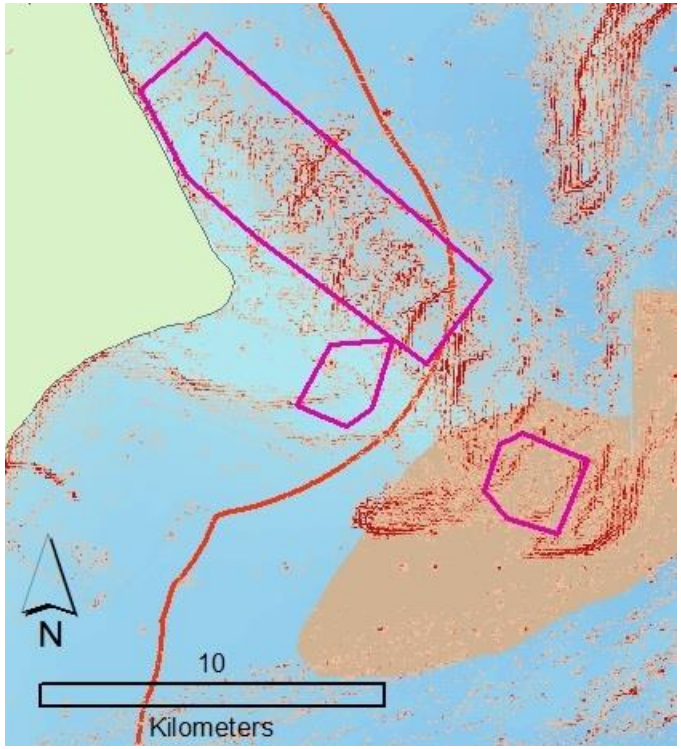
Rugosity as a Tool in Sand Reconnaissance



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Marine Minerals Branch
Sterling, VA

February, 2016
FSBPA Coastal Tech

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Agenda

- Overview of OCS sand resources
- What is rugosity?
- Preliminary evaluation of rugosity as a sand search tool

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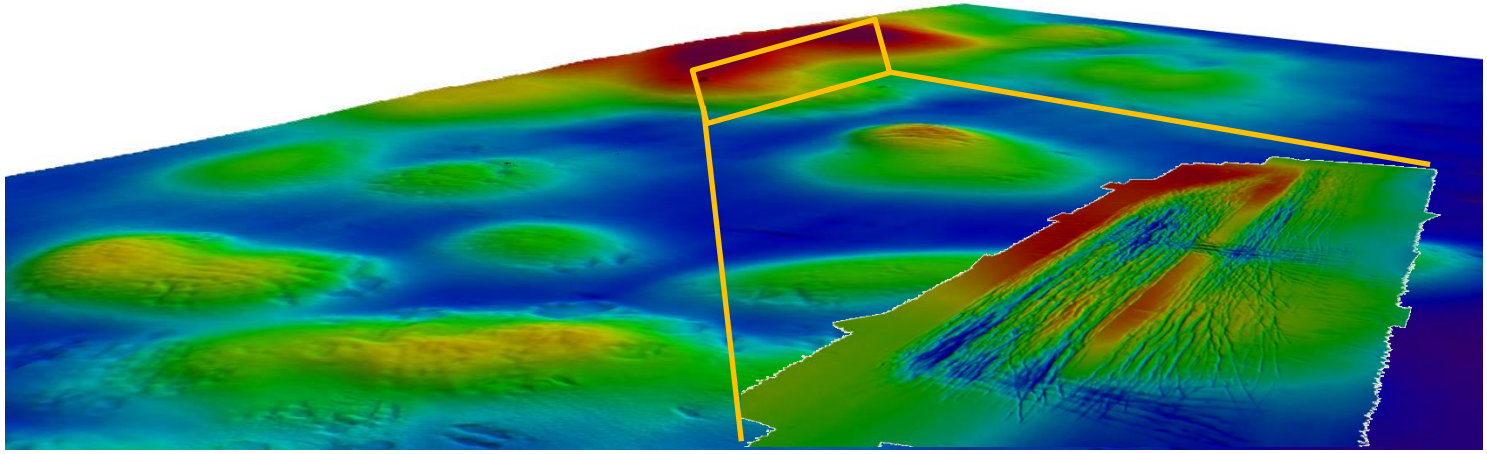
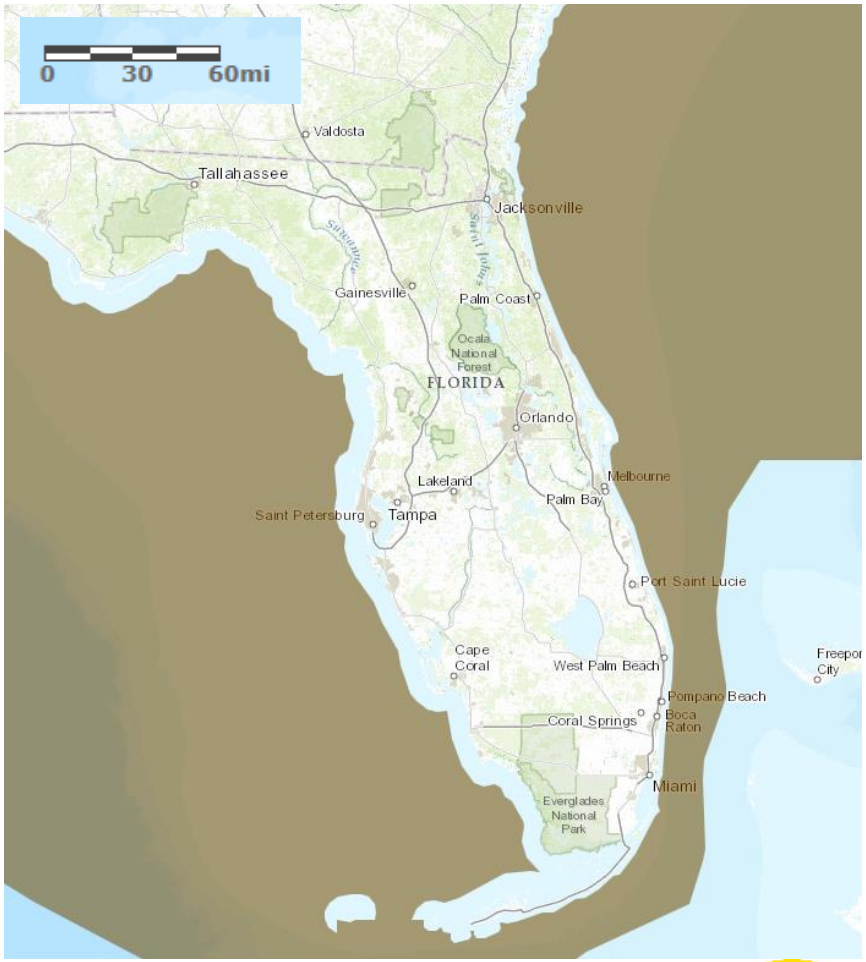
MMP and OCS Marine Minerals

- Bureau of Ocean Energy Management (BOEM)
  - authority under Outer Continental Shelf Lands Act ("OCLSA", 1953, Sec. 8(k))
- Marine Minerals Program (MMP): all non-energy minerals
- Negotiated Non-Competitive Agreement Leasing Process

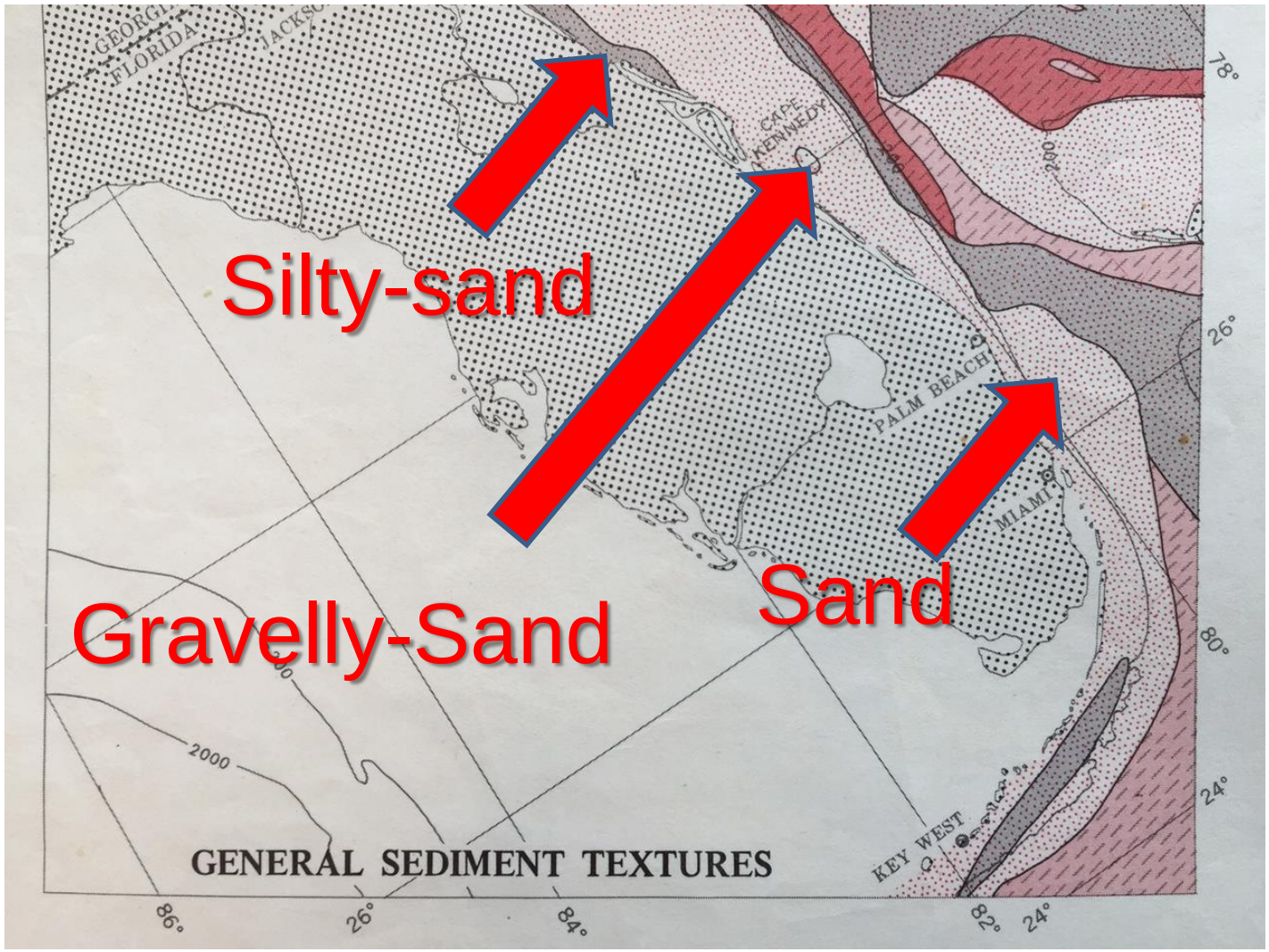


MMP and OCS Marine Minerals

- BOEM is part of the Department of Interior
- MMP is the steward of non-energy minerals, including sand and gravel, located in Federal waters
- Outer Continental Shelf:
  - 3 Nautical Miles
  - 3 Nautical Leagues (west Florida, Texas)



Sand distribution 1973



Geological Survey Professional Paper 529

1973

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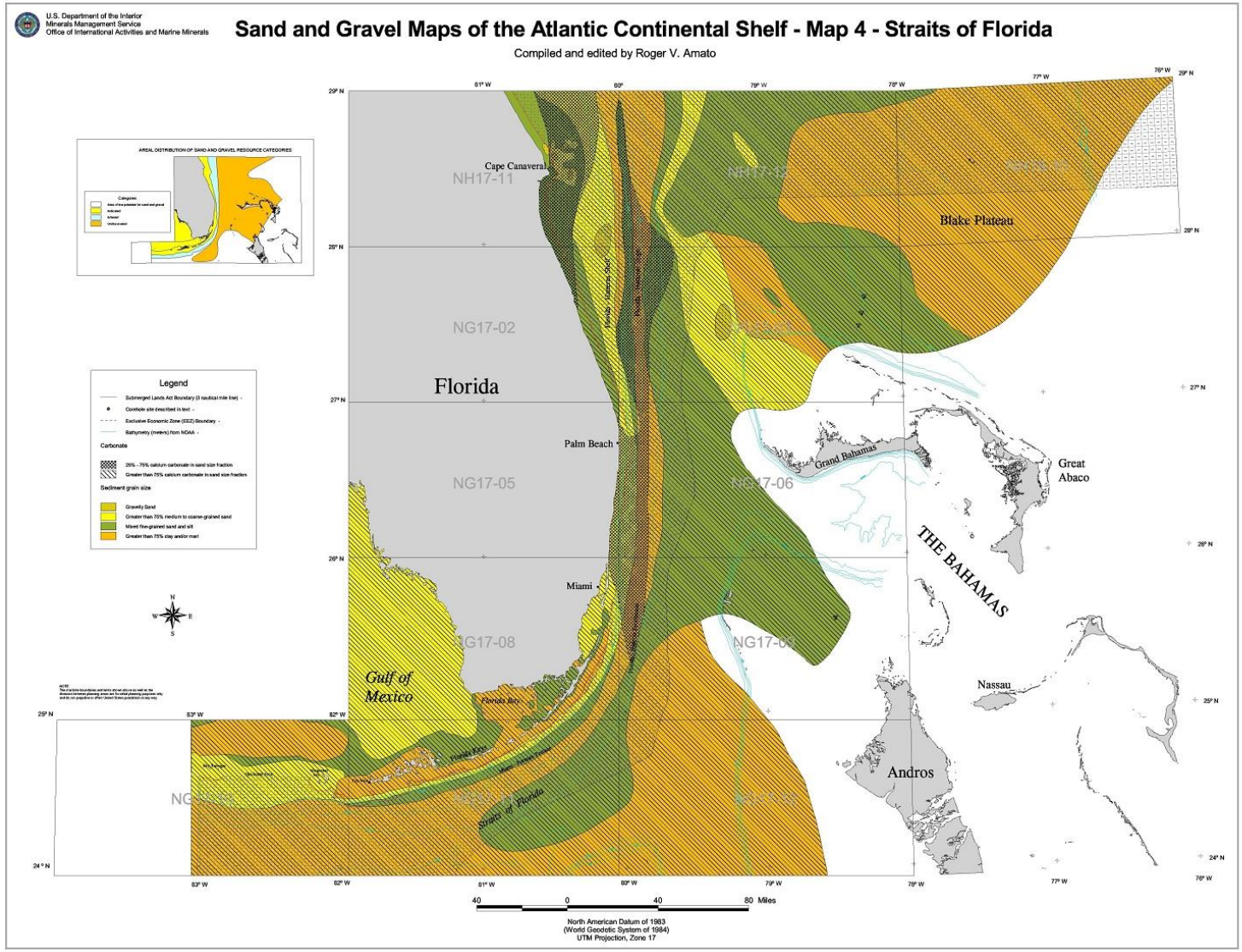
Sand distribution 1993



OCS Monograph MMS93-0037

1993

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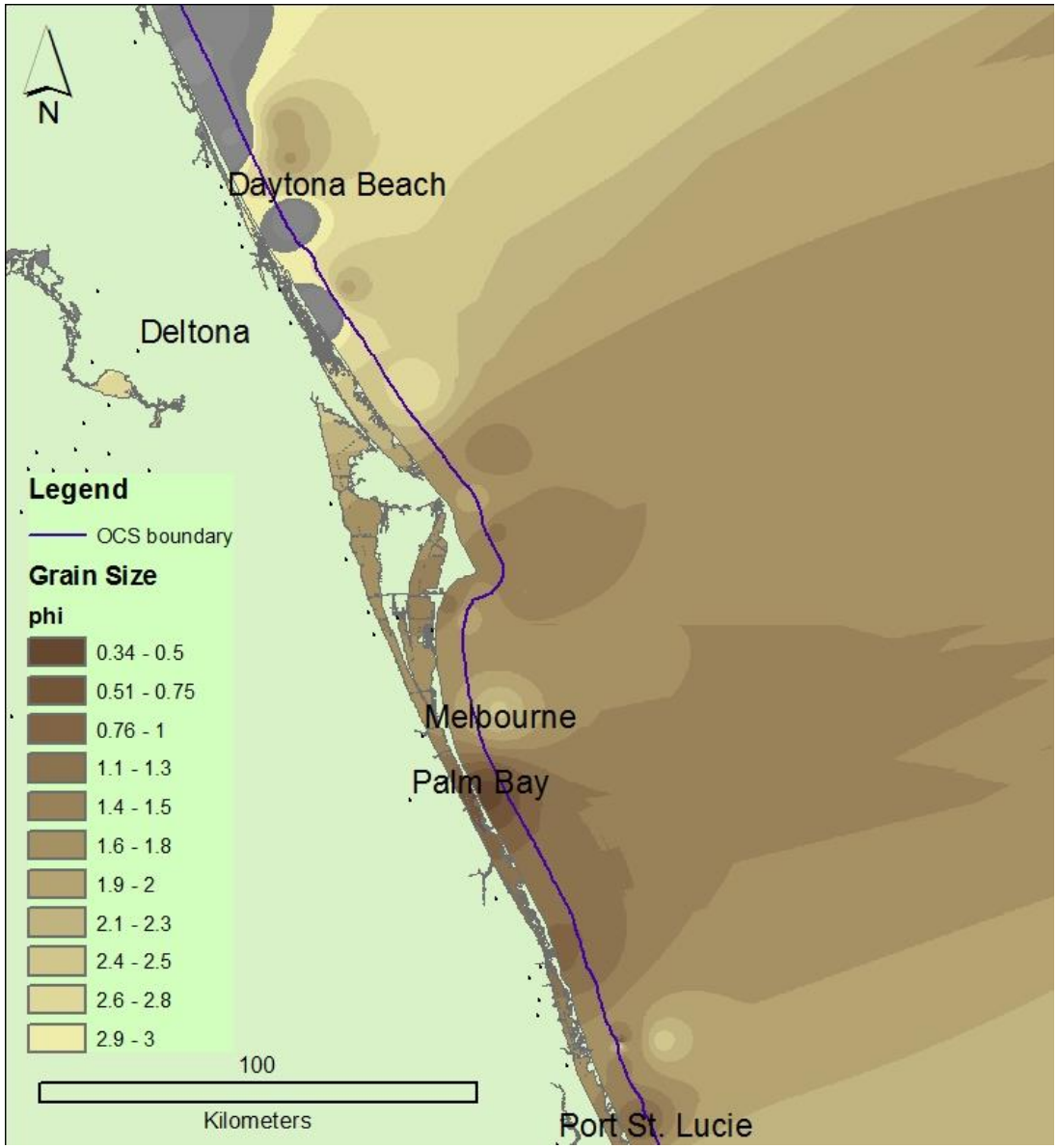
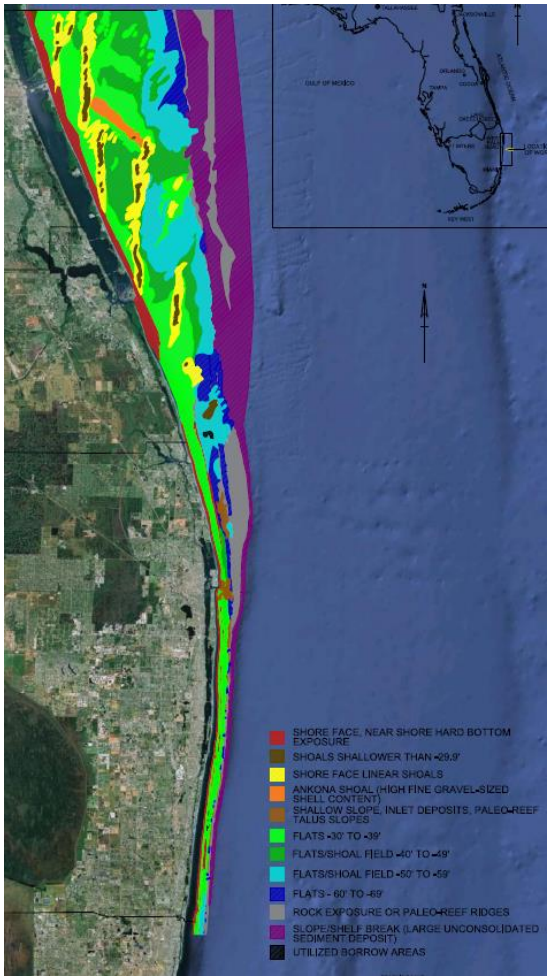
Sand distribution 2006





SAND study, USACE, 2013

Also: ROSSI

usSEABED USGS Data Series, 2006

U.S. Department of the Interior · March 3, 1849

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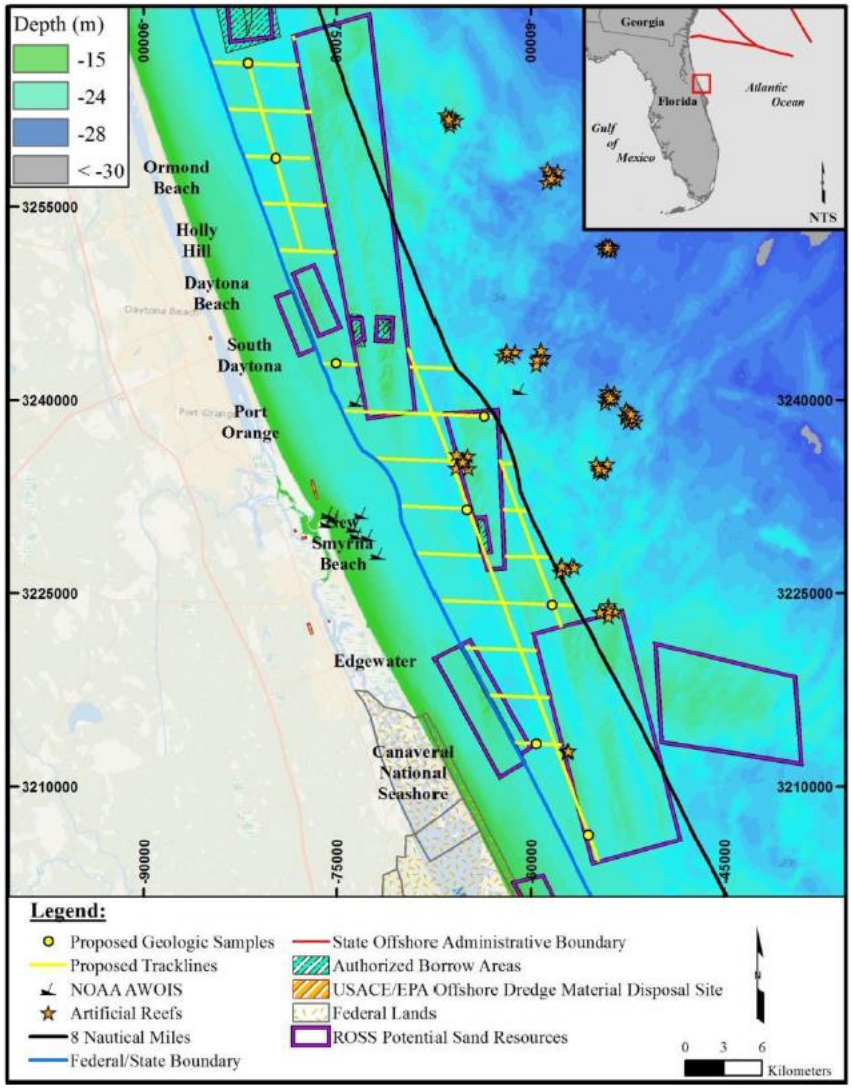
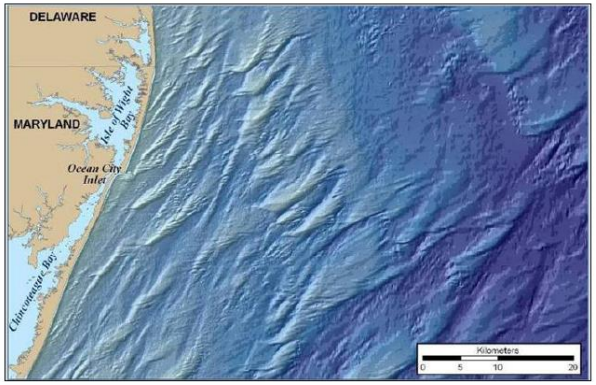
Sand Search 2016



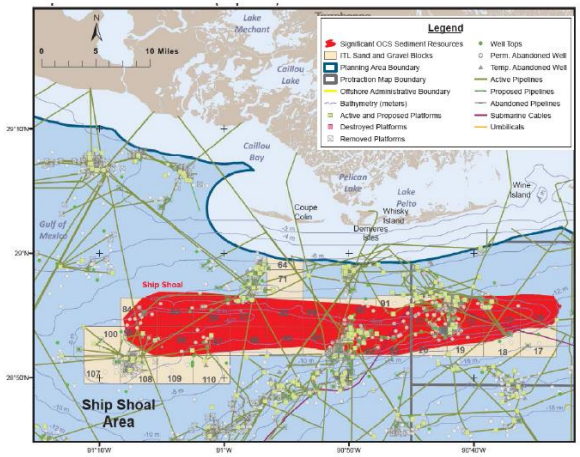
BOEM study

- Recon of Eastern seaboard for sand and gravel
- Hurricane Sandy
- Florida's allocation:
  - 30 cores
  - 505 km seismic
  - ~10% of total
- Limited resources require focused effort

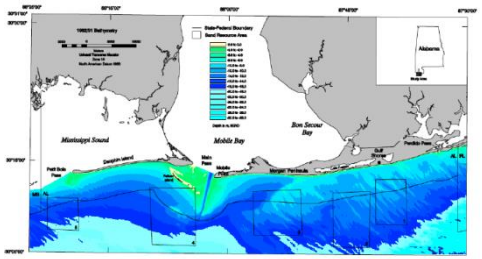
Borrow Areas

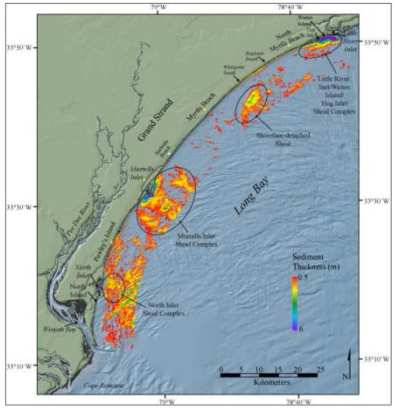


Ridge and swale



Sand shoal





BOEM study 2013-0119

- Surficial Sand
  - **Ridge and swale complex**
  - **Inner-shelf sand shoal (reworked barrier island)**
  - Ebb-tidal delta
  - Low-relief sand ridges and sheets
- Buried Sand

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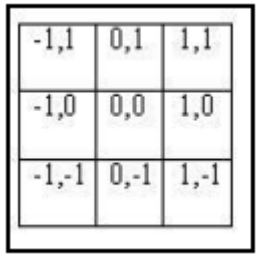
Rugosity

- Rugosity
- Roughness
- Ruggedness
- Surface-area ratio

- Measurement of terrain complexity
- Ecological habitat studies
  - Shelter
  - Living area
  - Cover and concealment
  - Current rate and direction
  - Water chemistry
  - Sediments

Calculating Rugosity

- Simple



Rugosity =

(
| z(-1,1) - z(0,0) |
+
| z(0,1) - z(0,0) |
+
| z(1,1) - z(0,0) |
+
| z(-1,0) - z(0,0) |
+
| z(1,0) - z(0,0) |
+
| z(1,-1) - z(0,0) |
+
| z(0,-1) - z(0,0) |
+
| z(1,-1) - z(0,0) |
)

/ 8

4	4	4
4	0	4
4	4	4

= (| 4 - 0 |

+ | 4 - 0 |

+ etc.) / 8

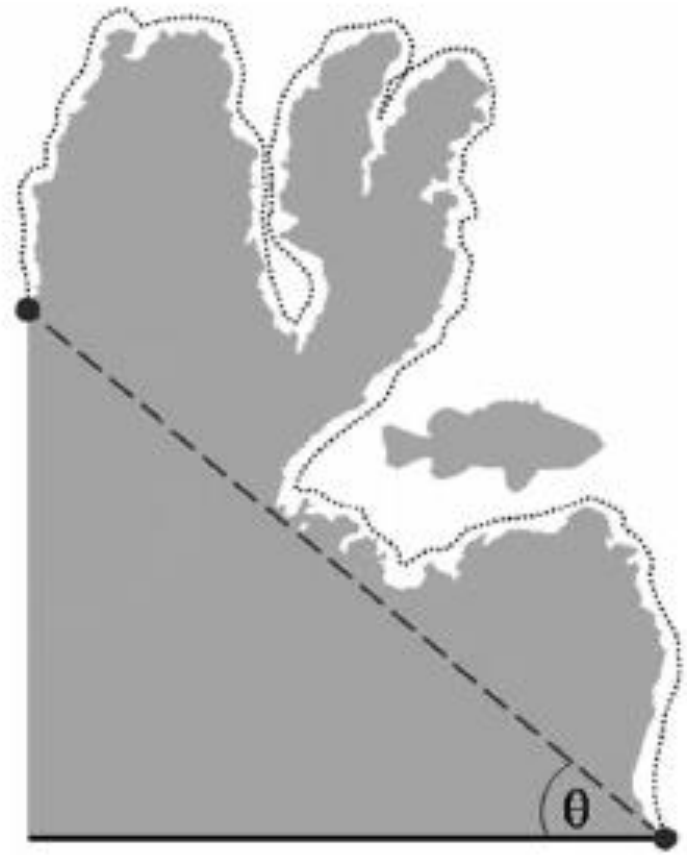
= (32 / 8)

= 0.5

Robbins et al., 2008

Calculating Rugosity

- Complex



$$\text{Rugosity} = \frac{\text{Contoured distance}}{\text{Planar distance}} \text{ or } \frac{\text{Contoured area}}{\text{Planar area}}$$

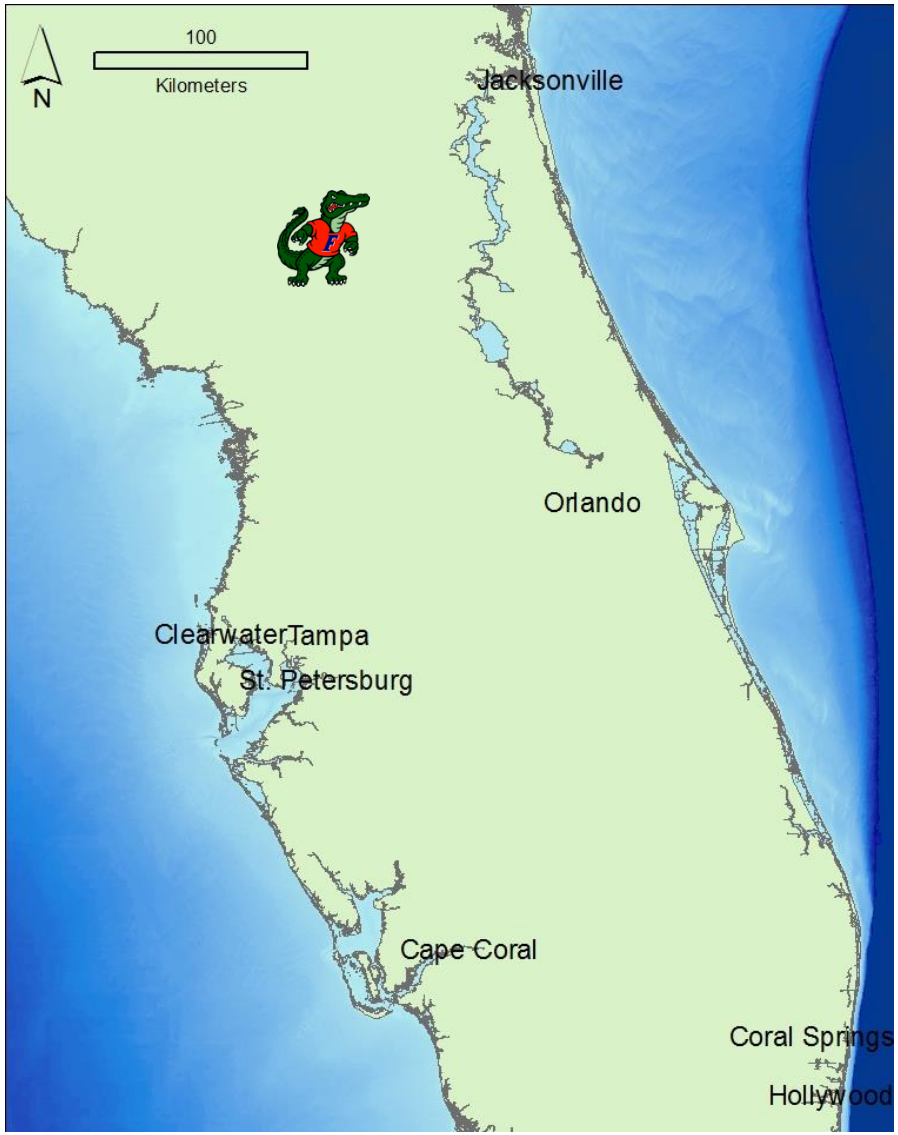
Du Preez, 2015

Calculating Rugosity

- Alternative: Terrain Ruggedness Measure

Pendleton et al., 2016

Florida Bathymetry



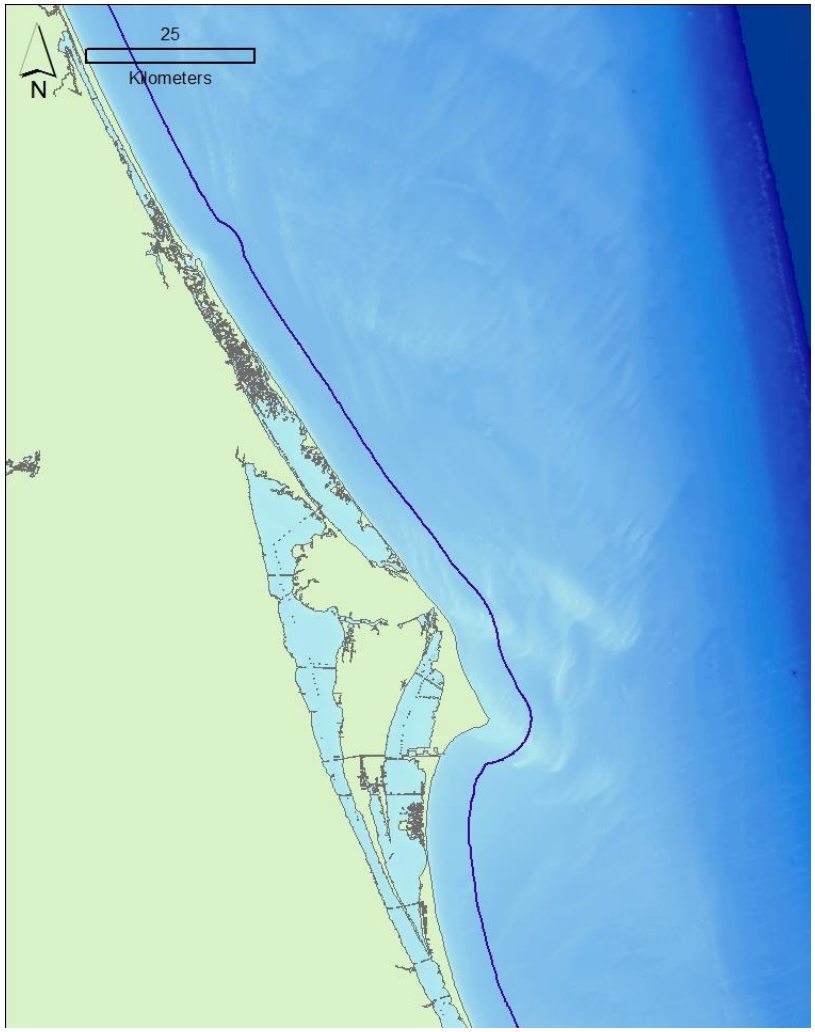
Cartographic production for the Florida Shelf Habitat (FLaSH) map study: generation of surface grids, contours, and KMZ files

USGS Open-File Report 2007-1397

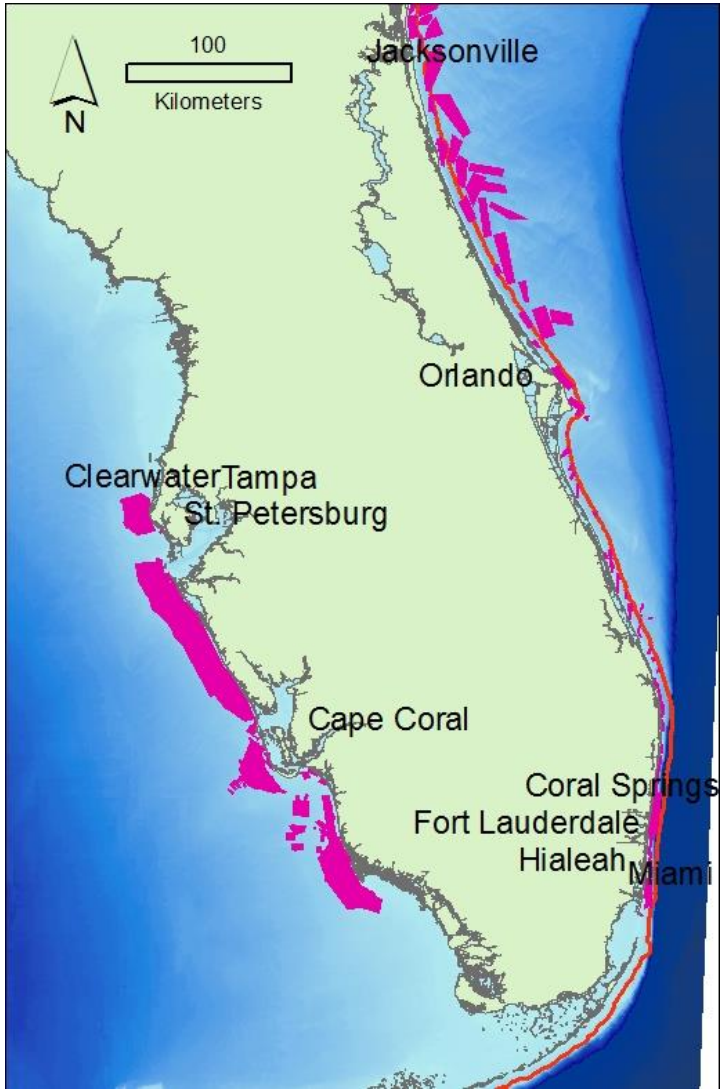
Robbins et al., 2007

50 m grid

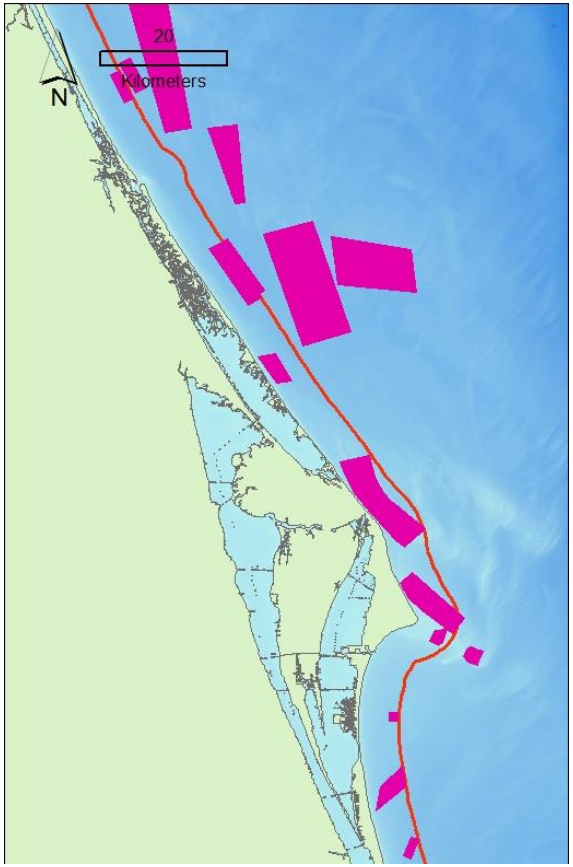
Florida Bathymetry



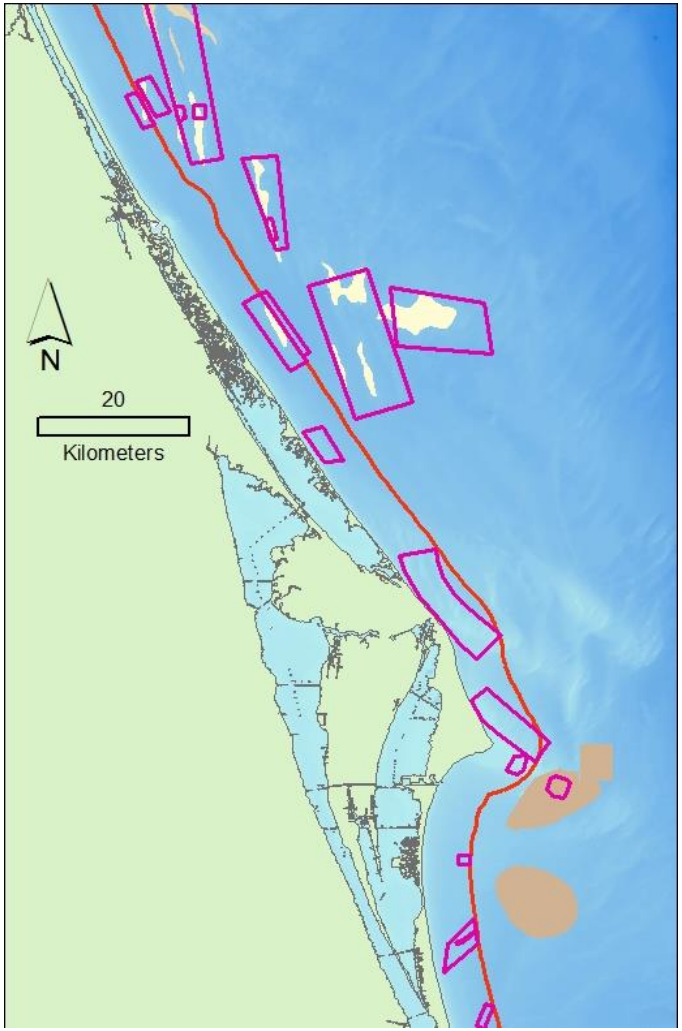
Florida Borrow Areas



Regional Offshore Sand Source Inventory (ROSSI), 2016



Florida Sand

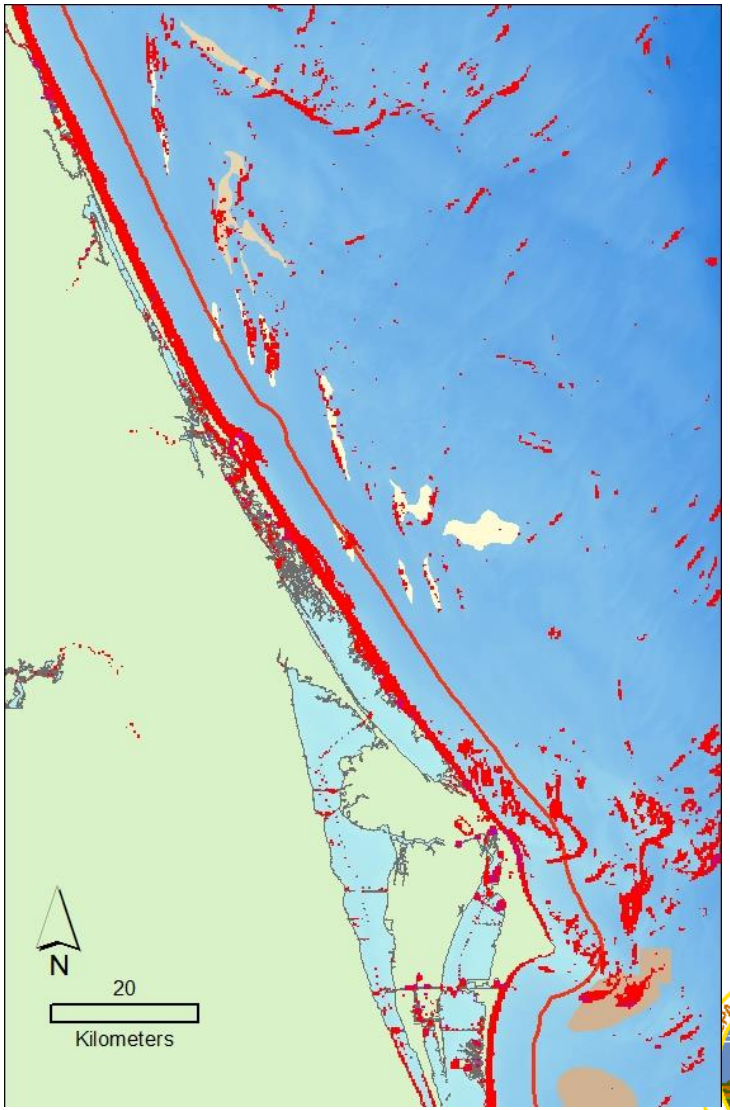


BOEM, MMPGIS, 2016

Sand Resources
Representation: SandResources_Rep
Proven
Probable
Potential
Possible
Unusable

Space Coast Detail

- Rugosity from 250 meter grid
- Red indicates high rugosity (>= 1)



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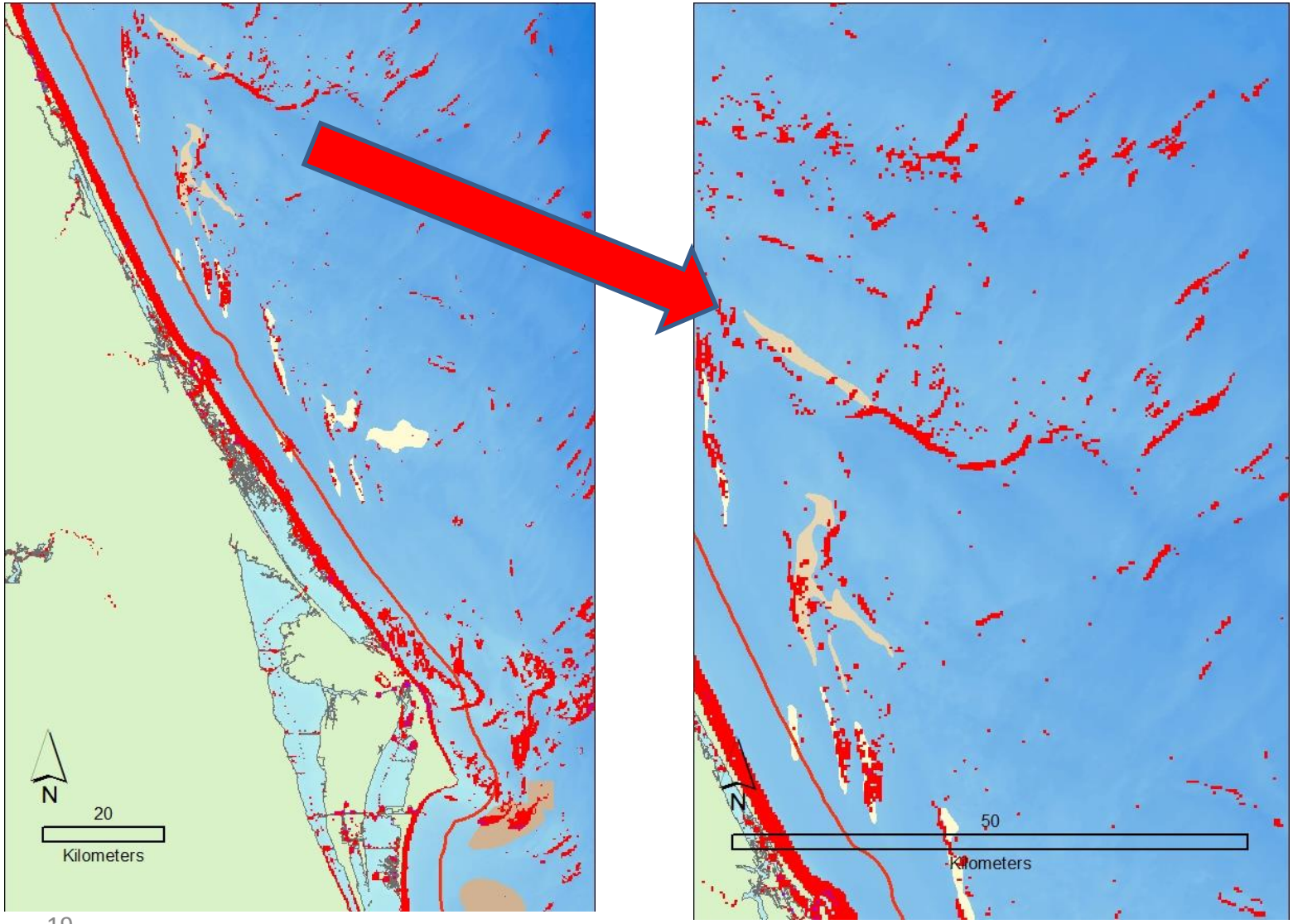
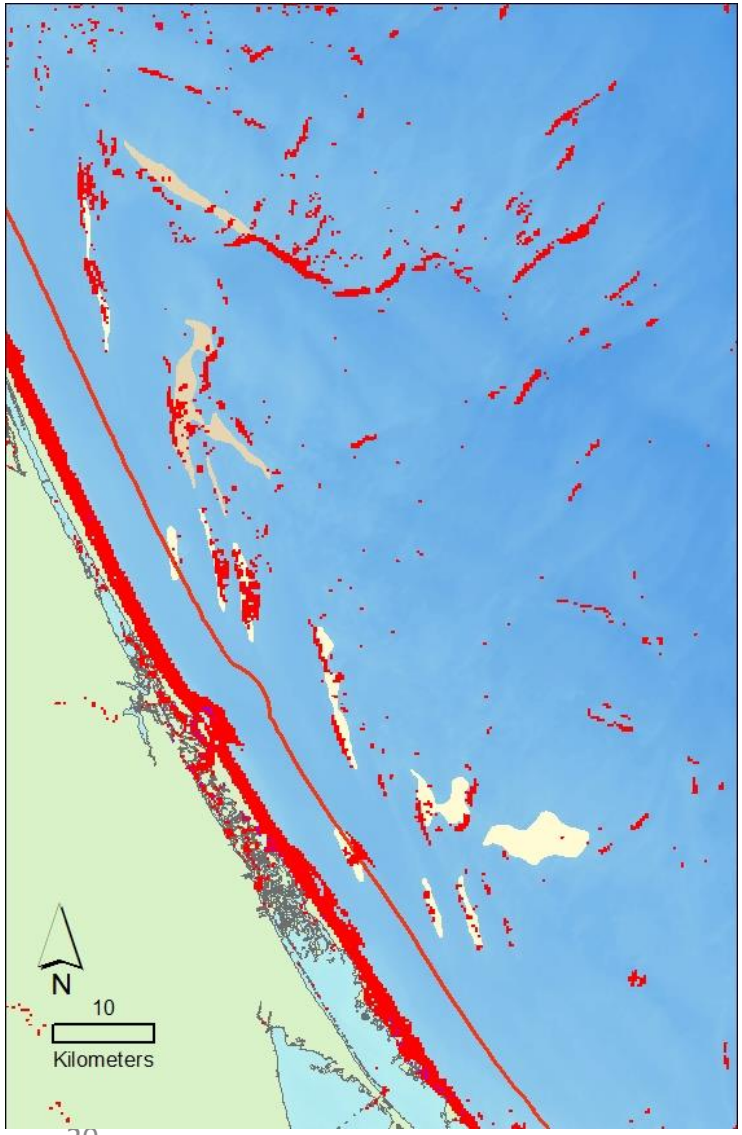
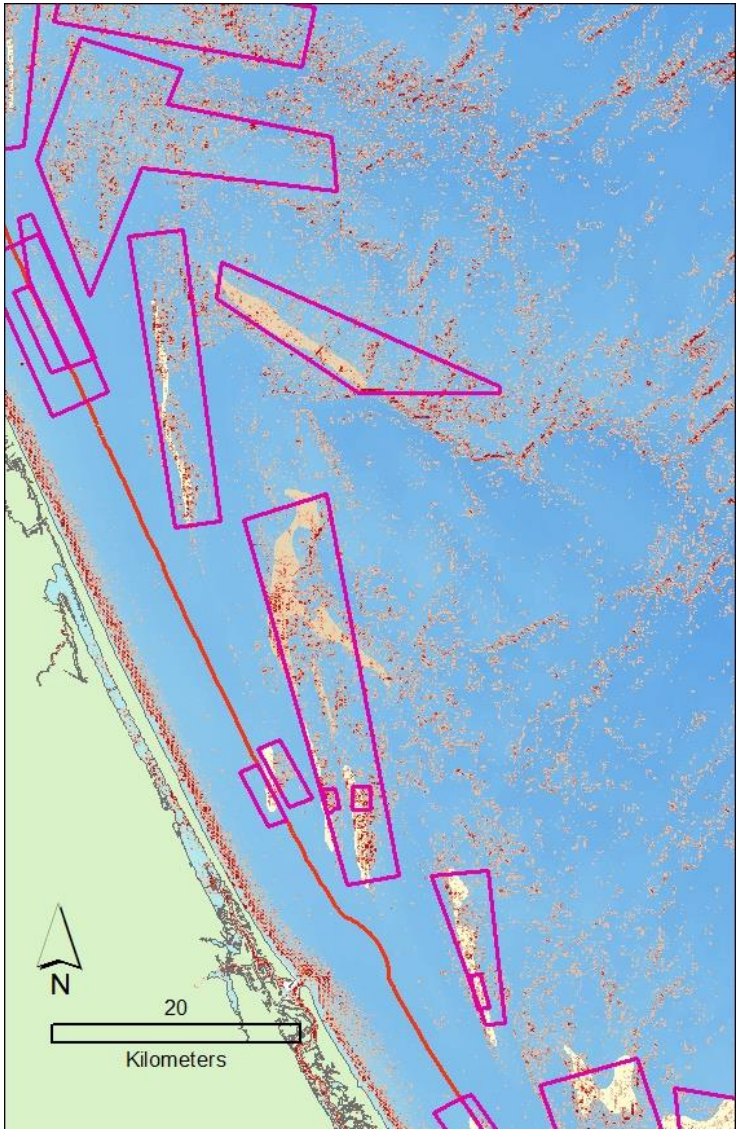
Space Coast Rugosity



Space Coast Rugosity

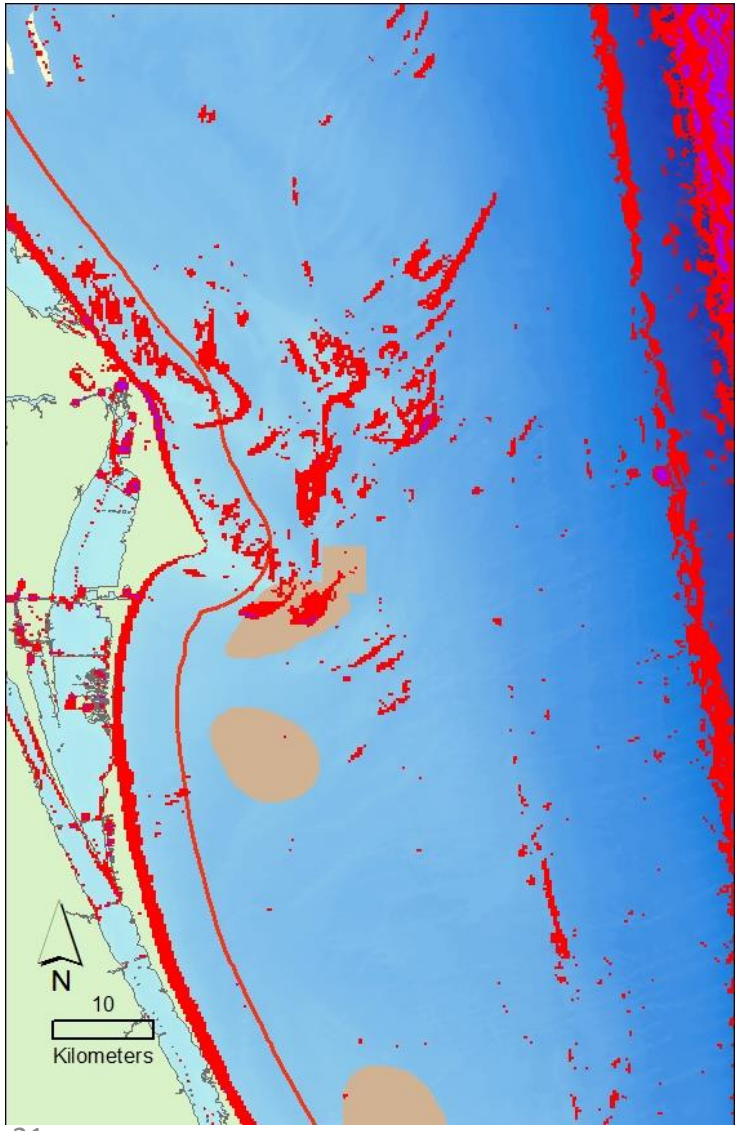


250 m

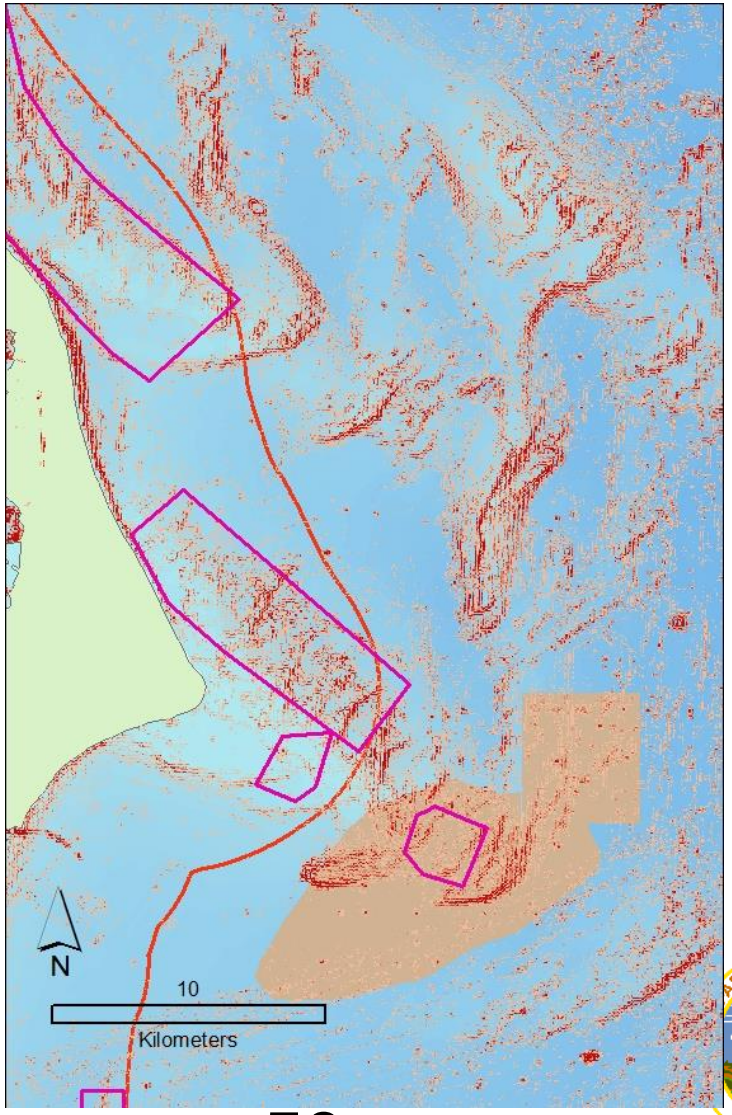


50 m

Canaveral Rugosity

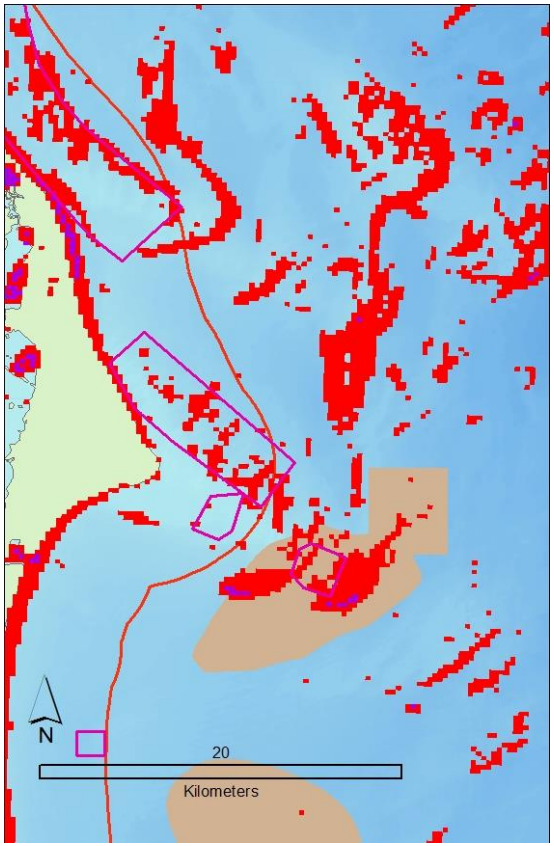


250 m

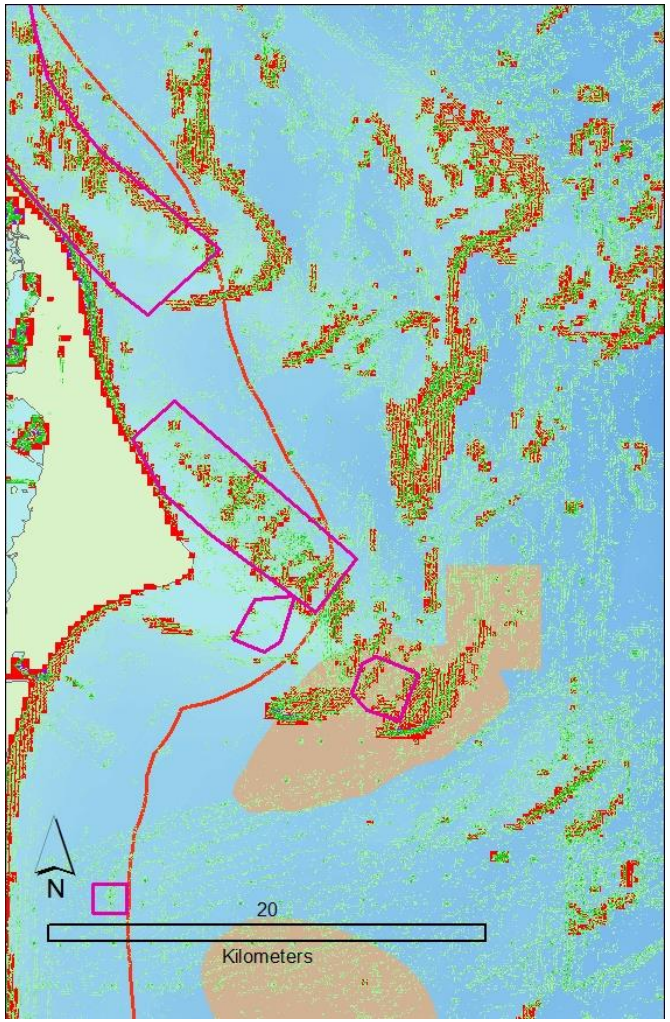


50 m

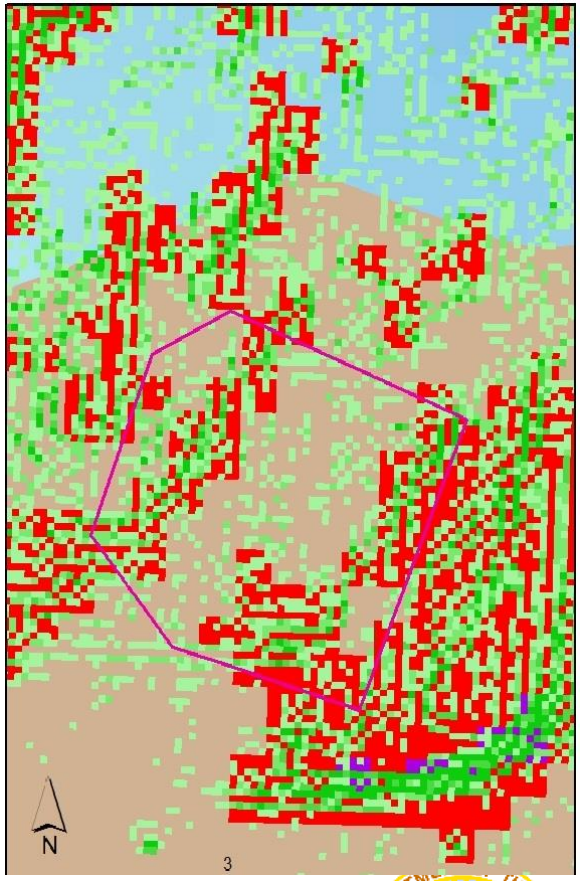
Canaveral Rugosity



Canaveral 250 m



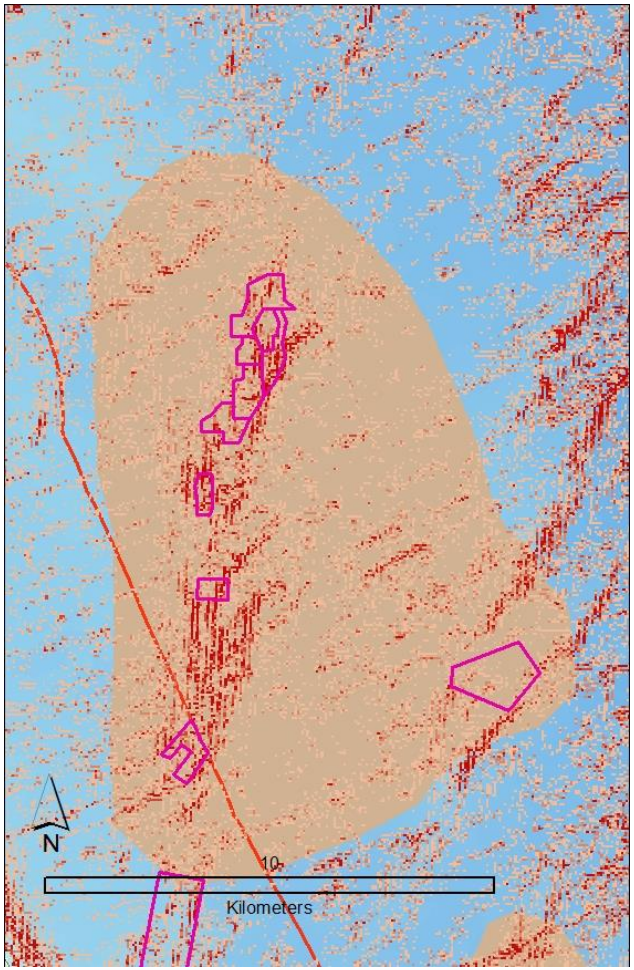
Canaveral 50 & 250 m



Zoom

Other Rugosity

vicinity Collier



vicinity Martin

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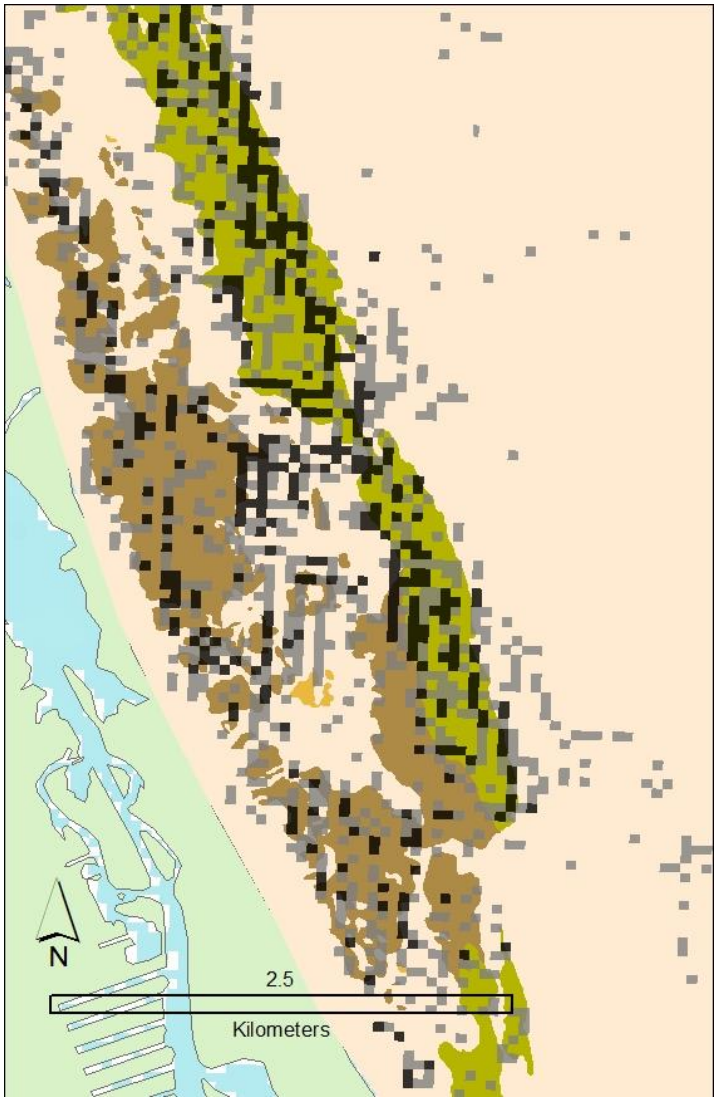
Applications, Future Efforts



- Geomorphology
- Habitat Classification
- Ecological Tracking

- Formal Statistical Relationships
- Effects of Varying Resolution

Thanks!

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