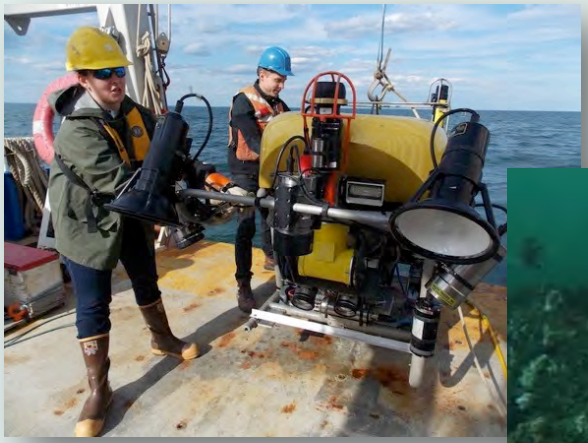
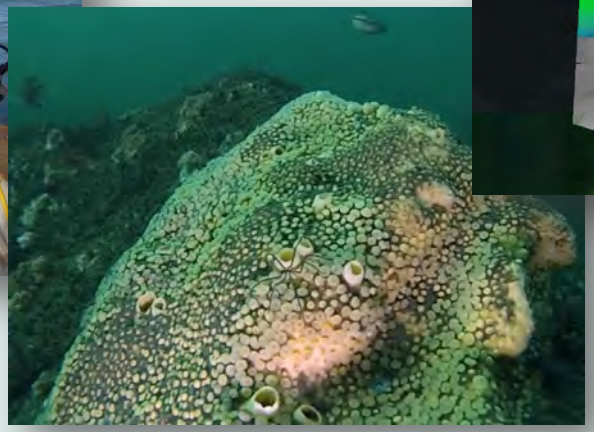
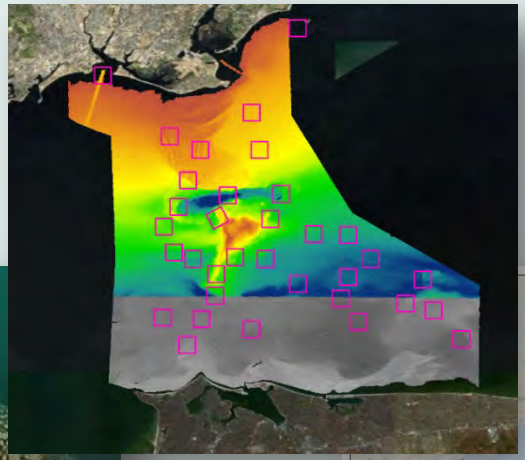
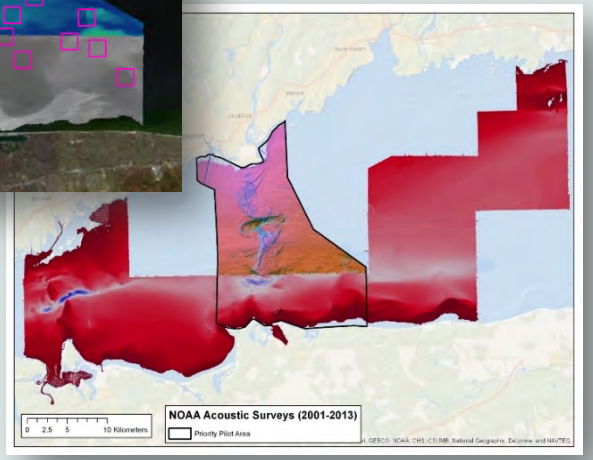








LIS Seafloor Habitat Mapping Initiative Update

DeAva K. Lambert, LISCF Project Manager
Technical/Coastal Resources
Land & Water Resources Division
CT Dept. Energy & Environmental Protection
Long Island Sound Research Conference
May 18, 2022

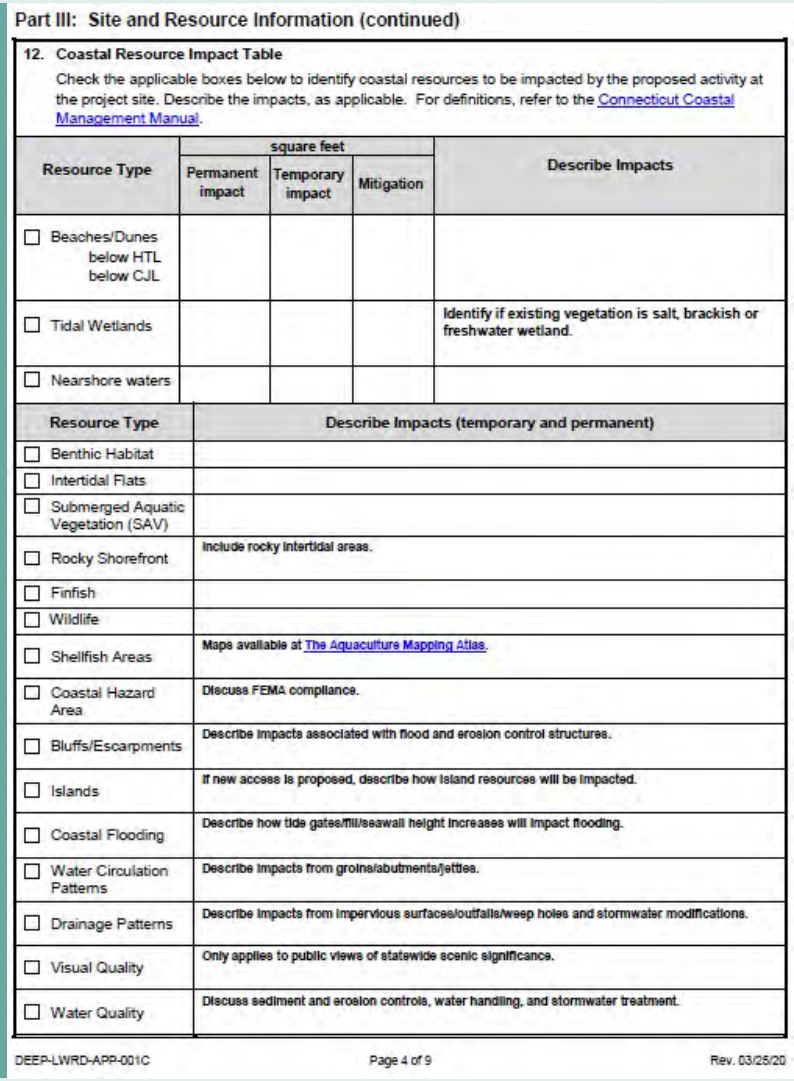
Connecticut Department of Energy and Environmental Protection

DEEP Coastal Management Program

- Operating Principle:
  - Balance human needs/uses with protection, preservation & restoration of the natural functions & benefits of coastal environments.

Coastal Management - Context

- Resource Managers need relevant, complete, and accurate information to enable the best possible decision-making.
- Without it, decisions are prone to:
  - Have unintended impacts to resources, communities, and users;
  - Necessitate mitigation and potential litigation.



Part III: Site and Resource Information (continued)

12. Coastal Resource Impact Table

Check the applicable boxes below to identify coastal resources to be impacted by the proposed activity at the project site. Describe the impacts, as applicable. For definitions, refer to the Connecticut Coastal Management Manual.

Resource Type	square feet: Permanent impact	square feet: Temporary impact	square feet: Mitigation	Describe Impacts
☐ Beaches/Dunes below HTL below CJL				
☐ Tidal Wetlands				Identify if existing vegetation is salt, brackish or freshwater wetland.
☐ Nearshore waters				

Resource Type	Describe Impacts (temporary and permanent)
☐ Benthic Habitat	
☐ Intertidal Flats	
☐ Submerged Aquatic Vegetation (SAV)	
☐ Rocky Shorefront	Include rocky intertidal areas.
☐ Finfish	
☐ Wildlife	
☐ Shellfish Areas	Maps available at The Aquaculture Mapping Atlas.
☐ Coastal Hazard Area	Discuss FEMA compliance.
☐ Bluffs/Escarpments	Describe impacts associated with flood and erosion control structures.
☐ Islands	If new access is proposed, describe how island resources will be impacted.
☐ Coastal Flooding	Describe how tide gates/fill/seawall height increases will impact flooding.
☐ Water Circulation Patterns	Describe impacts from groins/abutments/jetties.
☐ Drainage Patterns	Describe impacts from impervious surfaces/outfalls/weep holes and stormwater modifications.
☐ Visual Quality	Only applies to public views of statewide scenic significance.
☐ Water Quality	Discuss sediment and erosion controls, water handling, and stormwater treatment.

DEEP-LWRD-APP-001C Page 4 of 9 Rev. 03/25/20

Establishment of the LIS Cable Fund

- June, 2004 Settlement Agreement between CT & NY with the three utility companies created a $6M fund for research/restoration projects in LIS.
- The fund is managed by a bi-state, multi-agency Steering Committee:
  - **Led by CTDEEP, NYDEC, EPA LISS, CT & NY SeaGrants, NYDOS**
  - **Priority Goal: *provide data products for resource management & infrastructure siting in LIS***

Collaborative Partners Identified (2010)

Long Island Sound Mapping and Research Collaborative (LISMaRC)

UCONN
UNIVERSITY OF CONNECTICUT

UNIVERSITY OF NEW HAVEN

UNIVERSITY OF RHODE ISLAND HOPE 1892

USGS
science for a changing world

NOAA Ocean Service Collaborative
NOAA OCS
National Centers for Coastal Ocean Science NCCOS

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Office of Coast Survey OCS

Lamont - Doherty Earth Observatory Collaborative
LDEO

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

STONY BROOK
STATE UNIVERSITY OF NEW YORK

QUEENS COLLEGE

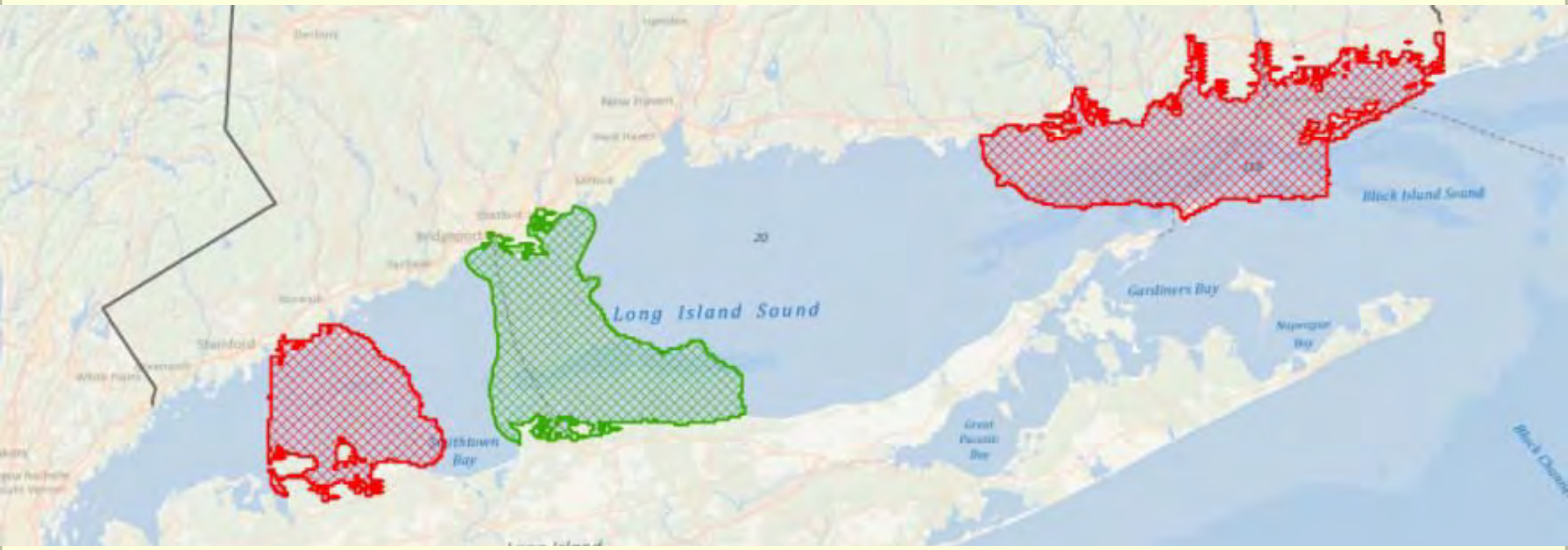
WESLEYAN UNIVERSITY

Identifying Mapping Target Areas

- Planning approach developed in 2011 to maximize available funding.
- PGIS support tool devised to promote the interaction and engagement of stakeholders.
- Spatial information used to address decision-making processes about specific landscapes to identify priority mapping areas.

Identifying Mapping Target Areas

Highest Priority Areas for Benthic Mapping in LIS

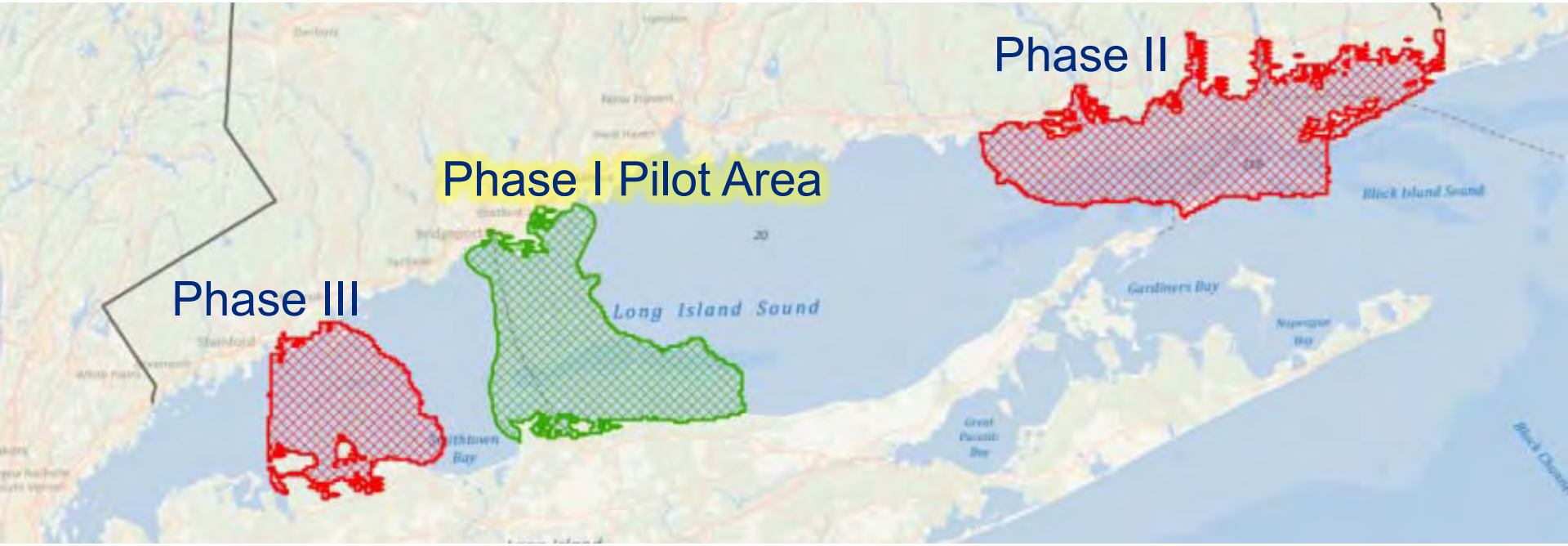


- Highest Priority Areas selected as target areas

Highest Priority Mapping Areas

- Share core issues of:
  - Regulatory, Planning & Resource Management
- Characteristics supporting core issues:
  - Represent Significant Natural Areas
  - Relevant to Infrastructure
  - Have Knowledge Gaps
  - Have High Use/Potential for Use Conflicts

Highest Priority Mapping Areas



Phase I Pilot Area Mapping Goals

- 2012 – 2015:
  - Define and implement technical components for a mapping program focusing on:

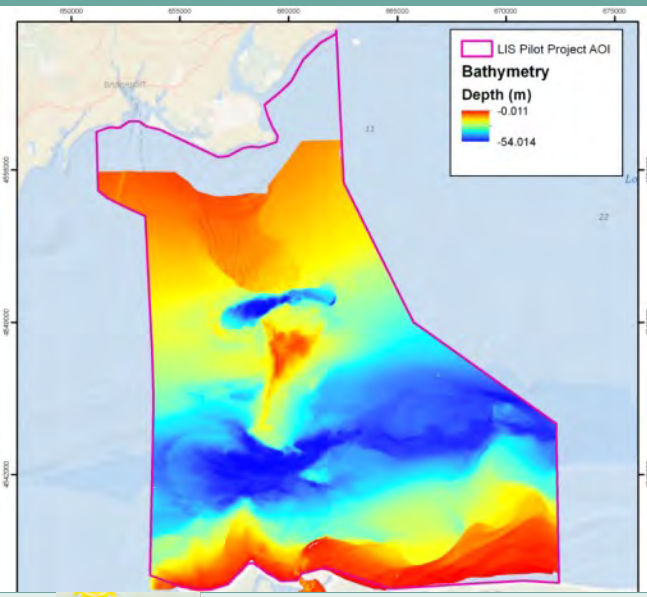
Acoustic Intensity / Seafloor Topography	Benthic Habitats & Ecology
Sediment Texture & Grain Size	Physical Environments
Sedimentary Environments	Data Management System

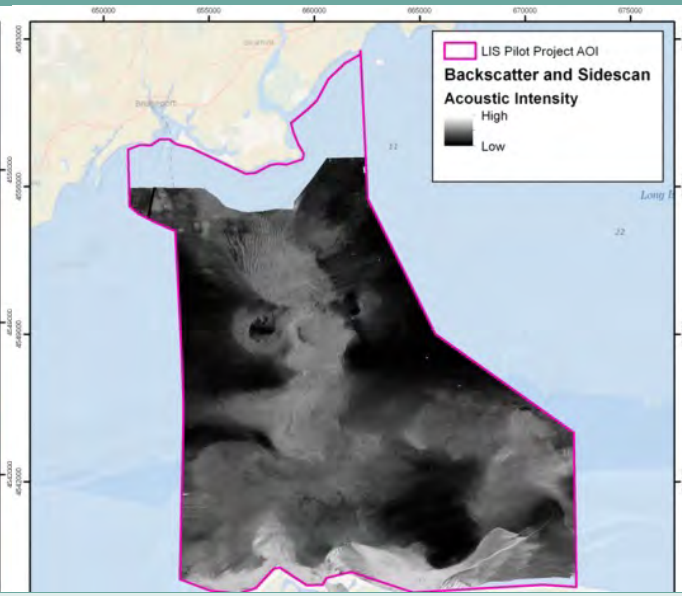
  - Assess implementation strategies
  - Report on methods, analysis, results and conclusions/recommendations

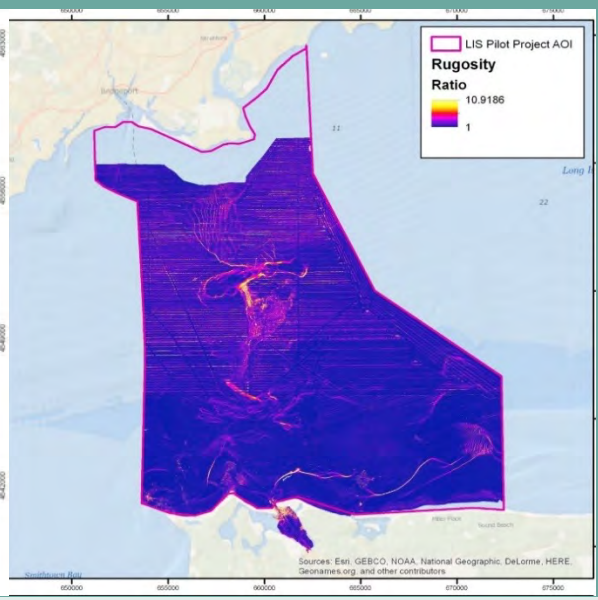
Acoustic Intensity & Backscatter

- Provides depth & backscatter data
- Derives roughness, slope, rugosity
- Most of the other data products directly or indirectly depend on acoustic data

NOAA Survey Vessel
Thomas Jefferson





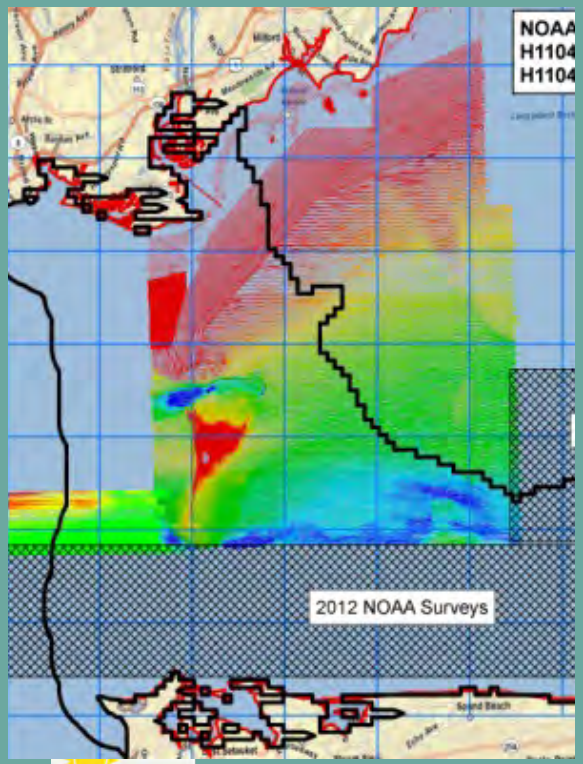


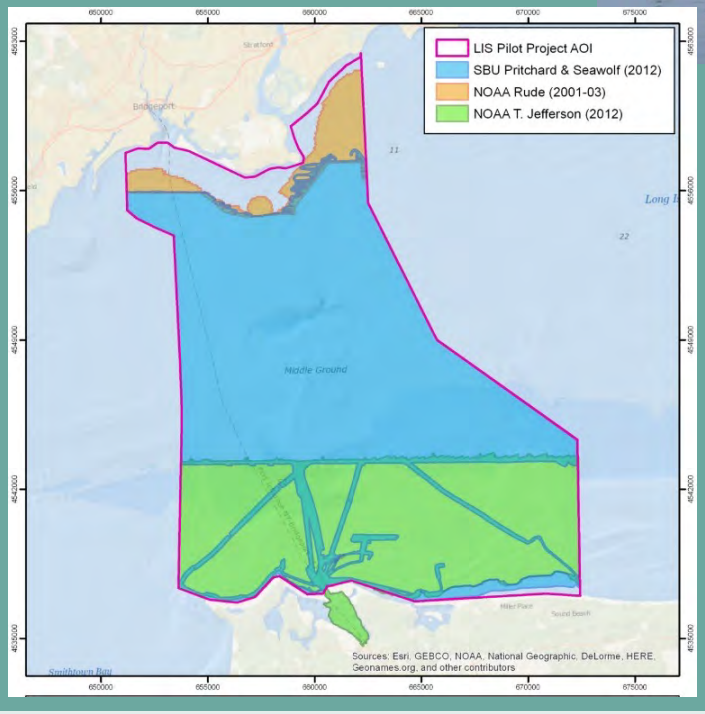
Connecticut Department of Energy and Environmental Protection

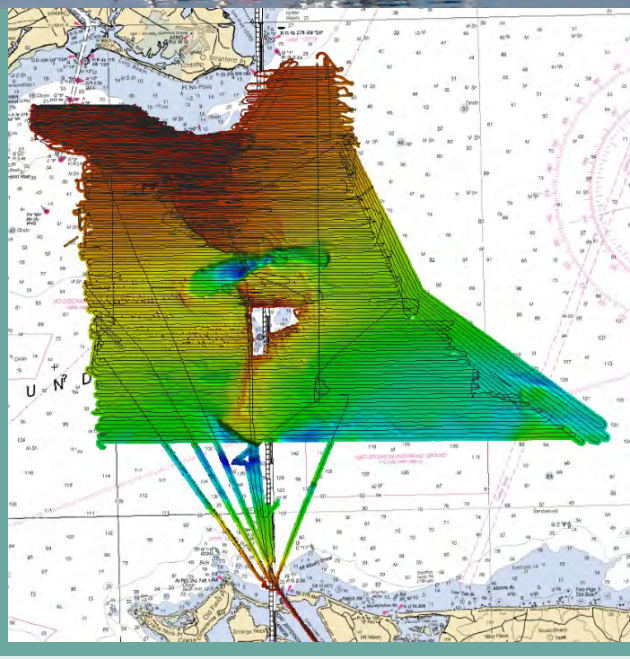
Existing Acoustic Data

Compilation of:

- previous NOAA data &
- 2012 NOAA & Stony Brook surveys

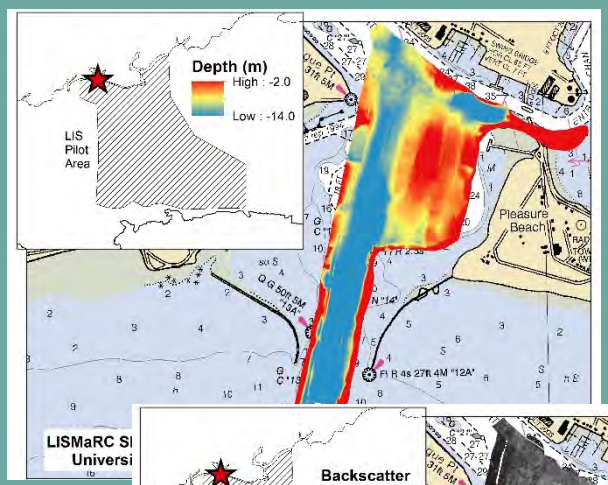


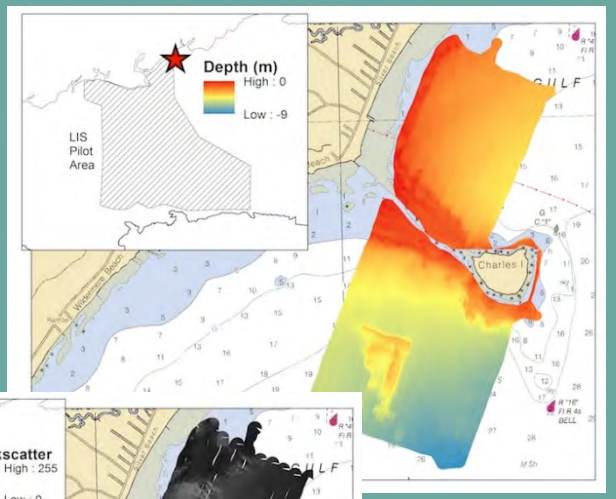


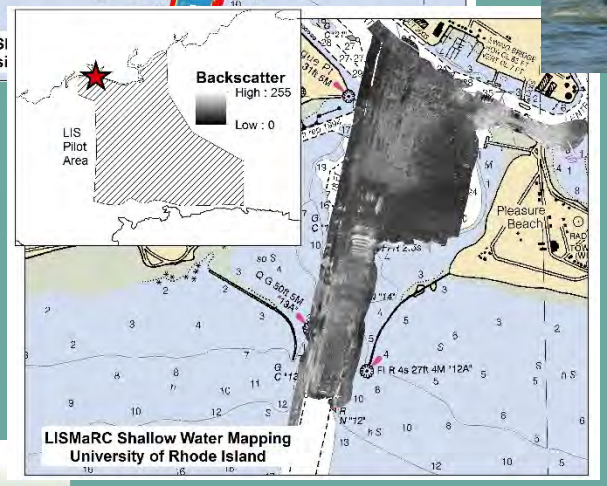


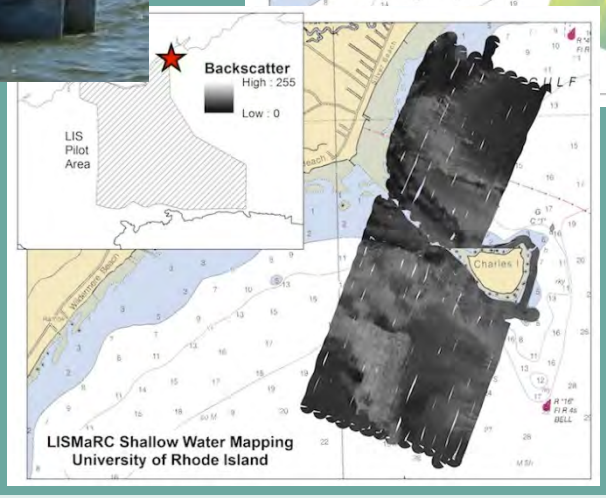
Shallow Water Mapping

- URI conducted Shallow water mapping using an interferometric (vs beam forming) sonar





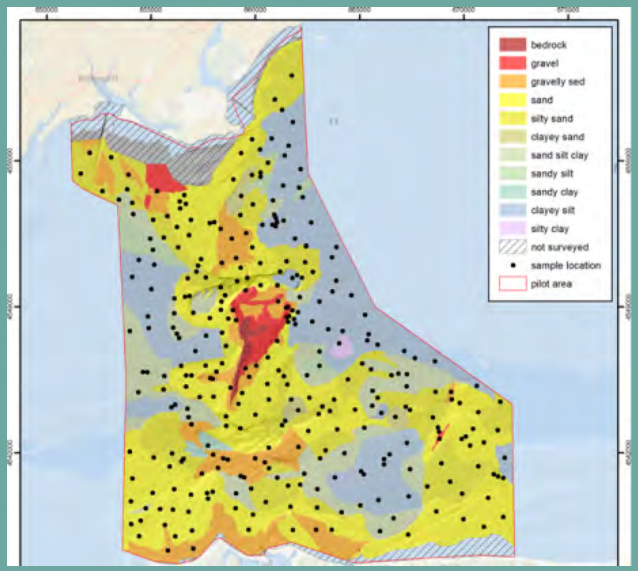


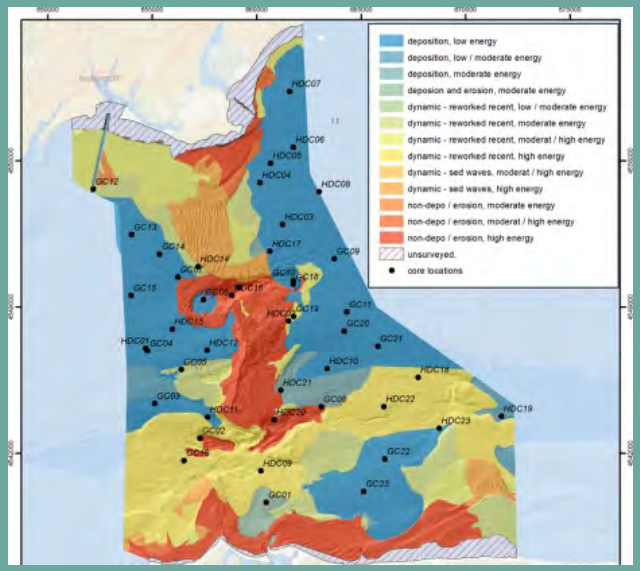


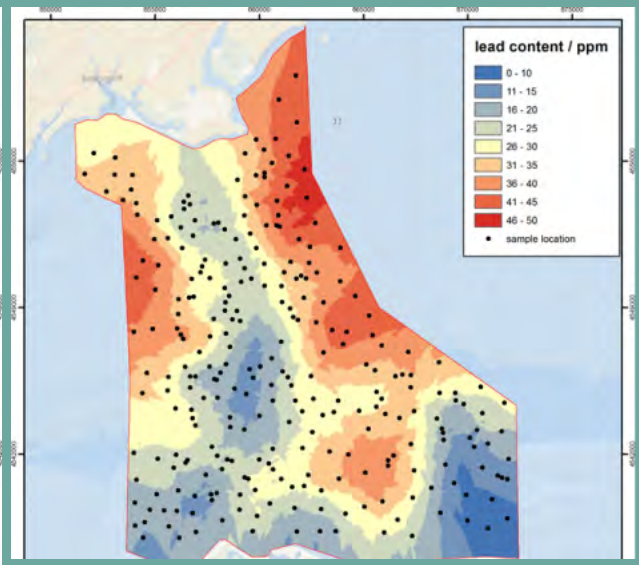
Connecticut Department of Energy and Environmental Protection

Sediment Texture & Grain Size

- Provides detailed bottom composition description (e.g., gravel, sand, mud, silt, etc.) and energy dynamics
- Grab samples were also analyzed for sediment chemistry (TOC, N, Pb, Zn, Cu)

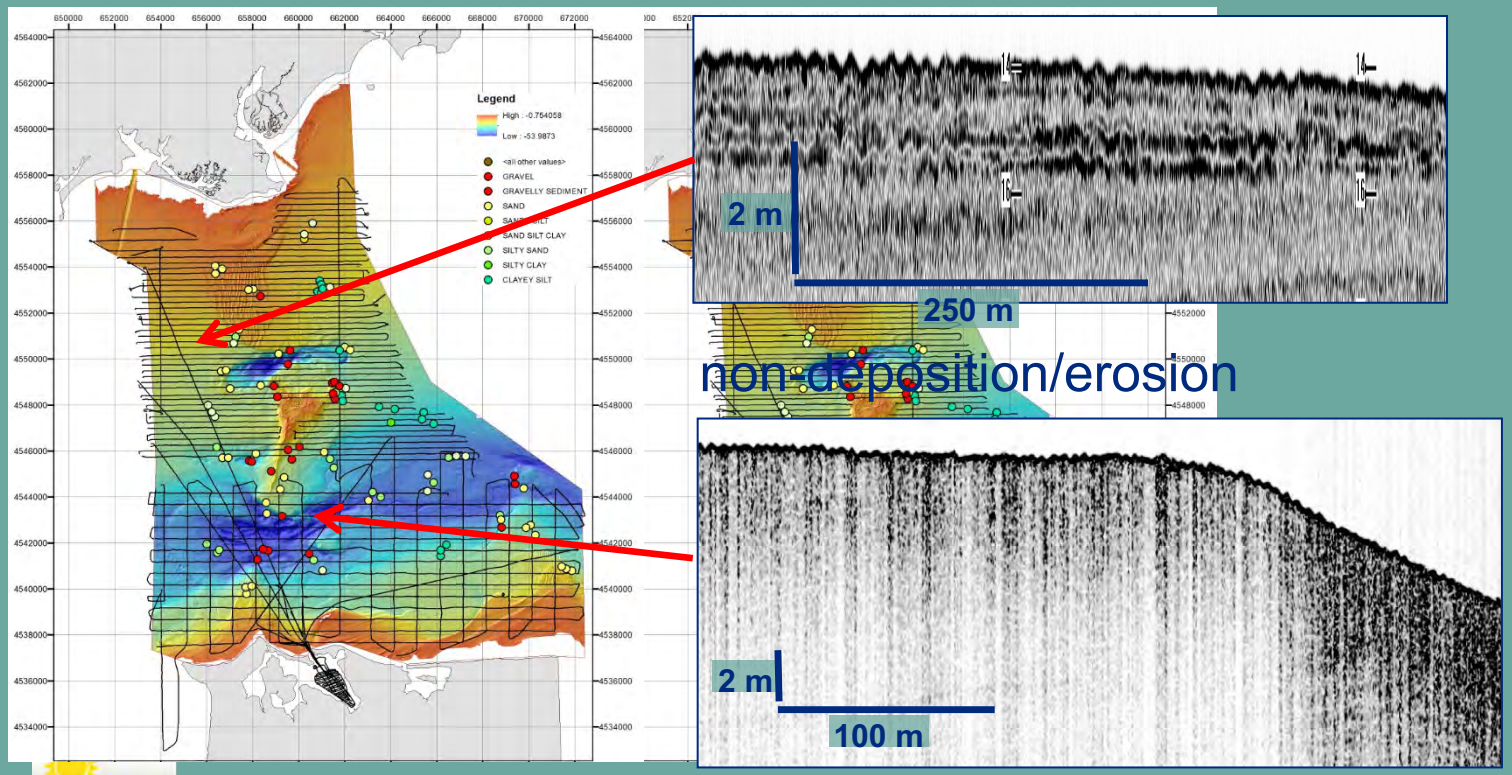






Sedimentary Environments

- Sub-bottom profiling used to develop sediment environments
  - Examples: depositional layers

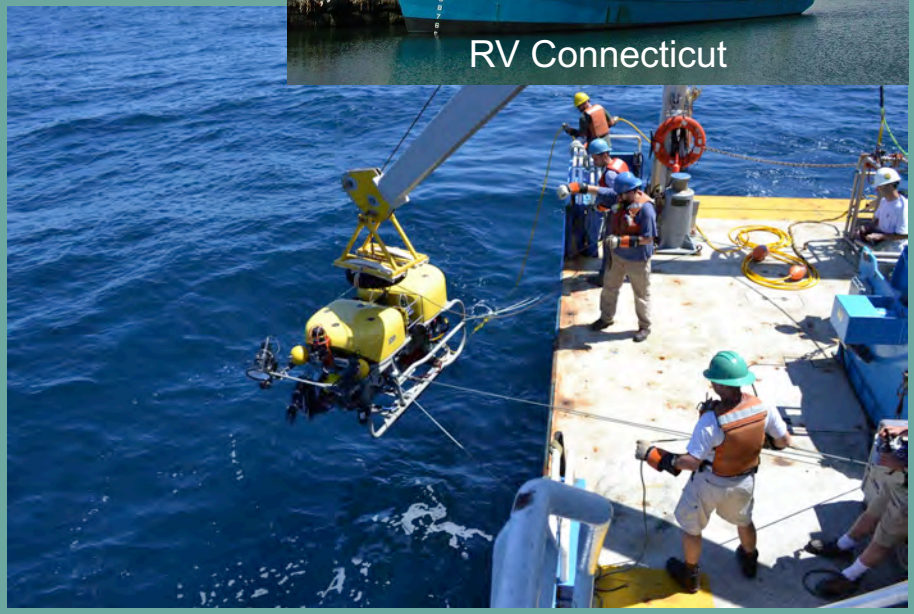


Ecological Characterization

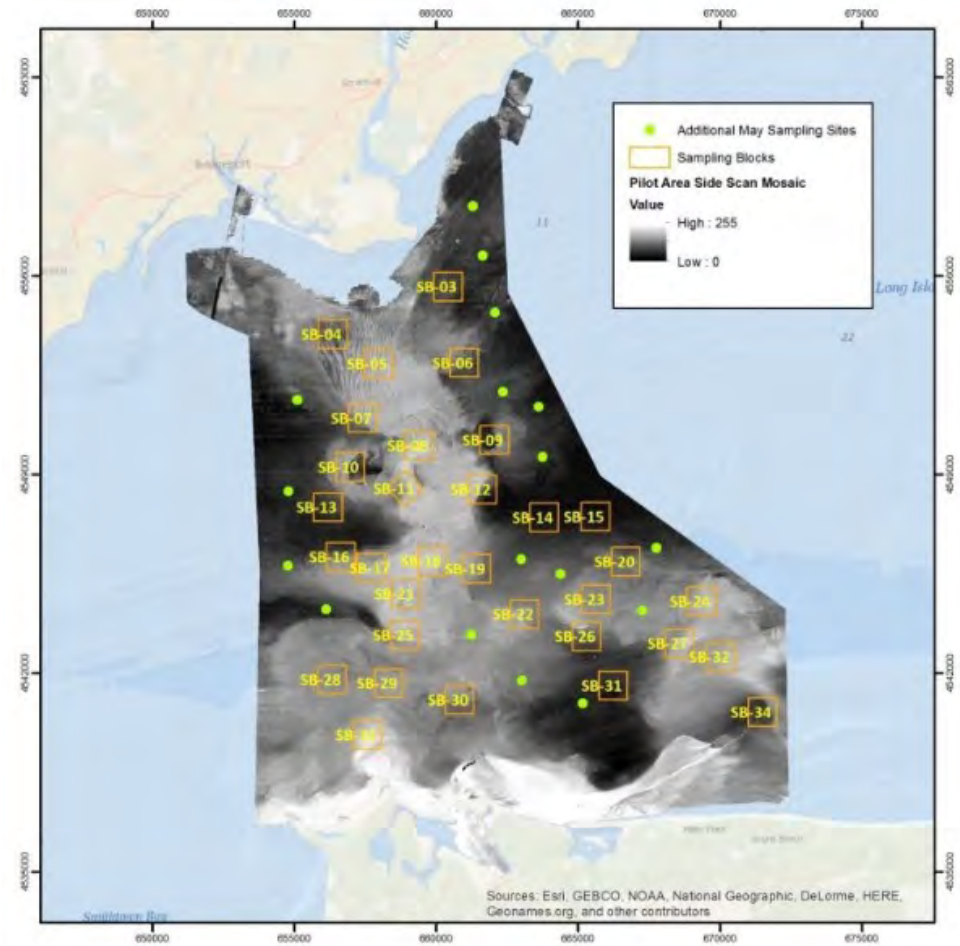
- Teams characterized benthic habitats using the SEABOSS and Kraken2 ROV.

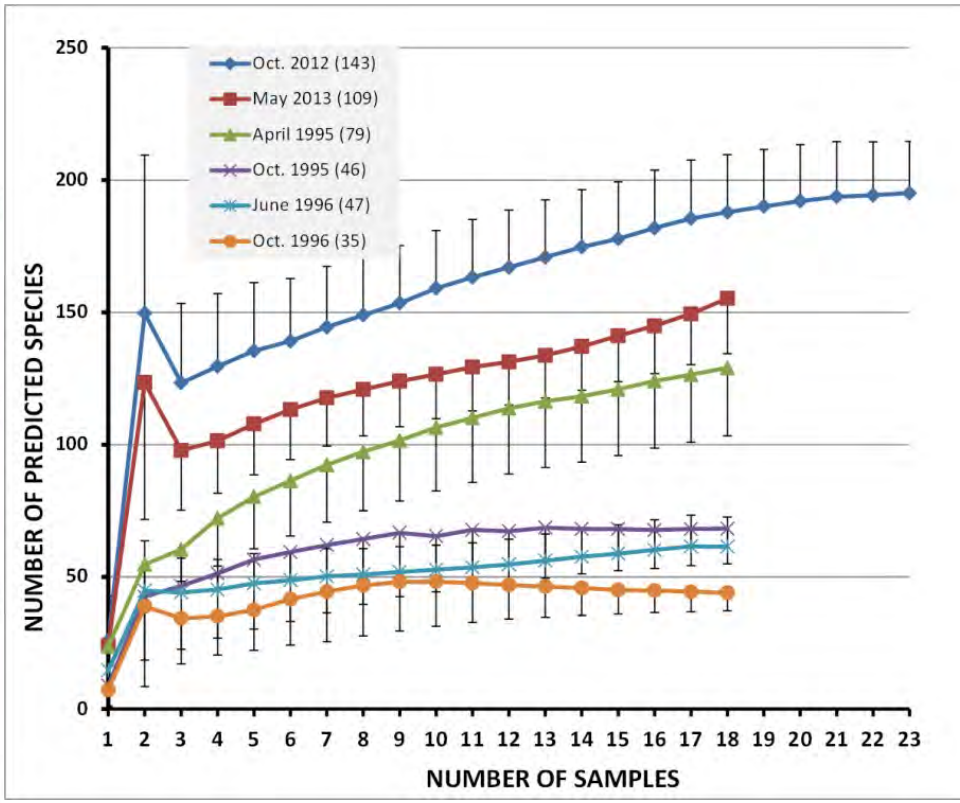
RV Connecticut

SEABOSS


Kraken2 ROV

Ecological Characterization: Infauna

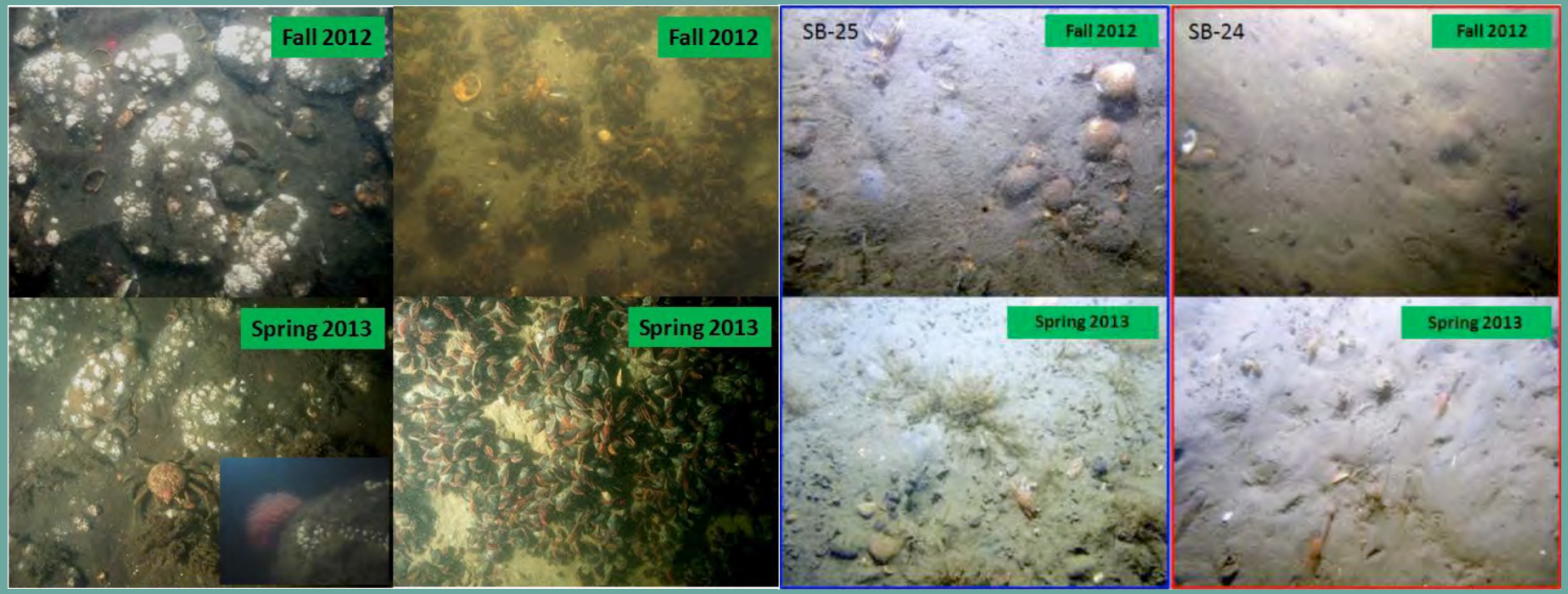




Backscatter data utilized for sample site selection

Ecological Characterization: Epifauna

- Seasonal analyses showed ecological stability and change

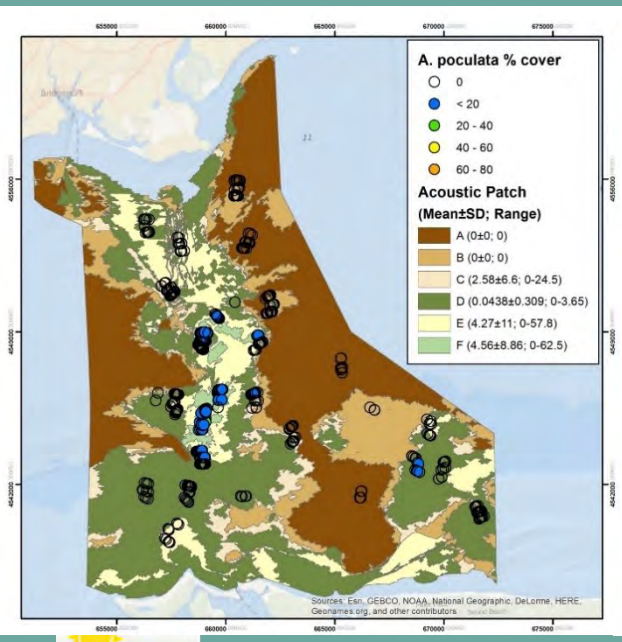


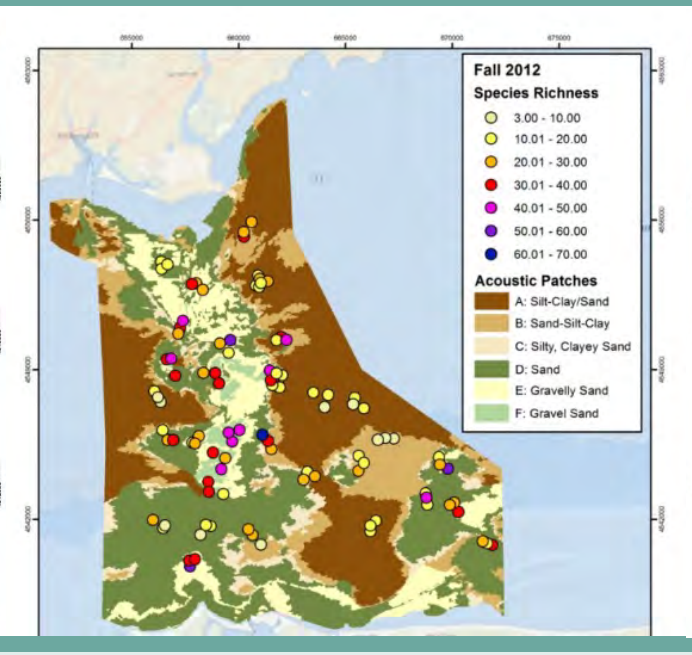
Stable hard substrates

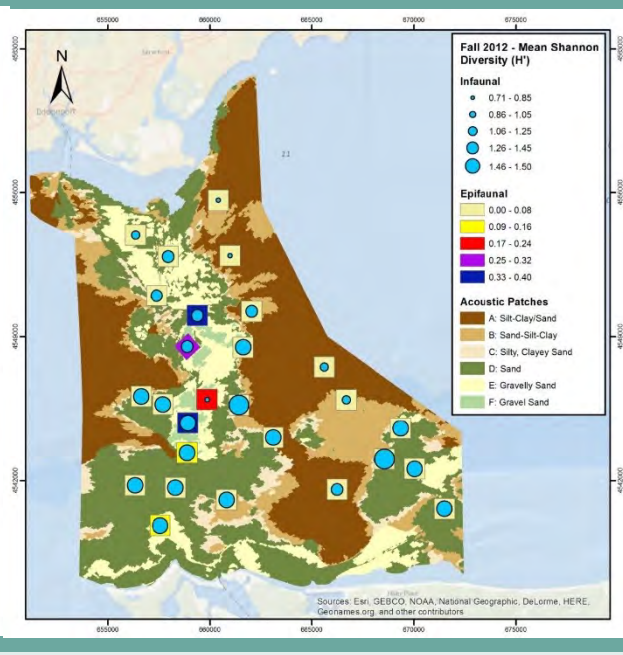
Seasonally variable soft substrates

Classification & Ecological Analysis

- Generated numerous data products including individual species distribution, biogenic features, species richness and diversity maps.

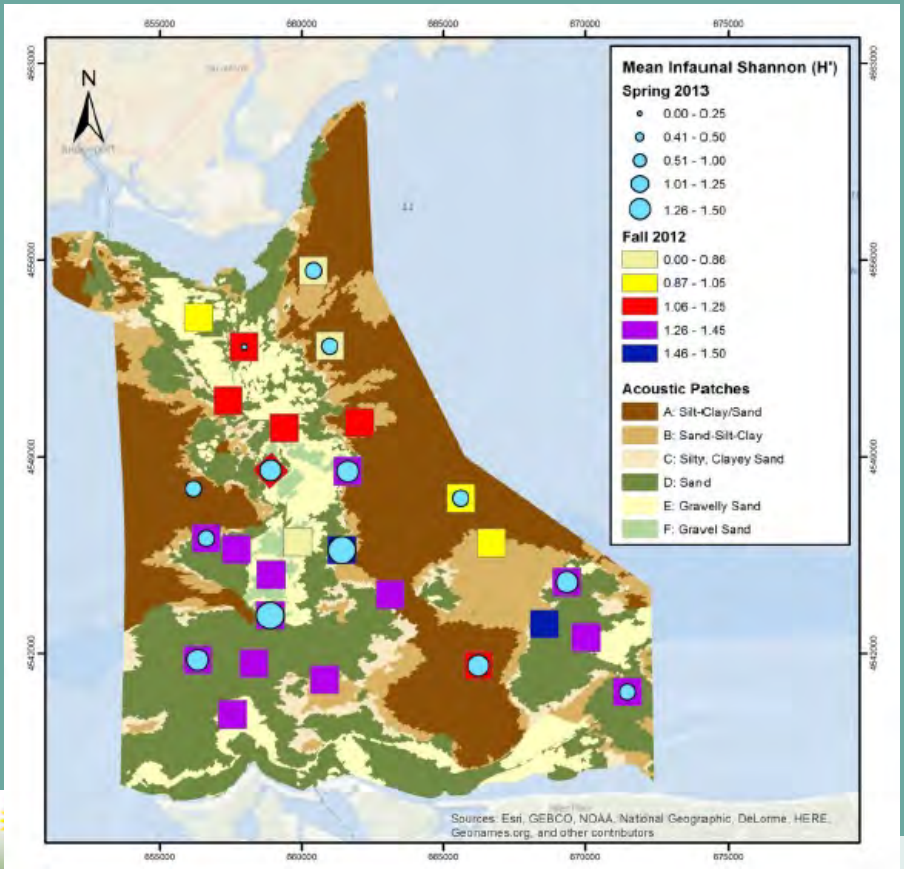


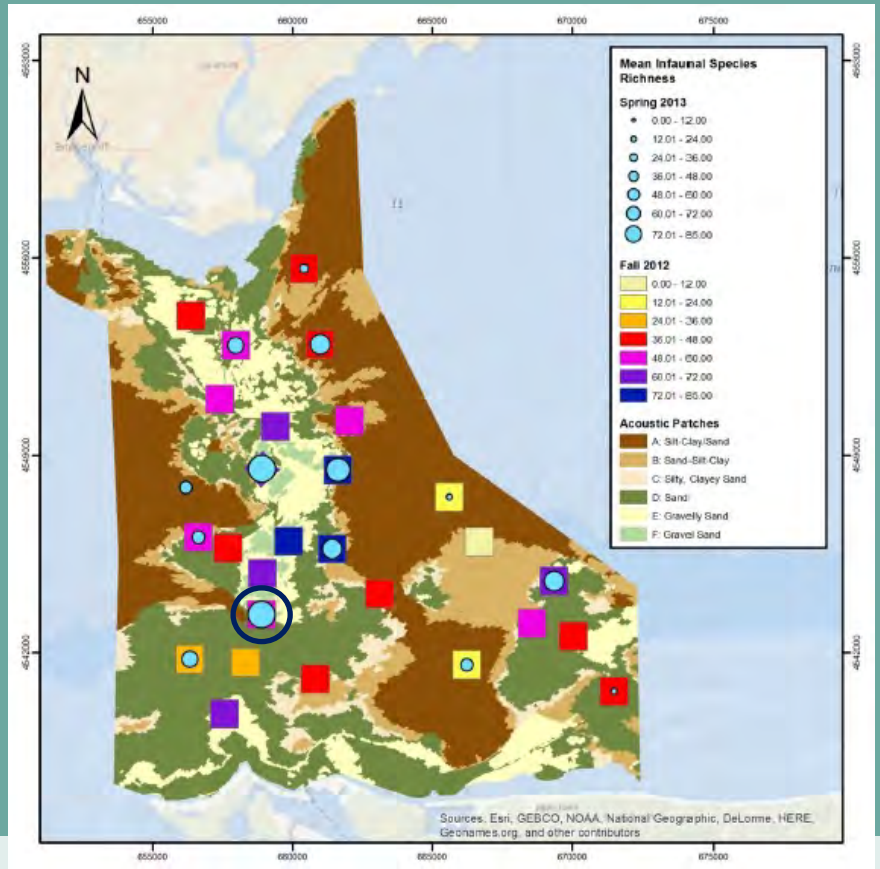




Classification & Ecological Analysis

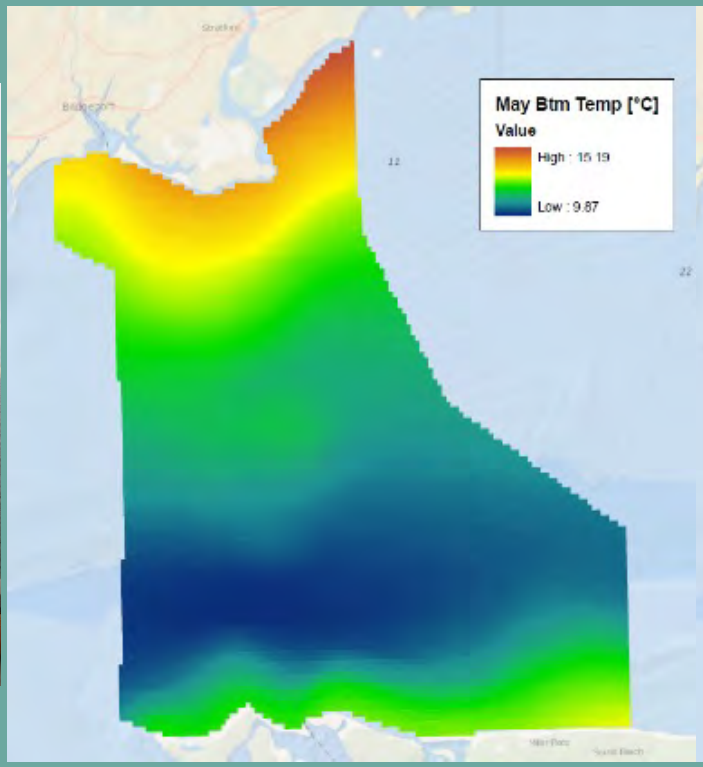
- Seasonal analyses showed areas with ecological stability and others with seasonal change

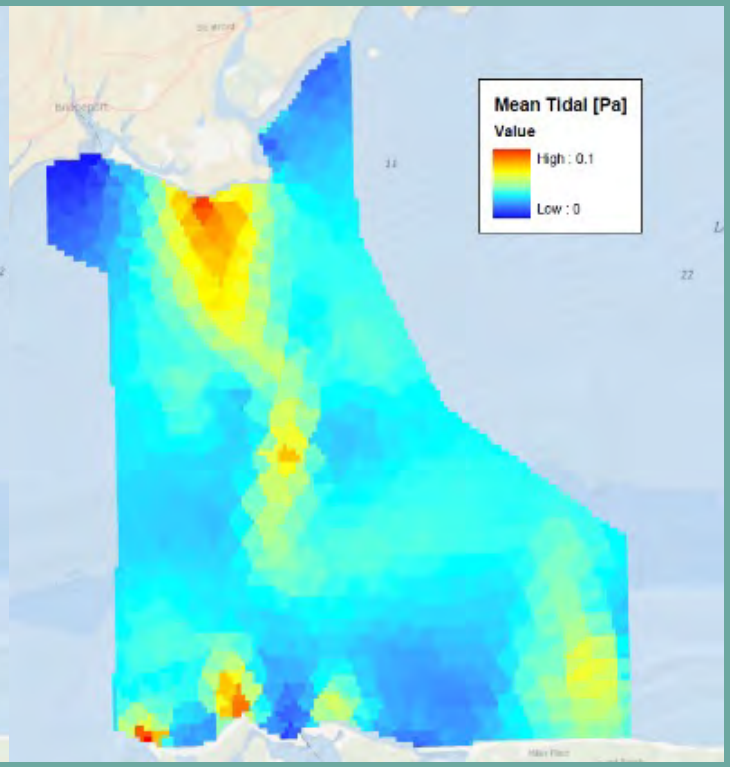


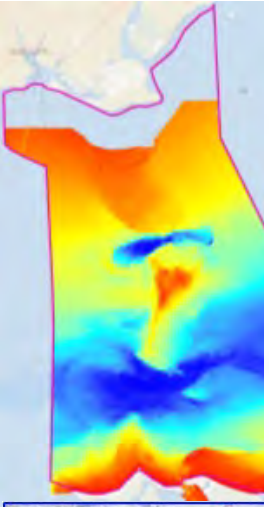


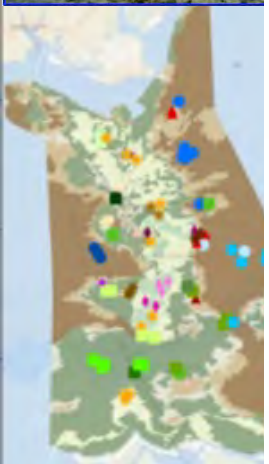
Physical Oceanography

- Data on temperature, salinity, currents, bottom stress, etc., based on observations and modeling.



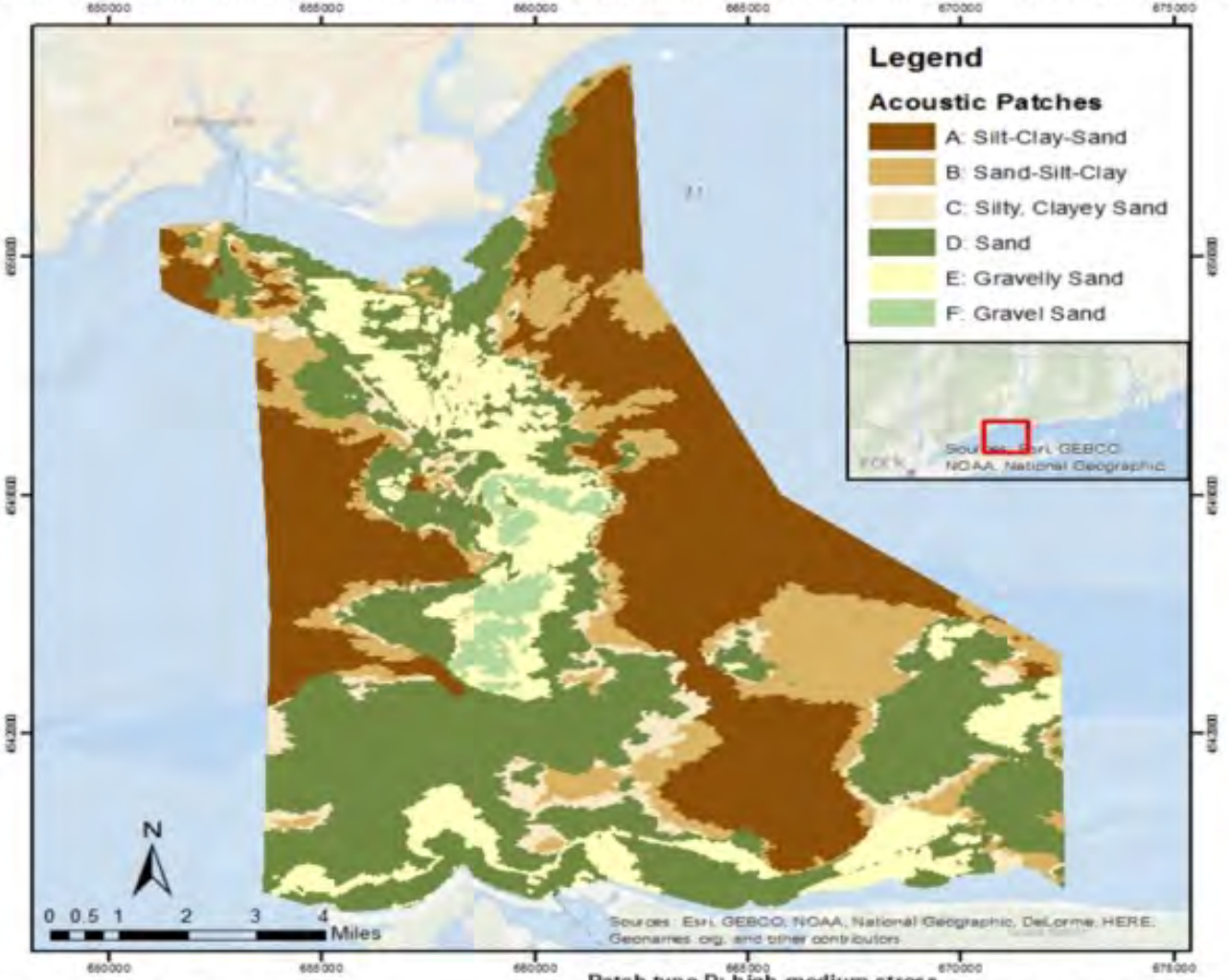






Integrated Habitat Map

Based on mean bottom tidal stress, defining ecological characteristics of infaunal (I) and epifaunal (E) communities, and predominant biogenic features (BF) in relation to acoustic patch types.



Patch type A: low-medium stress
I: Mixed burrowing and tubiculous taxa
E: Solitary ascidians, *Mytilus*
BF: Shell, burrows

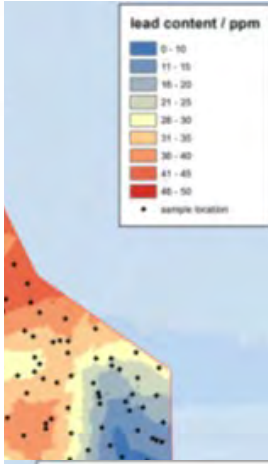
Patch type B: low-high stress
I: Tubiculous taxa, motile surface feeders
E: Bivalve, *Corymorpha*, solitary ascidian
BF: Shell

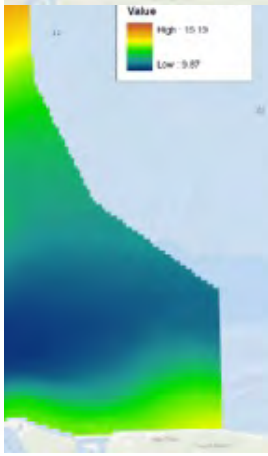
Patch type C: predominantly medium stress
I: Variable mix of tubiculous taxa and burrowers
E: *Mytilus*, *Corymorpha*, solitary ascidian
BF: Burrows, shell

Patch type D: high-medium stress
I: Small tubiculous taxa (polychaetes and amphipods); High density of bivalves
E: Hydroids, *Mytilus*, barnacle
BF: High coverage of shell patches and burrows

Patch type E: predominantly high stress
I: Oligochaetes and archiannelids, small tubiculous taxa, deep burrowing taxa
E: Hydroids, *Mytilus*, *Astrangia*
BF: High coverage of shell patches

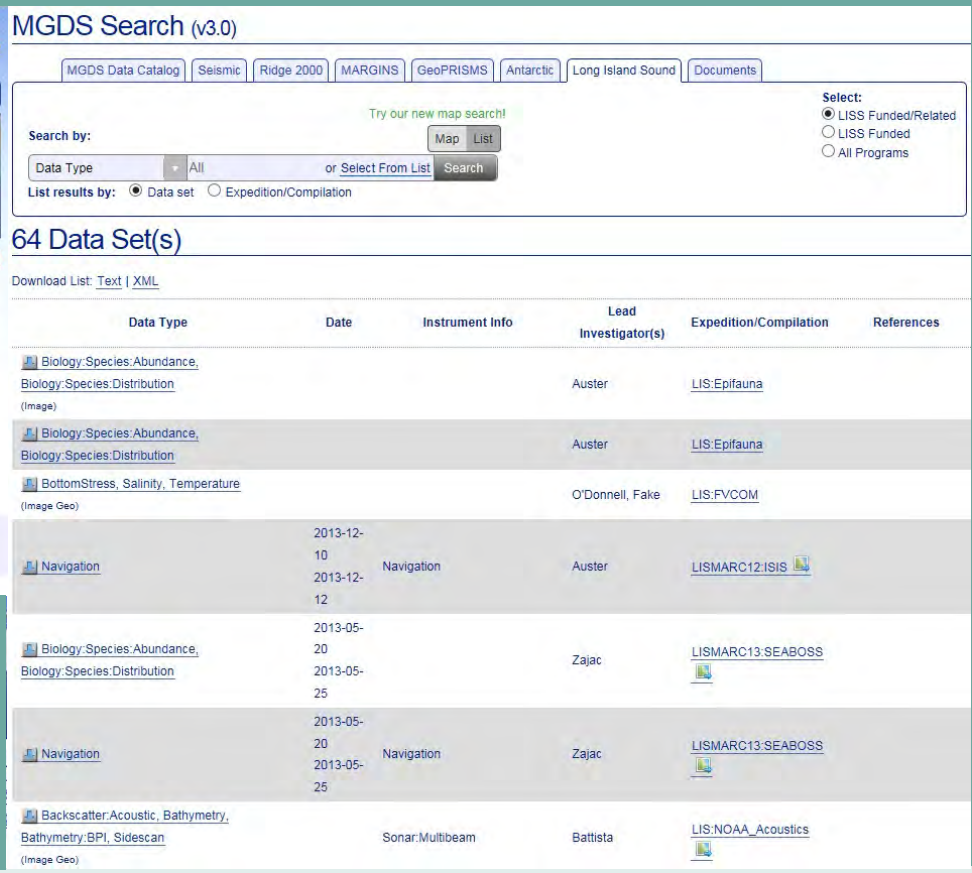
Patch type F: predominantly high stress
I: Oligochaetes and archiannelids, small tubiculous taxa (polychaetes and amphipods), moderate bivalve abundances
E: *Crepidula*, *Diadumene*, *Astrangia*
BF: High coverage of shell patches





Data Management

- Leveraged an existing NSF funded system at LDEO to store and share results: http://www.marine-geo.org/portals/lis/



Phase I Findings

Bathymetric & Topographic Data

- Critical in guiding subsequent analyses; and
- Helped to identify changes in decadal seafloor geomorphology.

Geochemical Analysis

- Revealed large- and small-scale variations in sediment distribution, improving on older data;
- Provided a novel look at large-scale surficial concentrations/distributions of several chemical constituents:
  - Advanced current understanding of large-scale grain size distributions while establishing variations on a smaller scale;
  - Sediment cores revealed dramatic change in down-core sedimentation, indicating changes in depositional environments and possibly ecosystems within short-time spans.

Ecological Processes

- Integrating the analyses of spatial and seasonal variation of infaunal and epifaunal communities proved significant:
  - Provided more robust understanding of their:
    - seasonal population characteristics,
    - distributions, and
    - relationships to environmental characteristics.
  - Revealed consistent patterns in high diversity, persistent across seasons in:
    - simple species richness (S) and
    - Shannon diversity (H').

Geological and Ecological Connections

- General faunal response to:
  - Grain size gradient (i.e., fine to coarse), and
  - Increasing tidal stress.
- Species shift from:
  - short-lived to long-lived fragile epifaunal species, and
  - burrowed sediments to shell reef coverage.

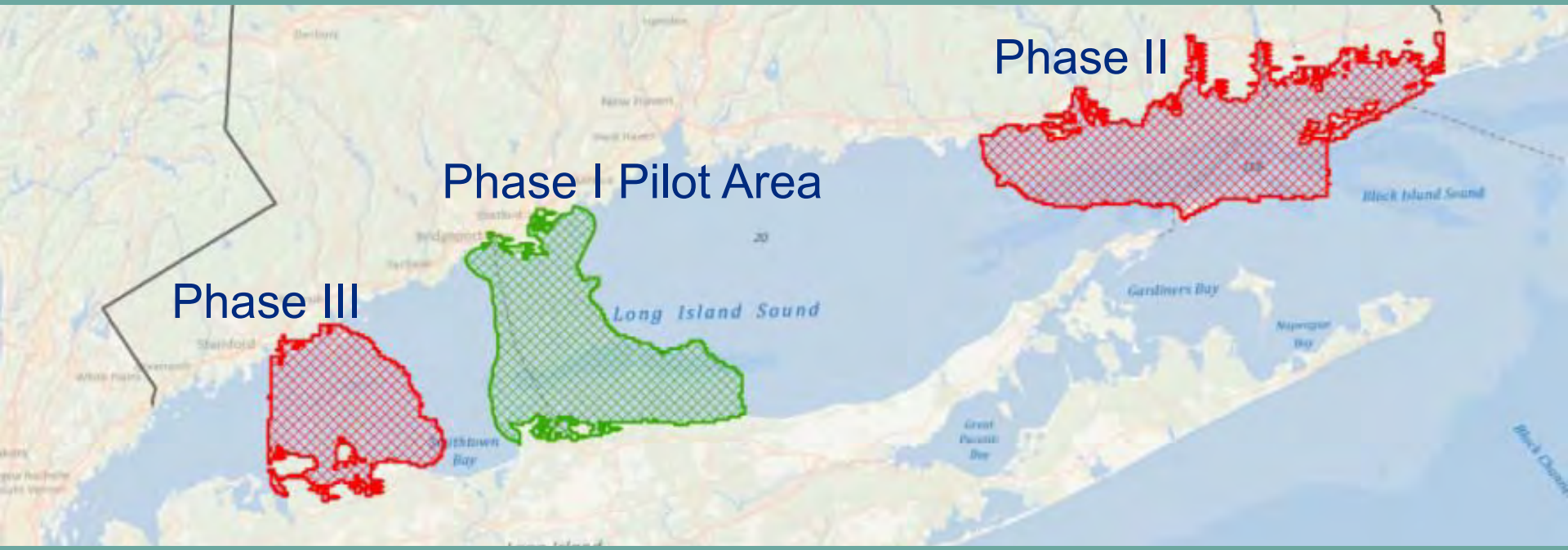
Finite Volume Community Ocean Model

- Modelling Results
  - Showed accordance with field measurements of:
    - Temperature,
    - Salinity,
    - Current, and
    - Bottom stress
  - Validated FVCOM use for spatial interpolation
  - Estimation of bottom stress is imprecise
    - Underestimates higher frequency and finer scale motions.

Phase I Pilot Outcomes

- Report and Appendices submitted June 2015
  - https://longislandsoundstudy.net/research-monitoring/seafloor-mapping/
- Consensus the pilot project was successful
  - Generated useful data and examples of how data can be visualized and synthesized
  - Demonstrated collaborative teams can be an effective at approaching complex, large scale efforts
- Areas for Improvement
  - Better definition and application of data standards
  - Improved coordination and communication (between teams as well as between teams and SC)

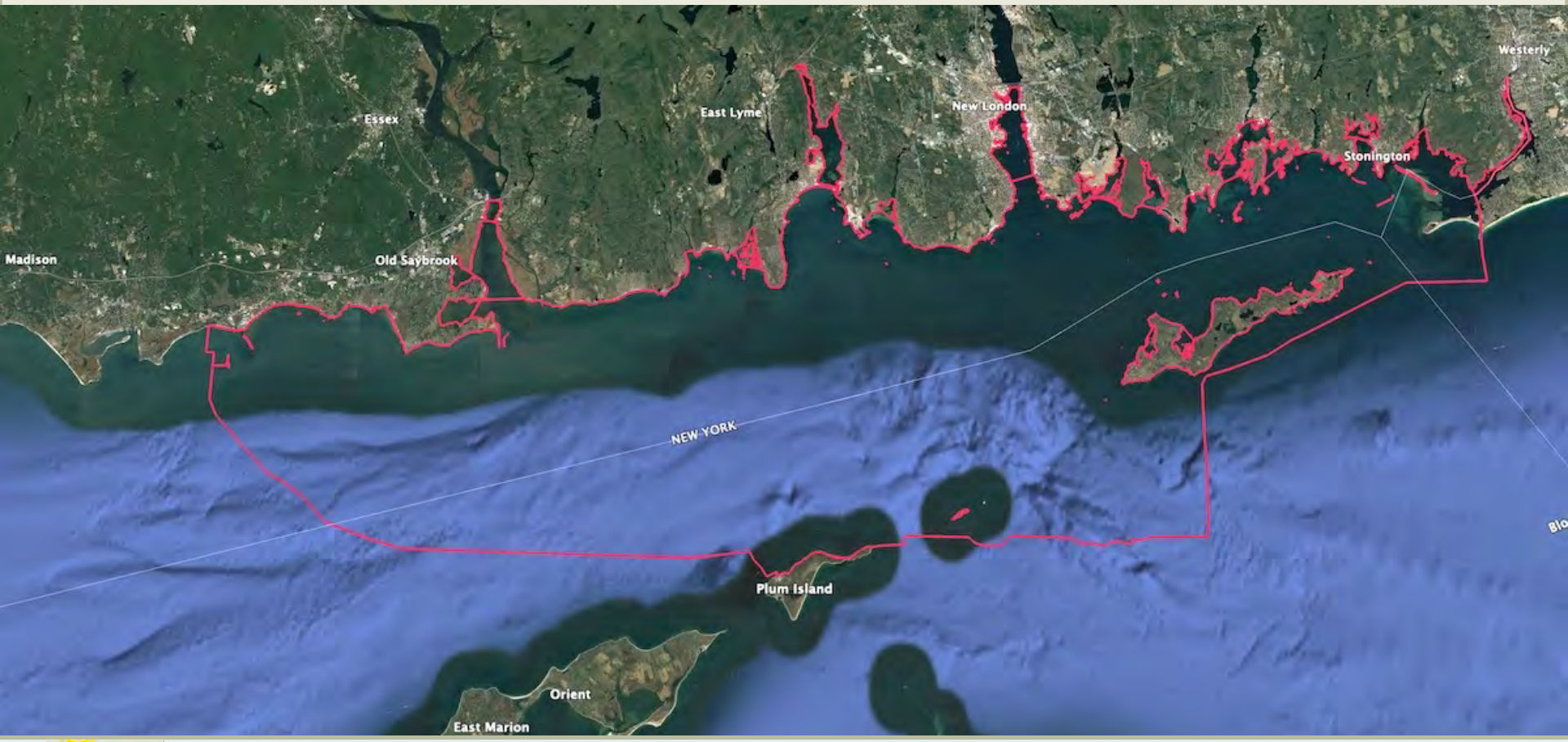
On to Phase II of the Mapping Initiative



Connecticut Department of Energy and Environmental Protection

Phase II Mapping Initiative

Phase II Mapping Area



Connecticut Department of Energy and Environmental Protection

Phase II Mapping Initiative

Long Island Sound Mapping and Research Collaborative

UCONN
UNIVERSITY OF CONNECTICUT

UNH
UNIVERSITY OF NEW HAVEN

USGS
science for a changing world

NOAA Ocean Service Collaborative

National Centers for Coastal Ocean Science NCCOS

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Office of Coast Survey OCS

Lamont - Doherty Earth Observatory Collaborative

LAMONT-DOHERTY EARTH OBSERVATORY
THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

STONY BROOK
STATE UNIVERSITY OF NEW YORK

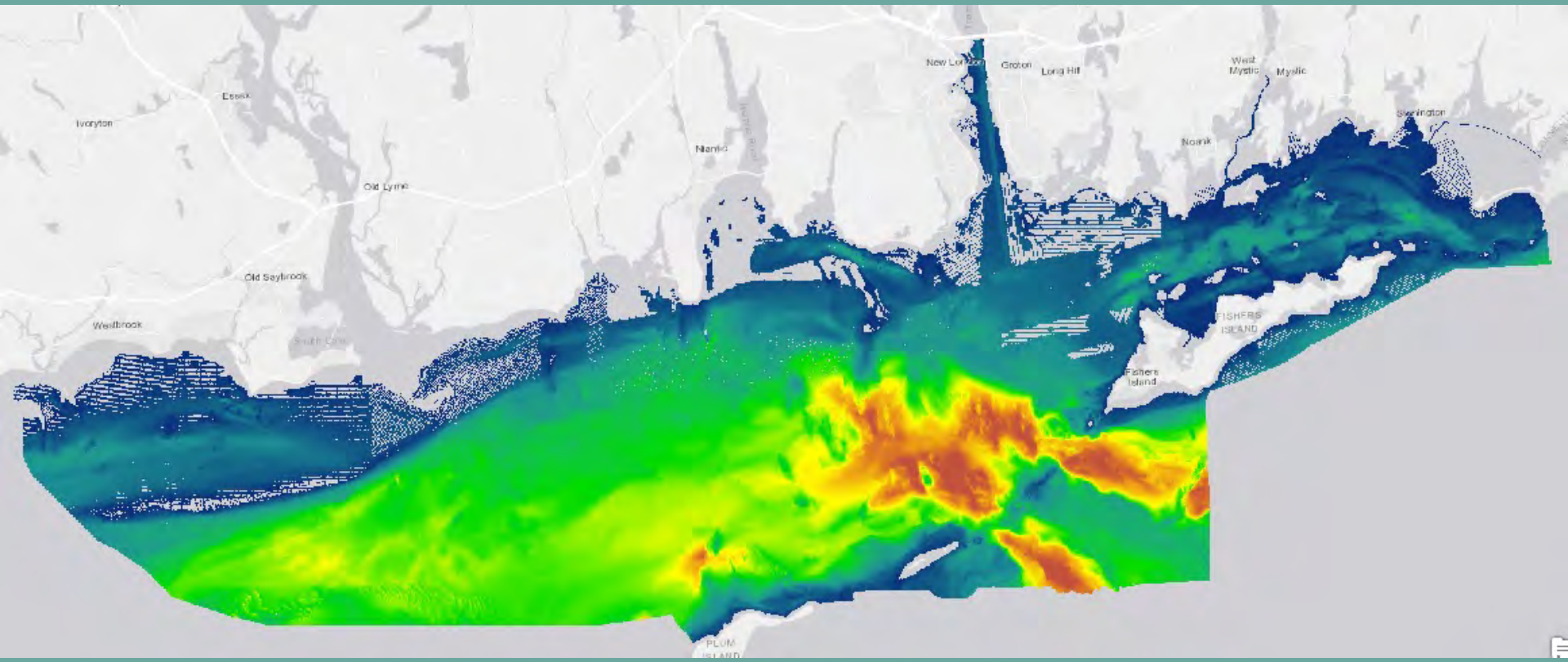
QUEENS COLLEGE

Phase II Mapping Goals

1. Product deliverables to identify/help understand:
   - ⇨ Predominant topographic, geologic, physical, and ecological characteristics
   - ⇨ Distribution of characteristics
   - ⇨ Physical, ecological or geological attributes/functions of an area based on various characteristics
2. Data collection & processing
3. Improvements to Pilot processes:
   a. Communication/cohesiveness about standards and processes
   b. Timelines and scheduling of inter-team dependencies
   c. Earlier feedback on draft products
   d. Distribution & access of final data products

Acoustic Data - Gaps

Bathymetry – ca 2013



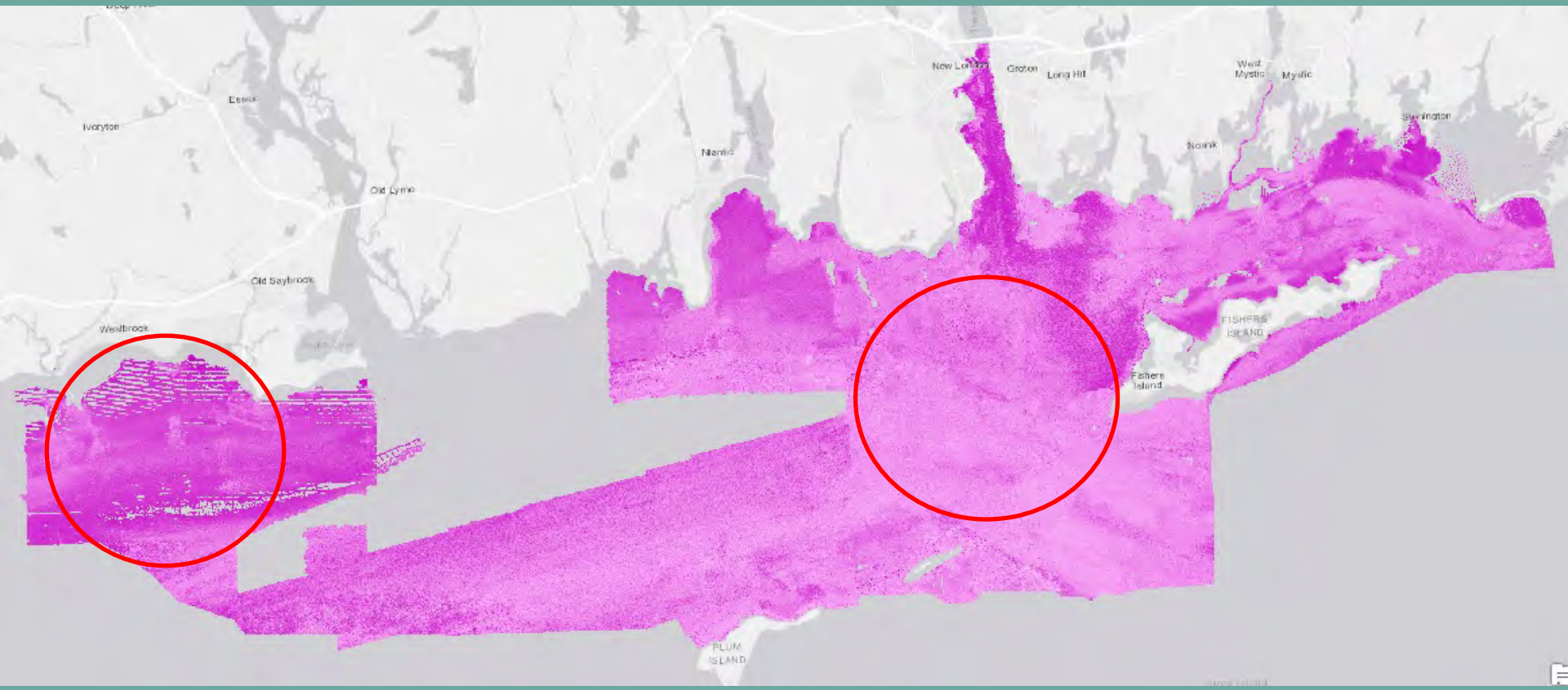
Connecticut Department of Energy and Environmental Protection

Acoustic Data - Gaps

Bathymetry – ca 2013

Acoustic Data - Gaps

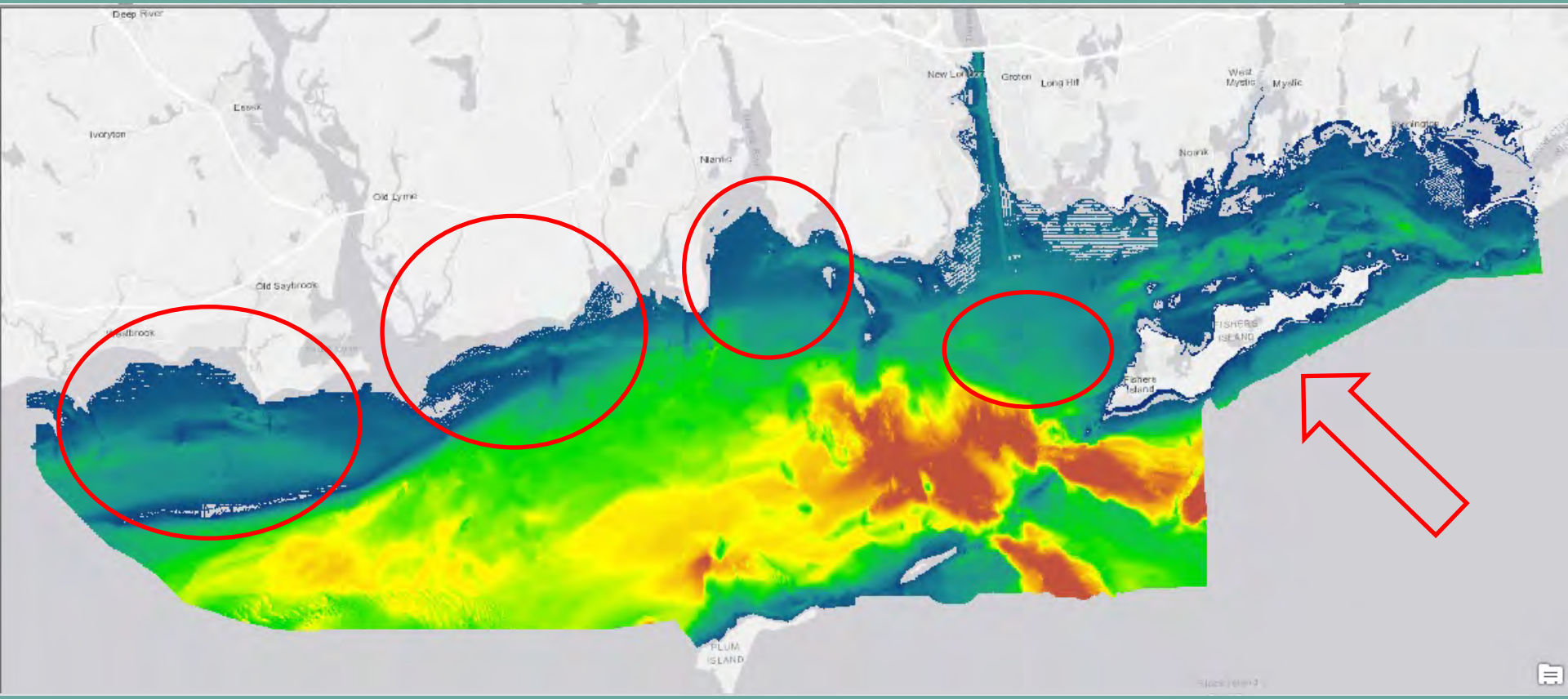
Backscatter/intensity – ca 2013



Connecticut Department of Energy and Environmental Protection

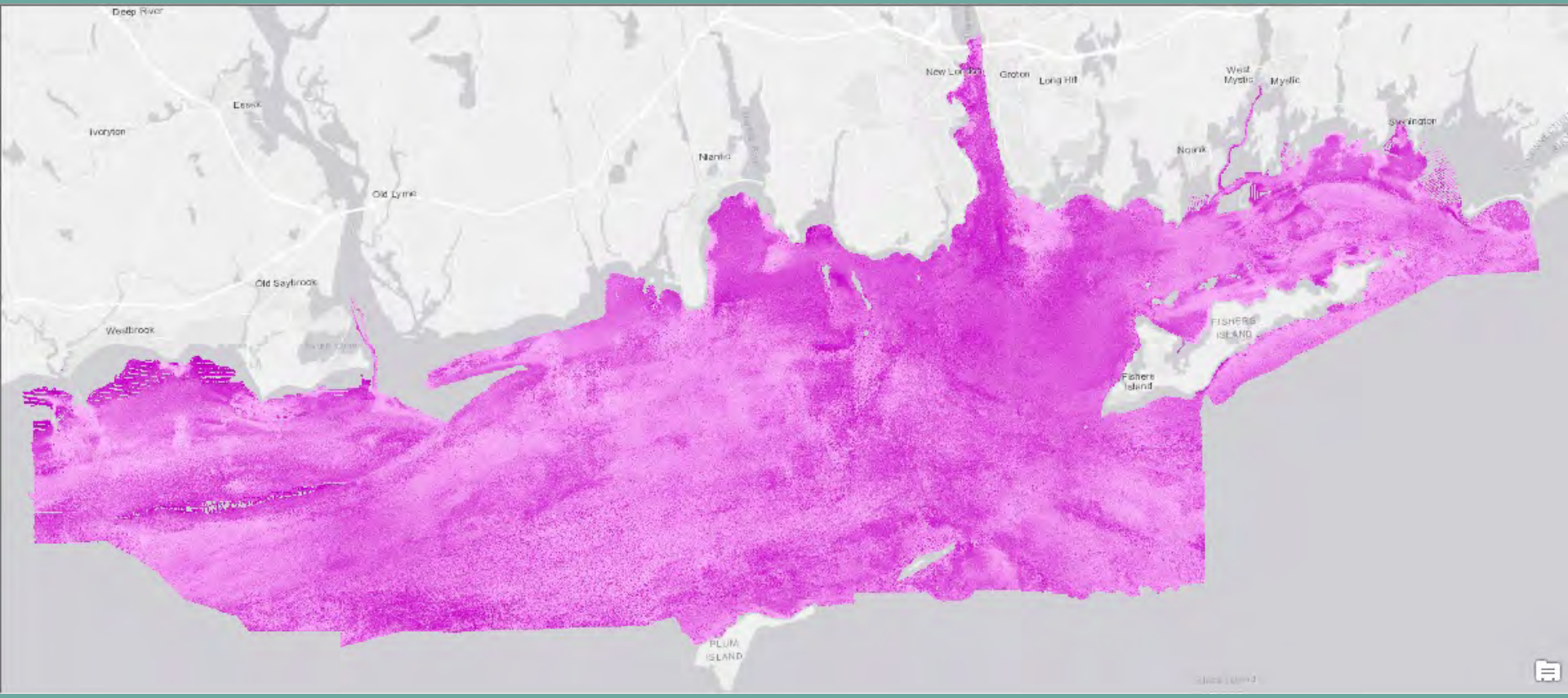
Acoustic Data – Acquisition/Integration

Bathymetry: NOAA (2014), Stony Brook University (2016-18)

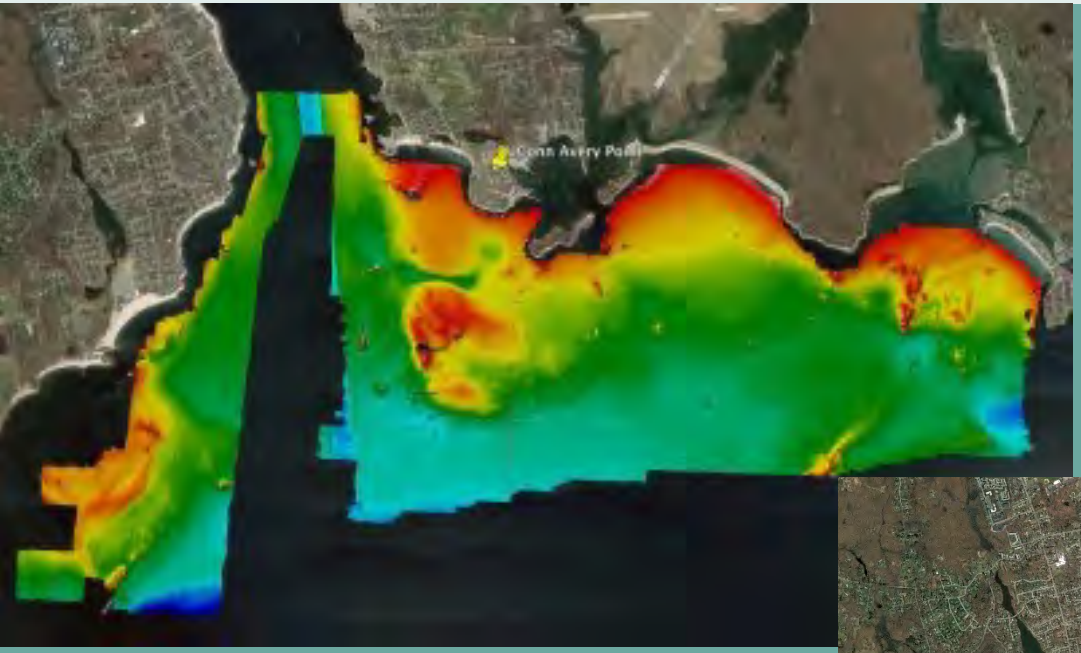


Acoustic Data – Acquisition/Integration

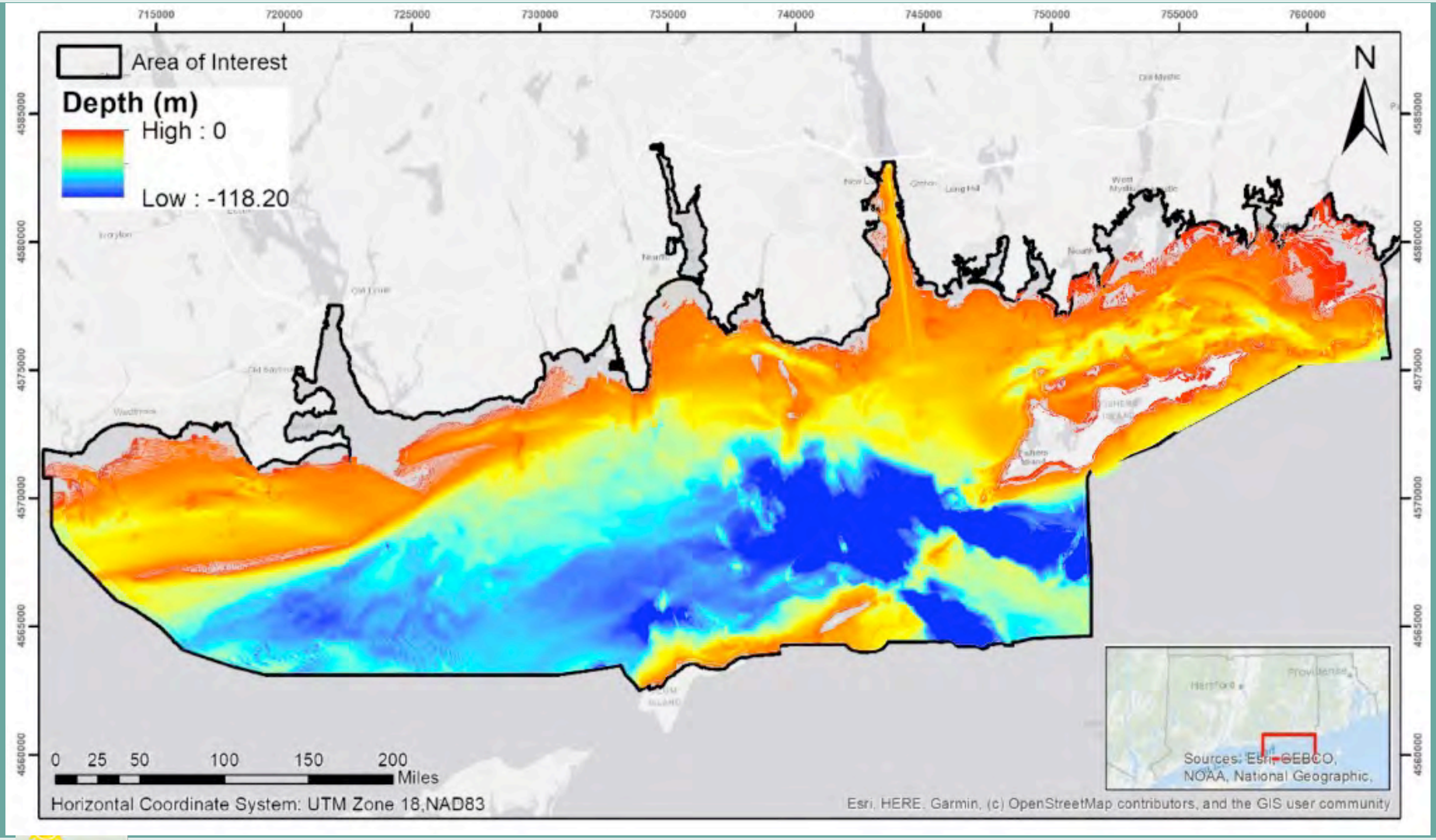
Backscatter/intensity – NOAA (2014), Stony Brook University (2016-18)



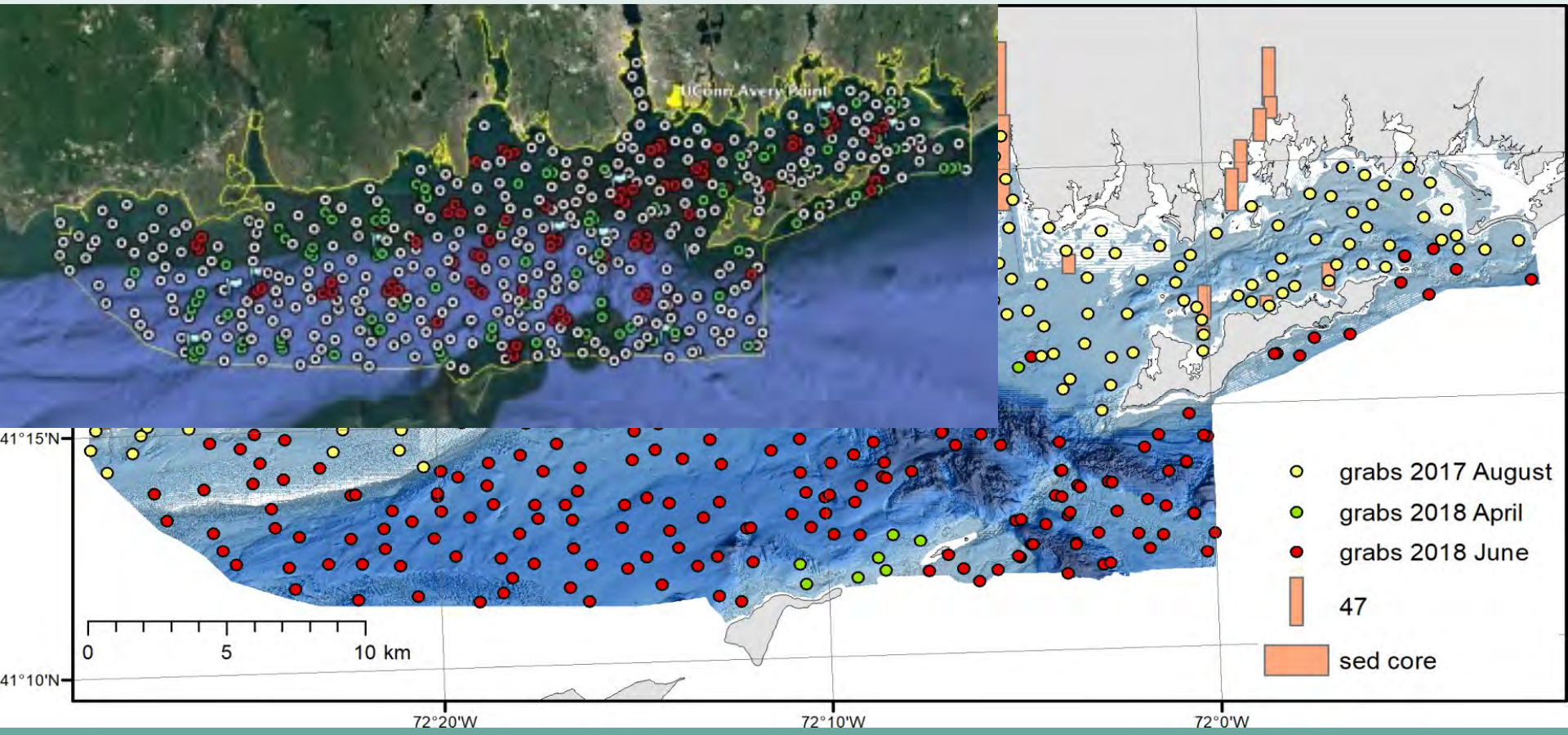
Acoustic Data Acquisition



Acoustic Data Acquisition



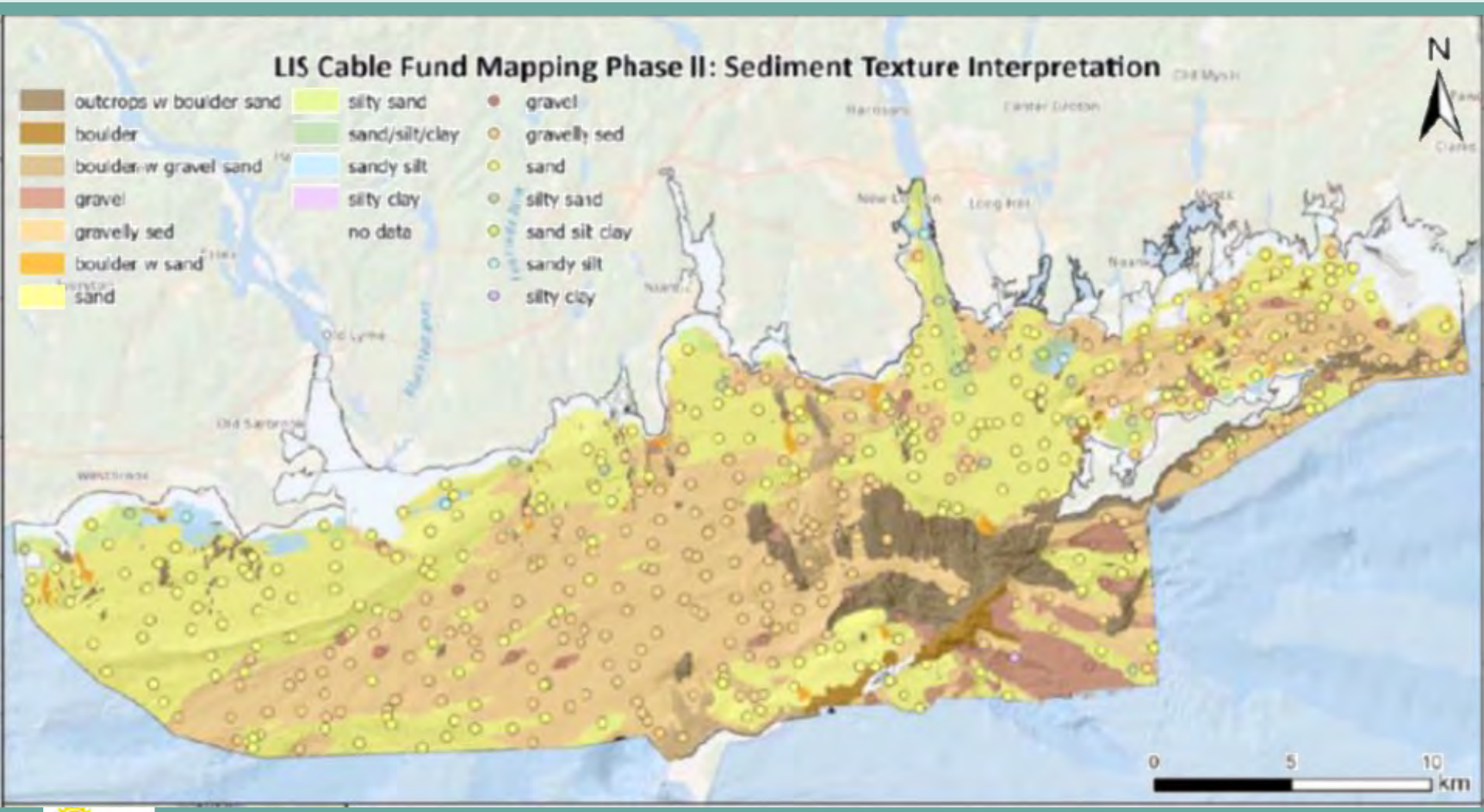
Sediment Grab and Core Locations



- Collection complete; analyses 99% complete

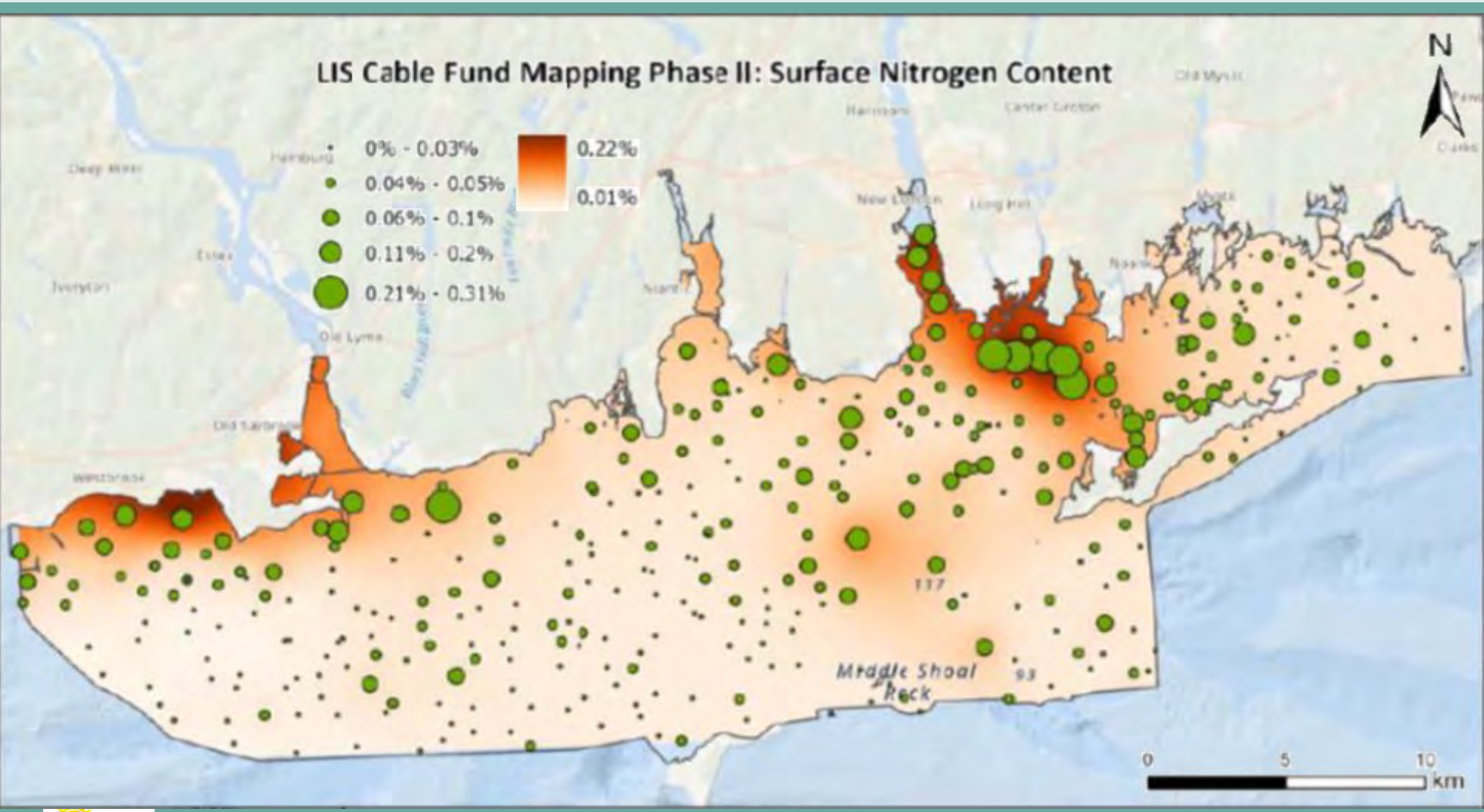
Connecticut Department of Energy and Environmental Protection

Sediment Classification (99% complete)



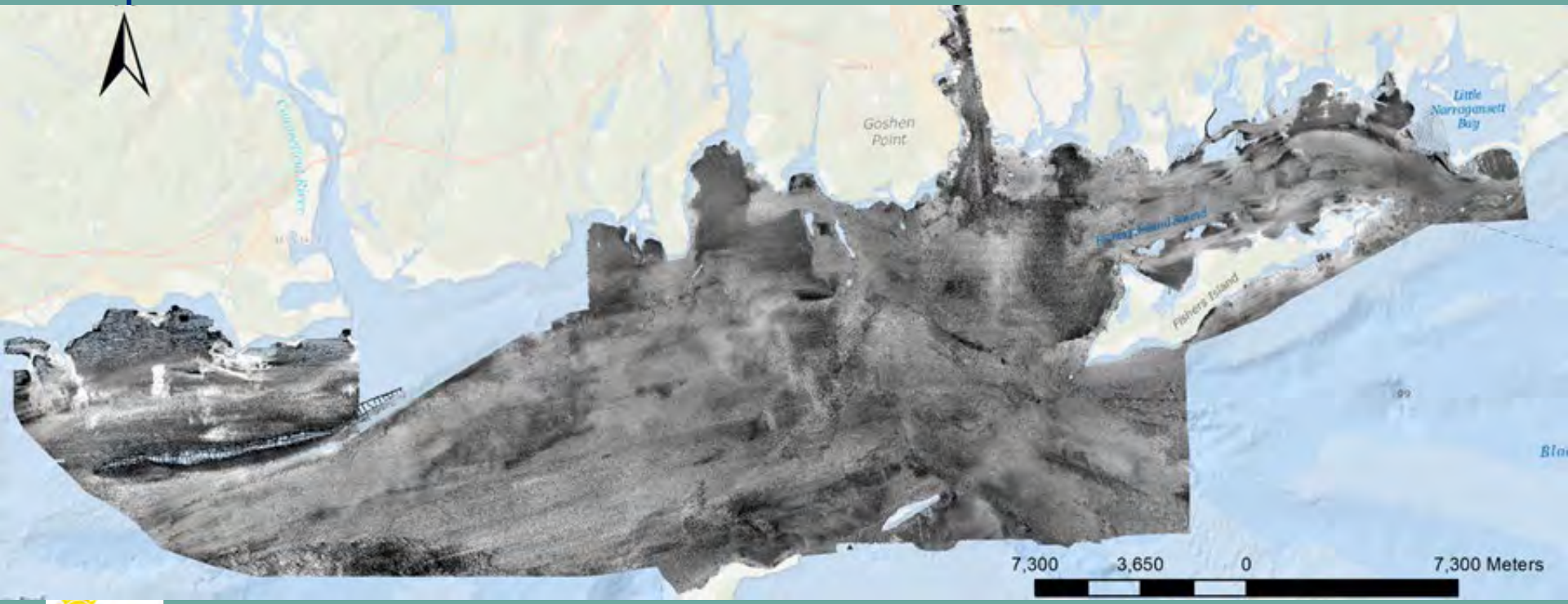
Connecticut Department of Energy and Environmental Protection

Surficial Chemistry (99% complete)



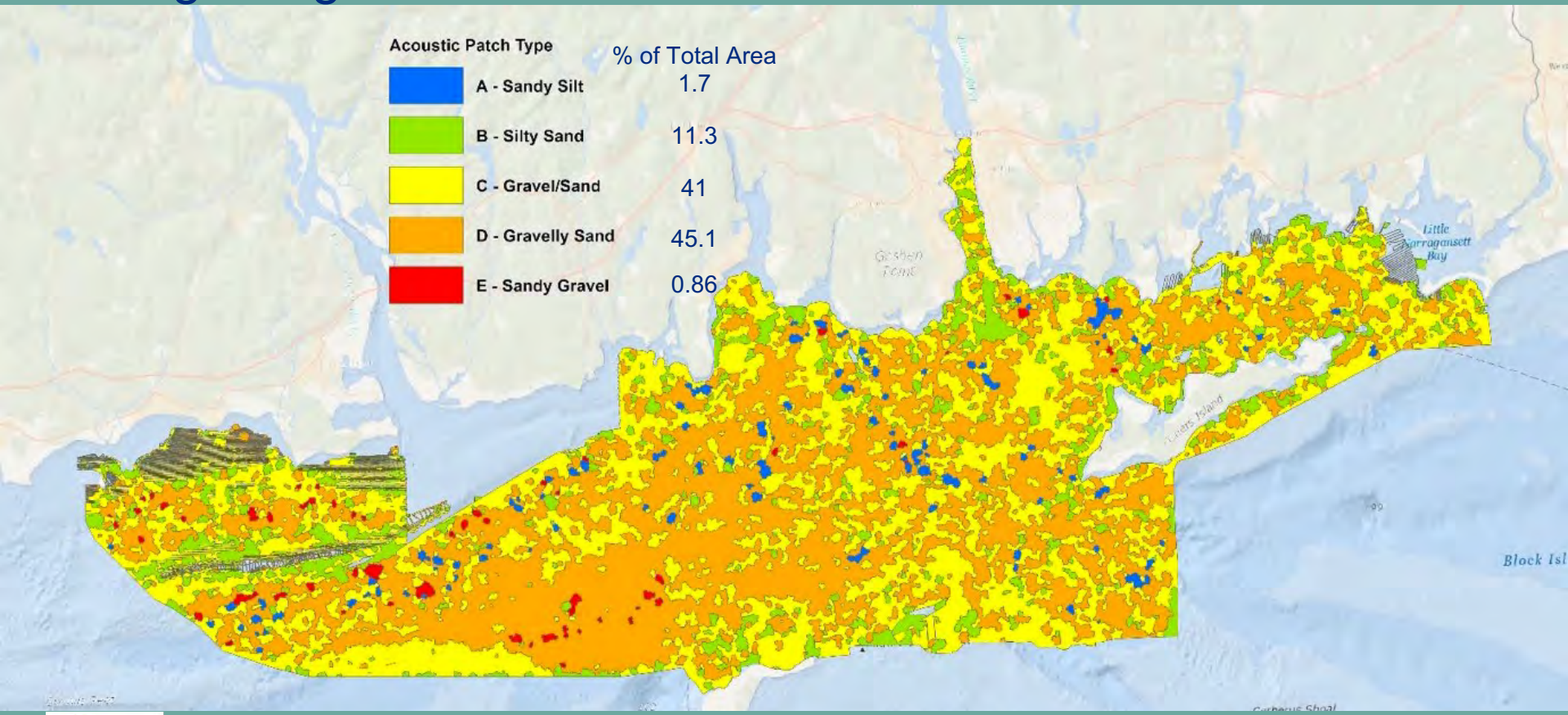
Seafloor/Habitat Characterization

Acoustic backscatter mosaic of the Phase II study area that was used for seafloor characterization. Darker shades generally represent finer sediments; lighter shades generally represent coarser sediments.



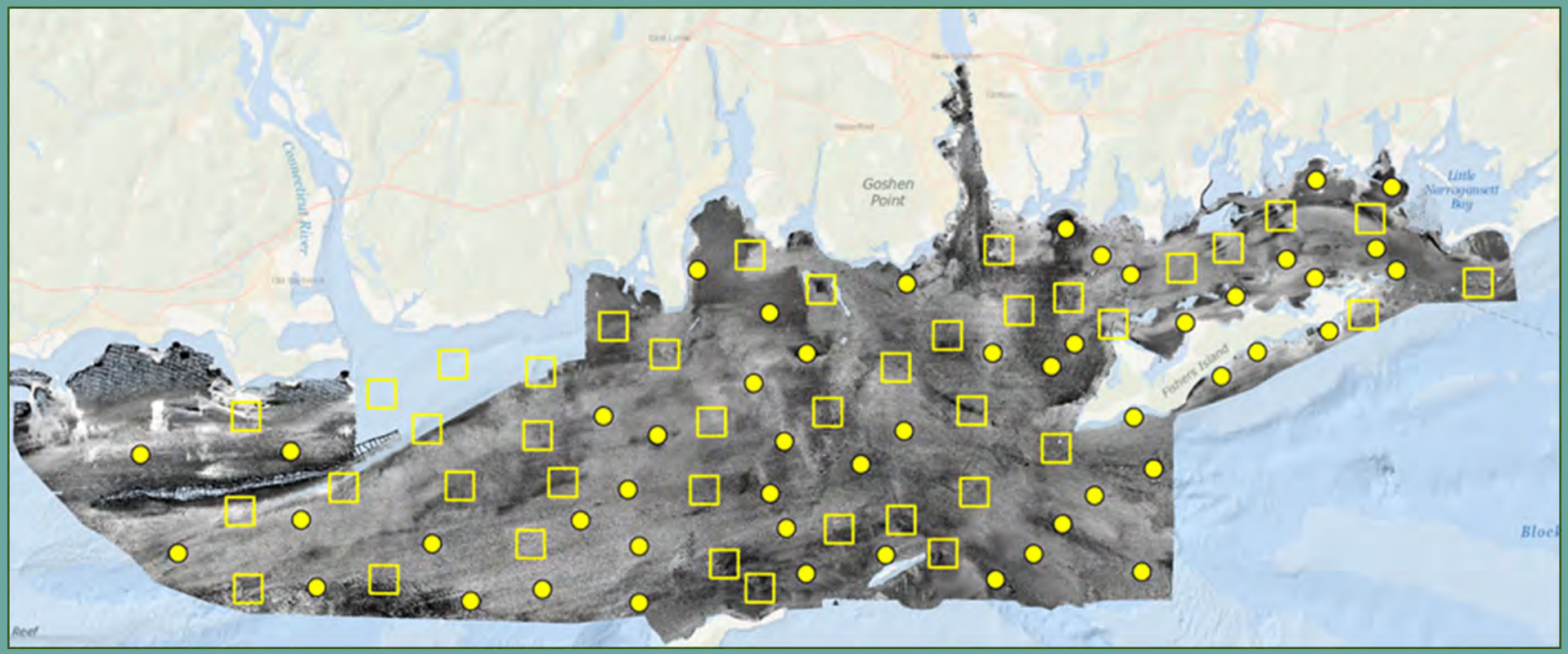
Seafloor/Habitat Characterization

Acoustic patch types identified in the Phase II study area using eCognition



Ecological Sampling

Sites (blocks – multiple samples, sites – single samples)

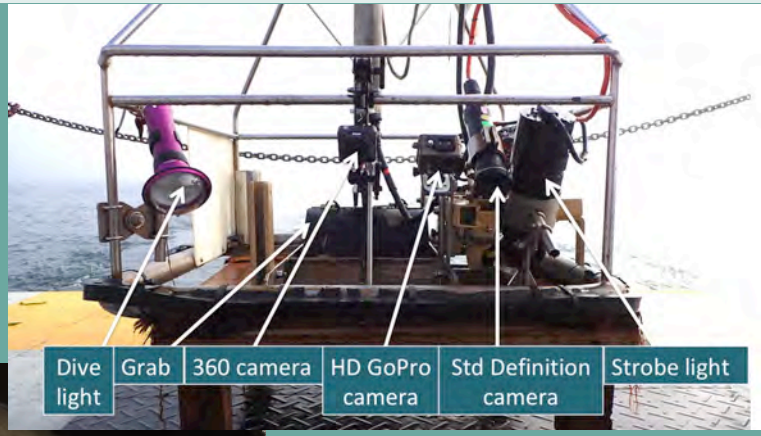


Ecological Sampling

- 40 sample *blocks* (1 km^2)/50 sample *sites*: 3 random grab samples w/in blocks; 1/site
- Backscatter and bathymetry data used to refine video transects at sample blocks and sites (min of 3/block, 1/site).
- Transects were selected to maximize seafloor complexity & sediment transitions from one habitat type to another to delineate and validate boundaries between habitats

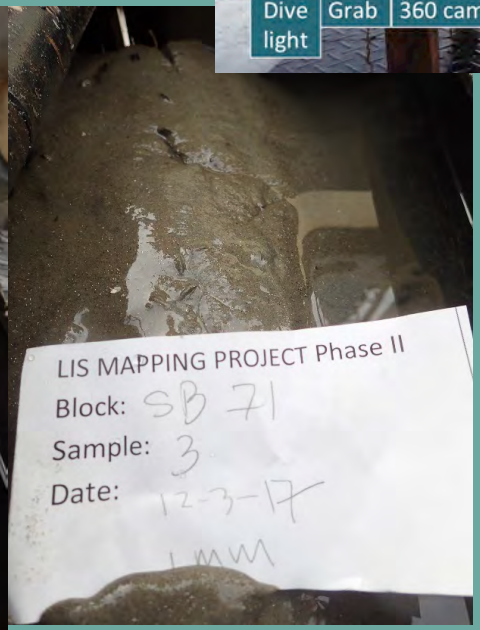
Ecological Characterization: Infauna

Example of three grab samples used for infaunal characterization from the same Sample Block (SB71



Sand

Gravely Sand / Shell Hash

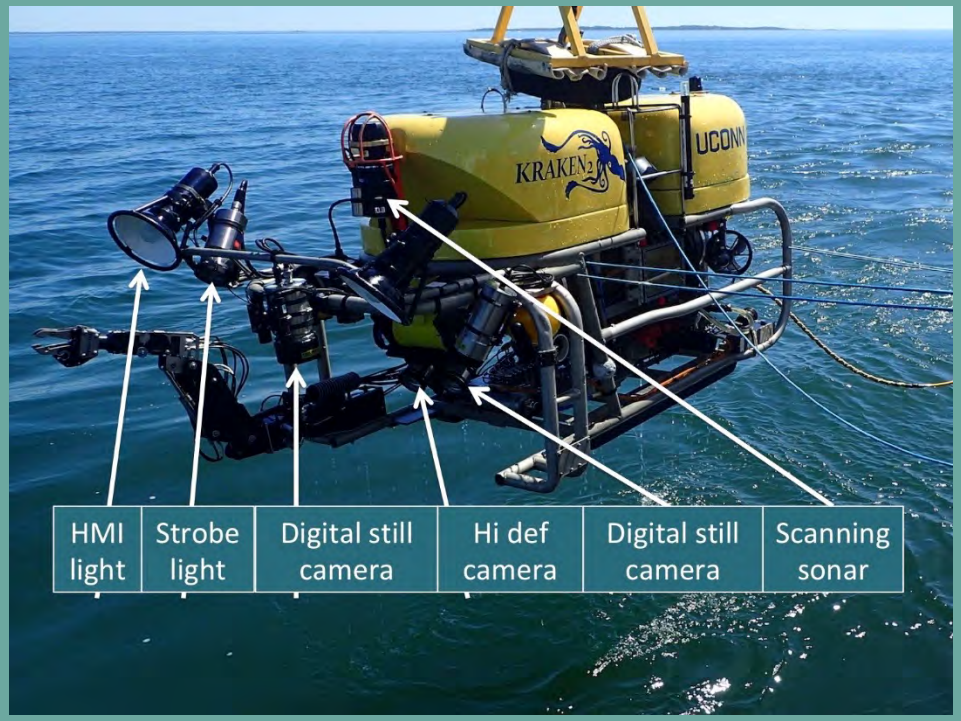


Muddy Sand

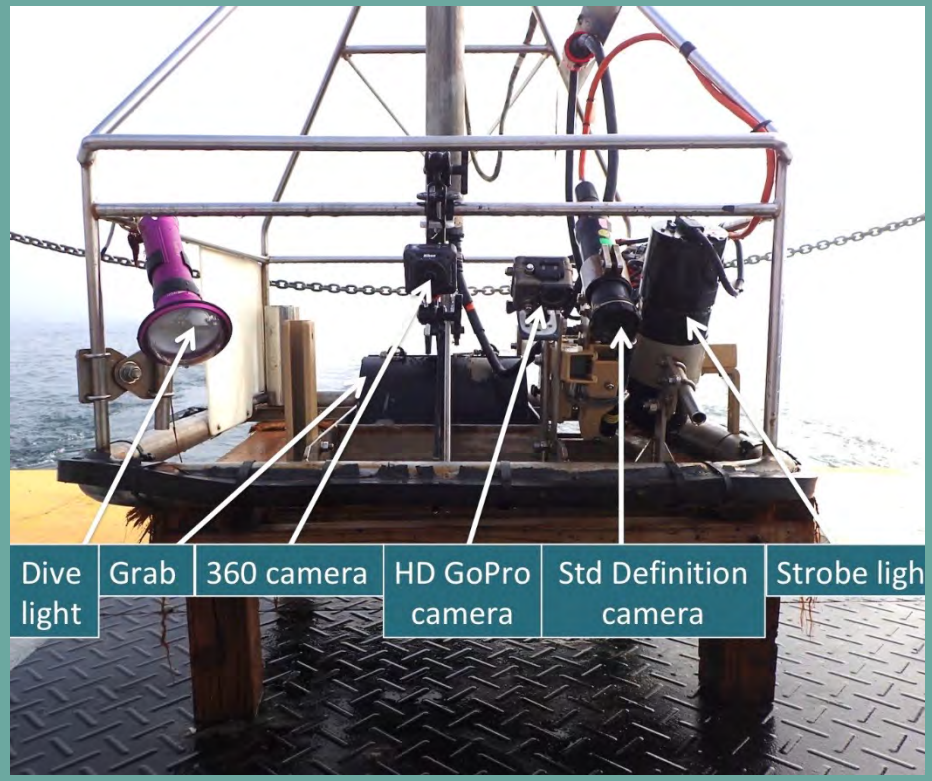
USGS SEABOSS used for infaunal sampling

Connecticut Department of Energy and Environmental Protection

Ecological Characterization: Epifaunal

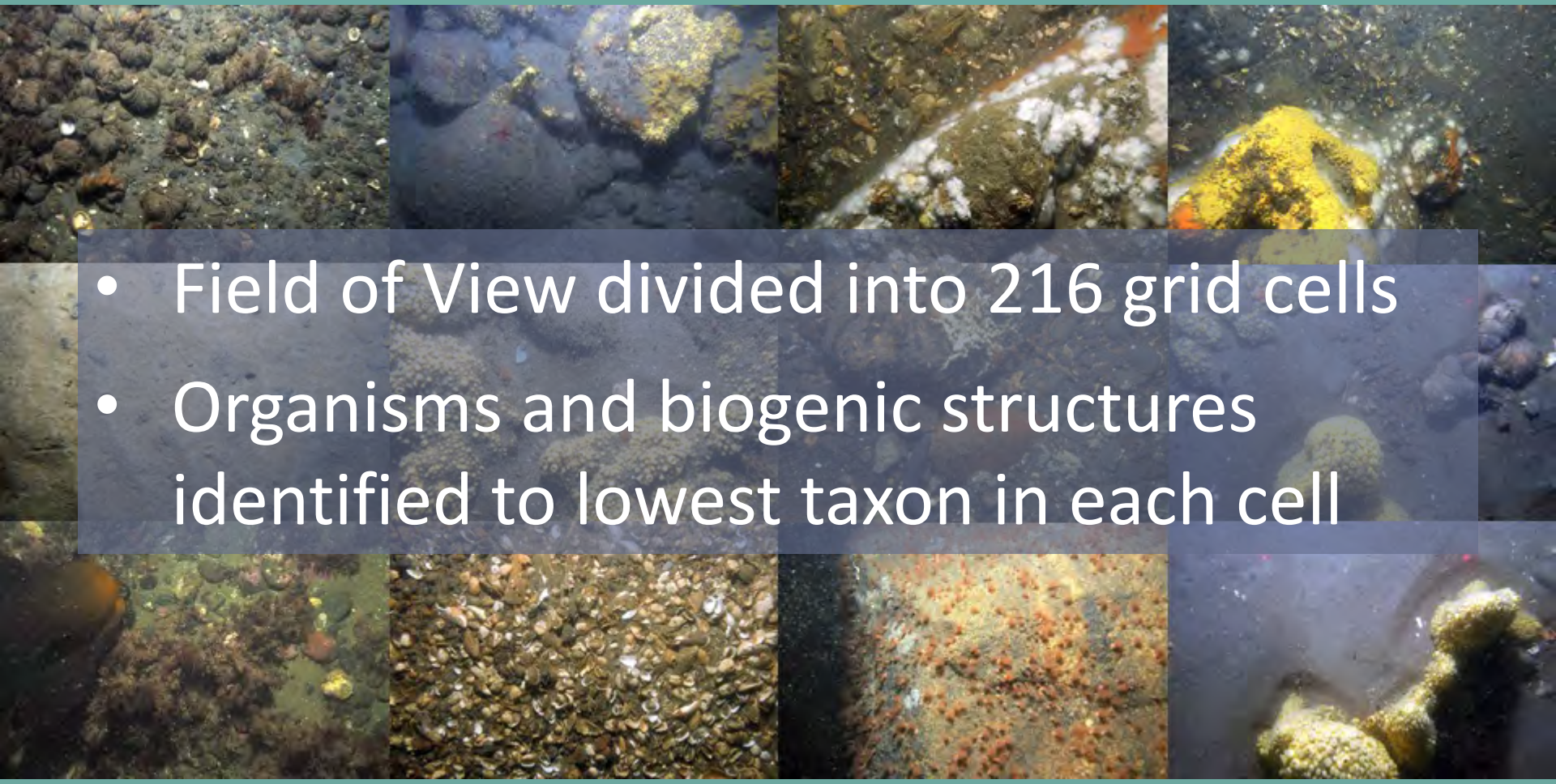


Kraken2 ROV - Spring 2018



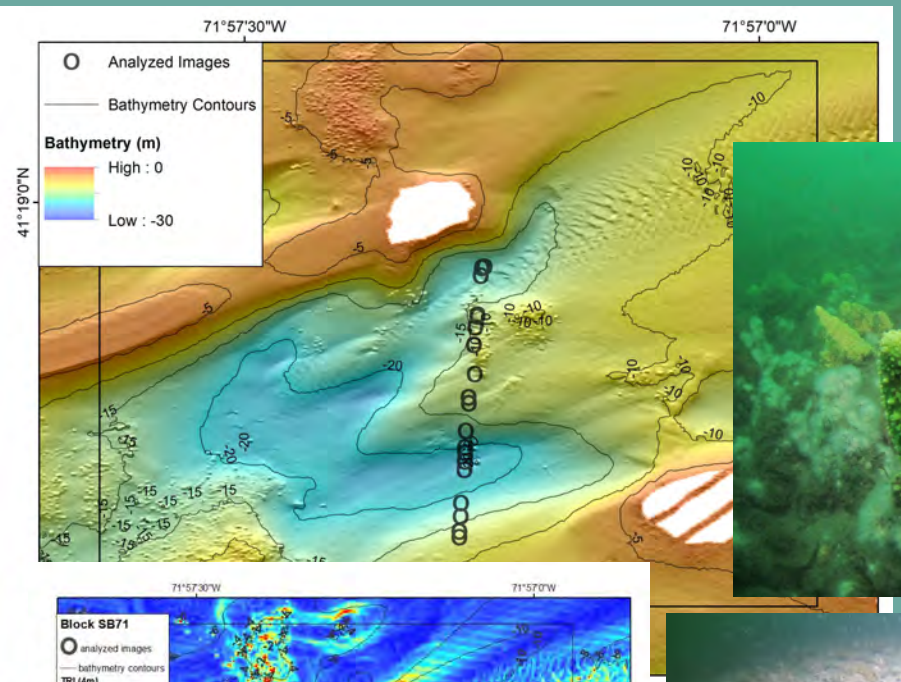
USGS SEABOSS - Fall 2017 and Spring 2018

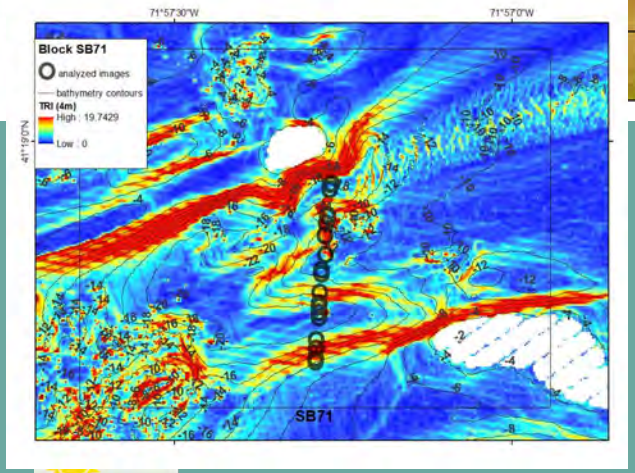
Ecological Characterization: Epifaunal



- Field of View divided into 216 grid cells
- Organisms and biogenic structures identified to lowest taxon in each cell

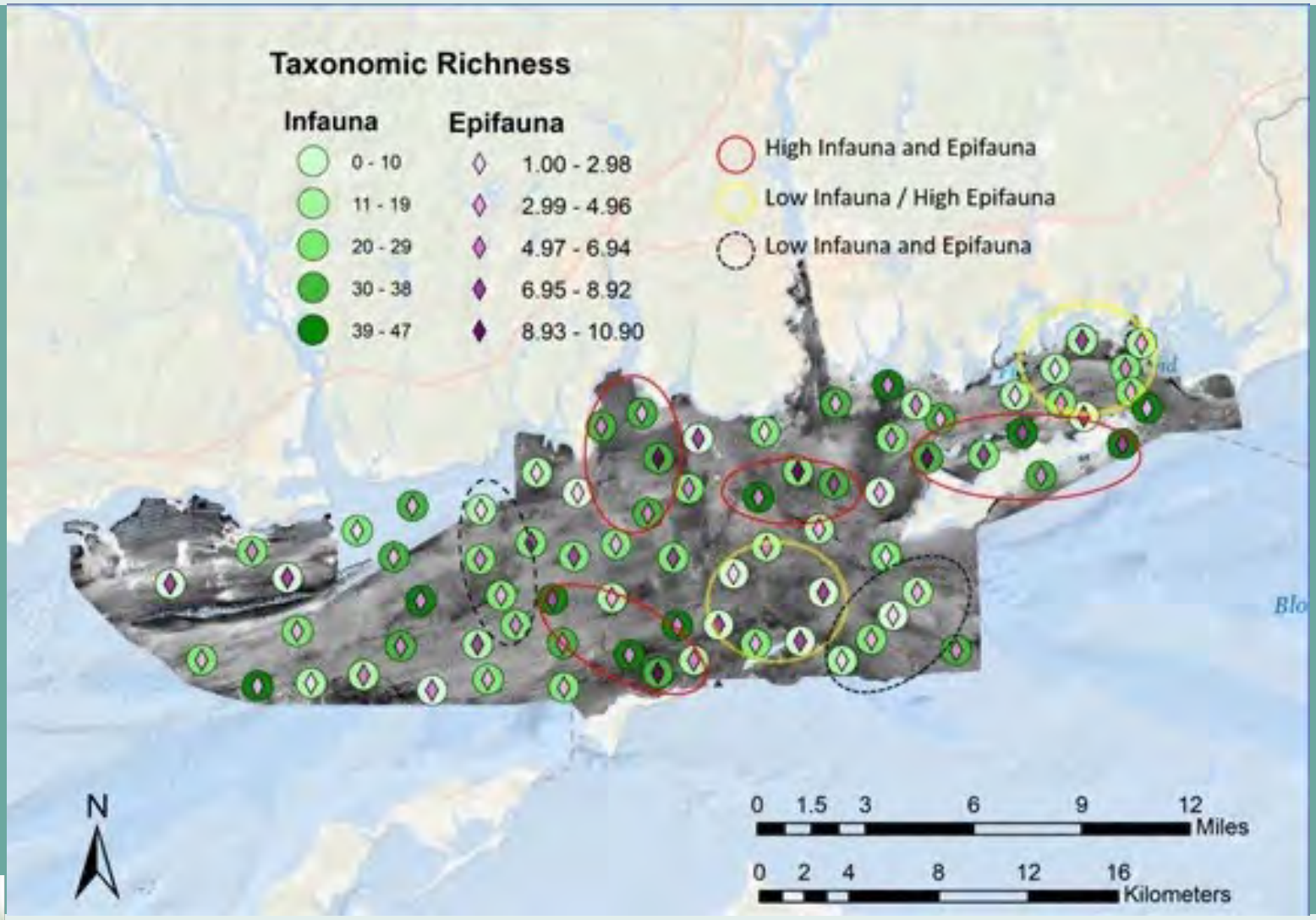
Ecological Characterization: Epifaunal





Connecticut Department of Energy and Environmental Protection

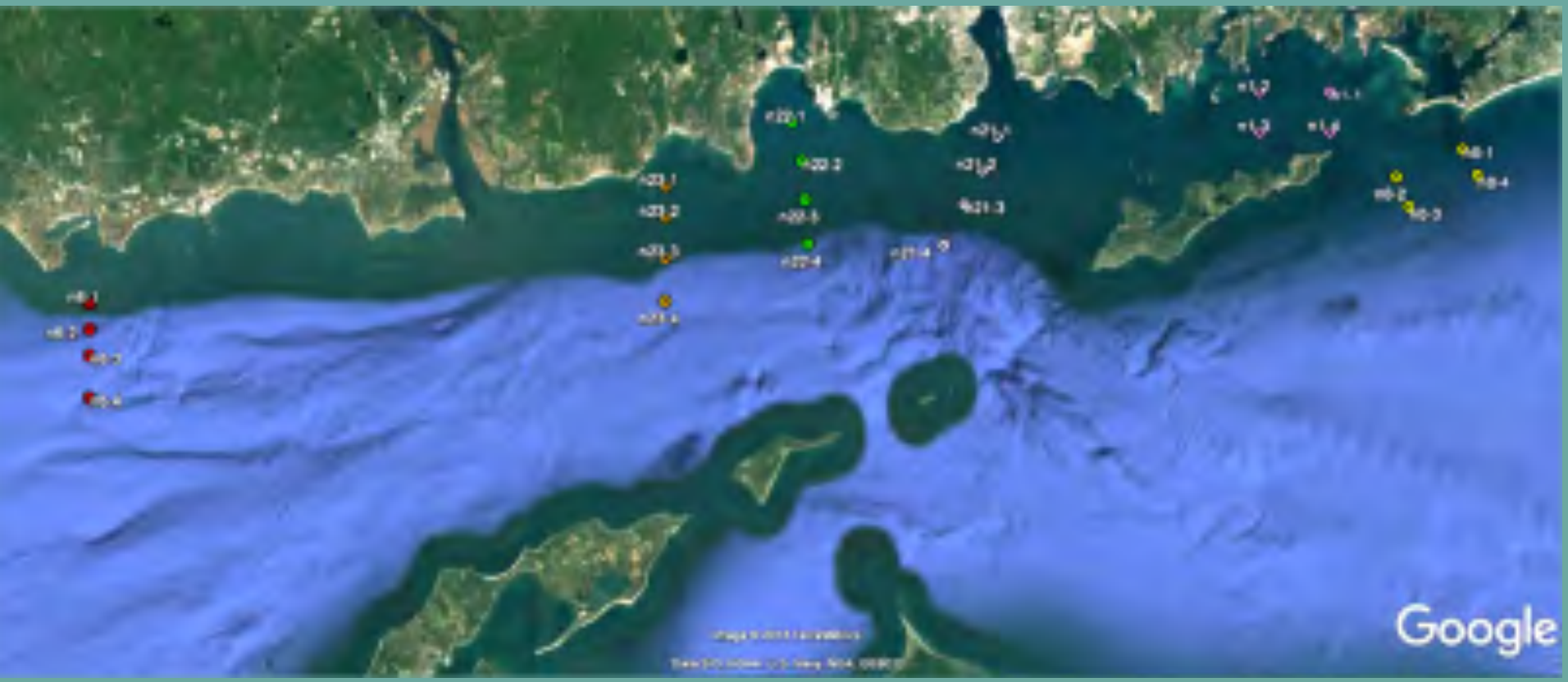
Spatial Variability of Taxonomic Richness



Connecticut Department of Energy and Environmental Protection

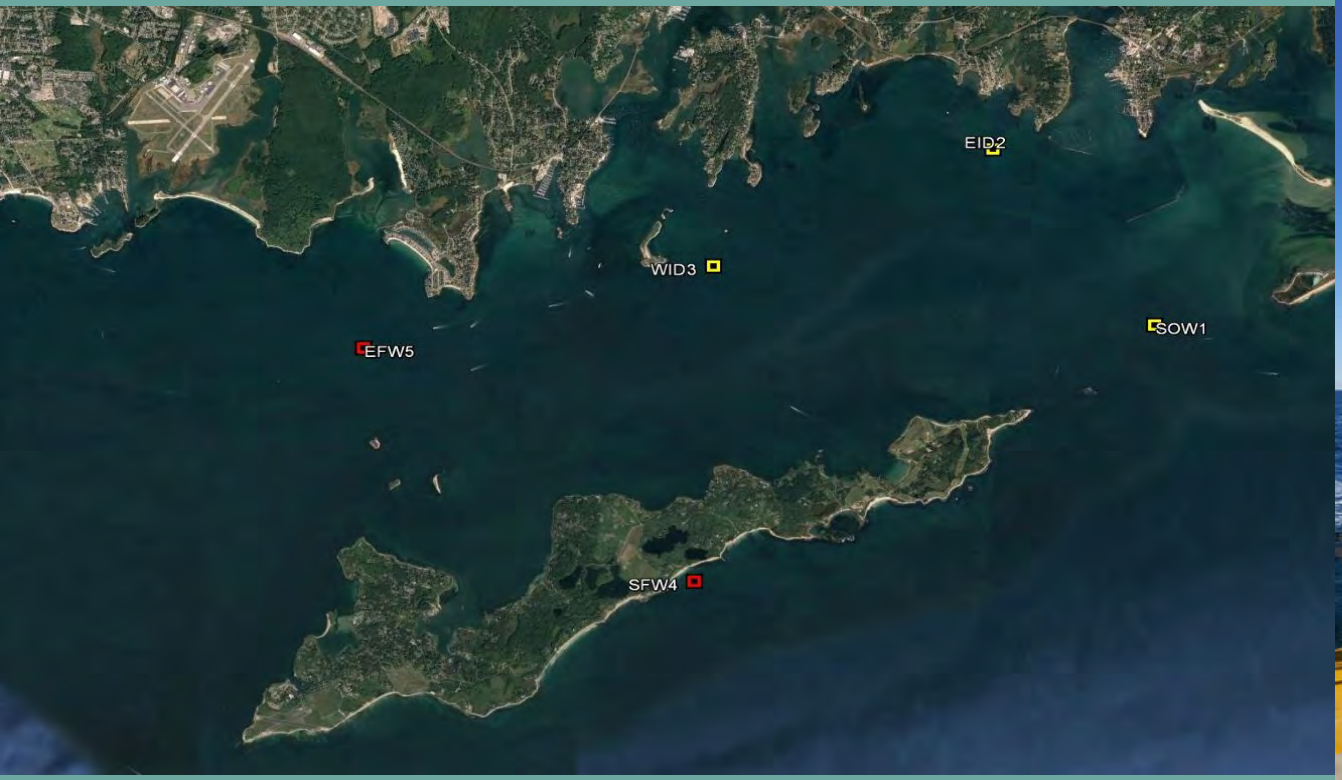
Physical Oceanography

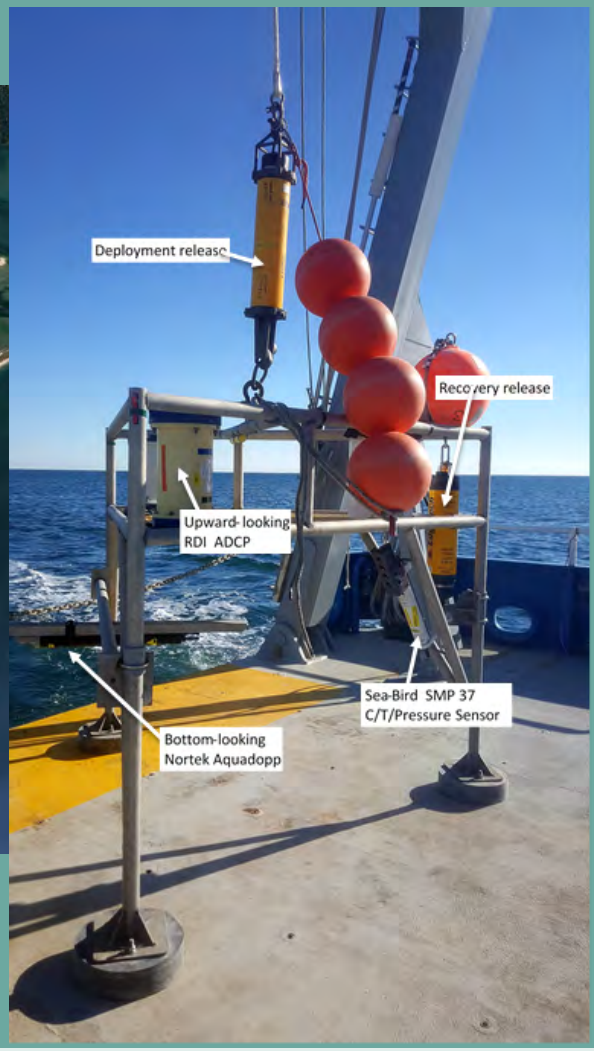
CTD Sampling Locations



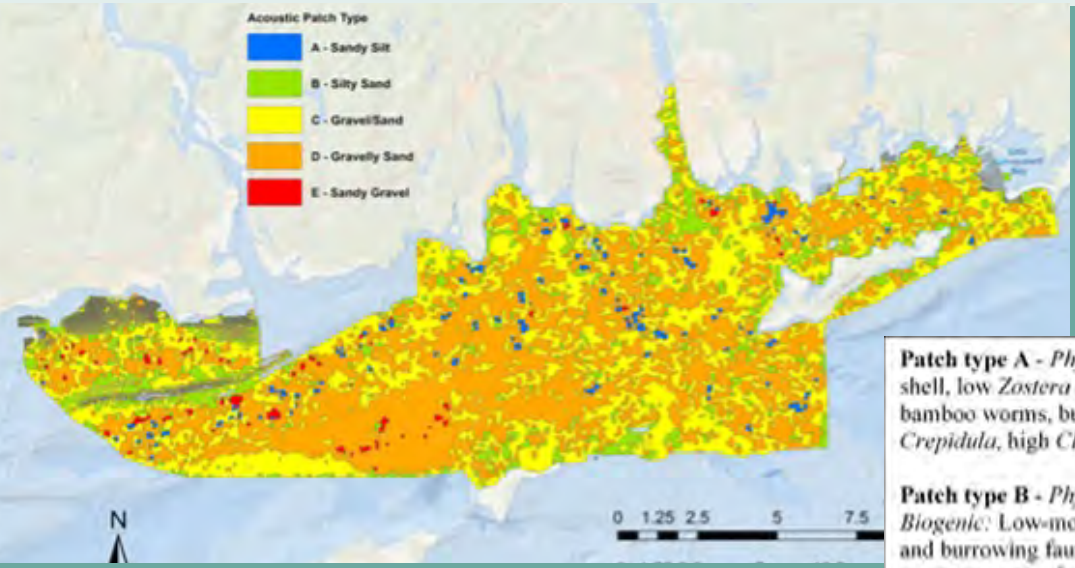
Physical Oceanography

Bottom observation platforms





Putting it all together….Integrated Habitat Map



Patch type A - *Physical:* Generally shallow, low complexity, low energy. *Biogenic:* Lowest coverage of shell, low *Zostera* debris; *Infaunal taxa:* Tube building and burrowing fauna, molluscs, *Ampelisca*, bamboo worms, burrowing anemones; *Epi- emergent- taxa.* Low hydrozoan-bryozoan turf, high *Crepidula*, high *Cliona*, high Rhodophyta (some shallow sites).

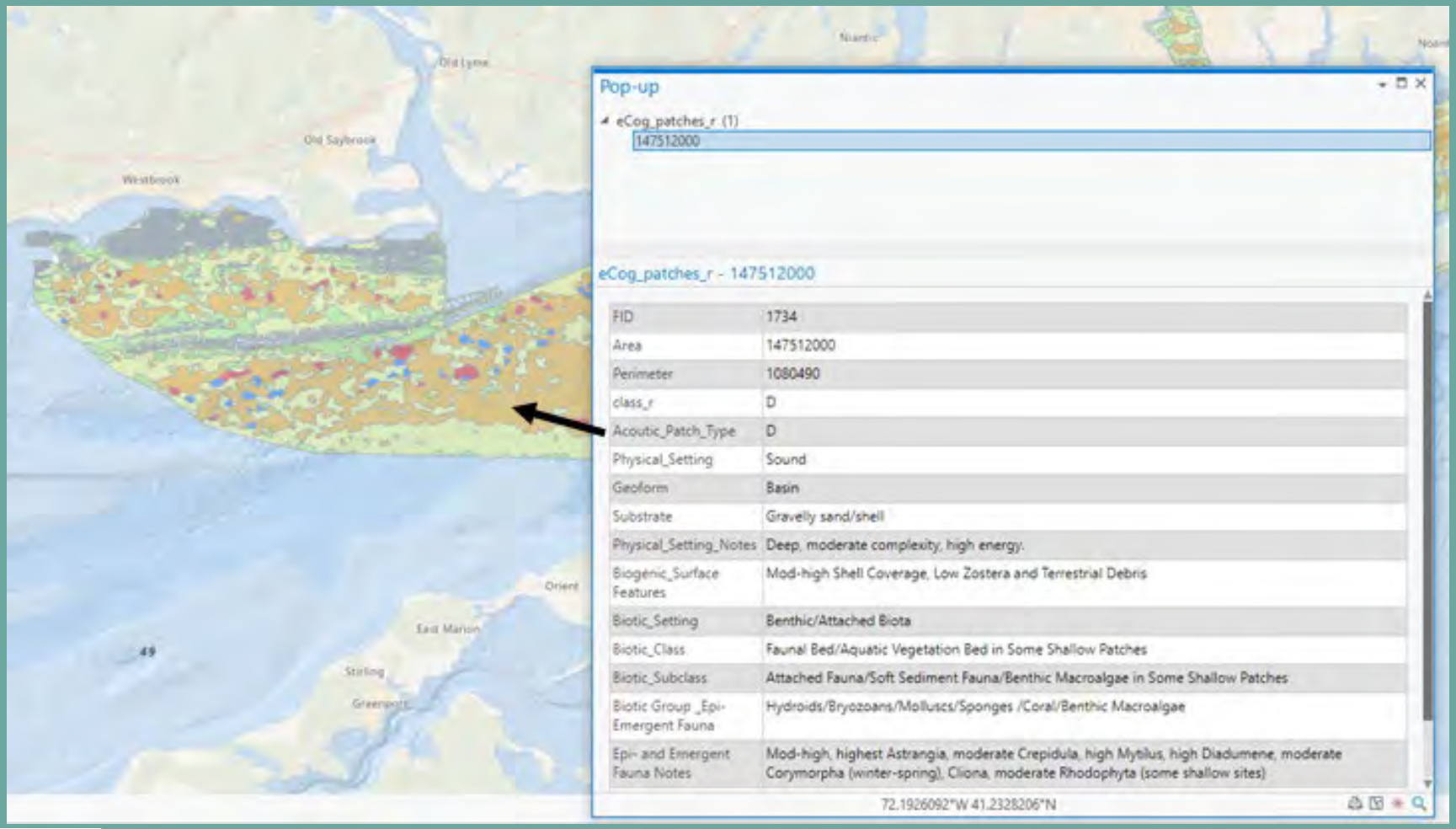
Patch type B - *Physical:* Moderate depths, moderate to high complexity, low to moderate energy. *Biogenic:* Low-mod shell coverage, moderate *Zostera* and terrestrial debris; *Infaunal taxa:* Tube building and burrowing fauna, hermit crabs, amphipods, bamboo worms, burrowing worms, sand dollars; *Epi- emergent- taxa:* Low-mod hydrozoan-bryozoan turf, low *Astrangia*, low *Crepidula*, low *Mytilus*, *Diadumene*, *Corymorpha* (winter-spring), *Cliona*, high Rhodophyta cover at some shallow sites.

Patch type C - *Physical:* Deepest, highest complexity, moderate to high energy; *Biogenic:* Moderate shell coverage, moderate *Zostera* and terrestrial debris; *Infaunal Taxa:* Tube building and burrowing Fauna, molluscs, *Astarte* spp., amphipods, bamboo worms, burrowing worms, sand dollars; *Epi- emergent- taxa:* Moderate hydrozoan-bryozoan turf, moderate *Astrangia*, moderate *Crepidula*, moderate *Mytilus*, *Diadumene*, moderate *Corymorpha* (winter-spring), *Cliona*, moderate *Rhodophyta* (some shallow sites).

Patch type D - *Physical:* Deep, moderate complexity, highest energy; *Biogenic:* Mod-high shell coverage, low *Zostera* and terrestrial debris; Infaunal Taxa: Molluscs, *Astarte* spp., tube building and burrowing fauna, amphipods, bamboo worms, sand dollars. *Epi- emergent- taxa:* Moderate-high to highest *Astrangia*, moderate *Crepidula*, high *Mytilus*, high *Diadumene*, moderate *Corymorpha* (winter-spring), *Cliona*, moderate *Rhodophyta* (some shallow sites).

Patch type E - *Physical:* Shallow to moderate depths, low complexity, high energy; *Biogenic:* Highest coverage of shell; *Infaunal taxa:* Molluscs, *Astarte* spp. tube building and burrowing fauna, ophiuroids, sand dollars; *Epi- emergent- taxa:* Highest hydrozoan-bryozoan turf, high *Astrangia*, low *Crepidula*, moderate *Mytilus*, high *Corymorpha* (winter-spring).

Putting it all together….CMECS



Completing the Phase II Initiative

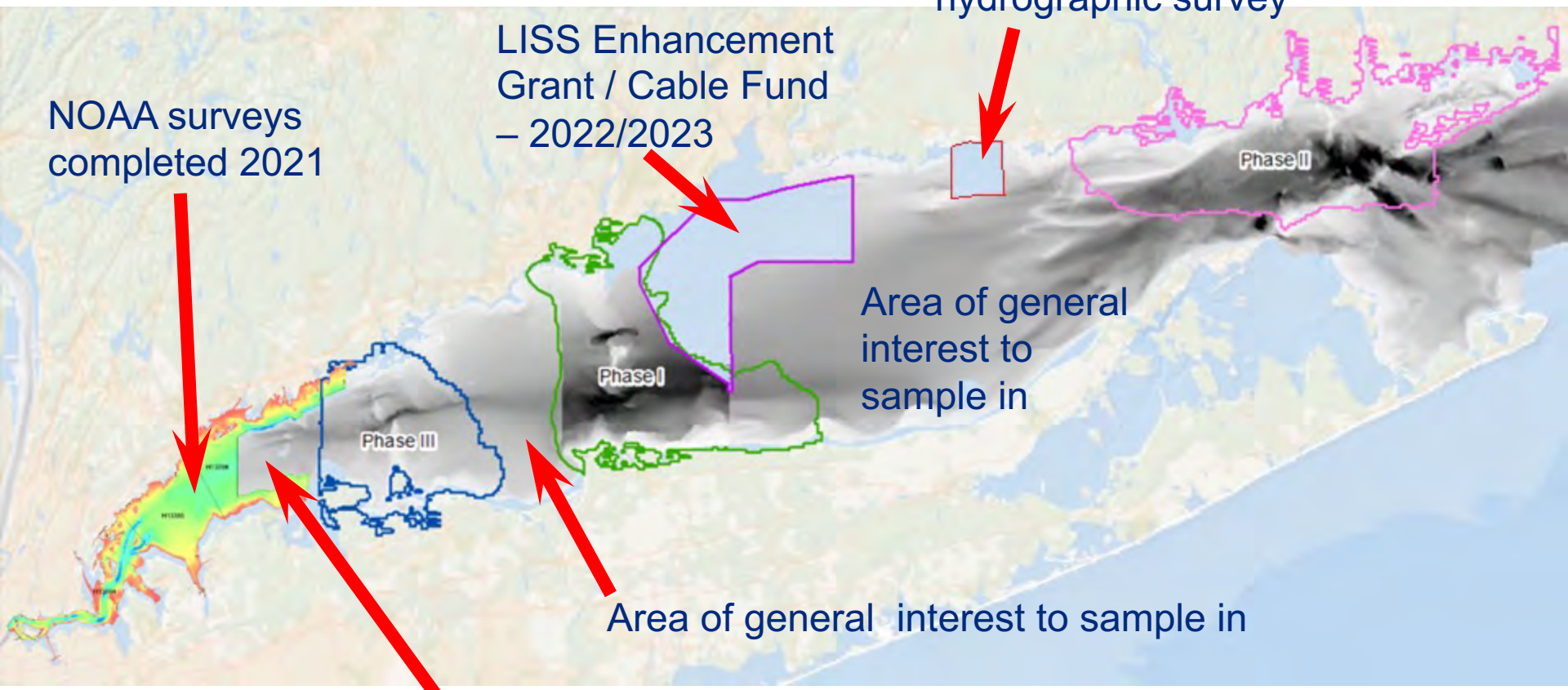
dimen coring operations on the RV Pritchard

Students assisting with sediment coring operations on the RV Pritchard

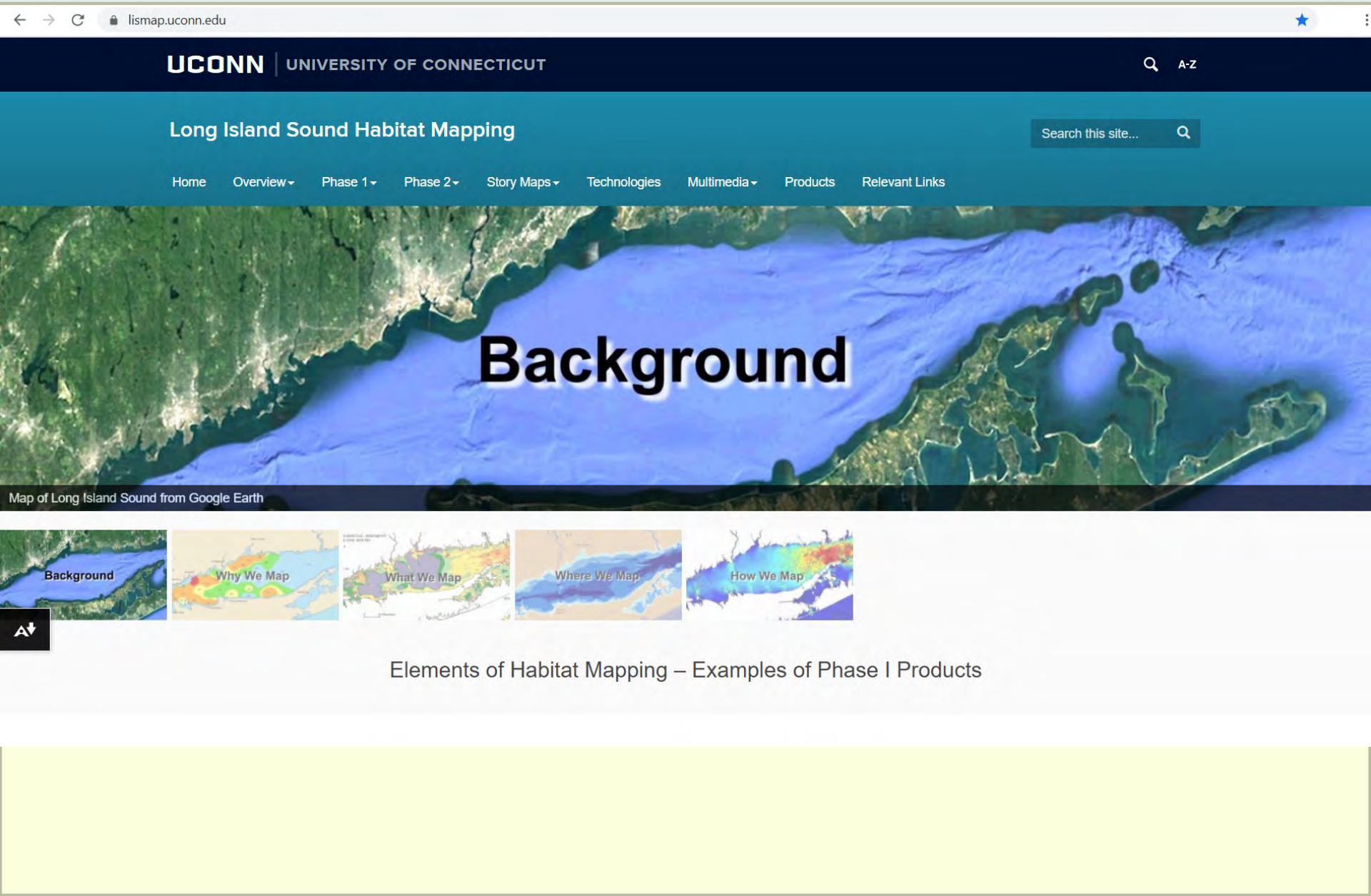
Phase I and II Outcomes

- Results were included in the LIS Blue Plan inventory (eg cold water corals, areas of seafloor complexity)
- A preliminary report was generated in 2021 to guide cable routing decisions in LIS 2021
- Data were provided to NYSERDA to also guide cable routing

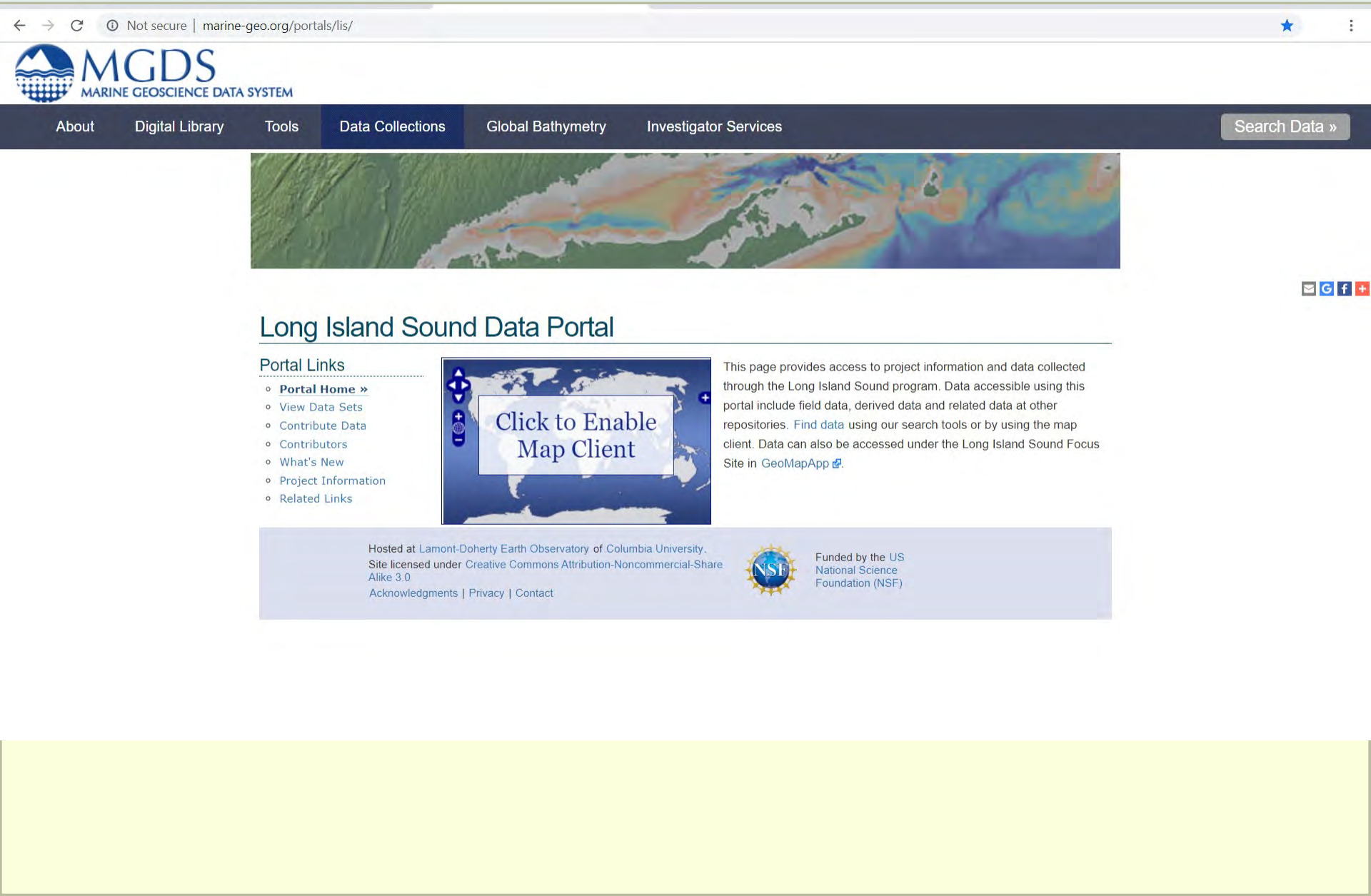
Phase III & Beyond



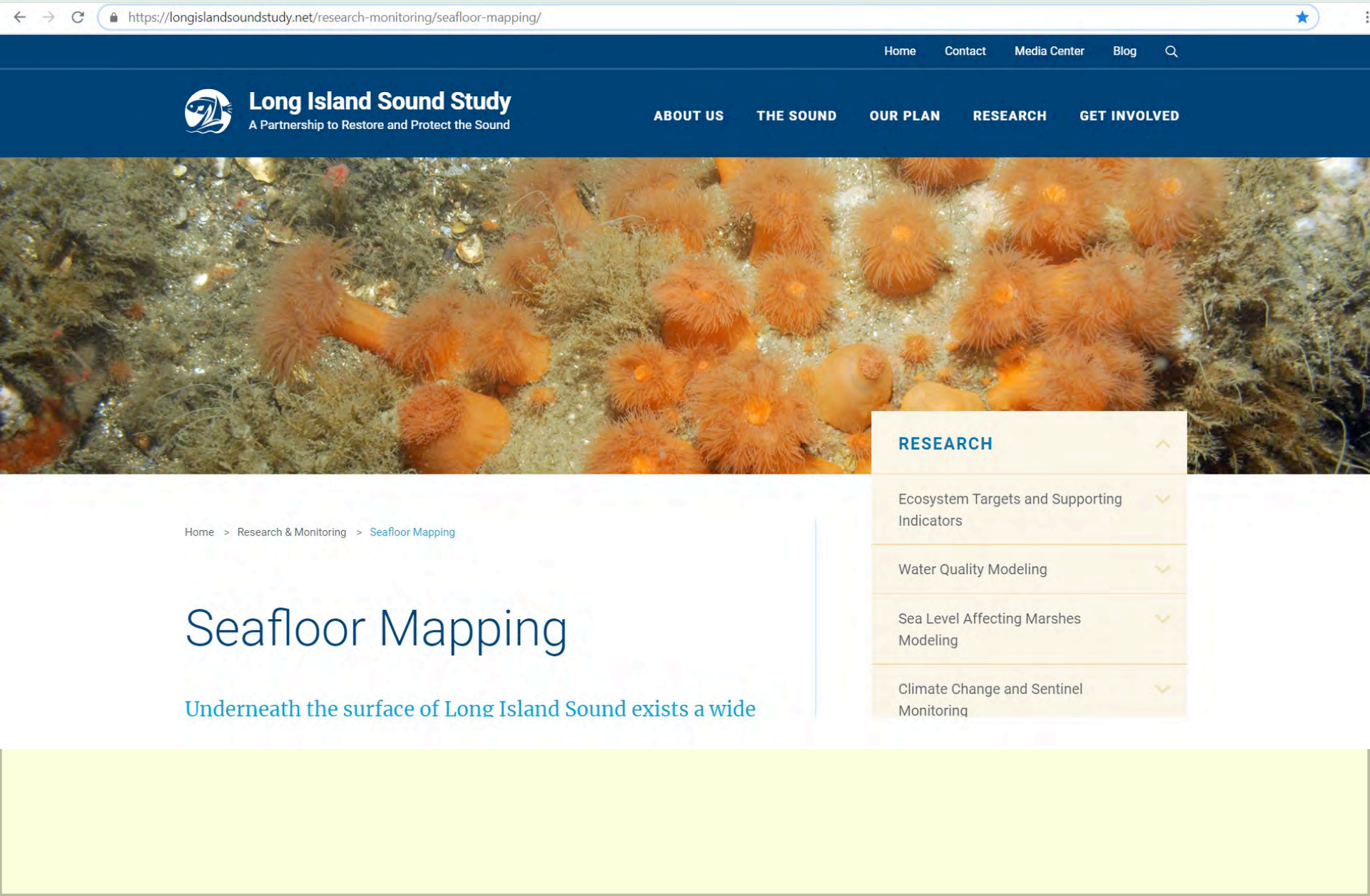
LIS Mapping Initiative Resources



LIS Mapping Initiative Resources



LIS Mapping Initiative Resources



Questions?
DeAva.Lambert@ct.gov | Kevin.OBrien@ct.gov

LIS Mapping Initiative Resources

- https://lismap.uconn.edu/
- http://www.marine-geo.org/portals/lis/
- https://longislandsoundstudy.net/research-monitoring/seafloor-mapping/