Benthic community patterns across west-central Long Island Sound sea floor landscapes and implications for conservation, management and spatial planning

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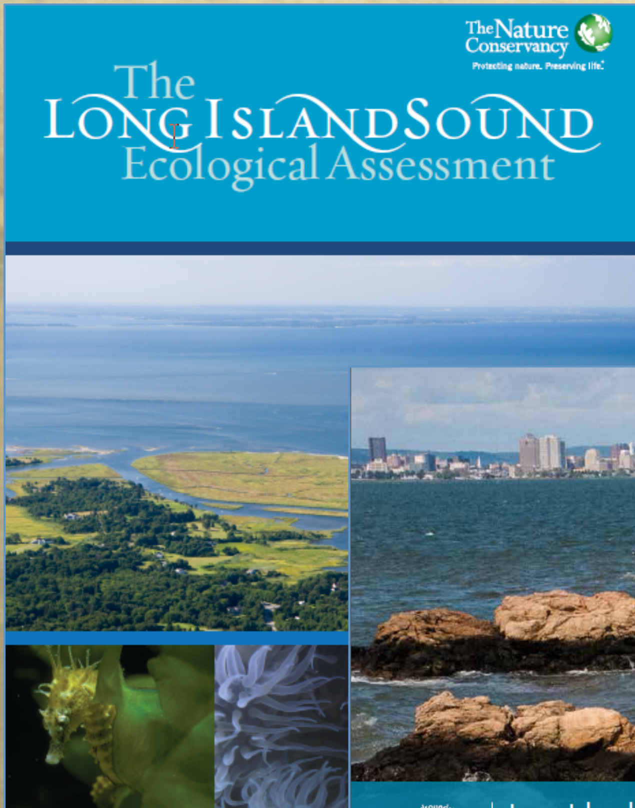
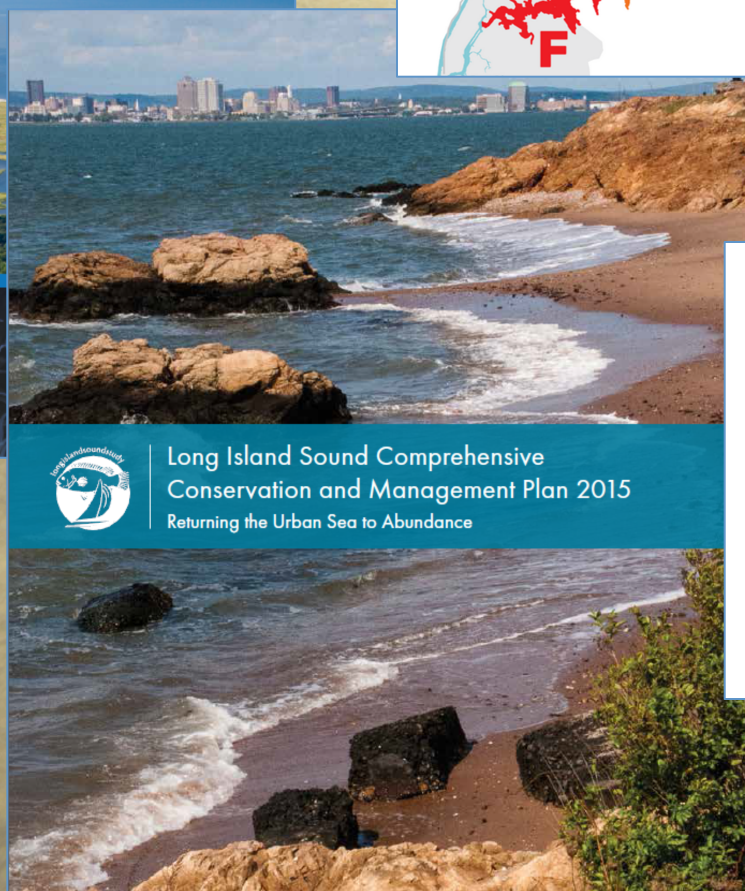
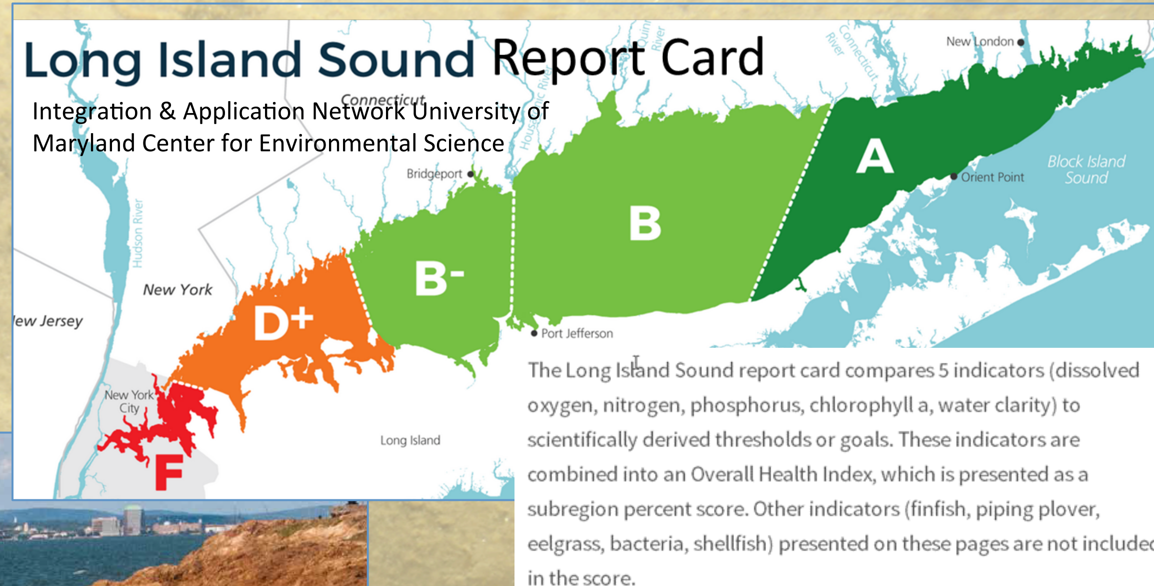
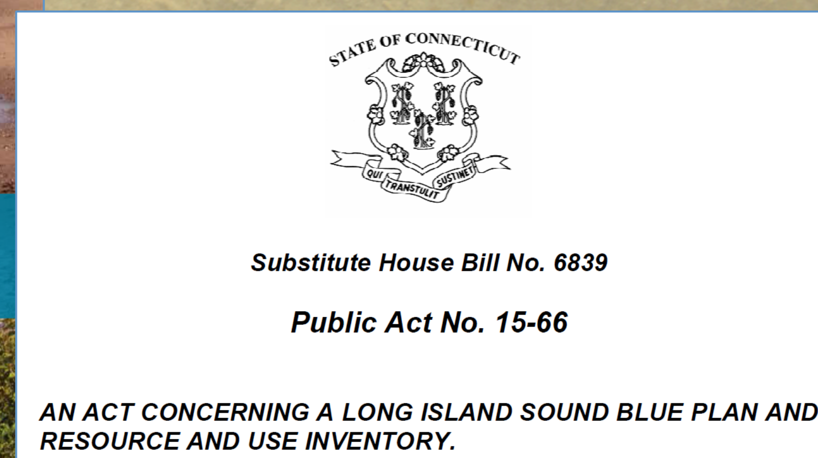
Many LIS management & assessment initiatives / projects new, revised, ongoing








STATE OF CONNECTICUT

QUI TRANSTULIT SUSTINET

Substitute House Bill No. 6839

Public Act No. 15-66

AN ACT CONCERNING A LONG ISLAND SOUND BLUE PLAN AND RESOURCE AND USE INVENTORY.

and others

The Blue Plan *Some Highlights*

1. Completion of an inventory of Long Island Sound's uses and natural resources (the "Long Island Sound Resource and Use Inventory") and

2. Develop a plan to preserve and protect the Sound that may include maps, illustrations, and other media (the "Long Island Sound Blue Plan").

LONG ISLAND SOUND RESOURCE AND USE INVENTORY

Under the bill, the inventory must be completed by a Long Island Sound Inventory and Science subcommittee. It must be comprised of the best available information and data on Long Island Sound's natural resources and uses, including ***all*** of its:

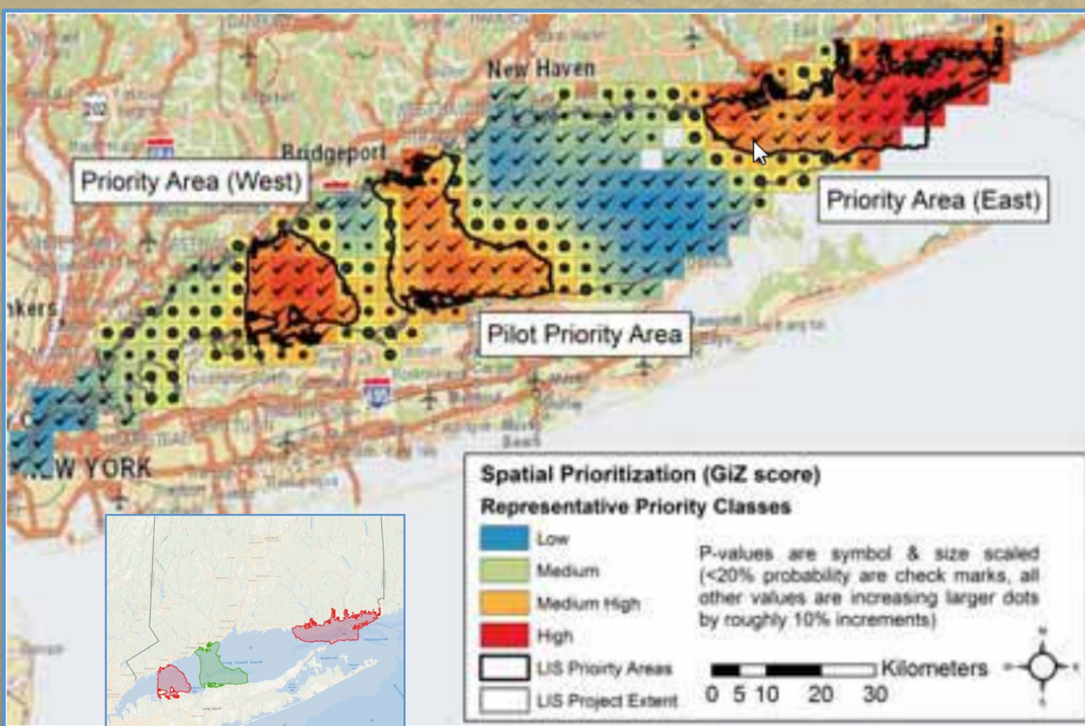
1. plants, animals, and habitats;
2. ecologically significant areas in nearshore and offshore waters and their substrates (surfaces where organisms grow);
3. uses of the waters and substrates, such as (a) boating and fishing; (b) waterfowl hunting; (c) shellfish beds; (d) aquaculture and energy facilities; (e) shipping corridors; and (f) electric power line, gas pipeline and telecommunications crossings; and
4. updates and additions to the comprehensive environmental assessment and plan on Long Island Sound crossings (such as pipelines).

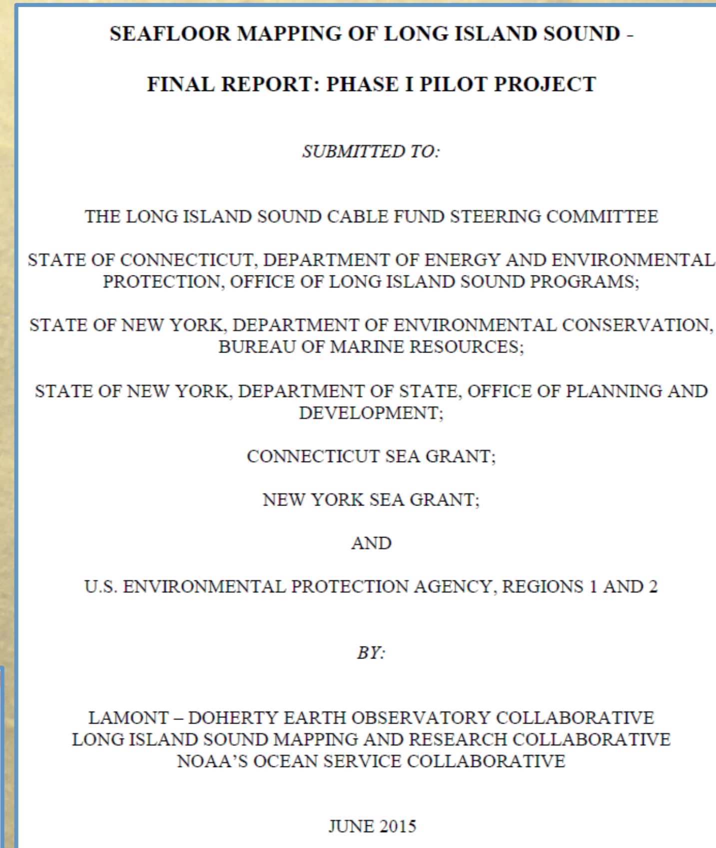
Long Island Sound Cable Fund

* Support new projects and activities that enhance Long Island Sound.

*Promote improved scientific understanding of the biological, chemical, and physical effects of existing or potential cable and pipeline crossings and mitigation of their impacts.

* Emphasize benthic mapping as a priority need, essential to an improved scientific basis for management and mitigation decisions.





SEAFLOOR MAPPING OF LONG ISLAND SOUND -

FINAL REPORT: PHASE I PILOT PROJECT

SUBMITTED TO:

THE LONG ISLAND SOUND CABLE FUND STEERING COMMITTEE

STATE OF CONNECTICUT, DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION, OFFICE OF LONG ISLAND SOUND PROGRAMS;

STATE OF NEW YORK, DEPARTMENT OF ENVIRONMENTAL CONSERVATION, BUREAU OF MARINE RESOURCES;

STATE OF NEW YORK, DEPARTMENT OF STATE, OFFICE OF PLANNING AND DEVELOPMENT;

CONNECTICUT SEA GRANT;

NEW YORK SEA GRANT;

AND

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGIONS 1 AND 2

BY:

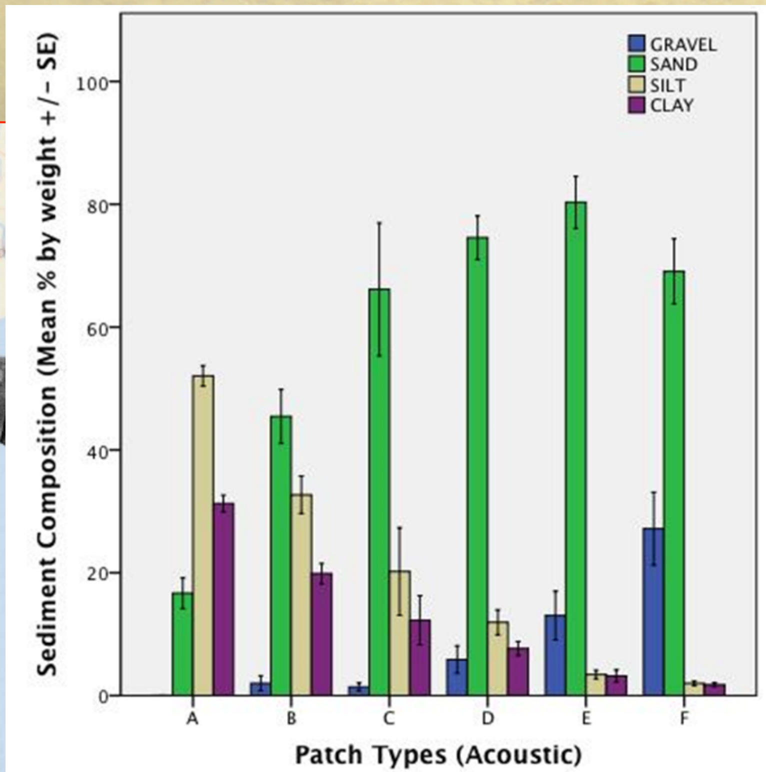
LAMONT – DOHERTY EARTH OBSERVATORY COLLABORATIVE
LONG ISLAND SOUND MAPPING AND RESEARCH COLLABORATIVE
NOAA'S OCEAN SERVICE COLLABORATIVE

JUNE 2015

The data, assessments and products from the Cable Fund provide information for the Blue Plan and other efforts, particularly for subtidal nearshore and deeper waters.

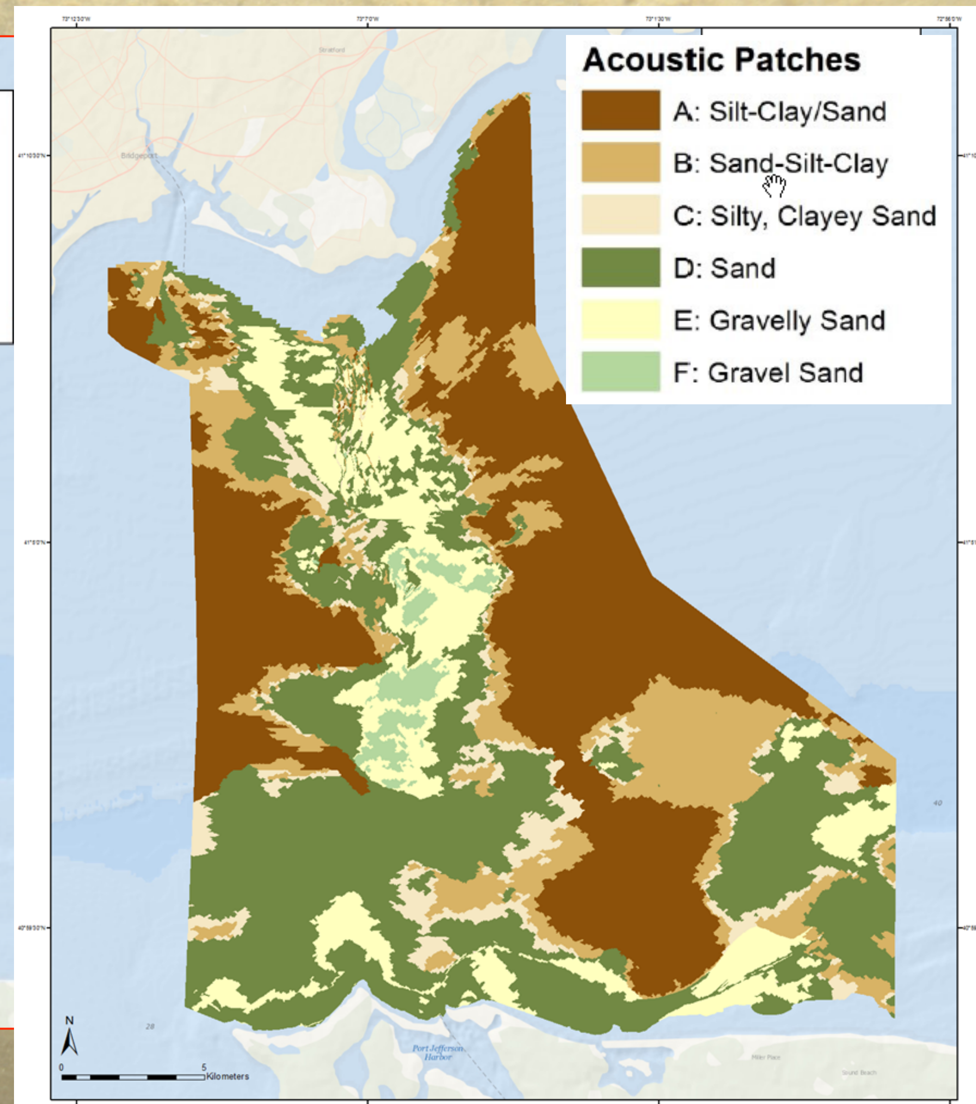
Overview of benthic community ecology findings from the Ecological Characterization Component of Phase I and potential applications

Sea floor landscapes, component habitats /patches and characteristics



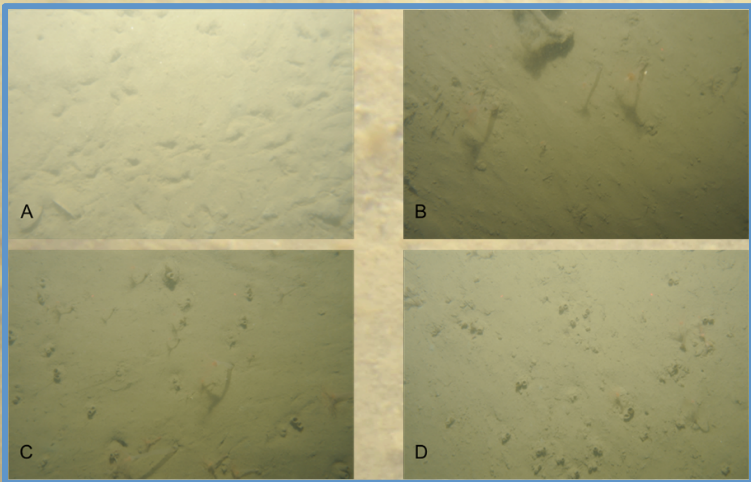
Large –scale structure

Image analysis of backscatter data – Ecognition / GIS



Identify sub-patches for meso-scale structure and variation

GIS- based modeling



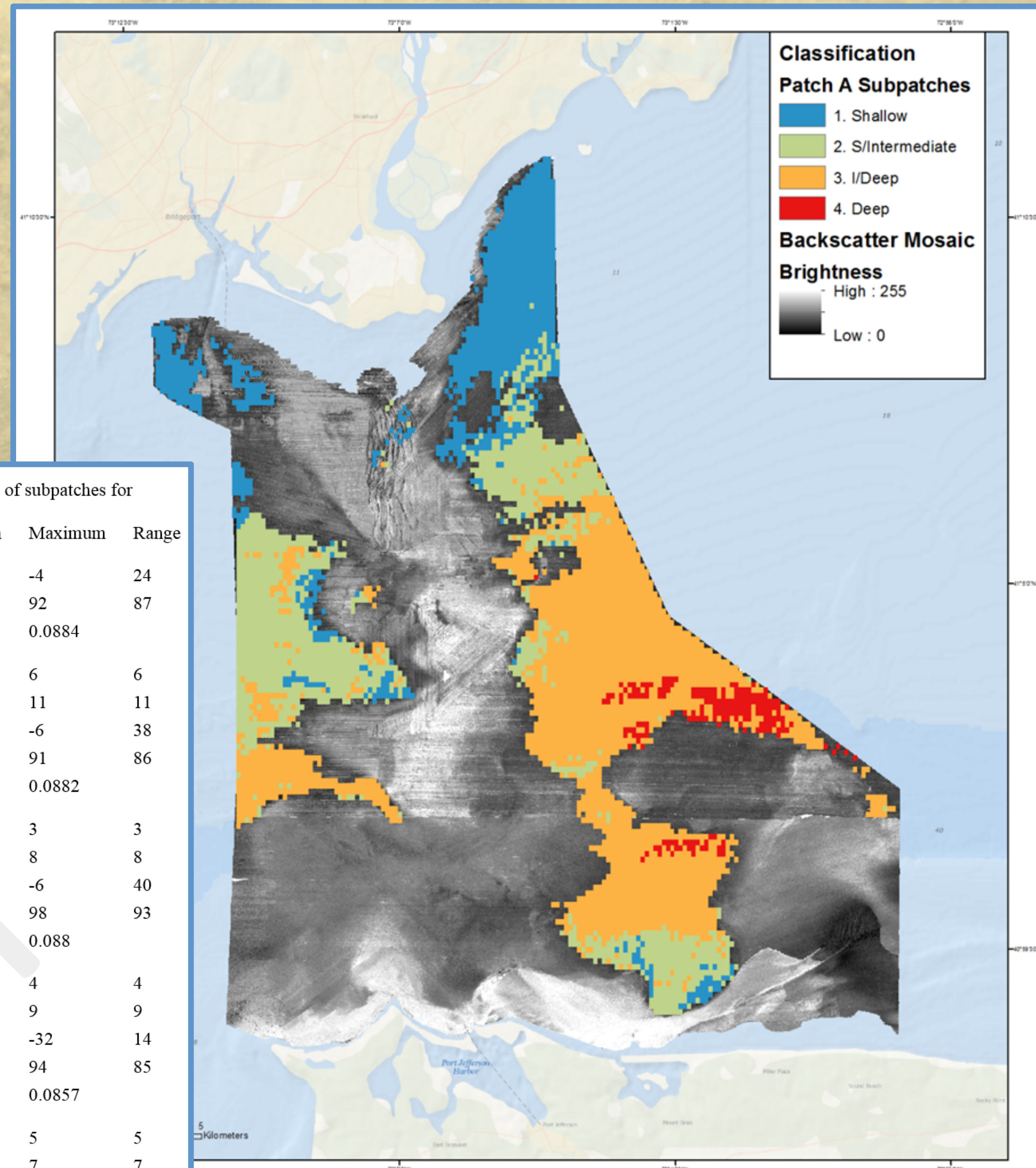


Table 5.2-5: Value range, mean and standard deviation for habitat modifiers form the analysis of subpatches for Acoustic patch type A.

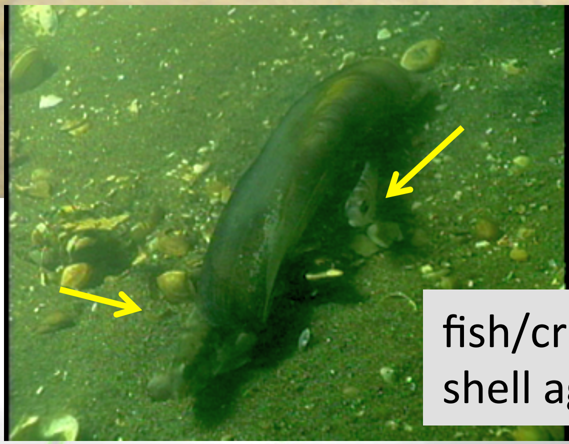
Subpatch	Layer	Pixel Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Range
1	Bathymetry	1071	-10.5061 m	4.501268	0.137544	-28.00	-4	24
	Silt-Clay	1088	57.5083 %	21.38898	0.648449	5	92	87
	Bottom Stress	1088	0.0161 P	0.0161		0	0.0884	
	TRI	1071	0.0924	0.35893	1.10E-02	0	6	6
	Slope	1066	0.1060°	0.575739	1.76E-02	0	11	11
2	Bathymetry	1490	-19.4302 m	4.44557	0.115169	-44	-6	38
	Silt-Clay	1494	64.6165 %	15.76709	0.407921	5	91	86
	Bottom Stress	1494	0.0531 P	0.0108		0	0.0882	
	TRI	1490	0.2691	0.467248	1.21E-02	0	3	3
	Slope	1490	0.0906°	0.431133	1.12E-02	0	8	8
3	Bathymetry	2461	-28.9655 m	5.822093	0.117361	-46	-6	40
	Silt-Clay	2487	67.8717 %	19.20083	0.385019	5	98	93
	Bottom Stress	2487	0.0617 P	0.008		0	0.088	
	TRI	2461	0.9041	0.601951	1.21E-02	0	4	4
	Slope	2461	0.3218°	0.676889	1.36E-02	0	9	9
4	Bathymetry	200	-35.7600 m	2.402344	0.169871	-46	-32	14
	Silt-Clay	200	64.4850 %	18.57755	1.313631	9	94	85
	Bottom Stress	200	0.0752 P	0.0058		0	0.0857	
	TRI	200	1.1650	0.599644	4.24E-02	0	5	5
	Slope	200	0.44°	0.7934405	0.05610471	0	7	7

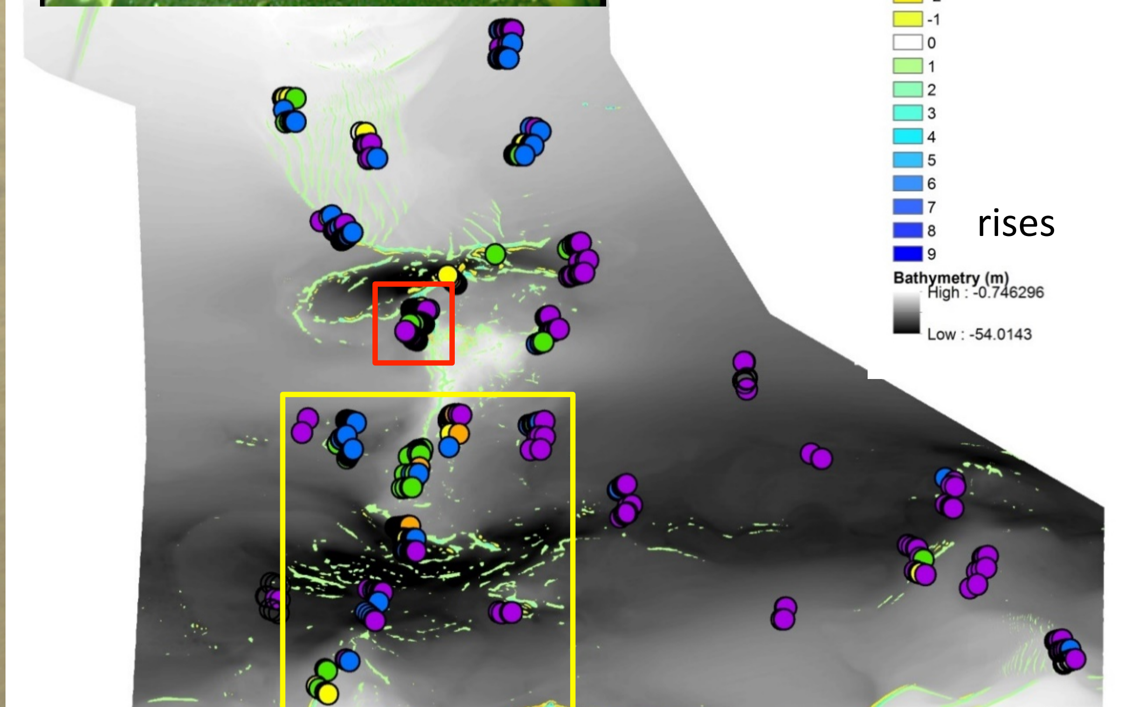
DRAFT

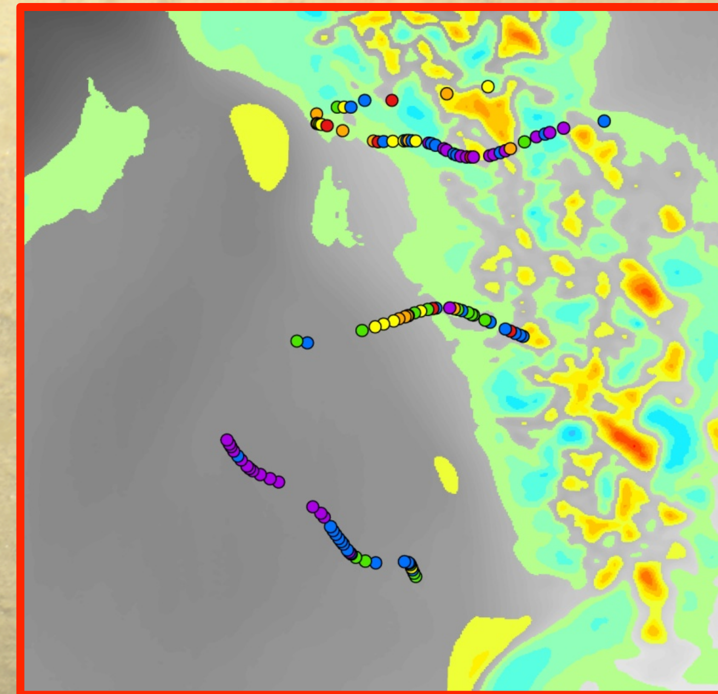
TRI – Terrain roughness index

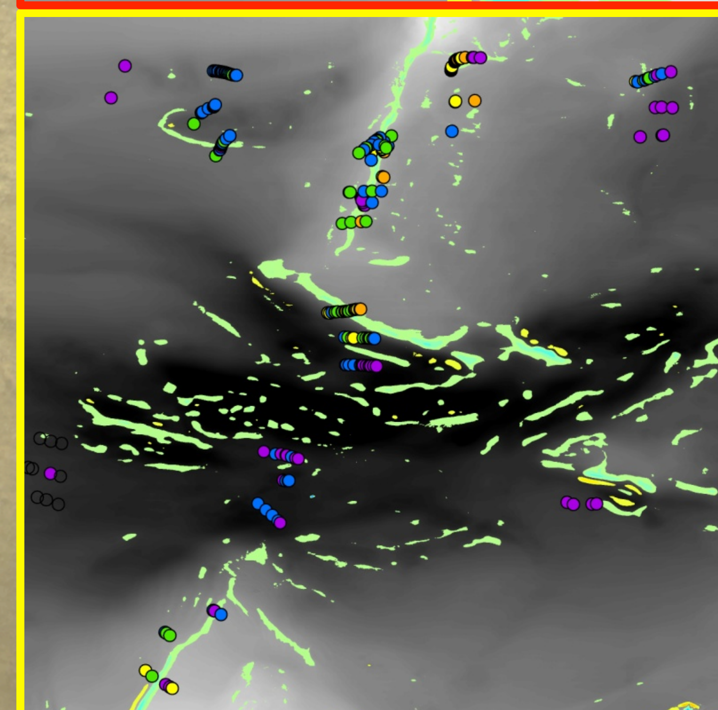
Small-scale habitat features from videos and photos

Biogenic Features: Shell







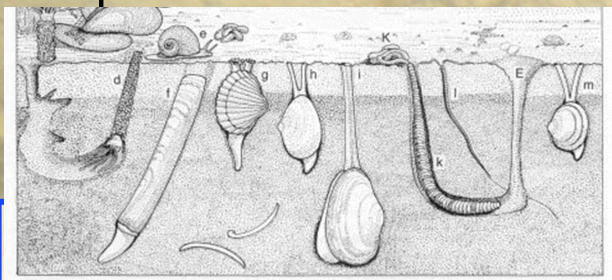


a higher percent cover of shell is found on flat topographic highs, at the bases of steep slopes, and in depressions.

INFAUNAL COMMUNITIES

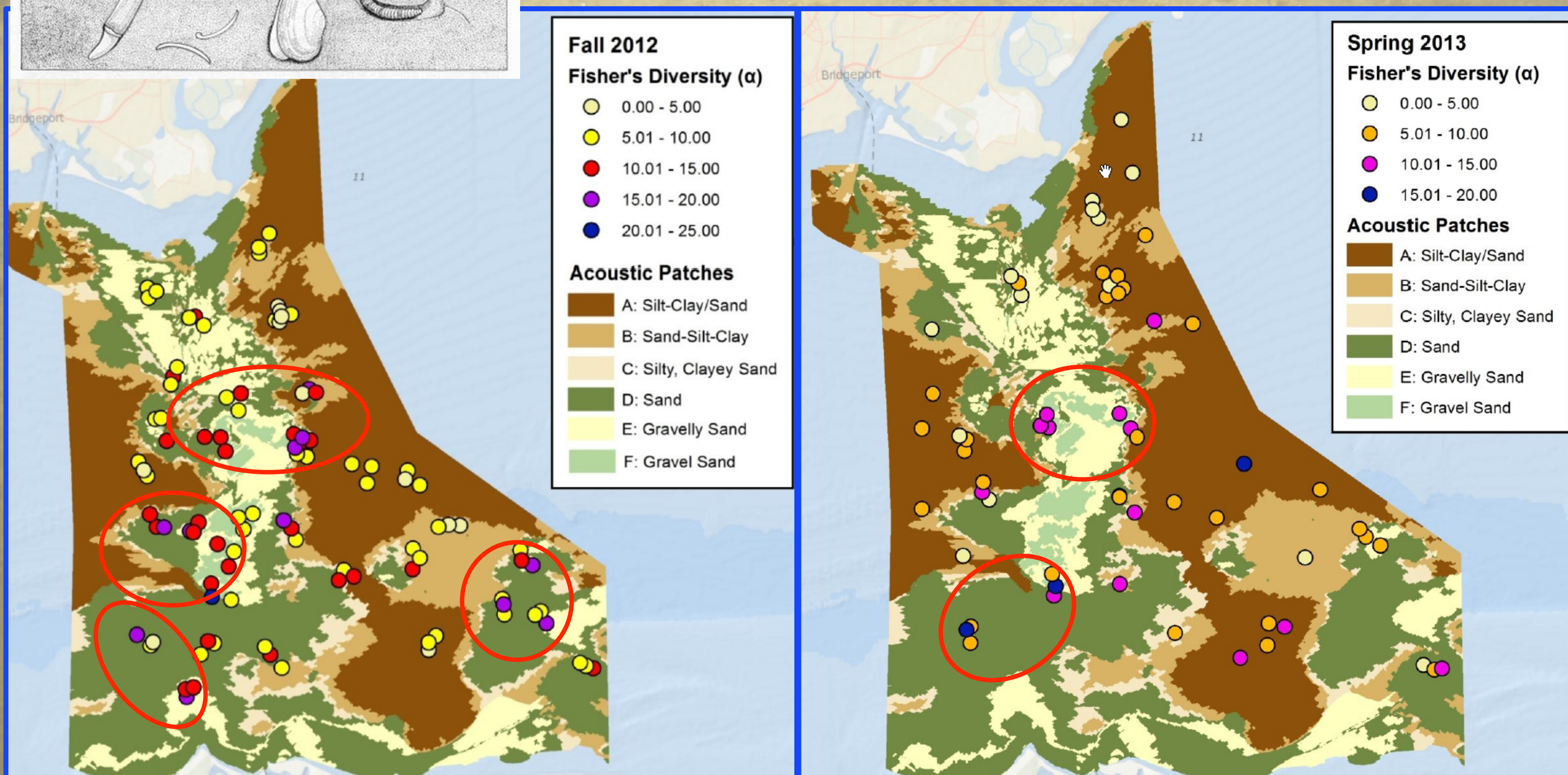
* important integrators of environmental conditions over time and space

* are the main variables in most environmental indices and assessments of seafloor impacts and conditions

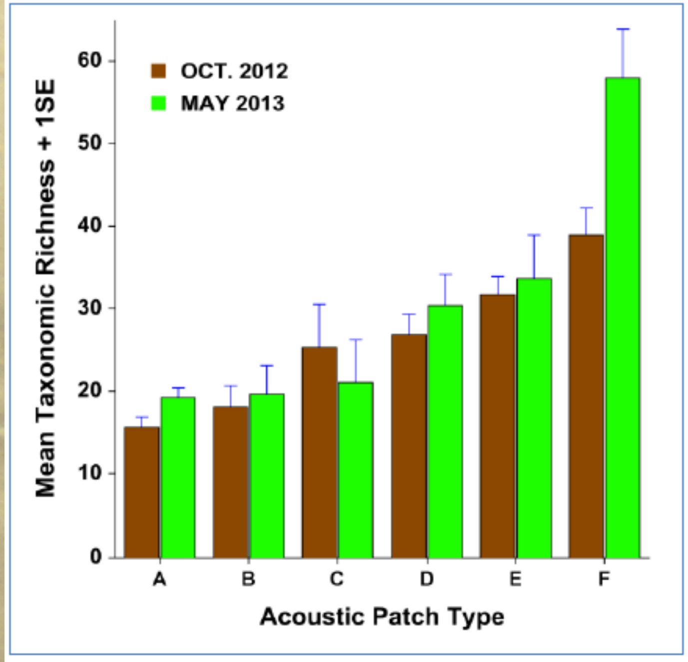


Species Diversity Patterns

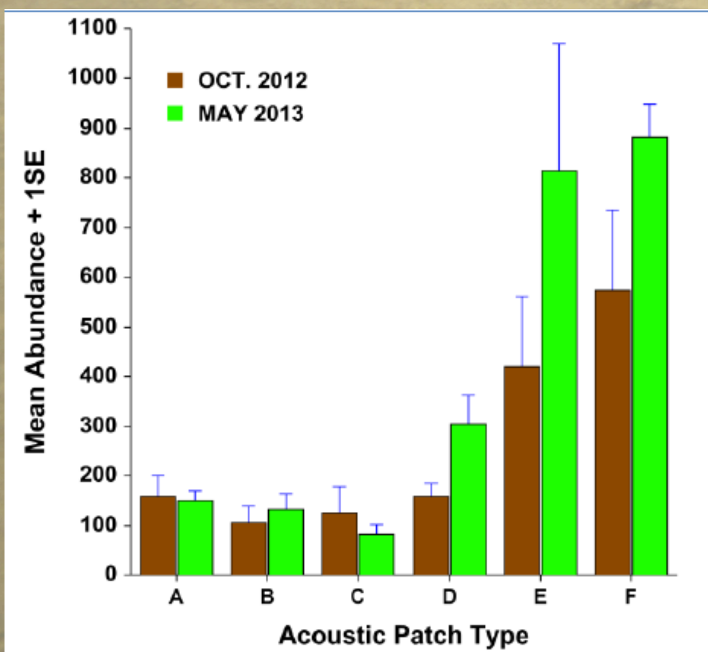
- Variable across patch types but generally higher in patches with coarser sediments
- "Hot Spots" can be identified



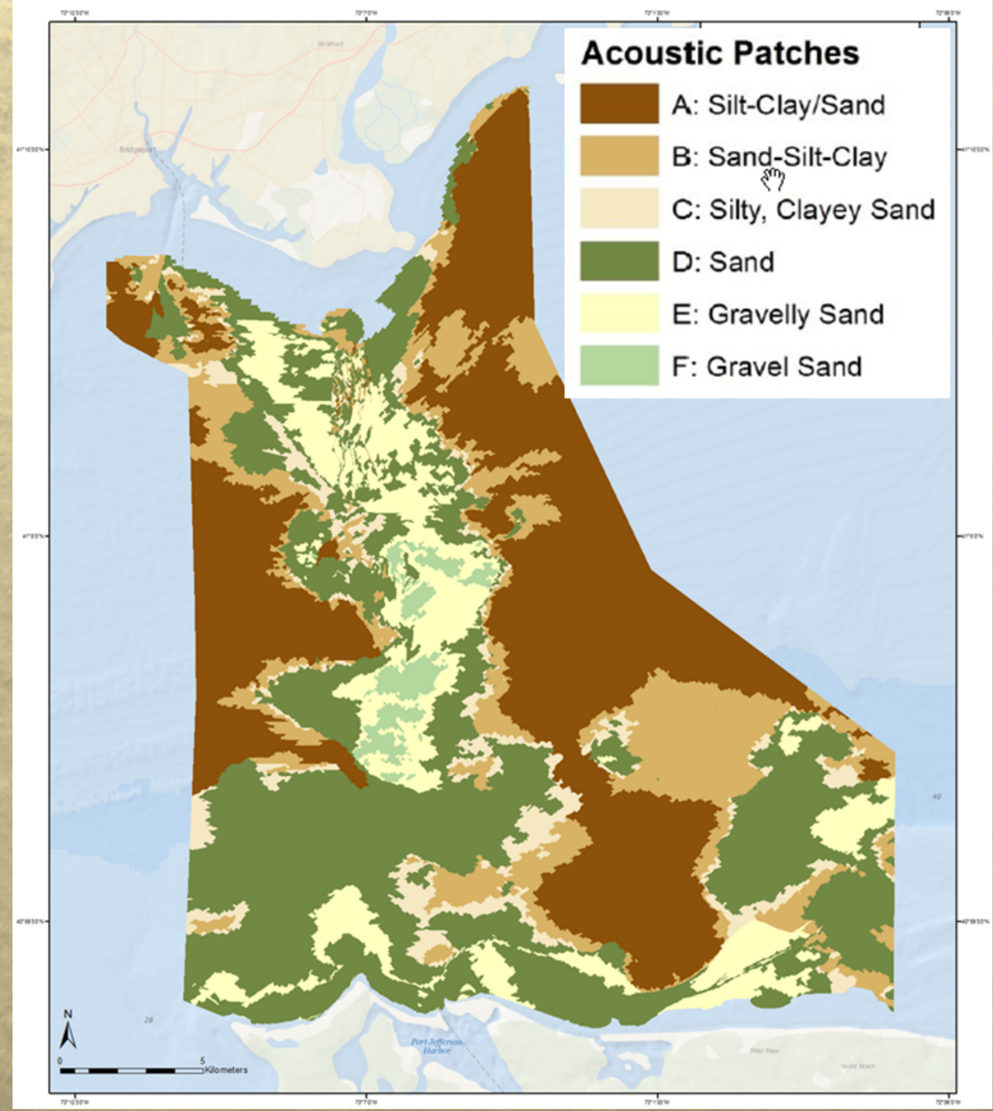
Some seasonal consistency



OCT. 2012
MAY 2013
Mean Taxonomic Richness + 1SE
0
10
20
30
40
50
60
A
B
C
D
E
F
Acoustic Patch Type



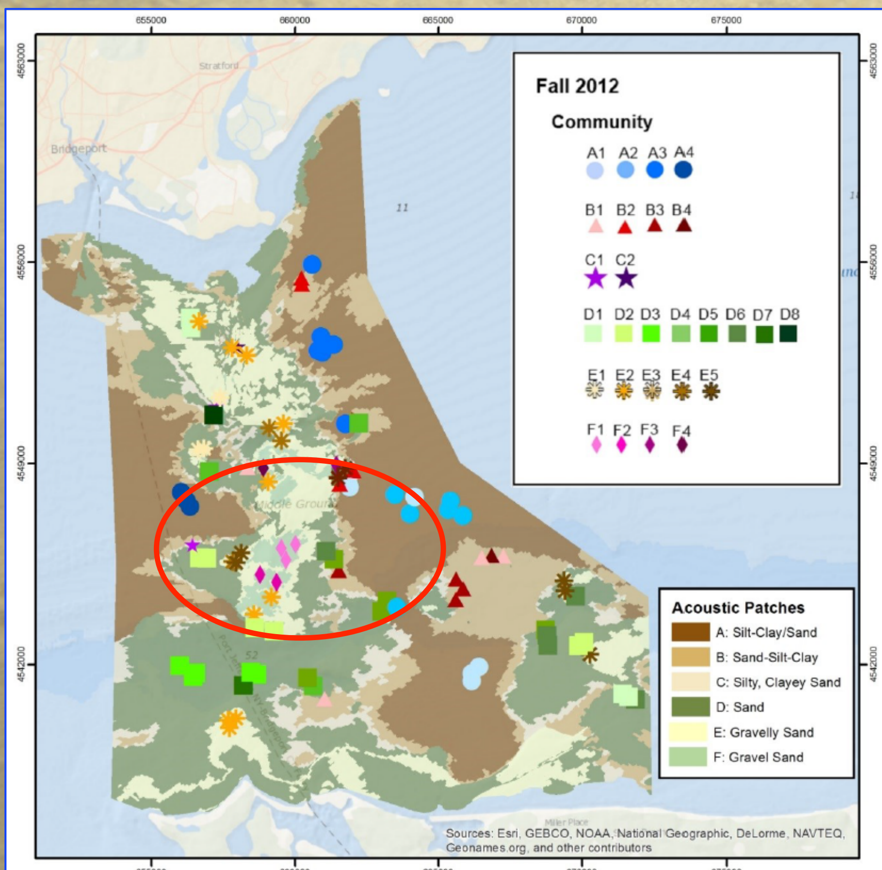
OCT. 2012
MAY 2013
Mean Abundance + 1SE
0
100
200
300
400
500
600
700
800
900
1000
1100
A
B
C
D
E
F
Acoustic Patch Type

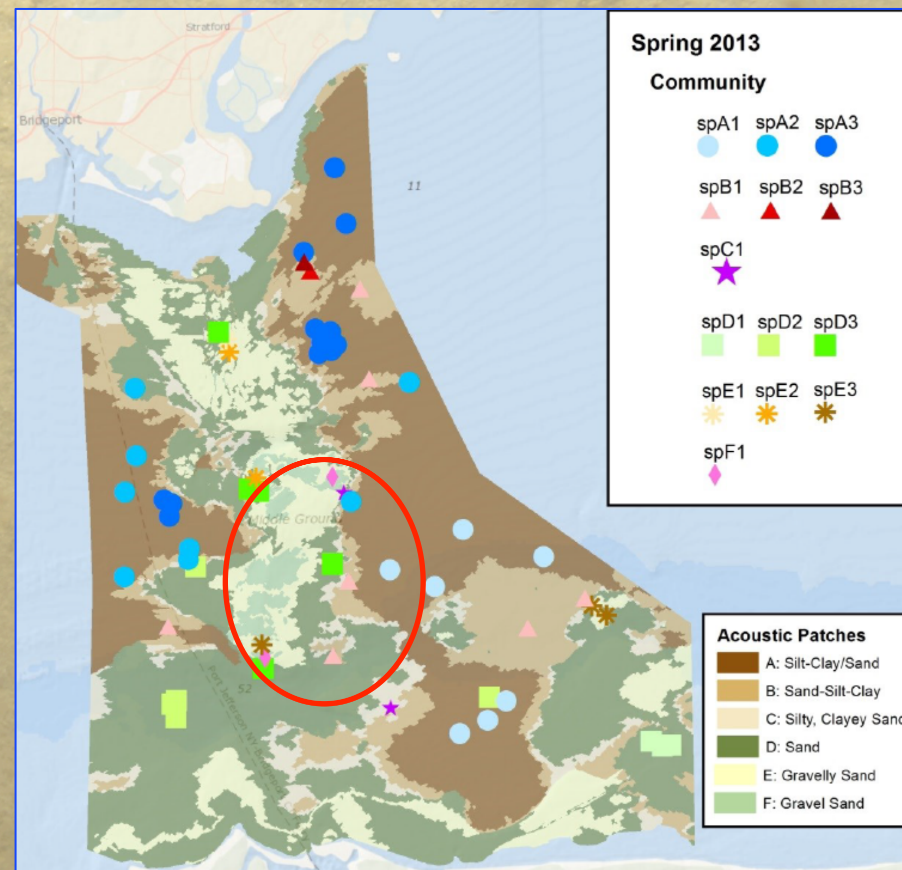


Acoustic Patches
A: Silt-Clay/Sand
B: Sand-Silt-Clay
C: Silty, Clayey Sand
D: Sand
E: Gravelly Sand
F: Gravel Sand
N
0
5
Kilometers

INFAUNAL COMMUNITIES – *Community types and variation*

* Significant relationship to large- and meso-scale patch types in fall and spring
* Variation within and among patches indicates high β-diversity across the study area
(all areas within mud patches (and other types) are not all the same …. need to consider meso-scale features in management / planning / conservation efforts)



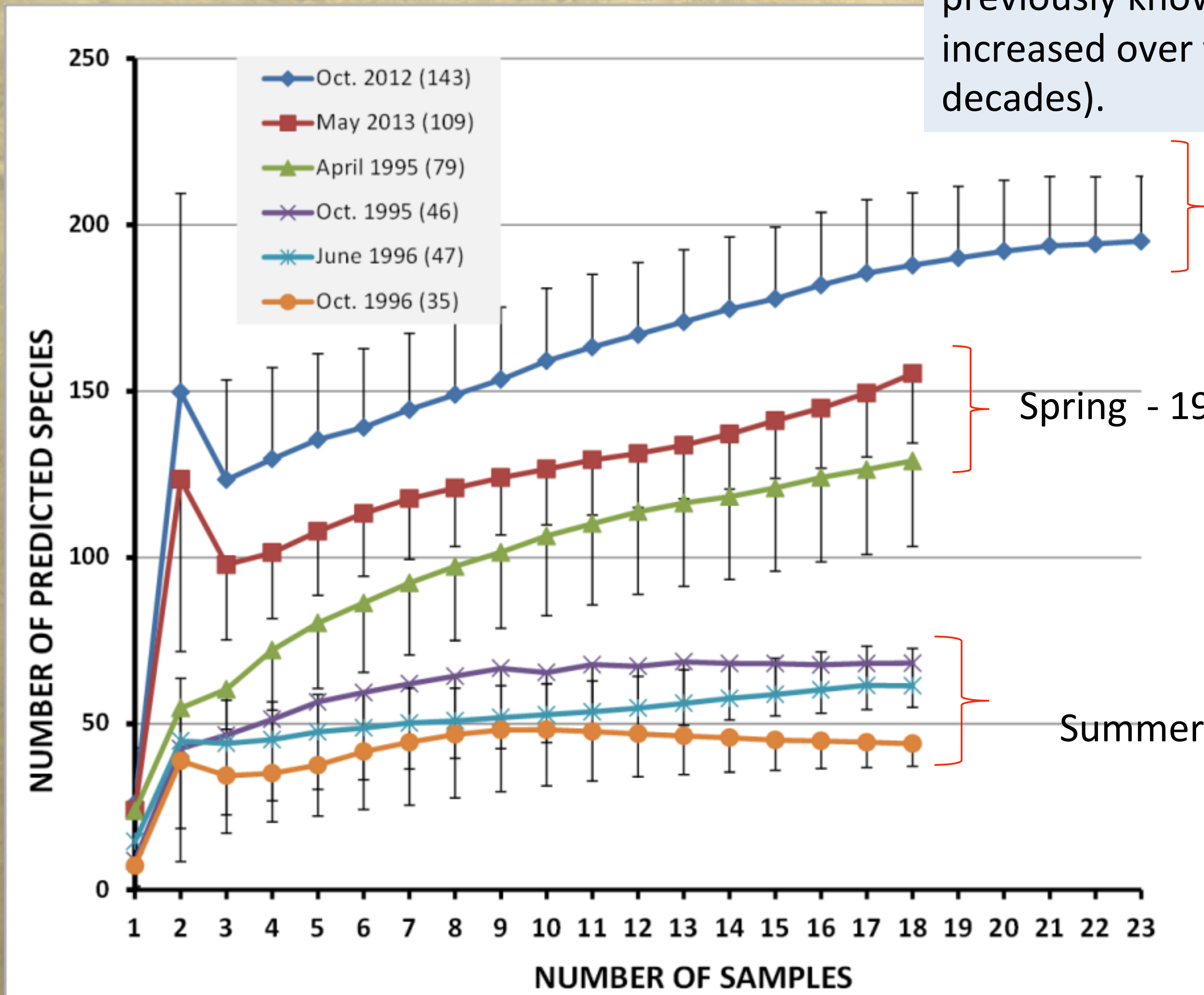


Identify areas of high community diversity
Transition zones (ecotones) are high α and β diversity areas

Assessment of long-term temporal trends in LIS ecological characteristics

Same area , same sampling design, sieve sizes differ (finer mesh in 94 and 95, smaller sampler)

LIS benthic biodiversity is higher than previously known - and/or has increased over the past several decades).



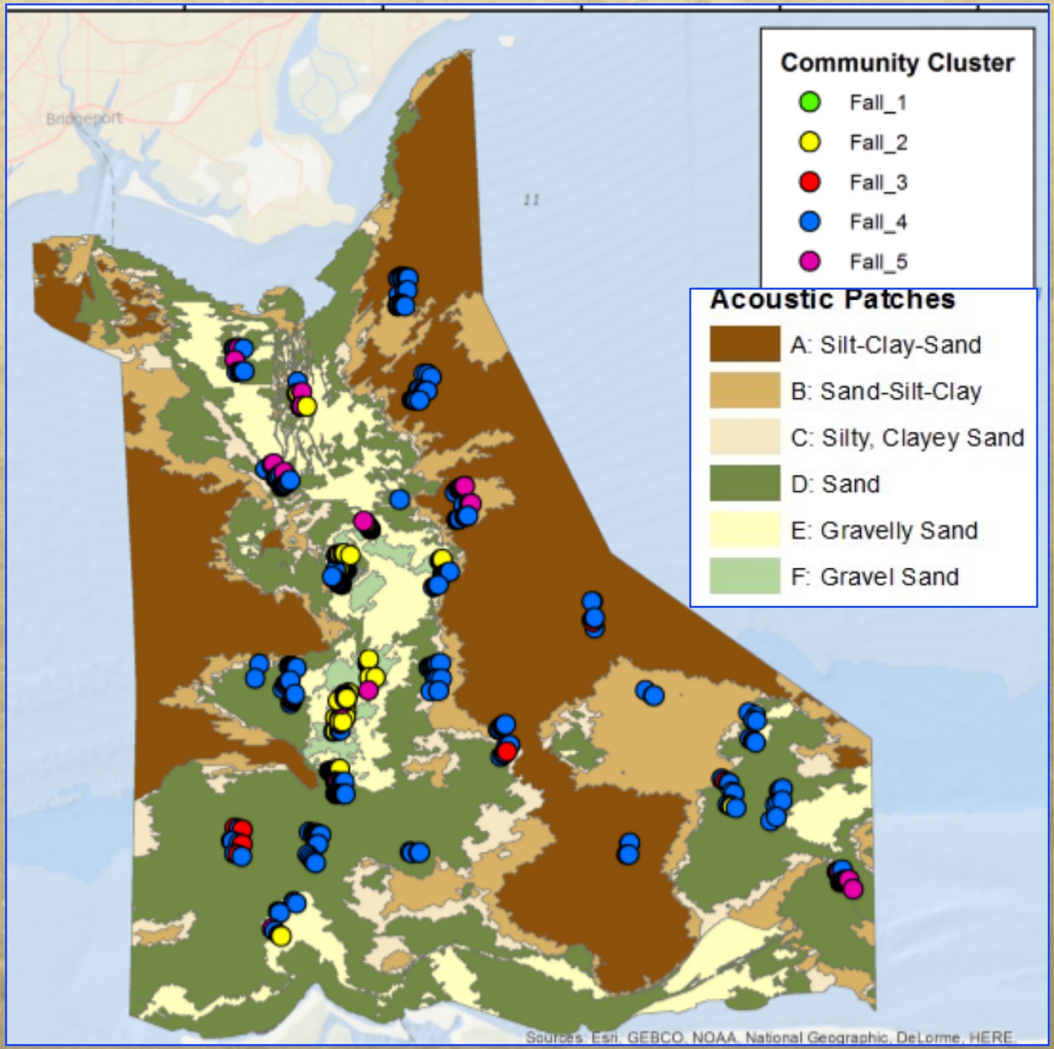
Fall 2012

Spring - 1995 & 2013

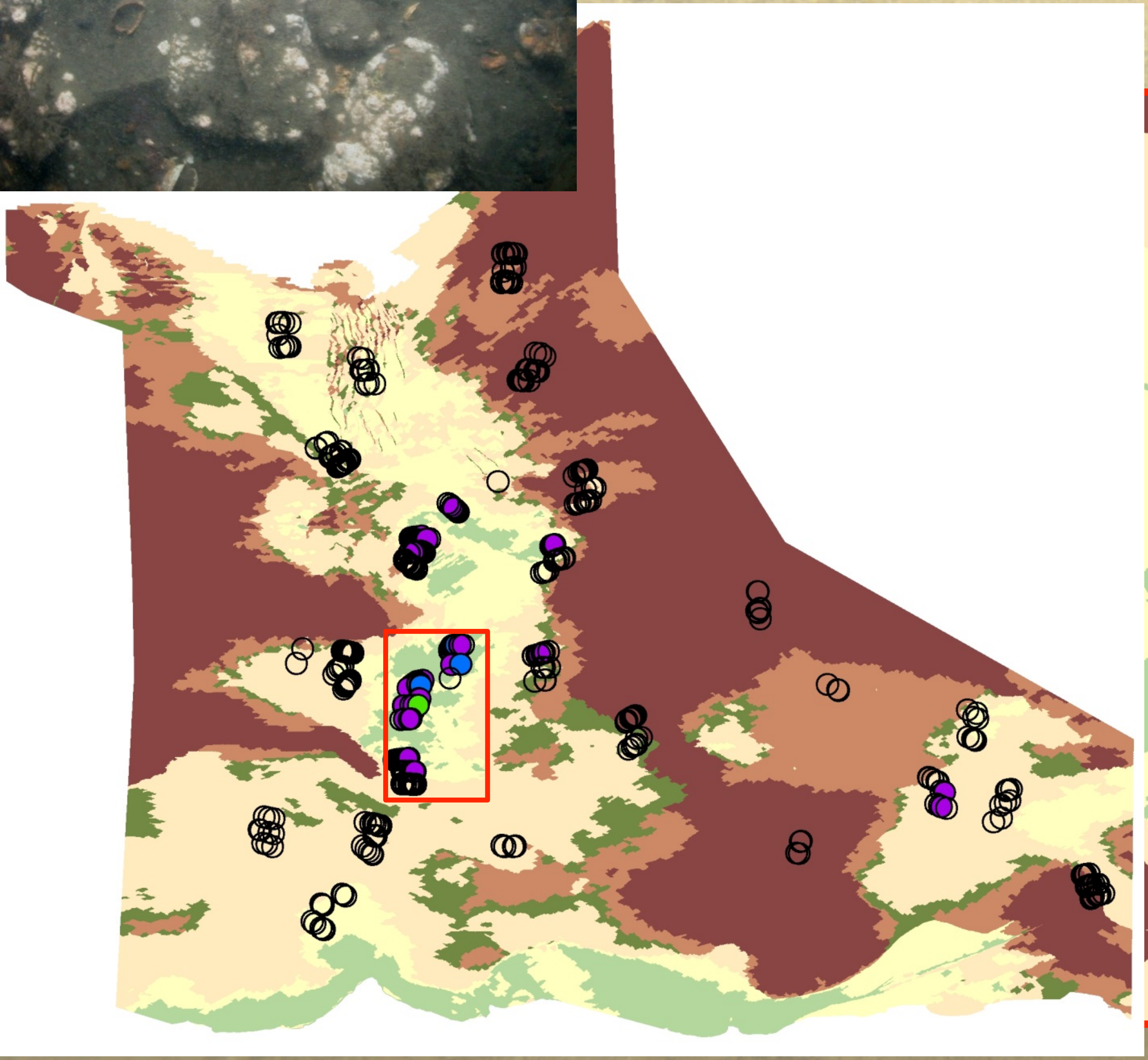
Summer / Fall 1995-1996

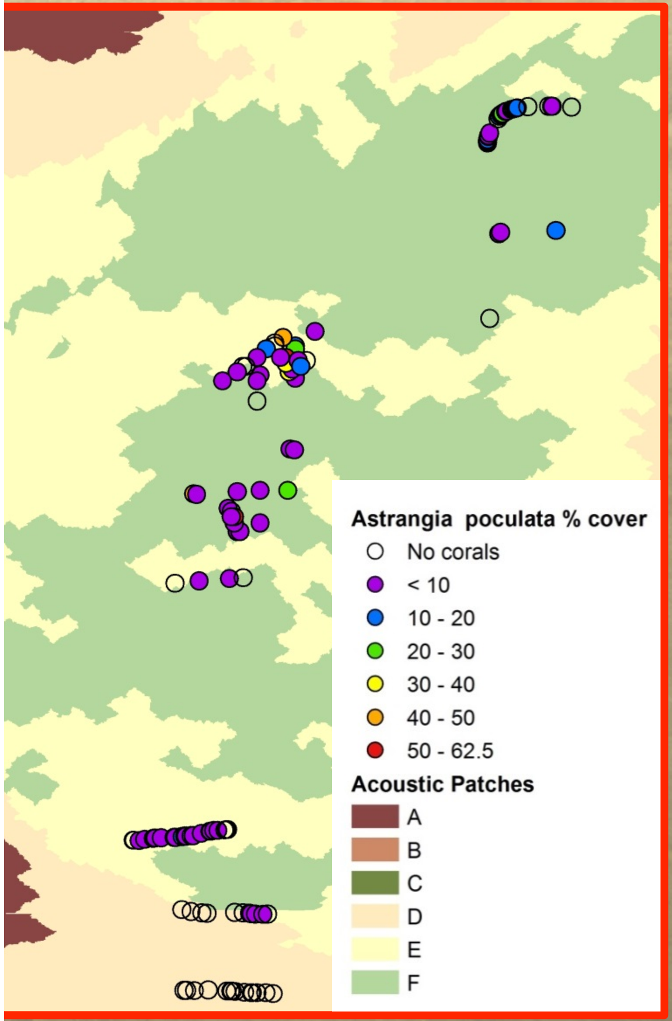
Emergent and Epi-Fauna

- Epifaunal communities related to Acoustic Patch types A to F (i.e., fine to coarse grain) along with the concomitant gradient of increasing tidal stress.
- Shift from short-lived species (in fine grain habitats) to long-lived fragile epifaunal species (in coarse grain habitats).
- Shift in biogenic features from burrowed sediments (in fine grain habitats) to high coverage patches of biogenic shell (in coarse grain slope and crest habitats).

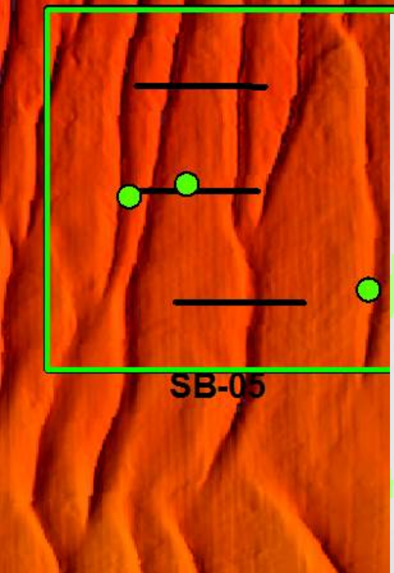


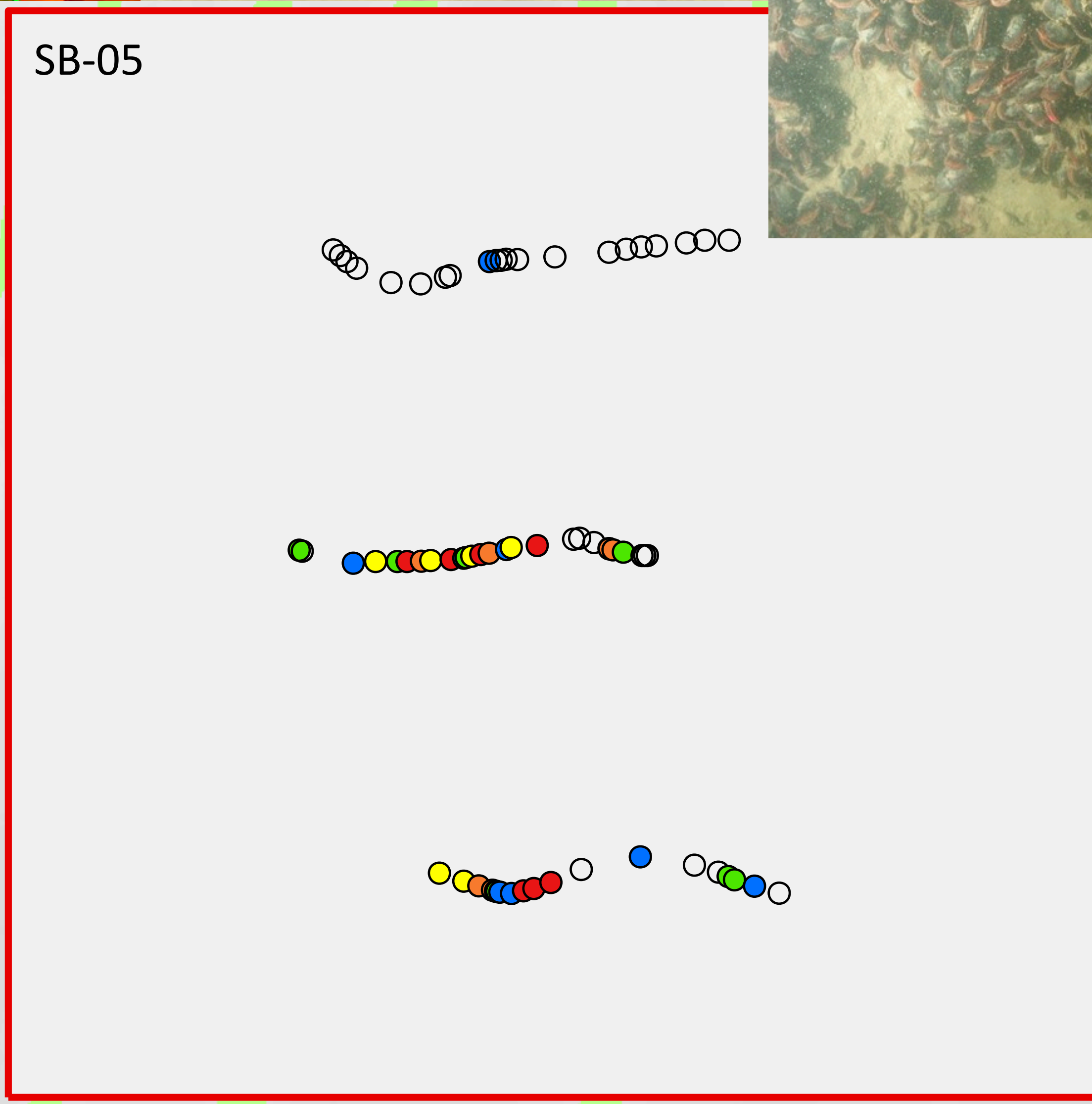
Broad-scale distribution patterns: Northern Star Coral

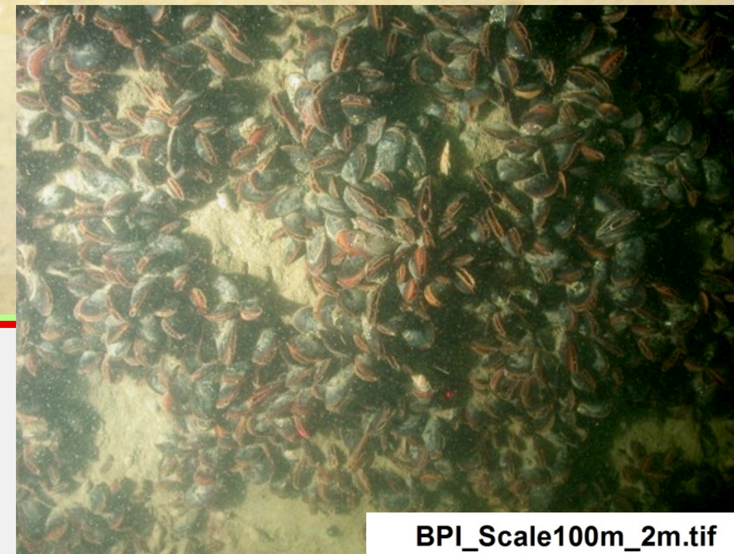




Fine scale distribution patterns: Blue Mussel

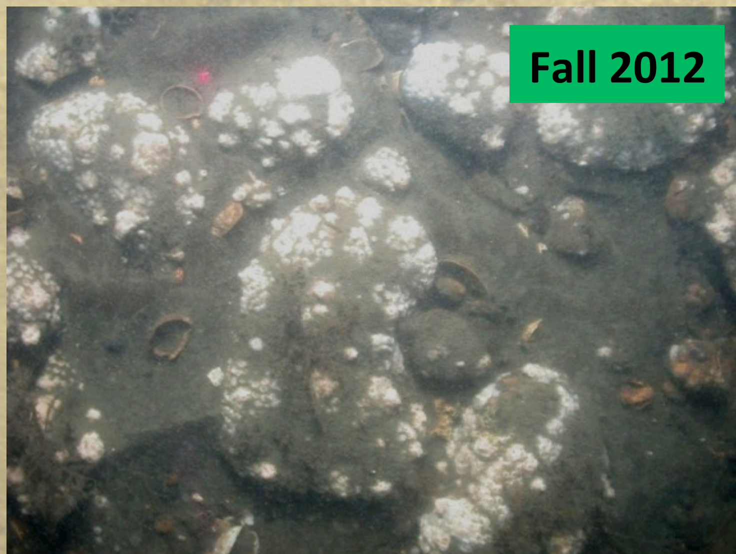






Inter-seasonal stability

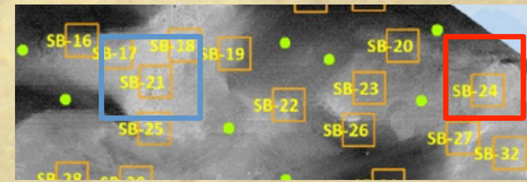
Northern star coral along boulder reef

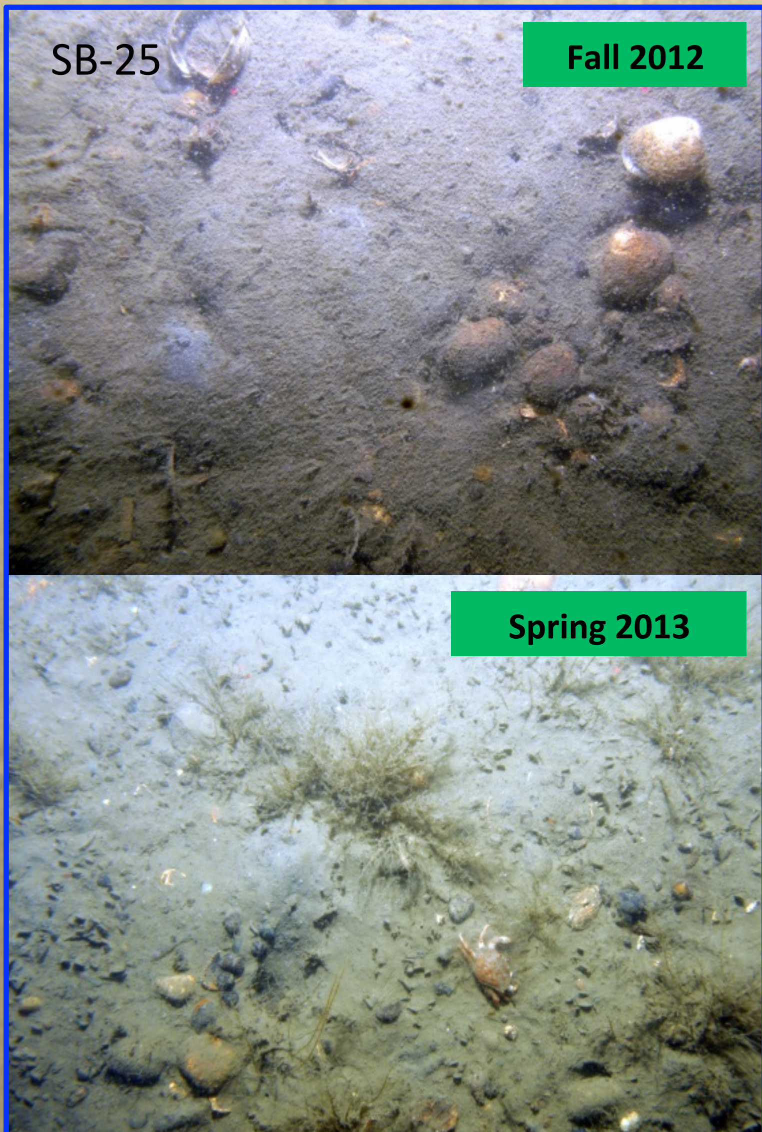


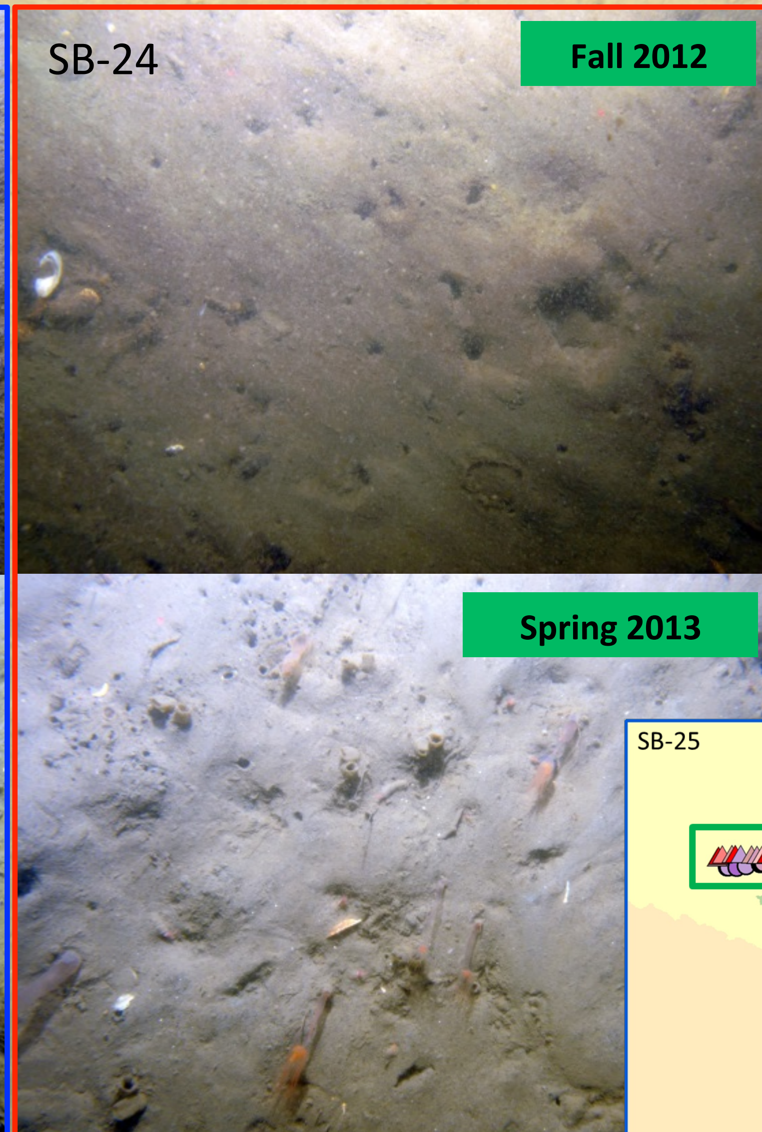
Blue mussel beds in sand wave troughs

Inter-seasonal variation

Inter-seasonal variation driven by species with shorter life histories

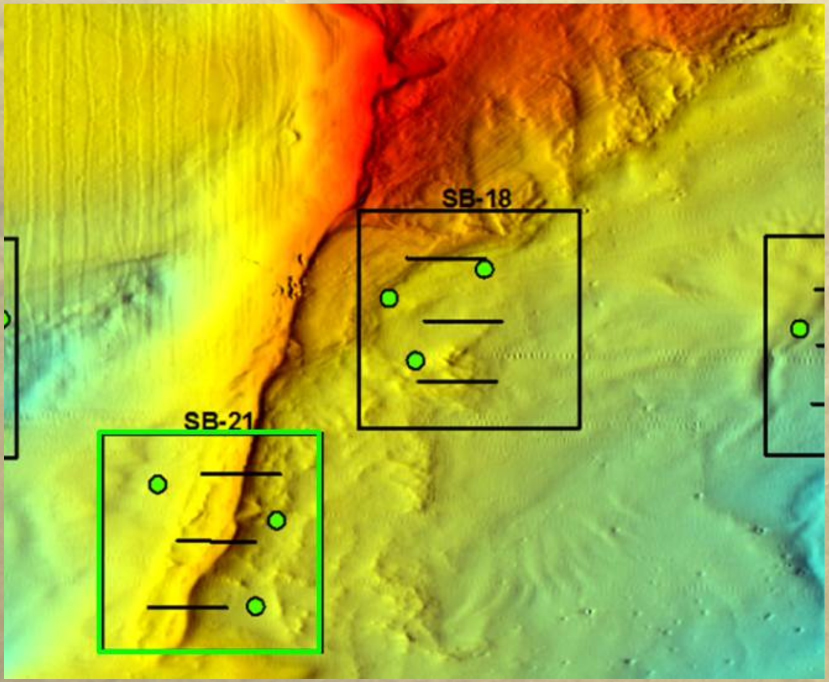






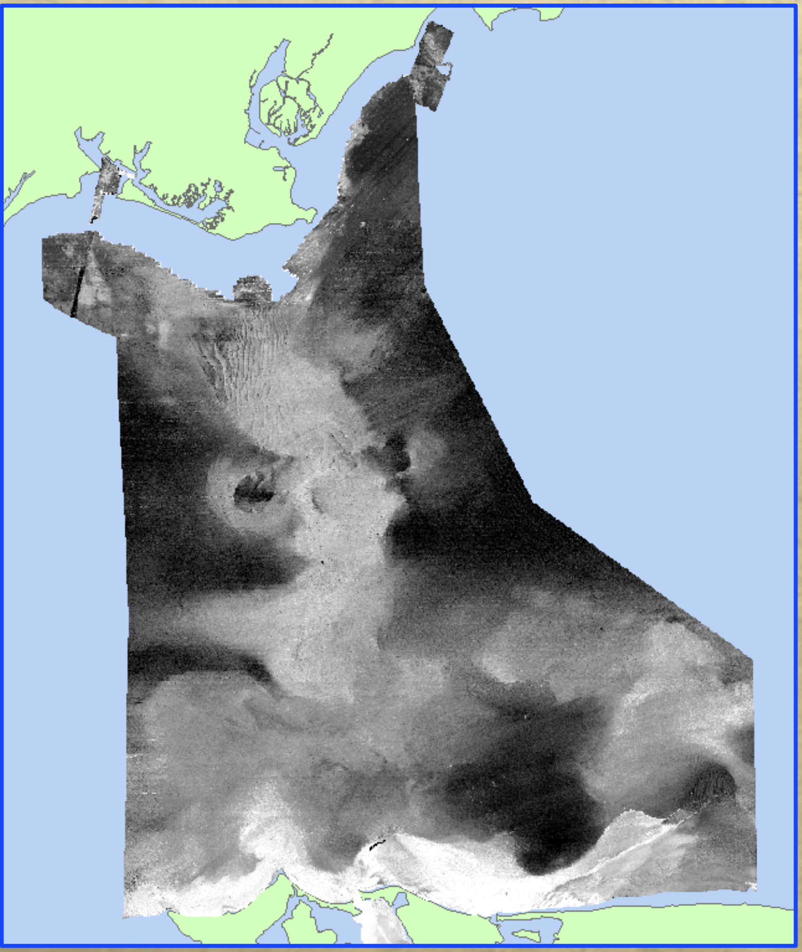
Less seasonal variation in epifaunal species richness in coarser sediments

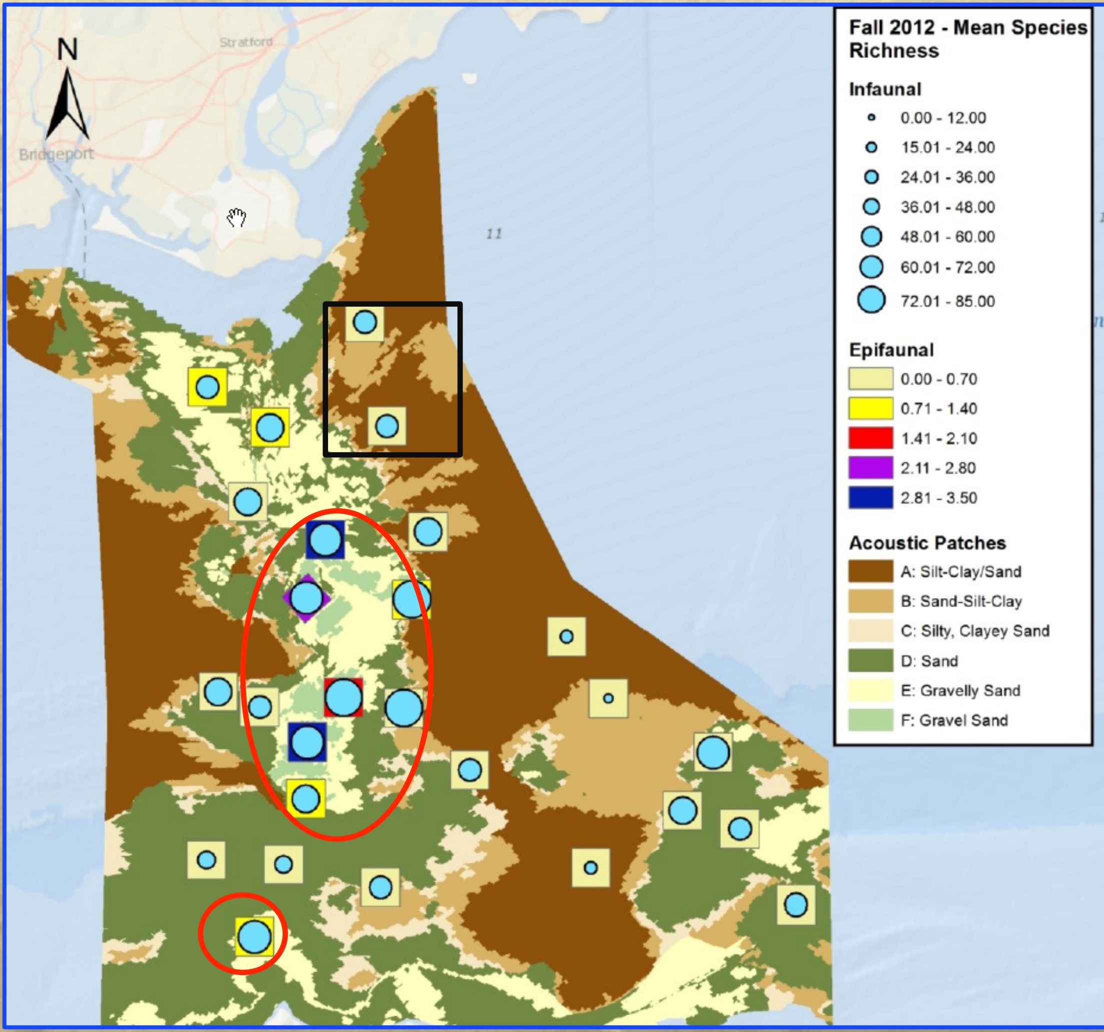
Boulder Reef Long-term Dynamics



•1991-2010: *Haliclona oculata*, *Astrangia poculata*, *Mytilus edulis* and branching bryozoa were reef dominants
•2012-2013: *Haliclona* absent from reef fauna
•A number of mechanisms (e.g., species interactions, disease, recruitment failure, thermal stress, sediment load, freshwater input) may have contributed, individually or synergistically, to the change in this community

Integrated Infaunal and Epifaunal Community Characteristics

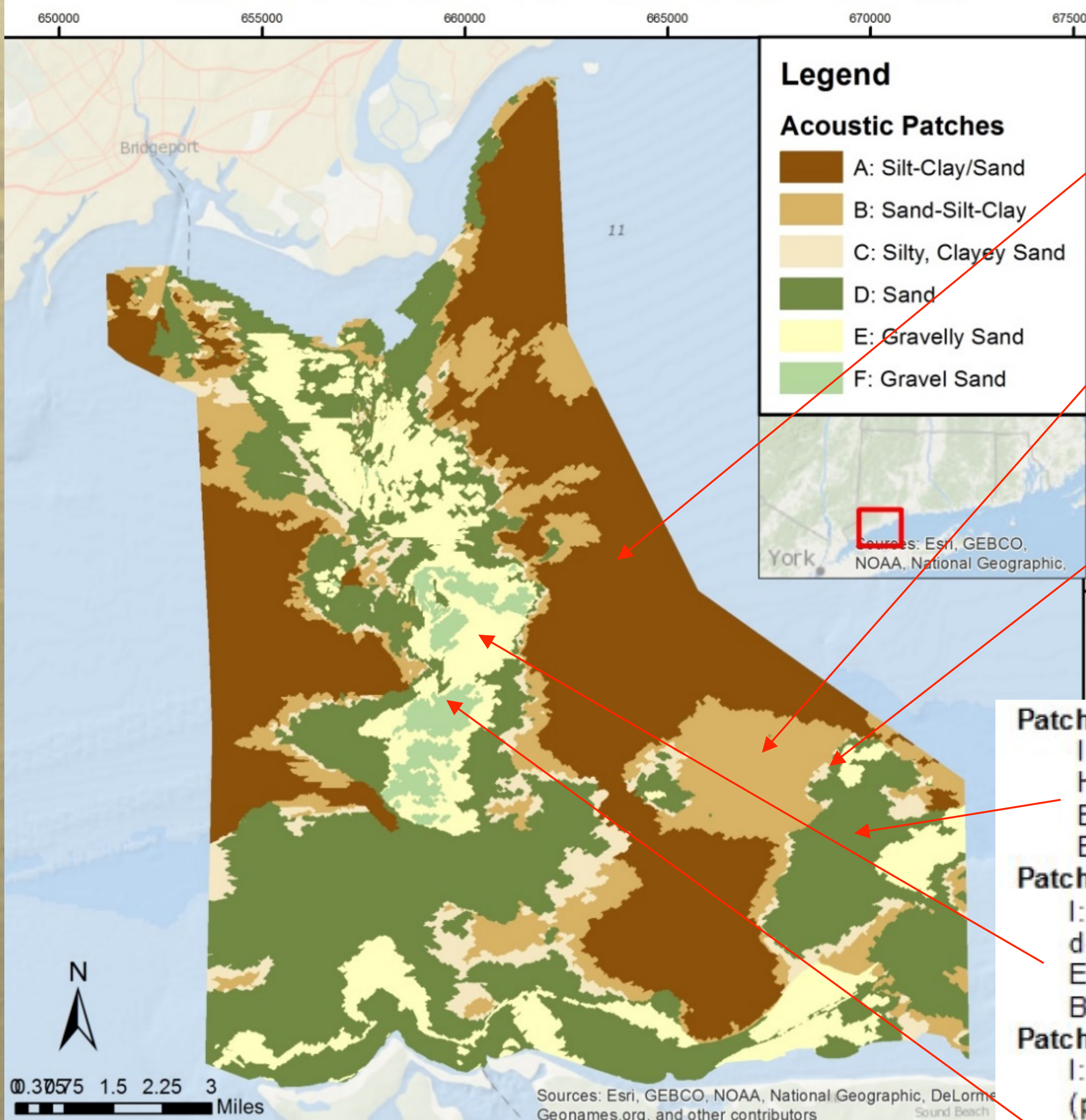




* Integration of ecological characteristics from varying habitats

Integrated Habitat Map

based on mean bottom tidal stress, defining ecological characteristics of infaunal (I) and epifaunal (E) communities, and predominant biogenic features (BF).



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

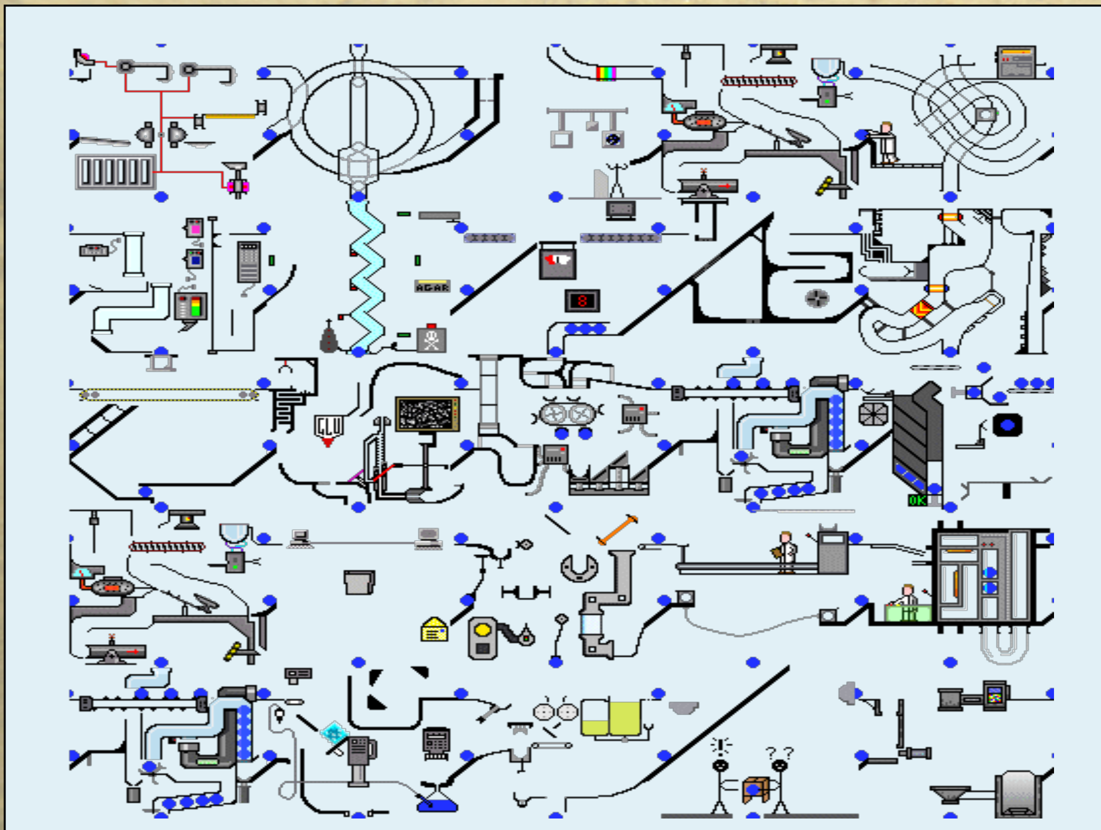
Patch type C: predominantly medium stress
- I: Variable mix of tubiculous taxa and burrowers
- E: *Mytilus*, *Corymorpha*, solitary ascidian
- BF: Burrows, shell

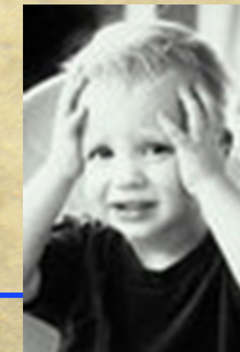
Patch type D: high-medium stress
- I: Small tubiculous taxa (polychaetes and amphipods); High density of bivalves
- E: Hydroids, *Mytilus*, barnacle
- BF: High coverage of shell patches and burrows

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

Coastal and Marine Spatial Planning – a complex endeavor





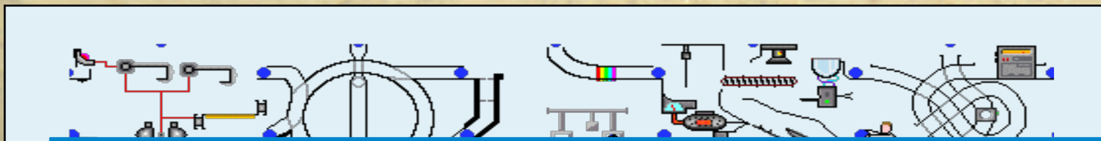
Issues:

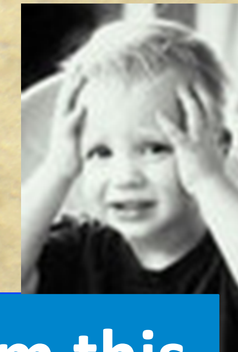
* Site selection for specific goals
  development - conservation
* ecological criteria and function
* necessary physical conditions

* Socio-political hurdles and resolutions

* Effective management to attain goals (protection of biodiversity, fisheries enhancement, economic growth, energy infrastructure)

Coastal and Marine Spatial Planning – a complex endeavor





Our results, analyses and data products can inform this complex endeavor in many ways, for example:

*** detailed contemporary ecological assessment (for all benthic biota) – can be utilized for varied management related analyses**

*** identification of critical habitats and communities to aid decision-making (minimize project/permit impacts)**

***aid resource survey designs, impact studies and their interpretation**

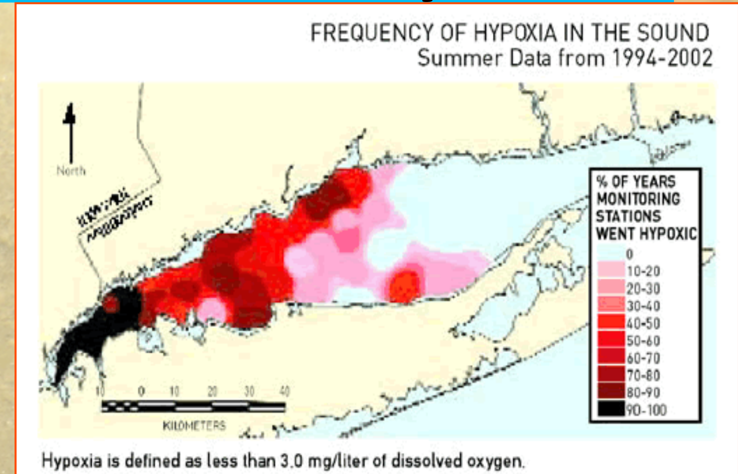
*** provides basis for selected monitoring of long-term trends relative to climate change issues**

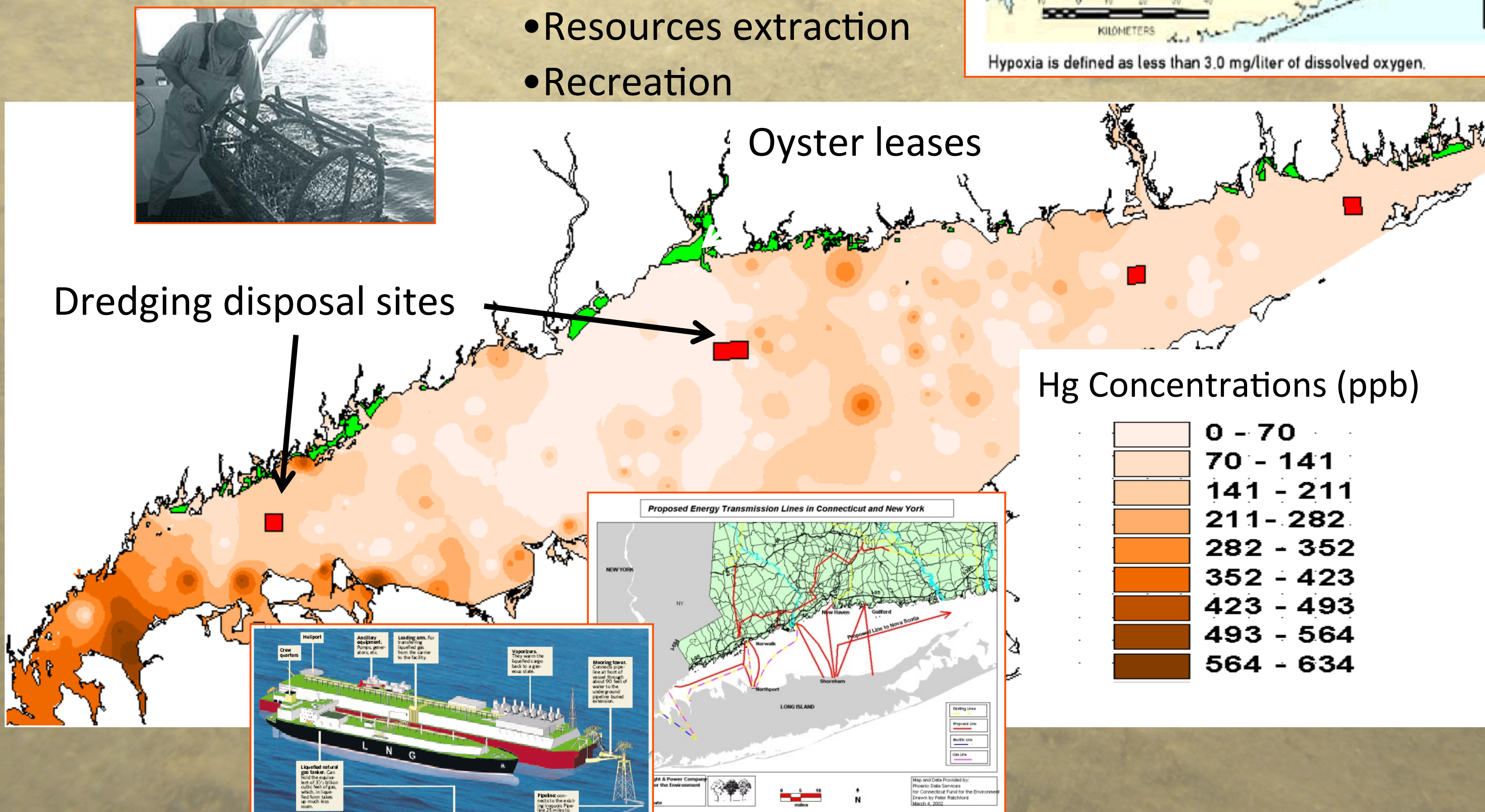
Coastal and Marine Spatial Planning in Estuarine Systems

Complex set of factors to consider

* Strong gradients
  - Physical
  - Chemical
  - Biological

* Human activities and impacts
  - Dredging
  - Harvesting
  - Pollution
  - Resources extraction
  - Recreation

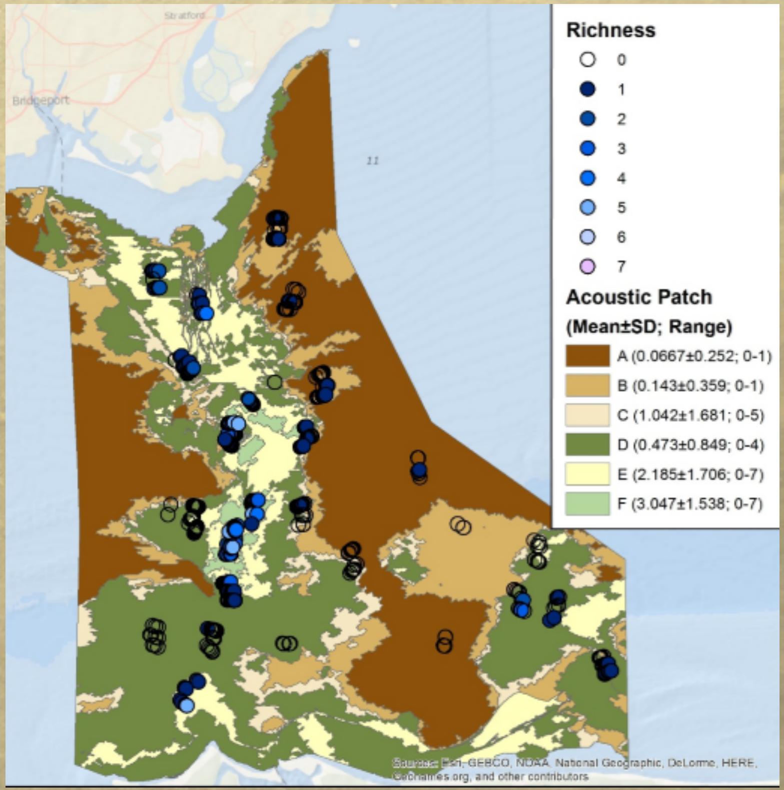




Emergent and Epi-Fauna

Primary Results continued

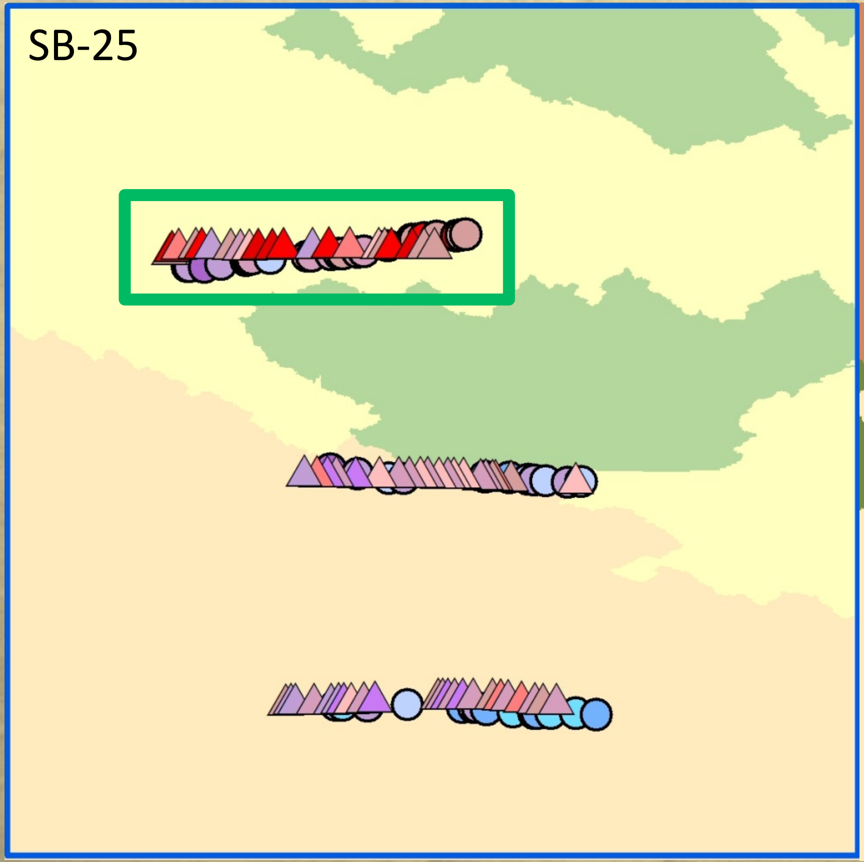
- Shallow communities characterized by coral and mussel, relatively long-lived species, exhibited a high degree of stability across seasons, while deeper fine grain sedimentary settings, characterized by short-lived solitary and colonial hydroids, solitary ascidians, and amphipods, exhibited a high degree of change due to spring recruitment dynamics.
- High diversity of emergent and epifaunal taxa along the crest and slopes of Stratford Shoal (patch types D-F) as well as slope environments to the southwest and southeast off the north shore of Long Island.

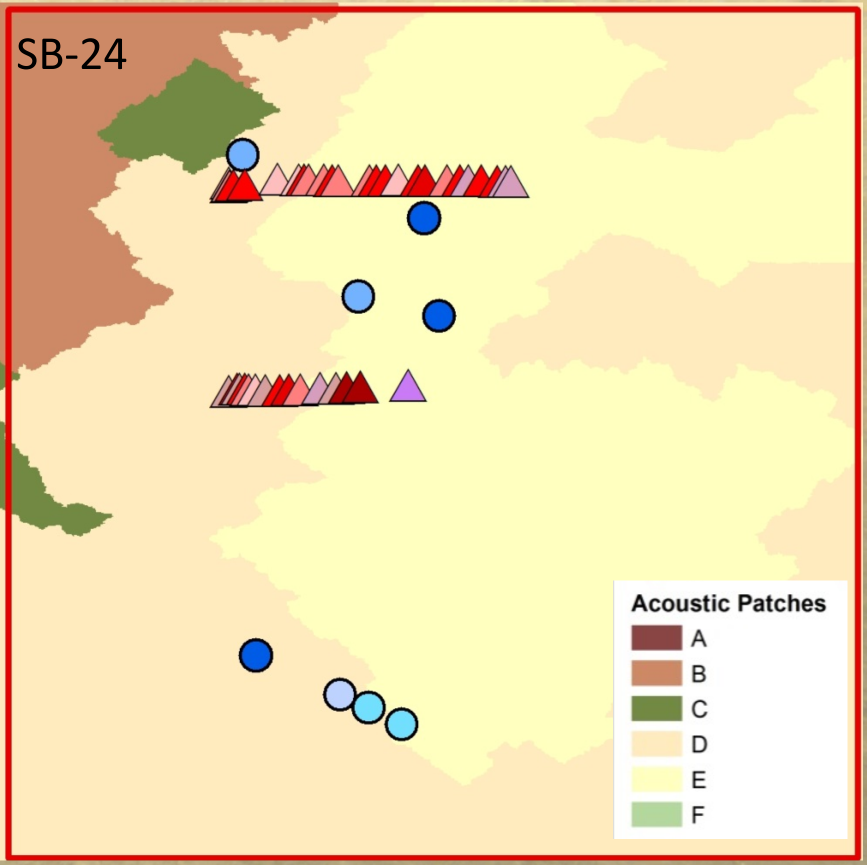


Emergent and Epi-Fauna

- **Implications**
  - **Based on life-history characteristics of fauna from survey data, and loss of a dominant species with long-term presence from historic analysis, we can infer reduced/low resilience of communities in crest and slope physiographic settings.**
  - **Recovery of emergent fauna in fine grain habitats may occur from months to a year; recovery (but not resilience) of emergent and epifauna in coarse grain habitats unknown, but multiple years at best, based on life histories.**

Inter-seasonal dynamics





Transects in hard substrate area had less inter-seasonal variation