

Artificial Reef Performance in Lake Pontchartrain, Louisiana

Thesis Defense



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Artificial Reefs

- *What is an artificial reef?*

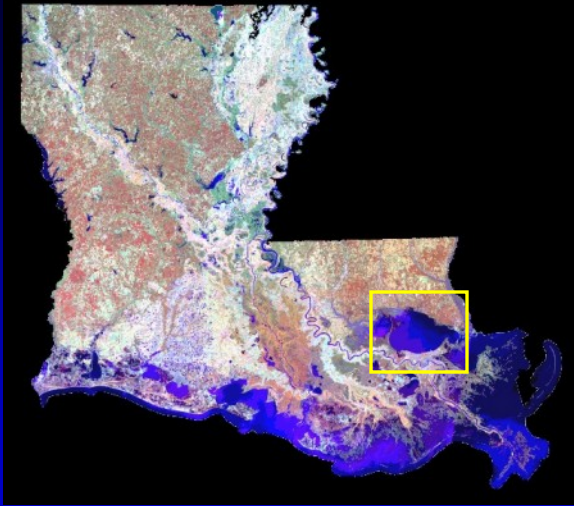


- Object of natural or human origin, deployed on seafloor to influence aquatic species for biological or economic gain

- 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

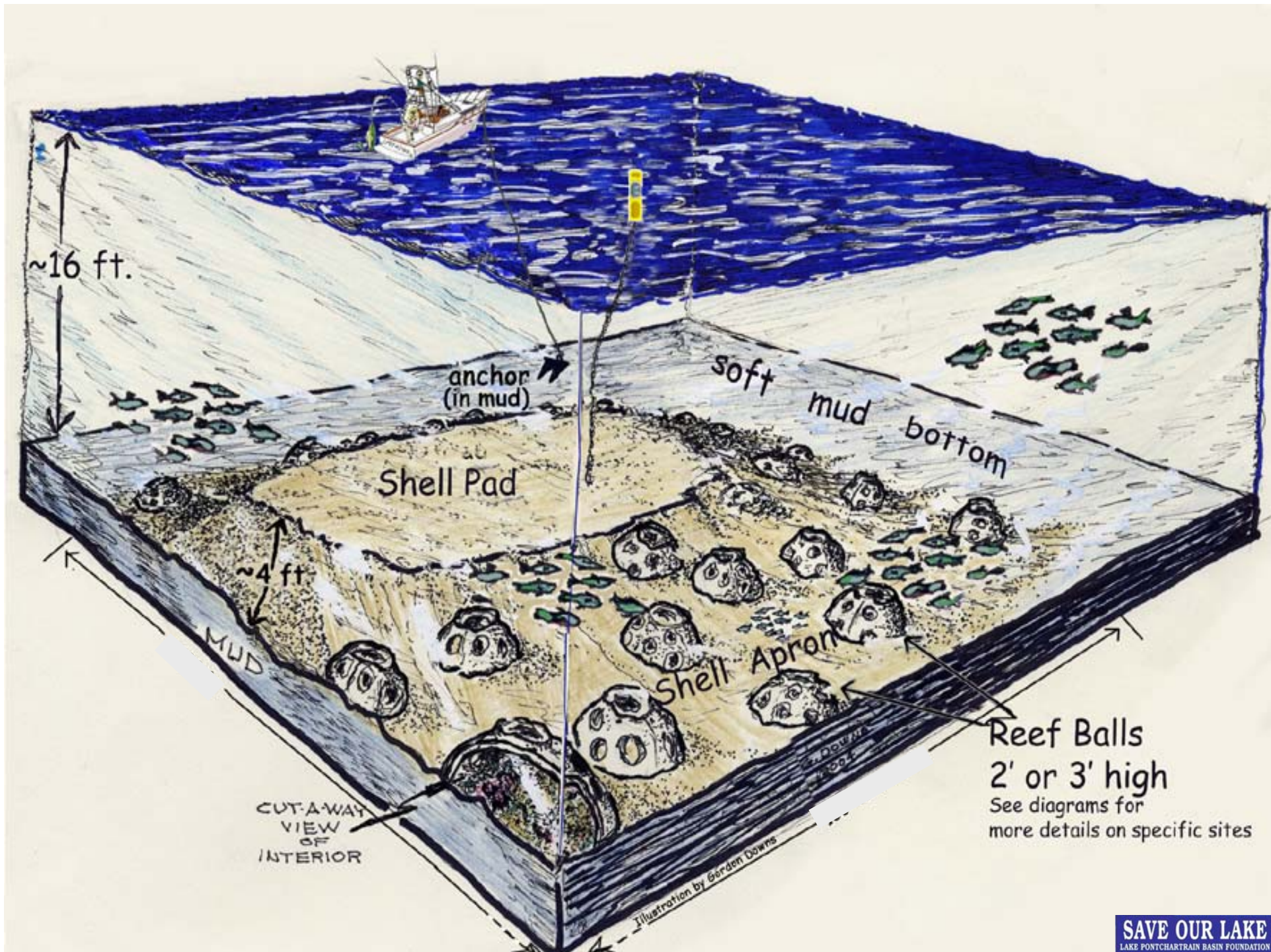
Organized in June 2000

- 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



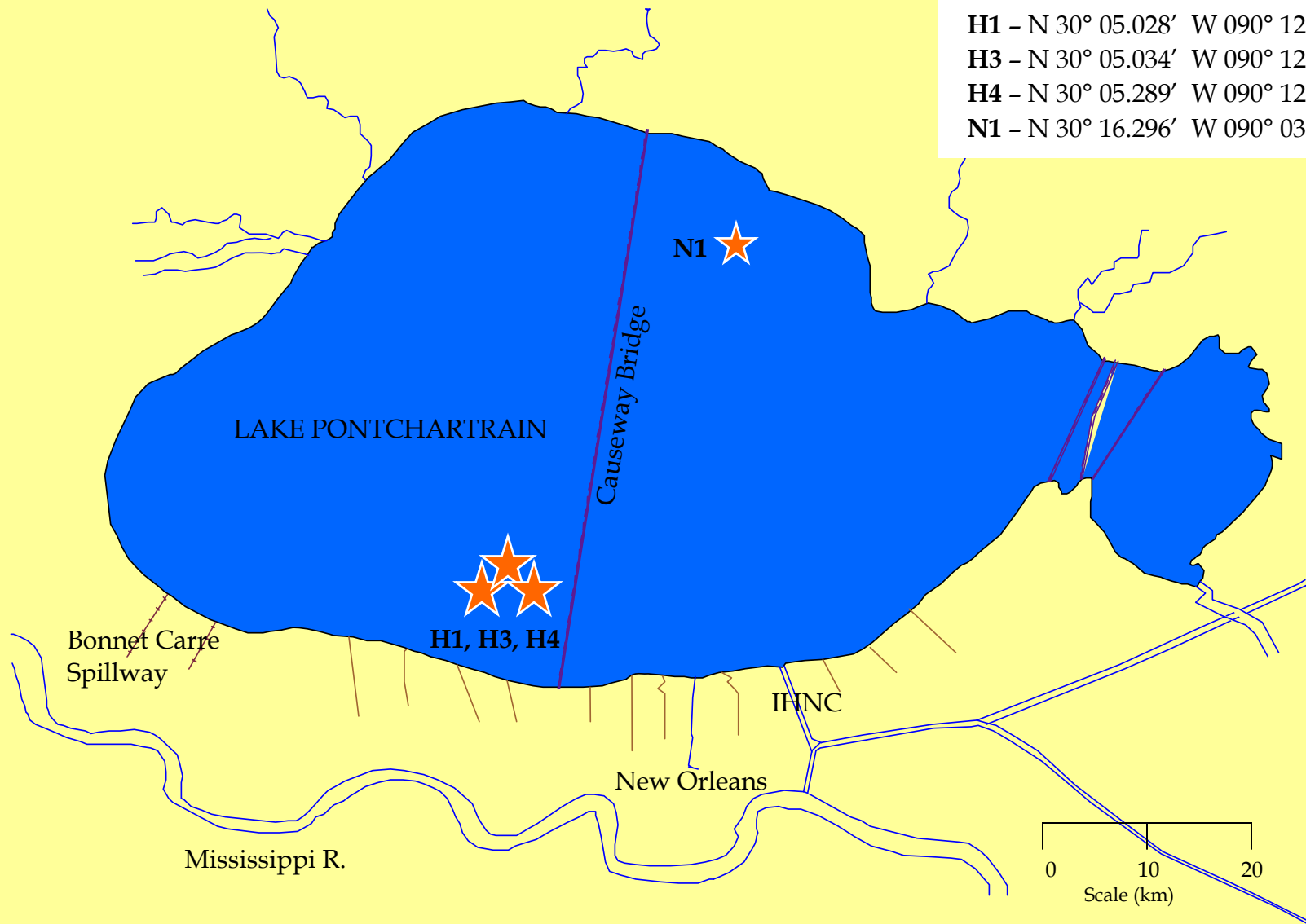
Coordinates of Artificial Reef Sites

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

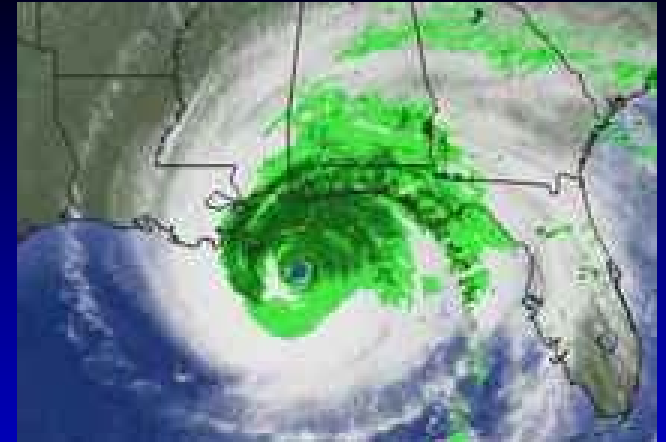
Water Quality

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

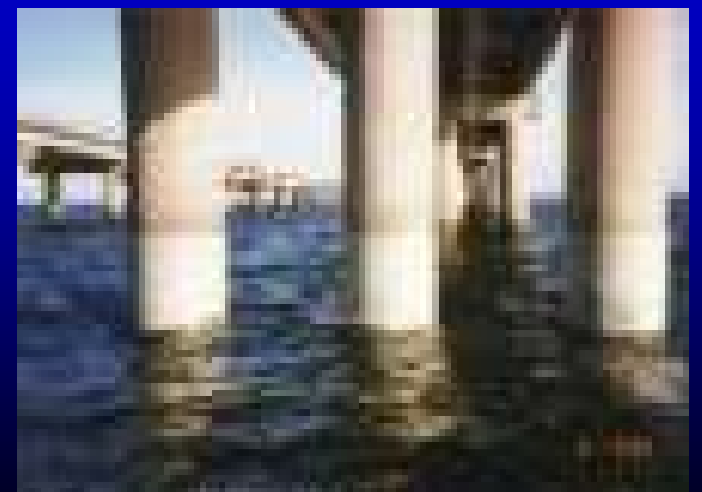
Water Quality

- 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





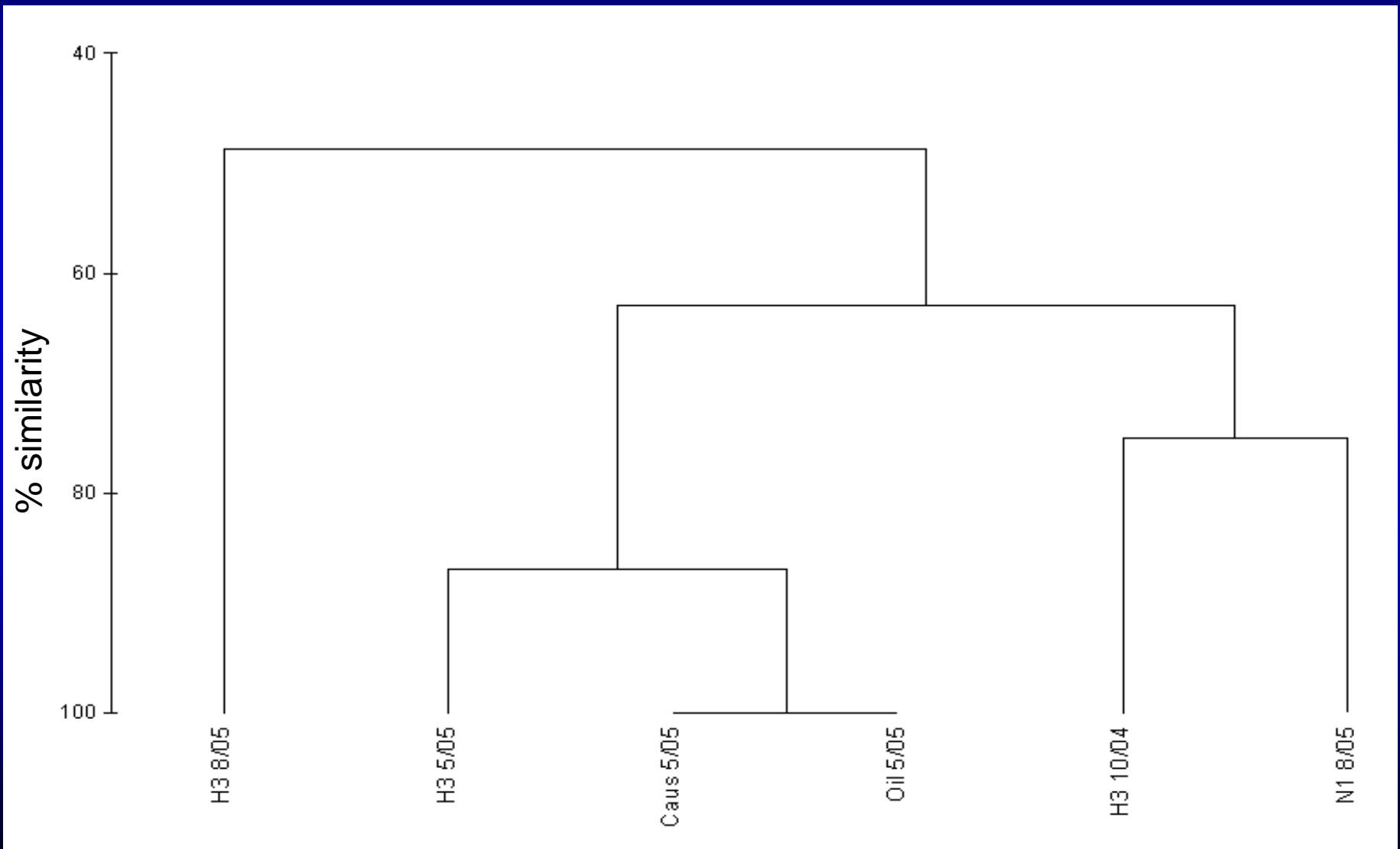
Balanus sp.

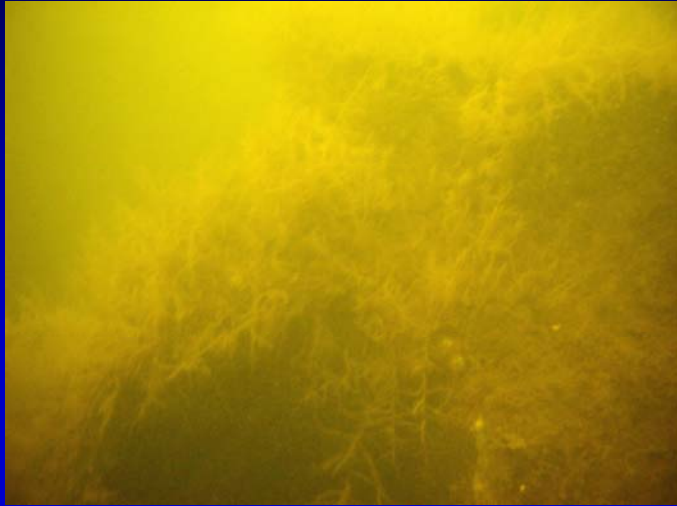
Benthic Macroinvertebrates

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	<i>Spongilla alba</i>	X	-	-	-	-	X
	<i>S. alba gemmules</i>	X	X	X	X	X	X
Cnidaria	<i>Garveia franciscana</i>	X	X	-	X	X	X
	<i>Cordylophora caspia</i>	X	-	-	-	-	-
Bryozoa	<i>Victorella pavida</i>	X	-	X	X	X	X
	<i>Conopeum</i> sp.	X	X	-	X	X	X
Nematoda	nematode worms	X	X	X	X	X	X
Annelida	<i>Polydora websteri</i>	X	X	X	X	X	X
	<i>Neanthes succinea</i>	-	-	X	-	-	X
	Class Oligochaeta	-	-	X	-	-	X
Mollusca	<i>Congeria leucophaeta</i>	X	X	X	-	-	X
	<i>Ischadium recurvum</i>	-	-	-	-	-	X
Arthropoda	<i>Balanus improvisus</i>	-	X	-	X	X	-
	<i>B. subalbidus</i>	X	X	-	X	X	-
	<i>Corophium lacustre</i>	-	X	X	X	X	-
	<i>Uromunna reynoldsi</i>	X	X	-	-	-	X
	<i>Melita</i> sp.	-	X	-	X	X	-
	<i>Rhithropanopeus harrissii</i>	-	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

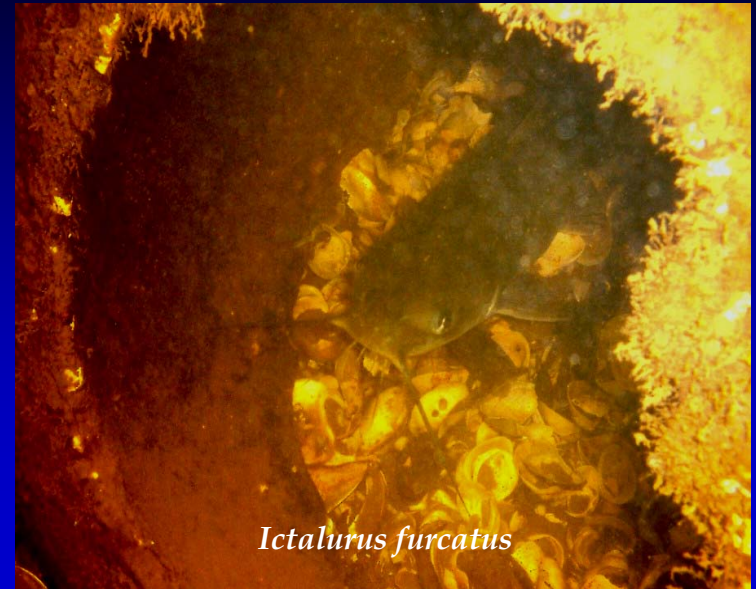
- Results:
 - 30 hrs of survey effort over 10 days in summer 2005

Fishes:

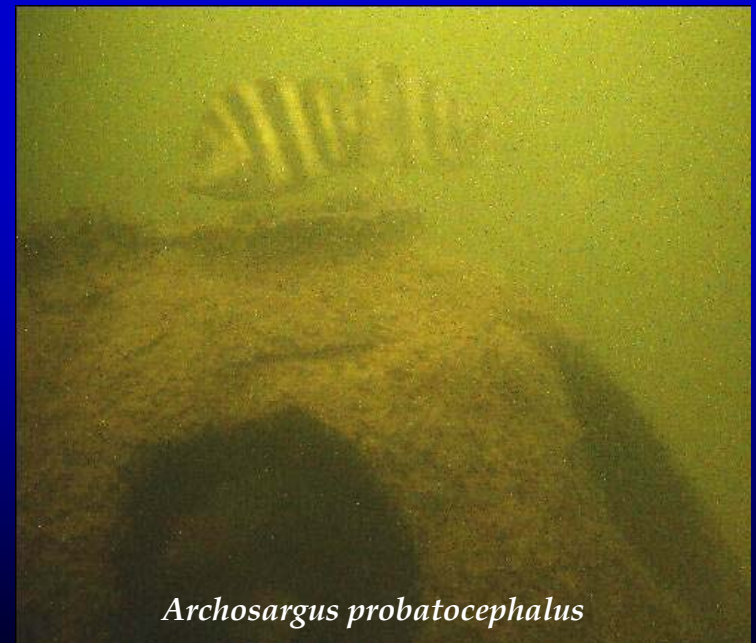
- Number of species greater over reef than shell and mud
- Total abundance over reef higher than shell pad and mud

Mobile Macroinvertebrates:

- Abundance highest over reef



Ictalurus furcatus



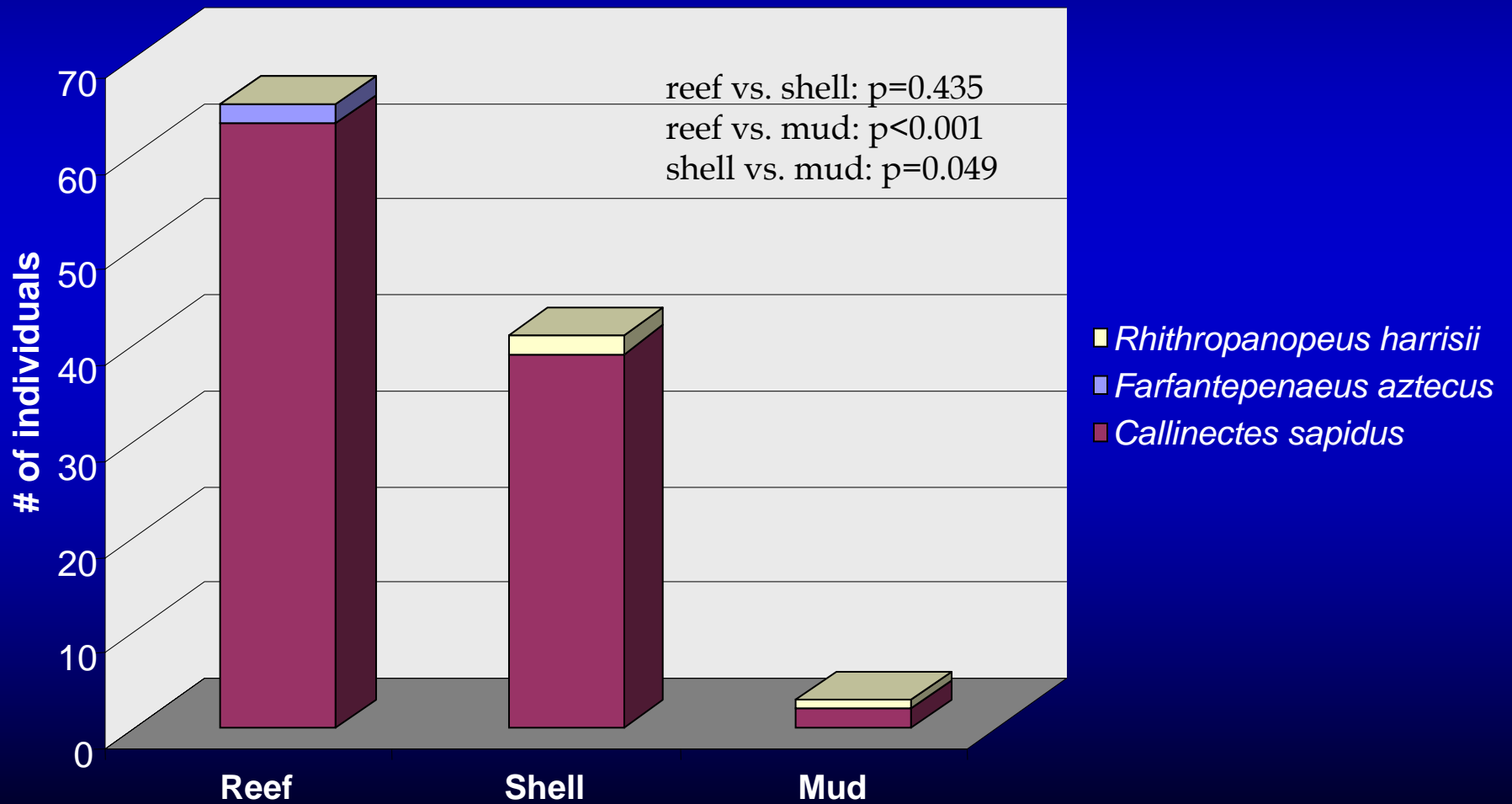
Archosargus probatocephalus

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

Invertebrates	Species	Common	Reef	Shell	Mud
Penaeidae	<i>Farfantepenaeus aztecus</i>	brown shrimp	2	0	0
Portunidae	<i>Callinectes sapidus</i>	blue crab	63	39	2
Xanthidae	<i>Rhithropanopeus harrisi</i>	mud crab	0	2	1

Mobile Macroinvertebrates

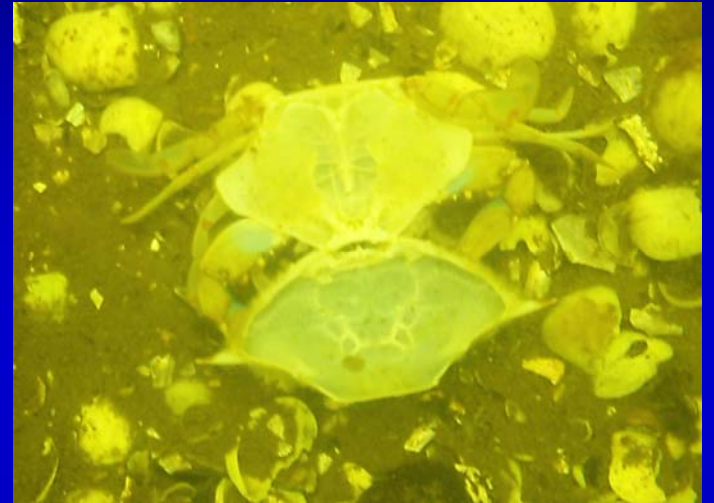
Visual Surveys



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

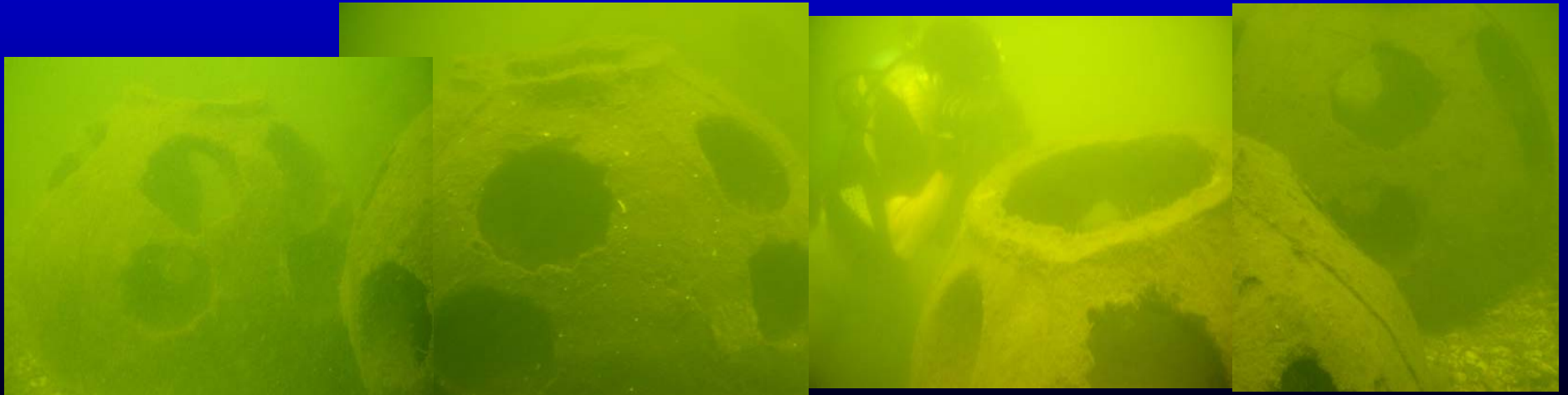


- Results:
 - 21 respondents (2 in 2004 / 19 in 2005)
 - 16 visited south shore; 3 north shore; 2 limestone
 - Target species
 - Speckled trout, redfish, flounder
 - Catch
 - 8/21 speckled trout (mean 21 / range 10-35)
 - Flounder, white trout, sheepshead, catfish, croaker
 - Disposition
 - 16/21 reefs 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?*

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