

# REMOTE SENSING OF HAZARDOUS INLET SHOALS

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COASTAL INLETS RESEARCH PROGRAM  
FY24 IN PROGRESS REVIEW



U.S. ARMY



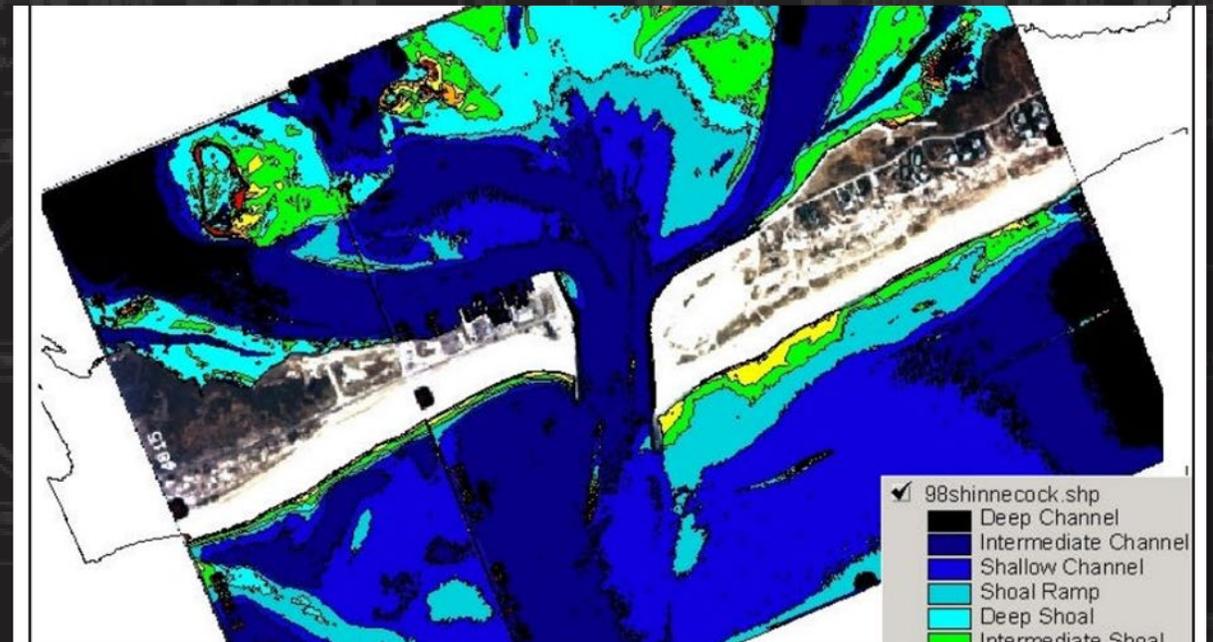
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ERDC



CIRP





# PROBLEM STATEMENT



Shoals that form across inlet navigation channels and cause natural inlet channels to migrate create hazards to navigation and complicate inlet operations and maintenance. At many of the over 150 USACE managed inlets, these shoals reappear immediately after dredging and greatly increase the costs of dredging. We lack the necessary datasets to predict the formation of these shoals because district hydrographic data is concentrated on the navigation channel and USACE lidar bathymetry is collected only every five years.

## **Statement of Need:**

SON 1923: Hazardous Inlet Shoals: Improving Prediction and O&M Strategies

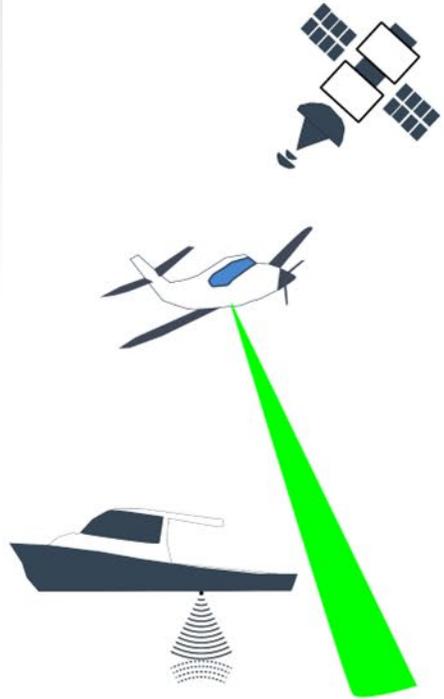
SON 2159: Shoal Migration and Formation: Technology for Near Real-Time Monitoring and Predictions

**FY24 was Year 1 of 3.**

Completed literature review, tested potential methods, and engaged PDT composed of ERDC and District experts



# CAPABILITY AND STRATEGIC IMPACT



Supplement traditional surveys (hydrographic, lidar) by filling temporal and/or spatial gaps with analysis of satellite imagery

Improve understanding of shoal migration and transport dynamics to enhance sediment budgeting and inlet management



Decrease operational costs and maximize return on investment while increasing mariner safety

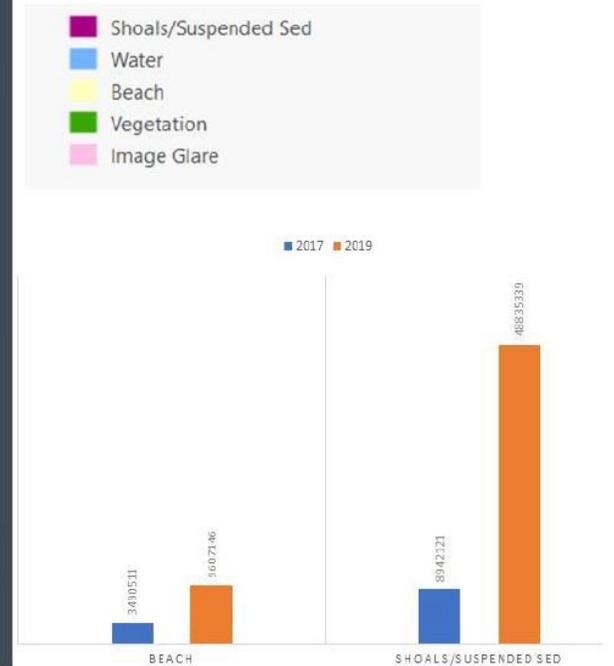
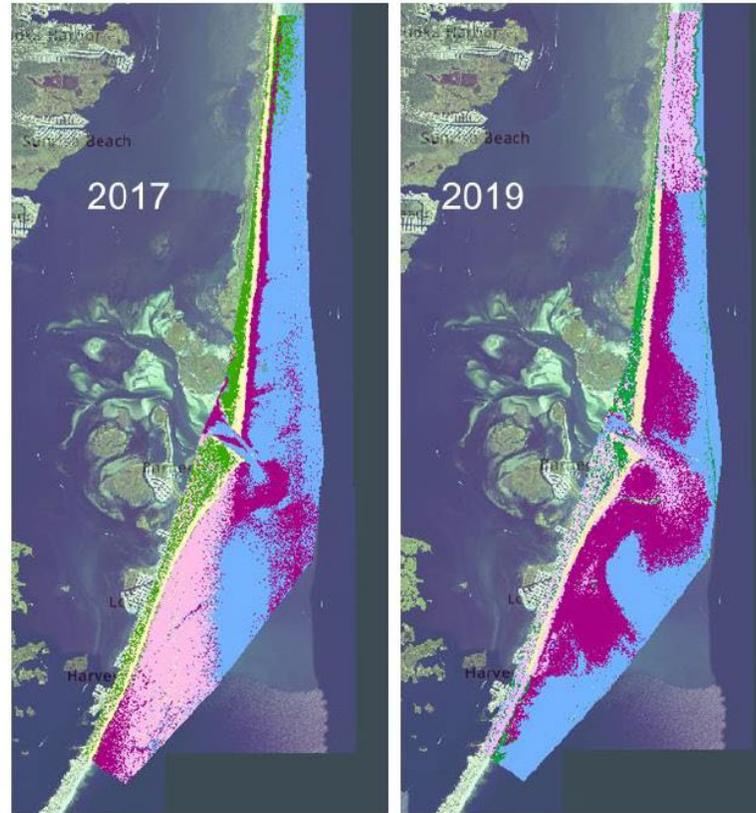


# MOTIVATION



## Barnegat Inlet Reimbursable Study

- Identified data coverage gap
  - Footprint of hydrographic surveys are limited
  - National Coastal Mapping Program lidar and imagery = 5-year cycle
  - “Missing middle”
- Is satellite/aerial image classification a viable solution?





# MOTIVATION, CONT.

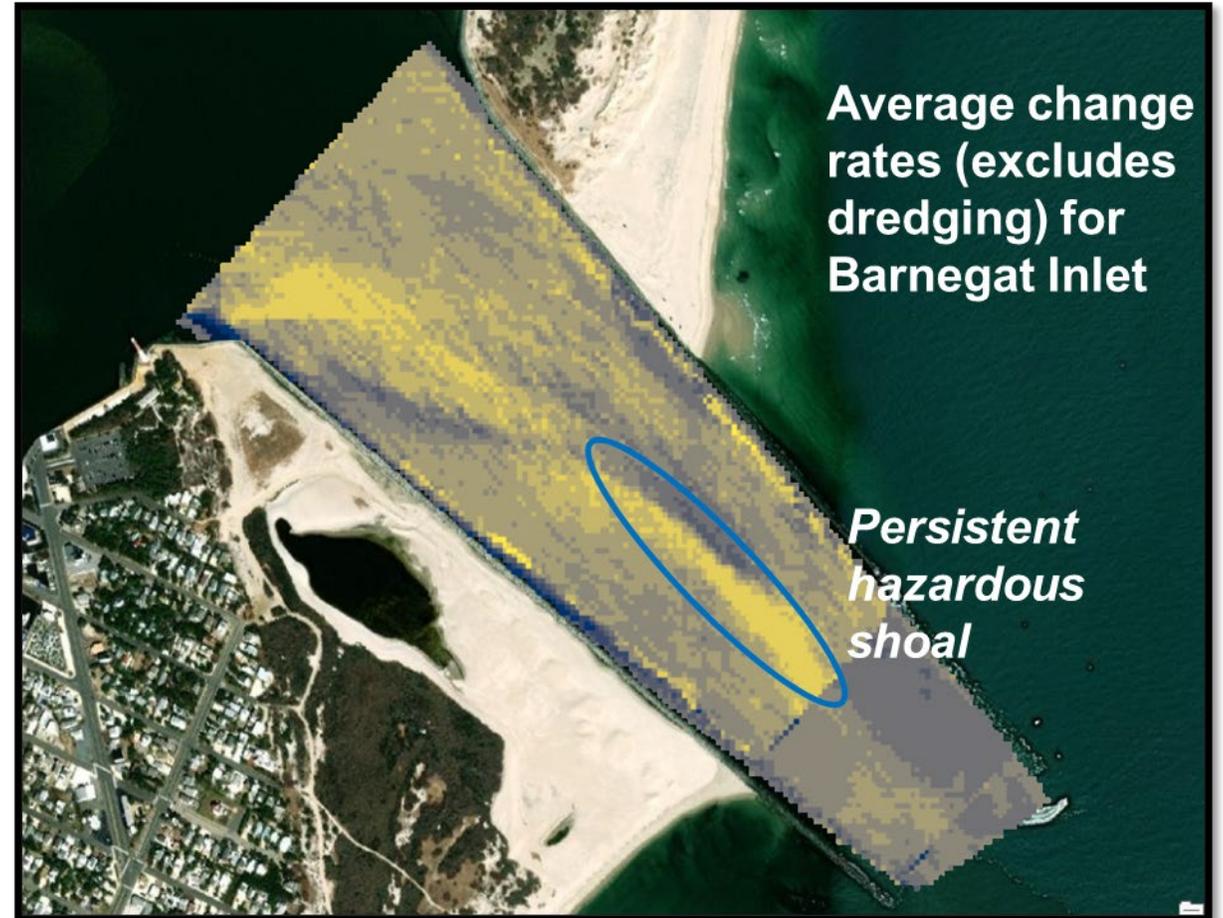


## SON 1923 (Chasten)

- Inlet shoals pose hazards to navigation
- Understand/predict temporal changes
- New tools to monitor shoals

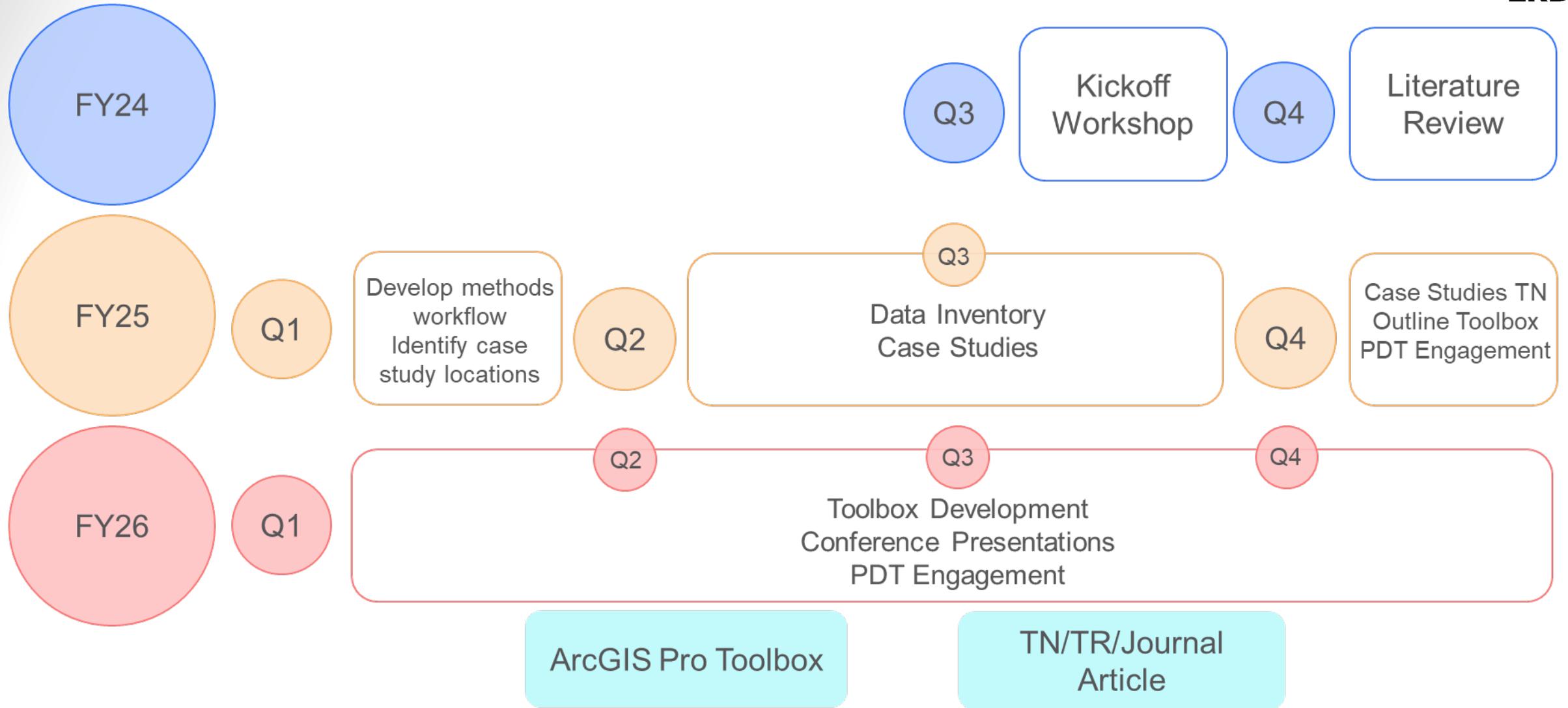
## SON 2159 (Malburg)

- Great Lakes channels
- Remote sensing and local tools
- Near real-time estimates of shoal formation and migration





# PROJECT ROADMAP





# PDT ENGAGEMENT

Districts:  
 Monica Chasten (NAP)  
 Elizabeth Godsey (SAM)  
 Rachel Malburg (LRE)

ERDC:  
 Kate Brodie,  
 Annika O’Dea, Ian Conery,  
 Shannon Brown, Sean  
 McGill, Charlene Sylvester,  
 Molly Reif



**Question 1**

What are the biggest pain points you see with current approaches to tracking inlet shoals? For District folks (and ERDC folks working with districts), what needs do you see related to shoal detection (time and spatial scales)?

timeliness & cost of physical vessel surveys  
 Predictability of problematic shoals for O&M Contracting

Turbidity (imagery), shallow water restrictions on vessel surveys  
 Temporal resolution of available data

**Question 4**

Are there specific ERDC reports or literature that you’re familiar with that you’d like us to include in the literature review?

From sediment budget perspective:  
 The transport into/bypassing around inlets on the open coast can sometimes be difficult to quantify past a conceptual level. Additionally, specifically with NL, the most recent budget (2006) makes note that the inlet related transport is highly uncertain, especially between back bays and inlets, hopefully this work can help...

From the tool transfer perspective  
 If the tool isn’t a simple one click i interest is going to drop. If the tool is complicated and requires lots of v time, the interest is going to conti

Gather all M&I project lit review and technology product publications s from CHL colleagues.

How to identify what decision makers are relying on in order to cost out future dredging needs? DM&I’s are based on historical needs, some O&M managers understand those trends and the uncertainty involved with storms and adjacent sediment management projects. Need to include manager positions to reflect the product outcome.

**Question 2**

What are helpful lessons learned from past or ongoing district or ERDC projects? (RIOS, shoreline mapper, sat bathy, CSAT, sediment budgets) Specifically, did you encounter technical challenges? Limitations? User engagement?

desktop tools vs web capabilities have great cost difference. Desktop is this project’s goals, but its less user-friendly for tech transfer

using existing datasets and tools to enhance this product line

Lack of robust ground truth. Challenges generating interest and engagement from districts

**Question 7**

What limitations do you foresee with image-based methods for shoal tracking? What advice do you have on how we should communicate those limitations and compare the limits of this method to the menu of other methods available?

Target solving one specific District decision point product that they need to begin an action (survey, USCG channel move, dredge contract)

temporal frequency

Whiteboarding during virtual workshop  
 One-on-one and small group meetings





# LITERATURE REVIEW



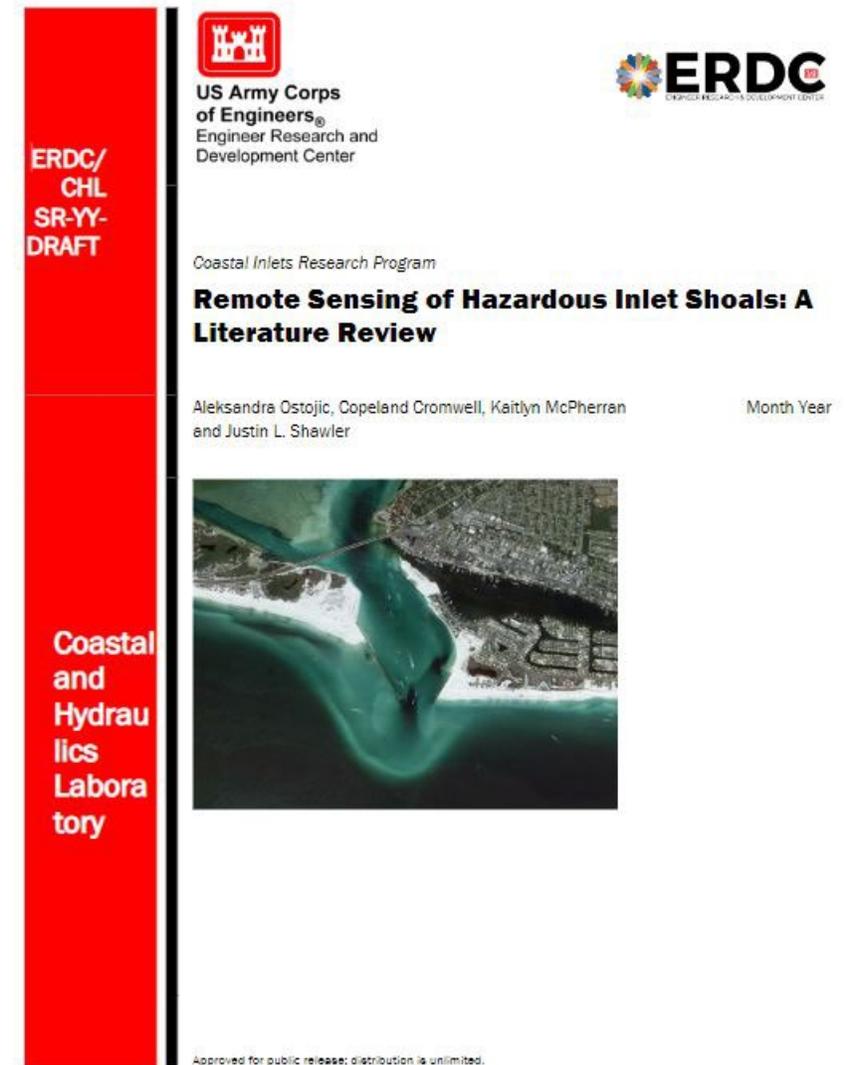
60+ peer review articles, conference proceedings, reports, and theses/dissertations

## Non-Satellite Based Tools for Inlet Shoal Monitoring

- Hydrographic Surveys
- Airborne Bathymetric Lidar
- Radar Inlet Observing System
- Imagery & Video (fixed camera, UAS, aerial)

## Satellite Approaches

- Satellite Derived Bathymetry
- ***Image Classification of Inlets & Similar Environments***
  - ***\*\*Workflow will rely on these methods\*\****



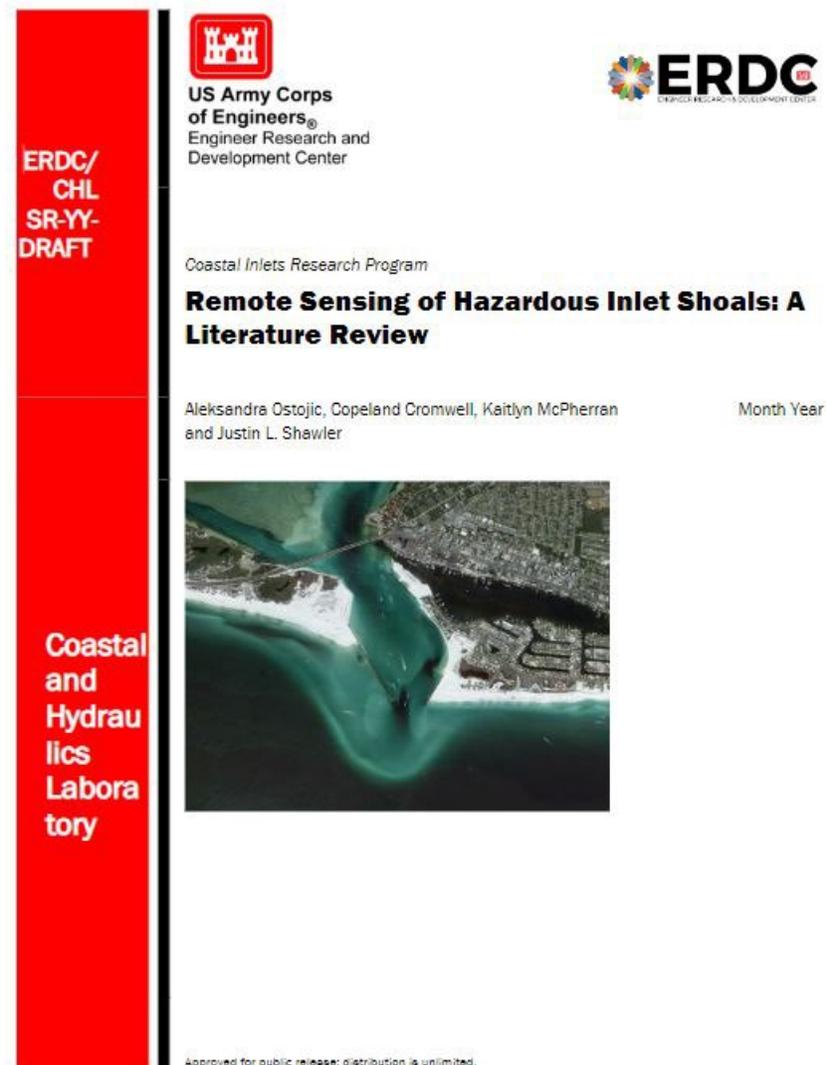


# LITERATURE REVIEW, CONT.



## Key Takeaways

- Reliability of remotely inferred bathymetry:
  - Qualitative/features are generally good
  - Relative bathymetry and/or feature tracking common
- Wave celerity-based approaches generally difficult due to complexity of inlet hydrodynamics
- Shoal migration rates of 100 – 1000 m/yr



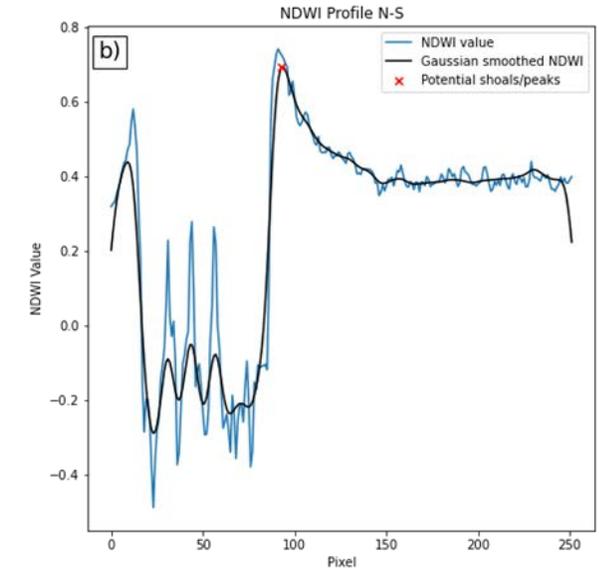
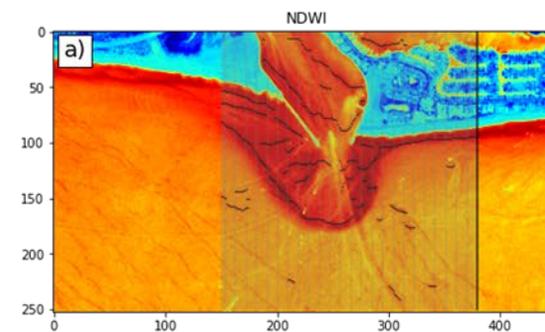
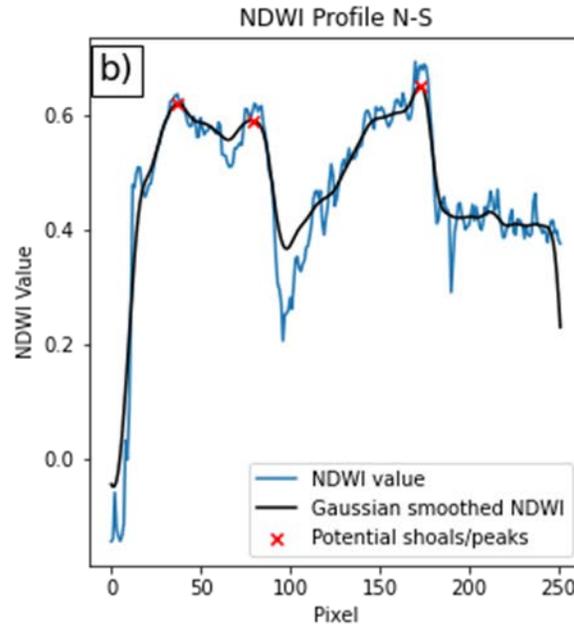
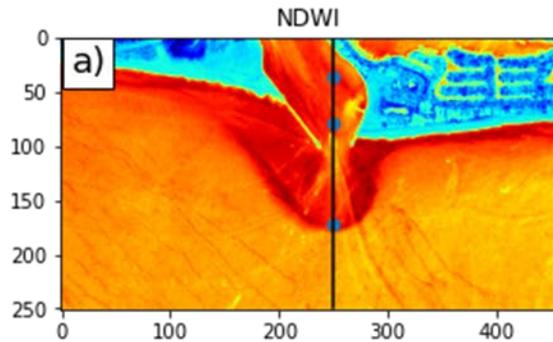
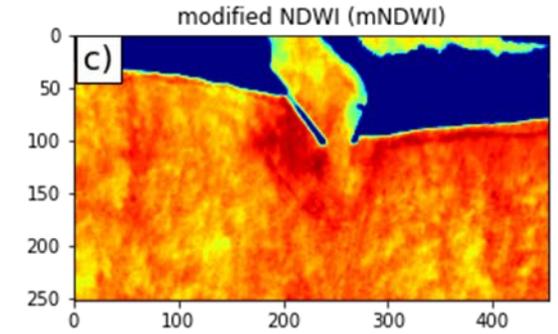
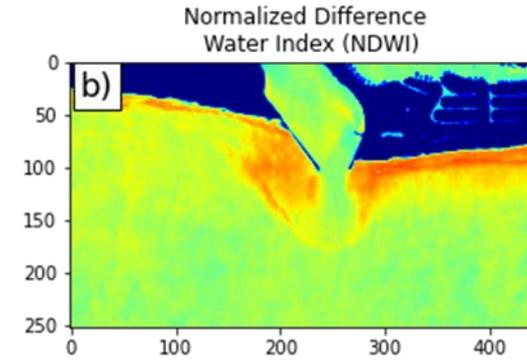
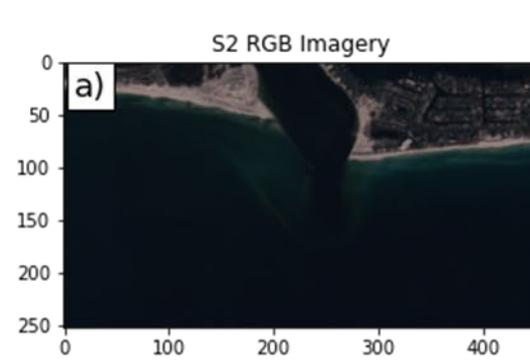


# METHODS DEVELOPMENT



East Pass Inlet, Destin, FL

$$NDWI = \frac{Green - NIR}{Green + NIR}$$





# SUMMARY

## FY24 Major Advancements in Capability

- Literature review draft with team for final internal review
- Tested image analysis and classification methods (Normalized Difference Water Index)

## FY24 Major Products & Collaborations

- District and ERDC PDT Workshop
- Literature review (EPAS submission expected FY25 Q1)

## FY25 Products & Advancements

- **Develop methods workflow – share with program manager**
- Identify case study locations
- Data Inventory – geodatabase
- Case Studies
- **Case Studies Technical Note**
- Outline Toolbox – share with program manager
- **Mid-Project PDT Engagement**