The U.S. Coastal & Marine Ecological Classification Standard

Opportunities To Inform Science And Marine Spatial Planning

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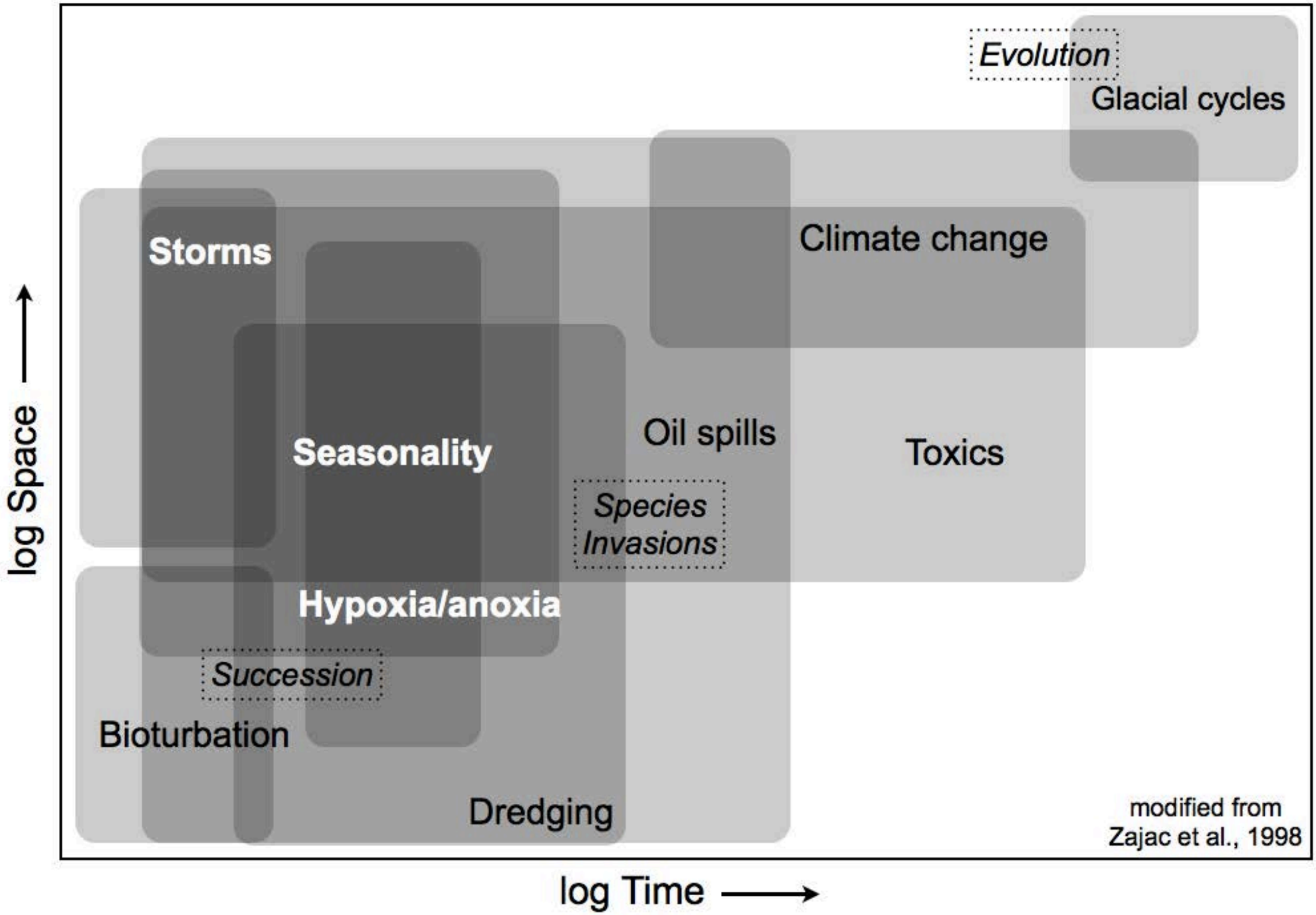
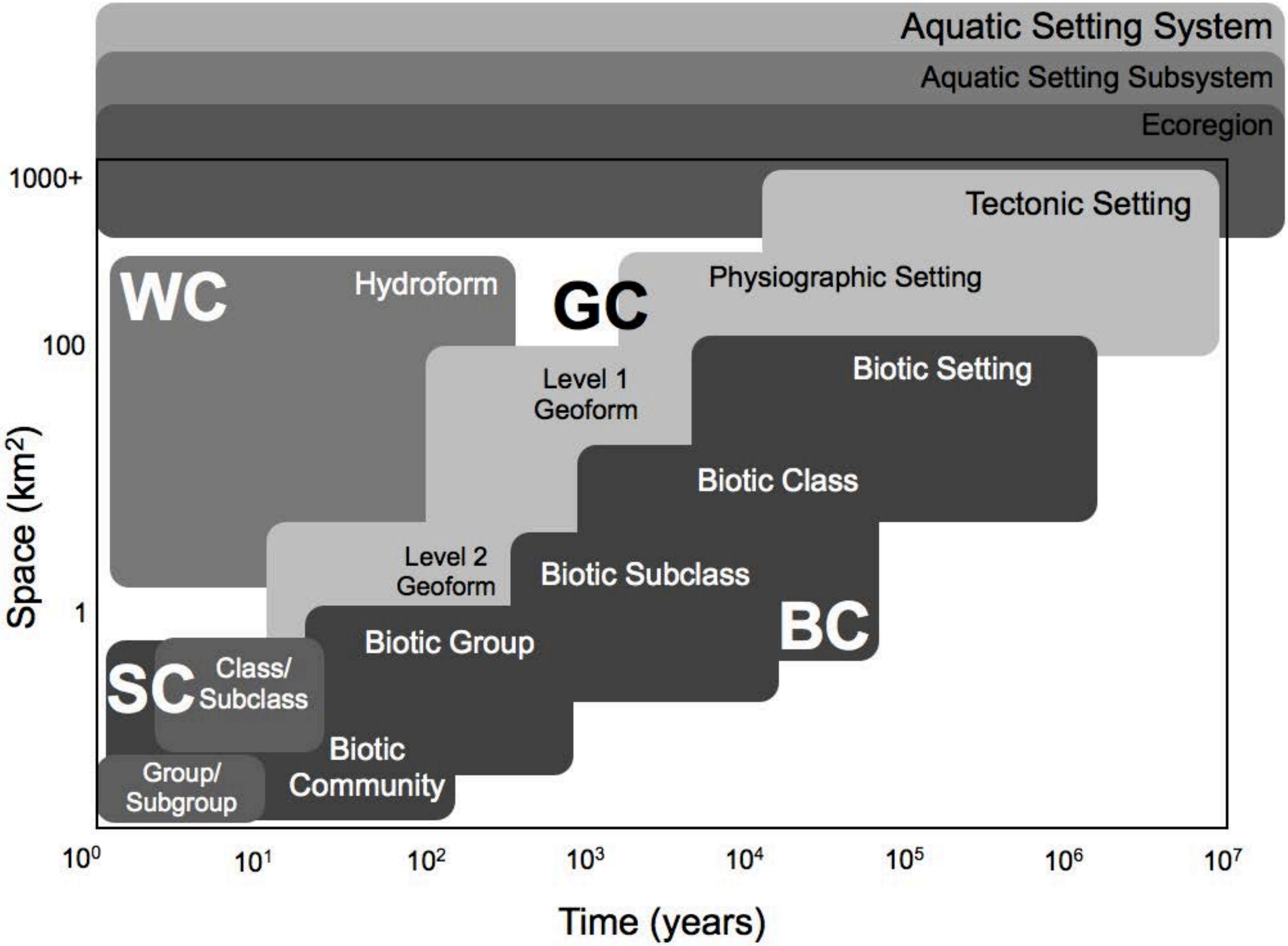
Informing Science & Marine Spatial Planning

- Introduction/overview of CMECS
- Applications in Rhode Island, USA
  - Biotope mapping
  - Marine landscape (Geoform) mapping
  - Framework for guidance on characterizing and monitoring marine renewable energy development

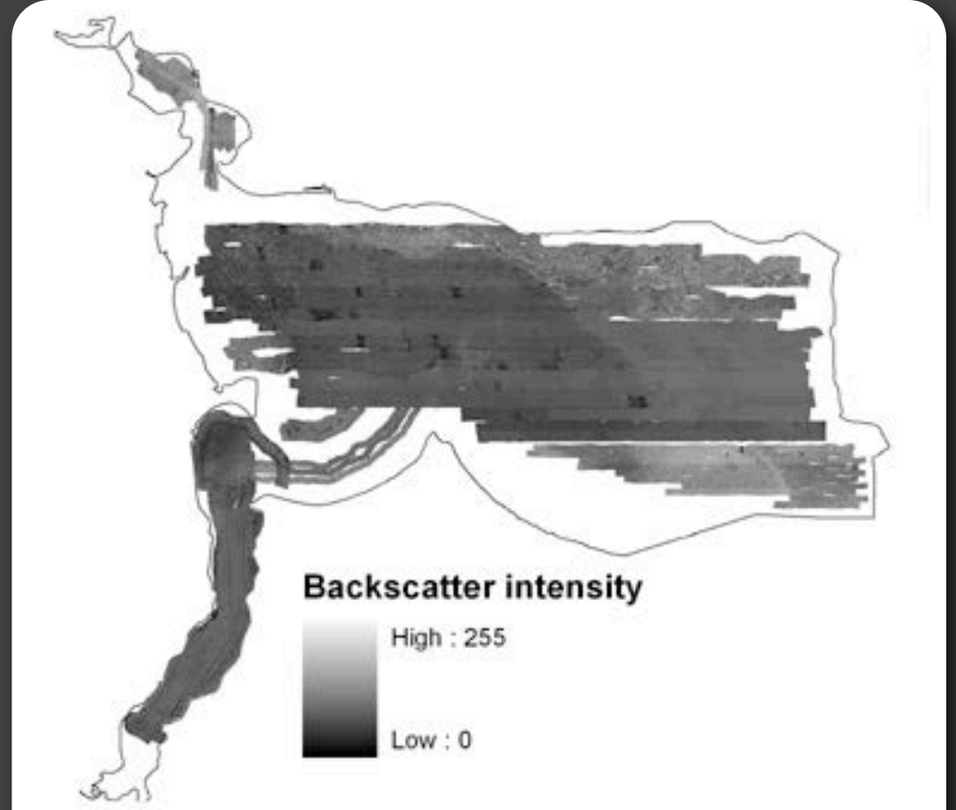
Biogeographic Setting (BS)	Aquatic Setting (AS)	Water Column Component (WC)	Geoform Component (GC)	Substrate Component (SC)	Biotic Component (BC)
Realm *Province* *Ecoregion*	*System* *Subsystem* *Tidal Zone*	**Layer Subcomponent**	**Tectonic Setting Subcomponent**	*Substrate Origin* *Substrate Class* *Substrate Subclass* *Substrate Group* *Substrate Subgroup*	*Biotic Setting* *Biotic Class* *Biotic Subclass* *Biotic Group* *Biotic Community*
		Salinity Subcomponent	**Physiographic Setting Subcomponent**		
		Temperature Subcomponent	**Level 1 Geoform Subcomponent** *Geoform Origin* *Level 1 Geoform* *Level 1 Geoform Type*		
		Hydroform Subcomponent *Hydroform Class* *Hydroform* *Hydroform Type*	**Level 2 Geoform Subcomponent** *Geoform Origin* *Level 2 Geoform* *Level 2 Geoform Type*		
		Biogeochemical Feature Subcomponent			


Evolution
Glacial cycles
Storms
Climate change
Seasonality
Oil spills
Toxics
Species Invasions
Hypoxia/anoxia
Succession
Bioturbation
Dredging
modified from Zajac et al., 1998
log Space
log Time


Aquatic Setting System
Aquatic Setting Subsystem
Ecoregion
Tectonic Setting
Physiographic Setting
Biotic Setting
Biotic Class
Biotic Subclass
Biotic Group
Biotic Community
WC
Hydroform
GC
Level 1 Geoform
Level 2 Geoform
BC
SC
Class/ Subclass
Group/ Subgroup
1000+
100
1
Space (km²)
10⁰
10¹
10²
10³
10⁴
10⁵
10⁶
10⁷
Time (years)

Aerial image credit: Giancarlo Cicchetti, U.S. EPA, Chris Deacutis, Narragansett Bay Estuary Program

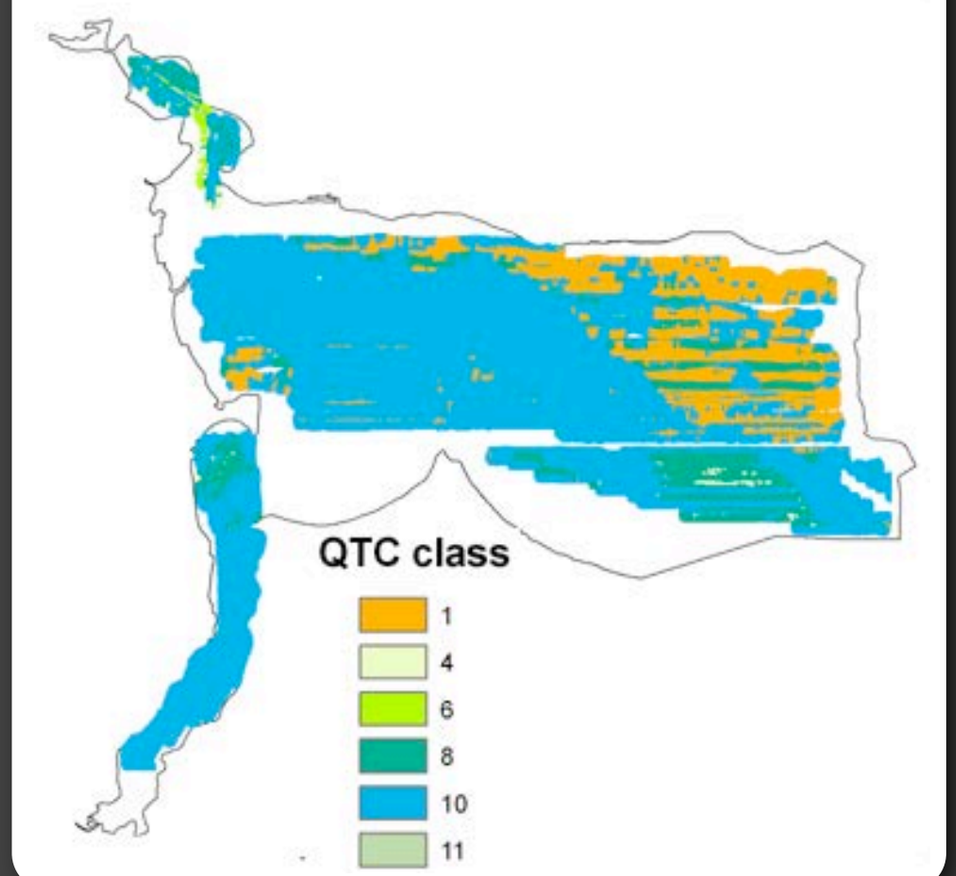
Physical variables

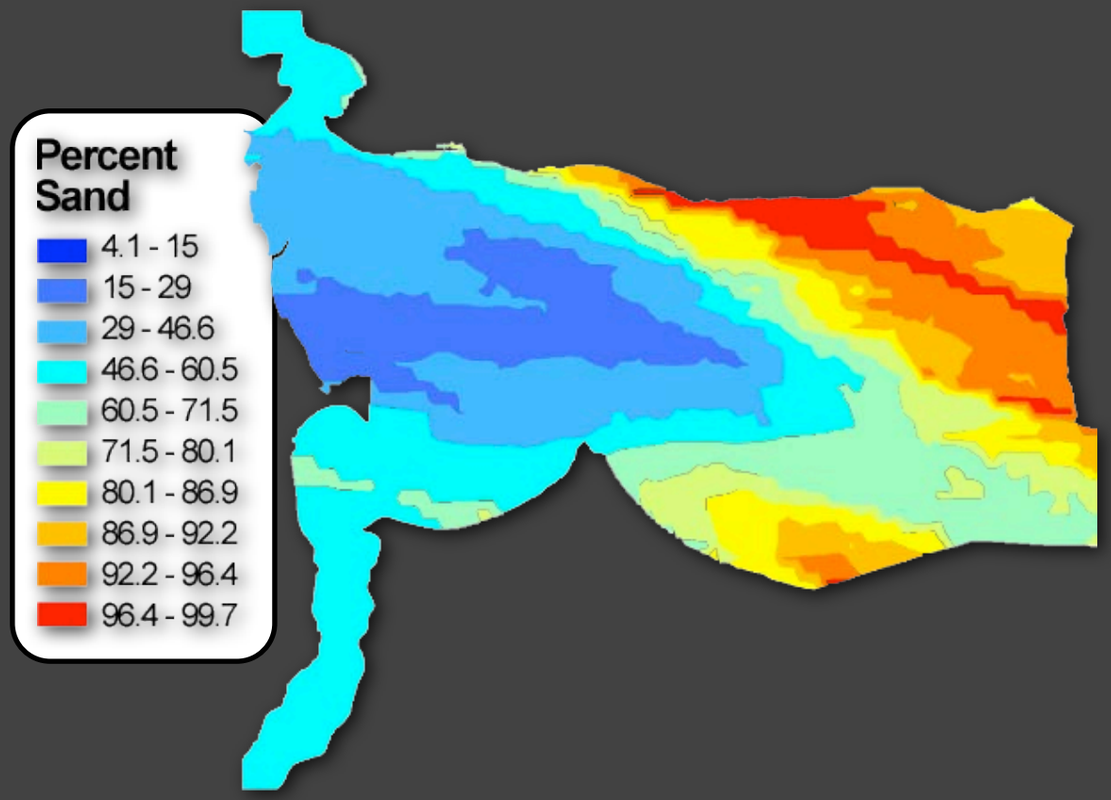


Backscatter mean, median, standard deviation, skewness, kurtosis

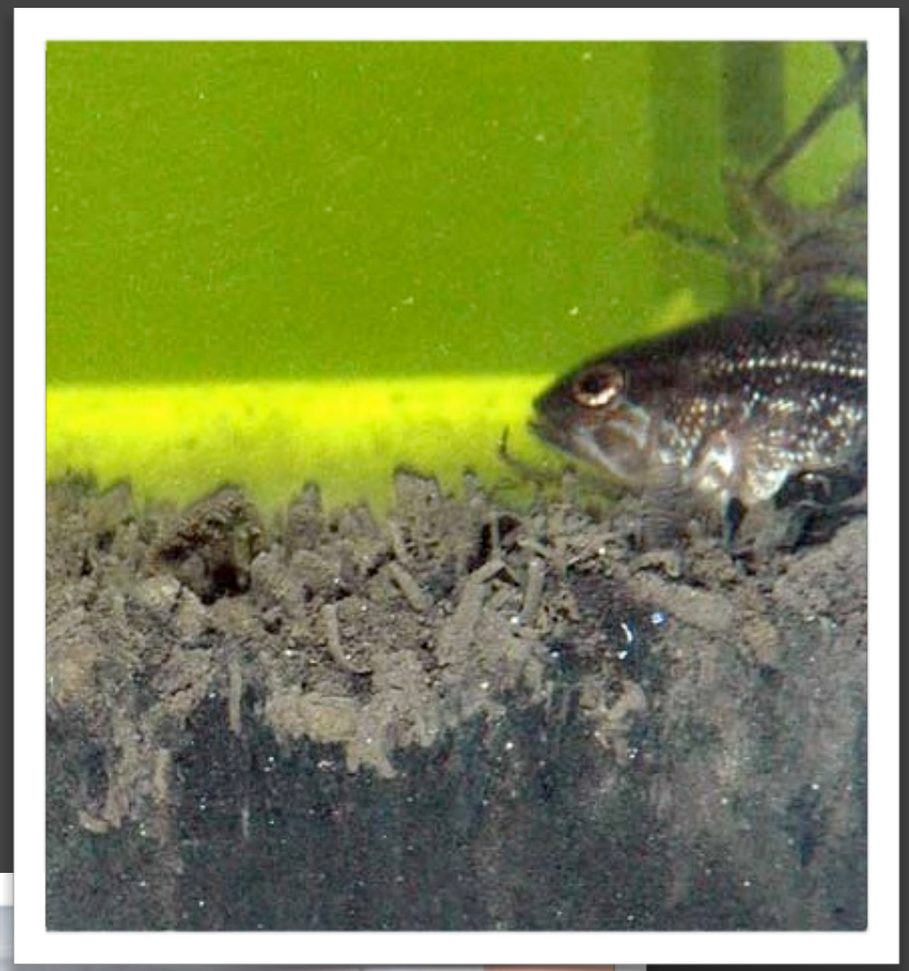
Percent sand, Total organic content

Depth



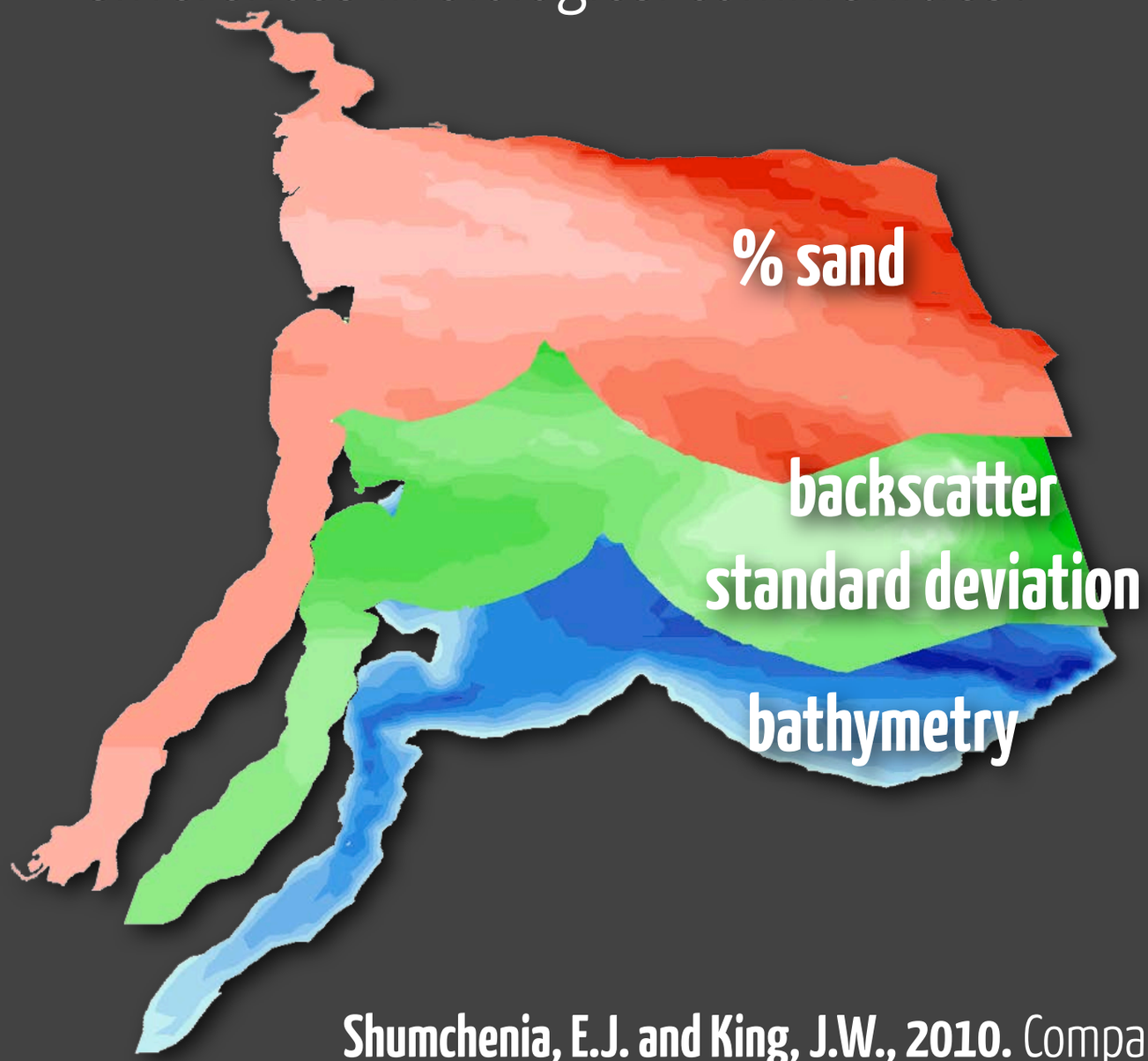


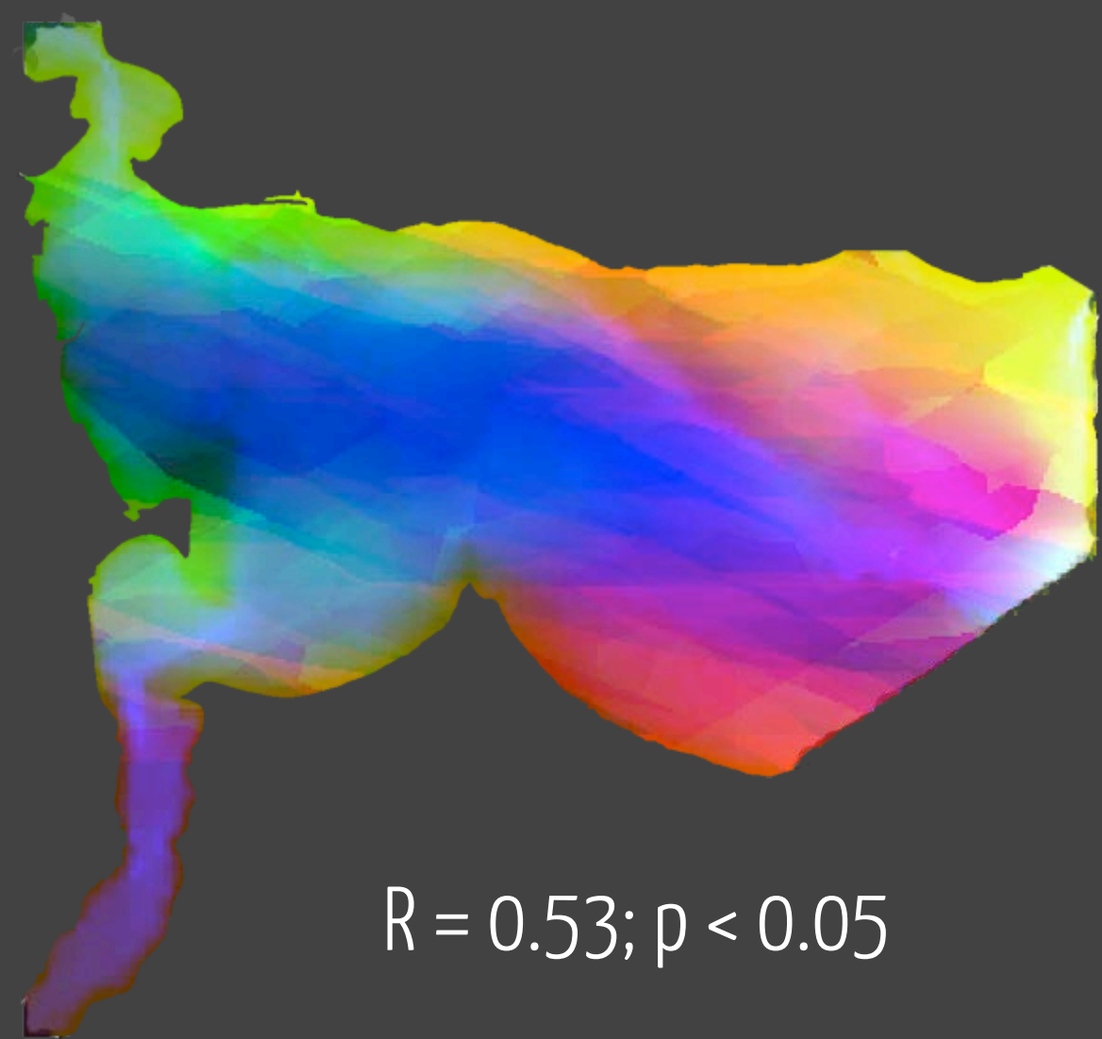
Biological variables



“Bottom-up” methodology

Is there a combination of acoustic and environmental variables that can describe differences in biological communities?

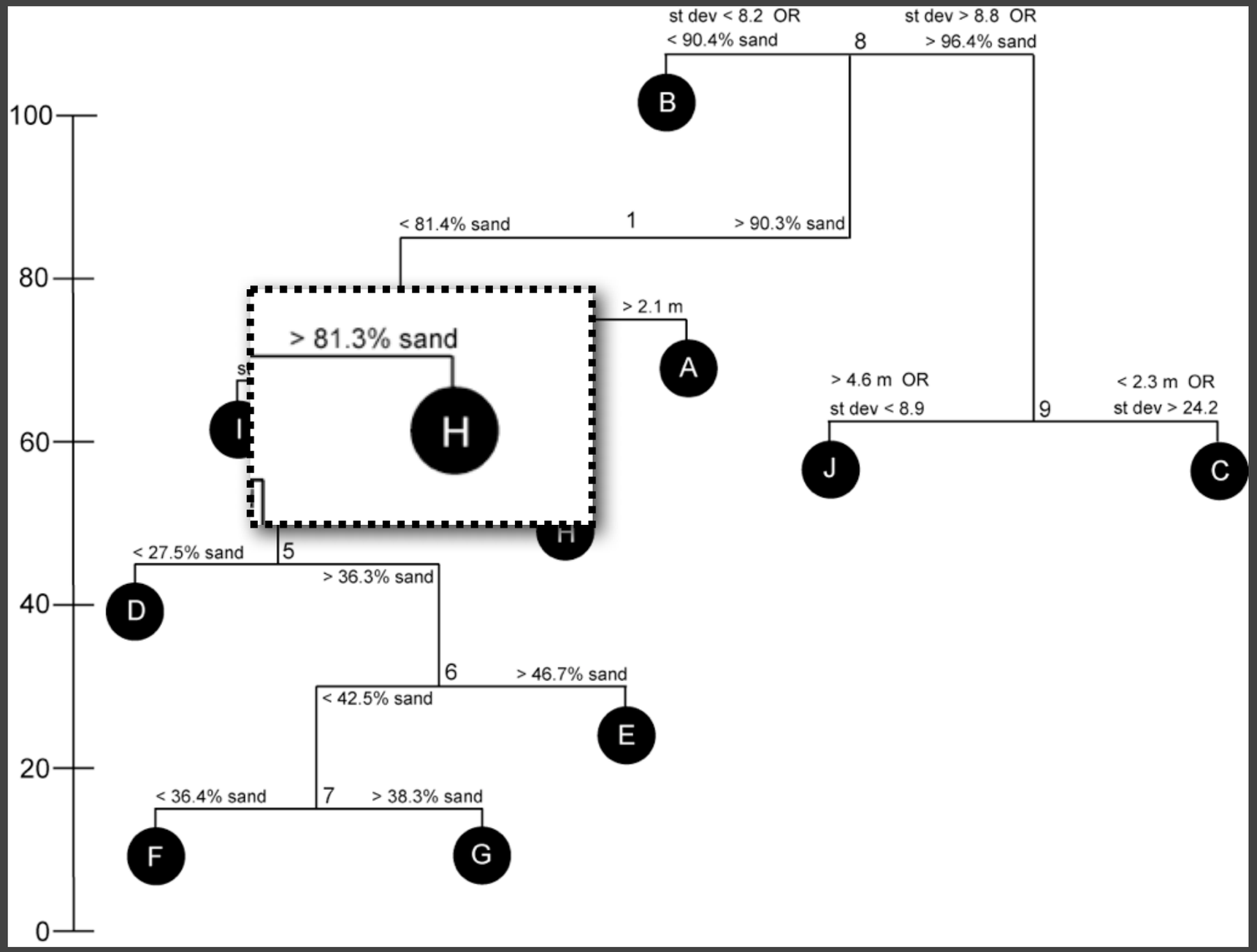




$R = 0.53; p < 0.05$

Shumchenia, E.J. and King, J.W., 2010. Comparison of methods for integrating biological and physical data for marine habitat mapping and classification. **Continental Shelf Research 30, 1717-1729.**

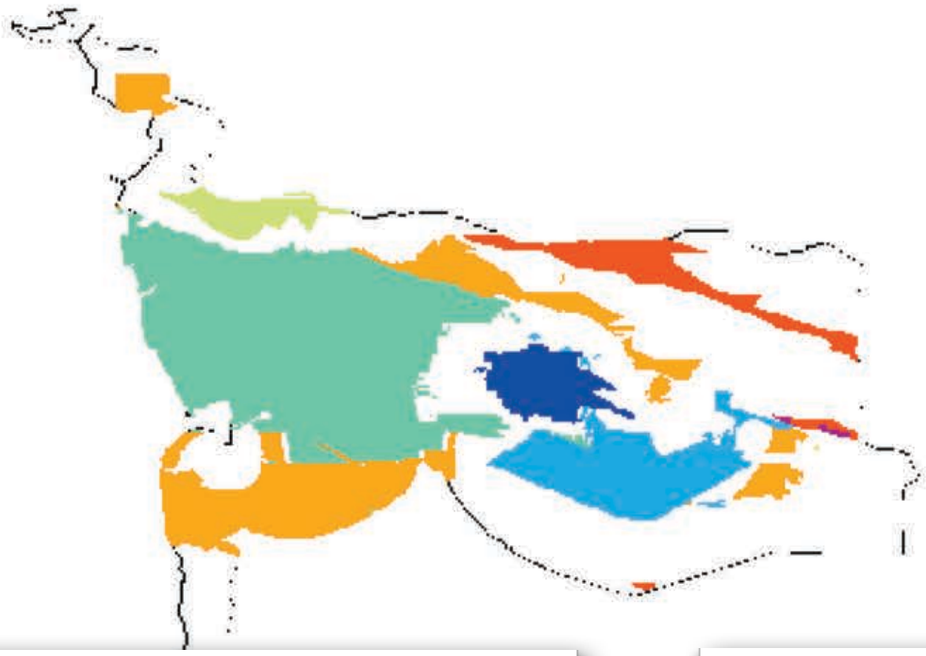
Classification using linkage tree



Characterizing Biotopes

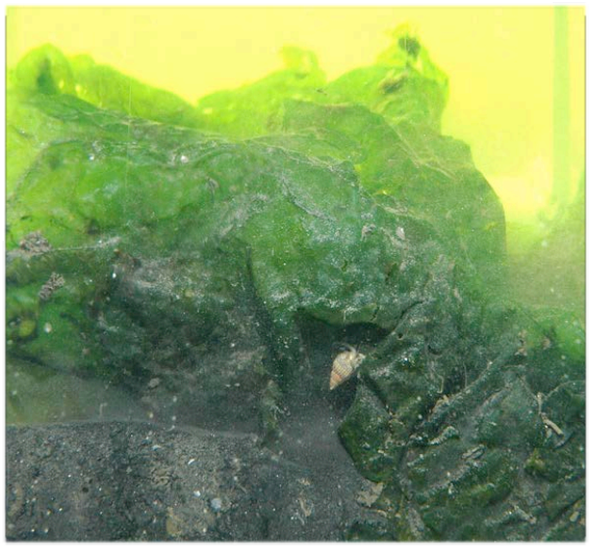
Linktree class	I	J
Substrate group	Muddy sand	Sand
% sand	67.7 - 81.4%	> 96.4%
Biotic community	Ampelisca community	Spiochaetopterus community
Biotope	Ampelisca on muddy sand, high backscatter std dev	Spiochaetopterus on shallow coarse sand

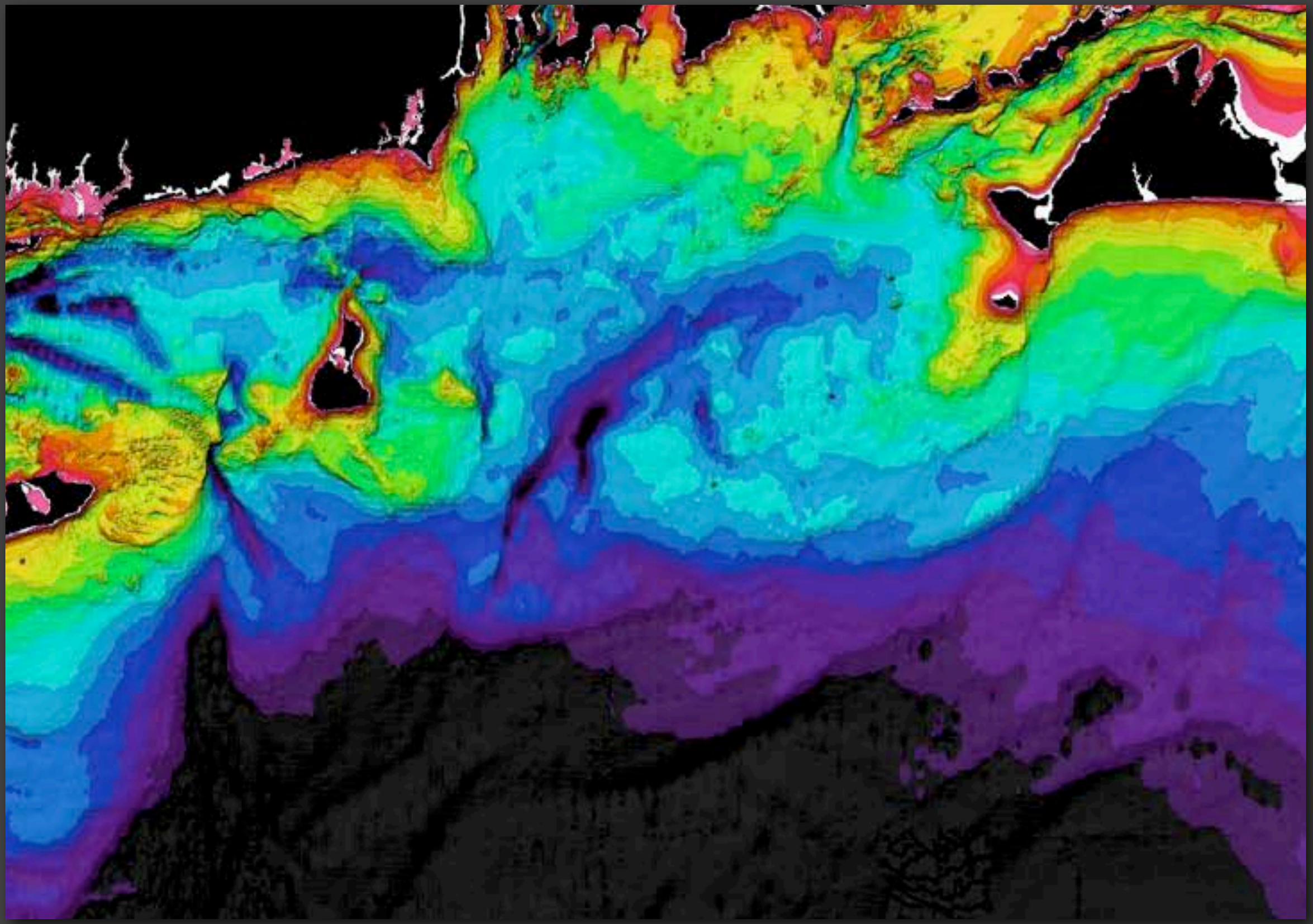
Biotope Maps



Biotic Component
Biotopes

- Ampelisca on muddy sand, high backscatter std dev
- Ampelisca on shallow mud, low backscatter std dev
- Ampelisca on deep mud, low backscatter std dev
- Ampelisca on sandy mud, low backscatter std dev
- Ampelisca on sandy mud, high backscatter std dev
- Spiochaetopterus on shallow coarse sand
- Spiochaetopterus on deep coarse sand





Geoform Mapping

MESHAtlantic 2012

Benthic Terrain Modeler

Untitled.mxd - ArcMap - ArcView

File Edit View Insert Selection Tools Window Help

1:434,227 | Benthic Terrain Modeler Menu | Spatial Analyst | Layer: SAMP Geoforms

Editor | Task: Create New Feature | Target: | Layer: SAMP Geoforms | 500

Layers

Benthic Terrain Modeler

Create / edit classification dictionary

Specify an existing classification dictionary: C:\Data\Emily\RISAMP_geoforms.xml

File Name: RISAMP_geoforms.xml Title: RI Ocean SAMP Geoforms

Description: CMECS Geoforms of the RI Ocean SAMP area

Classification		Broad Scale BPI Paramaters		Fine Scale BPI Paramaters		
Class	Zone	Lower Bounds	Upper Bounds	Lower Bounds	Upper Bounds	Lowe
6	Slopes	-100	100	-10	100	
7	Crests	-100	100	100		
8	Channels		-100		-100	
9	Peaks	100		100		
10	Mid-depth flat	-100	100			

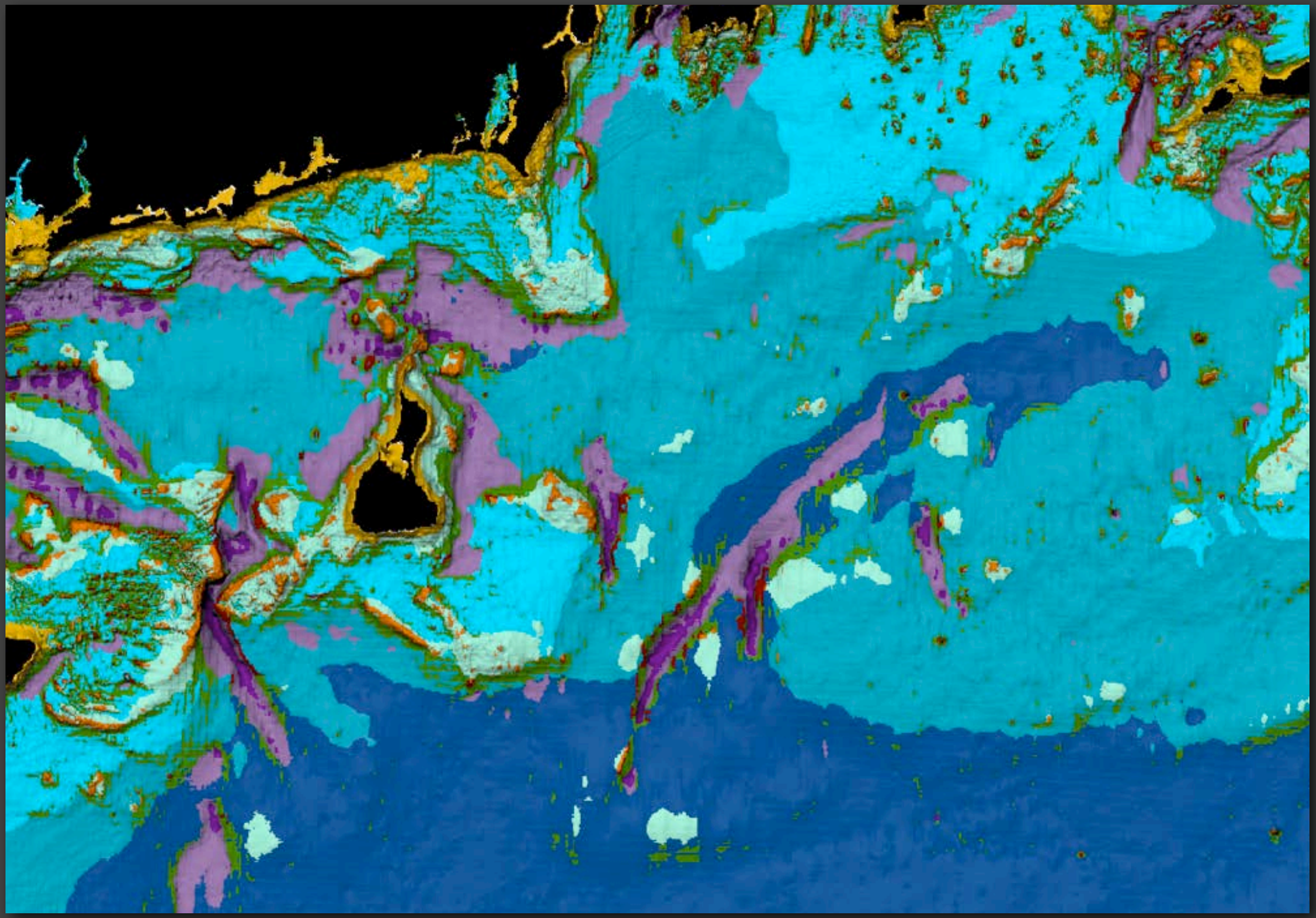
Optional Fields | Delete Record | Add Record | Save Dictionary

More about classification dictionaries... | Close

Display | Source | Selection

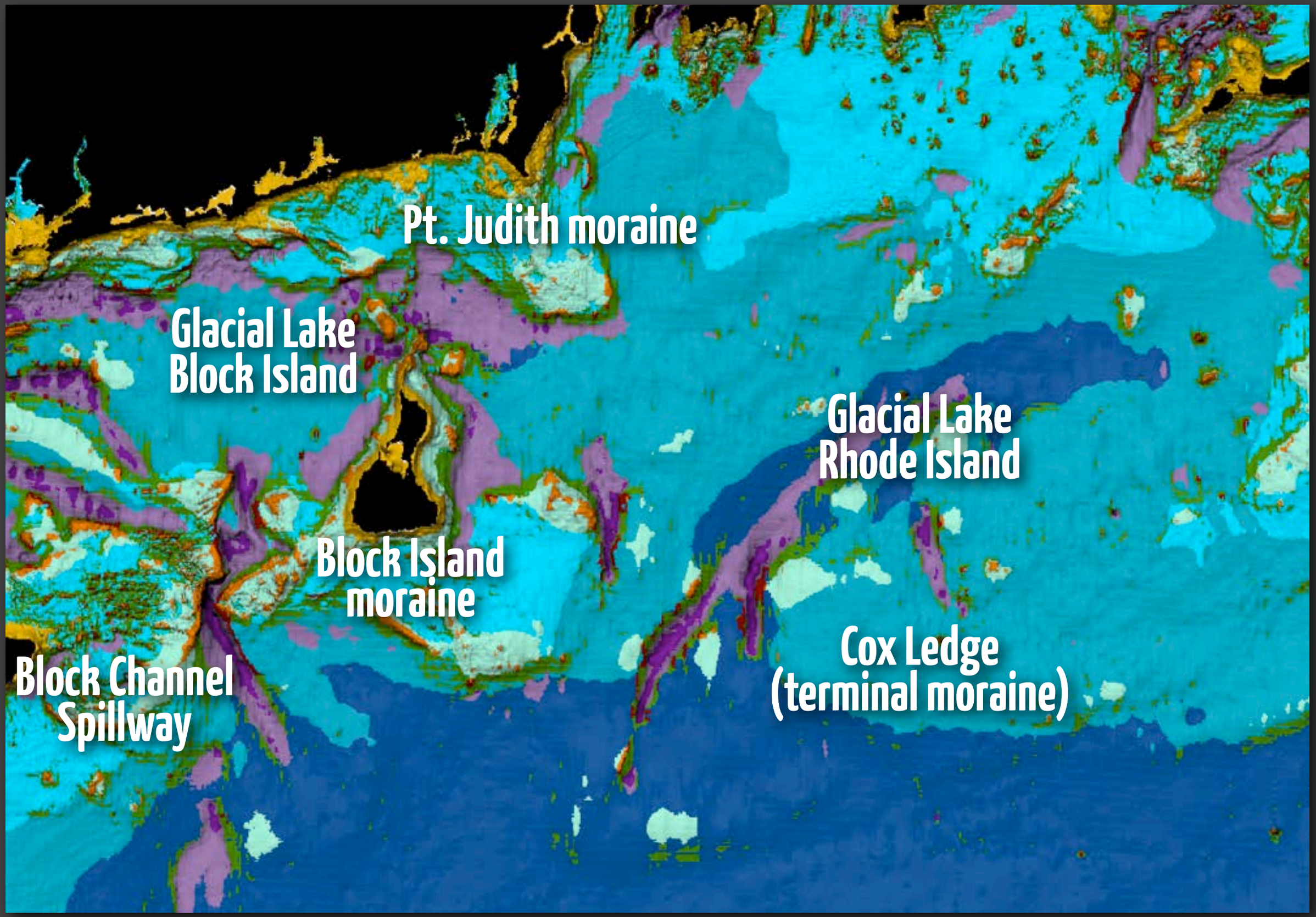
Drawing | Arial | 10

154181.509 150674.698 Feet



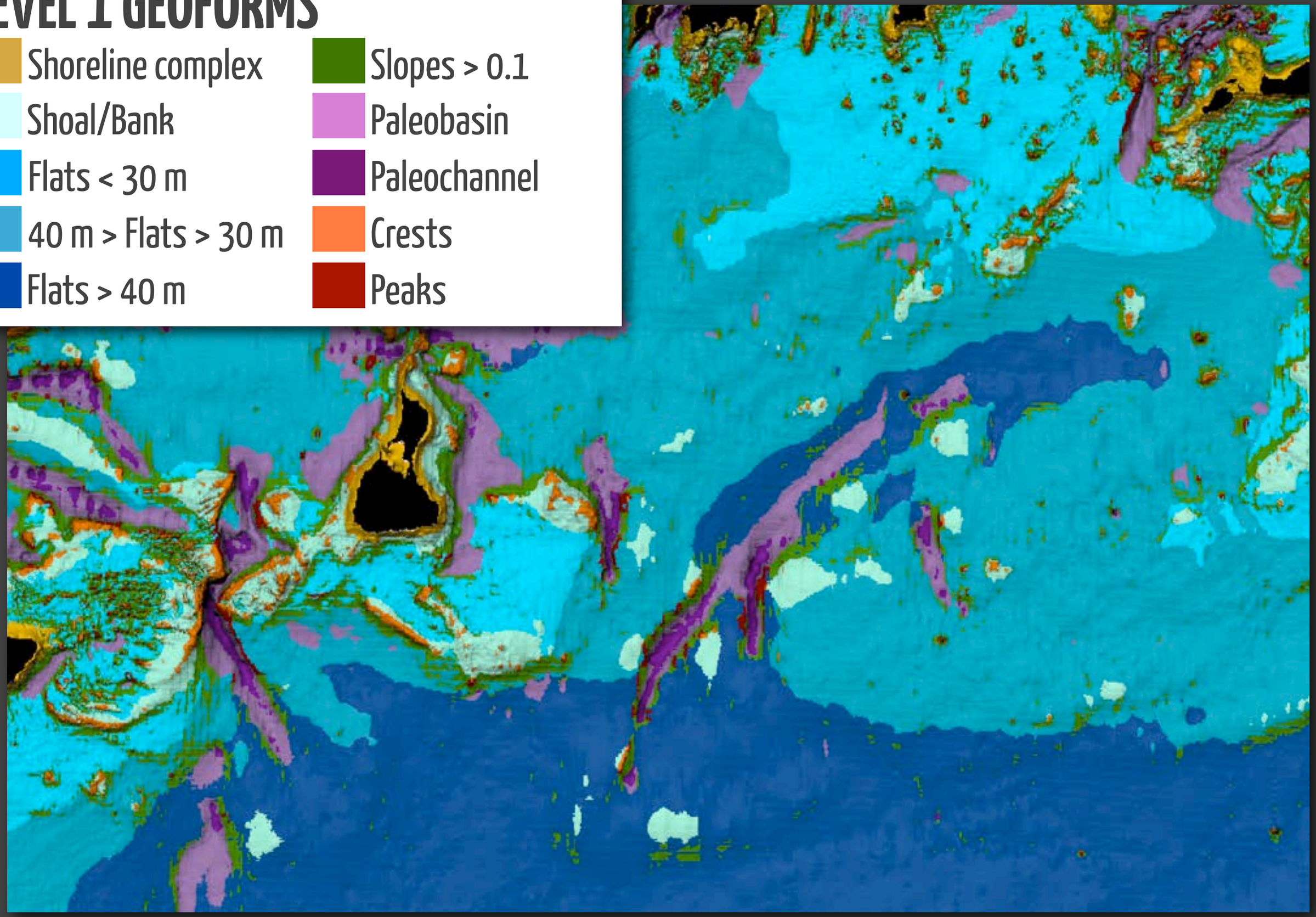
Geoform Mapping

MESHAtlantic 2012


Pt. Judith moraine
Glacial Lake
Block Island
Glacial Lake
Rhode Island
Block Island
moraine
Cox Ledge
(terminal moraine)
Block Channel
Spillway

LEVEL 1 GEOFORMS

- Shoreline complex
- Shoal/Bank
- Flats < 30 m
- 40 m > Flats > 30 m
- Flats > 40 m
- Slopes > 0.1
- Paleobasin
- Paleochannel
- Crests
- Peaks



Marine spatial planning

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Decision tools:
Ecosystem valuation models, indices

↓

Predictive capability

↓

Physical-biological linkages

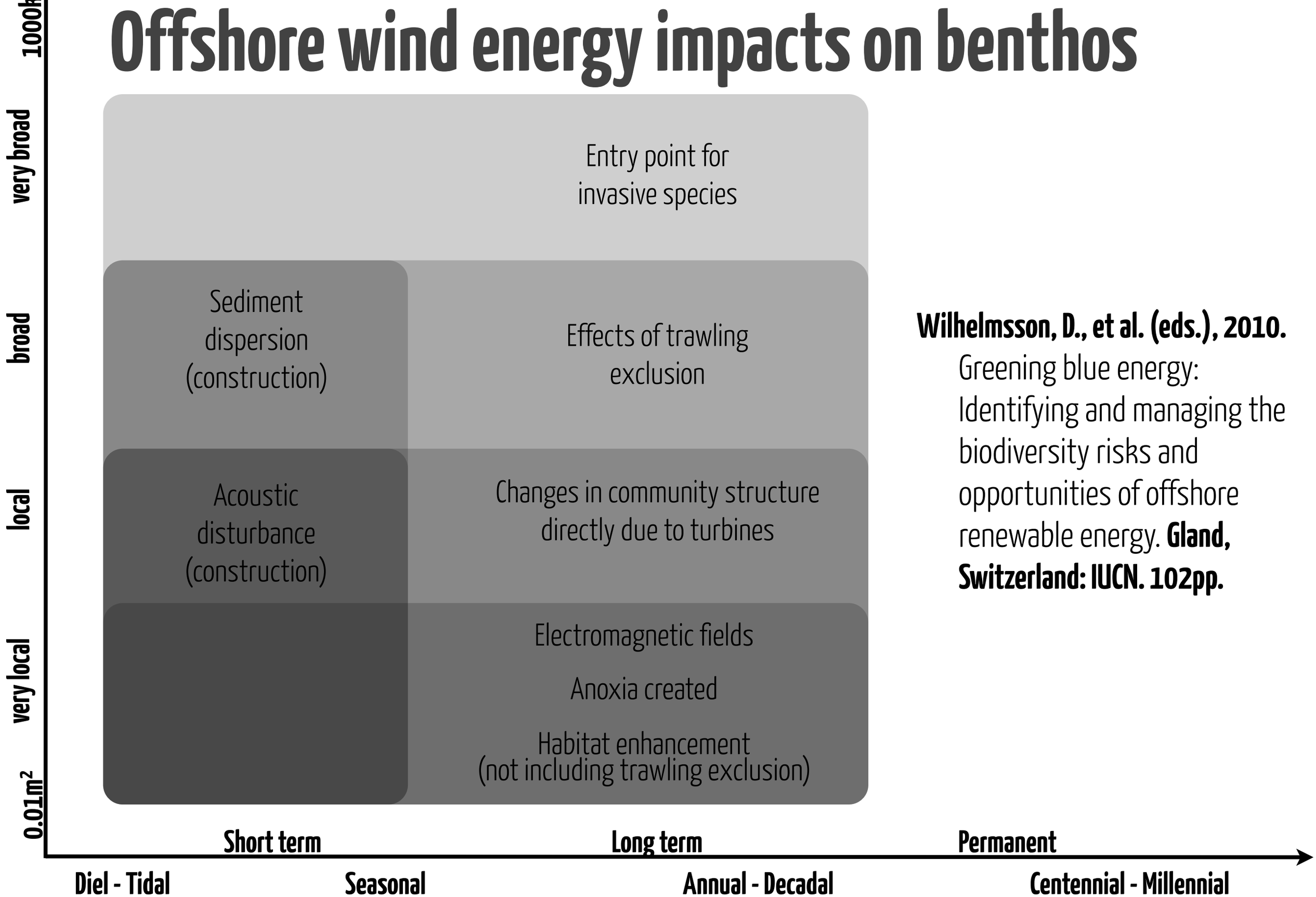
↓

Overlap in space-time framework
Patterns link to processes

Developing Monitoring Protocols

- Identify impact and its spatial-temporal scale
- Identify existing baseline data or if none, proceed to next step
- Estimate sampling frequency based on relevant temporal scale
- Identify relevant CMECS components
- Choose tool based on spatial-temporal scale, CMECS data attainable, cost

Offshore wind energy impacts on benthos



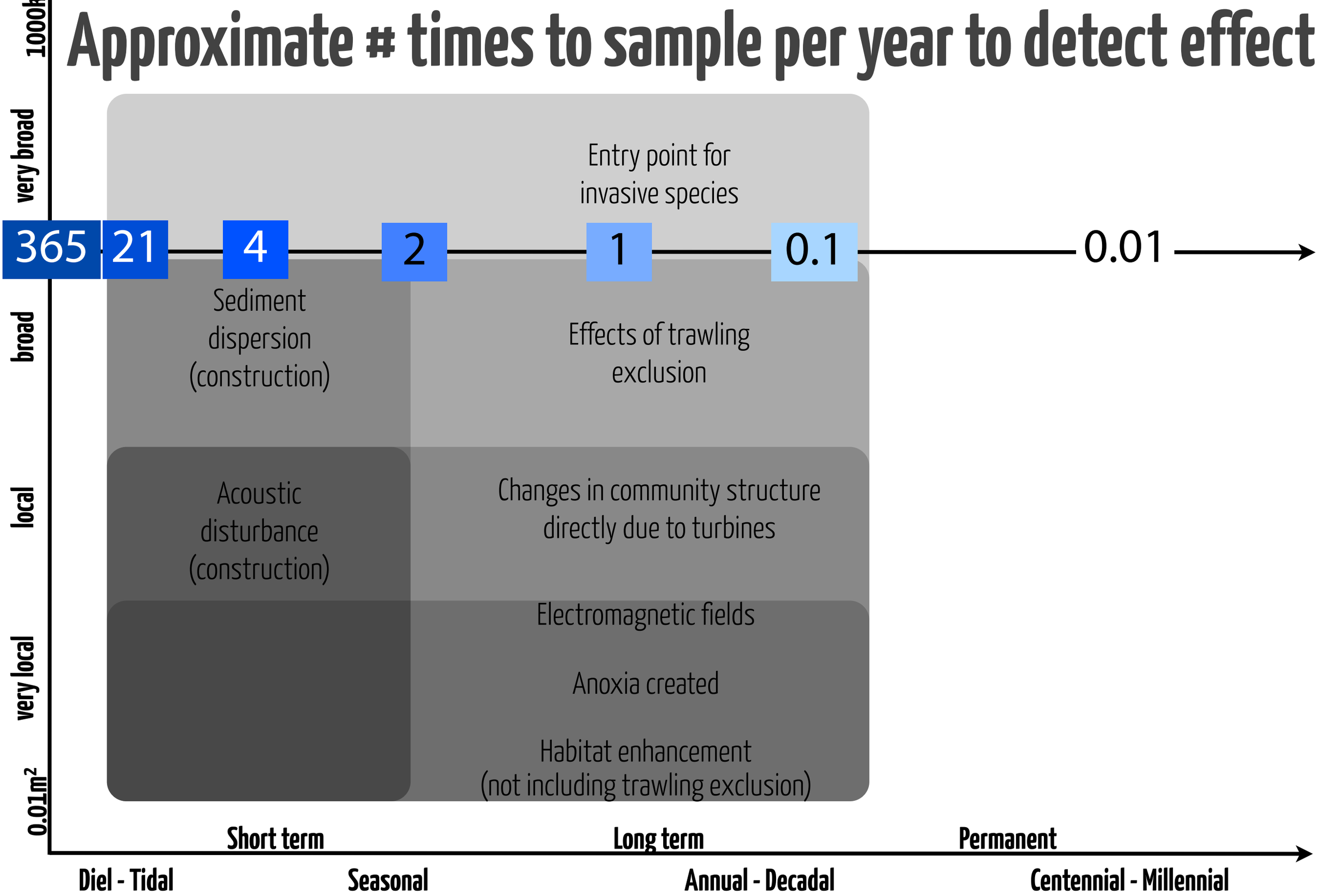
Wilhelmsson, D., et al. (eds.), 2010. Greening blue energy: Identifying and managing the biodiversity risks and opportunities of offshore renewable energy. **Gland, Switzerland: IUCN. 102pp.**

Establishing baselines

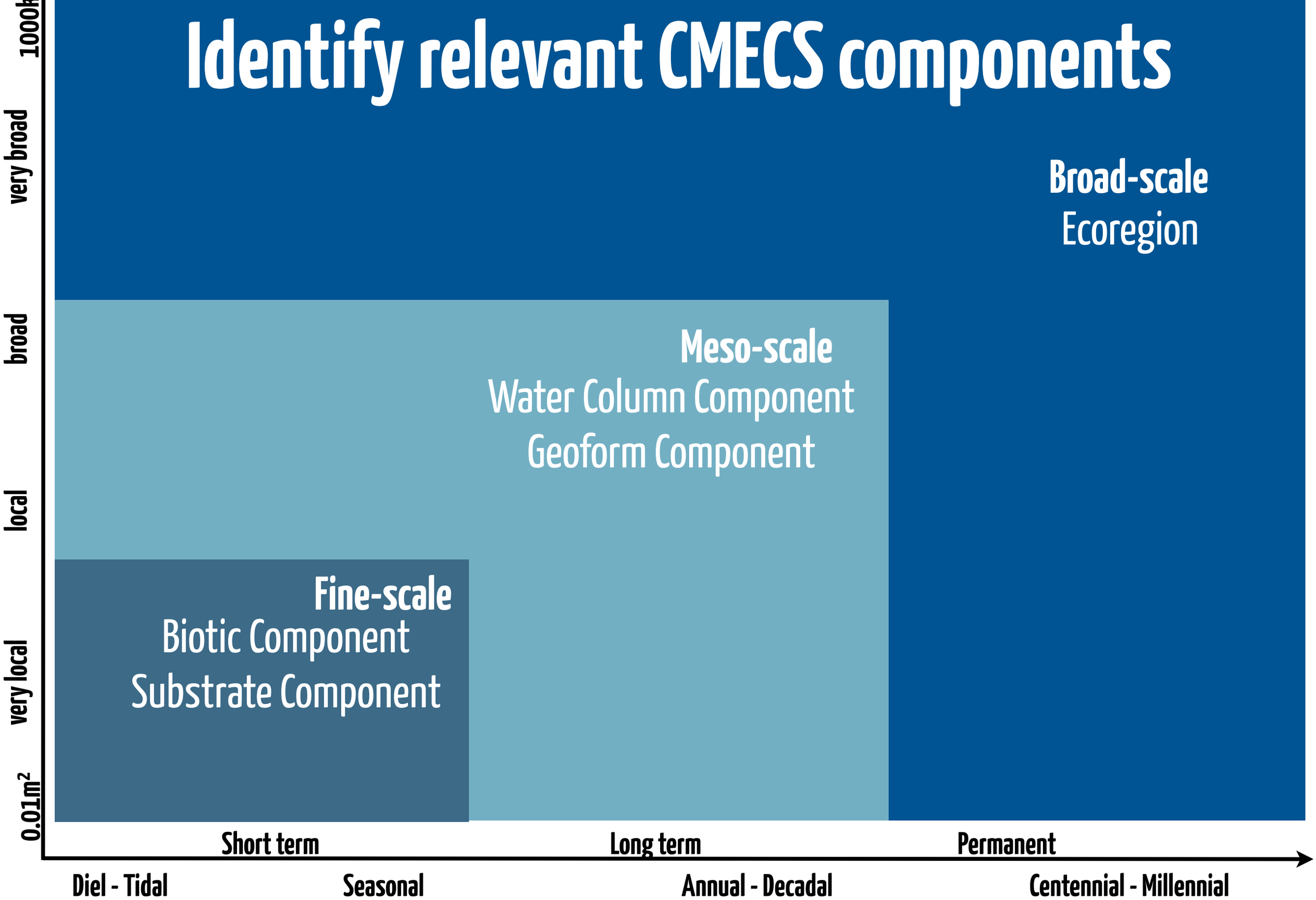
- Existing reference level (e.g., endangered spp.)
- Historic, or undisturbed reference site
- Reference direction (e.g., decrease in seagrass)
- Reference based on a threshold (ref point is linked mathematically to a functional relationship)

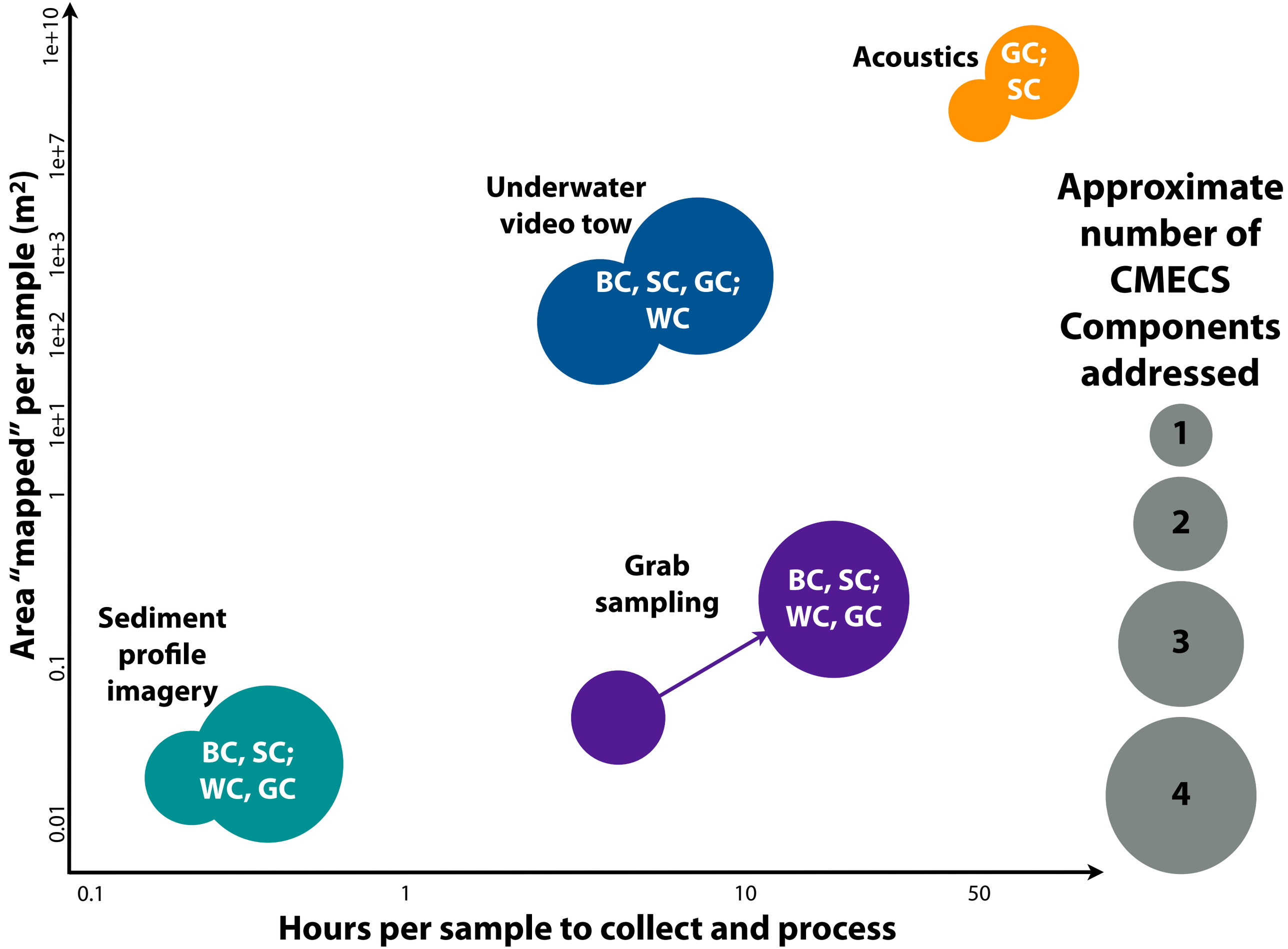
Samhouri, J.F., Levin, P.S., James, C.A., Kershner, J., Williams, G., 2011. Using existing scientific capacity to set targets for ecosystem-based management: A Puget Sound case study. **Marine Policy 35, 508-518.**

Approximate # times to sample per year to detect effect



Identify relevant CMECS components




Acoustics
GC; SC
Underwater video tow
BC, SC, GC; WC
Grab sampling
BC, SC; WC, GC
Sediment profile imagery
BC, SC; WC, GC
Approximate number of CMECS Components addressed
1
2
3
4
Area "mapped" per sample (m²)
1e+10
1e+7
1e+3
1e+2
1e+1
1
0.1
0.01
0.1
1
10
50
Hours per sample to collect and process

Well-funded	Poorly-funded
grabs + SPI	SPI
Detailed, long-term study	Rapid assessment
Biannual sampling for 20 years	Annual sampling for 5 years
30 hours work/station	~1 hour work/station
Populate CMECS Geoform, Water Column, Substrate and Biotic Components	Populate CMECS Biotic, Substrate Components

Thank You

University of Rhode Island

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NOPP Team, RI OSAMP Team

The CMECS Implementation Group

R. Allee, G. Cicchetti, M. Finkbeiner, K. Goodin, L. Handley,
C. Madden, G. Mayer, J. Soule