Artificial Reef Performance in Lake Pontchartrain, Louisiana

Thesis Defense

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Artificial Reefs

- What is an artificial reef?
  - Object of natural or human origin, deployed on seafloor to influence aquatic species for biological or economic gain
    - Enhance fisheries
    - Enhance tourism
    - Protect habitats
    - Restore coral reefs
    - Stabilize shorelines

- Attraction vs. production
  - Attraction known
  - Production debatable
Lake Pontchartrain

- 1,632 km² estuary
- Mean salinity 4 ppt, oligohaline
- Average depth 3.7 m
- Sediment bottom, no natural reefs

Artificial reefs developed to:

- Enhance recreational fisheries and fishing
- Promote awareness of improved water quality and environmental conditions
- Supplement hard substrate lost by shell dredging
Artificial Reef Development

Louisiana Artificial Reef Program 1986
• Convert offshore oil/gas platforms to artificial reefs
• Oyster reef restoration, inshore

Lake Pontchartrain Artificial Reef Working Group
Organized in June 2000
• NGOs, state and federal fisheries agencies, parishes, sportsmen’s organizations, commercial fishing associations

• 2001: 1st reef by Lakefront airport, limestone rubble
• 2003/2004: reef ball reefs – 3 south shore/1 north shore
Material: Reef Balls

- Concrete, perforated domes
- Durable, stable
- Non-toxic, pH adjusted
- Faster invertebrate colonization
- Heavy base
- Two sizes:
  - Bay: 0.9 m diameter, 340 kg
  - Pallet: 1.2 m diameter, 1000 kg
Coordinates of Artificial Reef Sites

- **H1** – N 30° 05.028’ W 090° 12.096’
- **H3** – N 30° 05.034’ W 090° 12.582’
- **H4** – N 30° 05.289’ W 090° 12.336’
- **N1** – N 30° 16.296’ W 090° 03.753’

**South shore reefs (H1, H3, H4)**  ~200 balls each

**North shore reef (N1)**  ~80 balls
Lake Pontchartrain Artificial Reef Evaluation

- Assess performance and efficacy of artificial reefs in low-salinity estuary

Management concerns:
- Do reef balls move with strong storms?
- Not a “natural habitat”, what fish and invertebrate assemblages are present?
- Will anglers/divers use the reefs?
- Is the cost worth the benefit?
Evaluation Components

- Structural Integrity
- Water Quality
- Benthic Macroinvertebrate Colonization
- Fish Assemblage
- Recreational Activity
Reef Structural Integrity

- **Purpose**
  - Storms could cause movement or sinking of balls, or scouring around balls
  - Compromise colonization and persistence of reef

- **Methods**
  - Monitored reef ball locations before and after 2004 hurricane season
    - Identified survey area and reef balls
    - Measured distances to balls and markers
    - Measured depth of base in substrate
Reef Structural Integrity

• Results:
  – Storms of 2004
    • Hurricane Ivan, 16 September
    • Tropical Storm Matthew, 10 October
  – 37 hours of underwater survey effort

  – No sinking, sliding, or scouring around balls detected
  – Reef balls are stable material for Lake Pontchartrain
Water Quality

• Purpose:
  - Abiotic conditions influence fish and invertebrate assemblages
  - Vertical relief of reefs could offer protection from bottom hypoxia

• Methods:
  - Water quality sampled at all reef visits
  - Measured dissolved oxygen, temperature, and salinity

• Results:
  - Salinity ranged: 2.3 – 5.0 ppt
  - Temp ranged: 22- 32°C
  - DO ranged: 5.5 – 8.6 mg/L
  - Hypoxia not detected at reefs
Benthic Macroinvertebrates

• **Purpose:**
  - Compare faunal composition
    • Over time
    • South shore reef to north shore reef
    • South shore reef to other artificial substrates

• **Methods:**
  - Sampled
    • Reefs
    • Oil platform pilings
    • Causeway pilings
  - 10 x 10 cm replicate scrape samples
  - Stained, preserved, and sorted
  - Compared presence/absence
### Benthic Macroinvertebrates

<table>
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<tr>
<th>Phylum</th>
<th>Species</th>
<th>H3 reef</th>
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<th>Causeway</th>
<th>Oil Platform</th>
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Bray-Curtis Similarity Index
Benthic macroinvertebrates

% similarity
• **Purpose:**
  - Compare species composition and abundance of fishes
    • South shore reef
    • Nearby shell pad (no reef balls)
    • Mud-bottomed site

• **Methods:**
  - Visual surveys by SCUBA divers
    • **Roving Diver Technique**
      - Paired divers, timed swim over survey areas
      - 2 - 10 minute surveys per pair per site per day
      > 2 m visibility, measured vertically and horizontal
      - Recorded all fish and mobile macroinvertebrates
Visual Surveys

• Results:
  – 30 hrs of survey effort over 10 days in summer 2005

Fishes:
  • Number of species greater over reef than shell and mud
  • Total abundance over reef higher than shell pad and mud

Mobile Macroinvertebrates:
  • Abundance highest over reef
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<th>Species</th>
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Fish Assemblages
Visual Surveys

Reef vs. shell: p=0.016
Reef vs. mud: p<0.001
Shell vs. mud: p=0.185

Trinectes maculatus
Aplodinotus grunniens
Myrophis punctatus
Menidia beryllina
Micropogonias undulatus
Dasyatis sabina
Opsanus beta
Gobiesox strumosus
Anguilla rostrata
Ictalurus furcatus
Carnax hippos
Paralichthys lethostigma
Mugil cephalus
Lagodon rhomboides
Hypsoblennius iothonas
Archosargus probatocephalus
Gobiosoma bosc
Mobile Macroinvertebrates
Visual Surveys

- Reef vs. shell: p=0.435
- Reef vs. mud: p<0.001
- Shell vs. mud: p=0.049

- Rhithropanopeus harrisi
- Farfantepenaeus aztecus
- Callinectes sapidus
Mobile Macroinvertebrates
Visual Surveys

- *Callinectes sapidus* (blue crab)
  - Occupied cavities in and under reef balls
  - Molted shells observed
  - Pairs in mating pose
  - Reefs offer protection during vulnerable life stages
Recreational Activity

• Purpose:
  - Determine if public is aware of and using reefs
  - What species are being caught

• Methods:
  - Vessel observations at reefs
  - Interviews at local fishing rodeos
  - Online recreational fishing and diving survey:
    • Lake Pontchartrain Basin Foundation
    • Louisiana Fishing and Hunting
      [http://rodnreel.com](http://rodnreel.com)   June – Aug 2005
Recreational Fishing & Diving Survey

• Results:
  - 21 respondents (2 in 2004 / 19 in 2005)
    • 16 visited south shore; 3 north shore; 2 limestone
  - Target species
    • Speckled trout, redfish, flounder
  - Catch
    • 8/21 speckled trout (mean 21/ range 10-35)
    • Flounder, white trout, sheepshead, catfish, croaker
  - Disposition
    • 16/21 reefs enhanced fishing
    • 5 reef enhanced diving (4/5 reported both)
    • 12 fished more / 4 dived more
Conclusions

• Reef balls are stable reef material in the lake
• Artificial reefs support more fish and macroinvertebrates than surrounding habitat
• Recreational users are aware of reefs, feel they have enhanced fishing/diving opportunities
Future Work

- Predation experiments/trophic level interactions
- Expand hypoxia monitoring in Lake Pontchartrain
- Identify innovative techniques for sampling reefs/structural habitat
- Cost worth the benefit?
Acknowledgements

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- Dr. John Lopez
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  - Willie Whitmore, Ryan Poirrier, Carol Franze, Kenny Blanke, Chad Ellinwood, Les Dautrive, and Mark Schexnayder
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  - Hammerhead Dive Club of Mandeville