# Developing Methodology for Efficient Eelgrass Habitat Mapping Across Lidar Systems

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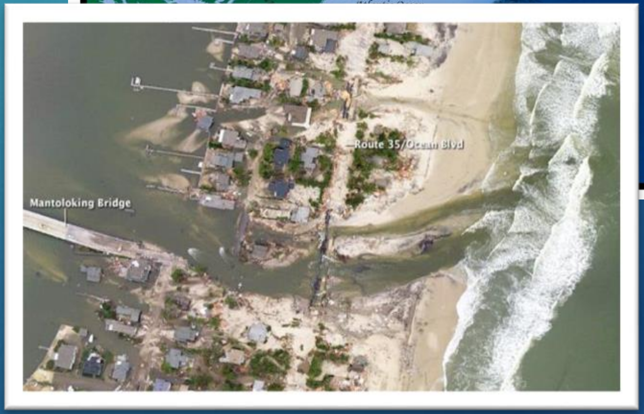
# Some background knowledge…

- Hurricane Sandy
  - Made landfall on October 29, 2012
  - $50 Billion in damages
  - Most of damage focused on coastal zones of New York, New Jersey, and Connecticut, USA
  - Huge data collection efforts in response to the storm
  - Airborne lidar bathymetry (ALB) collected in days immediately before and after storm- provides a unique opportunity to observe storm effects on backshore environments

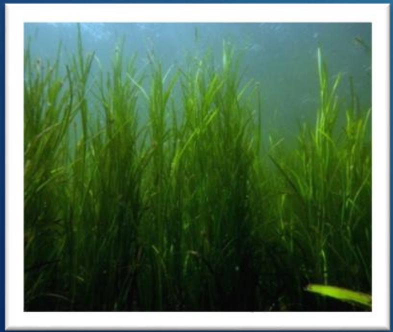
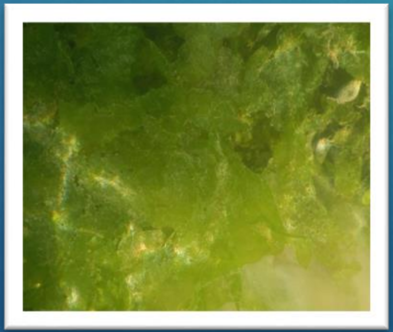
# Where is our study area?

- Barnegat Bay, NJ
  - Shallow, sandy, poorly flushed
  - Bordered by development
  - Two meters of storm surge during Sandy
  - Barrier island breach
  - Overwash

# Our questions:

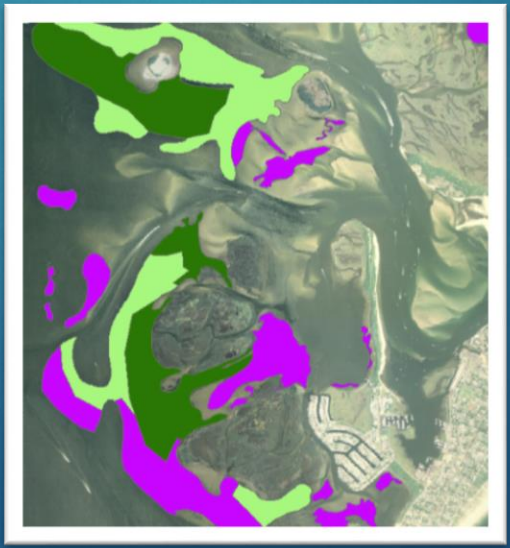
- How can we use lidar in conjunction with imagery to detect and classify submerged aquatic vegetation (SAV)?
- Is Object-Based Image Analysis (OBIA) an effective and efficient method for SAV classification?
  - Object-Based Image Analysis: Identifies objects contained within geospatial data and structures them into a network
  - Traditional manual classification from imagery is cumbersome- it is time consuming, and one person must classify all data sets
- Can one classification scheme be used across multiple lidar sensors?

# Methodology: Manual classification

- Manual classification with New Jersey Aerial Imagery: 2002, 2006, 2007, 2010, 2012, 2013
  - Long-term time series for monitoring and  possible storm impact assessment
  - Many limitations due to imagery quality and variation in collection times

2002

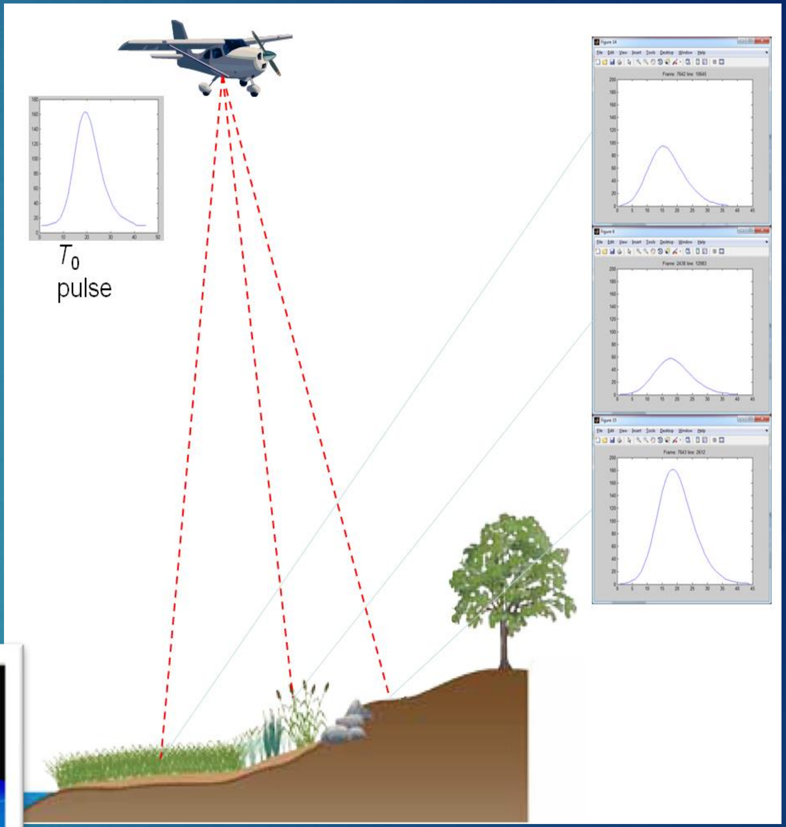


2006

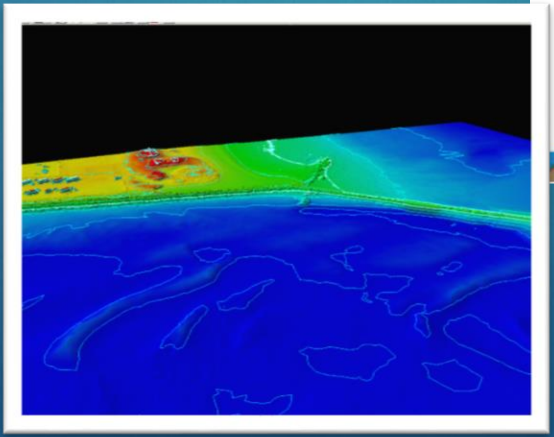
2012

# A brief introduction to lidar…

- Light Detection and Ranging
- Uses laser pulses to measure elevation or bathymetry
- Newer topobathymetric sensors allow for benthic mapping of waters too shallow for acoustic data collection methods

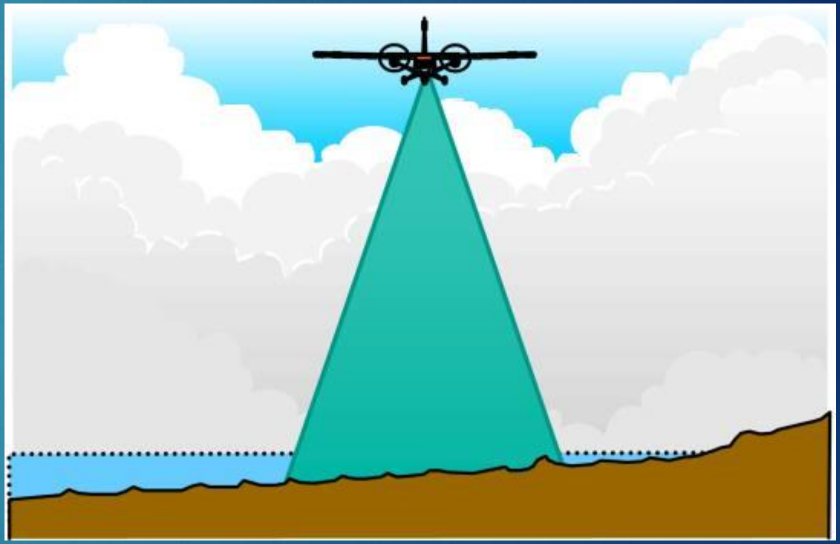



Parrish, C.E. et al. 2014. *Geoscience and Remote Sensing Letters*, Vol. 11, No. 2, pp. 569-573.



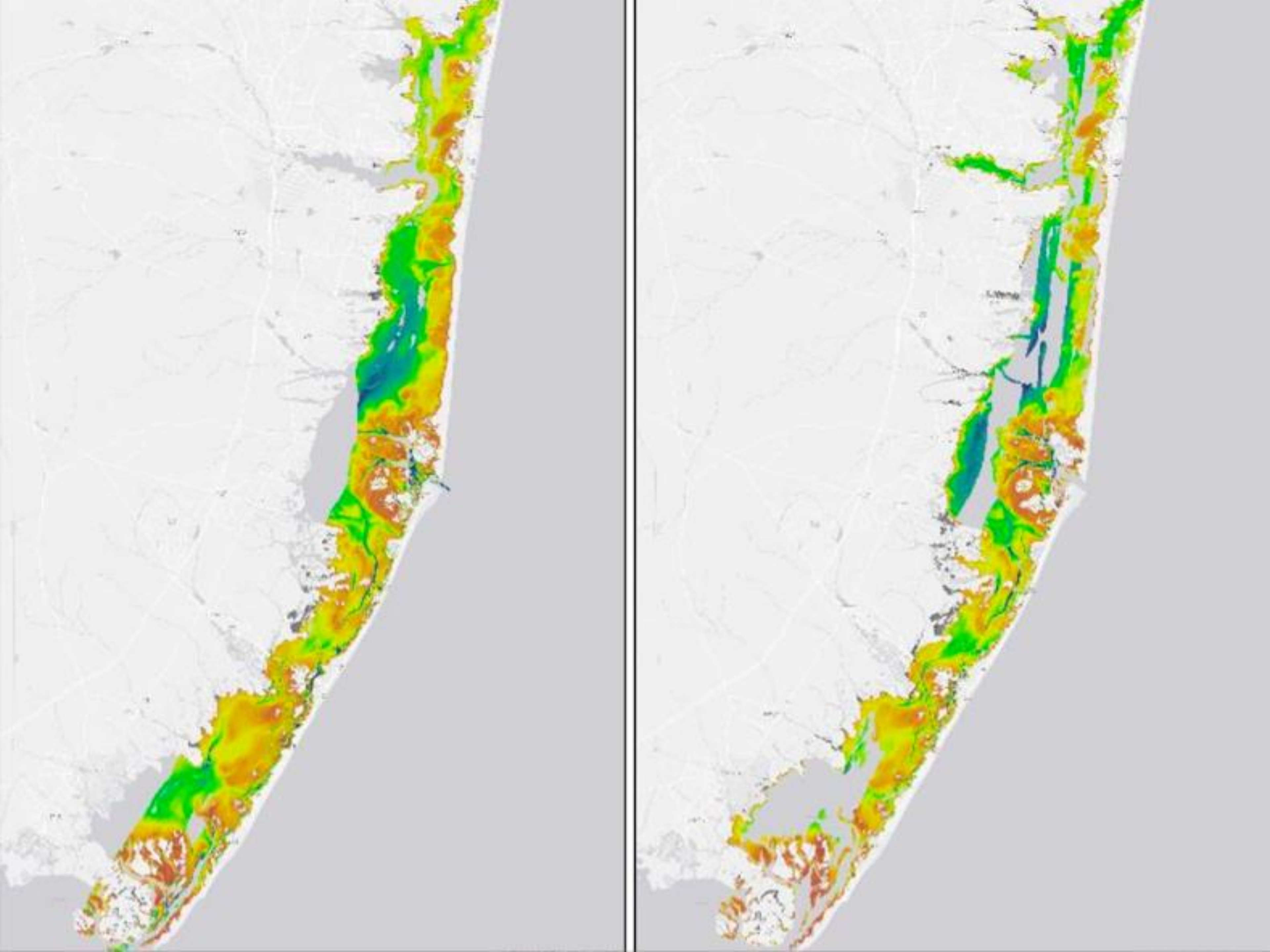
# Topobathymetric Lidar

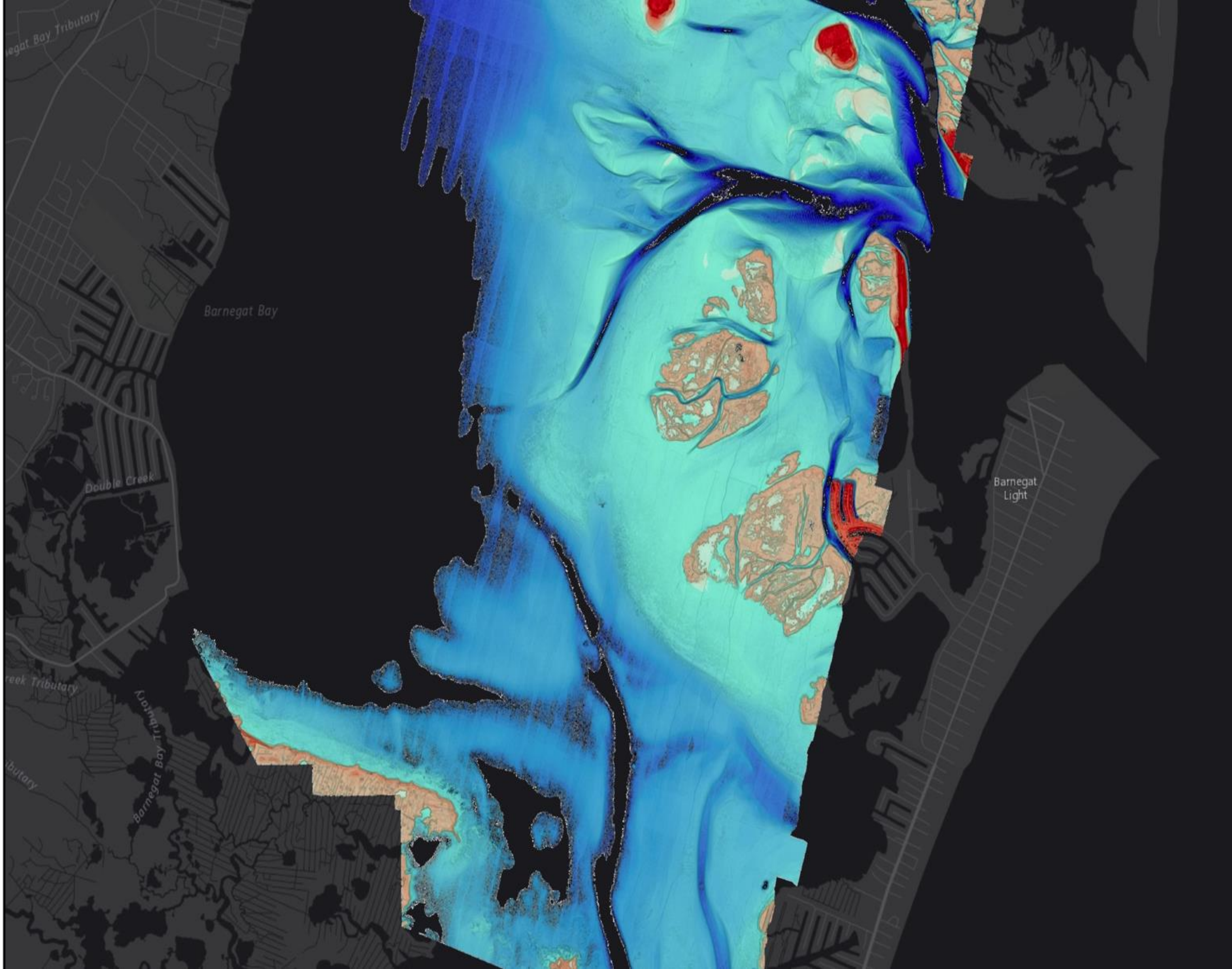
- Narrow beam, green laser (532 nm) lidar systems
  - Collects high resolution data (<1m footprint)
  - Suitable for backshore, intertidal and shallow nearshore areas
- Benefits:
  - The ability to rapidly survey very large areas
  - The ability to collect data immediately after storm events, when debris may pose navigational hazards to small vessels for acoustic data collection
  - Provides a more robust data set than other frequently used remote sensing techniques (imagery, satellite)



# The systems we used

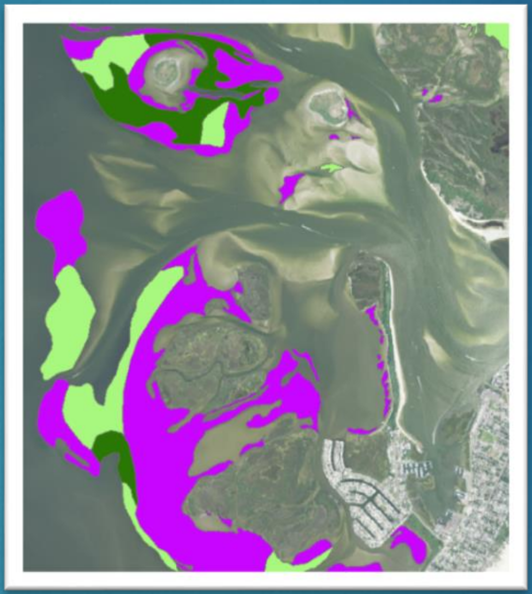
| | Riegl VQ-820-G | AHAB Chiroptera II | USGS EAARL_B |
|---|---|---|---|
| Agency | NOAA NGS (National Geodetic Survey) | NOAA NOS (National Ocean Service) | USGS |
| Footprint | 0.6 m | 1.5 m | 0.3 m |
| Max depth | 1x secchi depth | 1.5 x secchi depth | 2.5 x secchi depth |




Barnegat Bay Tributary
Barnegat Bay
Double Creek
Barnegat Light
Creek Tributary
Barnegat Bay Tributary
Tributary

# Methodology: eCognition, imagery, and lidar

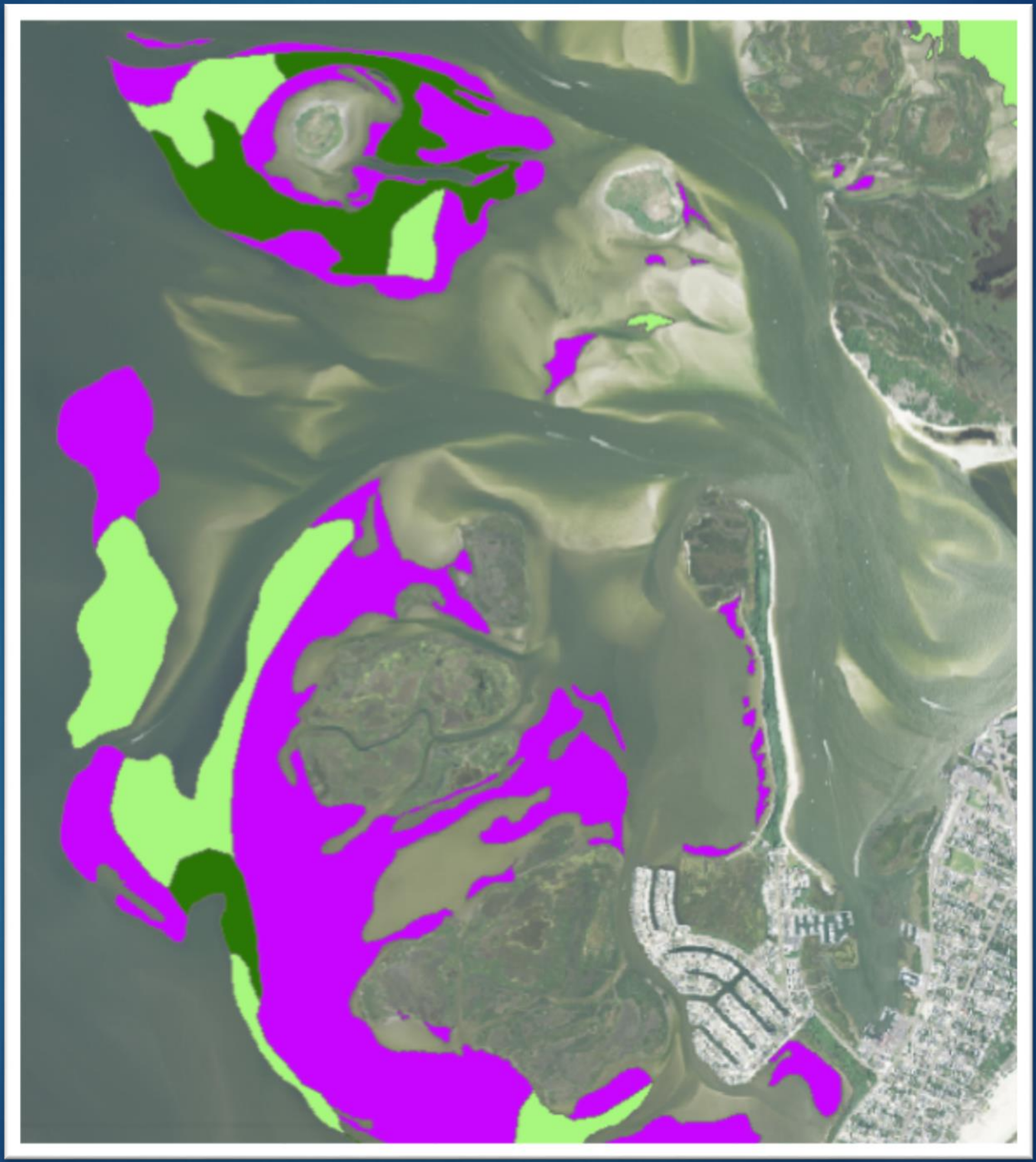
- Benefits of lidar:
  - Can be flown immediately after a storm
  - High resolution data
  - Multiple data types (bathymetry, reflectance, more metrics coming soon)
- Object Based Image Analysis
  - eCognition uses a “holistic” approach to image classification- users can train rule sets based on their knowledge



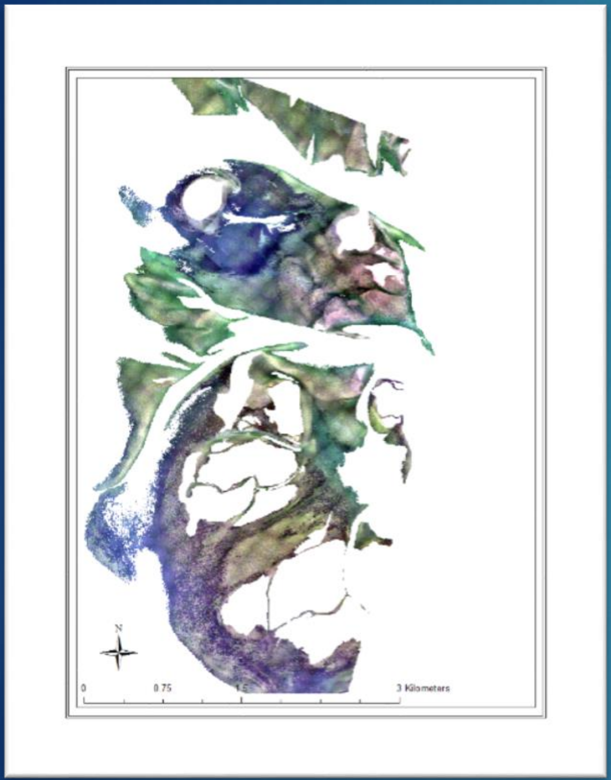
2013 Imagery Alone

2013 Riegl Imagery and Lidar

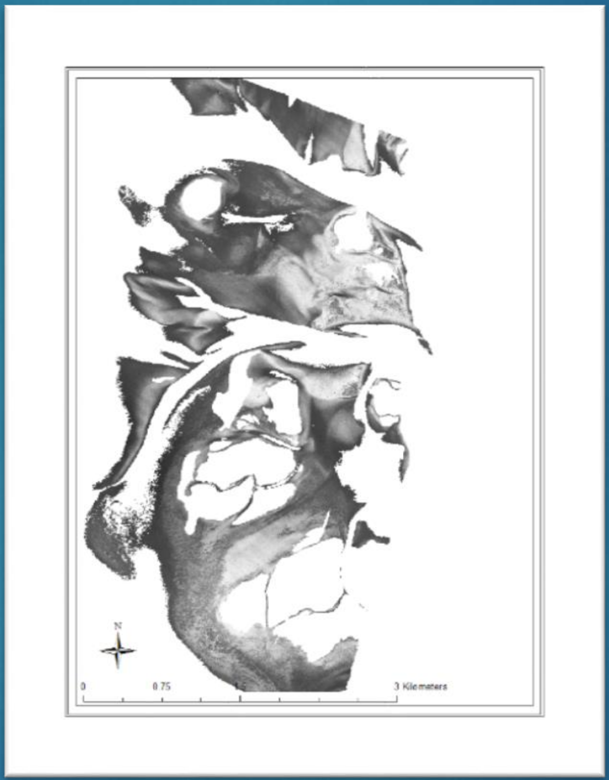
Here, we compare methodology- is OBIA a faster way to get the same results as the current manual classification methodology?



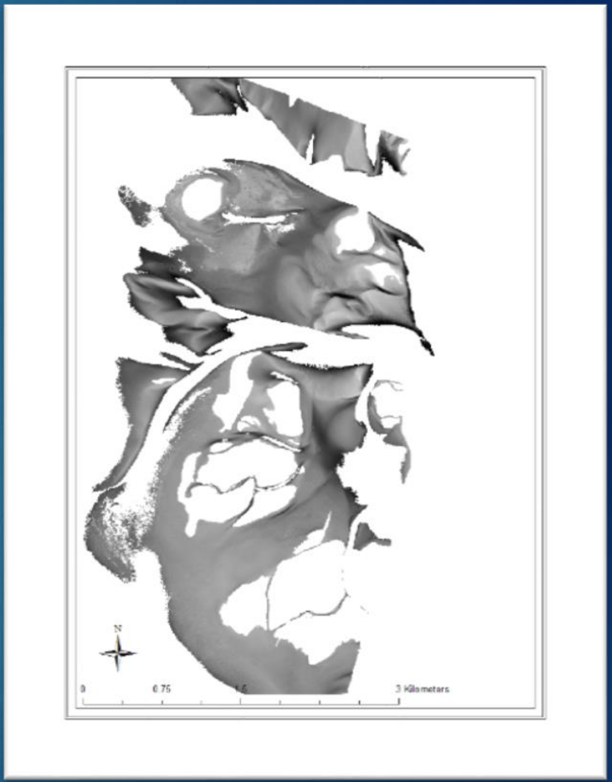
# Data Layers




Imagery

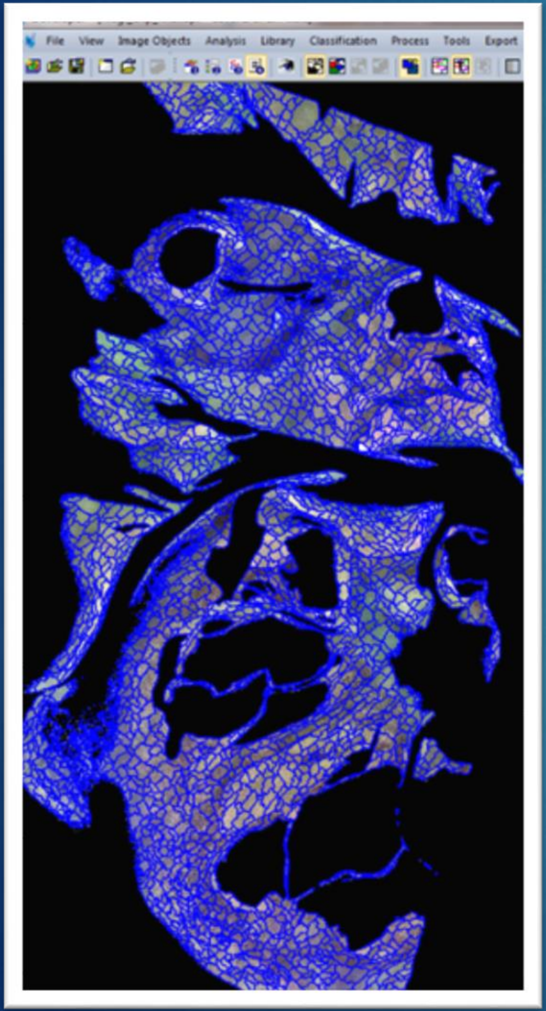



Reflectance

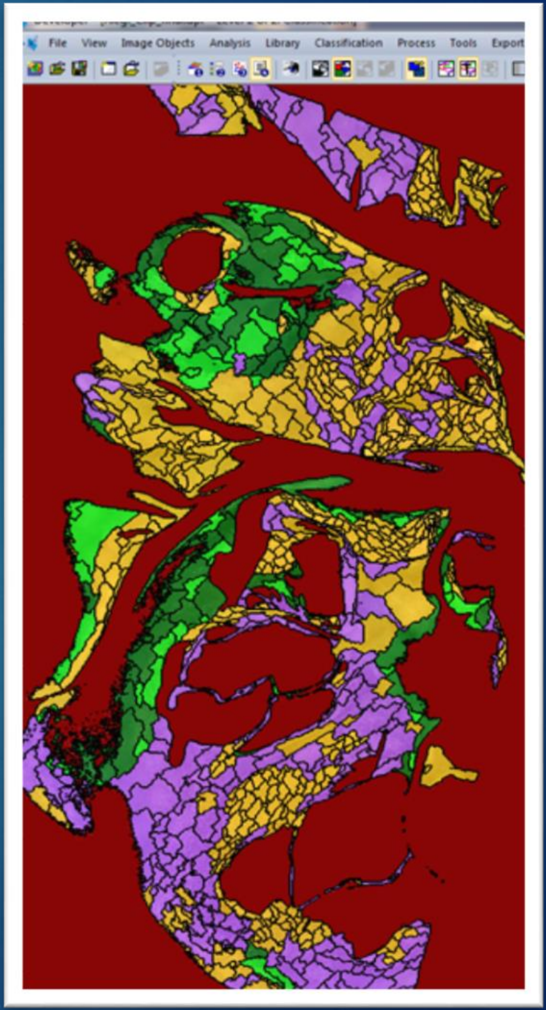



Elevation

# Segment and Classify

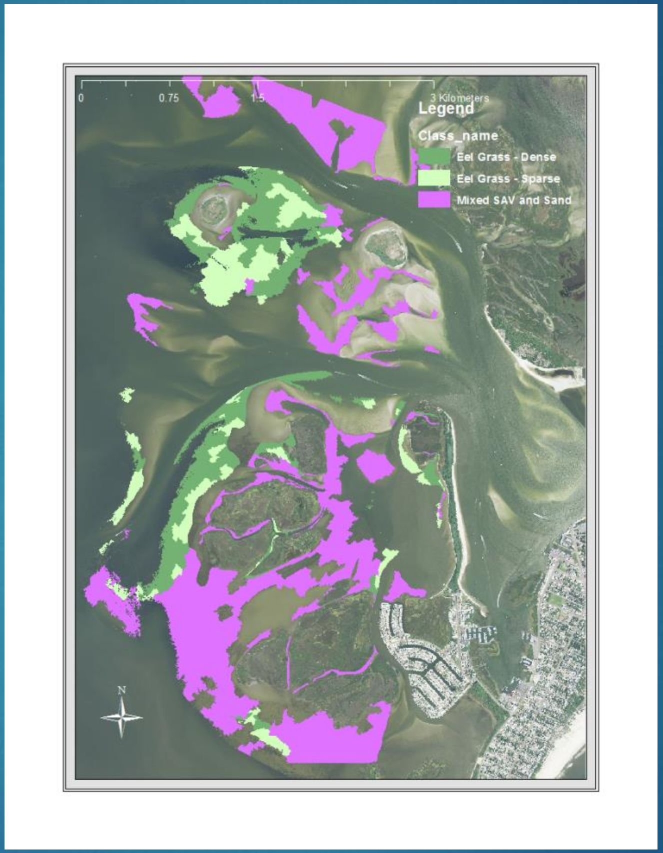






# What did we find? Comparing methods


Manual classification

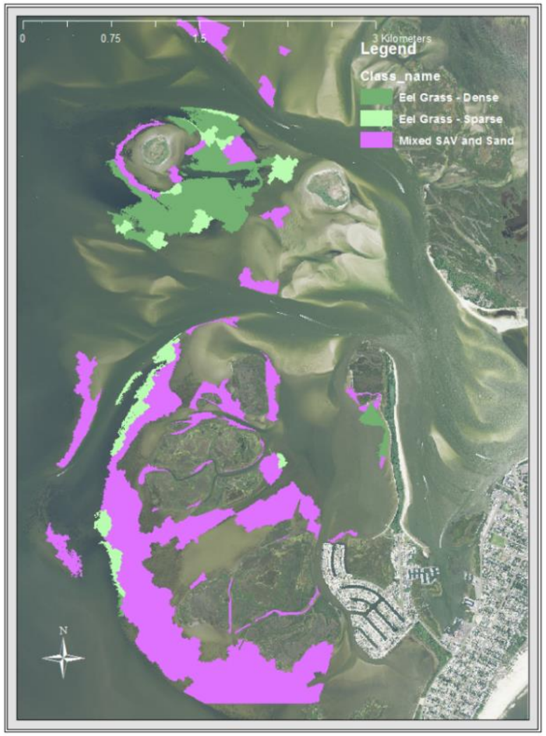



OBIA using Lidar (Riegl)

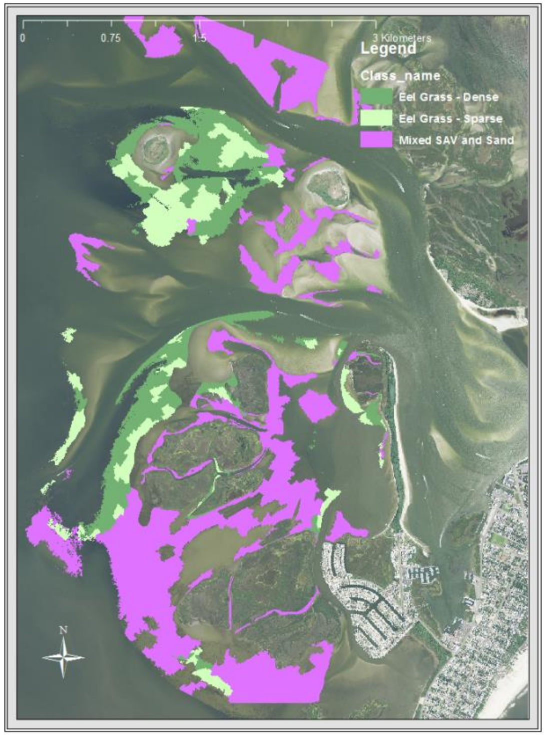
Mann-Whitney Test

| Parameter | p |
|---|---|
| Number of Patches | 0.06 |
| Mean Patch Size | 0.26 |
| Patch Size St. Dev | 0.41 |
| Mean Patch Edge | 0.41 |
| Mean Shape Index | 0.41 |
| Perimeter to Area Ratio | 0.25 |

# What did we find?
# Analysis across systems




Chiroptera




Riegl

Mann-Whitney Test

| Parameter | p |
|---|---|
| Number of Patches | 0.19 |
| Mean Patch Size | 0.41 |
| Patch Size St. Dev | 0.41 |
| Mean Patch Edge | 0.41 |
| Mean Shape Index | 0.13 |
| Perimeter to Area Ratio | 0.02* |

# What does this mean?

- No significant differences in classification between manual methods and OBIA using lidar and manual classification using imagery alone.
  - These methods are comparable for detecting and mapping SAV
  - Still need ground truthing to determine accuracy- this is difficult logistically

- No significant differences in classification for OBIA classification between lidar systems
  - This methodology can easily be applied to multiple data sets collected by multiple sensors

# Caveats and considerations

- Manual classification:
  - Variation with imagery quality, depth
  - Time consuming
  - What one person sees as “dense” may be another person’s “sparse”- one person needs to classify all years

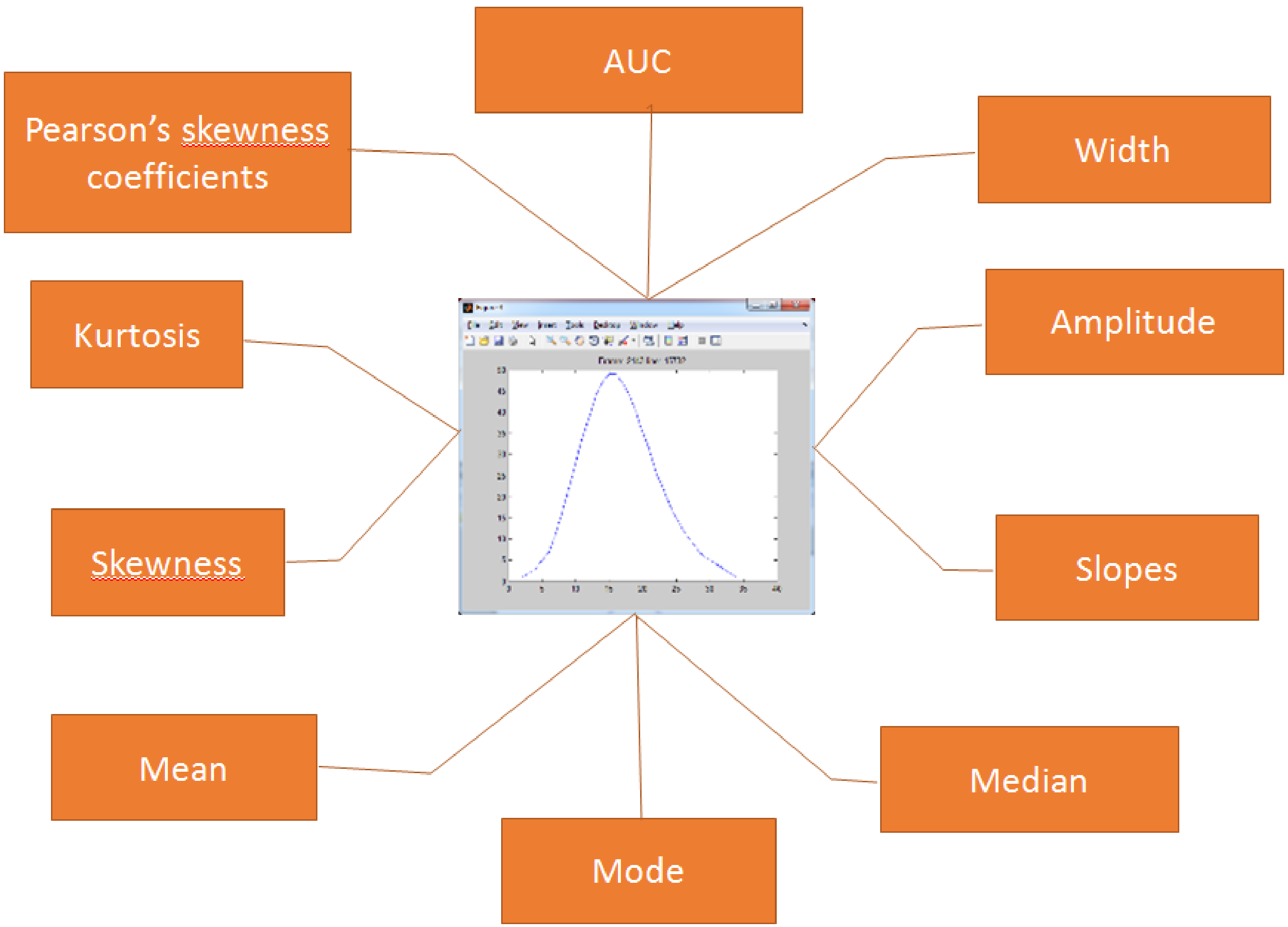
- OBIA using lidar and imagery:
  - More data layers
  - Large areas surveyed quickly
  - Efficient- once a rule set is developed, it can be used to classify large data sets
  - Lidar faces many of the same limitations as imagery- water clarity, wave action can affect data quality

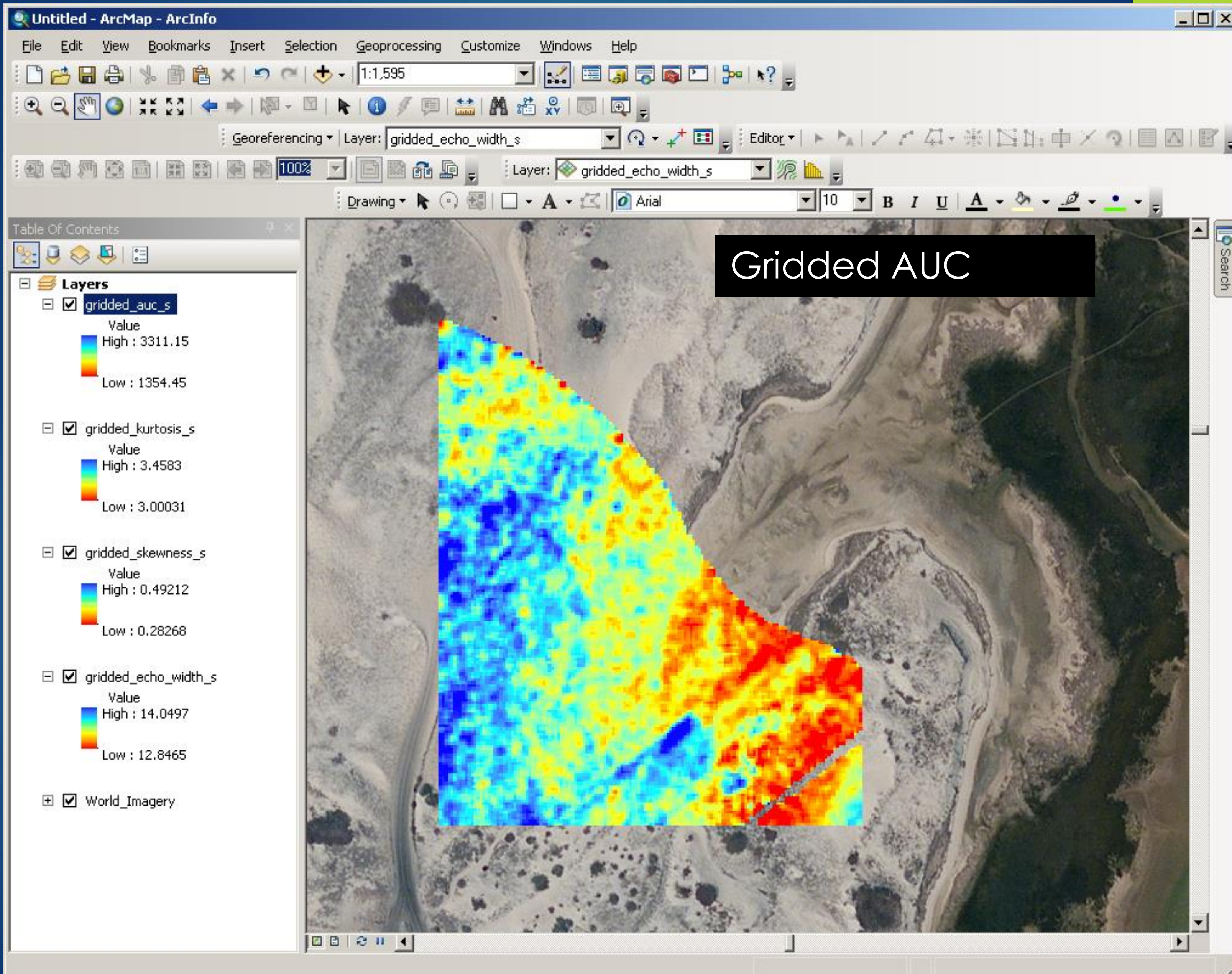
# What's next?

- Is OBIA a more *accurate* method for SAV classification?
  - Intensive ground truthing in collaboration with Stockton College
- Analysis of EAARL-B lidar data collected pre- and post-Hurricane Sandy- assess the immediate effects of the storm
- Large-scale classification of Barnegate Bay from EAARL-B data, NJ coast from Riegl data
- The addition of several more lidar wave form metrics as a data layer for OBIA- create an even more robust data set
  - Can we differentiate between vegetation types?

# What do those wave forms tell us?

## Bottom returns: shape based features

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# Thanks!


- Funding provided by NOAA
- Thank you to the USGS, Stockton College, and UVM's Spatial Analysis Laboratory


If anyone is interested in an "OBIA for Marine Mapping" user group, please come see me!