Artificial Reef Performance in Lake Pontchartrain, Louisiana

Thesis Defense

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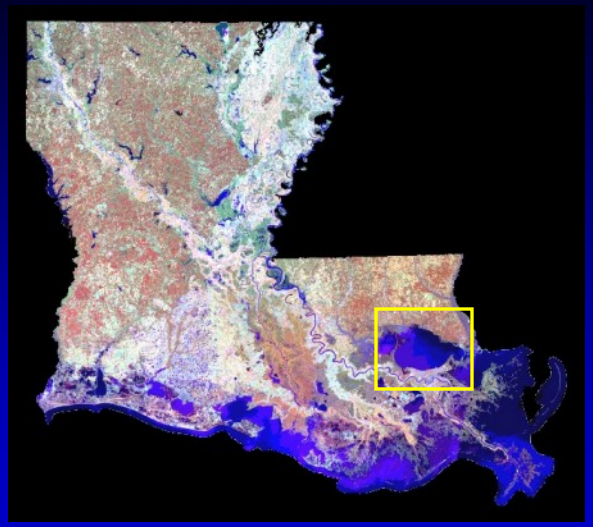
Artificial Reefs

- *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 km^2 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

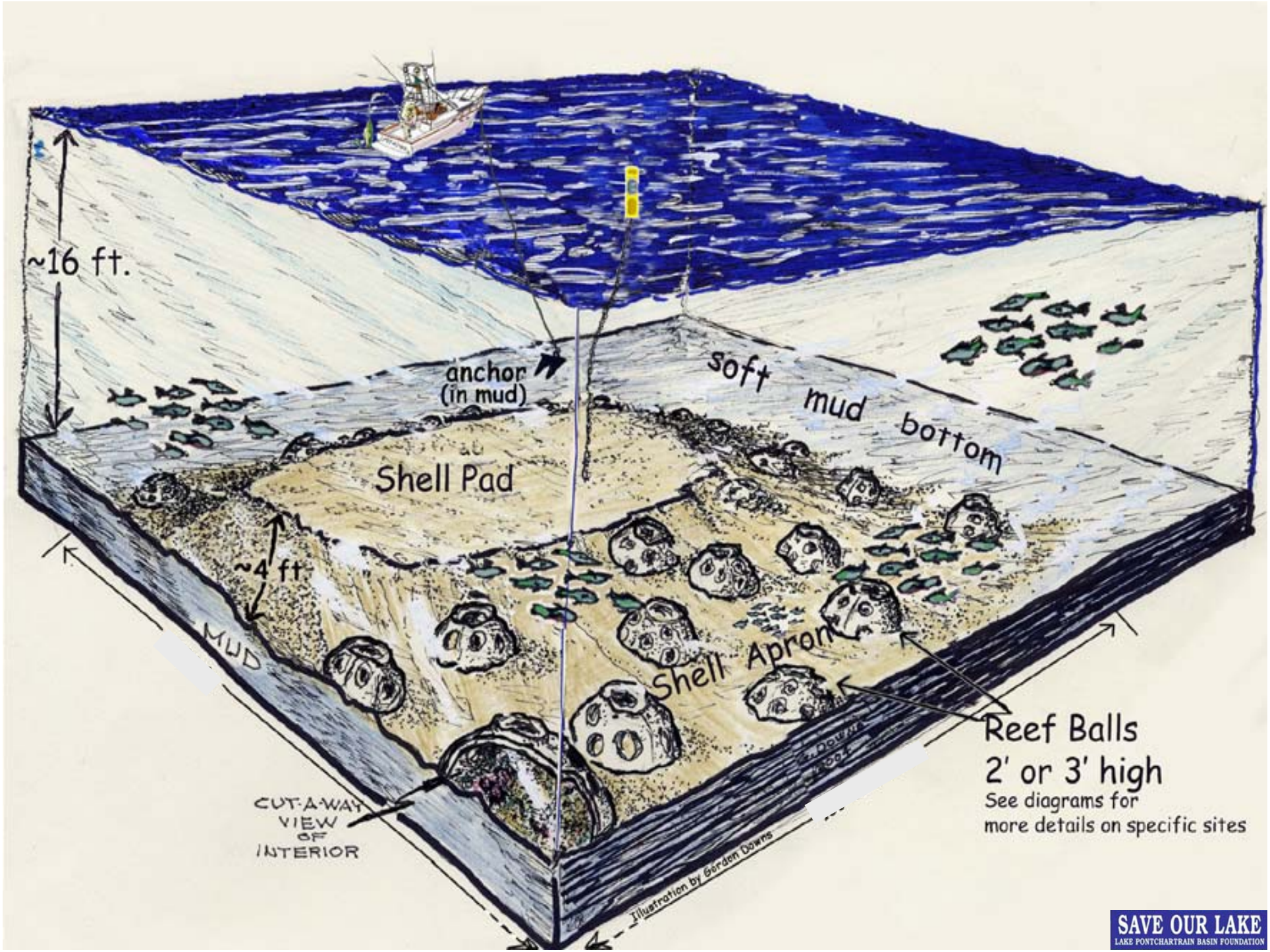
Organized in June 2000

- NGOs, state and federal fisheries agencies, parishes, sportsmen's organizations, commercial fishing associations

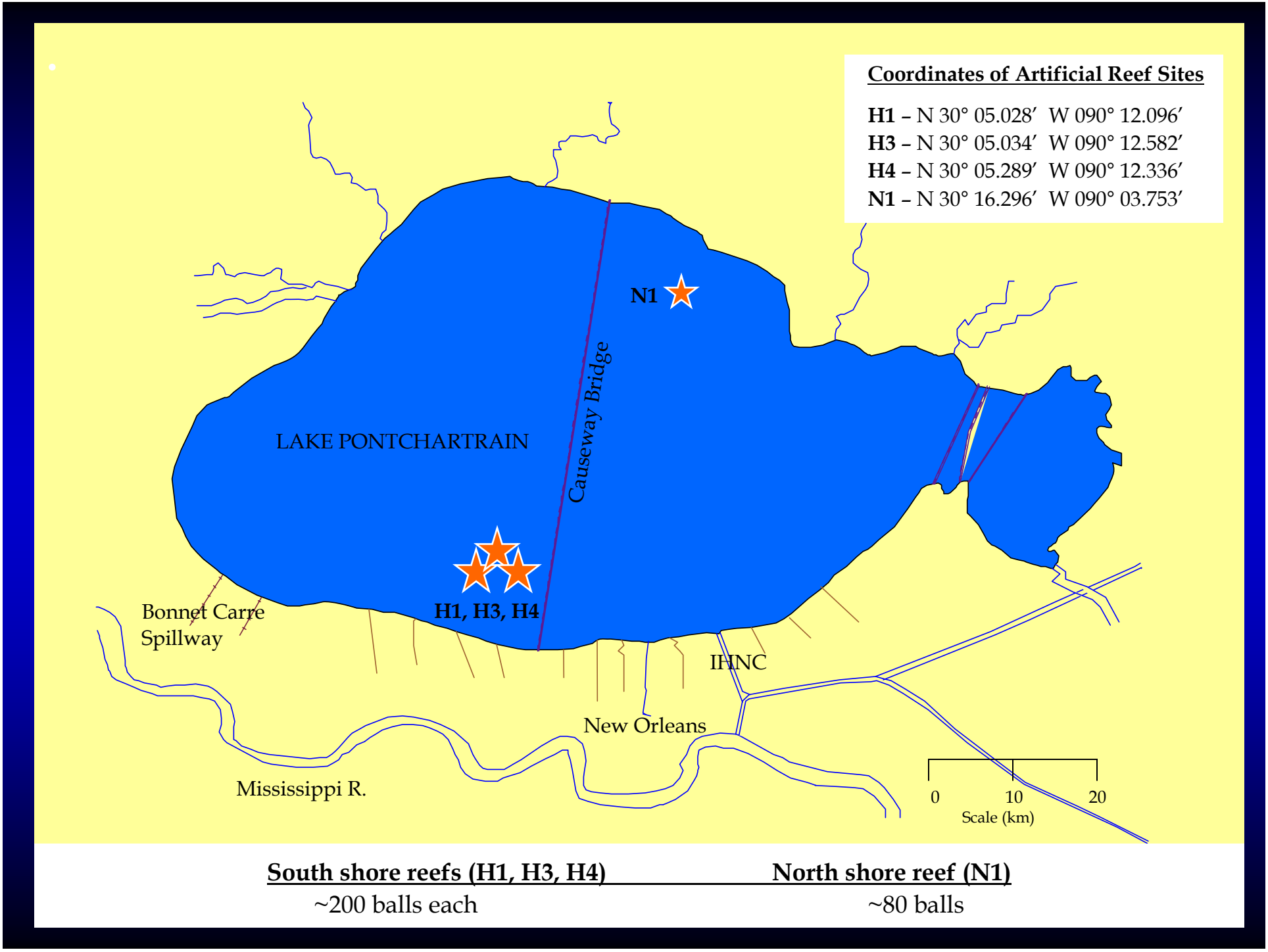
- 2001: 1st reef by Lakefront airport, limestone rubble
- 2003/2004: reef ball reefs – 3 south shore/ 1 north shore

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



SAVE OUR LAKE
LAKE PONTCHARTRAIN BASIN FOUNDATION



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

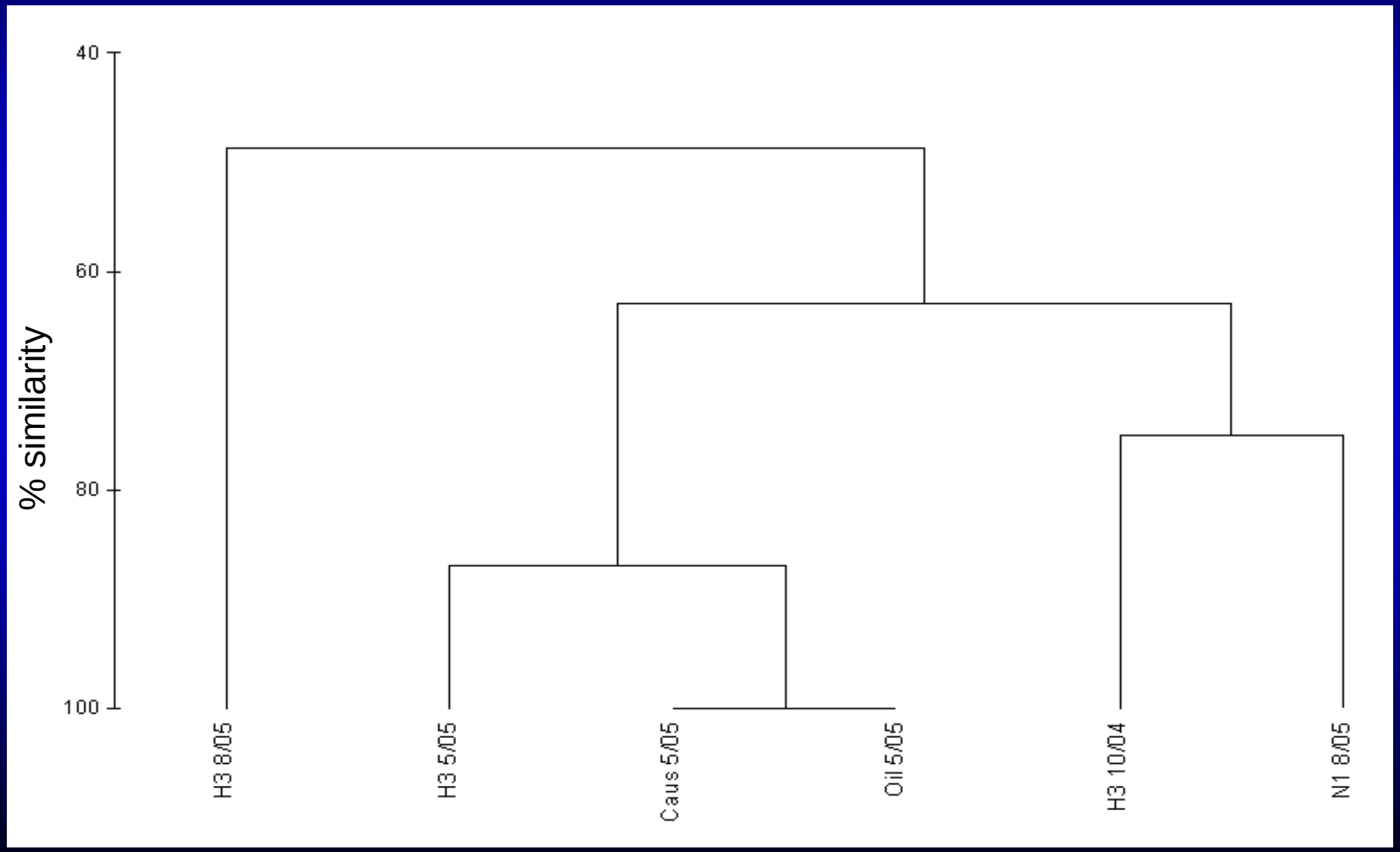

Balanus sp.

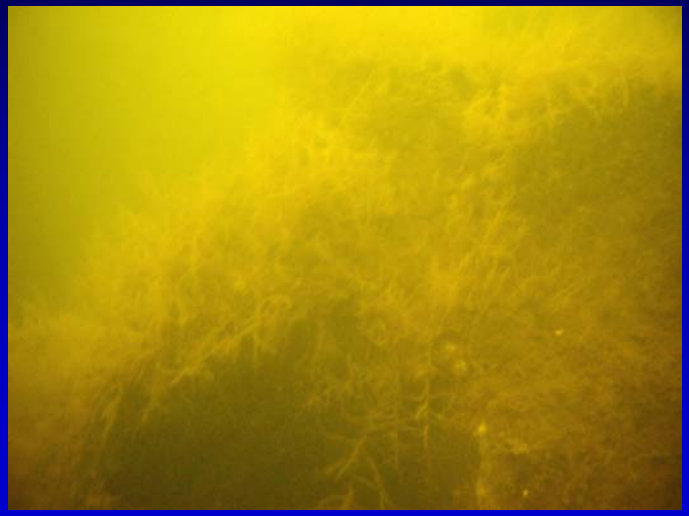
Benthic Macroinvertebrates

Phylum	Species	10/28/04 H3 reef	5/04/05 H3 reef	8/05/05 H3 reef	5/17/05 Causeway	5/17/05 Oil Platform	8/21/05 N1 reef
Porifera	*Spongilla alba*	X	-	-	-	-	X
	S. alba gemmules	X	X	X	X	X	X
Cnidaria	*Garveia franciscana*	X	X	-	X	X	X
	Cordylophora caspia	X	-	-	-	-	-
Bryozoa	*Victorella pavida*	X	-	X	X	X	X
	Conopeum sp.	X	X	-	X	X	X
Nematoda	nematode worms	X	X	X	X	X	X
Annelida	*Polydora websteri*	X	X	X	X	X	X
	Neanthes succinea	-	-	X	-	-	X
	Class Oligochaeta	-	-	X	-	-	X
Mollusca	*Congeria leucophaeta*	X	X	X	-	-	X
	Ischadium recurvum	-	-	-	-	-	X
Arthropoda	*Balanus improvisus*	-	X	-	X	X	-
	B. subalbidus	X	X	-	X	X	-
	Corophium lacustre	-	X	X	X	X	-
	Uromunna reynoldsi	X	X	-	-	-	X
	Melita sp.	-	X	-	X	X	-
	Rhithropanopeus harrissii	-	X	-	X	X	X

Bray-Curtis Similarity Index

Benthic macroinvertebrates





May 2005

August 2005

Fish Assemblage

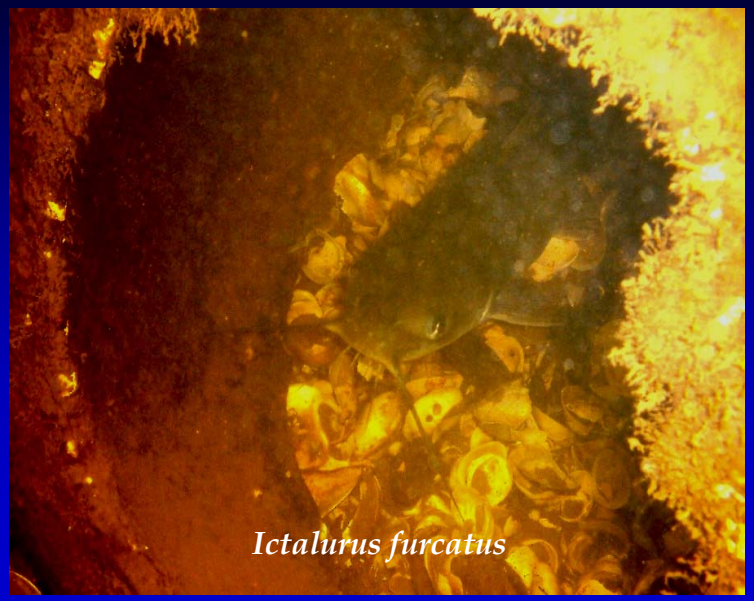
- Purpose:
  - Compare species composition and abundance of fishes
    - South shore reef
    - Nearby shell pad (no reef balls)
    - Mud-bottomed site
- Methods:
  - Visual surveys by SCUBA divers
    - **Roving Diver Technique**
      - Paired divers, timed swim over survey areas
      - 2 - 10 minute 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


Ictalurus furcatus

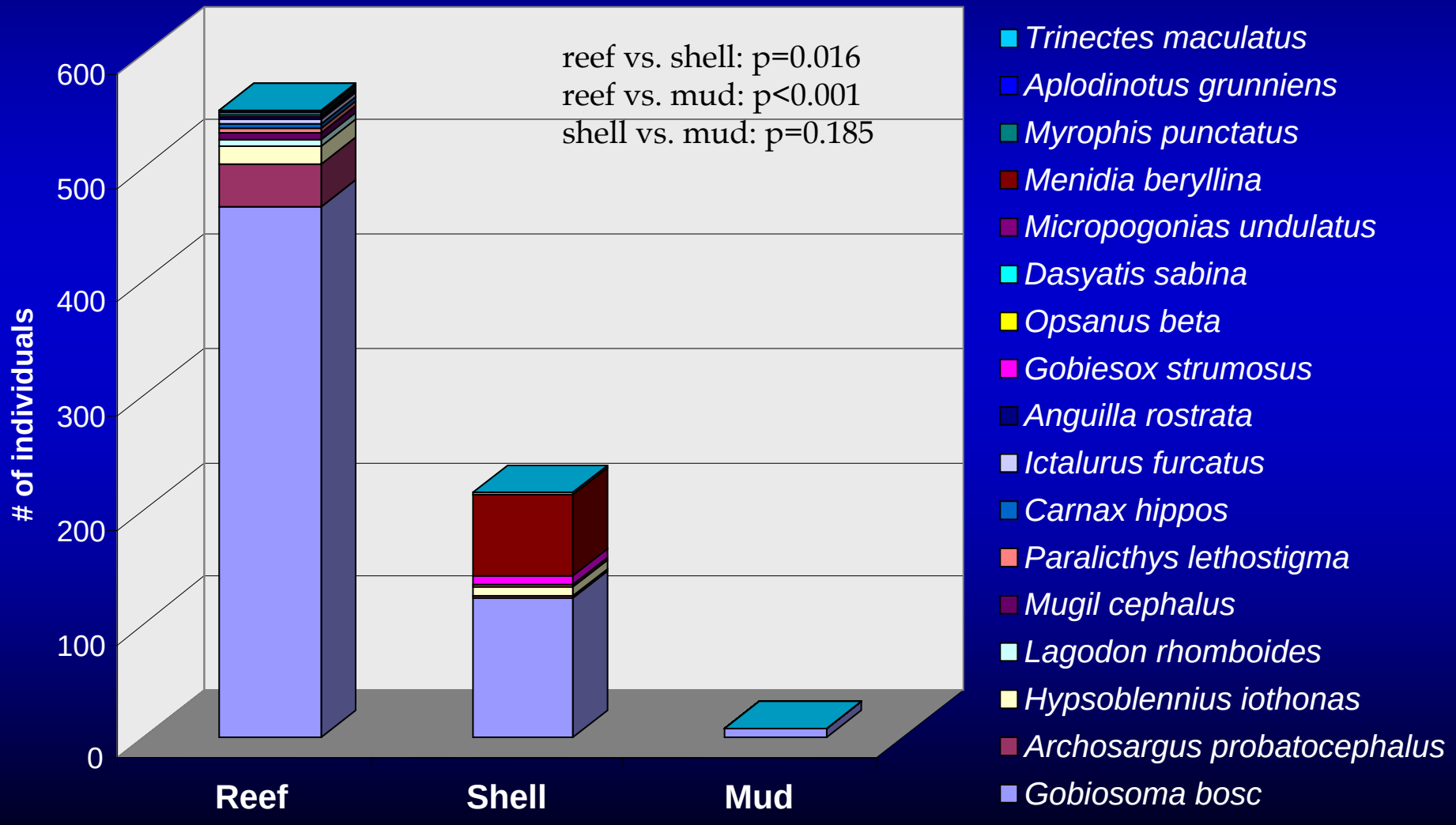

Archosargus probatocephalus

Fishes	Species	Common	Reef	Shell	Mud
Anguillidae	*Anguilla rostrata*	american eel	2	0	0
Atherinidae	*Menidia beryllina*	tidewater silverside	0	70	0
Batrachoididae	*Opsanus beta*	oyster toad fish	1	0	0
Blennidae	*Hypsoblennius iothonas*	freckled blenny	15	9	0
Bothidae	*Paralicthys lethostigma*	Southern flounder	4	2	0
Carangidae	*Carnax hippos*	jack Crevalle	4	0	0
Dasyatidae	*Dasyatis sabina*	Atlantic stingray	1	0	0
Gobisocidae	*Gobiesox strumosus*	skilletfish	2	8	0
Gobiidae	*Gobiosoma bosc*	naked goby	466	122	8
Ictaluridae	*Ictalurus furcatus*	blue catfish	3	0	0
Mugilidae	*Mugil cephalus*	striped mullet	6	0	0
Ophichthidae	*Myrophis punctatus*	speckled worm eel	0	1	0
Sciaenidae	*Micropogonias undulatus*	Atlantic croaker	1	0	0
Sciaenidae	*Aplodinotus grunniens*	freshwater drum	1	0	0
Soleidae	*Trinectes maculatus*	hogchoker	0	1	0
Sparidae	*Archosargus probatocephalus*	sheepshead	37	2	0
Sparidae	*Lagodon rhomboides*	pinfish	7	0	0

Invertebrates	Species	Common	Reef	Shell	Mud
Penaeidae	*Farfantepenaeus aztecus*	brown shrimp	2	0	0
Portunidae	*Callinectes sapidus*	blue crab	63	39	2
Xanthidae	*Rhithropanopeus harrisii*	mud crab	0	2	1

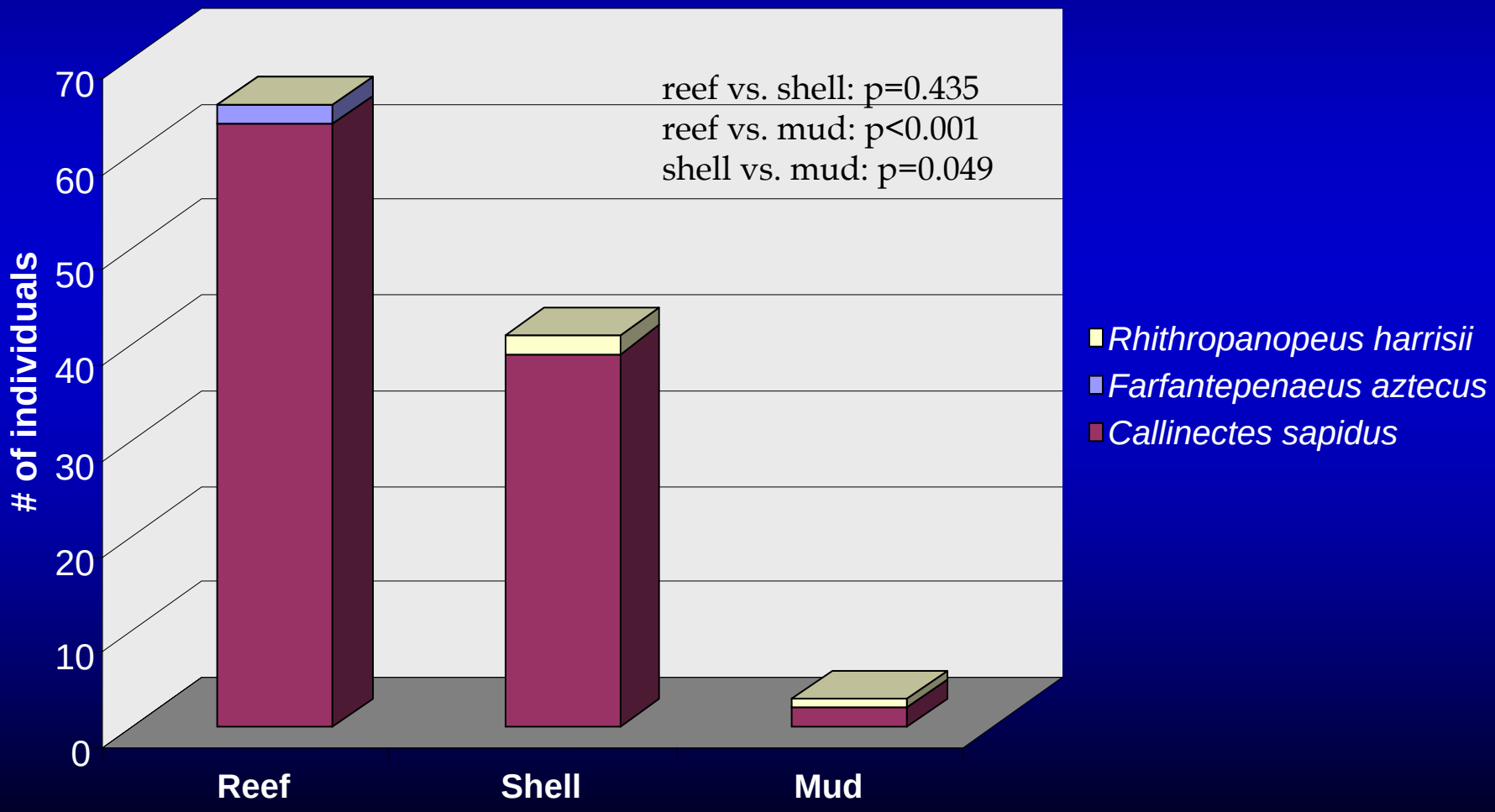
Fish Assemblages

Visual Surveys



Mobile Macroinvertebrates

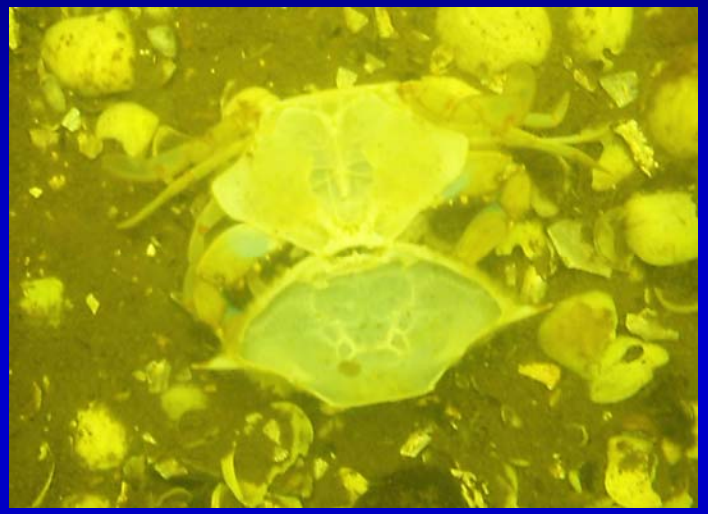
Visual Surveys



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

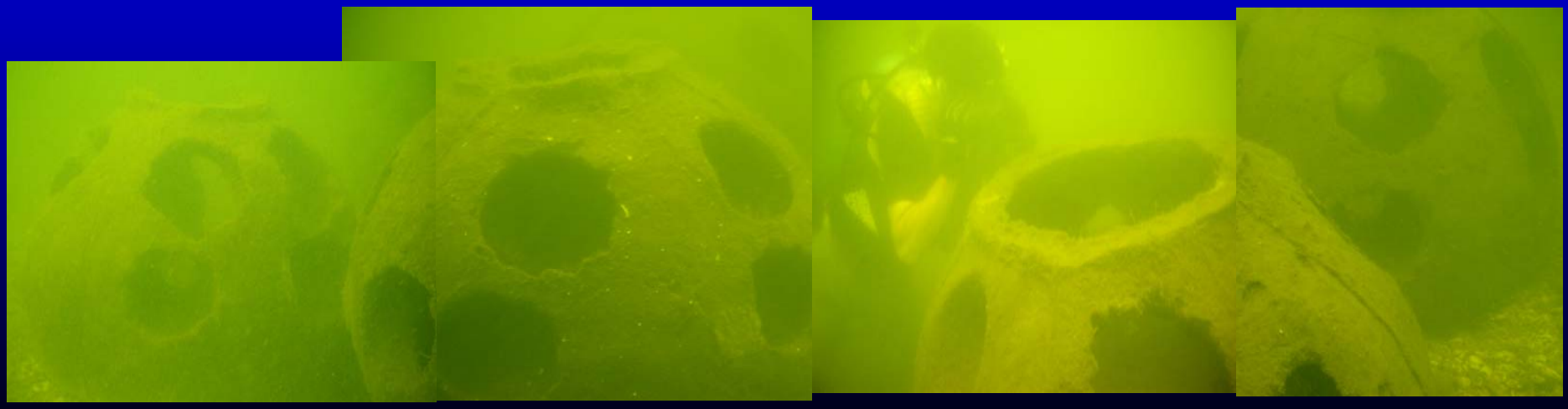
- Purpose:
  - Determine if public is aware of and using reefs
  - What species are being caught
- Methods:
  - Vessel observations at reefs
  - Interviews at local fishing rodeos
  - Online recreational fishing and diving survey:
    - Lake Pontchartrain Basin Foundation http://saveourlake.org Oct 2004 - present
    - Louisiana Fishing and Hunting 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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