Regional Process Analysis Tool

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August 13, 2014
Webinar

US Army Corps of Engineers
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Overview

Description/Challenges

- Standardize the use of 1) spatial and 2) meteorological and oceanographic data for defining sediment budgets and reducing the uncertainty in estimates and variability
- Determine the amount of sediment entering/leaving a system and quantify the inlet sink for balancing the budget.

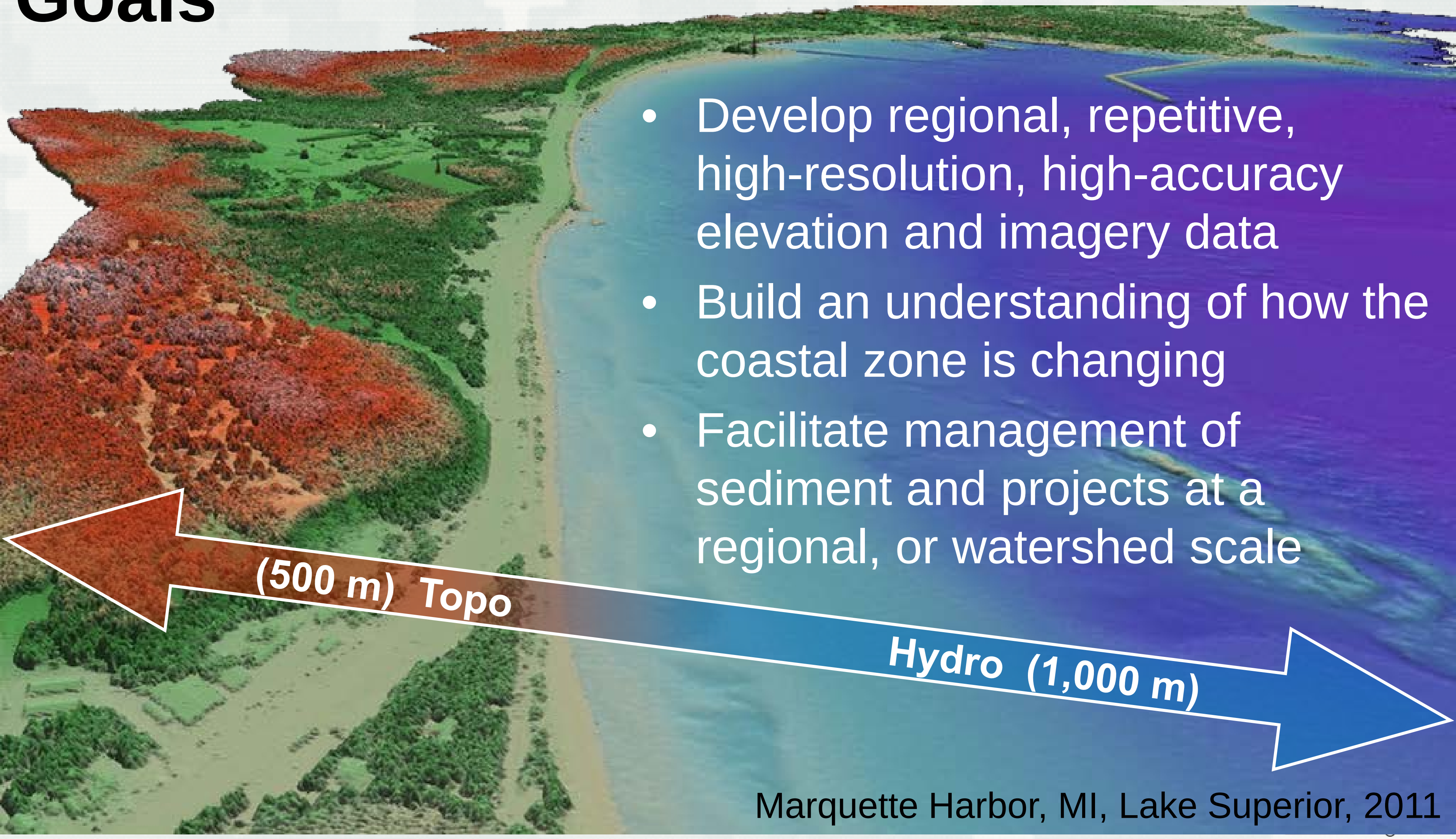
Objectives

- Develop tools and methods to utilize spatial data to provide input into a sediment budget

BLUF: RPAT is an ArcGIS data calculator and semi-automated methods to facilitate gathering regional process information, and “smart analysis” of lidar bathymetry and topography to extract volume/shoreline change for the purposes of constructing sediment budgets and providing boundary/quality-control information for numerical models. This work addresses Statement of Need (SoN) 2013-N-5 “Automated Feature Extraction for Sediment Budgets.”

National Coastal Mapping Program Goals

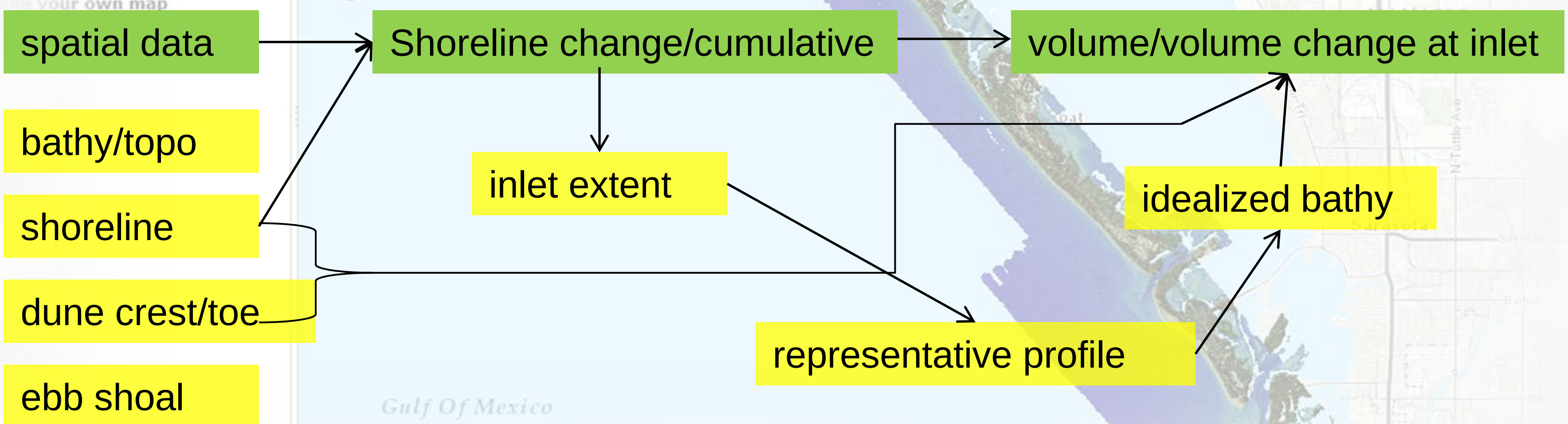
- Develop regional, repetitive, high-resolution, high-accuracy elevation and imagery data
- Build an understanding of how the coastal zone is changing
- Facilitate management of sediment and projects at a regional, or watershed scale



Marquette Harbor, MI, Lake Superior, 2011

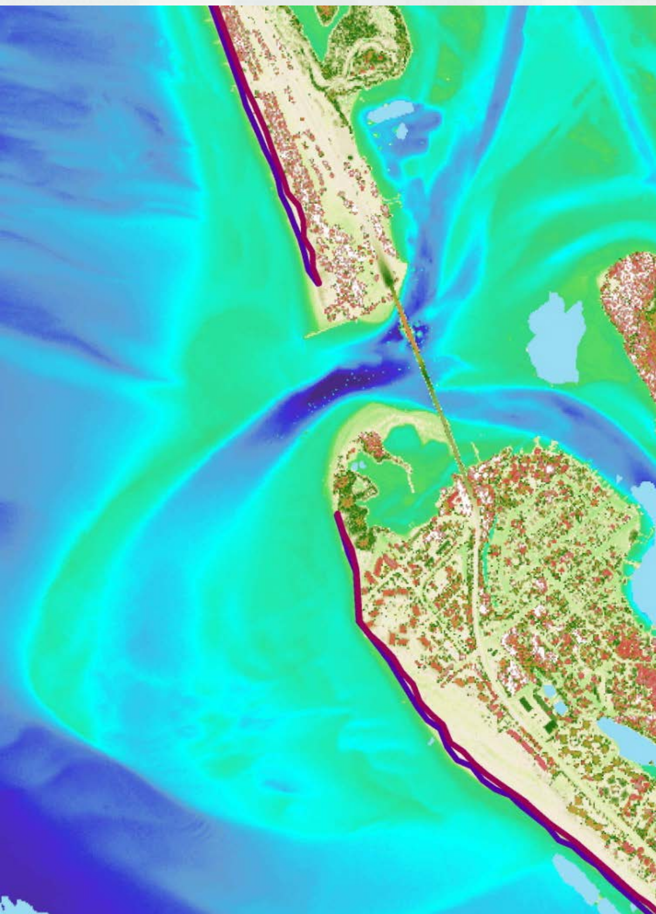
Approach

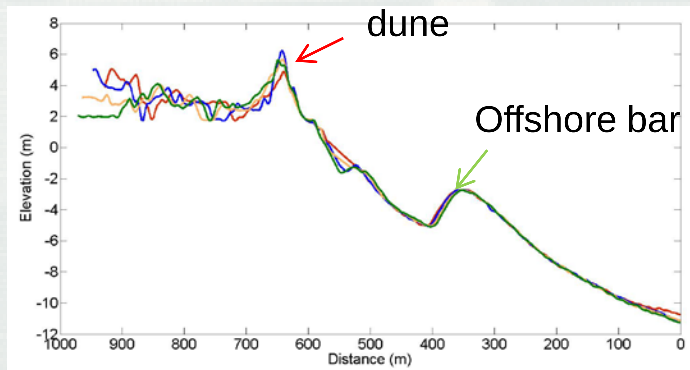
- Provide input into sediment budgets utilizing three-dimensional spatial data
  - Extract features from spatial data
  - Shoreline change and cumulative change
  - Inlet influence extent
  - Representative profile
  - Delineate ebb shoal feature
  - Volume/volume change at inlet



Dunes

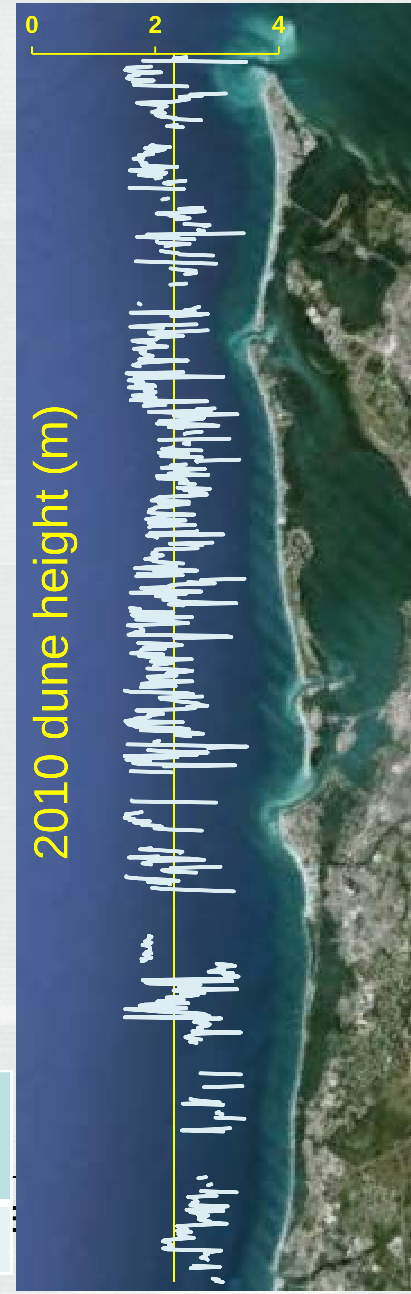
- Provide natural buffer from waves/runup to upland areas
- Volume of sediment available for beach recovery
- Included as part of beach nourishment projects



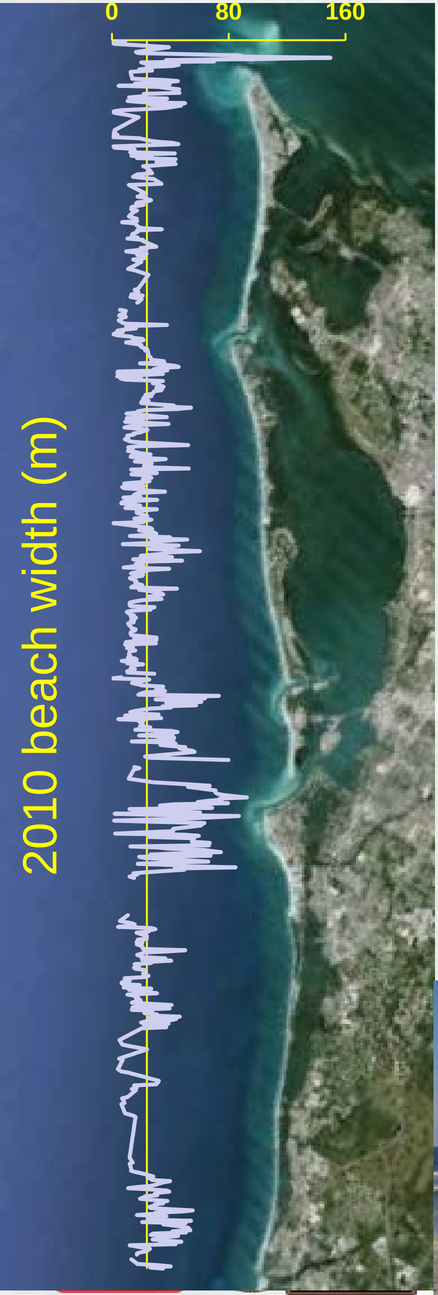


- Dune height – crest of the first dune
- Dune toe – slope change in dune

2010 Dune Height
2 m



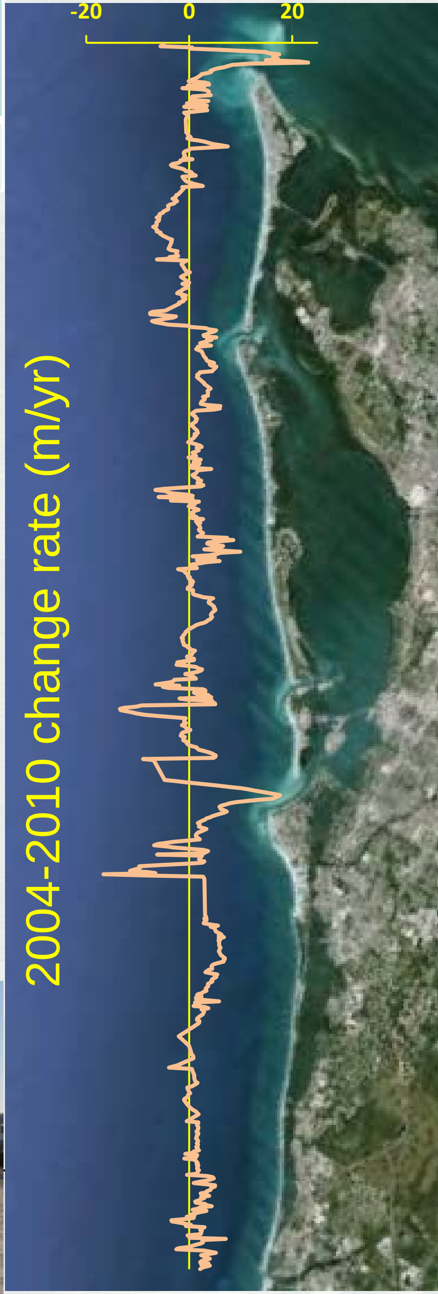
Zero Contour



2010 Beach Width
24 m

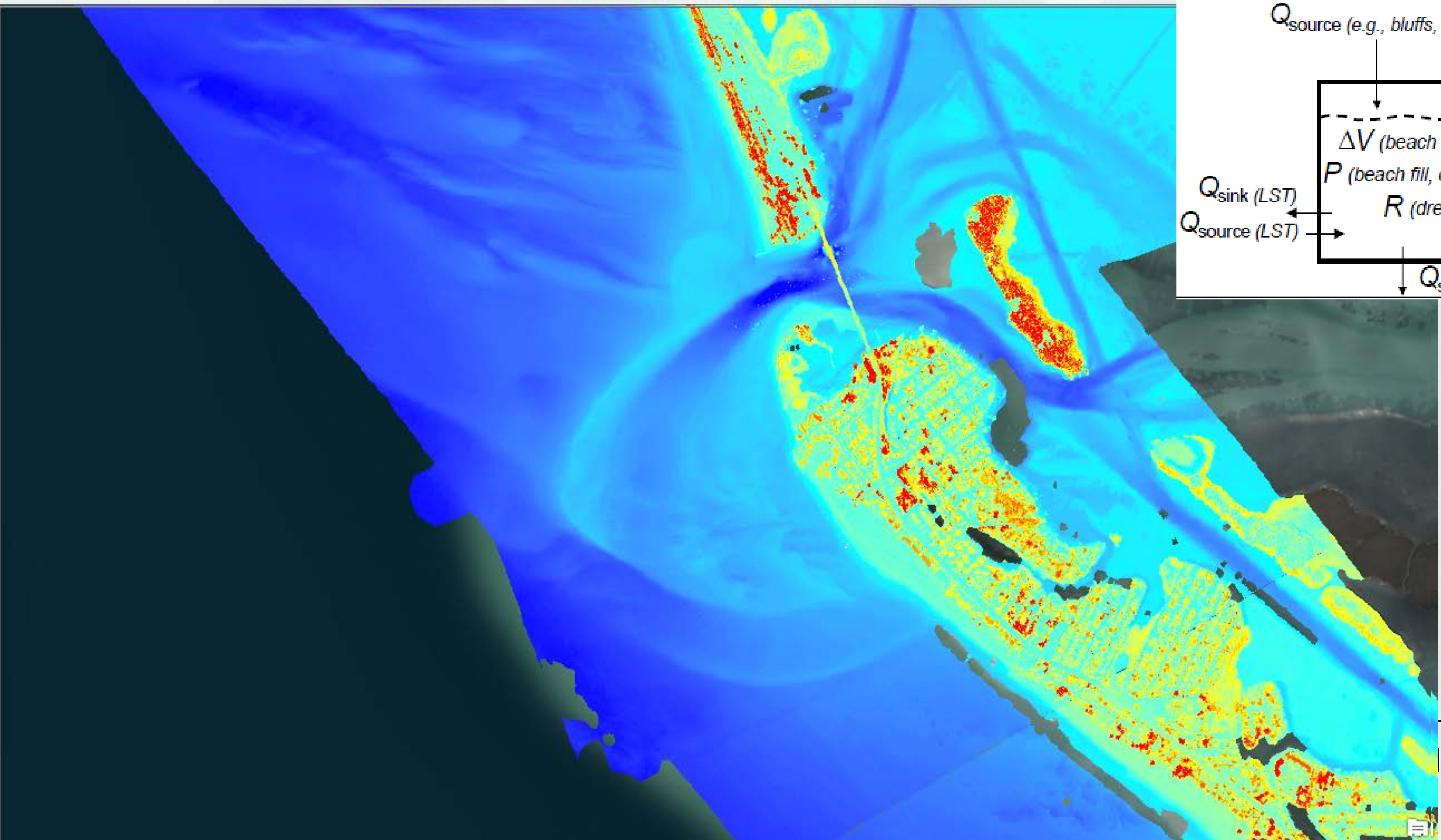
Zero Contour Change Rate
1.3 m

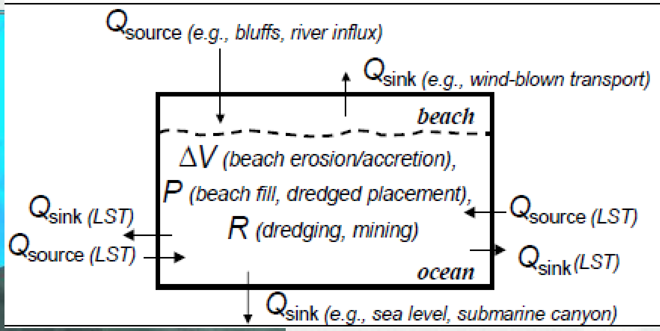
- Beach width provides buffer before the dune as well as recreational benefits
  - Defined as the distance between the zero contour and the dune toe
  - Active portion of the beach
- Contour change rate
  - Used to determine hot spots of erosion and cumulative change can identify extent of inlet influence



Ebb Shoal

- Migration of sediment in ebb shoal may fill in navigation channels
- Use ebb shoal boundaries from multiple years to create a maximum polygon for the ebb shoal feature





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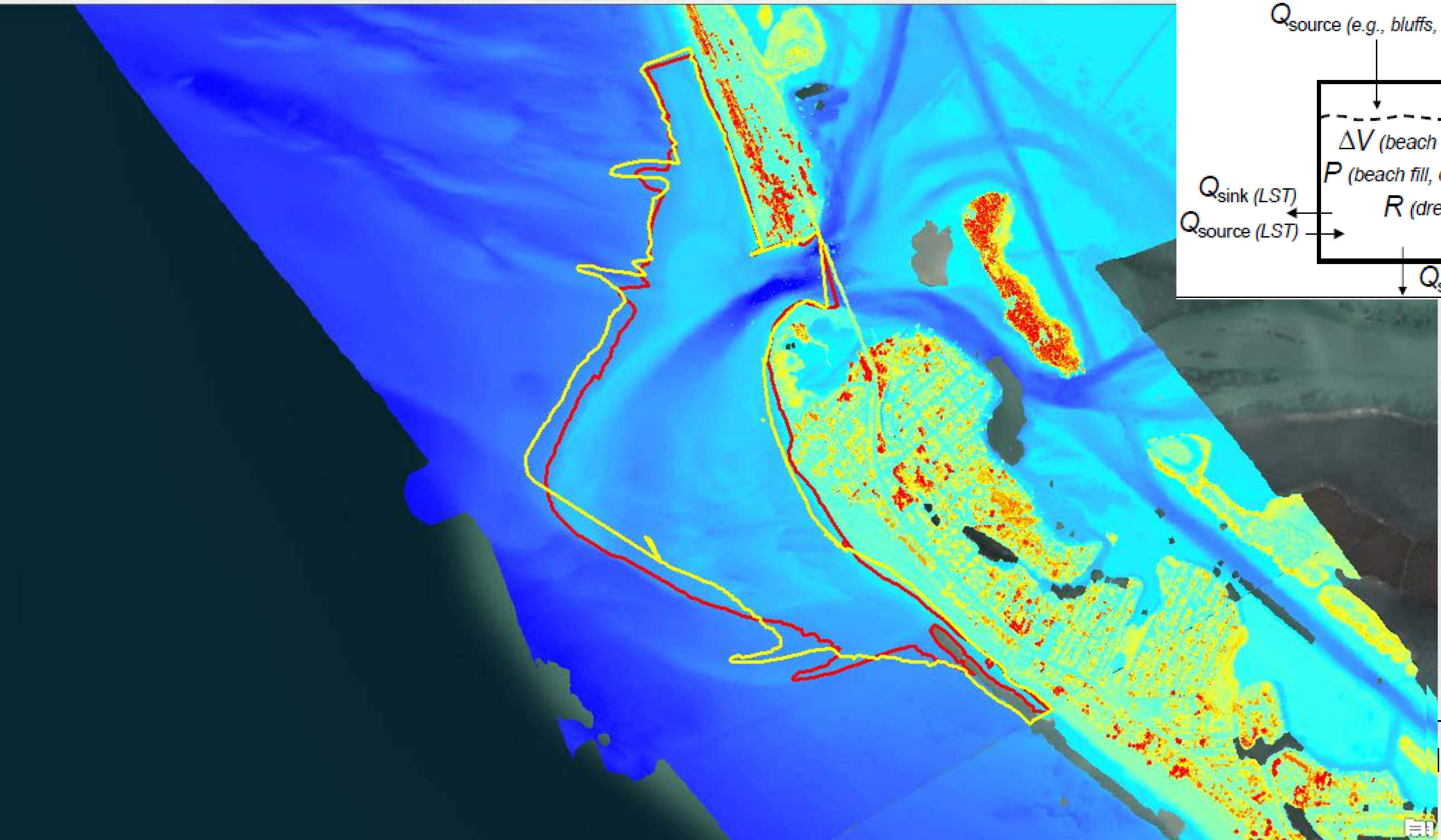

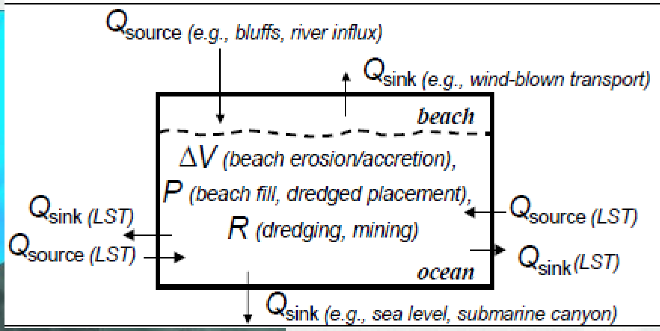

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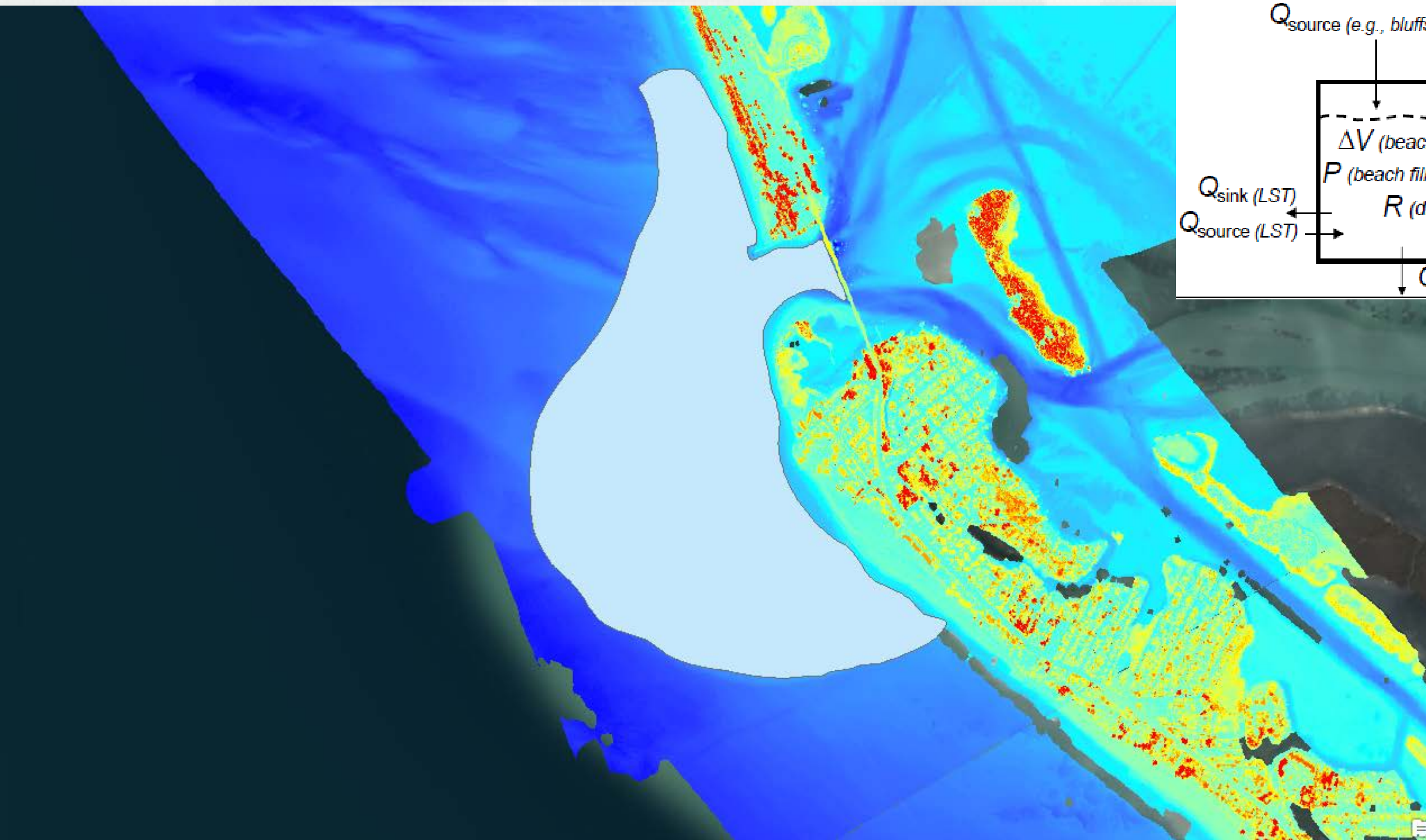

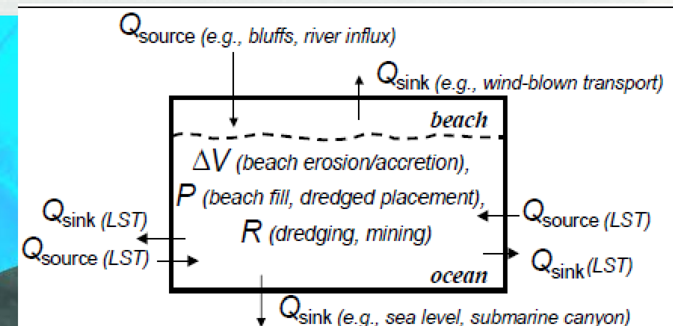

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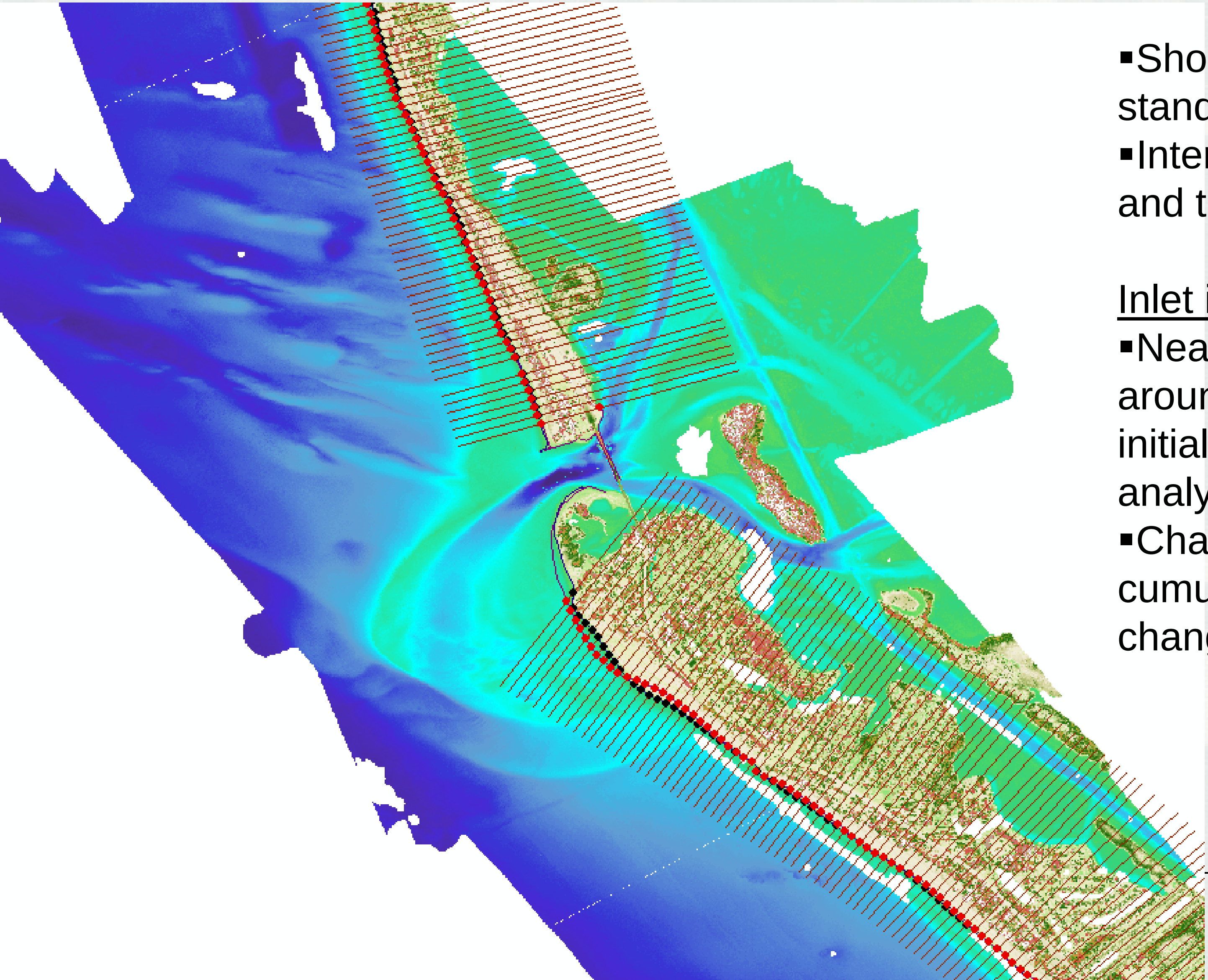
Shoreline Change



- Shoreline vector – standard NCMP product
- Intersect shoreline vector and transects

<u>Inlet influence extent</u>

- Nearest neighbor search around inlet to create initial boundary for change analysis
- Change in slope of cumulative shoreline change for inlet extent

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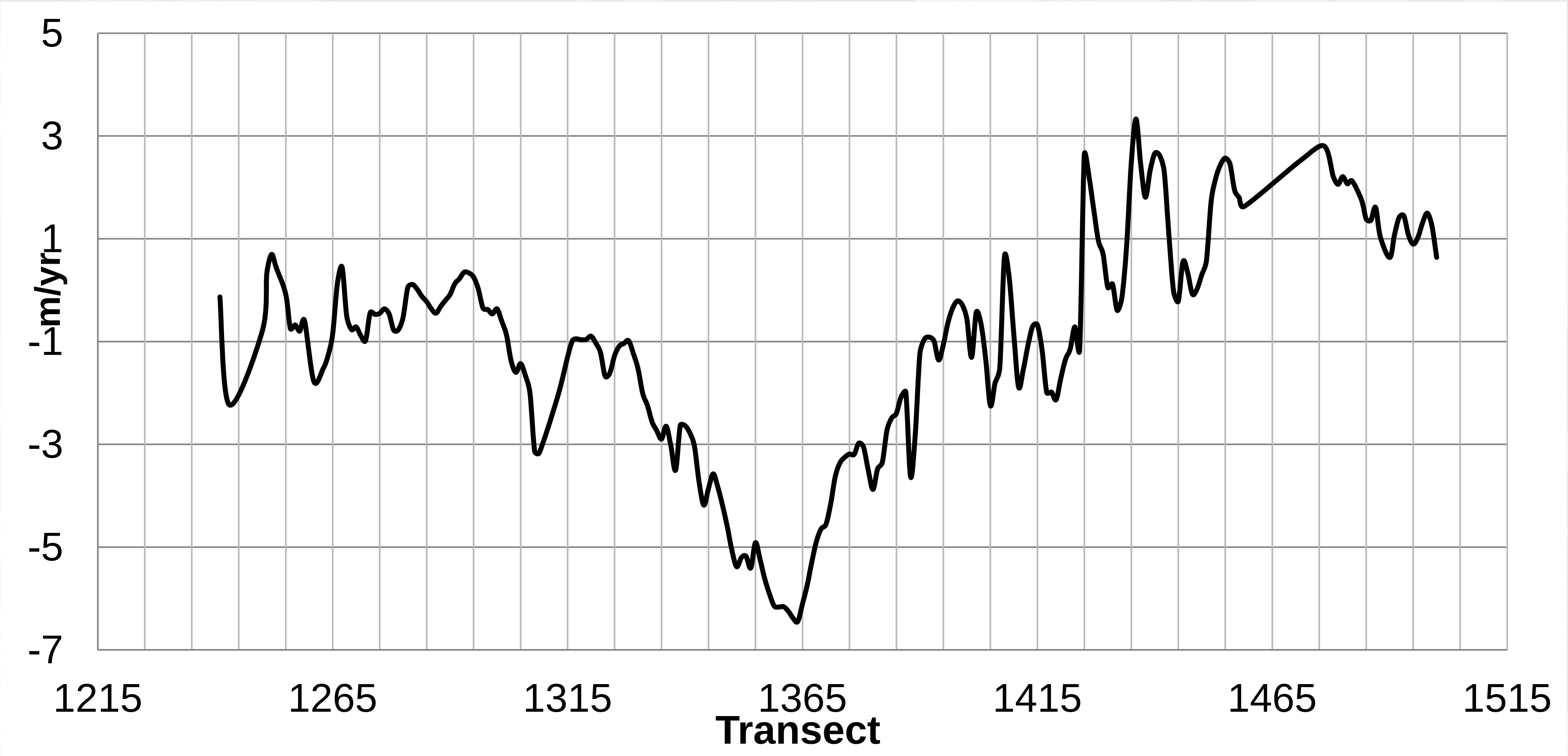
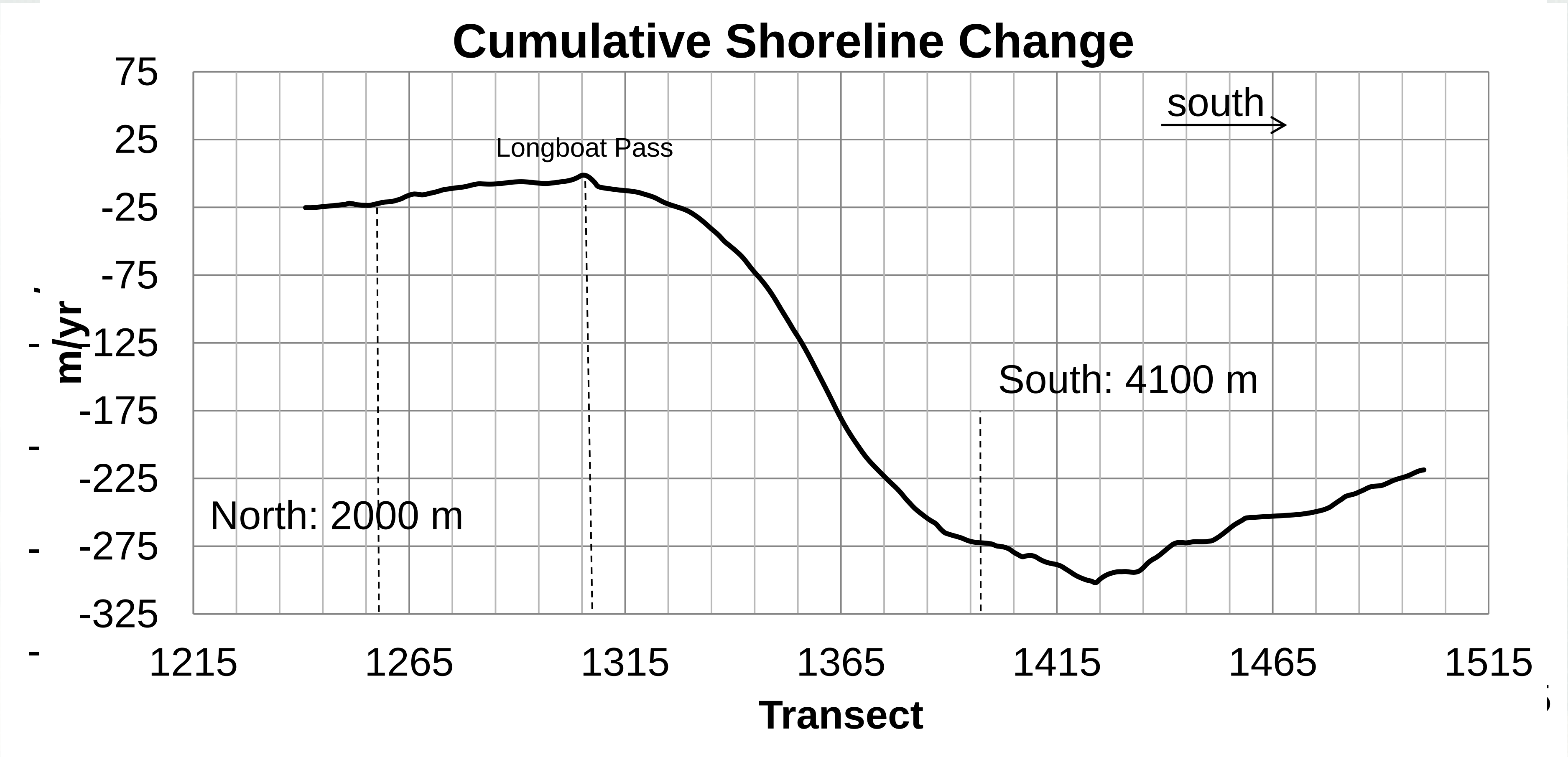
Shoreline Change

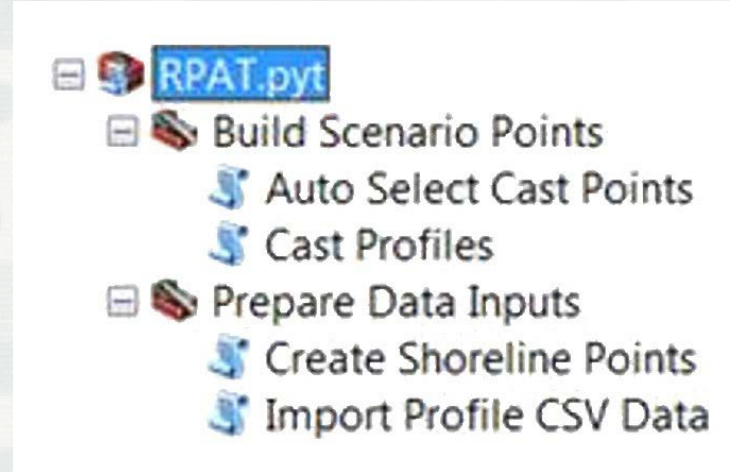


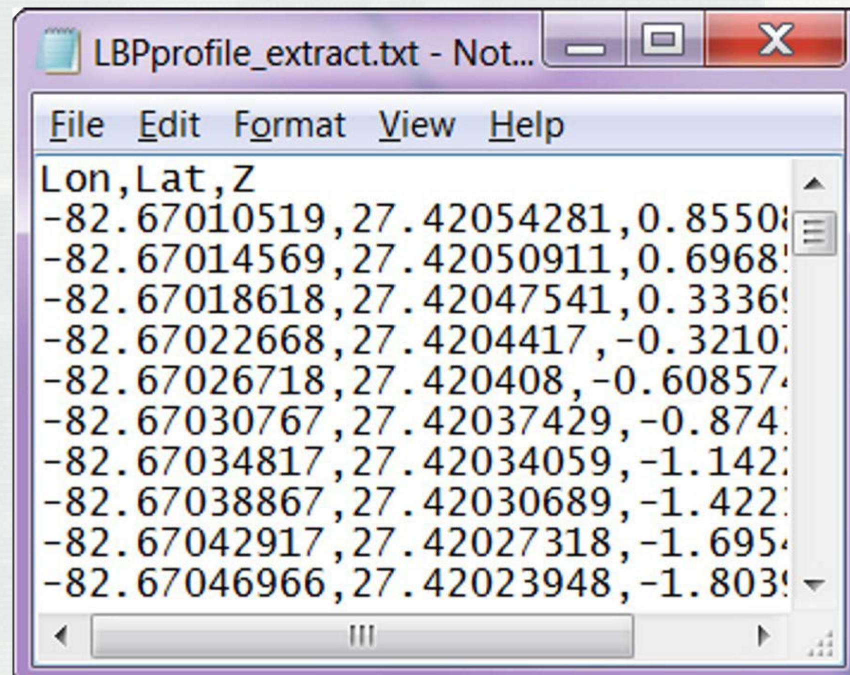
Shoreline Change



Data Inputs

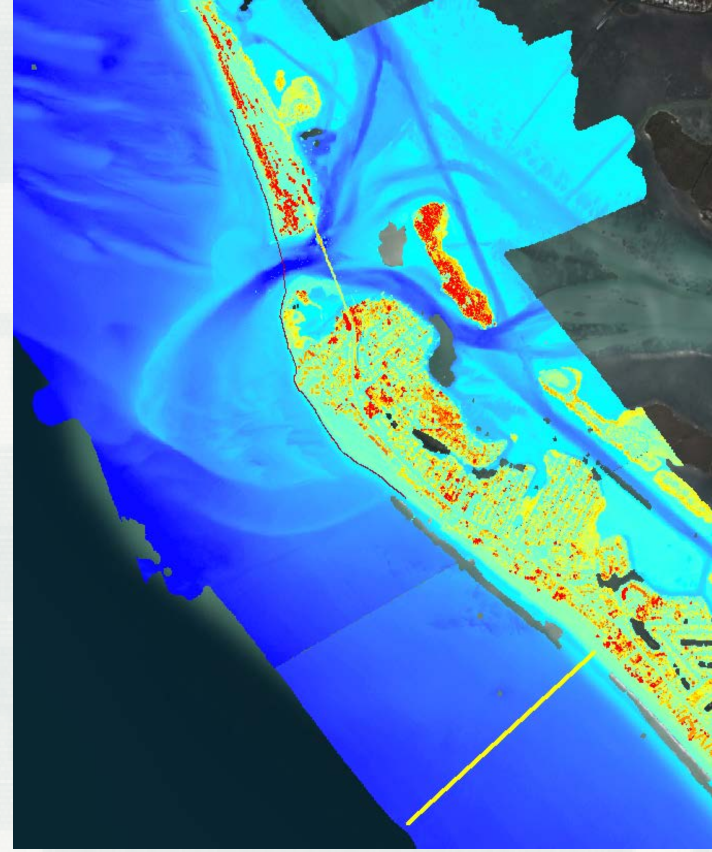
- XYZ text file representing a single profile line
  - Representative profile from region beyond inlet influence
  - This file must be comma-separated.
  - Coordinates must be represented in decimal degrees.
- Shoreline polyline with a defined coordinate system
  - If a coordinate system is not defined, use the Define Projection tool within ArcToolbox.

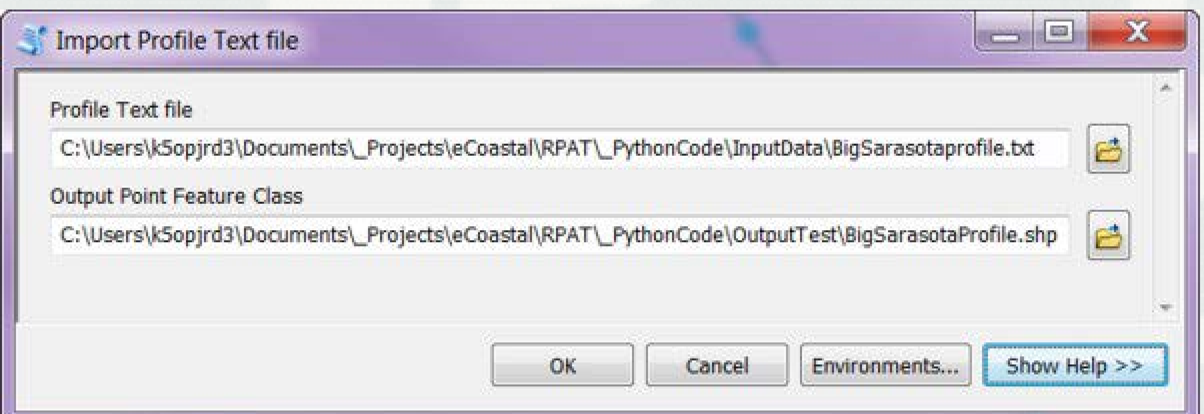




Profile

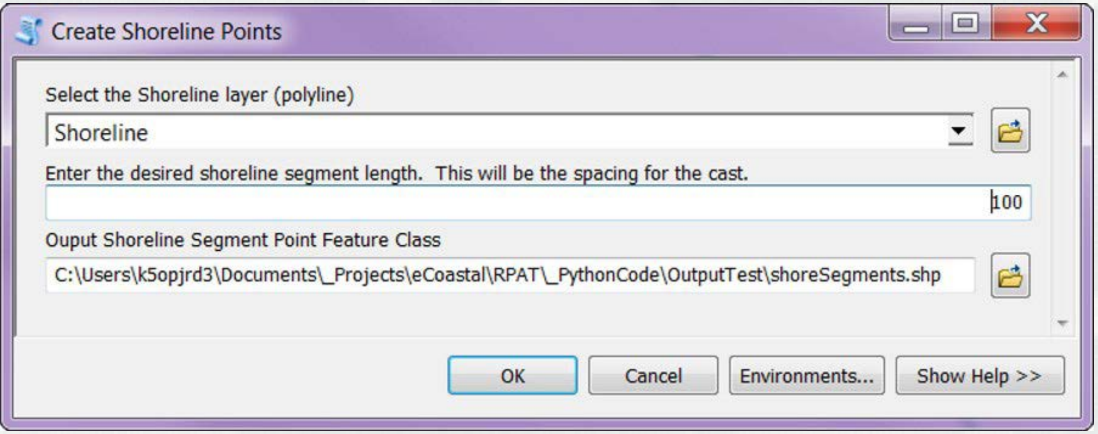
- Import the profile text file, and convert the profile points to a point shape file.
  - This profile will be used to generate the idealized ‘no inlet’ bathymetry





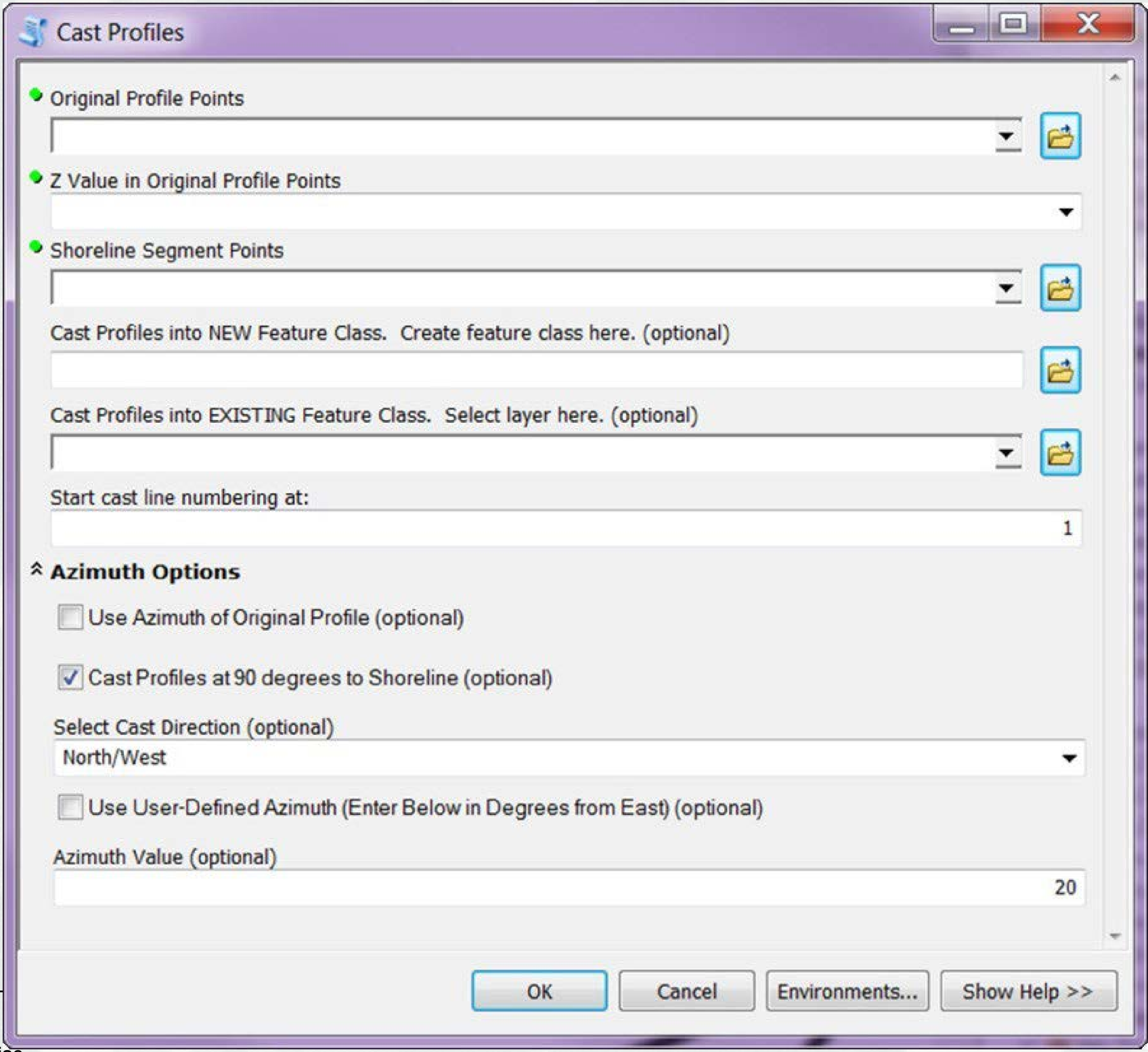
Shoreline

- Divide the input shoreline into a segment.
  - Each segment is represented by a point. These point locations serve as the starting point for the casted profile lines.
  - Smooth the shoreline polyline prior to segmenting to simplify the line



Casting Profiles

- Representative profile points are cast at the shoreline segment locations.
- Shoreline segments are numbered
- Selecting shoreline segments will only cast profiles for those locations
- User has control over azimuth options

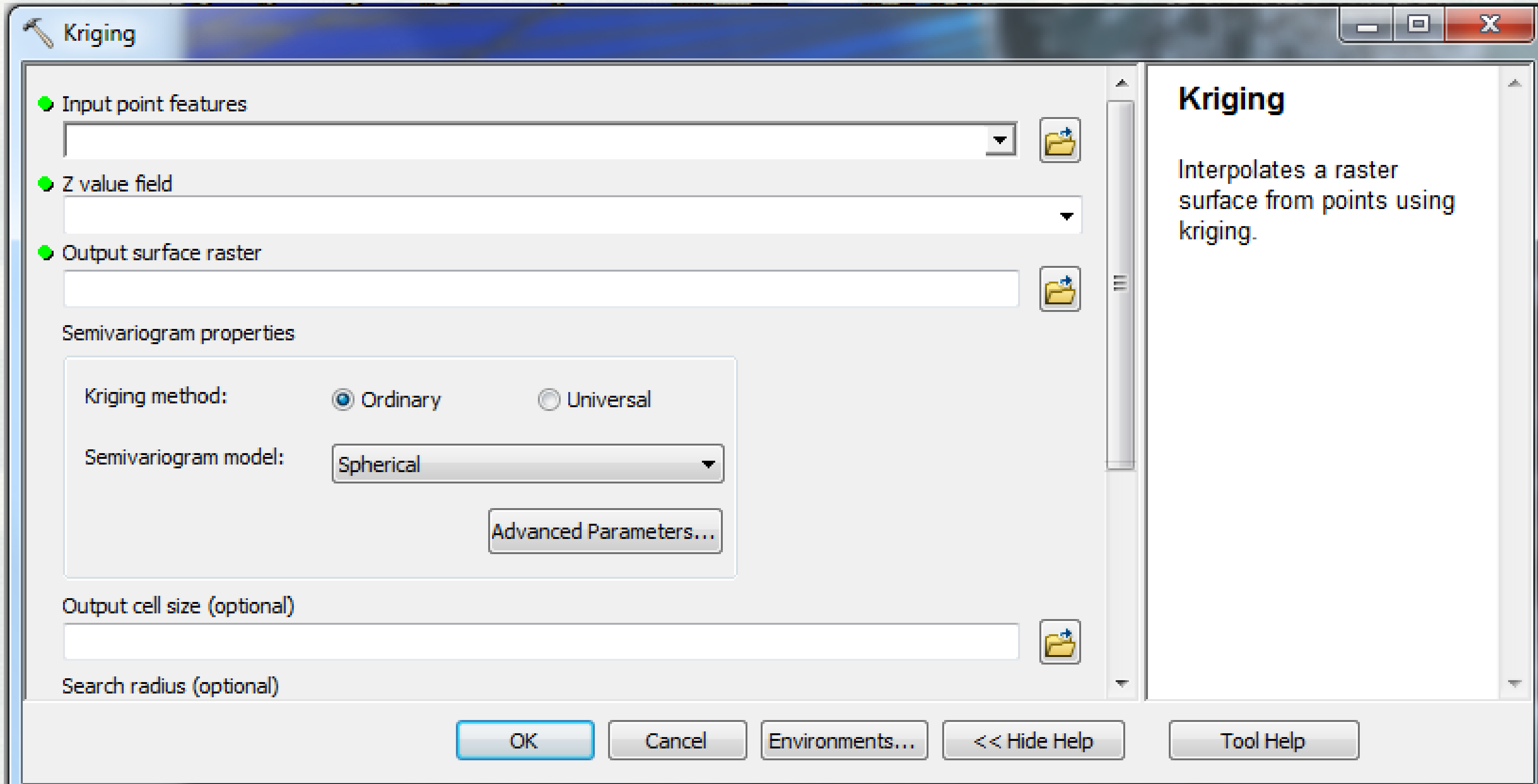


Casting Profiles

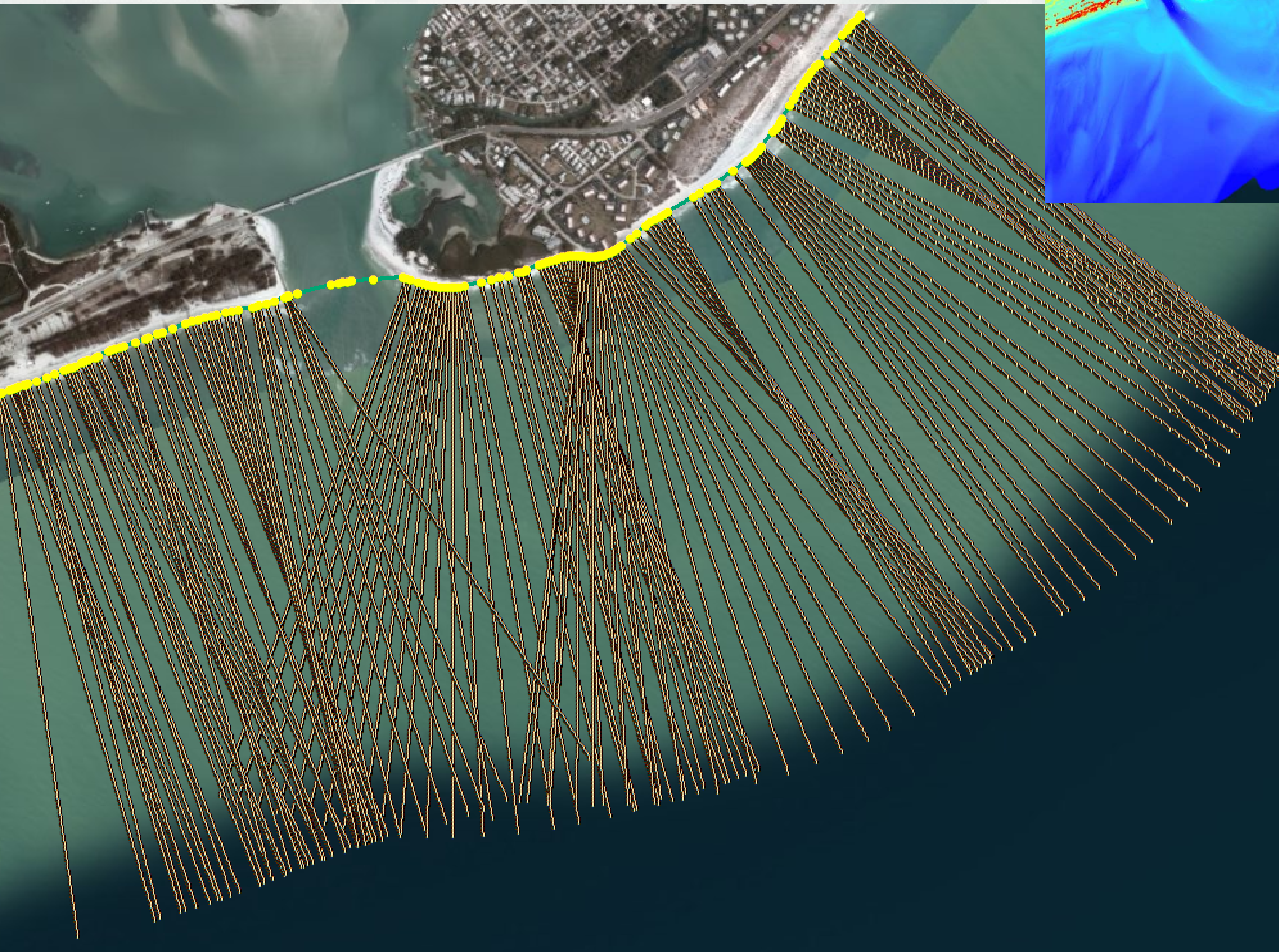
- Cast Profiles at 90 Degrees to Shoreline—
  – Select this option to calculate the line direction between the shoreline segments. For each selected shoreline segment point, a line is cast at 90 degrees. This is the default option.
- Use Azimuth of Original Profile—
  – Select this option to calculate the azimuth of the original profile points. This value is used to cast all points.
  – Note: If you select this option, you must also select the direction in which to cast the scenario profile points. For example, if the water is to the west of the shoreline, you would want to cast in that direction. North/West = counterclockwise, and South/East = clockwise.
- Use User-Defined Azimuth—Select this option if you want to use your own azimuth value for the calculation.
  – Note: Enter the value in the Azimuth Value field.

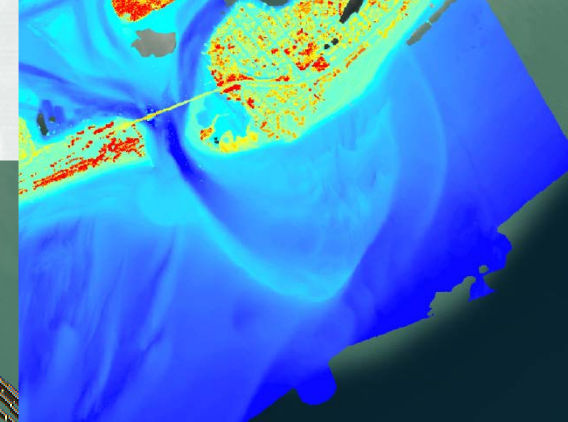
Idealized Bathymetry

- Generate the raster surface from the representative profile
- Use the raster interpolation tools within spatial analyst



Idealized Bathymetry





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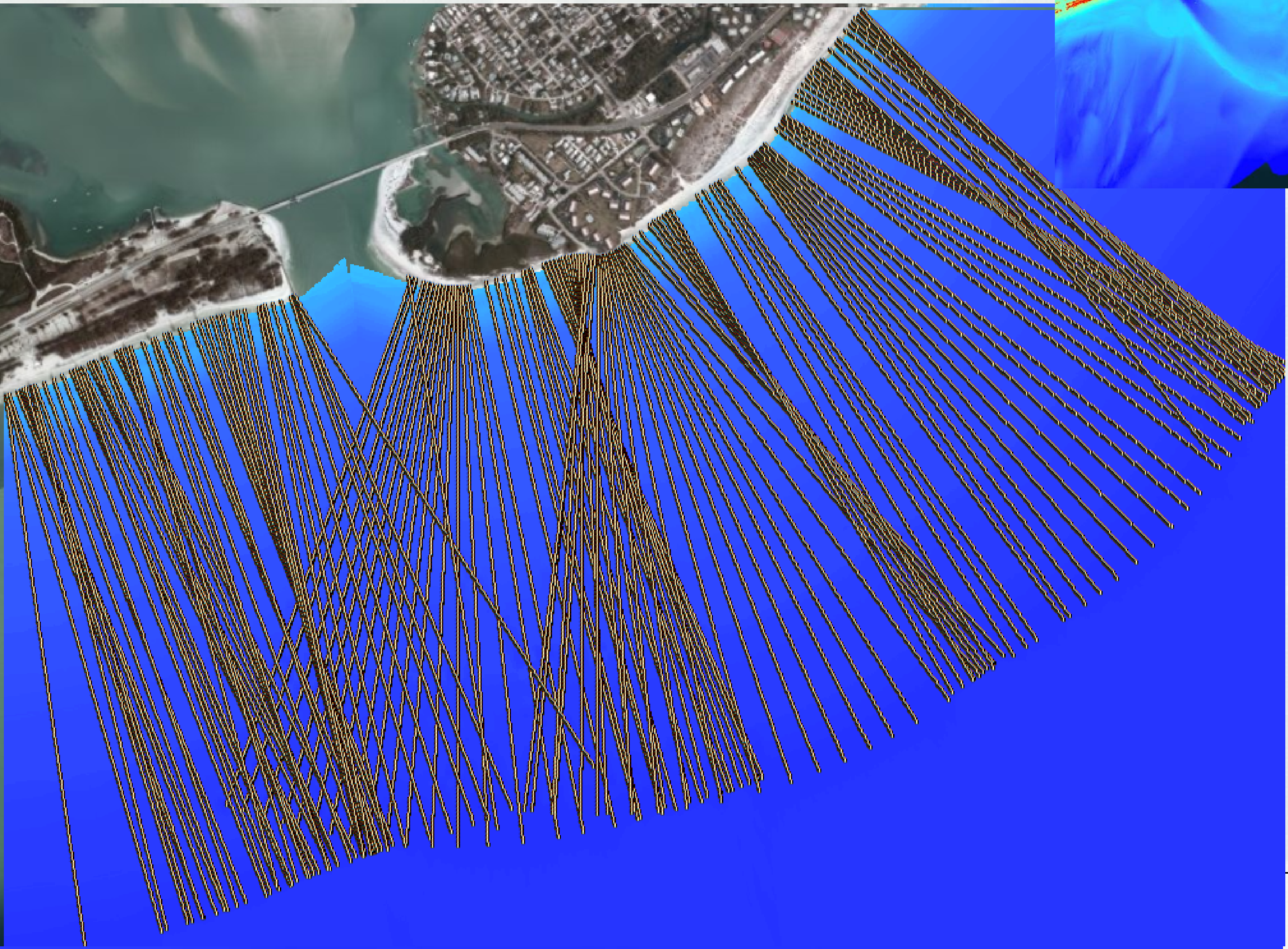

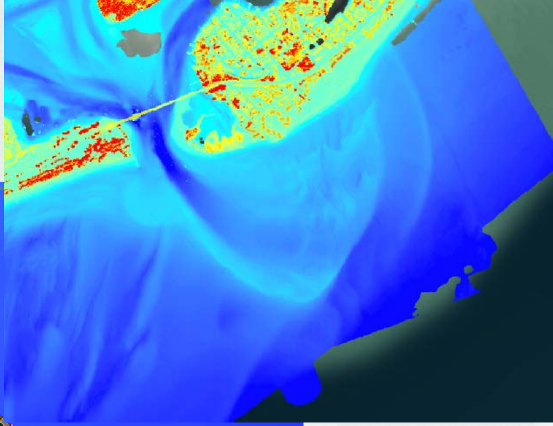

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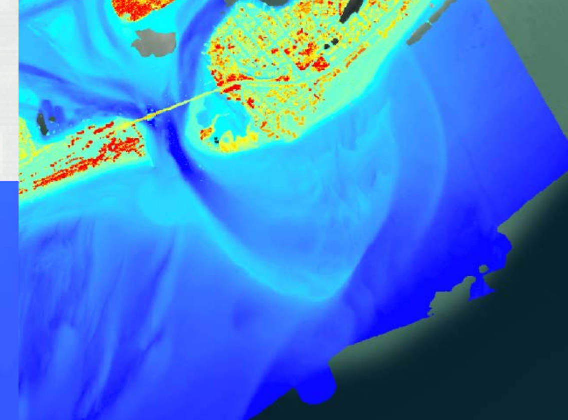
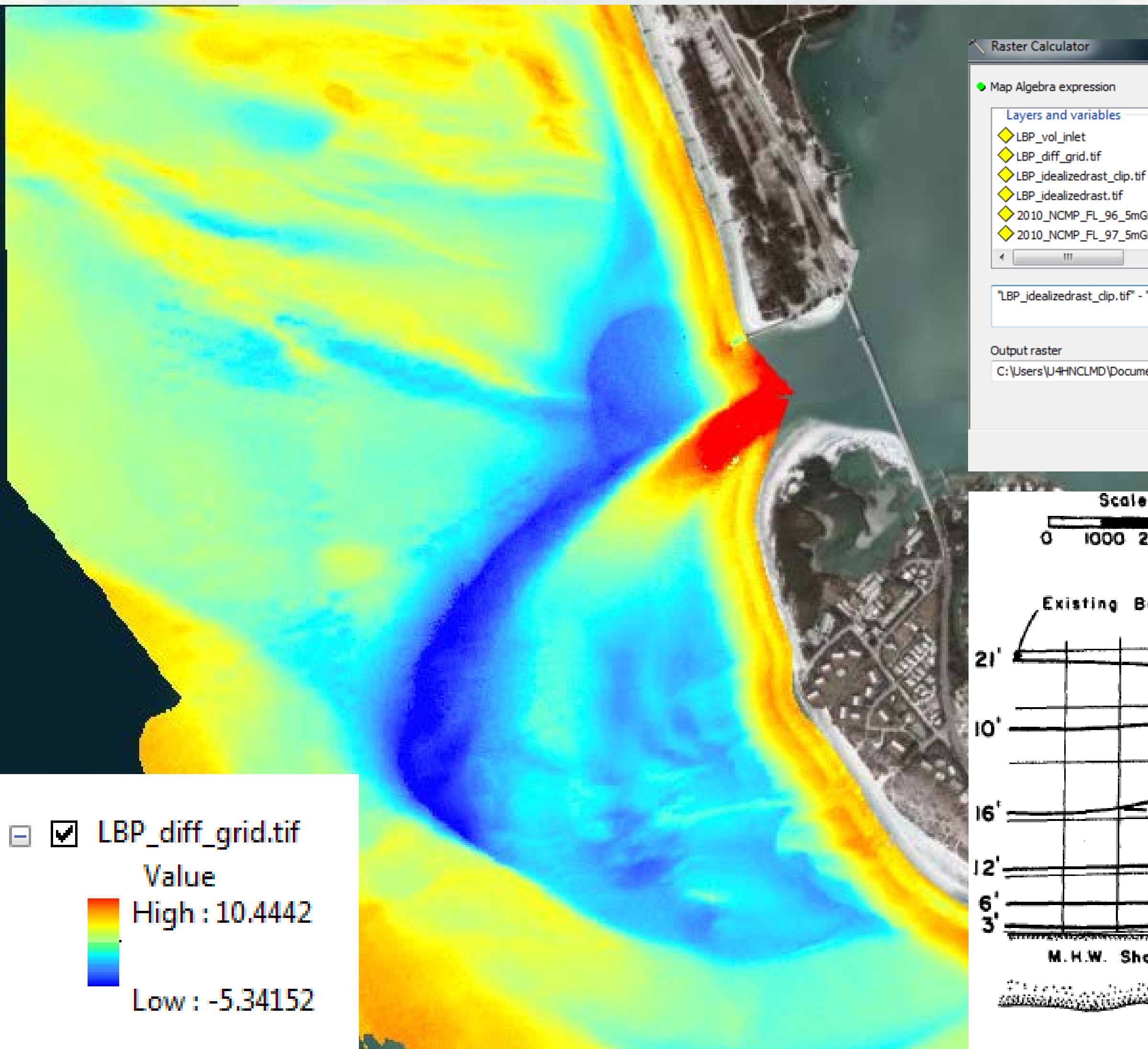
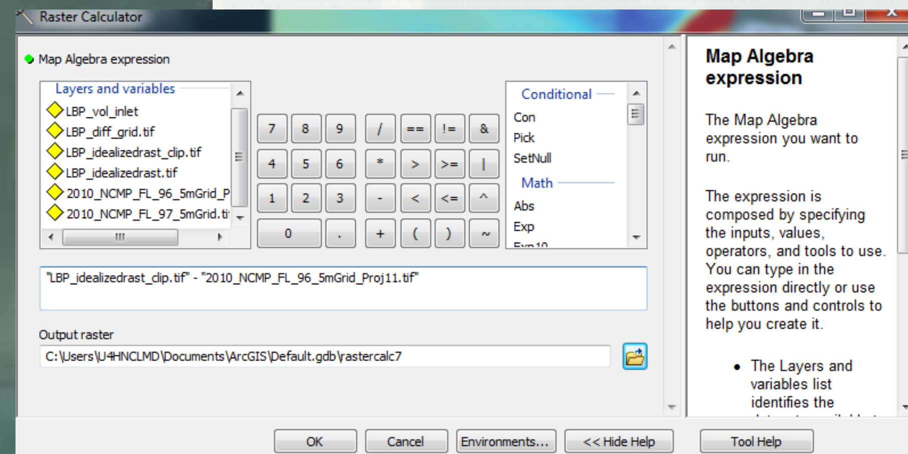
Idealized Bathymetry

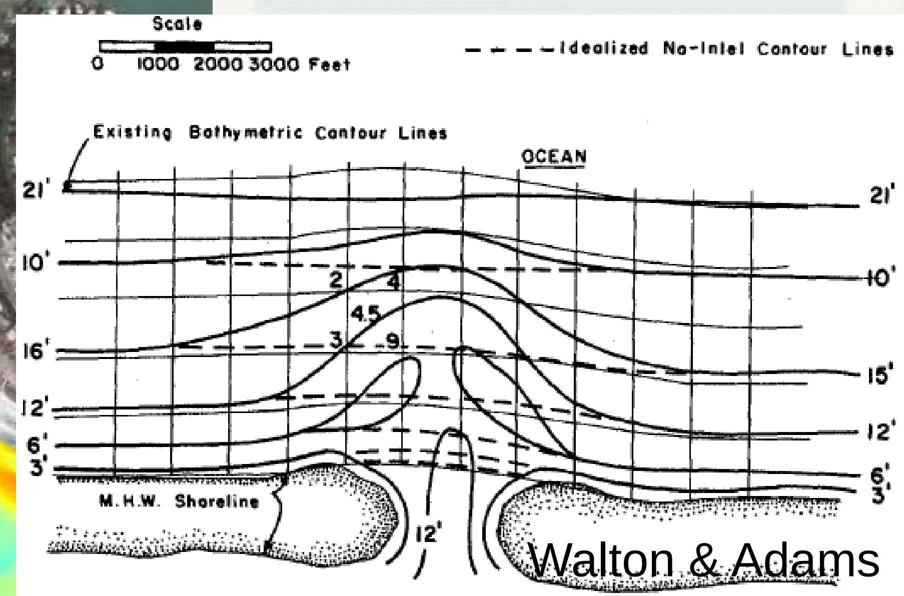


Volume

- Compare the idealized ‘no inlet’ bathymetry with the existing bathymetry
  - Generate elevation difference grid

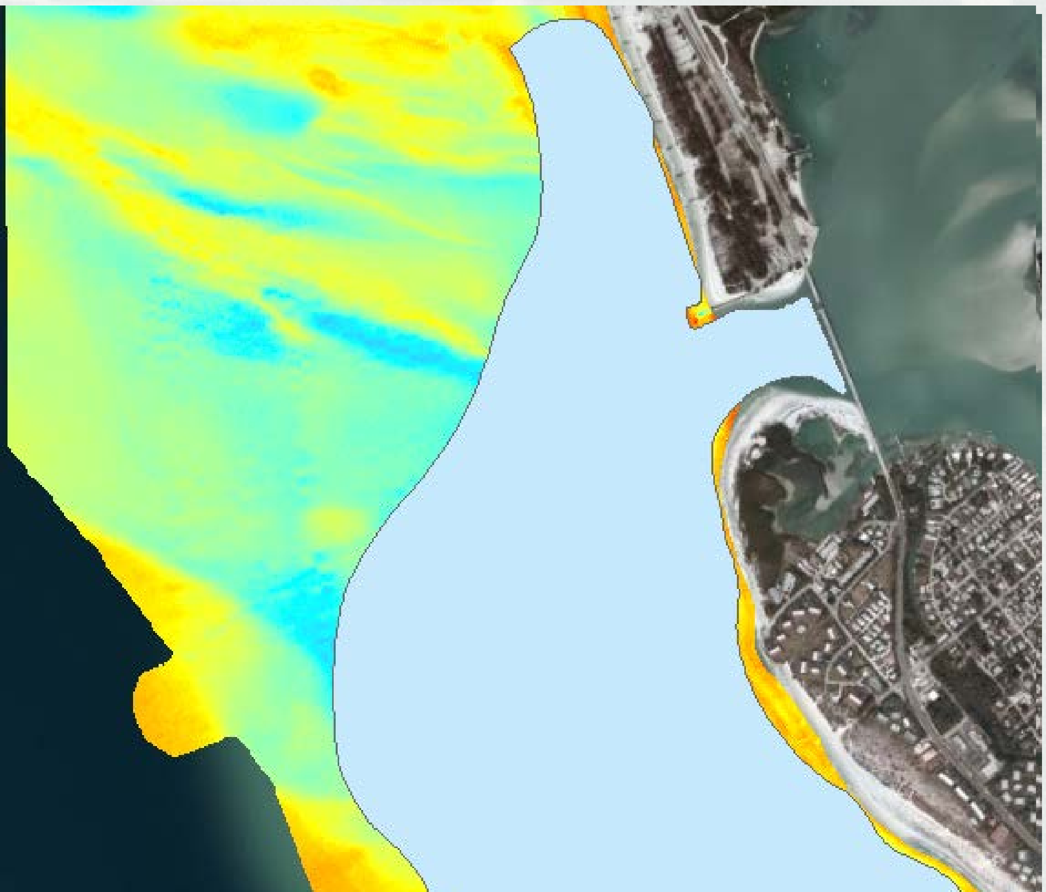


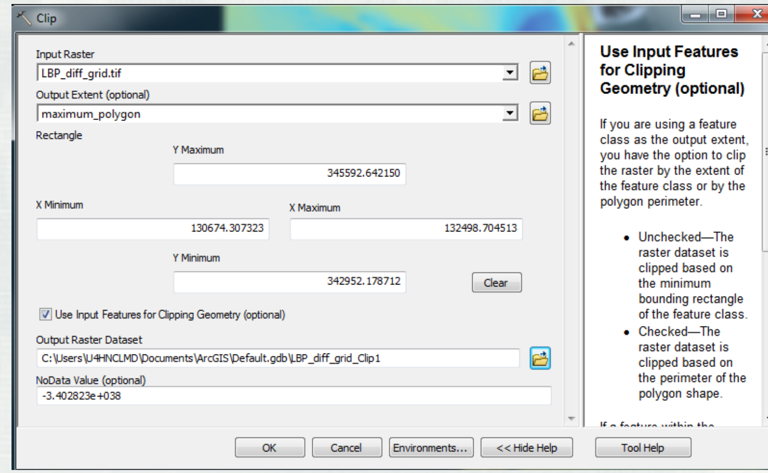


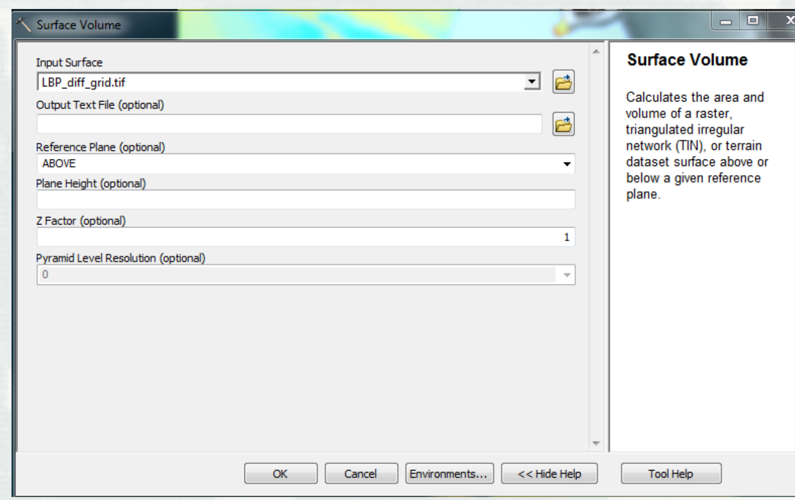


Volume

- Volume in inlet area
  - Clip difference elevation raster to extent of maximum ebb shoal polygon or other boundary





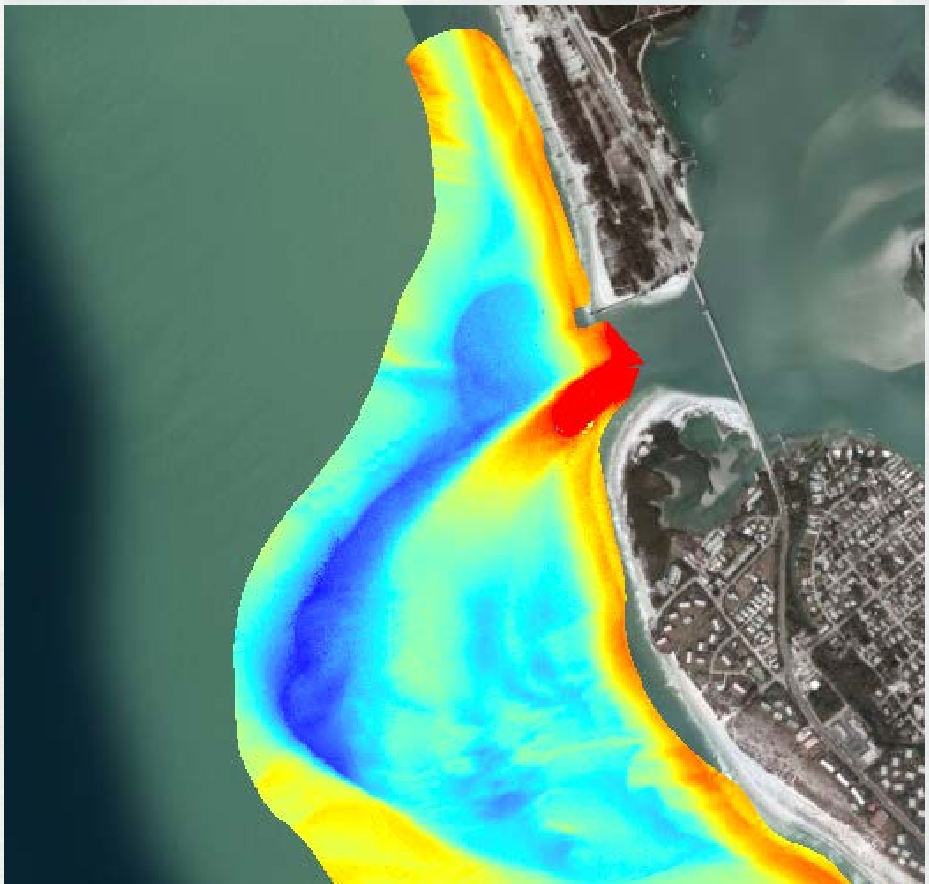


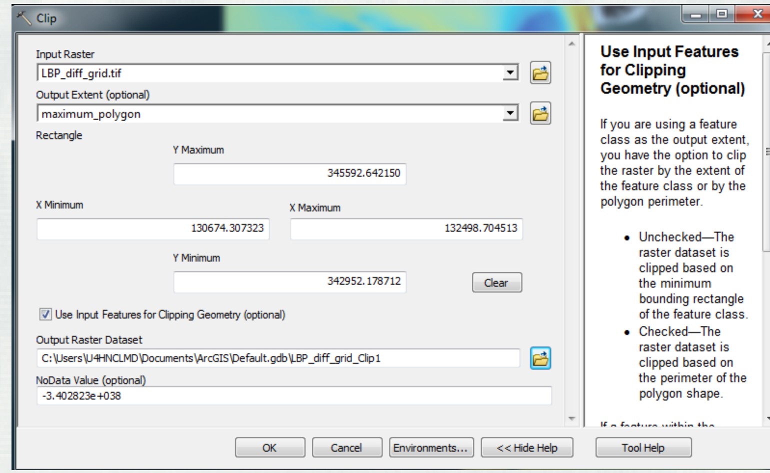
LBP_vol_inlet_2010

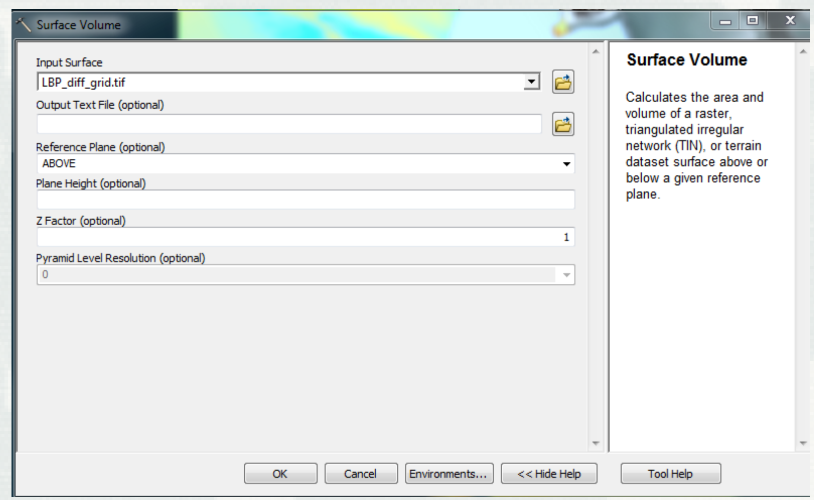
Dataset	Plane_Height	Reference	Z_Factor	Area_2D	Area_3D	Volume
..\WebinarMaterial\LBP_vol_inlet	-5.34	ABOVE	1	2146225.380479	2147946.947054	7086403.8357

Volume

- Volume in inlet area
  - Clip difference elevation raster to extent of maximum ebb shoal polygon or other boundary





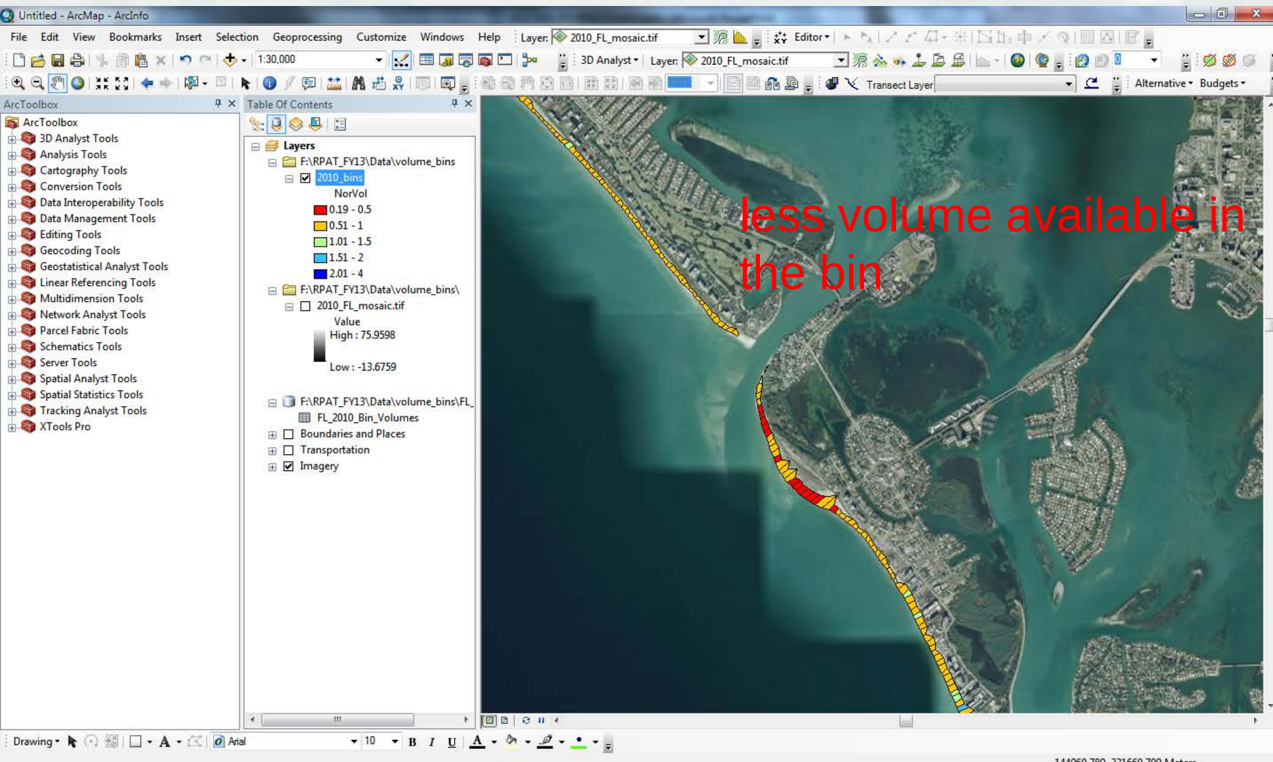


LBP_vol_inlet_2010

	Dataset	Plane_Height	Reference	Z_Factor	Area_2D	Area_3D	Volume
▸	..\WebinarMaterial\LBP_vol_inlet	-5.34	ABOVE	1	2146225.380479	2147946.947054	7086403.8357

Volume

- ArcGIS tool that calculates volume available using a seaward and landward boundary, such as the shoreline and dune line or back line (landward limit of dune field)
  - Volume calculated for each bin created (transect lines are used to divide the region alongshore)



- Total Volume and Area of each bin are calculated
- For comparison between bins, the volume is divided by the area to account for larger/smaller bin sizes

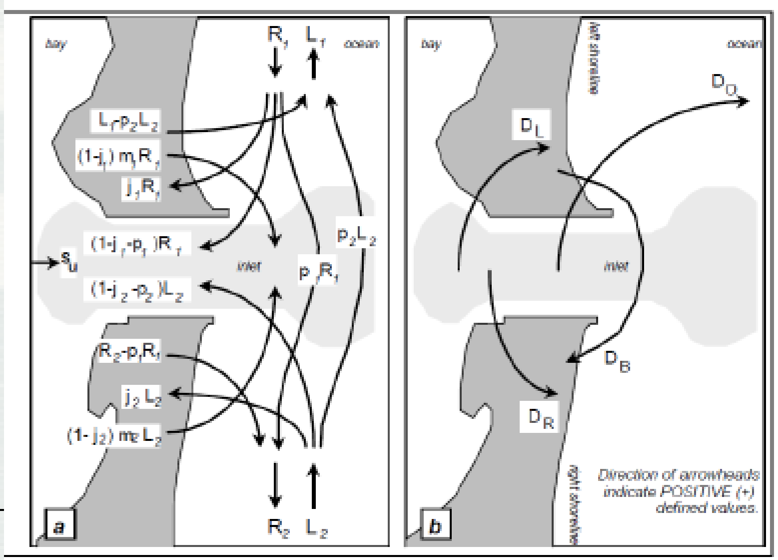
Sediment Budget Input

- Use tools/methods to determine how much sediment is entering/leaving the system
  - Volume and volume change
  - Inlet sink – representative profile beyond inlet influence compared to existing bathymetry at inlet
  - Provide input into Sediment Budget Calculator and SBAS

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = \text{Residual}$$

Q source , Q sink = Import or Export to the cell
ΔV = Volume change within cell
P = Placement in the cell
R = Removal in the cell
Residual = cell surplus or deficit, 0 = balanced cell

Sediment Budget Calculator



Volume Map

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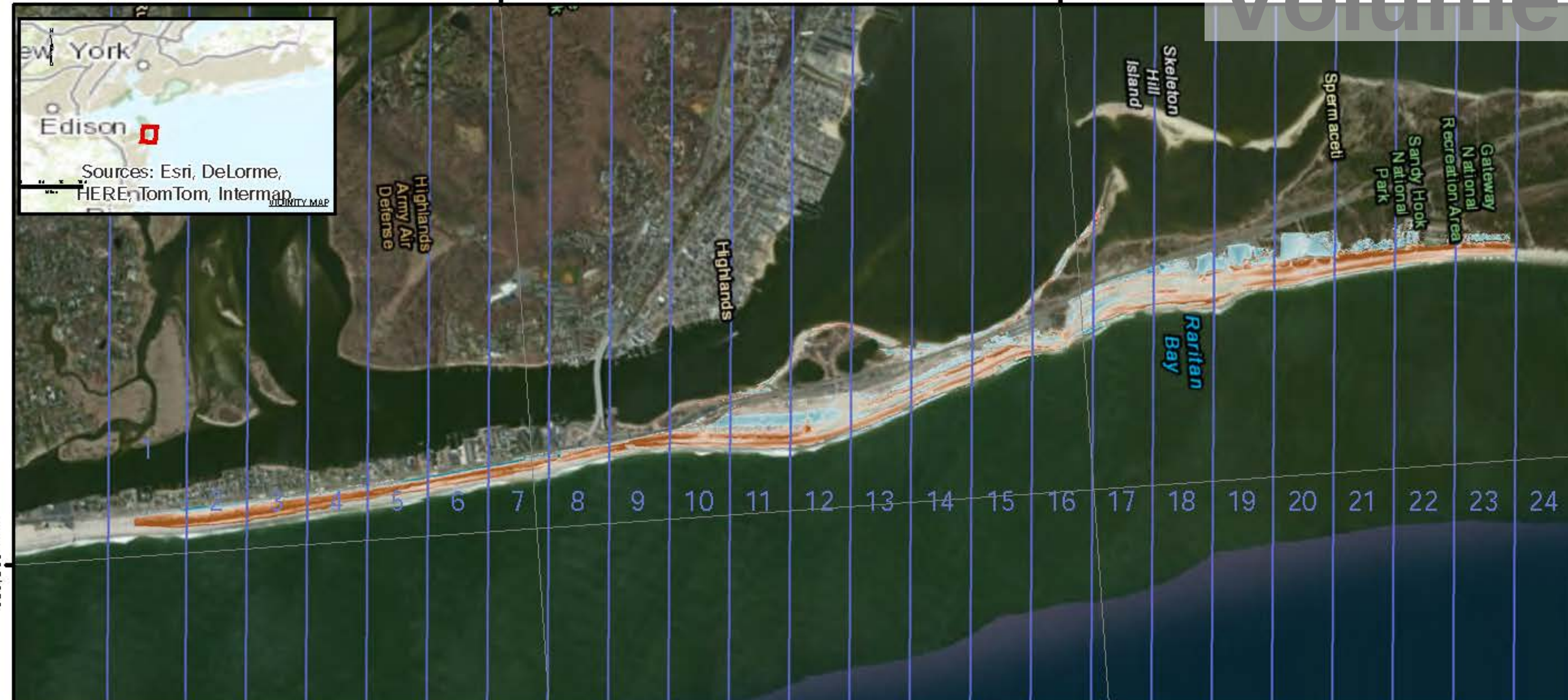
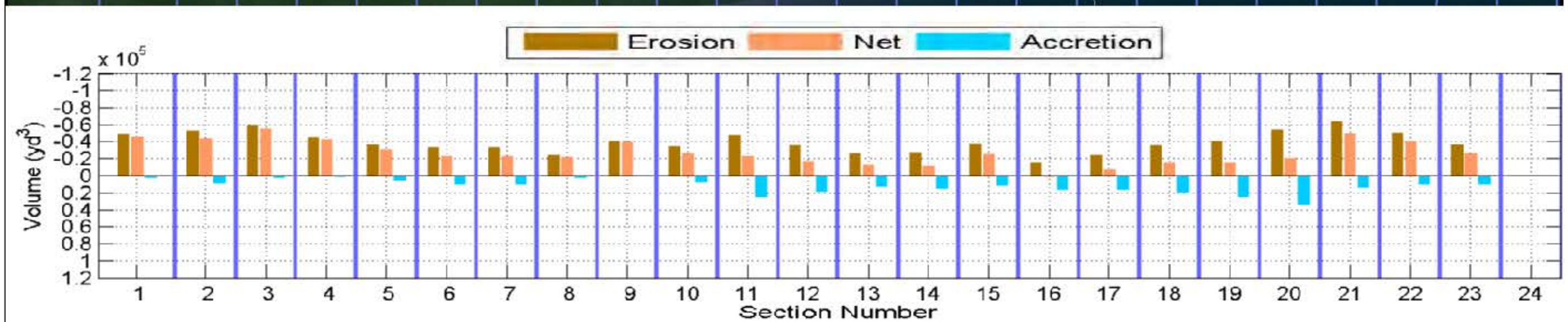
US Army Corps of Engineers District: CENAN





568,514   648,489

Section	Net (yd^3)	Erosion (yd^3)	Accretion (yd^3)	Section	Net (yd^3)	Erosion (yd^3)	Accretion (yd^3)
1	-46000	-49000	3000	13	-13000	-26000	13000
2	-44000	-53000	9000	14	-11000	-27000	16000
3	-56000	-59000	3000	15	-25000	-37000	12000
4	-43000	-45000	2000	16	2000	-15000	17000
5	-30000	-36000	6000	17	-7000	-24000	17000
6	-23000	-33000	10000	18	-15000	-35000	20000
7	-23000	-33000	10000	19	-15000	-40000	25000
8	-21000	-24000	3000	20	-20000	-54000	34000
9	-39000	-40000	1000	21	-50000	-64000	14000
10	-26000	-34000	8000	22	-41000	-51000	10000
11	-23000	-48000	25000	23	-26000	-36000	10000
12	-16000	-35000	19000				

Elevation Difference (yd)

High : 2

Low : -2

Miles 0 0.5 1

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Horizontal Coordinate System: NAD 1983 StatePlane New Jersey FIPS 2900 Feet

Datum: North American 1983

Distance Units: Foot US

The information depicted on this map represents volume change between 2010 and 2012.

Data Sources: Volumes were derived using the JALBTCX 2010 LIDAR and the JALBTCX 2012 Post-Sandy LIDAR.

Aerial Photography data source: ESRI Basemaps

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National Coastal Mapping Program

Post-Superstorm Sandy Elevation Differences and Volumes

New Jersey 04: 000248

Sheet Reference Number 1 of 1

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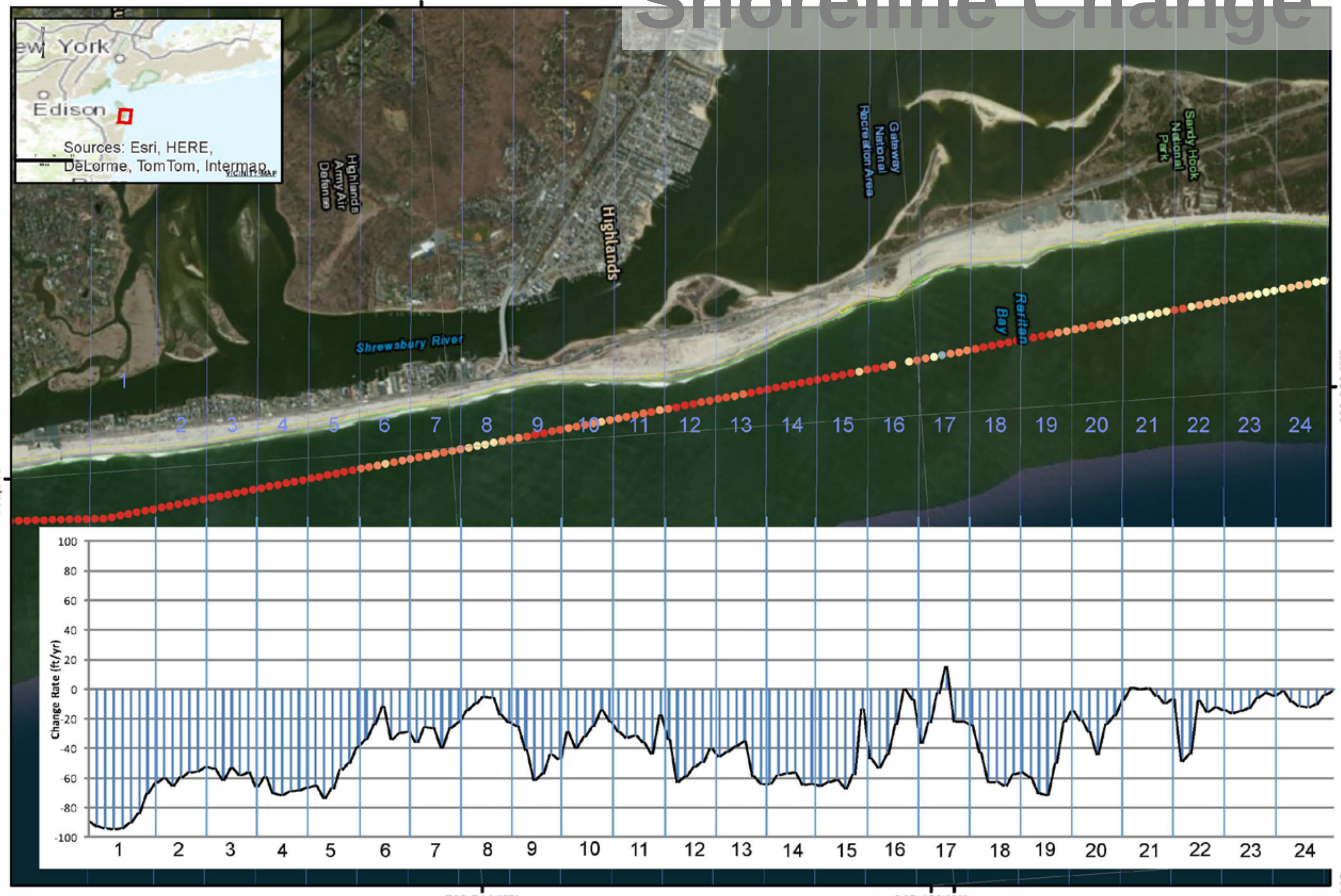
Shoreline Change Map



2010 Shoreline

2012 Shoreline

Shoreline Change Rate (ft/yr)

< -50	< -10	> 10
< -40	< -5	> 15
< -30	< 0	> 20
< -20	> 0	> 30
< -15	> 5	> 40

Miles: 0 0.5 1

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National Coastal Mapping Program
Post-Superstorm Sandy Shoreline Change
New Jersey 04: 000248

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Questions?

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