Setting Priorities for Eelgrass Conservation and Restoration

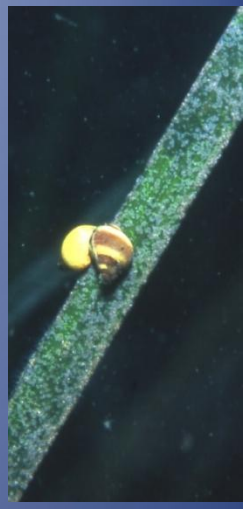
Robert Buchsbaum

Massachusetts Audubon Society

Mass Audubon

Protecting the Nature of Massachusetts

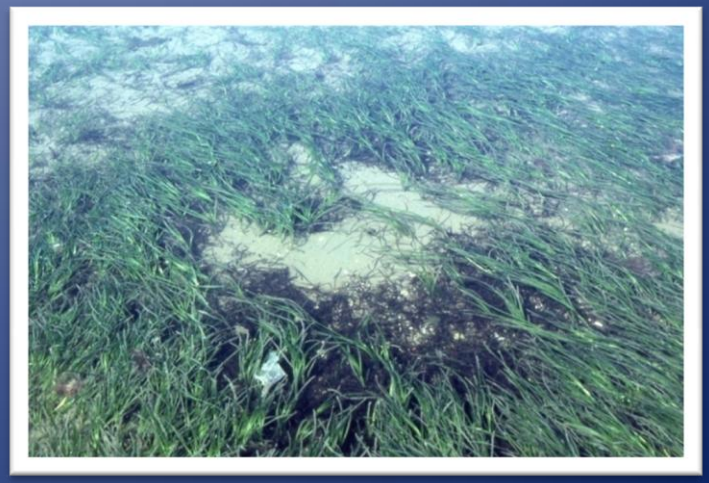
Eelgrass habitat values



- A rich, productive habitat for many marine organisms
  - Nursery habitat for fish and invertebrates
  - Feeding area for many waterfowl, fish, and invertebrates
  - Consumed directly or as detritus
- Filter of nutrients
- Stabilizer of sediments

The Massachusetts Oceans Act-2008
from Section 2:

- The [ocean management] plan shall:
  - (v) value biodiversity and ecosystem health
  - (vi) identify and protect special, sensitive or unique estuarine and marine life and habitats
- Scope is MA coastal water from 0.5 km out to seaward boundary .



Three approaches to prioritizing habitats

- Regulatory: Areas or resources with legal protection
- Biotic: Habitats considered important for life stages of different species or groups of species.
- Abiotic: unique or sensitive habitats as indicated by physical parameters.

Track 1: Legally protected areas

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

Figure 2. Mapped habitat areas / resources with special legal protection

Seagrasses:
Legal protction in MA

1. MA Wetlands Protection Act
2. Special aquatic site under federal Clean Water Act

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

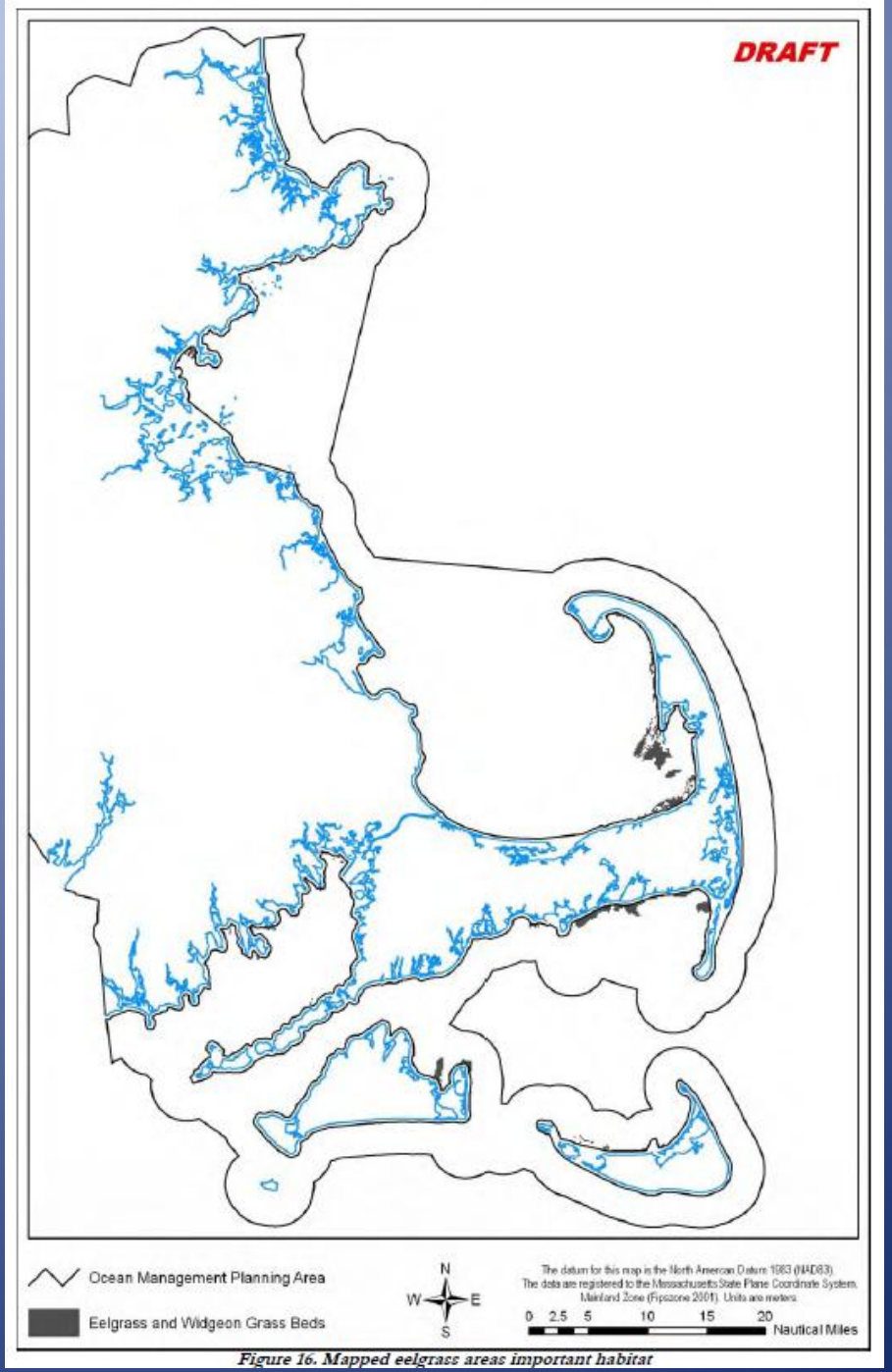
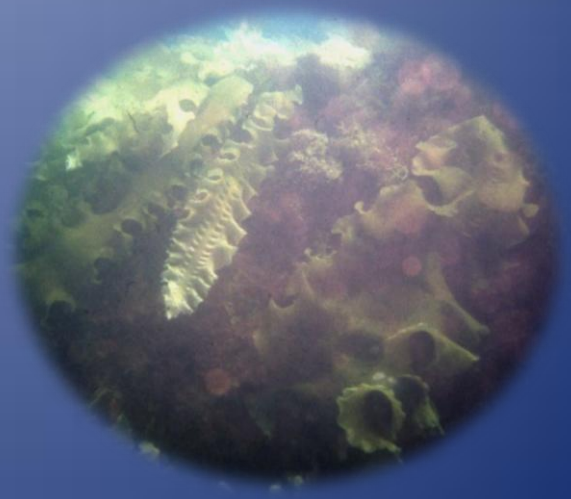


Figure 16. Mapped eelgrass areas important habitat

Track 2: Biotic criteria*

- Which taxa or habitats?
  - – Driven by presence of data –
    - Charismatic species
    - Commercial species
  - – Limited time for analysis
  - – Acknowledged data gaps:
    - Kelp
    - Most marine invertebrates
    - Non commercial fish



* Habitat critical to or providing specific life stage support for important species (or group of species, such as guilds or assemblages

Criteria used for comparing different types of habitats

Standard / Condition	Score
Rare, unique, and/or sensitive habitat. Identified as critical habitat for endangered or threatened species (e.g., nesting, staging) where there are no or very few other areas exist that provide similar structure or function.	3
Exceptional and somewhat unique habitat and/or habitat with high vulnerability. These are habitat areas where few others exist providing similar structure or function	2
Important habitat and/or habitat or resources susceptible to adverse impacts. Identified as areas that support endangered, threatened, or special concern species or other important species, but where use is general or occurs over large geographic areas.	1

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

Biotic data used in ranking

Habitat	Ranking
Roseate Tern breeding and staging	3
North Atlantic Right Whales	3
Humpback Whale concentrations	3
Fin whale concentrations	3
Sei Whale concentrations	2
SAV – eelgrass and wigeongrass	2
Colonial waterbird nesting colonies	2
Leach's Storm Petrel nesting	2
Common, Least and Arctic tern nesting and staging	2
Common, Least and Arctic tern foraging	1
Long-tailed Duck winter habitat	1
Other marine seaducks and waterbirds	1
Seal haul out islands	1

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

Data integration of ranked aggregate scores

Grid cell raw score	Quartile Reclassification Class
0-1	Low
2-3	Medium
4-5	High
6-16	Critical

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

Integrated ranking of biotic criteria

Grid blocks are 250 m^2

Scale set up after overlapping criteria using either ranks or no ranks.

From Mass Ocean Mgmt Habitat Working Group draft report-11/26/08

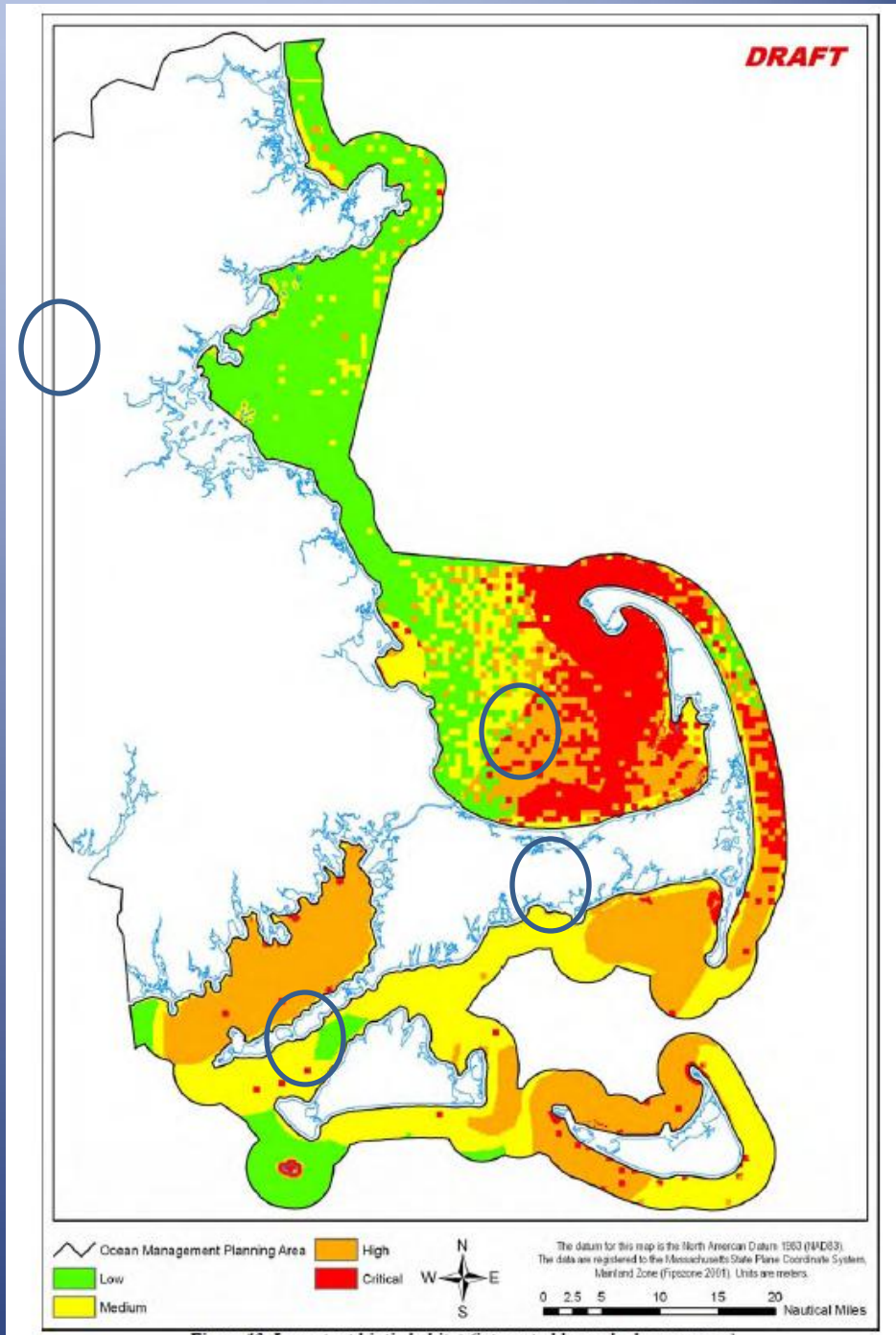
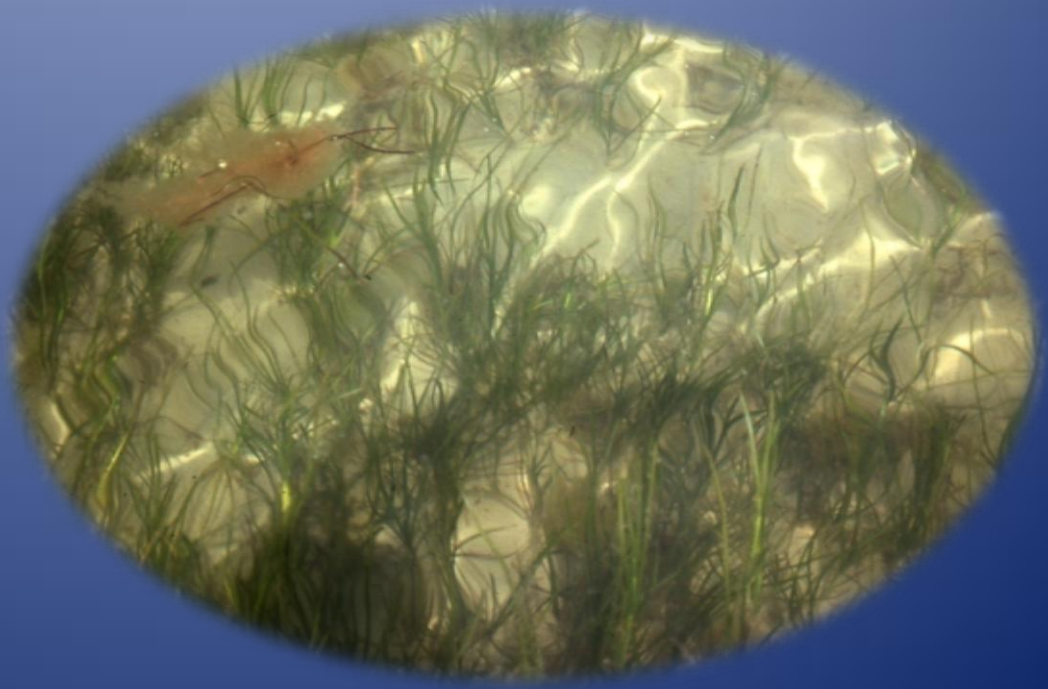


Figure 18. Important biotic habitat (integrated by ranked occurrence)

Within habitat types

- Are some habitats of higher priority than others?
- Terrestrial model of “exemplary natural community”



Options for evaluating within a habitat

- Presence/absence
- Some kind of ranking system

Seagrass landscapes

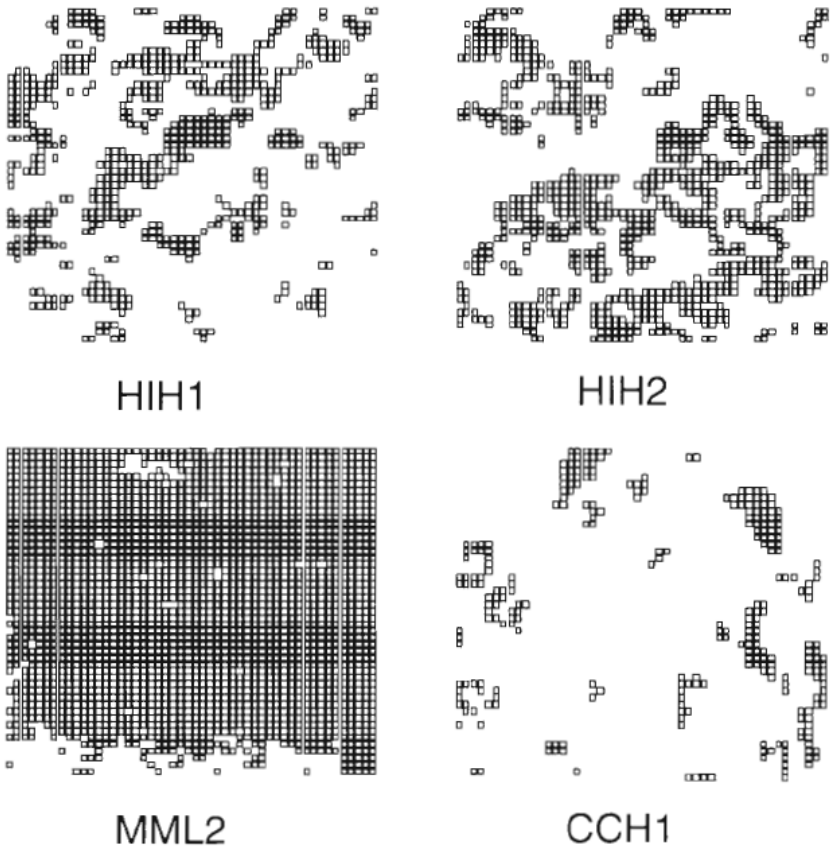
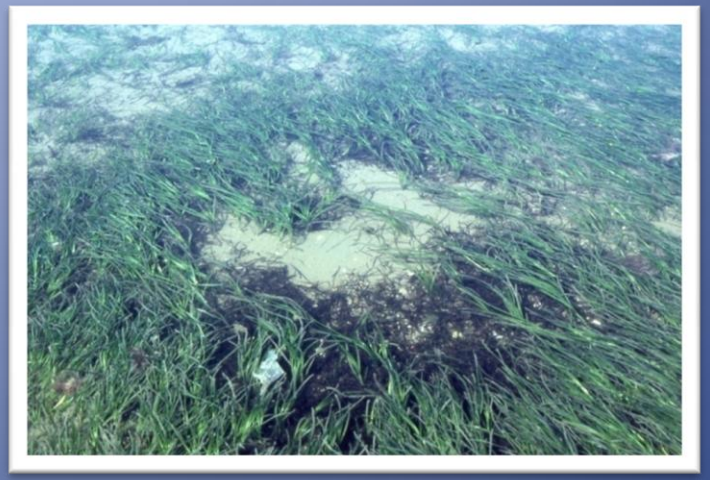


Fig. 1. Maps (50 × 50 m) of 4 representative North Carolina study sites at 50 m scale with 1 m resolution showing variation in seagrass coverage. Each square represents a 1 m^2 area of seagrass cover; unvegetated areas are unmarked. Site HIH1: 36% cover, relative exposure index (REI) of ~3.78×10^6, maximum tidal current speed (U) of 30 cm s^{-1} and a sediment organic content (OM) of 1.4%; site MML2: 89% cover, REI ≈ 6.19×10^5, U = 17 cm s^{-1}, OM = 2.0%; site HIH2: 36% cover, REI ≈ 4.83×10^6, U = 23 cm s^{-1}, OM = 1.2%; site CCH1: 13% cover, REI ≈ 5.09×10^6, U = 36 cm s^{-1}, OM = 1.0%

Fonseca and Bell 1998. MEPS



Fonseca and Bell suggest cover threshold of 59% below which there would be functional effects or changes of associated organisms.

What landscape features of eelgrass meadows might influence values?

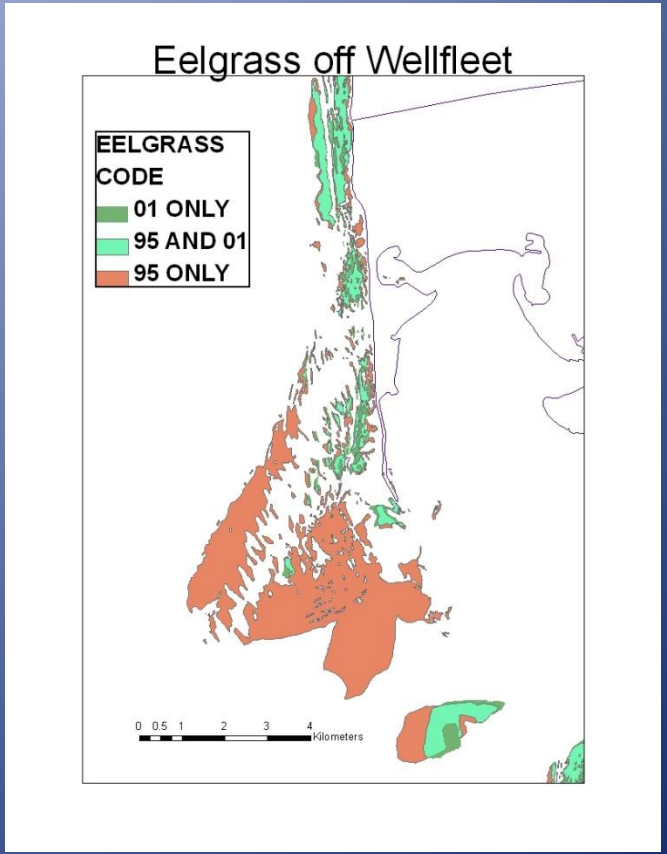
- Size of bed
- Density of plants
- Patchiness – sizes, shapes, distances between
- Fragmentation
- Proximity of other habitats
  - Salt marshes, shellfish beds, sources of larvae
- Depth

Cover of seagrass is a response to:

- Internal regulation of growth:
  - Rhizome elongation rates and branching which are effected by:
    - Sediment type
    - Light levels
    - Nutrients

External factors

- External natural factors
  - Wave and current exposure
  - Current speed
  - Water depth
  - Herbivory
- Human disturbances
  - Trawling
  - Moorings
  - Boat wakes



From MassGIS seagrass coverage

Scale influences the perception of eelgrass values

- Studies often focus on smaller more sedentary organisms
- Harder to compare habitat function of different beds on a large scale with larger, more motile organisms.

Landcape features

- Large scale
  - Patch size
  - Fragmentation
  - Edge effects
  - Proximity to other habitats
- Small (local) scale
  - Plant density
  - Artifical seagrass units

The Theory of Island Biogeography

by Robert MacArthur
and E.O. Wilson
1967

- Larger islands will contain more species than smaller ones.
- Islands closer to the mainland, will have more species than distant ones.
- Islands that are more diverse in habitats will have more species
- Extincts and immigrations are in equilibrium on islands

Island Biogeography Model applied to seagrasses

- One might predict that the diversity and abundance of species within an eelgrass meadow would follow patterns of islands:
  - Larger patches and more connected patches should have more species
  - More complex seagrass meadows should have more species
    - Plant density
    - Mosaics of habitat types

Taxa in various studies*

- Bivalves
- Fish
- Crustaceans
- Epifauna
- Infauna

*Reviewed by Bostrom, Jackson and Simenstad 2006, Estuarine and Coastal Shelf Science 68:303-483

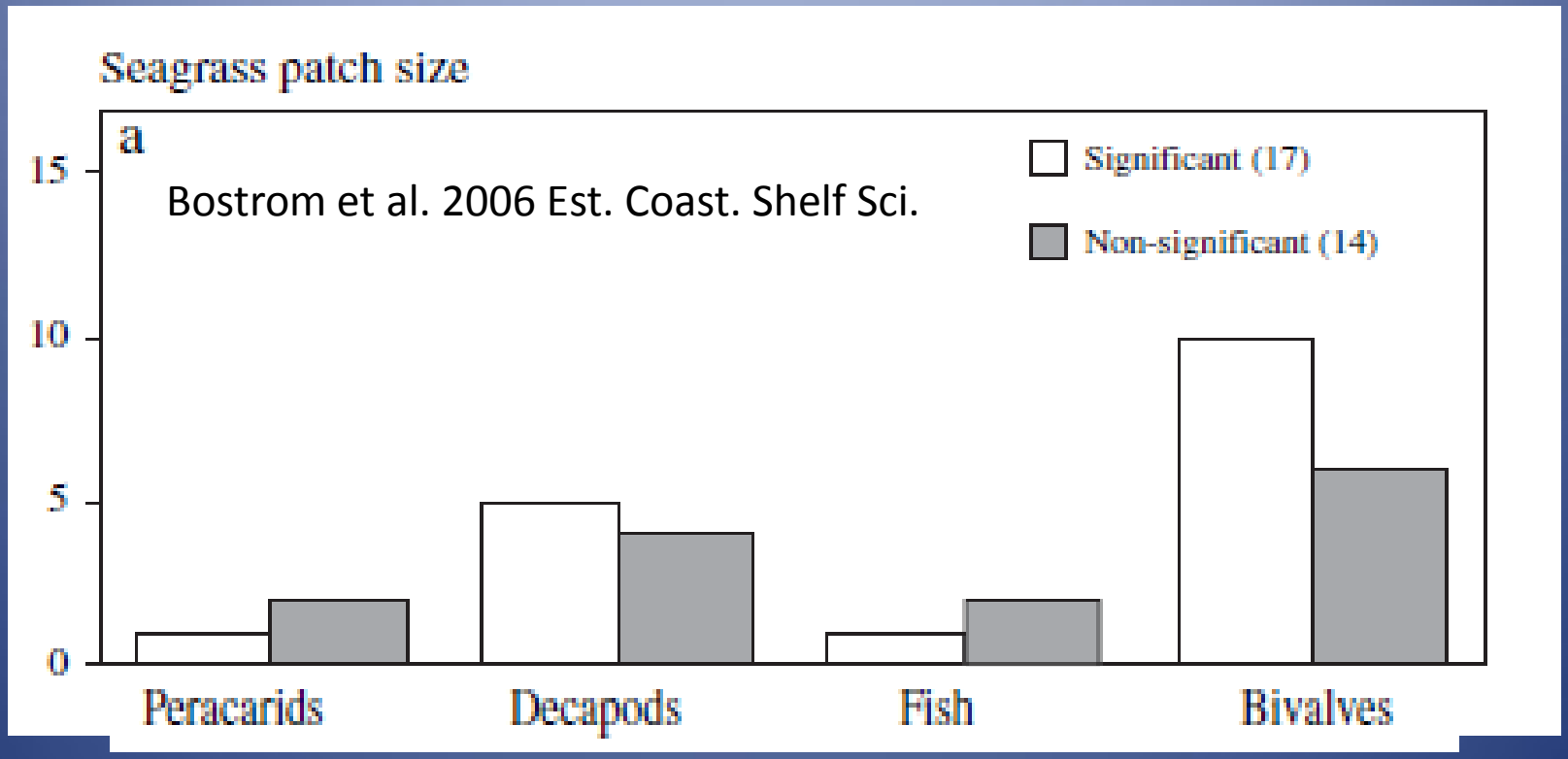
Response variables to landscape features

- Biomass
- Mortality
- Reproduction
- Growth
- Predation
- Number of species

Only two studies of diversity v patch size

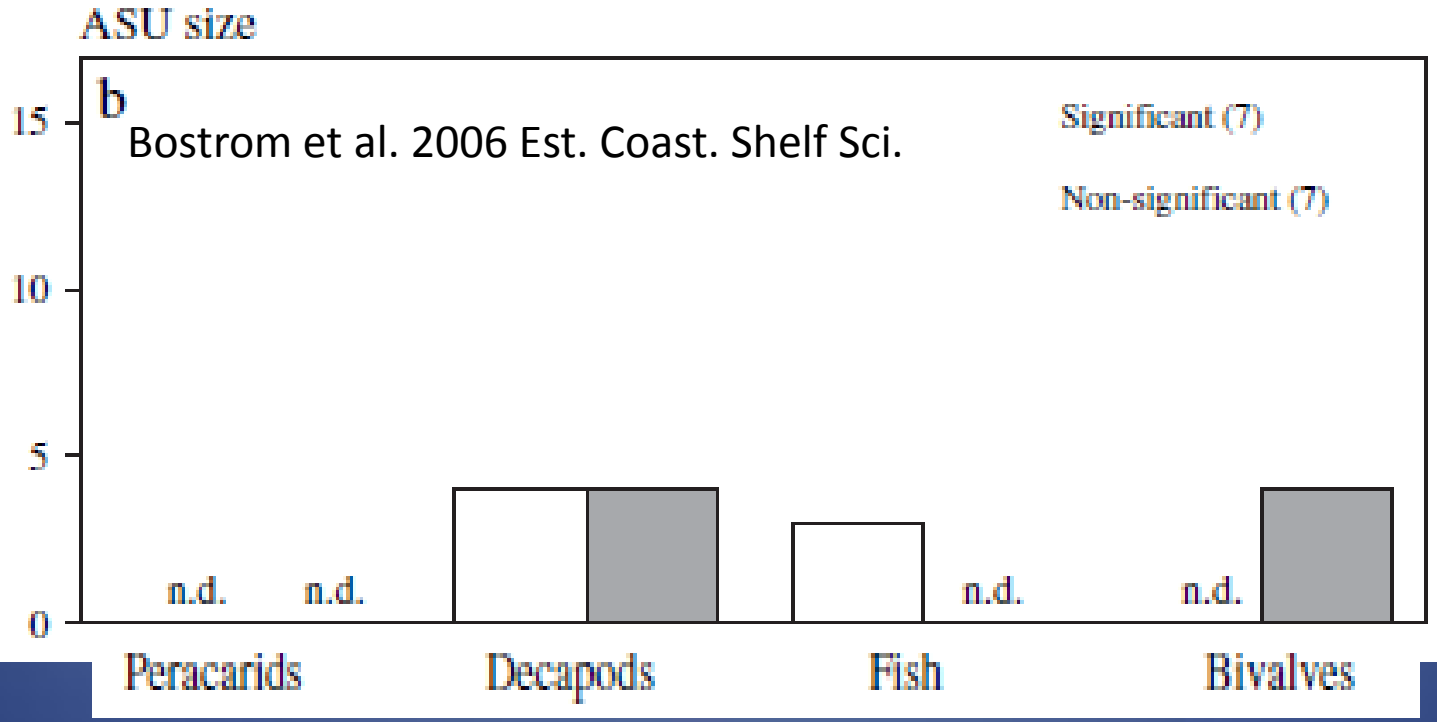
- Bowden et al. 2001 - positive effect on invertebrate taxa
- Bell et al. 2001 - no relationship of seagrass patch size with amphipod diversity

Effects of seagrass patch size – natural beds



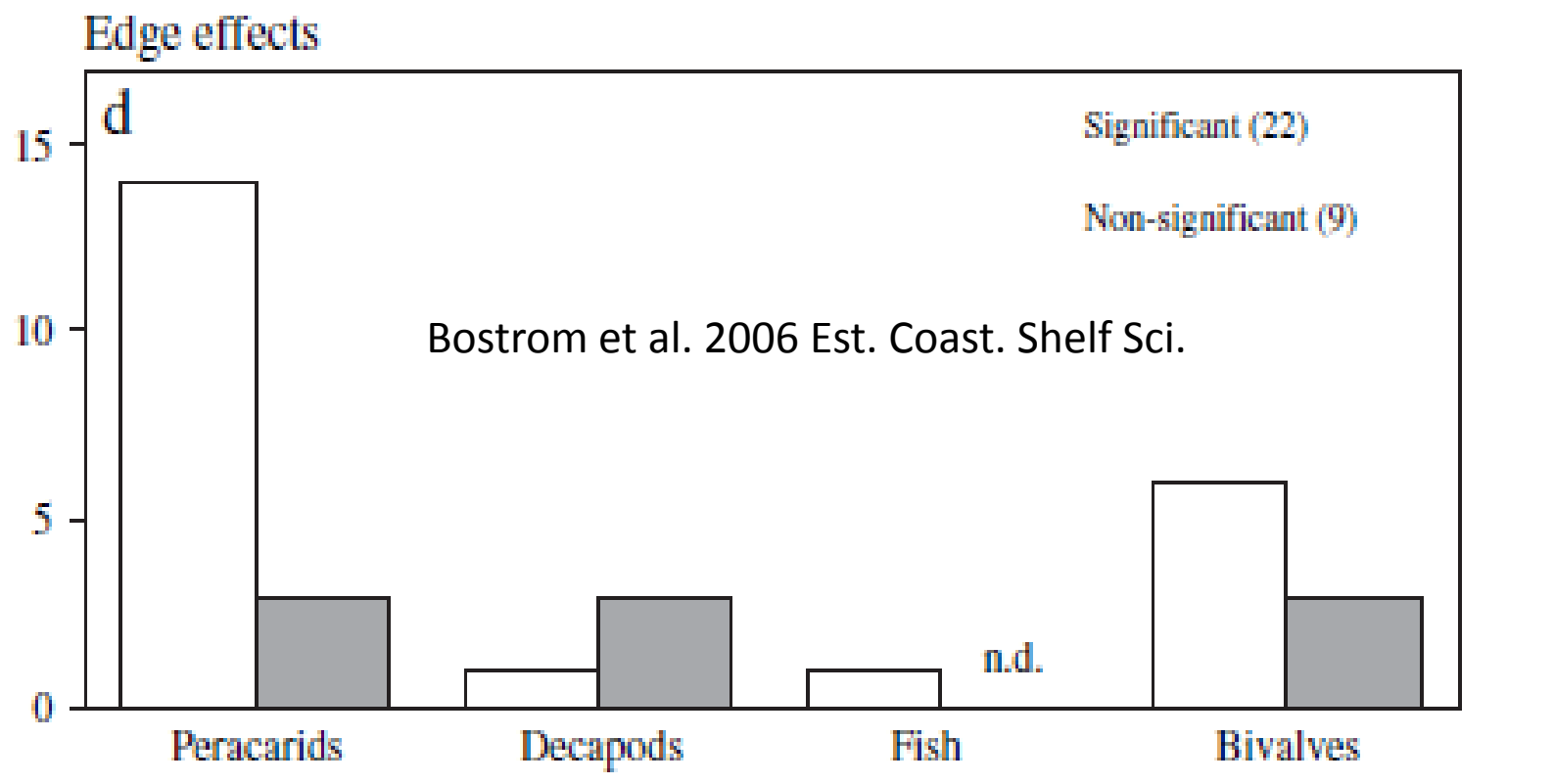
As a group, only bivalves seem to show more positive associations with larger seagrass patch sizes. Lower mortality in larger patches

Effects of patch size using artificial seagrass units



Direction of the significant effects can be either positive or negative.

Edge Effects

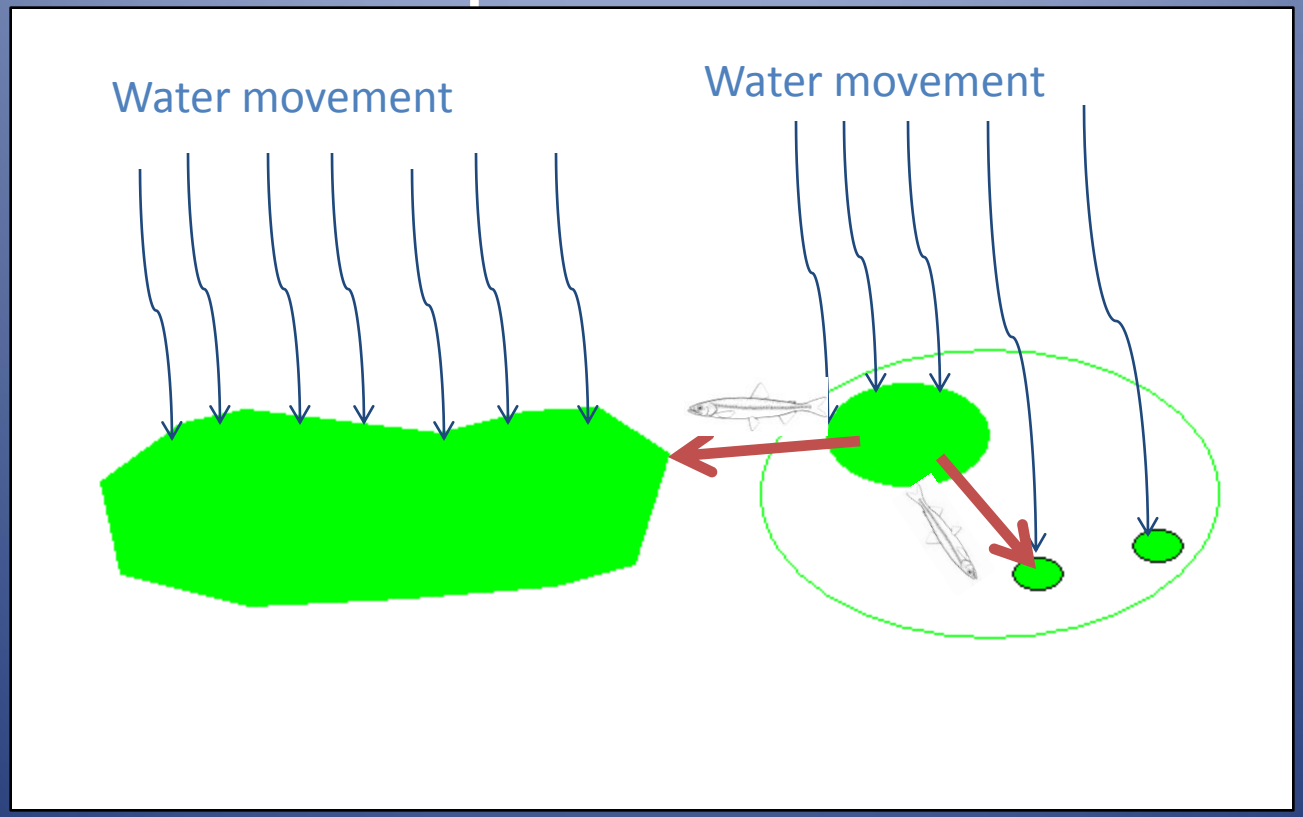


- Significantly higher density of peracarids at edges of seagrass meadows in most studies
- Bivalves often show greater growth rates but higher mortality with increased edge

Conclusions from meta analysis

1. Large variation in responses of different groups of organisms to landscape features
2. Preference for edges may be related to decrease in water movement at those points – passive transport.
3. Space between patches may foster movement of predators.
4. Habitat choices by animals may be a trade off between foraging efficiency (higher in less dense, more patchy beds) and susceptibility to predation.
5. Areas adjacent to seagrass patches support more species than those where no beds are present.

Patch size effects on settling of larvae, feeding potential, and movements of predator



Factors effecting variation in nursery role of seagrass beds within an estuary

Biotic	Abiotic	Landscape
Larval supply	Water depth	Spatial pattern – size, shape, fragmentation, etc.
Structural complexity	Dissolved O2	Location relative to other key habitats – e.g., larval supply, marshes.
Predation	Salinity	
Competition for food	Disturbance regime	
Food availability	Tidal regime	

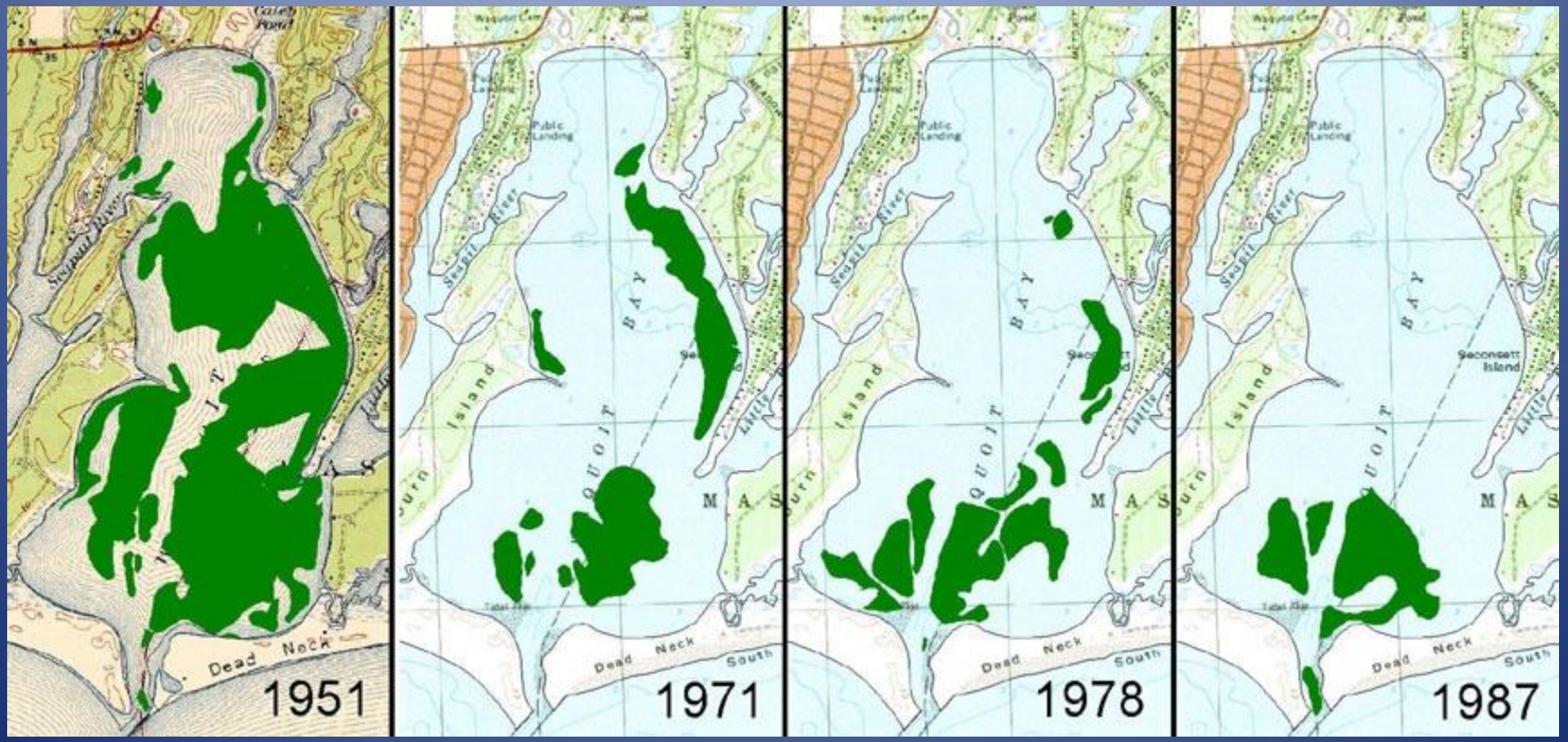
Beck et al. 2001. BioScience 51

Sources of variation in nursery value of seagrasses*:

- Position within estuary
  - Source of larvae
  - Location of adult habitat
  - Nearby habitats (could be positive or negative)
- Latitudinal gradients
- Structural complexity of bed

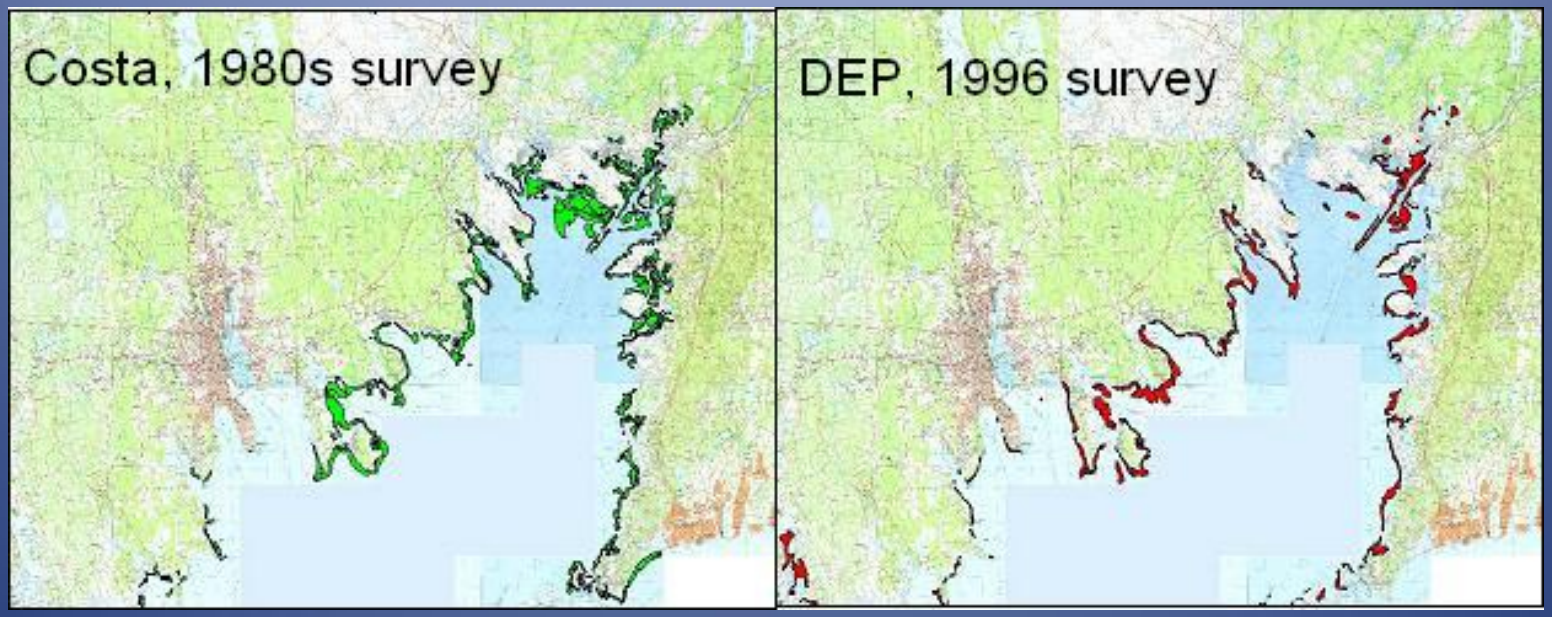
*Beck et al. 2001. BioScience 51

Former Habitat



http://www.buzzardsbay.org/eelgrass.htm

Changing nature of eelgrass



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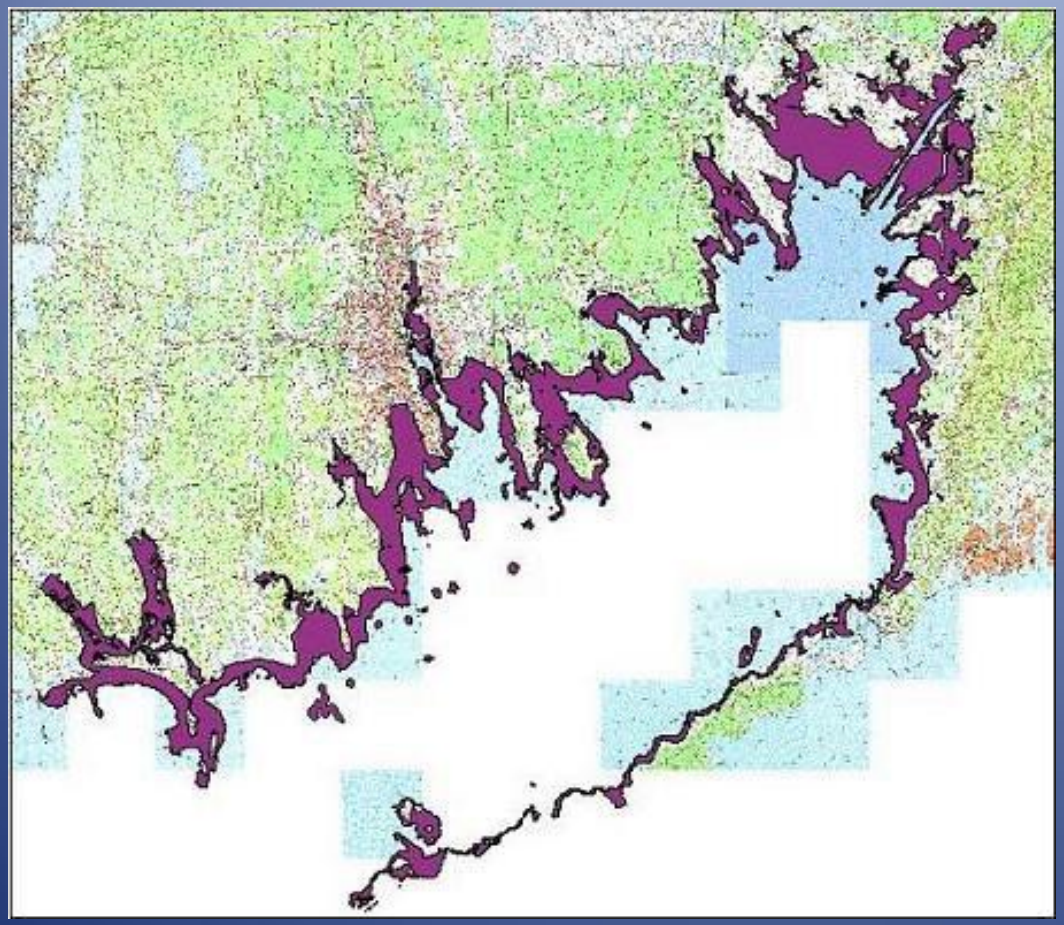
Potential Habitat – Abiotic criteria

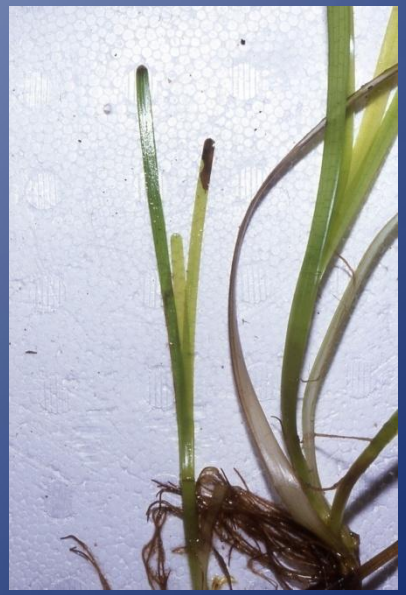


Hypothetical distribution of eelgrass in Buzzards Bay ca. 1600 based on depth contours.

http://www.buzzardsbay.org/eelgrass.htm

Issues raised about eelgrass habitat delineations

- Incompleteness of mapping
  - Defining deep end
  - Delineating smaller (<20 m) patches
  - Delineating very dispersed eelgrass
- Dynamic nature of eelgrass beds
- Defining potential habitats
- Need for:
  - More regular surveys
  - More extensive ground truthing



Conclusions

- There can be variation in the functions of seagrass meadows within an estuary and between estuaries
- These variations are hard to predict based on landscape criteria
- Regardless, all seagrass patches in New England waters, large or small, have habitat value far beyond that of unvegetated adjacent areas
- The mosaic of an eelgrass meadow includes vegetated and unvegetated areas that interact to support other species.