



# SANDSNAP: ENGAGING CITIZEN SCIENTISTS TO CREATE A BEACH GRAIN SIZE DATABASE

**Brian McFall, David Young,  
Kelsey Fall, Doug Krafft**

Coastal & Hydraulics Laboratory



**Shelley Whitmeyer**

James Madison University

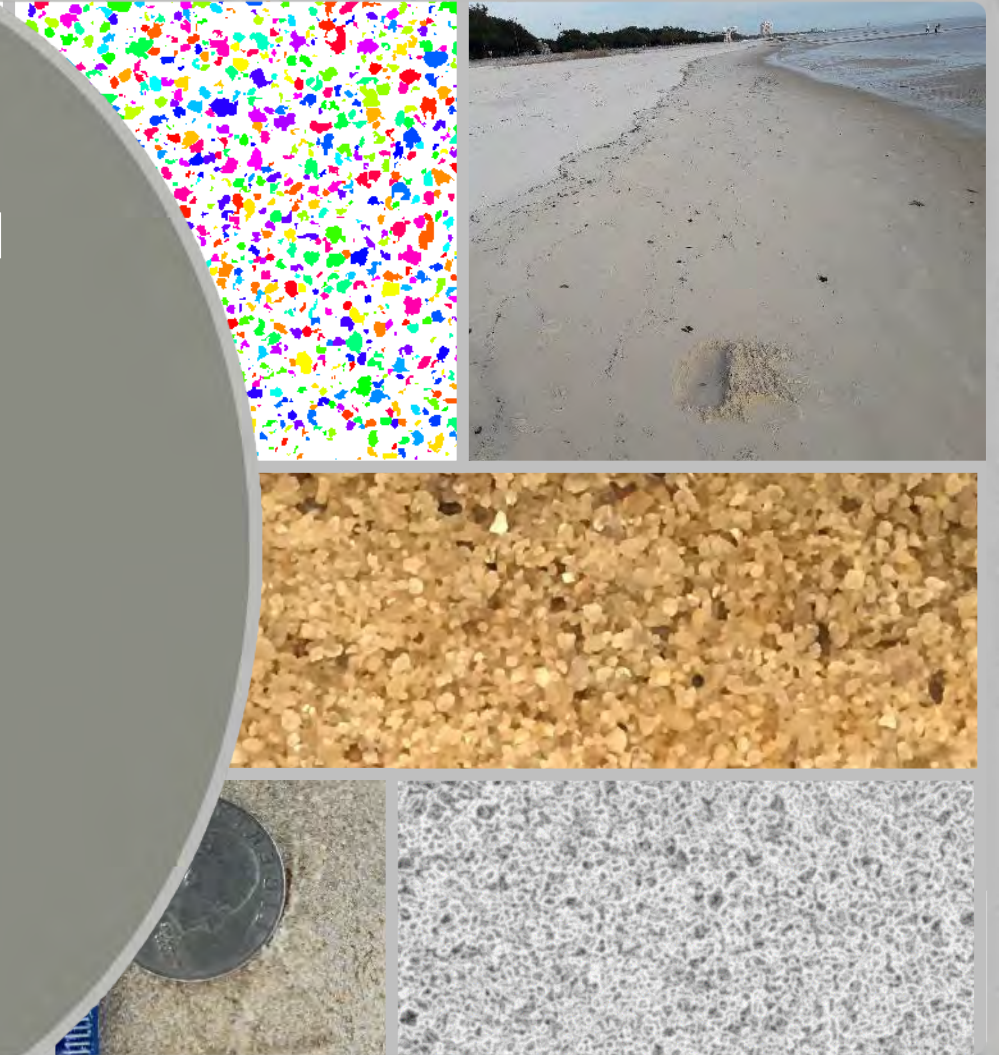


**Daniel Buscombe**

MARDA Science, LLC

**MARDA SCIENCE**  
COMMUNICATIONS :: ANALYTICS

16 June 2020

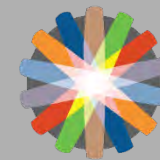


US Army Corps  
of Engineers®



**CHL**

COASTAL &  
HYDRAULICS  
LABORATORY



**ERDC**  
ENGINEER RESEARCH & DEVELOPMENT CENTER

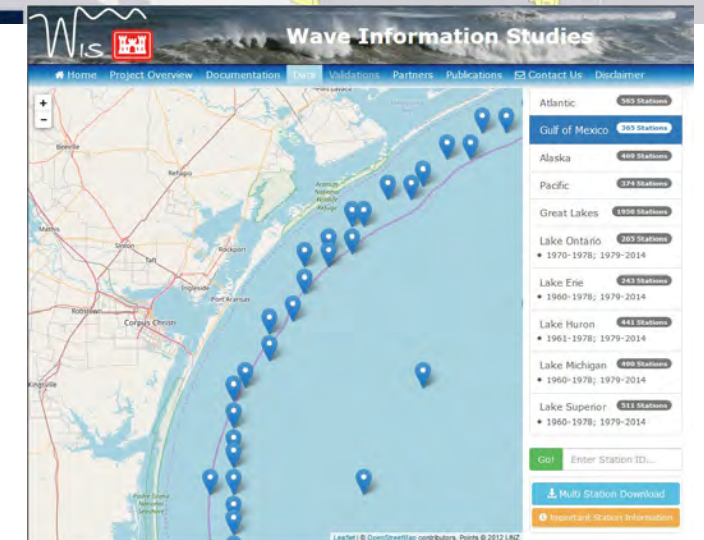
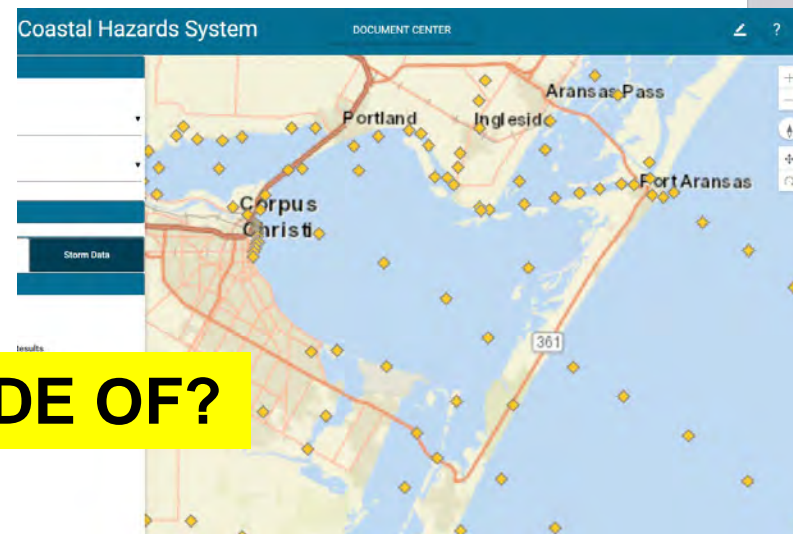
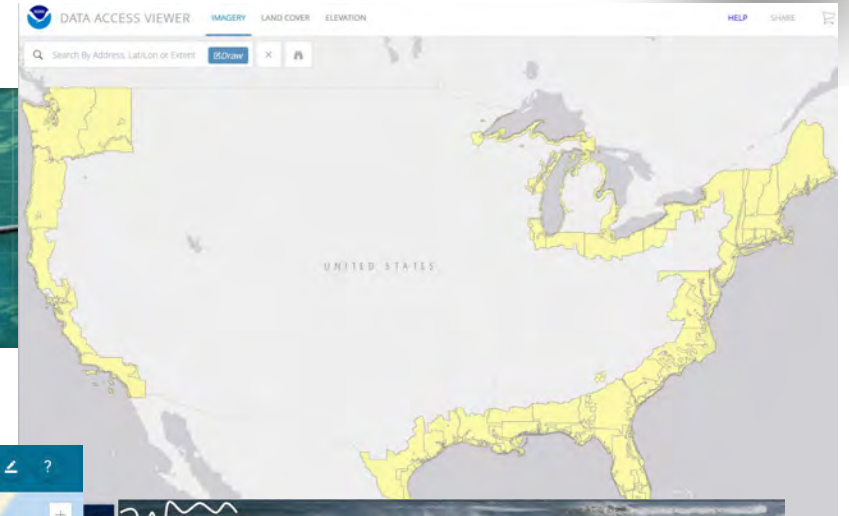
DISCOVER | DEVELOP | DELIVER



# Motivation

## Coasts are a Data Rich Environment

- Topo & Bathymetric
  - LiDAR
  - Photogrammetry
- Shoreline Position
  - Satellite and Aerial Imagery
- Wave Information
  - Buoys
  - WIS
  - Coastal Hazard System

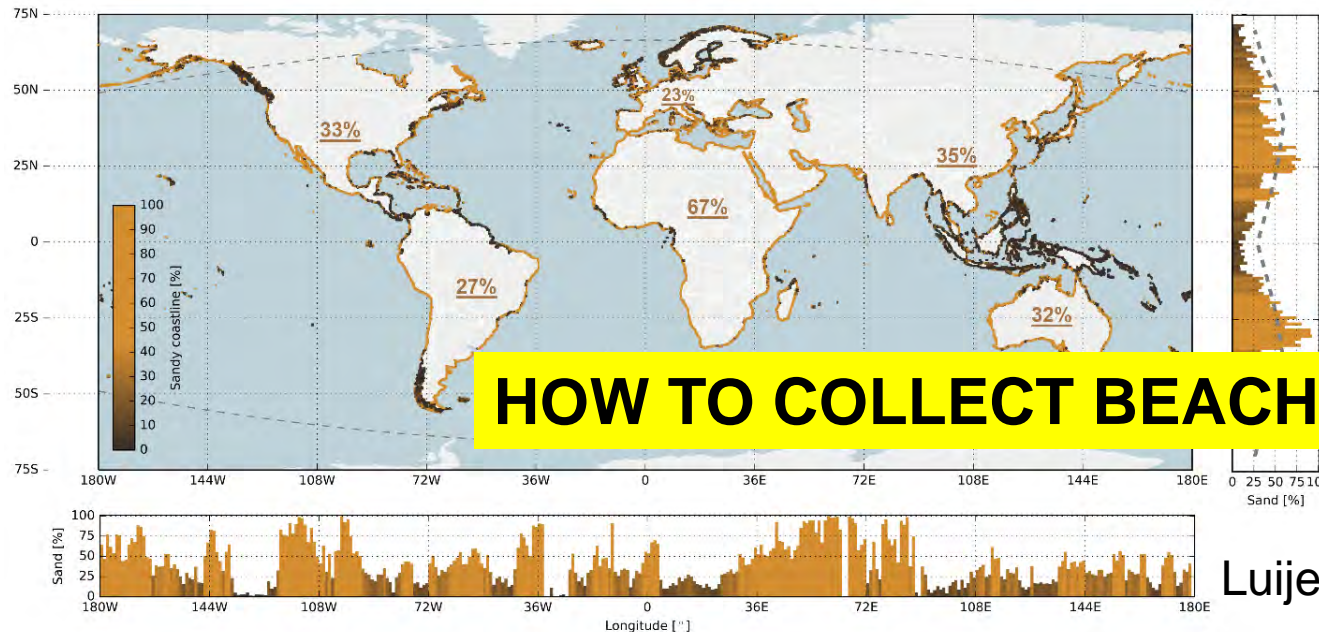


**WHAT'S THE BEACH MADE OF?**



# Beach Grain Size Database Uses

- Large-scale Preliminary Studies
- Depth of Closure Studies
- Regional Sediment Management
- Analysis of Spatial and Temporal Gradation Variation
  - Improved Life Cycle Analysis and Uncertainty
  - Beach Compatibility



**HOW TO COLLECT BEACH GRAIN SIZE DATA?**

Luijendijk et al. (2018)



Hartman and Kennedy (2016)



# Sample Methodology

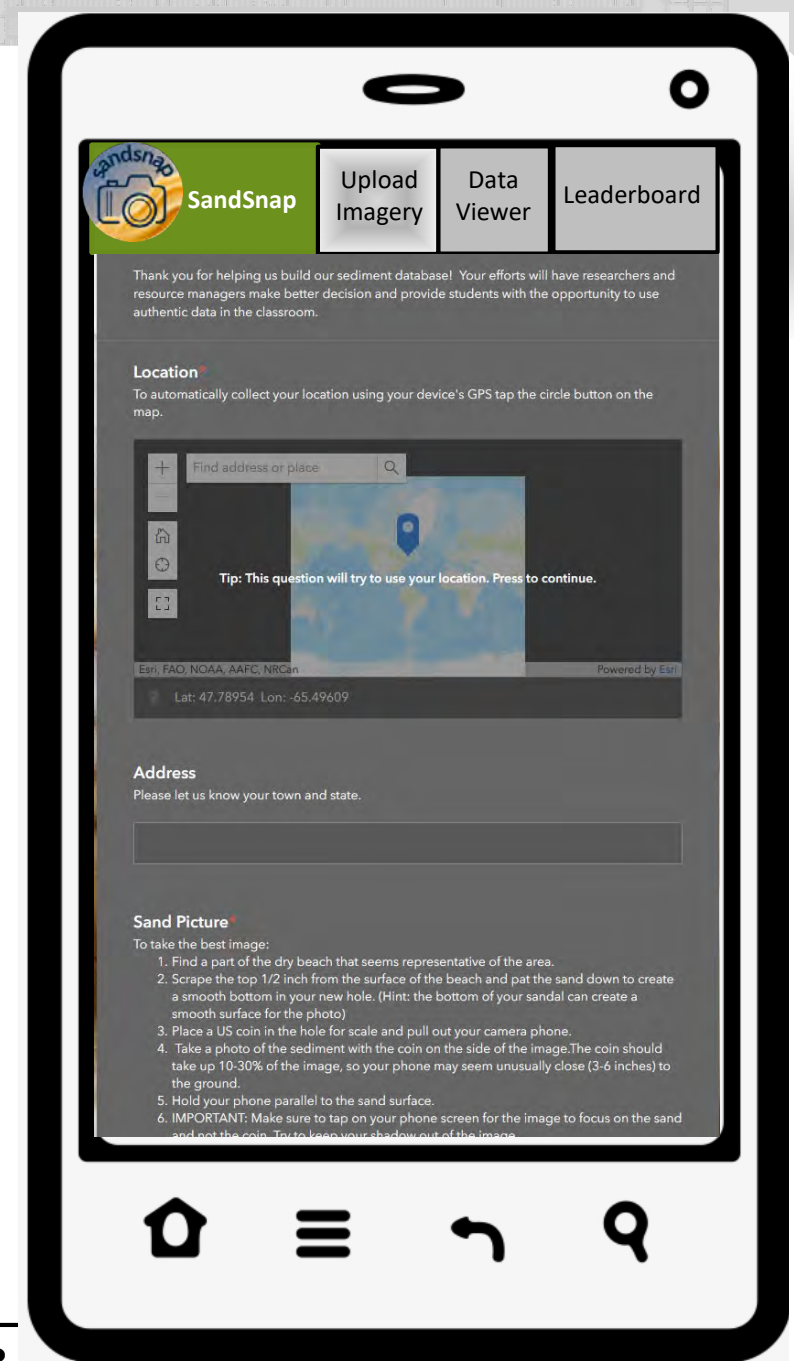
1.



2.



3.







# SandSnap

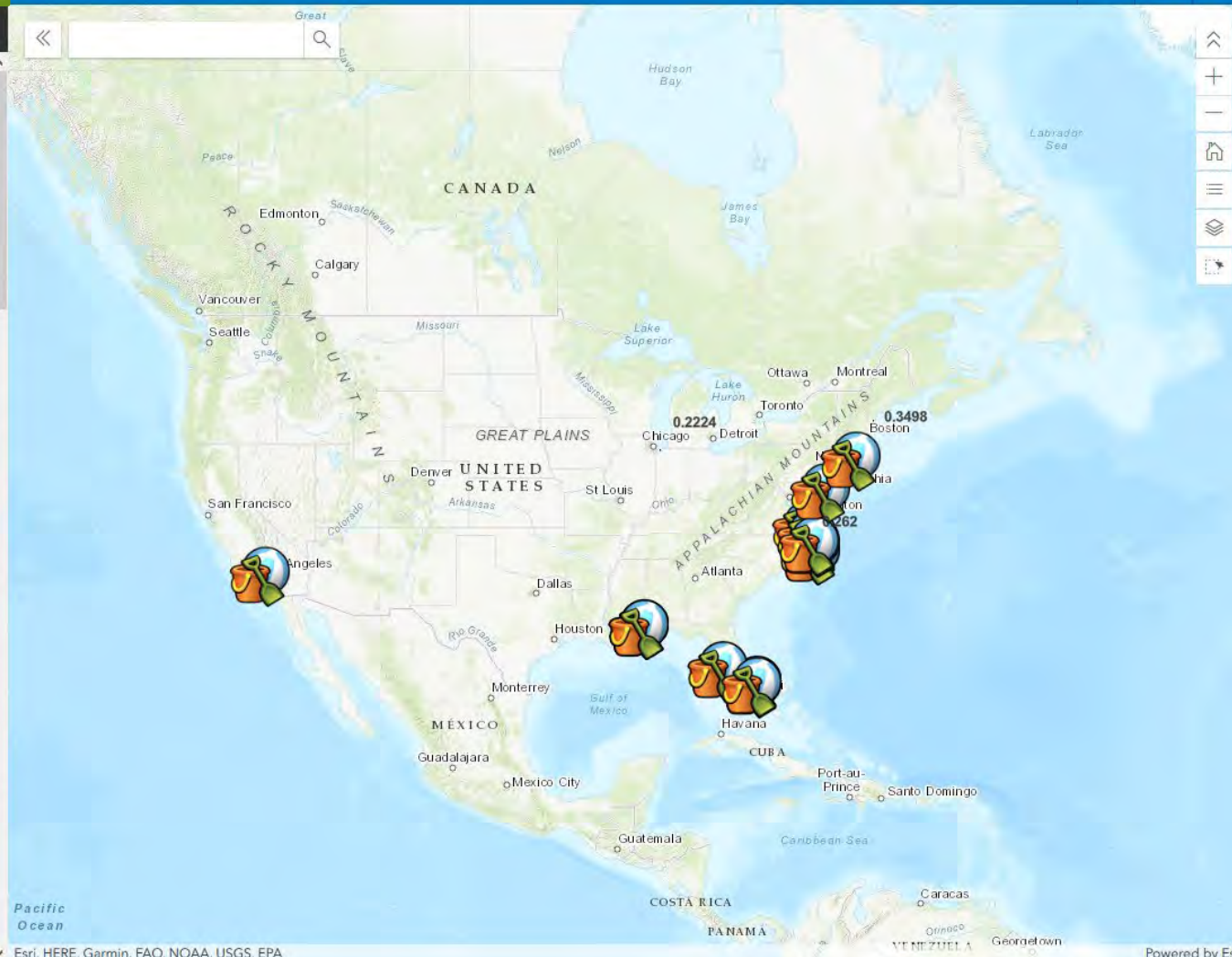
Upload Imagery

Data Viewer

Leaderboard



Sample Location (not analyzed)





# Methods Investigated

- Grain Size Techniques Investigated:
    - Geometrical Analysis: Matlab Image Processing
    - Statistical Analysis: Wavelet Analysis
    - **Deep Learning Analysis**
    - Physical Shipment
- d<sub>50</sub> % Error**  
43% (12% on platform)  
35%  
<20% for good images



# Deep Learning Analysis

SediNet (Buscombe, 2020)

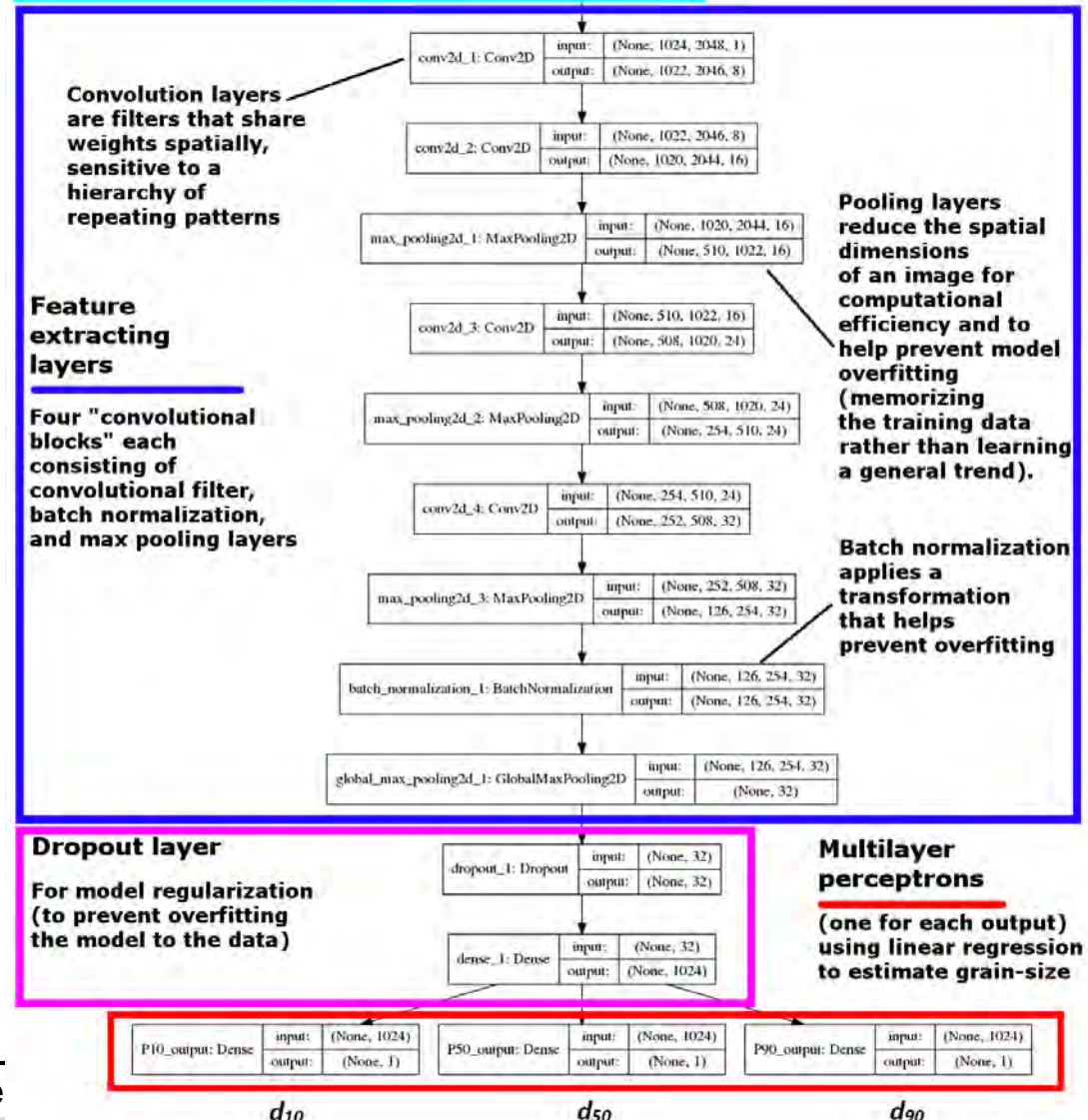
- Deep Neural Network Framework

- Numbers in input and output layers correspond to the size in pixels of the image features used by that layer.
- By the final layer, the information in the image has been reduced to a vector of length 1024 that is used to make grain size predictions.

Input image  
(1024 x 1024 x 3 pixels)



SediNet model  
for beach grain size



# Deep Learning Analysis

- 63 Images
- Cropped to 1024x1024 pixels to Avoid Coin
- Flipped Horizontally
- Total of 517 Images
  - 50% for Training
  - 50% for Testing



Site Name	Original Images	Images Used for Model Training & Testing	Mean error in $d_{50}$
Assateague, MD	12	116	62.3 %
Biloxi, MS	8	74	14.5 %
Calvert Cliffs, MD	5	32	17.1 %
False Cape, VA	12	106	47.8 %
Gulfport, MS	10	88	19.05 %
Ocean Springs, MS	8	67	19.2 %
Outer Banks, NC	8	34	18.2 %
<b>Total/overall:</b>	<b>63</b>	<b>517</b>	<b>33.5 %</b>



US Army Corps of Engineers



# Ongoing Work

- We Created Sample Instructions
  - Tested with Non-Coastal Researchers
  - Instructions on the CIRP website:  
<https://CIRP.usace.army.mil>
- Collect More Samples to Train
  - CHL Researchers Headed to Beaches
  - CWG/RSM Sample Request
  - Coastal Universities
  - Test at State Park
- Develop Interactive Web Application
  - Reply Response with Results from Photo
  - Online Scoreboard for Most Submissions



## Citizen Science - Beach Grain Size Data Collection

The US Army Corps of Engineers, James Madison University, and Northern Arizona University have partnered together in an endeavor to develop a way to collect beach grain size information using citizen scientists armed with their cell phone and any US coin. We need beach sediment samples and images from all over the United States to test out processing techniques and your help will be quite valuable!



**Instructions**

- 1) From a sandy beach, find a section of dry beach that seems representative of the area.
- 2) Scrape the top 1/2-inch from the surface of the beach and pat the sand down to create a smooth bottom within the depression.  
*It is important that the surface to be photographed is smooth. (Hint: use the bottom of your sandal to smooth it out)*



**Image Collection**

- Place a US coin in the hole for scale and pull out your camera phone.
- Take photos of the sediment with the coin on the side of the image (see example images).
- The coin should take up 10-20% of the image, so your phone may seem unusually close (4-8 inches) to the ground.

**IMPORTANT:**

- 1) Make sure to tap on your phone screen to focus the image on the sand and not the coin.
- 2) Make sure the camera is parallel with the ground and try to keep any shadows out of the image.
- 3) Take multiple photos from several vertical positions to test out techniques with multiple resolutions.

- Upload your images at <https://arcg.is/1q58DT>
- Tap the icon or the "Press to Set Location" link to record the location of



# Outreach Plan

## Phase 1:

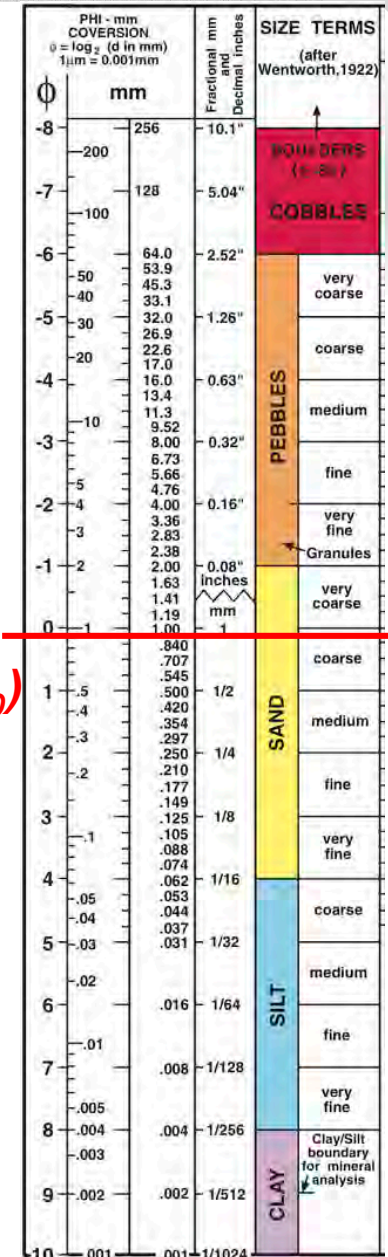
- USACE Coastal Districts
- Universities with Coastal Research
- Identified State Parks
- Coordinate with ASBPA
- Promote at conferences: ASBPA, GSA, AGU, etc.

## Phase 2 (after interactive website is created):

- Promote with nature-centric groups:
  - Master Naturalist Association
  - Audubon Society
  - Coastal State Parks
- Develop class lessons & science fair projects
- Incorporate into CoastSnap signs
- Incorporate into Boy Scout and Girl Scout merit badges



*Your Sample's  
Median Size ( $d_{50}$ )*





# Summary

- A Methodology Has Been Developed
- More Samples are Needed to Train the Model
- Please Collect More Sandy Beach Images and Samples The Next Time You're At a Beach!



**Brian McFall**

[Brian.C.McFall@usace.army.mil](mailto:Brian.C.McFall@usace.army.mil)

[CIRP.usace.army.mil](http://CIRP.usace.army.mil)