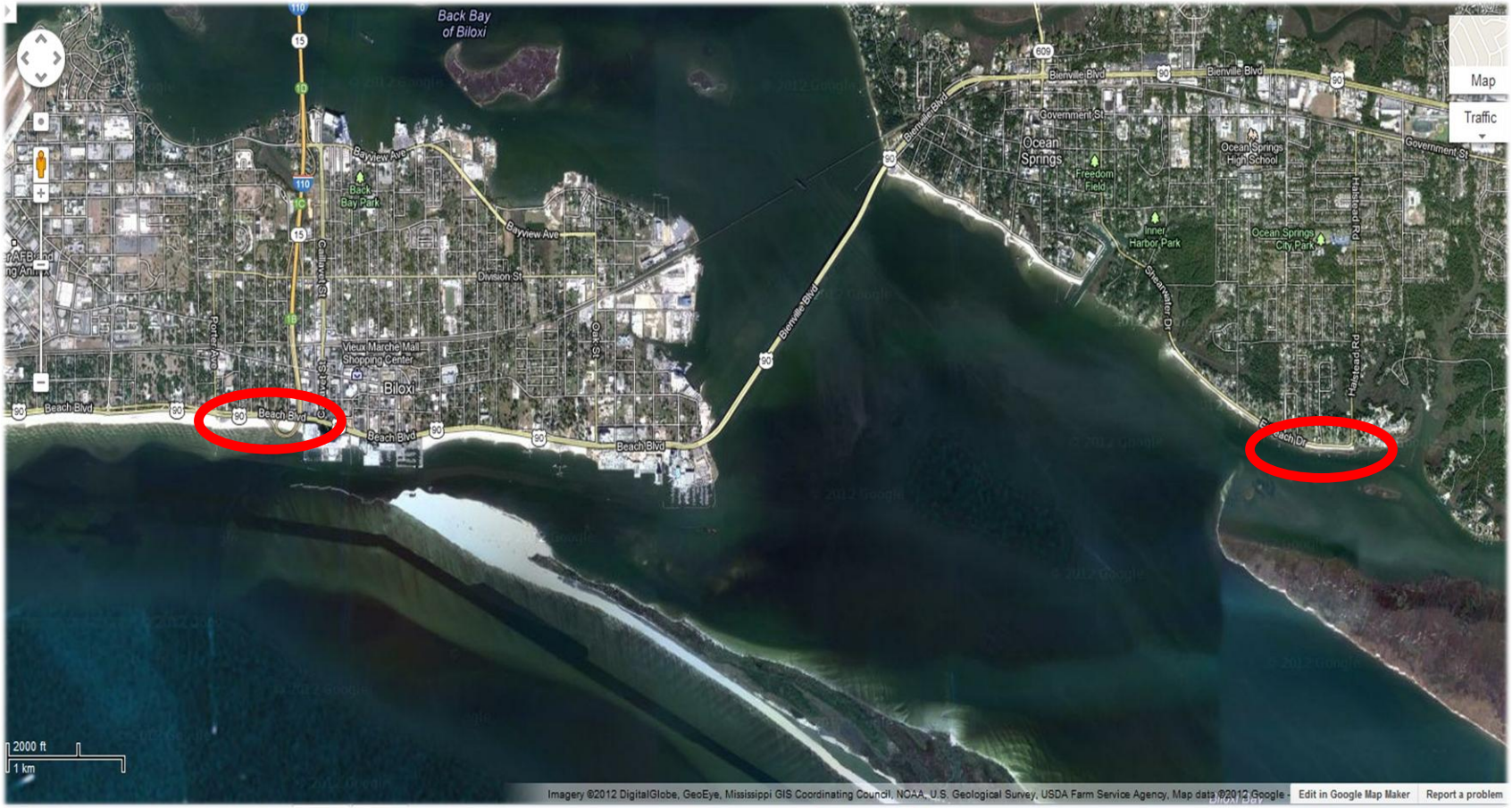


Photo Credit: Google Maps

Sediment analysis

- Interviews
- Collection of sand from coast
- Collection of cullet from Columbus Air Force base

- Grain size analysis and comparisons
  - Sand
  - cullet

Sediment Analysis Results

- Interviews
  - Cullet can be crushed and abraded to match size distribution of natural sand.
- Grain Size Analysis
  - Visible differences – color
  - Grain shape is similar
  - Distribution of grains are similar
  - Cullet fines may have environmental impacts

Siliciclastic sand

Cullet

ASD

- Looks at the amount of light reflected off a material.

- Compared:
  - Siliciclastic sand
  - Carbonate sand
  - Cullet

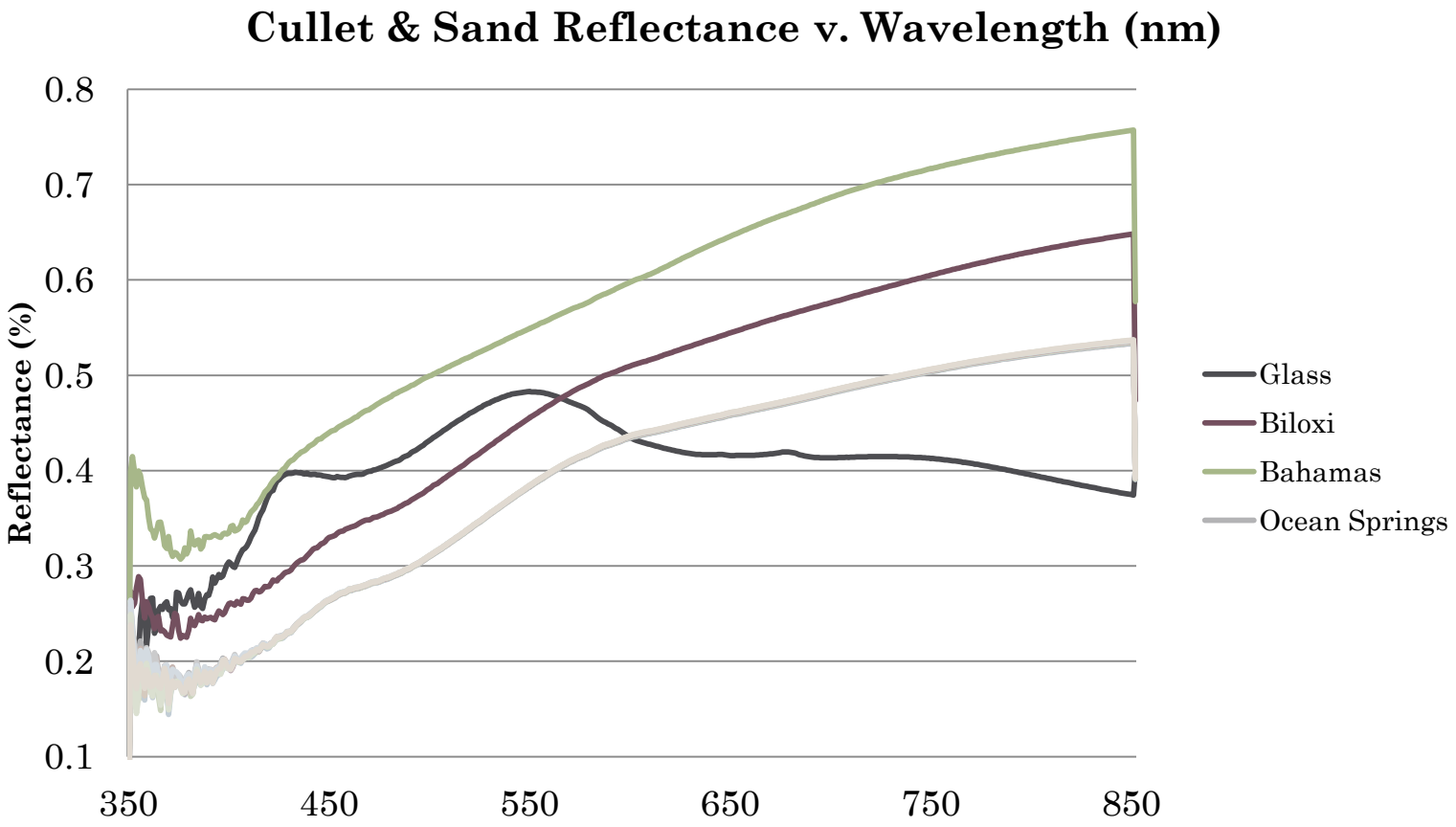
Siliciclastic sand

Carbonate sand

Cullet

ASD

- Visible differences in reflectance across compositional differences
  - Could it be used to map or track movement?



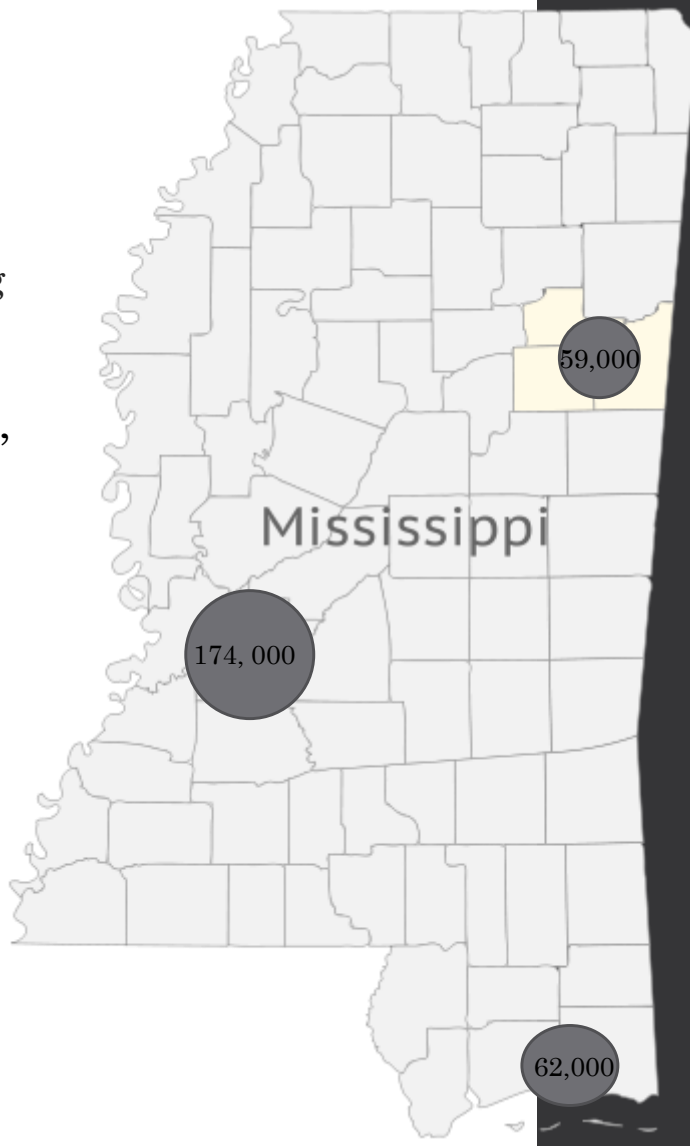
CBA

- Where is our money going??
- Compared cost of dredging projects in MS to cost of recycling
  - Factors:
    - Population size
    - Amount recycled
    - Cost to run facilities
    - Distance to source material
    - Fuel costs
- Columbus Air Force base is only location in GTR that currently recycles glass

http://en.wikipedia.org/wiki/Golden_Triangle_(Mississippi)

Results

- Large populations recycle more than small populations
  - Requires active participation in glass recycling programs
- The closer a recycling facility is to coastline, the more economic it is to use recycled materials
- In the case of a facility in MS Gulf Coast:
  - Approx. $300,000 to run facility with minimal transport costs.
  - Dredging: significantly more
- Environmental costs?



Summary

- Replenishing beaches and coastlines is a common practice in mitigating the effects of coastal erosion, especially in the Gulf Coast states.
- Glass has many potential uses, including being used as an alternative aggregate for beach sand in replenishment projects (Foye, 2005). This potential use would close the recycling loop and reduce the amount of glass products found in landfills (Babineaux, 2012).
- Cullet and beach sand have same general physical characteristics (Kerwin, 1997).
- Flora and fauna are not affected by cullet in a system (Makowski & Rusenko, 2007, Makowski et al, 2008, Makowski et al, 2013)
- Grain size distributions of sand and cullet are similar and cullet could be crushed to match this distribution (Babineaux, 2012)

Conclusions

- Recycled glass cullet is both biologically and chemically compatible with natural quartz sand.
- Sediment analysis shows the average size of locally sourced glass cullet is comparable to the average grain size for the sand from the Gulf Coast.
- Cost-benefit analysis shows that it is economically feasible to use glass cullet to replenish the beaches on the Gulf Coast.
- ASD can be used to monitor beaches where alternative beach fill sediments were used for beach replenishment.

Future Projects – Dissertation*

- Modeling of sediment transport
  - Combined model (Weathers & Voulgaris, 2013)
  - To determine how cullet will move through a system
- Public Opinion Surveys
  - To determine is general public would accept cullet as beach fill
  - Novelty – "Designer beaches!"
- Affects on Mississippi Gulf Coast Biota
  - SEM of cullet and sand
  - What naturally grows on each

*In progress!

Acknowledgements

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