Subtidal and intertidal restored reefs in North Carolina

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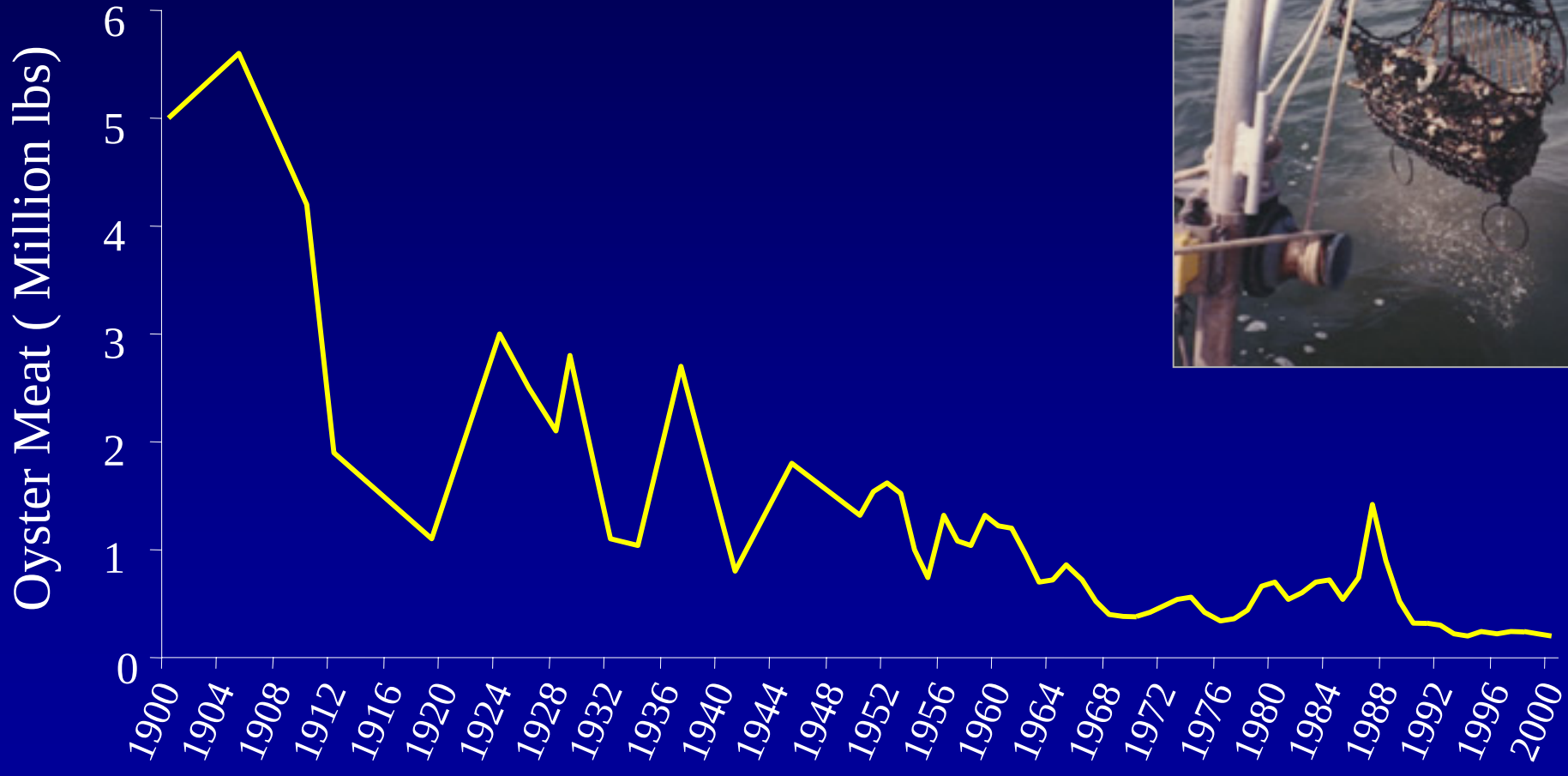
Summary Outline

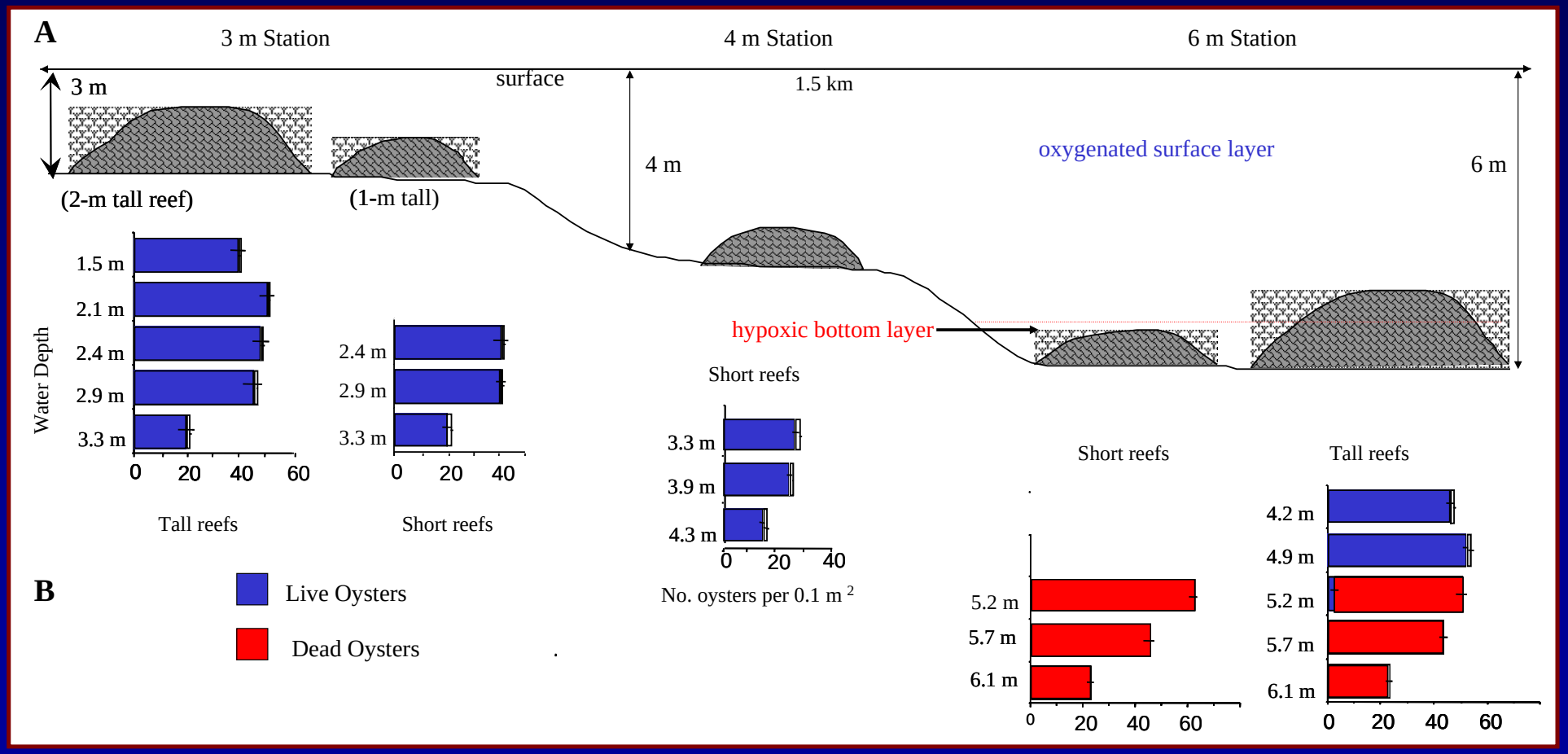
I. Brief synopsis of previous restoration research
   - Metrics quantified & major conclusions/lessons learned

II. Ongoing Investigations
   - Metrics quantified, preliminary data, & success status (initial assessment)

I. Historical Overview: Decline of the Eastern Oyster

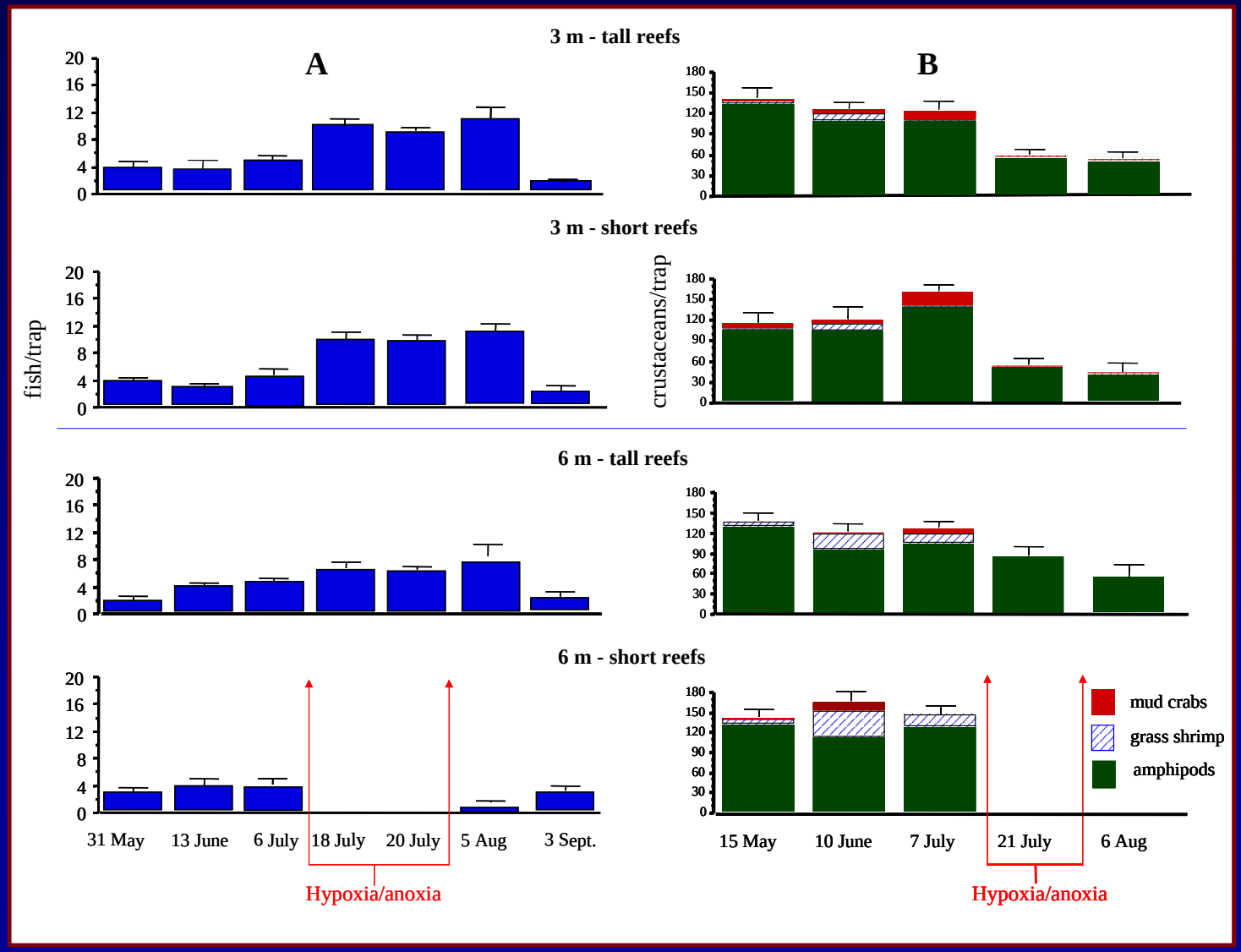


1. Elevation of subtidal reef habitat above anoxic bottom waters



Lenihan 1999

2. Oyster reef as essential fish habitat



Lenihan et al. 2001

3. Restoring oyster reefs within the estuarine landscape

Grabowski et al. 2004 (in review)

Landscape study

- Design
  - Landscape effects
  - Restored (1997 vs. 2000) vs. natural reefs
- Metrics
  - Resident and transient fauna (cores, quadrats, gill nets, traps, popup nets)
  - Oyster settlement & adult densities (cores and quadrats)
  - Oyster reef complexity (quadrats)

II. Ongoing Research:
Restoration Strategy

- Restoration efforts have targeted both the oyster fishery and reef ecosystem services

- "No harvest" or sanctuary reefs are central to proposed restoration efforts along the east coast

- Concern about disease dynamics has led to a movement to bring in exotic species

- Sanctuary included in this study
- Sanctuary not included in this study

Reefs monitored

- Each area has 1-24 sanctuary reefs, age ranges from 2 to 12 yrs old.
- Harvestable areas created by NCDMF
- Natural (harvested) reef areas.
- Reef & oyster condition and disease monitored late spring and late summer

Success criteria

- Density of living oysters
  - benchmark set relative to natural reefs (non-harvested when available)
- Spat recruitment
- Size-distribution (multiple age classes should be represented)

Status of Sanctuaries

Highly successful

Neuse River < 4 m

West Bay (Shell)

Middle Marsh I & II

Successful

West Bay (Marl)

Deep Bay

Wanchese

Status of Sanctuaries

<u>Failing</u>

Bogue Sound (burial)

Cape Hatteras (poor recruitment)

Neuse River > 5 m (post-settlement loss due to poor water quality)

Neuse River 4 m (burial?)

Alternative Substrates

- Small marl experimental reefs (1996 in West Bay)
  - Less successful settlement than adjacent shell reefs
- Large marl sanctuaries
  - Four built in 1996 throughout coastal NC
  - Difficult to harvest
  - Expensive and difficult to build
  - Limited success

Oyster - *P. marinus* relationships

- Disease prevalence and severity vs:
  - harvest status
  - age of non-harvested area
  - density of oysters
- Disease dynamics and variability in environmental setting of oyster reefs

Metrics

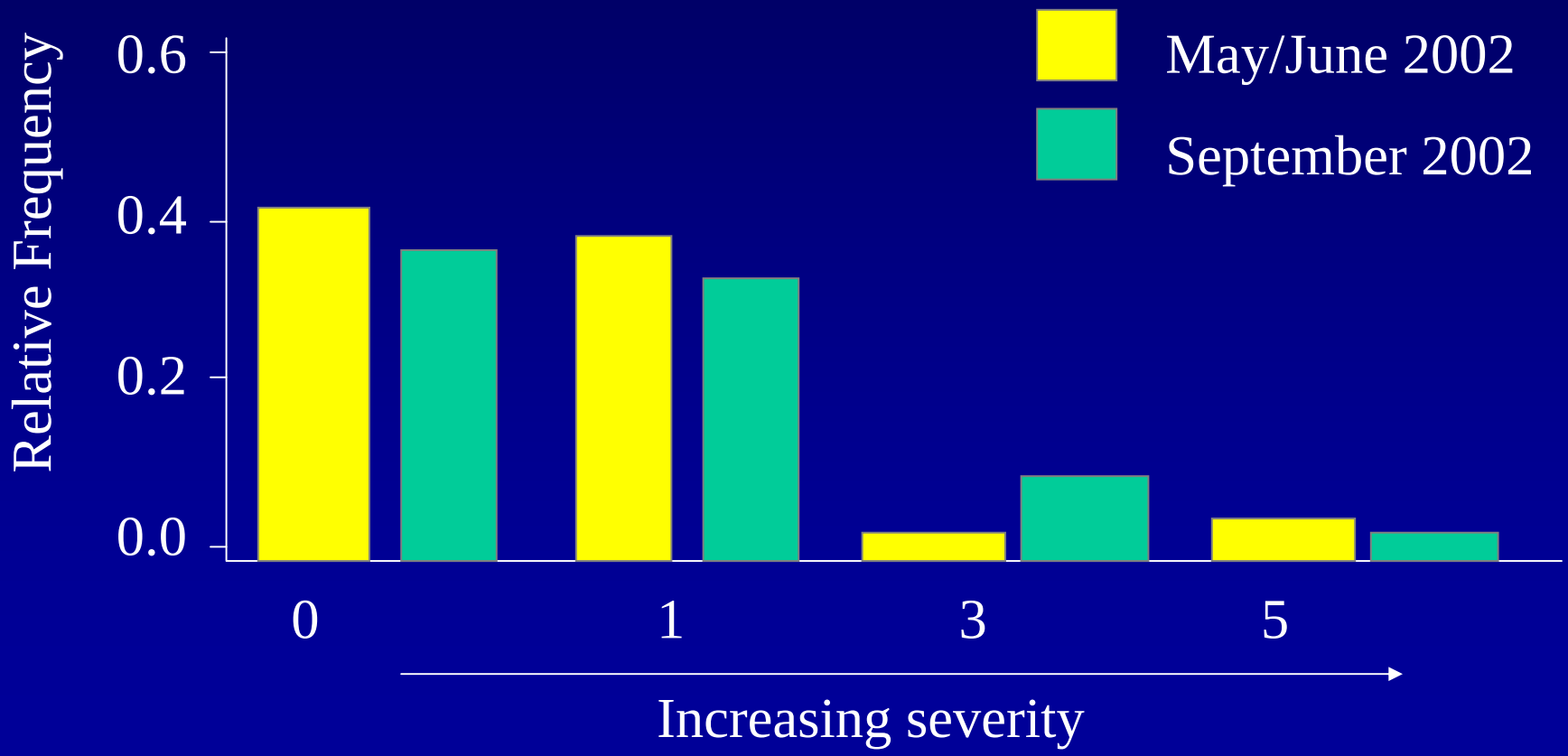
- Density of live & Dead Oysters
- Size-distribution
- Disease prevalence & severity (Dermo only)
- Physical/chemical parameters (Temp, Sal., D.O., velocity)

Current & Pending Funding

- Current funding
  - Sea Grant Oyster Disease Program
    - 2004-2005

- Importance experimental approaches
  - i.e., reef design & replicate reefs provide opportunities for longterm empirical studies

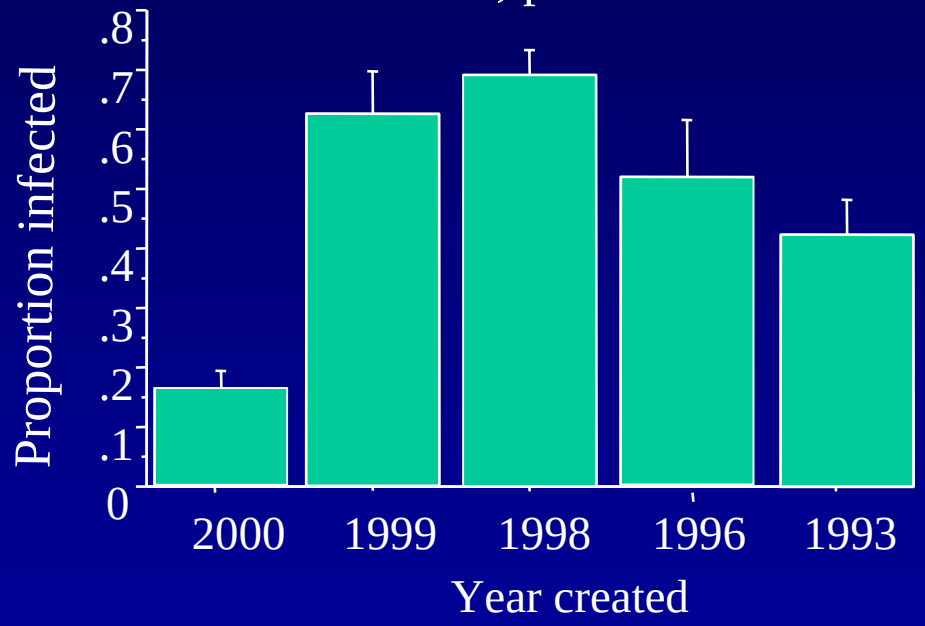
Disease severity 2002



Disease vs. age of oyster reef

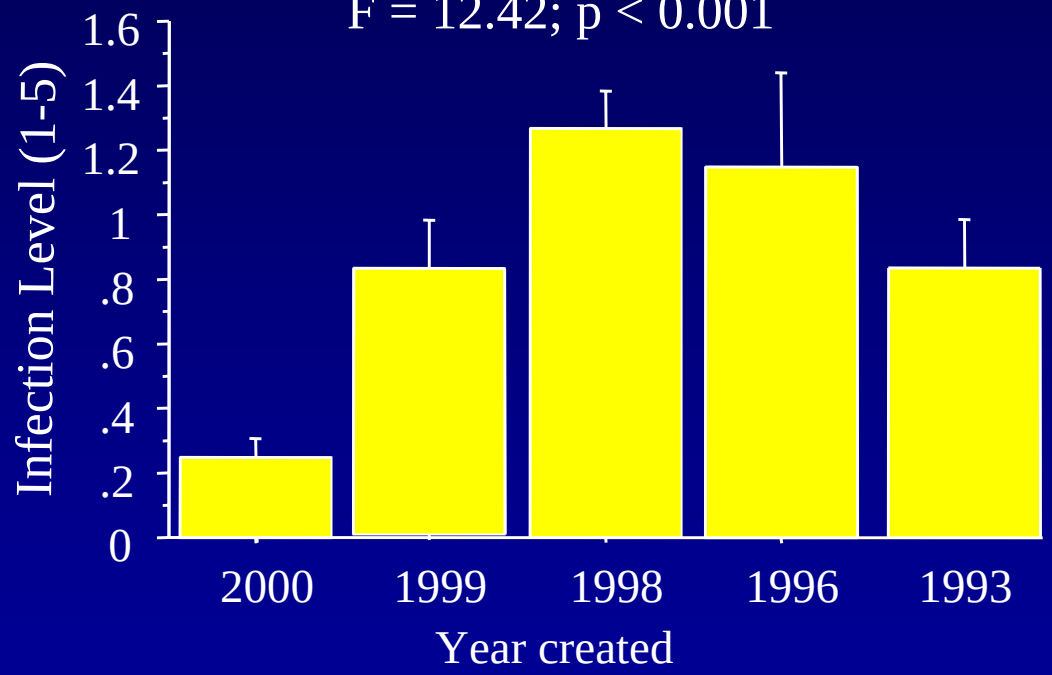
Disease prevalence

F = 17.28; p < 0.001

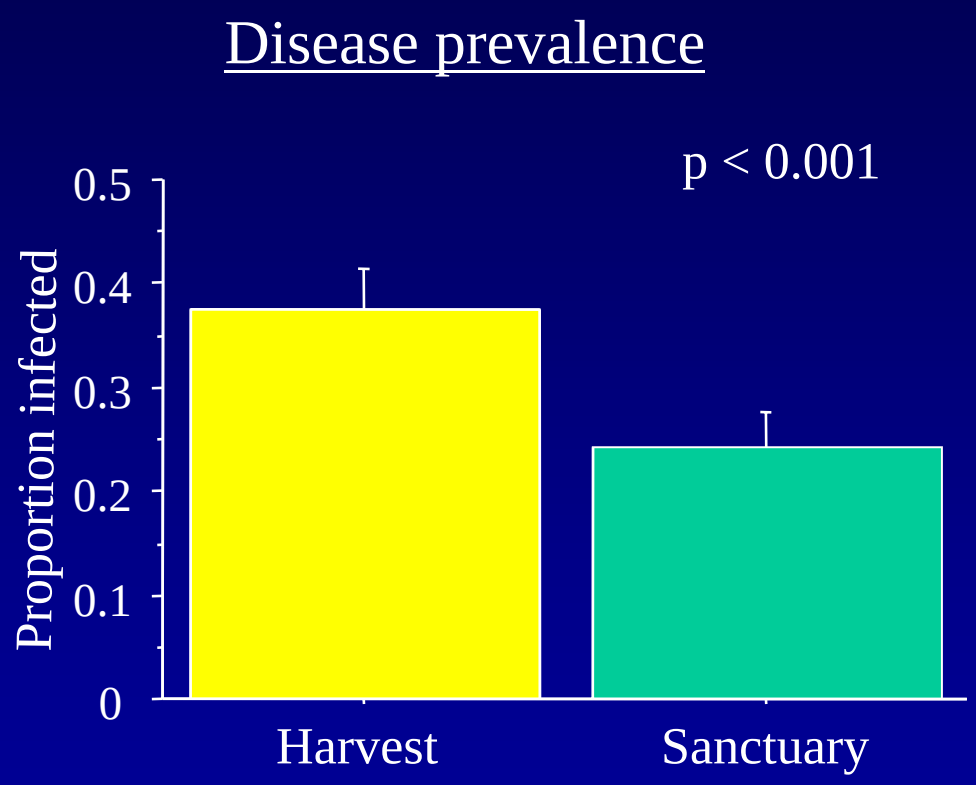


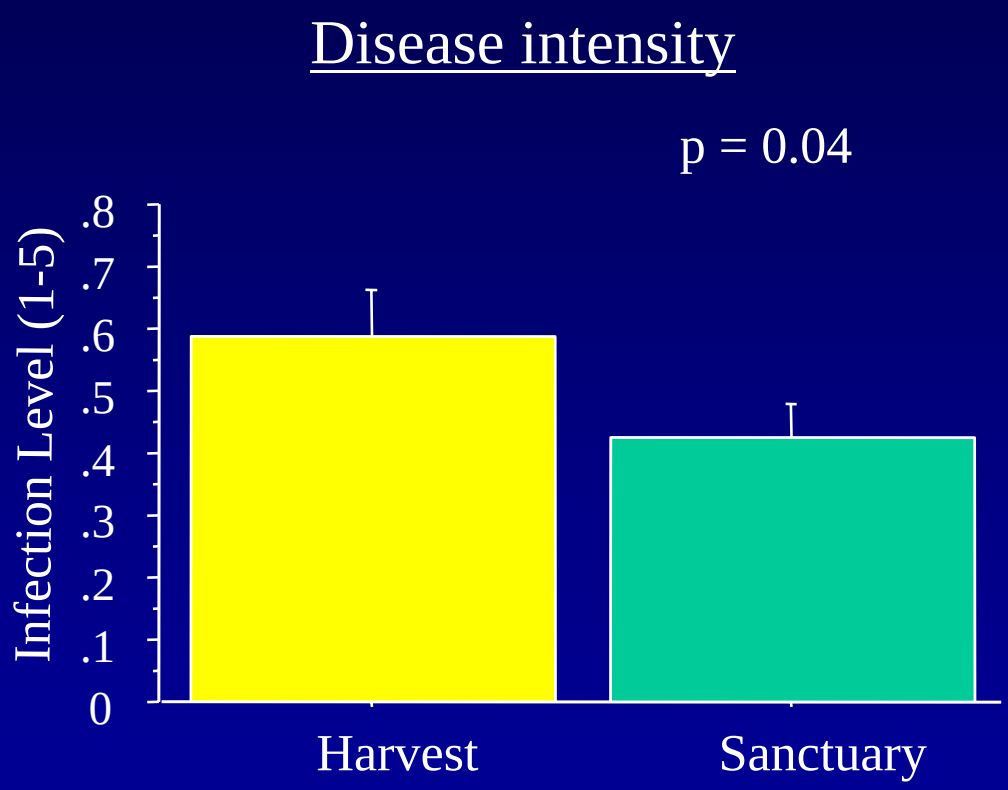
Disease severity

F = 12.42; p < 0.001

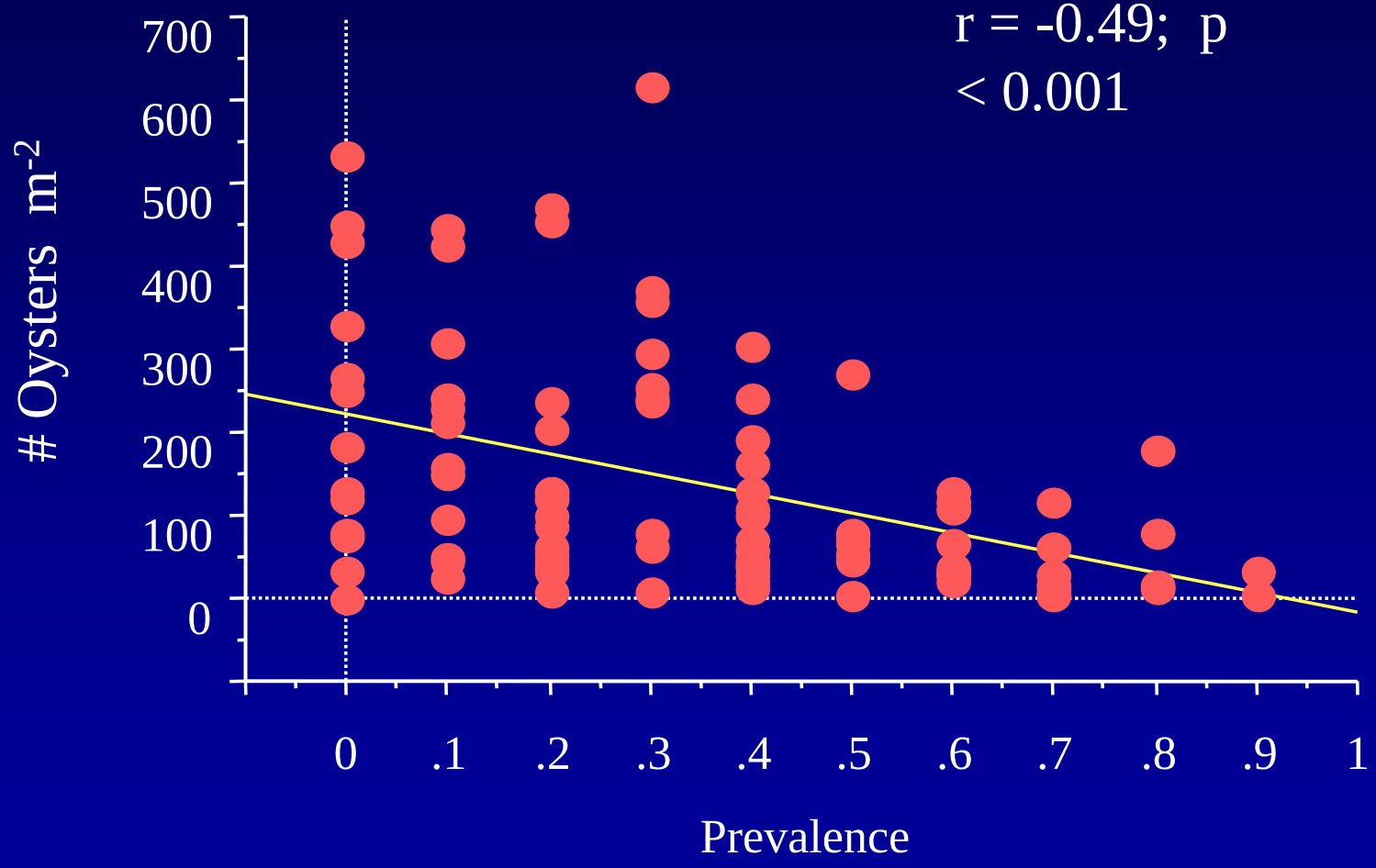


Sanctuary vs. harvested areas

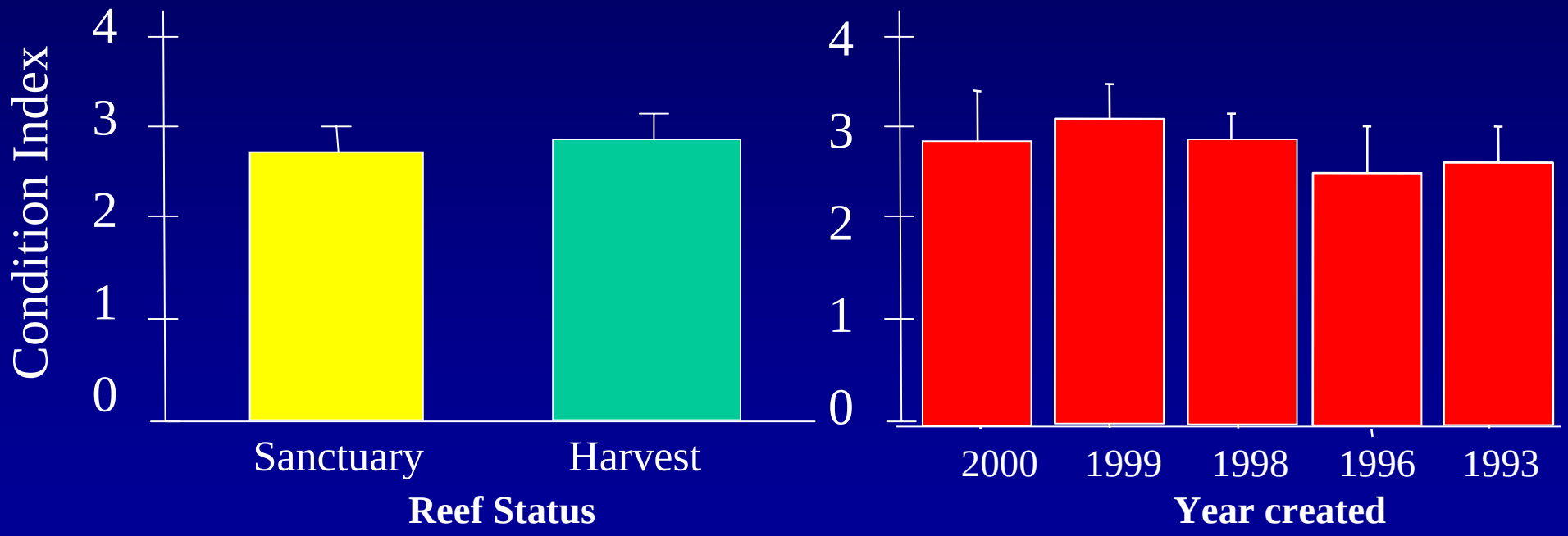




Disease prevalence vs. oyster density

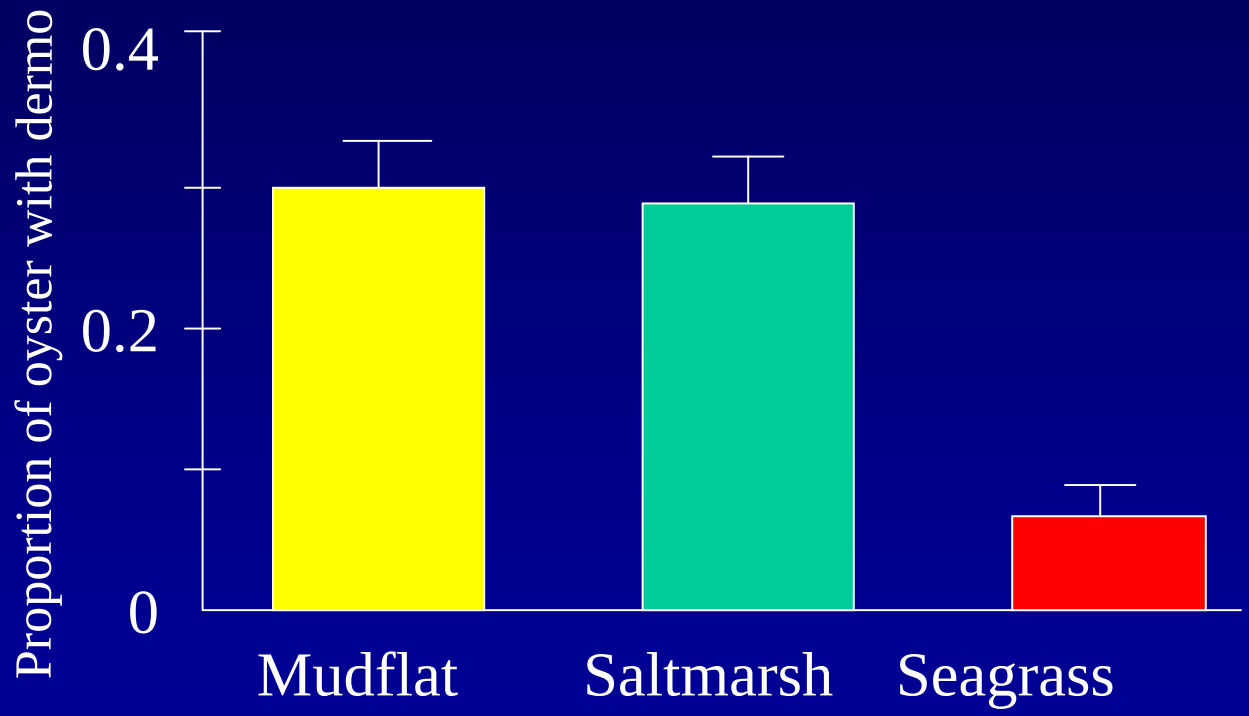


Oyster condition, sanctuary status, and reef age

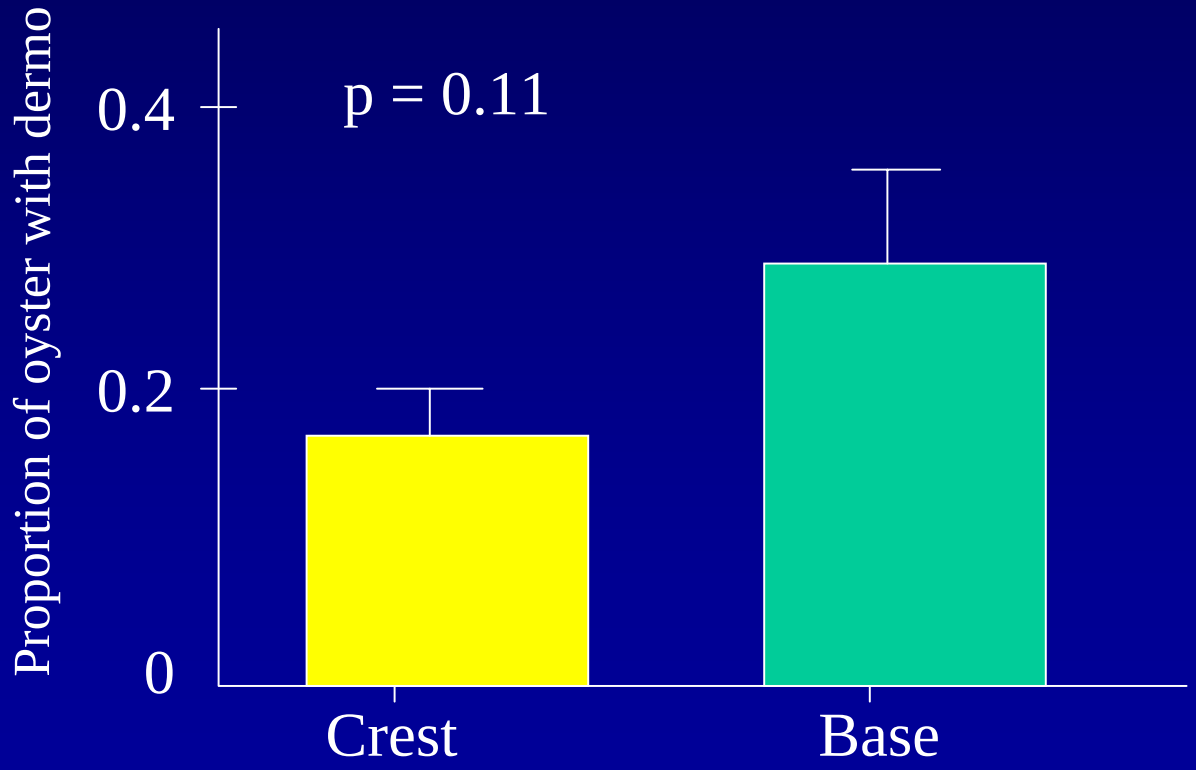


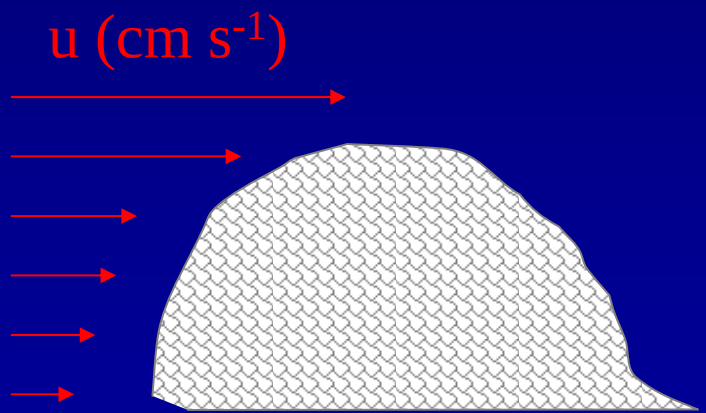
Condition Index = Weight/volume for oysters collected in early summer before disease level increases

Landscape setting vs. disease prevalence



Within reef factors: reef height





See also Lenihan et al. 1999, L&O Vol. 44

Feasibility of monitoring other variables

- Resident and transient fauna
- Filtering capacity
- Reproductive output
- Habitat dimensional complexity
- Shoreline/reef stability
- Indicator species

Summary & Conclusions

- Design, structure, and physical setting (e.g., landscape) of oyster reefs are critical in the success of restoration efforts.
- Restoration and management plans must consider and (when possible) test how actions may influence disease dynamics.
- Experimental investigations of the processes that structure oyster reef communities and determine successful provision of ecosystem goods and services should be investigated at large spatial scales (i.e., geographic variation).

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