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

A

3 m Station

4 m Station

6 m Station

Water Depth

3 m

2.1 m

2.4 m

2.9 m

3.3 m

0 20 40 60

Tall reefs

Short reefs

B

Lenihan 1999
2. Oyster reef as essential fish habitat

- Fish/trap
- Crustaceans/trap
- Amphipods
- Grass shrimp
- Mud crabs

Hypoxia/anoxia

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
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

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

Failing
- 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

Relative Frequency

May/June 2002
September 2002

Increasing severity
**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**

- Harvest: Proportion infected
- Sanctuary: Proportion infected

- p < 0.001

**Disease intensity**

- Harvest: Infection Level (1-5)
- Sanctuary: Infection Level (1-5)

- p = 0.04
Disease prevalence vs. oyster density

\[ r = -0.49; \quad p < 0.001 \]
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

Proportion of oyster with dermo
Within reef factors: reef height

Proportion of oyster with dermo

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<th>Crest</th>
<th>Base</th>
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<tr>
<td>Proportion</td>
<td>0.2</td>
<td>0.4</td>
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p = 0.11

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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