LAKE PONTCHARTRAIN ARTIFICIAL REEF EVALUATION: 2004 & 2005 RESULTS

Estuarine Research Laboratory
Department of Biological Sciences
University of New Orleans
New Orleans, LA 70148

LAKE PONTCHARTRAIN ARTIFICIAL REEF EVALUATION: 2004 & 2005 RESULTS

Submitted to:

Lake Pontchartrain Basin Foundation

P.O. Box 6965

Metairie, LA 70009

By:

Kelly A. Whitmore, Research Associate

Michael A. Poirrier, Principal Investigator

Estuarine Research Laboratory

Department of Biological Sciences

University of New Orleans

New Orleans, LA 70148

March 2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Lake Pontchartrain Artificial Reef Working Group established four artificial reefs constructed of reef ball modules in Lake Pontchartrain between August 2003 and January 2004. Three of the reefs are located along the south shore of the lake, west of the Causeway Bridge; the fourth is located off of the north shore, south of Mandeville, Louisiana. Researchers at the University of New Orleans' Estuarine Research Laboratory evaluated reef performance in 2004 and 2005. Program goals were to monitor: (A) structural integrity, in particular any movement of reef balls; (B) water quality; (C) colonization of benthic macroinvertebrates; (D) fish assemblages; and (E) fishing activity at the artificial reefs. Additionally, methods were developed to collect long-term reef monitoring data using volunteer SCUBA divers and internet-based fishing activity surveys. Reef data were collected from June to October 2004 and May to August 2005. Accomplishments and findings of the artificial reef evaluation include:

(A) Structural Integrity – Reef stability was assessed to determine whether reef balls move horizontally or vertically (sink) as strong storms pass over southern Louisiana. Individual reef ball locations were monitored prior to and following the 2004 hurricane season and into the 2005 season. No change in position of balls was detected following Hurricane Ivan (16 September 2004) or Tropical Storm Matthew (10 October 2004). When feasible, the affects of Hurricane Katrina on the artificial reefs will be assessed. Reef balls appear to be a stable reef material for Lake Pontchartrain.

(B) Water Quality – Physiochemical data collected at the reefs sites included dissolved oxygen, temperature, salinity, and transparency of surface and near-bottom waters. Hypoxia (low dissolved oxygen) was not detected during reef monitoring in 2004 or 2005. However, salinity stratification and bottom hypoxia were detected near the reef sites during lake-wide benthic sampling on one occasion in late October 2004. In

early July 2004, a cyanobacterial bloom was present over the south shore reefs. No algal blooms were detected at the reefs in 2005.

(C) Benthic Macroinvertebrates – Macroinvertebrate colonization of the reef balls was tracked visually and via specimen collection. The hydroid *Garveia franciscana* and freshwater sponge *Spongilla alba* were initial colonizers, along with bivalve *Congeria leucophaeta* that settled in crevices on irregular reef ball surfaces. In October 2004, estimated surface cover of epifauna was around 10 percent and consisted predominantly of *S. alba*. Other macroinvertebrate colonizers included bryozoans *Victorella pavida* and *Conopeum* sp., barnacle *Balanus subalbidus*, and nematode and annelid worms. In 2005, estimates of surface cover of epifauna markedly increased to around 50 percent and consisted primarily of *S. alba* and *G. franciscana*.

(D) Fish Assemblages – Underwater visual surveys were conducted to assess fish assemblages at the reef sites. Dedicated survey effort by divers totaled 900 minutes in 2005. On each sampling day fish surveys were conducted over a reef site and two reference sites, including a shell pad without reef balls and a natural mud-bottomed site. Total number of species and total number of individuals sighted were significantly over the reef when compared to shell and mud sites. In 2005, 14 out of a total of 17 fish species sighted were sighted at the reef, eight were sighted at the shell pad, and one was sighted over the mud. Total number of fish sighted at the reef was 577, at the shell pad was 215, and over the mud was eight. Species sighted most commonly at the reef were the naked goby *Gobiosoma bosc*, sheepshead *Archosargus probatocephalus*, and freckled blenny *Hypsoblennius iothonas*. Nine species of fish were only sighted on the reef. Three species of mobile macroinvertebrates were sighted during fish surveys, of which the majority (96 percent) were blue crabs *Callinectes sapidus*. Sixty-eight percent of the 127 *C. sapidus* sighted were over the reef. Gillnet sampling was conducted on 22 July and 18 August 2005 at the south shore reefs to supplement visual surveys. Of five 20-minute gillnet sets; two gafftopsail catfish *Bagre marinus* and one Atlantic croaker *Micropogon undulatus*

were caught. Hurricane Katrina arrested experimentation of gillnet sampling techniques directly over the artificial reefs.

(E) Fishing Activity – Recreational use of the artificial reefs was evaluated by conducting on-site observation of vessels, interviewing anglers at Lake Pontchartrain fishing rodeos, and collecting information through an internet-based creel survey. The survey was posted on the Lake Pontchartrain Basin Foundation's website (http://saveourlake.org) from October 2004 to present and on the Louisiana Fishing and Hunting website (http://rodnreel.com) from June 2005 to August 2005. A total of 21 surveys have been received. Anglers reported having caught speckled trout (spotted seatrout), white trout (sand seatrout), southern flounder, Atlantic croaker, and sheepshead at the south shore reefs (H1, H3, and H4); and speckled trout and catfish at the north shore reef (N1). In addition to anglers, spearfishers and SCUBA divers also visited the reefs. Most survey respondents indicated that the reefs have enhanced fishing and/or diving opportunities in the lake and that they personally have fished or dived more as result of the reefs. Crowding at the south shore reefs and difficulty finding reefs due to the format of published coordinates were also noted.

BACKGROUND

The Lake Pontchartrain Artificial Reef Program

Artificial reef development is a common fishery and aquatic management practice that has been used in nearly all U.S. coastal states and internationally (Christian et al. 1998, Seaman and Jensen 2000). Artificial reefs are objects of natural or human origin deployed purposefully on the seafloor to influence living marine resources, usually for some biological and/or socioeconomic gain (Seaman and Jensen 2000). Reefs increase diversity on a local scale by augmenting biotic and abiotic habitat complexity (Wilding and Sayer 2002). Although reefs attract and aggregate fishes, whether they contribute to new production of fish stocks is controversial (Bohnsack 1989, Bohnsack et al. 1997, Martin and Bortone 1997). If shelter or food is a limiting resource for fishes, primary production, benthic secondary production, and refuge habitat fostered by the reef may increase survival and growth of new individuals (Miller and Falace 2000). In contrast, structure that provides neither food nor refuge also attracts fishes and the attraction may simply relocate and concentrate existing populations (Bohnsack 1989, Martin and Bortone 1997).

In reviewing artificial reef literature it is apparent that monitoring and assessment of artificial reefs warrants equal or greater effort than construction, yet it is seldom funded (Christian et al. 1998). Reef managers know that artificial habitats attract fish but ecological functions of reefs are poorly understood (Bohnsack and Sutherland 1985). Evaluation is essential in identifying benefits and limitations of any fishery and/or natural resource management effort including artificial reef development. Responsible use of artificial reefs by fishery managers depends on knowing how well reefs are meeting project objectives.

Cooperative efforts between the Lake Pontchartrain Artificial Reef Working Group (LPARWG), state and federal agencies, and local interest groups, led to the development of four artificial reefs in Lake Pontchartrain between August 2003 and January 2004 (Lopez 2004). The reefs complement the inshore component of the Louisiana Department of Wildlife and Fisheries Artificial Reef Program, which was initiated in 1986 with the passing of the Louisiana Fishing Enhancement Act (Wilson et al. 1987, Louisiana Department of Wildlife and Fisheries 2005). Three of the reefs are located along the south shore of the lake approximately 5.6 km (3.5 mi) offshore and 6.4 km (4 mi) west of the Causeway Bridge

("H1" at N 30º 05.028' W 090º 12.096'; "H3" at N 30º 05.034' W 090º 12.583'' and "H4" at N 30º 05.289' W 090º 12.336' (Lopez 2004). The fourth reef is located along the north shore, 8.9 km (5.5 mi) south of Mandeville ("N1" at Nº 30 16.296' W 090º 03.753') (Lopez 2004, LPARWG 2004) (Figure 1). One other artificial reef exists in the lake ("L1" at N 30º 03.520' W 090º 59.610') located north of the Lakefront Airport in New Orleans, LA. It was developed by the LPARWG in 2001 and is composed of limestone rubble. An evaluation of the limestone reef conducted in 2002 reported structural stability, fish and invertebrate colonization, and recreational use of the site (Poirrier and Sinclair 2002).

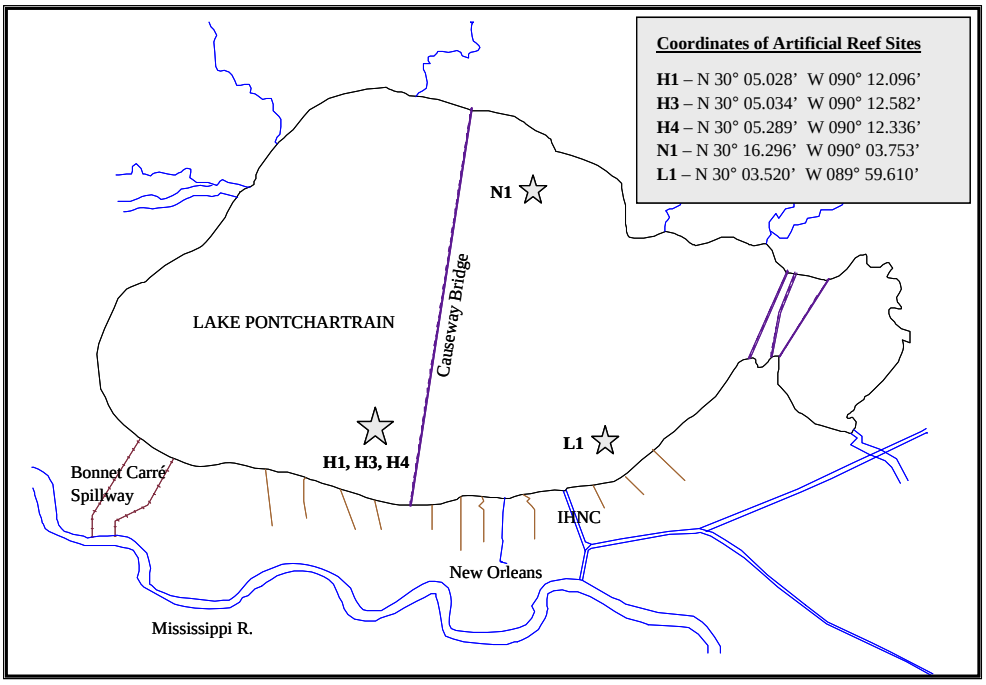

Figure 1. Map of Lake Pontchartrain, Louisiana artificial reefs. Stars indicate locations of reefs including reef ball reefs (H1, H3, H4, and N1) and the limestone reef (L1).

The newly established Lake Pontchartrain reefs are the first in Louisiana to utilize Reef Balls™, commercially fabricated low profile and environmentally-safe concrete units. The reefs restore hard substratum to the lake, a resource severely depleted by shell dredging from 1933 to 1990 (Abadie and Poirrier 2001). Projected benefits are based on those demonstrated in marine habitats including greater abundance and diversity of invertebrates and fishes, and increased fishing and diving opportunities (e.g. Serviss and Sauers 2003, Kasprzak 1998, Zalmon et al. 2002, Stephens and Pondella 2002, Turpin and Bortone 2002). Artificial reefs

composed of reef balls have been used extensively in marine environments and occasionally in freshwater but have never before been tested in a low-salinity estuarine environment (Barber, pers. comm.).

Reef balls were the preferred material for the Lake Pontchartrain project because they are structurally stable, non-toxic, and typically colonized quickly by invertebrates (RBDG 2002). Concrete use to make reef balls contains microsilica, which gives it a pH similar to seawater (~8) (Suprenant 2001, Buckeridge 2002, RBDG 2002). Regular concrete placed in saltwater leaches calcium hydroxide and increases alkalinity of surrounding seawater to around pH 12. This can affect settlement of some organisms (Anderson 1996, Walker et al. 2002). In marine environments, potentially Lake Pontchartrain, the microsilica additive will accelerate invertebrate colonization (Bell et at. 1997). Reef balls provide refugia for juvenile and adult fishes and a place of attachment for sessile invertebrates (RBDG 2002, Serviss and Sauers 2003, EPA 2005). Diversity, rate of growth, and abundance of fishes have been positively correlated with increased spatial and structural heterogeneity provided by artificial reefs (Eklund 1997, Demers et al. 2000, Serviss and Sauers 2003). Although artificial reef fish assemblages have been examined in many regions of the world, few studies have assessed faunal development on artificial reefs in estuaries (Martin and Bortone 1997). This study will generate data on the biological contribution of artificial reefs in brackish systems and may have a direct impact on the use of this fishery management strategy in estuaries.

In June 2004, the University of New Orleans' Estuarine Research Laboratory implemented the first phase of the Lake Pontchartrain Artificial Reef Evaluation Program to assess performance of the four artificial reefs as outlined in the Lake Pontchartrain Artificial Reef Evaluation Proposal (Poirrier 2004, Poirrier and Whitmore 2004). In May 2005, the second phase (Poirrier 2005) was implemented. Main goals of the program were to develop techniques for using local volunteer divers and creel surveys to collect reef performance data, and to monitor: (A) structural integrity, in particular, any movement of reef balls; (B) water quality; (C) colonization of benthic macroinvertebrates; (D) fish assemblages; and (E) angler utilization of the reefs. The study was limited in time (10 months in 2004 and in 2005) and resources (2.5 man months in 2004 and 2005). Components of the Lake Pontchartrain Artificial Reef Evaluation Program were evaluated from June 2004 to August 2005 and are reported on below.

A.) REEF STRUCTURAL INTEGRITY

Reef movement is a primary concern to reef managers because it could compromise invertebrate colonization, reducing the reef's capacity to support permanent communities. Although movement is not anticipated due to reef ball design, reports on reef ball stability were reviewed and a stability analysis of a Lake Pontchartrain artificial reef was conducted. For the analysis, individual reef balls were tracked prior to and following the 2004 hurricane season to determine whether reef balls move horizontally or vertically (sink) as strong storms pass over southern Louisiana.

Two sizes of reef balls compose the Lake Pontchartrain artificial reefs: 0.6 m x 0.9 m (2 ft x 3 ft) "bay balls," which weigh between 181.4 and 340.2 kg (400 and 750 lbs), and 1.2 m x 0.9 (4 ft x 3 ft) "pallet balls", which weight between 680.4 and 997.9 kg (1500 and 2200 lbs) Lopez 2004). Both types are designed so that over half of the weight is in their flat base. A large opening at the top of the unit reduces hydrofoil-lifting forces common to dome shapes (RBDG 2002). Side holes in the dome also help to reduce the effects of water currents. As reported by the Reef Ball Development Group (2002), all sizes of reef balls have remained in position through tropical storms in as little as 6.1 m (20 ft) of water without having been anchored.

An environmental scientist for the Sarasota Bay National Estuary Program reported no reef balls were missing or out of position from Sarasota Bay artificial reefs after a series of storms over Florida in 2004, although the area experienced tropical storm-force winds, shoreline erosion, and strong wave action (Raulerson, pers. comm.). An interim report on a New Zealand artificial reef composed of reef balls also reported no appreciable scouring, settlement into the sediment, or movement of balls during storm periods (Buckeridge 2002). A formal study on reef ball stability conducted by the Florida Institute of Technology in Melbourne, Florida examined minimum weights necessary for stability under various environmental conditions (Roehl and Harris 1996). Wave tank and wind tunnel experiments were conducted using scale models of reef balls subjected to various wave heights, wave periods, depths, and substrate types. The only structural instability observed was sliding; no overtopping occurred (Roehl and Harris 1996). Additional work is needed to apply this work to Lake Pontchartrain but the study appears to indicate that minimum production weights of

181.4 (400 lbs) for bay balls and 680.4 kg (1500 lbs) for pallet balls used in Lake Pontchartrain were sufficient for stability under moderate storm conditions. To determine the stability of Lake Pontchartrain artificial reefs, a south shore reef was monitored prior to and following the 2004 hurricane season and prior to the 2005 hurricane season.

Methods

The H3 south shore artificial reef (N 30° 05.034', W 090° 12.582') was selected as the primary monitoring site for movement due to uniform deployment of reef balls around the perimeter of the shell pad. Other reef sites had sections of deep mud where reef balls were not deployed (Lopez 2004). In July 2004, two study areas were established on the H3 site. One was located in the northern quadrant and the other in the southern quadrant of the reef. Each plot contained 10 to 15 balls including both bay and pallet balls. Plots were approximately square with sides oriented east to west and north to south. The presence of pallet balls in the plot confirmed that the outer perimeter of the reef had been incorporated. Divers marked the corners of each plot by driving PVC poles into the substrate approximately 1 m (3 ft), delimited the area with flagging tape, and identified all the balls within the plot according to their ID plate. Divers measured the distance from PVC poles to reef balls and from reef balls to other reef balls within the plot. Measurements were taken to the nearest 0.17 m (0.5 ft) and duplicate measurements were collected to verify repeatability of the procedure. A rough sketch of the plot and relative distances between balls and PVC poles was drawn (Figure 2) on an underwater slate. Measurements were made until all balls were accounted for and each had multiple measurements to PVC poles and other reef balls.

Tropical storms and hurricanes that affected southeastern Louisiana in 2004 and 2005 were recorded. Following the 2004 hurricane season and the first tropical storm affecting Lake Pontchartrain in 2005, SCUBA divers relocated the PVC poles and inclusive plots at the H3 reef site. Measurements were taken to/from PVC poles and reef balls. Pre- and post-storm distances were compared.

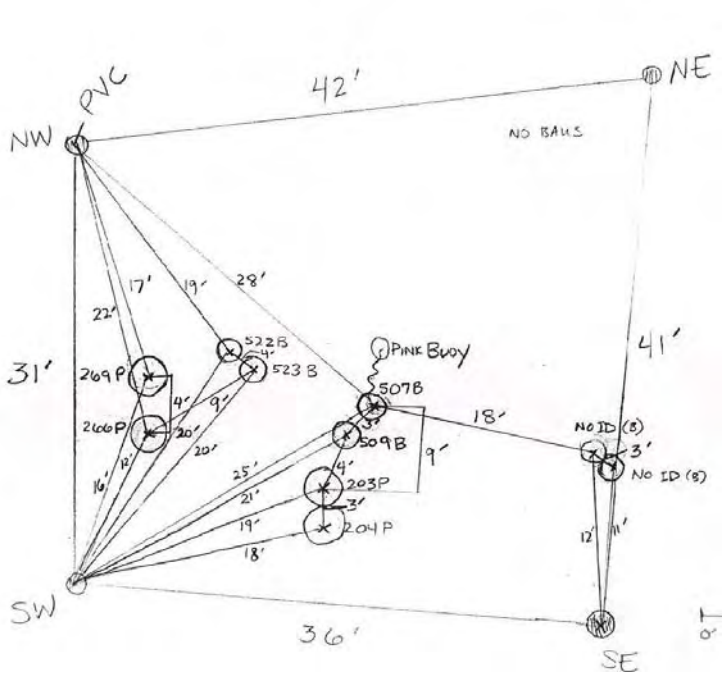

Figure 2. Diver sketch of the relative distances among reef balls on the H3 Lake Pontchartrain artificial reef monitoring plot.

Results

Divers identified, measured, and monitored the locations of reef balls on nine days in 2004: 1 July, 5 July, 10 July, 11 July, 22 July, 28 July, 4 August, 27 August, and 28 October 2004. Measurements were made on one day in 2005: 9 June 2005 (Figure 3). Underwater survey effort totaled over 37 hours (Appendix A). The majority of survey effort took place during the summer months when visibility in the lake was highest.

2004 Pre-Storm Measurements

H3 South Plot - On 10 and 11 July 2004 divers recorded the locations of 10 reef balls (six bay balls and four pallet balls) within a plot in the southern section of the reef (Figure 2). The eastern boundary of the plot measured 9.4 m (31 ft), the northern 12.8 m (42 ft), the western 12.5 m (41 ft), and the southern 11.0 m (36 ft). All reef balls were oriented upright and none exhibited signs of sinking. ID plates on two of the bay balls were missing.

H3 North Plot - On 4 and 27 August 2004 divers recorded the locations of 14 reef balls (seven ball balls and seven pallet balls) in a plot in the northern section of the reef. All boundaries measured 12.5 m (41 ft). One bay ball near the center of the plot was inverted.

2004 Storms

Two strong storms affected Lake Pontchartrain during the 2004 hurricane season, Hurricane Ivan on 16 September 2004, and Tropical Storm Matthew on 10 October 2004 (Figure 3). Hurricane Ivan made landfall near Gulf Shores, Alabama as a category 3 storm on 16 September 2004. Lake Pontchartrain experienced steady northwest winds 14 to 19 m/s (31 to 43 mph) that pushed water towards the south shore of the lake (LUMCOM 2004, NOAA 2004). Gauge data for West End on the south shore of Lake Pontchartrain showed the water level was 1.3 m (4.4 ft) above average (USGS 2005). Tropical Storm Matthew crossed the south-central Louisiana coast near Cocodrie on 10 October 2004. Considerable inland flooding occurred across much of southeastern Louisiana due to heavy rainfall (>25 cm/10 in some locations). Broad circulation of the storm and continuous east winds varying from 12 to 20 m/s (27 to 45 mph) pushed up to three feet of storm surge into portions of Lake Pontchartrain (LUMCON 2004, NOAA 2004).

2004 Post-Storm Measurements

Turbulent conditions in Lake Pontchartrain following Hurricane Ivan precluded reassessment of the study area until late October 2004. On 28 October 2004, divers surveyed reef balls in the H3 South plot. All four PVC poles were intact as were the 10 reef balls previously identified within the plot. All distances from reef balls to PVC poles and to other reef balls were within the allowable range of 0.15 m (0.5 ft) difference permitted for sagging of the measuring tape. No appreciable horizontal movement or vertical movement (sinking) was observed.

2005 Pre-storm Measurements

Ball locations on the H3 North and H3 South plots were resurveyed on 9 June 2005 (Figure 3). Many ID plates were missing from balls that previously had ID plates in 2004. Locations of reef balls had not changed. Divers swam the perimeter of the shell pad to check

for displacement of reef balls. All balls appeared to be on the shell pad and no signs of sliding, rolling, sinking, or other movement was observed.

2005 Storms

Five major storms affected Lake Pontchartrain during the 2005 hurricane season; Tropical Storm Arlene on 11 June, Tropical Storm Cindy on 6 July, Hurricane Dennis on 10 July, Hurricane Katrina on 29 August, and Hurricane Rita on 23 to 24 September 2005 (Figure 3). Tropical Storm Arlene made landfall just west of Pensacola (NOAA 2005). Winds across Lake Pontchartrain were 11 to 16 m/s (25 to 36 mph) (LUMCON 2005). Tropical Storm Cindy made landfall on Grand Isle, Louisiana, and moved over eastern Lake Pontchartrain with sustained winds of 22 to 31 m/s (50 to 70 mph) (LUMCON 2005). Hurricane Dennis, a category 4 storm, made landfall on the Florida/Alabama border producing sustained north winds of 8 to 11 m/s (17 to 25 mph) and gusts to 16 m/s (36 mph) in Lake Pontchartrain (NOAA 2005, LUMCON 2005). Hurricane Katrina was an extremely intense and exceptionally large storm. Before making land on the Louisiana/ Mississippi border on 29 August 2005, Katrina's intensity weakened from a Category 5 to Category 3. Lake Pontchartrain experienced sustained winds between 27 to 33 m/s (60 to 74 mph) (NOAA 2005, LUMCON 2005) and significant storm surge. Hurricane Rita, also a large storm, made landfall in eastern Texas. Lake Pontchartrain experienced winds around 20 to 24 m/s (45 to 54 mph).

2005 Post-storm Measurements

Impacts from Hurricane Katrina have precluded reassessment of the artificial reefs post-Katrina. University resources including research vessels were damaged and researchers were dislocated. In addition, weather patterns in January 2006 have caused recurrent winds and low transparency in the lake, also preventing underwater survey. When feasible, effects of Hurricane Katrina on the Lake Pontchartrain artificial reefs will be assessed and reported.

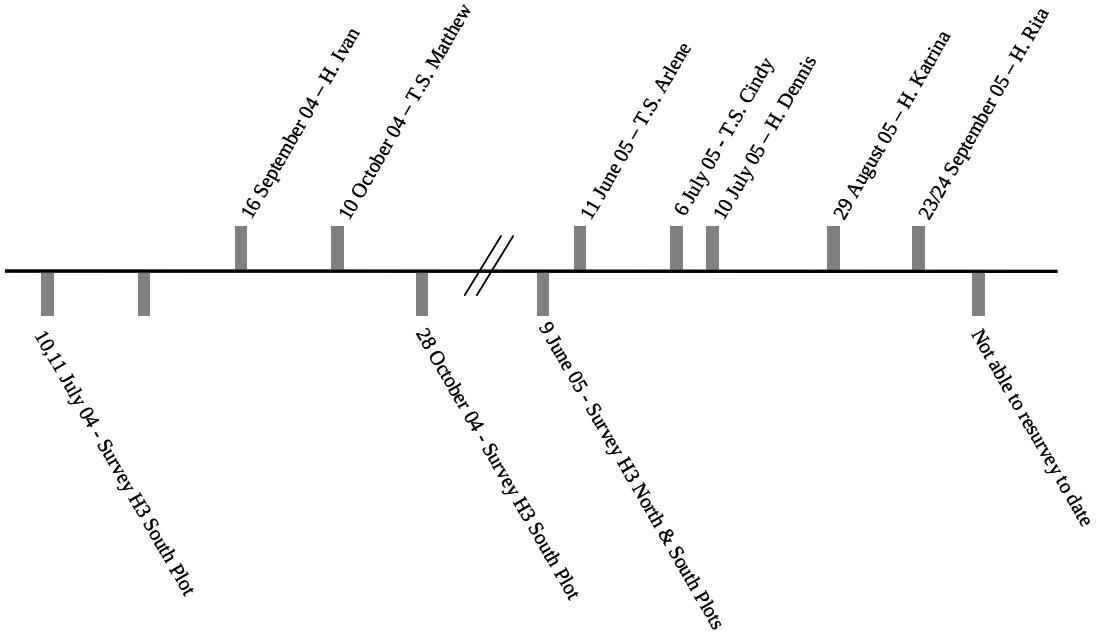

Figure 3. Timeline of reef ball stability surveys and storms affecting Lake Pontchartrain in 2004 and 2005.

Discussion

Data from structural integrity analyses indicate that reef balls are a stable artificial reef material in Lake Pontchartrain. All balls surveyed remained in their original deployment positions despite passage of strong storms over southeastern Louisiana and Lake Pontchartrain in 2004. Sinking, sliding, and scouring have all been negligible. One challenge associated with future evaluation of reef stability is that the fixative used to mount ID plates onto the balls has deteriorated and many plates have fallen off. ID plates have been found lying on the shell pad next to reef balls on multiple occasions and on all reefs. Selection of a more permanent marine fixative is recommended for future reef development efforts.

B.) WATER QUALITY

Abiotic factors such as dissolved oxygen, temperature, and salinity around artificial reefs influence assemblages (Bortone et al. 2000). A primary concern in Lake Pontchartrain is the potential for hypoxia to disrupt or destroy established invertebrate communities. Saltwater intrusion from the Inner Harbor Navigation Canal (IHNC) causes salinity stratification and hypoxic zones in the southeastern portion of the lake, which can adversely affect benthic fauna (Poirrier 1978, Junot et al. 1983, Abadie and Poirrier 2001). Reefs provide vertical relief that could offer protection for invertebrates and fishes during periods of low dissolved oxygen in bottom waters.

Methods

Physiochemical parameters including temperature, dissolved oxygen, and salinity were measured monthly at reef sites to check for salinity stratification and hypoxia. Surface and near-bottom measurements were taken using a handheld YSI model 85 SCT-DO meter and a YSI model 6600 multi-parameter sonde maintained and calibrated by the methods in the manufacturer's manual. Depth and Secchi disc transparency were measured using a standard 20 cm (7.9 in) Secchi disc. All physiochemical parameters were assessed using the methodology described in the Lake Pontchartrain Artificial Reef Evaluation Program Quality Assurance Project Plan (QAPP) (Poirrier 2001). Water samples were taken when algal blooms were observed in the water column at or near the reef sites.

Results

Water quality measurements were taken from July to October 2004 and April to August 2005 at least once a month when reef sites were accessed. Neither salinity stratification nor hypoxia was detected at any of the reef sites in 2004 or 2005 (Appendix B). In 2004, water transparencies at the south shore reefs ranged from 1.5 to 2.1 m (5 to 7 ft), with an average transparency of 1.8 ± 0.7 m (6 ± 2.3 ft). On 1 July and 5 July 2004, a cyanobacterial bloom was observed at the H3 reef site. The bloom extended from the water's surface to 3 m (9 ft) in the water column. Examination of water samples indicated that the bloom was composed of *Anabaena* sp., a cyanobacterium.

In 2005, daily water transparencies at the reefs ranged from 0.8 to 3.4 m (2.5 to 11 ft) with an average transparency of 1.9 ± 0.7 m (6.2 ± 2.3 ft). Water clarity was highest on average in June and August and lowest in May. Note these values do not represent the average transparency for all days over the course of study, only days on which the reefs were accessed. No algal blooms were observed in 2005.

Discussion

The Lake Pontchartrain artificial reefs may act as refuge for benthic invertebrates and fishes during episodes of hypoxia and anoxia in bottom waters. Currently, it is unclear whether low bottom dissolved oxygen (DO) caused by salinity stratification at the INHC persists as far west as the Jefferson Parish artificial reefs. Stratification was detected near the reefs on 25 October 2004, during lake-wide benthos surveys conducted by UNO Estuarine Research Laboratory researchers. Differences between surface and bottom DO were greater than 4 mg/L and bottom DO levels were at or below 2 mg/L, suggesting a hypoxic event just west of the artificial reefs (unpublished data). Water quality measurements taken at the reef sites on 28 October 2004 did not indicate salinity stratification or low DO. Other evidence of hypoxia in the southwestern region of the lake came from a report by an experienced commercial crabber on 10 August 2005. The fisherman reported dead crabs in his traps from the Seabrook Bridge to the Bonnet Carré Spillway due to a "wedge of bad water." He also reported much lower landings than average for that time of year (Ronnie, pers. comm.). Collection of water quality data throughout the Lake Pontchartrain during the summer and fall when hypoxia is most likely to develop would clarify the ecological role artificial reefs have in mitigating environmental stress and providing refuge for benthic invertebrates and fishes.

C.) BENTHIC MACROINVERTEBRATES

Viable invertebrate communities are vital for fish colonization and may enhance fisheries resources (Seaman and Jensen 2000, Perry et al. 2001, Relini et al. 2002, Steimle 2002). Invertebrate settlement rate, abundance, and species diversity are indicators of reef productivity (Bortone et al. 2000). The vertically elevated, solid reef balls supplement hard substrate, a limited resource in the lake, and should support a more diverse invertebrate community and productive fishery than alternative soft substrates. Although rapid settlement of reef balls has been demonstrated in marine environments patterns of colonization have not been documented in oligohaline estuaries (Martin and Bortone 1997).

Methods

Reef balls were inspected visually for macroinvertebrate epifauna on each dive made at the H3 reef site from July 2004 to October 2004 and May 2005 to August 2005. Presence of encrusting and/or mobile macroinvertebrates was recorded. Samples of epifauna were obtained on 28 October 2004 by scraping a 10.2 x 10.2 cm (4 x 4 in) patch on the outer surface of three reef balls on the H3 site using a putty knife. Samples were trapped in a plastic bag, sealed, and preserved in a 10 percent formalin solution. Organisms in the sample were rinsed through a 500 μm sieve, examined under a dissecting microscope, identified to the lowest practical taxon, and enumerated by experienced technicians using the Identification Guide to the Macroscopic Invertebrates of the Lake Pontchartrain Estuary, Louisiana (Poirrier 1984). Sample handling of benthic macroinvertebrates was in accordance with QAPP methods (Poirrier 2001).

Macroinvertebrate epifauna were again sampled from reef balls on 14 May and 21 August 2005. Macroinvertebrate samples were also taken from a shell pad (H) and a mud-bottomed site adjacent to the H3 reef. Shell and mud samples were obtained using a 15 cm x 15 cm Petite Ponar dredge. Three replicate samples were taken at each site.

Results

Visual observations revealed that from July until September 2004, macroinvertebrate epifauna on the reef balls was nearly absent. A thin layer of sediment was present on the surface of the balls approximately 0.3 cm (0.1 in) thick. In October 2004, visual estimates of macroinvertebrate cover increased from negligible to around 10 percent. Most growth was on the lower half of the balls and composed primarily of freshwater sponge *Spongilla alba*. At that time the sponge contained gemmules, small spherical bodies produced at the onset of winter through asexual reproduction (Brusca and Brusca 1990). False mussel *Congeria leucophaeta* were present in crevices on the outer surface of reef balls. Blue crabs *Callinectes sapidus* were sighted at the base of the balls. Eight species of macroinvertebrates from seven phyla were identified in the 2004 scrape samples (Table 1). In addition to *S. alba* and *C. leucophaeta*, the hydroid *Garveia franciscana*, bryozoans *Victorella pavida* and *Conopeum* sp., barnacle *Balanus subalbidus*, and nematode and annelid worms were identified.

Phylum	Species
Phylum Porifera	*Spongilla alba*
Phylum Cnidaria	*Garveia franciscana*
Phylum Nematoda	Nematode worms
Phylum Bryozoa	*Victorella pavida*
Phylum Bryozoa	*Conopeum* sp.
Phylum Annelida	*Polydora* sp.
Phylum Mollusca	*Congeria leucophaeta*
Phylum Arthropoda	*Balanus subalbidus*

Table 1. Taxonomic list of macroinvertebrates found on the H3 Lake Pontchartrain artificial reef on 28 October 2004.

In 2005, percent cover of macroinvertebrate epifauna on the south shore reef balls was noticeably greater than in 2004. Visual estimates ranged from 40 to 60 percent over the course of the summer. Growth was primarily composed of *Garveia franciscana* and *Spongilla alba*. *Garveia franciscana* was observed from May to August 2005 and *S. alba* from June to August 2005. *Congeria leucophaeta* were observed only in crevices, consistent with observations from 2004. Small *B. subalbidus* were present around the crown of some reef balls in May 2005. Visual estimates of epifaunal cover at the north shore reef were slightly higher than at the south shore reefs, around 80 percent in August 2005. Predominant

species were *G. franciscana* and *S. alba* analogous to the south shore reefs. Oil and gas platform pilings and Causeway bridge pilings adjacent to the south shore artificial reefs surveyed on 17 May 2005 (Appendix A) had epifaunal assemblages similar to reef balls, although *B. subalbidus* abundance was greater on the pilings than on reef balls.

Discussion

Initial macroinvertebrate colonization of the south shore artificial reefs was gradual. Percent cover was negligible throughout 2004 but increased considerably in 2005. No distinct differences in species composition were observed between the south and north shore artificial reefs, although the north shore reef had slightly greater percent cover of epifauna in the late summer of 2005. Species found on reef balls are similar to those found on other hard, vertical substrates in the lake including oil and gas platforms and Causeway Bridge pilings. Barnacles were more prevalent on the pilings than on the reef balls, which may be due to depredation by blue crabs *Callinectes sapidus* at the reef sites, but additional research is necessary to test this hypothesis. Changes in macroinvertebrate community composition are likely to occur as the reef matures and should continue to be monitored. Information on factors affecting settlement of epifauna under estuarine conditions is valuable for future reef efforts in Lake Pontchartrain and in other low-salinity estuaries.

D.) FISH ASSEMBLAGES

Abundance, species diversity, and residency of fishes are indicators of reef performance (Bortone et al. 2000). In addition to supplementing food resources through macroinvertebrate colonization, reefs may help aggregate baitfishes such as the bay anchovy *Anchoa mitchilli*, tidewater silverside *Menidia beryllina*, and Atlantic menhaden *Brevoortia patronus*. Lees created by disrupting bottom currents allow fishes to conserve energy (Baynes and Szmant 1989, Linquist and Pietrafesa 1989, Bohnsack et al. 1991, Sheng 2000). Larger predatory fishes such as spotted seatrout *Cynoscion nebulosus*, red drum *Sciaenops ocellata*, and Crevalle jack *Caranx hippos* are attracted to artificial structures for food, orientation, and refuge (Bohnsack et al. 1991, Eklund 1997, Walker et al. 2002). To assess Lake Pontchartrain artificial reef fish assemblage, a south shore reef was surveyed and compared to two reference sites, a shell pad without reef balls and the natural mud bottom. Additionally, the feasibility of using local volunteer divers to monitor reef stability and faunal assemblages over the long-term was assessed.

Methods

Visual detection and tallying of species is one of the few non-destructive methods available to assess reef fish communities (Brock 1982). Although there are certain errors inherent in underwater observation including misidentification and inaccurate group size estimation, the benefit of no mortality may outweigh limitations. Visual survey was selected as the preferred fish census method for the Lake Pontchartrain artificial reefs.

Dedicated underwater fish surveys were conducted from June 2005 through August 2005. Certified SCUBA divers surveyed the H3 south shore artificial reef, the H shell pad located at N 30° 05.110’ W 090° 12.198’ (Lopez 2004), and an adjacent mud-bottomed site located at N 30° 04.864’ W 090° 11.953’ (Figure 1). All divers had training and/or experience identifying estuarine fishes and macroinvertebrates of the Gulf of Mexico region and were instructed on formal survey protocols. Water quality and weather conditions were assessed prior to conducting fish surveys. A Secchi disk was used to measure transparency vertically and horizontally in the water column. Surveys were only conducted when vertical transparency was 1.8 m (6 ft) or greater. Horizontal transparency provided a measure of diver

visibility. A pair of divers obtained this measurement by holding the Secchi disk and chain horizontally while standing on the lake-bottom (Sheng 2000).

Divers used the Roving Diver Technique (RTD) to collect data on reef fish assemblages. The RDT is a rapid and inexpensive method of assessing natural and artificial reef populations used by fish survey groups worldwide (Schmitt and Sullivan 1996, Pattengill-Semens and Semmens 1998, REEF 2002). A pair of divers swam randomly throughout the survey area and recorded species and number of fishes sighted during two 10-minute intervals. Two diver teams surveyed each site twice, for a total of 40 minutes of survey time per site. On each survey-day, teams surveyed the artificial reef site, shell pad, and adjacent mud site for fish and mobile invertebrates. The order with which each site was surveyed was random, although occasionally influenced by angler presence. Fish surveys began as divers descended. Divers swam horizontally to the bottom and recorded all fish and mobile invertebrates sighted during the survey including species, number of individuals, and estimated length. Each pair of divers was provided with an underwater slate, waterproof paper, and ruler. One diver primarily sighted while the other recorded, and the pair regularly communicated to avoid recording duplicate sightings. Diver pairs swam randomly and slowly around the survey sites for 10 minutes, paused for a surface interval, then conducted a second 10-minute survey. Twenty minutes of survey time at each site was selected because an 80-cu3 airtank supplies the average diver for around 60 minutes with a safety reserve of 500 lbs of air, at 4 m depth. Area surveyed on each 10-minute interval was around 1000 m^2 (0.25 acre). One-way analysis of variance (ANOVA) was performed using the Compare Means procedure in SPSS (SPSS, Chicago, Illinois, USA) to compare abundances of fishes and mobile macroinvertebrates sighted on the reef, shell, and mud sites. Bonferroni post-hoc tests were run to distinguish differences between sites.

Visual surveys were supplemented by gillnet sampling in the summer of 2005. On 22 July and 18 August 2005, a 30 m gillnet comprised of five panels of varying mesh sizes was deployed adjacent to the H3 south shore reef. The net could not be deployed directly over the reef due to risk of equipment damage. On 22 July two diel sets were made, and on 18 August, three nocturnal sets. Ten minutes after deployment the research vessel was run around the net three times in gradually tightening circles, corresponding to the “Gillnet Strike Method” used

by the Louisiana Department of Wildlife and Fisheries. Total set time was 20 minutes. The net was retrieved and all captured fishes were processed.

Results

In 2004, divers sighted a total of seven species of fish at the H3 south shore reef while conducting monitoring activities, including the naked goby *Gobiosoma bosc*, freckled blenny *Hypsoblennius iothonas*, sheepshead *Archosargus probatocephalus*, Crevalle jack *Caranx hippos*, striped mullet *Mugil cephalus*, blue catfish *Ictalurus furcatus*, and anchovy *Anchoa* sp. (Table 2).

Date	Site	Species Sighted
07/01/04	H3	*Gobiosoma bosc* (naked goby), *Hypsoblennius iothonas* (freckled blenny), *Archosargus probatocephalus*(sheepshead), *Caranx hippos* (Crevalle jack), *Mugil cephalus* (striped mullet)
07/05/04	H3	*Ictalurus furcatus* (blue catfish), *Gobiosoma bosc*, *Hyposblennius iothonas*, *Archosargus probatocephalus*, *Mugil cephalus*
07/10/04	H3	*Archosargus probatocephalus*
07/11/04	H3	*Archosargus probatocephalus, Mugil cephalus*
07/22/04	H4	*Archosargus probatocephalus*, *Gobiosoma bosc*, *Mugil cephalus*
07/28/04	H3	No fishes sighted
08/04/04	H3	*Archosargus probatocephalus*, *Gobiosoma bosc*, *Hypsoblennius iothonas*
08/27/04	H3	*Archosargus probatocephalus, Gobiosoma bosc*
10/28/04	H3	*Anchoa* sp. (anchovy), *Hypsoblennius iothonas, Ictalurus furcatus, Mugil cephalus*

Table 2. Fishes sighted during monitoring efforts at the Lake Pontchartrain artificial reefs in 2004.

In 2005, dedicated fish surveys were conducted on ten days. Survey effort totaled 900 minutes (Appendix C). A combined total of 17 species of fish and three species of mobile macroinvertebrates were sighted at the reef, shell pad, and mud sites. Fourteen of the 17 species of fish were sighted at the artificial reef and included sheepshead *Archosargus probatocephalus*, blue catfish *Ictalurus furcatus*, Crevalle jack *Caranx hippos*, southern flounder *Paralichthys lethostigma*, pinfish *Lagodon rhomboides*, Atlantic croaker *Micropogon undulatus*, freshwater drum *Aplodinotus grunniens*, striped mullet *Mugil cephalus*, Gulf toadfish *Opsanus beta*, American eel *Anguilla rostrata*, Atlantic stingray *Dasyatis sabina*, naked goby *Gobiosoma bosc*, freckled blenny *Hypsoblennius iothonas*, and skilletfish *Gobiesox strumosus* (Appendix D). Mobile macroinvertebrates sighted on the reef

included the blue crab *Callinectes sapidus* and brown shrimp *Farfantepenaeus aztecus* (Appendix D).

Eight species of fish were sighted on the shell pad and included sheepshead *Archosargus probatocephalus*, southern flounder *Paralichthys lethostigma*, speckled worm eel *Myrophis punctatus*, tidewater silverside *Menidia beryllina*, hogchoker *Trinectes maculatus*, naked goby *Gobiosoma bosc*, freckled blenny *Hypsoblennius iothonas*, and skilletfish *Gobiesox strumosus*. Two species of mobile macroinvertebrates were sighted on the shell pad including the blue crab *Callinectes sapidus* and mud crab *Rhithropanopeus harrisii* (Appendix D). One species of fish and two species of mobile macroinvertebrates were sighted over the mud including *G. bosc*, *C. sapidus*, and *R. harrisii* (Appendix D).

Abundance of fish sighted at the reef was significantly higher than the number sighted over the shell ($p=0.016$) and mud ($p<0.001$) (Figure 4). Abundance of fish over the shell was not significantly different than abundance over the mud ($p=0.185$). Total numbers of fish sighted at the reef, shell, and mud sites were 577, 215, and 8, respectively. Sightings per unit effort at the three survey sites were 1.8, 0.7, and 0.3 fish per minute of survey time per pair of divers, respectively. Abundance of mobile macroinvertebrates at the reef was not significantly different from the abundance at the shell pad ($p=0.435$). However, abundances of mobile macroinvertebrates at the reef and shell pad were significantly higher than at the mud-bottomed site (reef $p <0.001$; shell $p=0.049$). Total number of mobile macroinvertebrates sighted at the reef, shell, and mud sites were 88, 41, and 3, respectively. Sightings per unit effort at the three survey sites were 0.3, 0.2, and 0.01 macroinvertebrate per minute of survey time per pair of divers, respectively.

Fishes sighted most frequently at the reefs were the naked goby *Gobiosoma bosc*, sheepshead *Archosargus probatocephalus*, and freckled blenny *Hypsoblennius iothonas* (Figure 4). Most common at the shell pad were *G. bosc* and the tidewater silverside *Menidia beryllina* (Figure 4), although all *M. beryllina* were in one school. Nine species were sighted only at the artificial reefs including Crevalle jack *Caranx hippos*, striped mullet *Mugil cephalus*, blue catfish *Ictalurus furcatus*, Atlantic croaker *Micropogon undulatus*, pinfish *Lagodon rhomboides*, freshwater drum *Aplodinotus grunniens*, Atlantic stingray *Dasyatis sabina*, American eel *Anguilla rostrata*, and Gulf toadfish *Opsanus beta* (Figure 4).

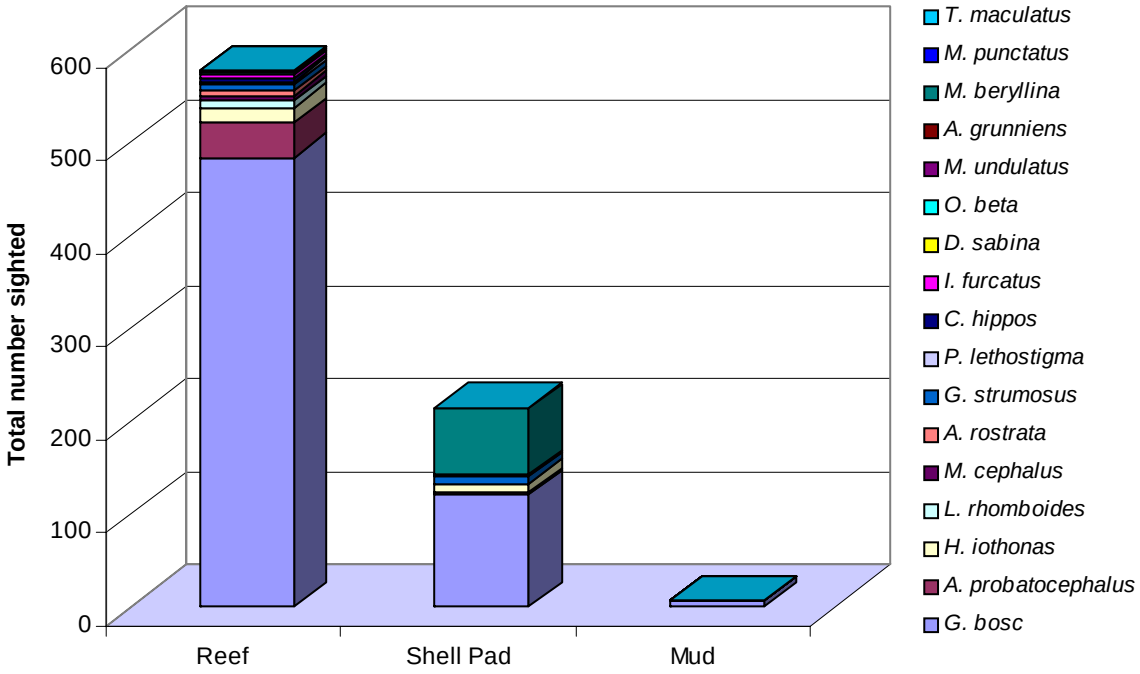

Figure 4. Comparison of species and abundances of fish sighted at the Lake Pontchartrain artificial reef, shell pad, and mud-bottomed sites in 2005.

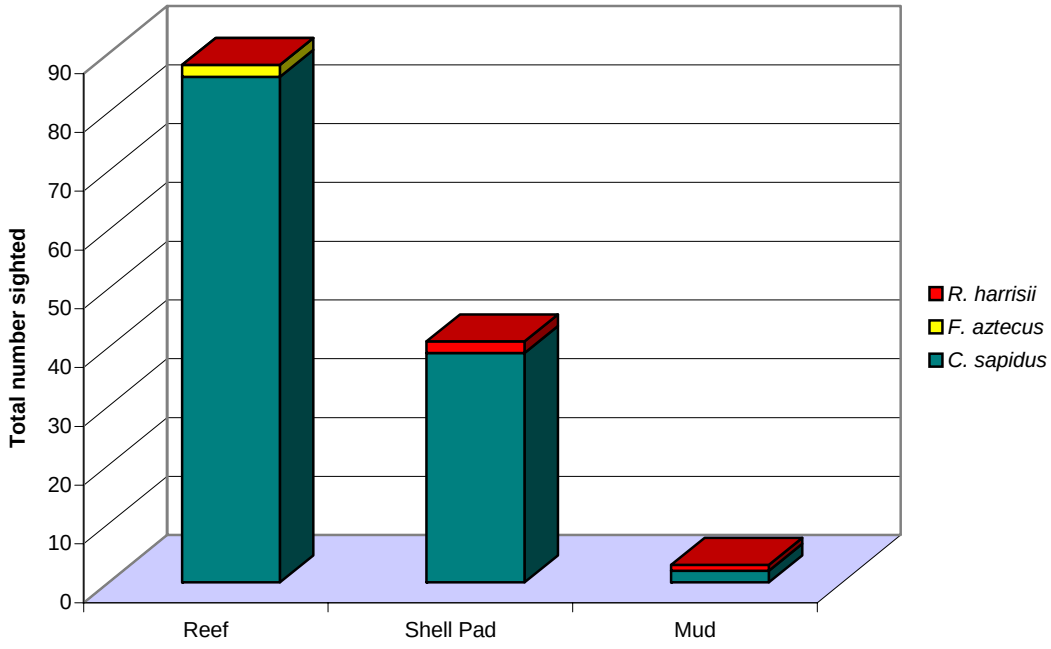

Figure 5. Comparison of species and abundances of mobile macroinvertebrates sighted at the Lake Pontchartrain artificial reef, shell pad, and mud-bottomed sites in 2005.

Of the mobile macroinvertebrates, the blue crab *Callinectes sapidus* was most prevalent (Figure 5). Ninety-six percent of all macroinvertebrate sightings were *C. sapidus*, of which 86 out of 127 (68%) were sighted at the artificial reef (Appendix D). Interestingly, out of 39 *C. sapidus* sighted on the shell pad, 32 were associated with additional non-natural structure including bricks, tires, pails, and other debris. On the reef site, cavities were observed in the substrate at the base of reef balls. These cavities were occupied and presumably dug by juvenile and adult *C. sapidus*. On 24 June 2005, four pairs of *C. sapidus* were observed in precopulatory or postcopulatory embraces (Bushmann 1991) inside reef balls, where the female was in an upright position cradled by the male (Figure 6). In July, evidence of *C. sapidus* ecdysis (molting) was also present on the south shore reefs. Many *C. sapidus* exoskeletons were found on the substrate inside and around reef balls in July.

Figure 6 – Blue crabs sighted in pre/postcopulatory pose at the H3 artificial reef site on 24 June 2005.

Gillnet sampling conducted on 22 July and 18 August 2005 did not yield many fish. On 22 July 2005 two gafftopsail catfish *Bagre marinus* were caught and on 18 August 2005 one Atlantic croaker *Micropogon undulatus* was caught. Weather and time constraints due to Hurricane Katrina restricted further experimentation of gillnet sampling methods on the artificial reefs, including direct deployment on the reefs with diver assistance (Poirrier 2005).

Discussion

Fish and mobile invertebrate surveys indicated that artificial reefs are productive fish and invertebrate habitats and with a higher diversity and abundance of fishes than the shell pad and natural mud-bottomed sites. Sheepshead *Archosargus probatocephalus*, southern flounder *Paralichthys lethostigma*, and blue catfish *Ictalurus furcatus* are important recreational species (O'Connell et al. 2005) and were regularly sighted at the reef. The presence of blue crabs *Callinectes sapidus*, a commercial fishery species for which Louisiana leads the US landings (NMFS 2002), was particularly interesting. *Callinectes sapidus* frequently occupied cavities at the base of reef balls and were observed in pre/postcopulatory positions. Molts were also found inside reef balls. Blue crab mating occurs in estuaries while the female is in a soft-shell state (Guillory et al. 2001) and habitat structural complexity minimizes predation risk during this vulnerable life stage (Hovel and Lipcius 2001). Structural habitat provided by the reefs may contribute to *C. sapidus* survival in Lake Pontchartrain. Further investigation into the contribution of the reefs to this fishery should be conducted.

Some recreationally important species that were not sighted during visual surveys include spotted seatrout *Cynoscion nebulosus*, sand seatrout *Cynoscion arenarius*, and red drum *Sciaenops ocellata* (O'Connell et al. 2005). These cryptic species may have heightened sensitivity to noises produced by divers (i.e. bubbles exiting regulators) and avoid detection. Although divers did not observe these species at the reef or elsewhere, anglers found they were present (see Fishing Activity). To account for this discrepancy, visual surveys were supplemented by gillnet sampling at the reefs. Gafftopsail catfish *Bagre marinus* and Atlantic croaker *Micropogon undulatus* were collected. Sampling effort was minimal due to sufficient data collection via visual census for most species. Hurricane Katrina also impacted experimentation of alternative gillnet techniques. One major drawback of the gillnet method used was that the net had to be placed adjacent to the reef rather than across it. Development of net sampling techniques where the net is deployed directly over artificial reefs would improve accuracy of reef survey effort in Lake Pontchartrain and worldwide.

An additional purpose of the visual surveys was to determine whether volunteers could be used to systematically monitor Lake Pontchartrain artificial reefs in the future. Based on data gathered, we determined it is feasible to utilize volunteers to conduct RDT-

style fish surveys and to monitor reef stability. Water clarity is usually high enough for reef surveys after three to five days of low wind conditions (less than 10 knots), especially in late summer. Implementation of a regular dive schedule may be helpful for coordinating volunteers, as it was difficult to assemble teams during brief windows of suitable visibility. In 2004, a list of around 50 divers interested in participating in Lake Pontchartrain artificial reef surveys was compiled. Many of these volunteers were active divers with the Aquarium of the Americas in New Orleans, LA and the Hammerhead Dive Club in Mandeville, LA. Several divers had assisted with deployment and early monitoring dives at the reef sites (Lopez 2004). A protocol for surveying the reefs using volunteers was developed based on methods used by the Reef Environmental Education Foundation (REEF). Pending authorization from REEF, Lake Pontchartrain will be added to REEF's list of Project Areas, which would allow current and future fish survey data to be submitted online and later accessed by the public. Public involvement in reef monitoring will encourage support and knowledge of the reefs, supplement key datasets on reef performance, and support a long-term monitoring program.

E.) FISHING ACTIVITY

One objective of the Lake Pontchartrain Artificial Reef Program is to enhance fishing opportunities in Lake Pontchartrain. Public awareness of lake resources generated through interaction with recreational uses is important for current and future lake restoration and protection. Documentation of recreational activity at the reef sites provides information on perception and performance of the reefs. Landings data from recreational anglers identifies species present at the reefs, including those not easily observed by divers during fish surveys. A goal of the first phase of monitoring was to identify effective methods for collecting information on recreational activity at the artificial reefs. Vessel observations and internet-based creel surveys were determined to be the most feasible in 2004 and carried out in 2005.

Methods

In early 2004, 15 X 35 binoculars were used to sight vessels and/or buoys at the south shore artificial reefs from the Williams Boulevard boat launch and Causeway Bridge. This method proved ineffective (Poirrier and Whitmore 2005). As an alternative, angler data was collected through internet-based creel surveys, interviews at fishing rodeos, and documentation of vessels at the reefs sites when researchers accessed the reefs to conduct monitoring activities. Number of vessels at each reef, type of recreation being conducted (i.e. fishing or diving), number of people present, and observed catch were recorded.

Anglers were interviewed at the Lake Pontchartrain Basin Foundation (LPBF) Fishing Rodeos on 29 and 30 May 2004 and 22 and 23 April 2005 at the Bonnabel Boat Launch in Metairie, Louisiana. Information was also solicited using the Internet sites: "Louisiana Fishing and Hunting" (http://rodnreel.com), "Louisiana Sportsman Magazine" (http://www.louisianasportsman.com), and "Fishing Louisiana" (http://www.fishinglouisiana.com), where anglers were asked to report on their fishing experiences at the Lake Pontchartrain artificial reefs. On 21 October 2004, a recreational fishing and diving survey (Appendix E) pertaining to the Lake Pontchartrain artificial reefs was posted on the LPBF website (http://saveourlake.org). This survey was also later posted on the Louisiana Fishing and Hunting website (http://rodnreel.com) from June 2005 through August 2005.

Results of Fishing Activity and Creel Surveys

Vessel Observations

A total of fifteen vessels were sighted at the Lake Pontchartrain artificial reefs during nine days of observation in 2004 (Appendix F). Fourteen of the fifteen contained anglers, one contained SCUBA divers who recreationally dove the south shore reefs. A total of ninety-six vessels containing 70 or more anglers were sighted during 18 days of observation in 2005 (Appendix F). Anglers were observed catching fish on October 28 2004, 27 April 2005, and 14 May 2005 including spotted sea trout *Cynoscion nebulosus*, Atlantic croaker *Micropogon undulatus*, and southern founder *Paralichthys lethostigma* (Appendix F).

Anglers were present at reefs on six out of nine days (67%) surveyed in 2004, and on 15 out of 18 (83%) days surveyed in 2005. At the south shore reefs, the total number of vessels per reef ranged from zero to five with an average of 0.6 ± 1.1 in 2004, and ranged from zero to eight with an average of 1.1 ± 1.3 in 2005. Commercial fishing activity was also noted at and around the south shore reefs in 2005 (Appendix F).

Fishing Rodeo Surveys

Six fishing activity surveys were collected at the 2004 LPBF Fishing Rodeo. Poor weather conditions limited angler turnout at this event. Of the anglers interviewed, all were aware of the artificial reefs but none had fished them during the Rodeo. Reasons included rough conditions on the lake, having fished the reefs earlier that week/month with no luck, and lack of transportation to the reefs. Three surveys were collected at the 2005 LPBF Fishing Rodeo. Windy conditions inhibited anglers from fishing the reefs because of their distance offshore. All interviewed knew of the reefs and had fished them in the past but not during the Rodeo.

Internet-based Creel Surveys

The Lake Pontchartrain Artificial Reef Recreational Fishing and Diving Survey (Appendix E) posted on the LPBF website in October 2004 generated two responses in 2004 (Appendix G). Nineteen surveys were submitted in 2005 from visitors to the LPBF and Louisiana Fishing and Hunting websites. Of the 21 total respondents, 17 reported that the reefs have enhanced recreational fishing in Lake Pontchartrain and five said the reefs have

enhanced diving opportunities as well. Fourteen respondents fished more in the past year than the previous as result of reef presence, and four people had dived more (Appendix G). Surveys indicated that sixteen respondents (76%) visited the south shore (Jefferson Parish) reefs, three visited the north shore (St. Tammany Parish) reef, and two visited the Orleans Parish artificial reef. Total time spent at each reef location was 43, 3.5, and 0.6 hours for the Jefferson (H1, H3, and H4), St. Tammany (N1), and Orleans reefs (L1), respectively. Seventeen of the respondents fished with hook and line, three spearfished, and the one diver did not fish. Individual respondents reported seeing from zero to 65 other anglers at the south shore reefs while fishing. The average number of other anglers sighted by any one respondent was 15 ± 15 adults and 2 ± 4 children.

The primary target species of most anglers was speckled trout (17 out 21 respondents). Eight anglers caught speckled trout. They landed between 10 to 35 speckled trout and averaged 21 ± 9 per vessel. All trout were caught at the south shore reefs, and anglers fished with a range of tackle including artificial lures and live shrimp. Other species caught by anglers at the south shore reefs included flounder (three respondents), sheepshead (three respondents), white trout (one respondent), and catfish (one respondent) (Appendix G). Hardhead and gafftopsail catfish were caught at the north shore reef (one respondent). No fish were caught at the Orleans reef.

Problems encountered by anglers at the reefs included fishing tackle losses (eight respondents), trouble locating reefs (five respondents), and crowded conditions at the reefs (four respondents). In the open-ended section of the survey, respondents commented on a variety of topics including requests for a diagram depicting reef and buoy orientation, missing buoys, safety at the reef sites when divers are present, and vessel crowding (Appendix G).

Discussion

Vessel observations indicated that significant recreational activity including both fishing and diving has been taking place at the Lake Pontchartrain artificial reefs. An increase in activity was observed from 2004 to 2005. The internet-based creel survey generated important data on fish presence and angler experiences at the artificial reefs sites. Although not regularly sighted during underwater fish surveys, spotted seatrout were landed by anglers. As a component of the evaluation, it was evident that the internet-based survey can be used to

monitor reef performance and recreational user preferences and experiences. Problems that might otherwise have gone unnoticed were evident in the surveys such as confusion about reef size and orientation relative to the buoy and difficulty interpreting or errors in the format of published coordinates. Relative to respondent concerns, we observed anglers mooring to reef buoys. This causes the buoy to be dragged off-center and/or offsite and later contributes to confusion about reef/buoy orientation. Signage at boat launches and greater public outreach will likely reduce occurrence of these issues. Overall, reef satisfaction appears high. Most respondents indicated the reefs have enhanced fishing and diving opportunities in Lake Pontchartrain and many felt positively about expanding the program.

CONCLUSIONS

Data collected during this two-year evaluation demonstrate that Lake Pontchartrain artificial reef performance has been consistent with expectations. Macroinvertebrates and benthic fishes have begun colonizing available hard substrate, recreationally important fish species have been observed by divers and caught by anglers, and commercially important blue crabs have also been sighted at the reefs. Reef development has expanded fishing and diving opportunities in the lake and the public has responded by recreating there.

Lake Pontchartrain, the largest oligohaline estuary in the southeastern U.S. (Moore 1992) is essential habitat for many of Louisiana's coastal fisheries (Penland et al. 2002). Coastal estuaries are the most productive and commercially important fisheries habitats worldwide (Boesch et al. 1994, Chesney et al. 2000, Demers et al. 2000). Despite their importance, they are also among the most endangered and altered aquatic habitats. Lake Pontchartrain has undergone major improvements in environmental quality over the last few decades due to restoration and revitalization efforts (Abadie and Poirrier 2001, Bourgeois-Calvin et al. 2004, LPBF 2005). The Lake Pontchartrain Artificial Reef Program has fostered awareness of these improved conditions and lake resources. Study of the reefs has generated fundamental background on artificial reef performance in low-salinity estuaries and may be used to assess the efficacy of future estuarine artificial reef development.

ACKNOWLEDGMENTS

We thank Mr. Carlton Dufrechou, Dr. John Lopez, and Mr. Mark Schexnayder for their assistance and support, and the Lake Pontchartrain Basin Foundation for funding for this study. We also thank divers Chip Crews, Ashley Walker, William Whitmore, Ryan Poirrier, Elizabeth Spalding, Les Dauterive, and Herb Leety for their help with reef monitoring.

LITERATURE CITED

Abadie, W. and M. Poirrier. 2001. Increased density of large *Rangia* clams in Lake Pontchartrain after the cessation of shell dredging. *Journal of Shellfish Researc*h 19:481-485.

Anderson, M.J. 1996. A chemical cue induces settlement of Sydney rock oysters, *Saccostrea commercialis*, in the laboratory and in the field. *Biological Bulletin of the Marine Laboratory, Woods Hole* 190:350-358.

Baynes, T.W. and A.M. Szmant. 1989. Effect of current on the sessile benthic community structure of an artificial reef. *Bulletin of Marine Science* 44:545-566.

Bell, M., M. Buchanan, J. Culbertson, J. Dodrill, R. Kasprzak, R. Lukens, and W. Tatum. 1997. Guidelines for marine artificial reef materials. Gulf States Marine Fisheries Commission. 123 p.

Boesch, D.F., M.N. Josselyn, A.J. Mehta, J.T. Morris, W.K. Nuttle, C.A. Simmestad, D.P. Swift. 1994. Scientific assessment of coastal wetland loss, restoration, and management in Louisiana. *Journal of Coastal Research* 20:1-103.

Bohnsack, J.A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? *Bulletin of Marine Science* 44:631-645.

Bohnsack, J.A., A.M. Ecklund, and A.M. Szmant. 1997. Artificial reef research: Is there more than the attraction-production issue? *Fisheries* 22:14-16.

Bohnsack, J.A. and D.L. Sutherland. 1985. Artificial reef research: a review with recommendations for future priorities. *Bulletin of Marine Science* 37:11-39.

Bohnsack, J.A., D.L. Johnson, and R.F. Ambrose. 1991. Ecology of artificial reef habitats and fishes. Pp 61-107. *In:* W. Seaman, Jr. and L.M. Sprague (eds.). *Artificial Habitats for Marine and Freshwater Fishes*. Academic Press, New York.

Bortone, S.A., M.A. Samoilys, and P. Francour. 2000. Fish and macroinvertebrate evaluation methods. *In:* Seaman, W. (ed.) *Artificial Reef Evaluation with Application to Natural Marine Habitats*. CRC Press, Boca Raton, pp. 1-20.

Brock, R.E. 1982. A critique of the visual census method for assessing coral reef fish populations. *Bulletin of Marine Science* 32:269-276.

Bourgeois-Calvin, A., J. Mastrototaro, S.L. Briuglio. 2004. A non-profit approach to addressing the effects of urbanization in the Lake Pontchartrain Basin, Louisiana. *Urban Ecosystems* 7:157-167.

Brusca, R. and G. Brusca. 1990. *Invertebrates*. Sinauer Associates Inc., Sunderland, Massachusetts pp. 198-200.

Buckeridge, J. Interim Report on the Artificial Reef. November 2002. Earth and Oceanic Science Research Centre, Auckland University of Technology. Accessed 13 January 2005 from http://www.artificialreefs.org/ScientificReports/NewZealand/htm

Bushmann, P.J. 1991. Concurrent signals and behavioral plasticity in blue crab (*Callinectes sapidus* Rathbun) courtship. *Biological Bulletin* 197:63-71.

Christian, R. F. Steimle, and R. Stone. 1998. Evolution of marine artificial reef development – a philosophical review of management strategies. *Gulf of Mexico Science* 1:32-36.

Demers, E., S.B. Brandt, K.L. Barry, and J.M. Jech. 2000. Spatially explicit models of growth rate potential: linking estuarine fish production to the biological and physical environment, pages 405-425. *In:* J.E. Hobbie, (ed.). Estuarine Science: *A Synthetic Approach to Research and Practice*. Island Press.

Eklund, A.M. 1997. The importance of post-settlement predation and reef resources limitation on the structure of reef fish assemblages. *Proceedings of the 8th International Coral Reef Symposium* 2: 1130-1142.

EPA (Environmental Protection Agency). Reef Ball – Punta Gorda Waterfront Juvenile Fisheries Habitat Project. Accessed 13 January 2005 from http://www.artificialreefs.org/Articles/PuntaGorda.htm

Guillory, V., H.M. Perry, and S.J. VanderKooy. 2001. The blue crab fishery of the Gulf of Mexico, United States: A regional management plan. Ocean Springs, Mississippi: Gulf States Marine Fisheries Commission.

Hovel, K.A. and R.N. Lipcius. 2001. Habitat fragmentation in a seagrass landscape: patch size and complexity control blue crab survival. *Ecology* 82:1814-1829.

Junot, J., M. Poirrier, and T. Soniat. 1983. Effects of saltwater intrusion from the Inner Harbor Navigation Canal on the benthos of Lake Pontchartrain, Louisiana. *Gulf Research Reports* 7:247-254.

Kasprzak, R.A. 1998. Use of oil and gas platforms as habitat in Louisiana's Artificial Reef Program. *Gulf of Mexico Science* 1:37-45.

Lindquist, D.G. and L.J. Pietrafesa. 1989. Current vortices and fish aggregations: The current field and associated fishes around a tugboat wreck in Onslow Bay, North Carolina. *Bulletin of Marine Science* 44:533-544.

Lopez, J. 2004. The Lake Pontchartrain Artificial Reef Program Deployment from 2000 to 2004. Final Report submitted to the Lake Pontchartrain Basin Foundation and Louisiana Department of Wildlife and Fisheries, 70p.

Louisiana Department of Wildlife and Fisheries. Louisiana Artificial Reef Program. Accessed 20 February 2005 from http://www.wlf.state.la.us/apps/netgear/index.asp?cn=lawlf

LPBF (Lake Pontchartrain Basin Foundation). Accessed 15 November 2005 from http://saveourlake.org/index.htm

LPARWG (Lake Pontchartrain Artificial Reef Working Group). Lake Pontchartrain Artificial Reef Program brochure. February 2004. Lake Pontchartrain Basin Foundation and members of the Lake Pontchartrain Artificial Reef Working Group, 2p.

LUMCON (Louisiana Universities Marine Consortium). LUMCON Weather Archive Data for Lake Pontchartrain. Accessed 24 January 2004 from http://weather.lumcon.edu/archivedata/select.asp.

LUMCON (Louisiana Universities Marine Consortium). LUMCON Weather Data Archive. Accessed 20 January 2005 from http://weather.lumcon.edu/archivedata/select.asp.

Martin, T.R. and S.A. Bortone. 1997. Development of an epifaunal assemblage on an estuarine artificial reef. *Gulf of Mexico Science* 2:55-70.

Miller, M.W. and A. Falace. 2000. Evaluation methods for trophic resource factors – nutrients, primary production, and associated assemblages. *In:* W. Seaman, Jr. (ed.). *Artificial Reef Evaluation with Application to Natural Marine Habitats*. CRC Press, Boca Raton.

Moore, R.H. 1992. Low-salinity backbays and lagoons. *In:* Hackney, C.T., S.M. Adams, and W.H. Martin (eds.). *Biodiversity of the Southeastern United States: Aquatic Communities*. New York: Wiley, pp. 541-614.

NMFS. 2002. Fisheries of the Unites States, 2001. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

NOAA (National Oceanic Atmospheric Administration), National Weather Service, National Hurricane Center. Tropical Weather Summary. Accessed 8 November 2004 from http://www.nhc.noaa.gov/archive/2004/tws/MIATWSAT_sep.shtml

NOAA (National Oceanic Atmospheric Administration), National Hurricane Center, Tropical Prediction Center. 2005 Atlantic Hurricane Season. Accessed 23 January 2005 from http://www.nhc.noaa.gov/2005atlan.shtml

O'Connell, M.T., C.D. Franze, E.A. Spalding, and M.A. Poirrier. 2005. Biological resources of the Louisiana coast: Part 2, coastal animals and habitat associations. *Journal of Coastal Research* SI44:146-161.

Pattengill-Semens, C. and B. Semmens. 1998. An analysis of fish survey data generated by nonexpert volunteers in the Flower Garden Banks National Marine Sanctuary. *Gulf of Mexico Science* 2:196-207.

Penland, S., A. Beall, and D. Maygarden. 2002. Environmental status and trends of the Lake Pontchartrain Basin. *In*: S. Penland, A. Beall, and J. Kinder (eds.) *Environmental Atlas of Lake Pontchartrain*. USGS Open File Report 02-206.

Perry, H. K. Larson, J. Warren, and C. Trigg. 2001. Seasonal colonization of low profile artificial reefs in Mississippi coastal waters: Invertebrates. *Proceedings of the 52nd Annual Gulf and Caribbean Fisheries Institute* 52:498-511.

Poirrier, M.A. 1978. Studies of salinity stratification in southern Lake Pontchartrain near the Inner Harbor Navigation Canal. *Proc. of the Louisiana Academy of Sciences* 41:26-35.

Poirrier, M.A. 1984. An Identification Guide to the Macroscopic Invertebrates of the Lake Pontchartrain Estuary, Louisiana. Louisiana Department of Environmental Quality, Water Pollution Control Division, 47 p.

Poirrier, M.A. 2001. Lake Pontchartrain Artificial Reef Evaluation Program Quality Assurance Project Plan. Estuarine Research Laboratory, Department of Biological Sciences, University of New Orleans, Louisiana, 24 p.

Poirrier, M.A. 2004. Lake Pontchartrain Artificial Reef Evaluation Proposal. Submitted to the Lake Pontchartrain Basin Foundation, 5 p.

Poirrier, M.A. 2005. Lake Pontchartrain Artificial Reef Evaluation Proposal. Submitted to the Lake Pontchartrain Basin Foundation, 6 p.

Poirrier, M.A. and J.E. Sinclair. 2002. Lake Pontchartrain Artificial Reef Evaluation Program. Final report to the Lake Pontchartrain Basin Foundation, 13p.

Poirrier, M.A. and K.A. Whitmore. 2005. Lake Pontchartrain Artificial Reef Evaluation Program: June through December 2004 results. Submitted to the Lake Pontchartrain Basin Foundation, 29 p.

RBDG (Reef Ball Development Group, Ltd). 2002. Internet Brochure. The Reef Ball Foundation Inc. Services Division. Accessed 10 January 2005 from http://www/reefball.com/reef/htm.

REEF (Reef Environmental Education Foundation). REEF's Fish Survey Project. 2002. Accessed 12 January 2005 from http://reef.org/data/surveyproject.thm.

Relini, G., M. Relini, G. Torchia, and G. de Angelis. 2002. Trophic relationships between fishes and an artificial reef. *ICES Journal of Marine Science* 59:S36-S42.

Roehl, E. and L. Harris. 1996. Stability analysis of Reef Ball artificial reef units. Florida Institute of Technology Wave Tank and Stability Analysis. Report prepared for Reef Ball Development Group Ltd. Accessed 16 December 2004 from http://www.reefball.org/stab.htm.

Schmitt, E. and K. Sullivan. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. *Bulletin of Marine Science* 59:404-416.

Seaman, W and A. Jensen. 2000. Purposes and practices of artificial reef evaluation. *In:* Seaman, W. (ed) *Artificial Reef Evaluation with Application to Marine Habitats*. CRC Press, Boca Raton, pp. 1-20.

Serviss, G. and S. Sauers. 2003. Sarasota Bay Juvenile Fisheries Habitat Assessment. Final Report to the Sarasota Bay National Estuary Program, 212p.

Sheng, Y.P. 2000. Physical characteristics and engineering at reef sites. *In:* W. Seaman, Jr. (ed.). *Artificial Reef Evaluation with Application to Natural Marine Habitats*. CRC Press, Boca Raton.

Steimle, F., K. Foster, R. Kropp, and B. Conlin. 2002. Benthic macrofauna productivity enhancement by an artificial reef in Delaware Bay, USA. *ICES Journal of Marine Science* 59:S100-S105.

Stephens, J. and D. Pondella. 2002. Larval productivity of a mature artificial reef: the ichthyoplankton of King Harbor, California, 1974 – 1997. *ICES Journal of Marine Science* 59:51-58.

Suprenant, B.A. 2001. Designing concrete for exposure to seawater. *Concrete Construction.*

Turpin, R.K. and S.A. Bortone. 2002. Pre- and post-hurricane assessment of artificial reefs: evidence for potential use as refugia in a fishery management strategy. *ICES Journal of Marine Science* 59:74-82.

USGS (United States Geological Survey). USGS Real-Time Water Data for station USGS 073802331 (COE) Lake Pontchartrain at West End, Louisiana. U.S. Army Corps of Engineers, New Orleans District. Accessed 10 January 2005 from http://nwis.waterdata.usgs.gov/la/nwis/dv?format=html&period=130&site_no=073802

Walker, B.K., B. Henderson, and R.E. Spieler. 2002. Fish assemblages associated with artificial reefs of concrete aggregates or stone quarry offshore Miami Beach, Florida, USA. *Aquatic Living Resources* 15:95-105.

Wilding, T.A. and M.D.J. Sayer. 2002. Evaluating artificial reef performance: approaches to pre- and post-deployment. *ICES Journal of Marine Science* 59:S222-S230.

Wilson, C.A., V.R. Van Sickle, D.L. Pope. 1987. Louisiana Artificial Reef Plan. Louisiana Sea Grant College Program, Louisiana State University, Baton Rouge, Louisiana. Louisiana Department of Wildlife and Fisheries Technical Bulletin No. 41. 143 p.

Zalmon, I.R., R. Novelli, M.P. Gomes, and V.V. Faria. 2002. Experimental results of an artificial reef programme on the Brazilian coast of north Rio de Janeiro. *ICES Journal of Marine Science* 59:83-87.

Personal Communications

Lane, M. Publisher, Louisiana Fishing and Hunting website (http://rodnreel.com). 16 Nov 04.

Ronnie. Lake Pontchartrain commercial blue crab fisherman. 10 Aug. 2005.

Raulerson, G. Sr. Environmental Scientist, Sarasota Bay National Estuary Program. 12 Jan04.

Appendix A. Log of dives made at the Lake Pontchartrain artificial reefs and reference sites in 2004 and 2005.

Reference	**Reef Site Descriptions:**	**Locations:**	**Diver Affiliations:**
	H3 - Monitoring Site - South Shore	N 30° 05.034' W 090° 12.582'	**UNO** - University of New Orleans
	H1 - South Shore	N 30° 05.028' W 090° 12.096'	**NOAA** - National Oceanic Atmospheric Administration
	H4 - South Shore	N 30° 05.274' W 090° 12.336'	**AOA** - Aquarium of the Americas, New Orleans
	N1 - North Shore	N 30° 16.296' W 090° 03.753'	**LPBF** - Lake Pontchartrain Basin Foundation
			MMS - Minerals Management Service

2004			
Dive #1	**Date:** 7/1/04 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** ~8ft **Purpose:** Observation **Approx. Bottom Time:** 80 min **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) Michael Poirrier (UNO) Chip Crews (UNO)	**Algae:** *Anabaena* sp. bloom from surface to 3 m Green algae on balls (1-2 cm long) **Invertebrates:** *Balanus* sp. only in small crevices on balls *Congeria* clams only in small crevices on balls Box oysters (dead) 7-12 cm **Fishes:** *Gobiosoma bosci* ball surfaces *Archosargus probatocephalus* around & inside balls *Hypsoblennius* sp. on surface of balls *Caranx hippos* (~0.8 m in length) around balls *Mugil cephalus* on surface water above balls feeding	**Notes:** Very little invertebrate colonization on reef balls Sediment covering surface of balls 0.1 in thick. Cleaned off plates of some balls to read. Measured strip width to be ~35 ft. Buoy w/in reefballs on southwestern flank. Balls in pairs, pallet on inside, bay on outside.
Dive #2	**Date:** 7/5/04 **Site:** H3 **Vessel:** Cape Horn (LPBF) **Visibility:** ~8ft **Purpose:** Observation, Site Scouting **Approx. Bottom Time:** 75 min **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) Kenny Ripberger (AOA) Les Dauterive (AOA) John Lopez (LPBF) Herb Leety (Hammerheads & MMS)	**Algae:** *Anabaena* sp. bloom from surface to 3 m Green algae on balls (1-2 cm long) **Invertebrates:** River shrimp (*Macrobranchium ohion*) inside balls *Congeria* only in small crevices on balls *Ishadium* on shell pad 4-7 cm **Fishes:** *Ictalurus furcatus* inside ball *A. probatocephalus* around and inside balls *G. bosci* on ball surface *Hypsoblennius* sp. on ball surface *M. cephalus* on surface water above balls feeding	**Notes:** Moved buoy back toward center of shell pad. Measured strip width to be 30-40 ft. Distance between balls ranges 5-15 ft. Usually one row pallet, two rows of bay balls cross through strip. Leety & Dautrive circumnavigated entire reef - documented 6 crooked balls (2 pallet, 4 bay) Surface temperature 86°F, bottom temperature 82°F Overturned or crooked balls: 211P (w), 230 (nw), 538 (n), 540 (n), 580 (ne), 557 (nw)
Dive #3	**Date:** 7/10/04 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** 7ft (Secchi) **Purpose:** Quadrant Set-up **Approx. Bottom Time:** 79 min **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) Michael Poirrier (UNO)	**Algae:** Surface algal bloom gone **Invertebrates:** *Callinectes sapidus* underneath balls **Fishes:** *A. probatocephalus* (~0.1-0.2 m in length)	**Notes:** Marked south quadrant using rebar. Hammered in 5 ft PVC ~2.5 ft through shell to mark corners. Marked south and west sides of quadrant with flagging tape. Caught by storm, could not finish distance measurements between poles and balls in quadrant. Received updated deployment report from J. Lopez.

	Ryan Poirrier (UNO)		
Dive #4	**Date:** 7/11/04 **Site:** H3 **Vessel:** Cape Horn (LPBF) **Visibility:** ~7ft **Purpose:** Quadrant Set-up **Approx. Bottom Time:** 103 min **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) Les Dautrive (AOA) John Lopez (LPBF)	**Algae:** **Invertebrates:** *Callinectes sapidus* underneath balls **Fishes:** *A. probatocephalus* (~0.1-0.2 m in length) *M. cephalus* on surface water above balls feeding	**Notes:** Finished south quadrant setup. Marked sides with flagging tape. Measured distances of reef balls to corner poles and to each other underwater w/ 50 m Kenson vinal tape. 10 balls total, 4 pallet balls and 6 bay balls. Received side scan sonar map and images on cd from J. Lopez.
Dive #5	**Date:** 7/22/04 **Site:** H4 **Vessel:** Aquarium of Americas boat **Visibility:** ~5ft **Purpose:** Site scouting, observation **Approx. Bottom Time:** 50 min **Divers:** Kelly Whitmore (UNO) Giulia Hammans (AOA) Brian (AOA) Rich Toth (AOA) Boat Driver	**Algae:** Duckweed on surface (*Lemna*) **Invertebrates:** *Callinectes sapidus* underneath balls **Fishes:** *A. probatocephalus* (~0.2-0.4 m in length) *G. bosci* on ball surface *M. cephalus* on surface water above balls feeding	**Notes:** First look at site. No balls found on eastern side of the reef. Balls on west packed tightly together, few overturned/crooked. 3-4 anchors caught in the balls. Visibility low, but workable. 6-8 balls no longer had ID plates .
Dive #6	**Date:** 7/28/04 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** ~1ft **Purpose:** Set up quadrant **Approx. Bottom Time:** 12 min **Divers:** Kelly Whitmore (UNO) Beth Spalding (UNO) William Whitmore (NOAA) Chip Crews (UNO) Boat Driver	**Algae:** Duckweed on surface (*Lemna*) **Invertebrates:** **Fishes:**	**Notes:** Poor visibility (~1ft). Could not set up northern quadrant. Took water quality on shell pad and in reefball area. Cleaned sediment off two balls; 507 & 509. No sightings due to poor visibility.
Dive #7	**Date:** 8/4/04 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** 6 ft (Secchi) **Purpose:** Set up northern quadrant **Approx. Bottom Time:** 150 min **Divers:** Kelly Whitmore (UNO) Ashley Walker (UNO) Chip Crews (UNO)	**Algae:** **Invertebrates:** Remnants of barnacles on balls *Congeria* only in small crevices on balls *Callinectes sapidus* underneath balls **Fishes:** *A. probatocephalus* around and inside balls *G. bosci* on ball surface *Hypsoblennius* sp. on and under balls	**Notes:** Placed 4 PVC pipes in shell/mud to mark movement-monitoring area in the northern section of the H3 reef site. Area is approximately 40x40 ft enclosing 15 reefballs. Visibility was good. Sunny, calm conditions.
Dive #8	**Date:** 8/27/04 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** 6 ft (Secchi) **Purpose:** Finish measurements	**Algae:** **Invertebrates:** **Fishes:** *A. probatocephalus* around and inside balls *G. bosci* on ball surface - fewer than earlier dives	**Notes:** Took measurements on upside-down ball and surrounding balls in the center of north quadrant plot. Visibilty wasn't good enough for new photos. Short dive due to class.

	Approx. Bottom Time: 55 min **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO)		Small buoy marking plot was gone.
Dive #9	**Date:** 10/28/2004 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** 4.5 ft (Secchi) **Purpose:** Repeat measurements **Approx. Bottom Time:** 150 min **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) Michael Poirrier (UNO)	**Algae:** **Invertebrates:** Hydroids up to 7 cm long Freshwater sponge growth w/in 0.3 m of bottom Bryozoans underneath sponge layer Sponges had gemmules **Fishes:** *Anchoa* sp. schooling at surface and around balls *Hypsoblennius* sp. under balls in holes *I. punctatus* (~0.5 m) inside ball *M. cephalus* on surface water and around balls	**Notes:** Repeated all ball measurements for southern quadrant on H3 site. Balls were present within .15m of the original measurements. 5 boats of fishers fishing, one catching many speckled trout Did not have time to check northern quadrant plot. Took scrape samples of invertebrates. More growth on balls than ever seen before, but still minimal.

2005			
Dive #1	**Date:** 14 May 2005 **Site:** H3 **Vessel:** C-Hawk (UNO) **Visibility:** 5 ft (Secchi) **Purpose:** Inspect invert growth **Approx. Bottom Time:** 35 min (70 total) **Divers:** Kelly Whitmore (UNO) William Whitmore (NOAA) **Boat Driver:** Michael Poirrier (UNO)	**Algae:** *None observed in water column or on reef balls* **Invertebrates:** *Hydroids on balls - some long up to ~6 in upper part* of balls *Small barnacles in some areas - not abundant* **Fishes:** *Gobiosoma bosci* *Hypsoblennius iothonas*	**Notes:** First dive of the season Greater epifaunal growth than previous summer and fall. Sediment layer on balls where hydroids were not present. In some locations small barnacles present around top hole of reef balls Took scrape samples
Dive #2	**Date:** 17 May 2005 **Site:** Oil/Gas Rid ~2 mi E of S reefs **Vessel:** Proline (UNO) **Visibility:** 2.5 ft (Secchi) **Purpose:** Inspect invert growth **Approx. Bottom Time:** 15 min (45 total) **Divers:** Kelly Whitmore (UNO) Ashely Walker (UNO) Chip Crews (UNO)	**Algae:** *None observed on pilings* **Invertebrates:** *Hydroids ~2-3 in long in patches most dense @ 5ft* *Barnacles* **Fishes:** *None observed*	**Notes:** Inspected wood pilings Other than barnacles and hydroids, no other sessile inverts present Growth not very different from that seen on reef balls in previous dive Took scrape samples
Dive #3	**Date:** 17 May 2005 **Site:** Causeway pilings E/SE of S reefs **Vessel:** Proline **Visibility:** 2.5 ft **Purpose:** Inspect invert growth **Approx. Bottom Time:** 12 min (36 total) **Divers:** Kelly Whitmore (UNO) Ashely Walker (UNO) Chip Crews (UNO)	**Algae:** *None observed on pilings* **Invertebrates:** *Large barnacles covering pilings except bottom* *Hydroids almost non-existent, small patches 2x3 in* around 5-8 ft **Fishes:** *None observed on pilings*	**Notes:** Less hydroid growth than on reef balls and wood pilings Took scrape samples

Dive #4	**Date:** 2 June 2005 **Site:** H3 & mud **Vessel:** C- Hawk **Visibility:** 6 ft **Purpose:** Fish Survey **Approx. Bottom Time:** 40 min (80 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) **Boat Driver:** William Whitmore (NOAA)	**Algae:** **Invertebrates:** *Callinectes sapidus* **Fishes:** *Gobiosoma bosci* *Archosargus probatocephalus*	**Notes:** 15 min fish surveys Chip & Kelly at H3 reef and mud GPS not working - couldn't survey shell pad Weather: very calm ~1 knot wind
Dive #5	**Date:** 3 June 2005 **Site:** H1 & shell pad & mud **Vessel:** C-Hawk **Visibility:** 6 ft **Purpose:** Fish survey **Approx. Bottom Time:** 70 min (280 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) William Whitmore (UNO) Chad Ellinwood (UNO)	**Algae:** **Invertebrates:** *Callinectes sapidus* **Fishes:** *Archosargus probatocephalus* *Gobiosoma bosci* *Paralichthys lethostigma*	**Notes:** For detailed fish survey information see fish survey list Conducted two 10 min surveys per diver team per area: mud, shell pad, and reef (H1) Underwater visibility - horizontal secchi 4.5 ft
Dive #6	**Date:** 9 June 2005 **Site:** H3 **Vessel:** C-Hawk **Visibility:** 4 ft **Purpose:** Take measurements of balls **Approx. Bottom Time:** 140 min (420 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) Ashley Walker (UNO)	**Algae:** **Invertebrates:** **Fishes:** *Archosargus probatocephalus* *Mugil cephalus*	**Notes:** Took measurements on northern movement monitioring plot of H3 Not as much hydroid growth as seen at the southern plot Some algal growth on balls Many missing ID tags - 3 that had had them last year were gone Large mullet around reef balls ~12-14 in
Dive #7	**Date:** 18 June 2005 **Site:** H3 **Vessel:** C-Hawk **Visibility:** 5 ft **Purpose:** Blue crab survey **Approx. Bottom Time:** 65 min (130 total) **Divers:** Kelly Whitmore (UNO) Ashley Walker (UNO)	**Algae:** *Some short green algae on some balls* **Invertebrates:** *2 Callinectes sapidus* *Hydroids* *Balanus* **Fishes:** *Myrophis punctatus* speckled worm eel 7" *Archosargus probatocephalus* *Carnax hippos*	**Notes:** Visibility was not good enough for fish surveys, conducted blue crab burrow survey instead - around base of reef balls
Dive #8	**Date:** 23 June 2005 **Site:** H3, H, mud **Vessel:** C-Hawk **Visibility:**	**Algae:** **Invertebrates:**	**Notes:** Two 10 min surveys by each pair at each site. Great visibility

	Purpose: Fish survey **Approx. Bottom Time:** 80 min (320 total) **Divers:** Kelly Whitmore (UNO) William Whitmore (UNO) Chip Crews (UNO) Ashley Walker (UNO)	*Callinectes sapidus* **Fishes:** *Archosargus probatocephalus*	
Dive #9	**Date:** 24 June 2005 **Site:** H3, H, mud **Vessel:** C-Hawk **Visibility:** 9 ft (Secchi) **Purpose:** Fish survey **Approx. Bottom Time:** 75 min (300 total) **Divers:** Kelly Whitmore (UNO) Mark Schexnayder (LSU Ag Center) Ryan Poirrier (UNO) Ashley Walker (UNO)	**Algae:** **Invertebrates:** *Callinectes sapidus* *Hydroids* *Rhithropanopeus harrisii* **Fishes:** *Ictalurus furcatus* *Archosargus probatocephalus* *Lagodon rhomboides* *Anguilla rostrata* *Gobiosoma bosci* *Hypsoblennius iothonas*	**Notes:** Two 10 min surveys by each pair at each site. Great visibility Crabs observed mating - 4 pairs of male and female inside balls Many molts of juvenile crabs found around base of balls
Dive #10	**Date:** 30 June 2005 **Site:** H3, H, mud **Vessel:** C-Hawk **Visibility:** 6 ft (Secchi) **Purpose:** Fish survey **Approx. Bottom Time:** 70 min (280 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) Ashley Walker (UNO) Beth Spalding (UNO)	**Algae:** **Invertebrates:** *Callinectes sapidus* *Spongilla alba* **Fishes:** *Gobiosoma bosci*	**Notes:** Two 10 min surveys by each pair at each site. Visibility back to "normal"
Dive #11	**Date:** 4 August 2005 **Site:** H3, H, mud **Vessel:** C-Hawk **Visibility:** 7.5 ft (Secchi) **Purpose:** Fish survey **Approx. Bottom Time:** 70 min (280 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) Ashley Walker (UNO) Ryan Poirrier (UNO)	**Algae:** **Invertebrates:** *Callinectes sapidus* *Spongilla alba* **Fishes:** *Carnax hippos* *Myrophis puncatus* *Lagodon rhomboides* *Gobiosoma bosci & Hypsoblennius iothonas* *Archosargus probatocephalus*	**Notes:** Two 10 min surveys by each pair at each site. Balls covered in soft, velvety organic matter. Took sample for analysis. Live sponge on some balls. Fewer crabs sighted than in late June but still many holes under reef balls
Dive #12	**Date:** 5 August 2005 **Site:** H, H3, mud **Vessel:** C-Hawk **Visibility:** 11 ft	**Algae:** **Invertebrates:**	**Notes:** Two 10 min surveys by each pair at each site. Excellent visibility but few fishes sighted

	Purpose: Fish survey **Approx. Bottom Time:** 70 min (280 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO) Ashley Walker (UNO) William Whitmore (NOAA)	*Callinectes sapidus* **Fishes:** *Lagodon rhomboides*	No juvenile flounder sighted unlike earlier in the season
Dive #13	**Date:** 16 August 2005 **Site:** H, H3, mud **Vessel:** C-Hawk **Visibility:** 10.5 **Purpose:** Fish survey **Approx. Bottom Time:** 90 min (320 total) **Divers:** Kelly Whitmore (UNO) Ashely Walker (UNO) Chip Crews (UNO) Ryan Poirrier (UNO)	**Algae:** **Invertebrates:** *Balanus* *Callinectes sapidus* **Fishes:** *Gobisox strumosus* *Hypsoblennius iothonas* *Lagodon rhomboides* *Gobiosoma bosci*	**Notes:** Good visibility over shell and reef but not over mud Few fishes sighted Small barnacles starting to colonize on upper portion of some balls Deployed barnacle substratum from Bayou St. John - took pics of coverage No surface algal blooms Dead pogies in 17th st canal and at west end boat launch
Dive #14	**Date:** 18 August 2005 **Site:** H1 **Vessel:** C-Hawk **Visibility:** night - est. 8-10 ft **Purpose:** Fish survey **Approx. Bottom Time:** 25 min (50 total) **Divers:** Kelly Whitmore (UNO) Chip Crews (UNO)	**Algae:** **Invertebrates:** *Callinectes sapidus* **Fishes:** *Gobisox strumosus 2 - 3"* *Gobiosoma bosci* *American eel - 3 - 15"*	**Notes:** Night gillnet sampling - no recovered catch (1-1" croaker in mud, 1-13" unidentified fish fell out over shell, catfish slime over reef) Night dive American eels coming out from under balls, along with many large (5-7 in) blue crabs - saw 23, one 1" blue crab all coming out from holes dug under reef balls large skilletfish on balls w/ naked gobies no large fish sighted
Dive #15	**Date:** 21 August 2005 **Site:** N1 **Vessel:** Glacier Bay (Mike's boat) **Visibility:** 6 ft **Purpose:** Invert samples **Approx. Bottom Time:** 50 min (120 total) **Divers:** Kelly Whitmore (UNO) Willie Whitmore (UNO) Ryan Poirrier (UNO)	**Algae:** **Invertebrates:** *hydroids* *Spongilla alba* **Fishes:** *Gaspergou* *Gobiosoma bosci* *Hypsoblennius iothonas* *Archosargus probatocephalus*	**Notes:** North Shore dive Took invertebrate scrape samples - ~80% cover of hydroids and sponge, no barnacles or other bivalves Fish survey - 10 minutes 6 - 5 x 5 cm scrapes from random areas of balls 1 overall sample Gemules in sponge samples

Appendix B. Water quality measurements taken at the Lake Pontchartrain artificial reefs and reference sites in 2004 and 2005.

Date Time	Site	Location	Depth	DO % Saturation	DO (mg/L)	Salinity (ppt)	Temp. (deg C)	Secchi Depth (ft)	Notes	Equipment
2004										
7/28/2004	H3	Reef	Surface	114.0	8.60	2.3	30.2	1		YSI-85
		Reef	Near-bottom (11ft)	98.5	7.20	2.3	29.7			
7/28/2004	H3	Shell pad	Surface	112.5	8.60	2.3	30.2	1		YSI-85
		Shell pad	Near-bottom (11ft)	97.0	7.33	2.3	29.7			
8/27/2004	H3	Reef	Surface	101.1	7.32	2.9	31.9	6		YSI-85
		Reef	Near-bottom (11ft)	80.9	5.47	2.8	32.5			
8/27/2004	H3	Shell pad	Surface	101.5	7.16	2.9	32.8	6		YSI-85
		Shell pad	Near-bottom (11ft)	90.8	6.91	2.9	32.5			
9/27/2004	H3	Reef	No samples available due to poor weather conditions.							YSI-85
		Reef								
10/28/2004	H3	Reef	Surface	99.1		4.7	31.6	4.5		YSI-85
		Reef	Near-bottom (11ft)	93.1		5.0	30.4			
10/28/2004	H3	Shell pad	Surface	95.9		4.5	30.8	4.5		YSI-85
		Shell pad	Near-bottom (11ft)	88.1		5.0	29.4			
2005										
4/27/2005	N1	Reef	Surface	101.9	8.33	3.4	24.5	4		YSI-85
13:16		Reef	Near-bottom (15.2 ft)	90.1	7.82	3.5	23.0			
4/27/2005	H1	Reef	Surface	102.2	8.13	3.3	25.9	4		YSI-85
14:07		Reef	Near-bottom (14.1 ft)	92.6	7.79	3.5	23.3			
4/27/2005	H3	Reef	Surface	101.3	8.46	3.8	23.8	4		YSI-85
14:00		Reef	Near-bottom (10.5 ft)	91.7	7.83	3.7	22.3			
4/27/2005	H4	Reef	Surface	102.5	8.34	3.9	24.6	3.5		YSI-85
13:53		Reef	Near-bottom (14.7 ft)	83.0	7.28	3.8	22.3			
5/14/2005	center of 3	Mud	Surface	91.8	6.86	3.4	27.7	5	Rep #1	YSI-85
10:00	S shore reefs	Mud	Near-bottom (15 ft)	87.7	6.74	3.2	27.6			
5/14/2005	center of 3	Mud	Surface	91.4	7.17	3.8	26.8	4.5	Rep #2	YSI-85
10:15	S shore reefs	Mud	Near-bottom (15 ft)	82.8	6.73	3.8	26.4			
5/17/2005	H3	Reef	Surface	85.7	6.67	3.8	25.8	2.5	Rep #1	YSI-85
7:10		Reef	Near-bottom (10.5 ft)	83.5	6.57	3.7	26.0			
5/17/2005	H3	Reef	Surface	84.7	6.70	3.6	26.3	2.5	Rep #2	YSI-85
7:50		Reef	Near-bottom (10.5 ft)	83.7	6.60	3.6	26.2			
6/2/2005	center of 3	Mud	Surface	99.6	7.44	2.7	30.6	5		YSI-85

9:20	S shore reefs	Mud	Near-bottom (15 ft)	92.7	6.96	2.7	30.0			
6/2/2005	H3	Reef	Surface	92.7	6.70	2.4	31.2	6		YSI-85
9:40		Reef	Near-bottom (15 ft)	91.9	6.73	2.4	31.0			
6/3/2005	H3	Reef	Surface				32.0	6	YSI error	YSI-85
9:05		Reef	Near-bottom (15 ft)				31.8			
6/9/2005	H	Shell pad	Surface	109.0	7.84	3.9	28.8	4		YSI-85
9:05		Shell pad	Near-bottom (13 ft)	103.0	7.87	3.9	28.6			
6/18/2005	center of 3	Mud	Surface	99.5	9.94	4.5	31.0	4.5		YSI-85
	S shore reefs	Mud	Near-bottom (15ft)	94.9	7.23	4.6	29.7			
6/18/2005	H3	Reef	Surface	102.8	7.60	4.4	31.3	5		YSI-85
		Reef	Near-bottom (10 ft)	91.5	7.05	4.5	29.7			
6/23/2005	center of 3	Mud	Surface	97.7	7.12	4.9	29.9	8.5		YSI-85
	S shore reefs	Mud	Near-bottom (14.5 ft)	97.2	7.13	5.0	29.9			
6/23/2005	H3	Reef	Surface	90.6	6.74	4.9	30.2	9		YSI-85
		Reef	Near-bottom (14 ft)	94.3	6.99	4.9	30.0			
6/24/2005	H	Shell pad	Surface	93.0	6.59	4.9	30.2	10		YSI-85
		Shell pad	Near-bottom (14 ft)	95.5	6.63	5.1	29.0			
6/24/2005	center of 3	Mud	Surface	90.5	6.40	4.9	30.5	8		YSI-85
	S shore reefs	Mud	Near-bottom (14 ft)	90.2	6.35	4.9	30.3			
6/24/2005	H3	Reef	Surface	95.8	7.15	4.7	30.6	9		YSI-85
		Reef	Near-bottom (13 ft)	95.2	6.98	4.7	30.3			
6/30/2005	H	Shell pad	Surface	97.6	7.05	4.0	31.4	7.5		YSI-85
		Shell pad	Near-bottom (13.5 ft)	94.2	6.96	4.0	30.8			
6/30/2005	center of 3	Mud	Surface	95.2	6.55	4.0	32.8	7		YSI-85
	S shore reefs	Mud	Near-bottom (14 ft)	95.1	6.91	4.2	31.0			
7/22/2005	H3	Shell pad	Surface	95.4	6.90	5.2	30.5	4		YSI-85
8:40		Shell pad	Near-bottom (15 ft)	94.6	6.97	5.2	30.5			
7/22/2005	center of 3	Mud	Surface	93.5	7.00	5.2	30.5	4.5	Bottom sampler	YSI-85
9:00	S shore reefs	Mud	Near-bottom (10 out of	91.3	6.70	5.2	30.5		not available	
7/26/2005	H3	Shell pad	Surface	91.4	6.47	5.1	31.7	5		YSI-85
8:09		Shell pad	Near-bottom (13 ft)	91.4	6.60	5.1	31.8			
8/3/2005	H3	Shell pad	Surface	94.2	6.84	4.3	31.0	6		YSI-85
11:59		Shell pad	Near-bottom (14.5 ft)	92.0	6.71	4.3	30.8			
8/3/2005	center of 3	Mud	Surface	98.9	7.11	4.3	31.4	6		YSI-85
13:30	S shore reefs	Mud	Near-bottom (15 ft)	96.0	7.01	4.3	30.9			
8/4/2005	center of 3	Mud	Surface	95.9	7.07	4.2	30.6	7.5	Bottom sampler	YSI-85
9:09	S shore reefs	Mud	Near-bottom (10 out of	94.8	6.76	4.2	30.6		not available	

8/4/2005	H3	Shell pad	Surface	94.7	7.03	4.1	30.8	7		YSI-85
10:32		Shell pad	Near-bottom (13 ft)	94.5	6.87	4.1	30.8			
8/5/2005	H3	Shell pad	Surface	94.3	7.04	3.9	30.1	11		YSI-85
9:15		Shell pad	Near-bottom (13 ft)	91.5	6.74	3.8	30.1			
8/5/2005	H	Shell pad	Surface	97.9	7.15	4.0	30.0	11		YSI-85
9:50		Shell pad	Near-bottom (13 ft)	95.3	7.04	4.0	30.1			
8/5/2005	center of 3	Mud	Surface	99.3	7.29	4.1	30.2	6.5	Bottom sampler	YSI-85
10:45	S shore reefs	Mud	Near-bottom (10 out of	96.6	7.08	4.1	30.2		not available	
8/16/2005	H3	Shell pad	Surface	92.6	6.75	3.7	31.1	10.5	Used bottom	YSI-85
8:50		Shell pad	Near-bottom (12.5 ft)	91.6	6.71	3.7	31.2		sampler	
8/16/2005	H	Shell pad	Surface	92.4	6.77	3.6	31.3	10		YSI-85
10:09		Shell pad	Near-bottom (10.5 ft)	91.7	6.35	3.6	31.1			
8/16/2005	S/E of H1	Mud	Surface	99.5	7.23	3.6	31.5	5		YSI-85
11:05		Mud	Near-bottom (14 ft)	87.4	6.23	3.5	31.2			
8/18/2005	center of 3	Mud	Surface			3.9	31.4	N/A	pH 5.83 bottom	YSI-6600
19:10	S shore reefs	Mud	Near-bottom (14 ft)			4.0	31.4		possible DO error	
8/21/2005	N1	Mud	Surface	96.7	6.97	4.5	31.3	6	pH 7.16 surface	YSI-6600
10:15		Mud	Near-bottom (13 ft)	93.9	6.70	4.5	31.3		pH 7.11 bottom	

Appendix B. Water quality measurements taken at the Lake Pontchartrain artificial reefs and reference sites in 2004 and 2005.

Appendix C. Divers, weather conditions, survey locations, and durations of 2005 fish surveys at the Lake Pontchartrain artificial reefs.

Date	Survey Team(s)	Weather Conditions	Regular Secchi (ft)	Diver Secchi (ft)	Survey Locations	Survey Duration	Total Survey Time (min)	Survey Times		
								Mud	Shell Pad	Reef
6/2/2005	A - Kelly Whitmore & Chip Crews	Calm (~2 knots)	Mud: 5 Shell: Reef: 6	Mud: 4.5 Shell: Reef: 4.5	Mud: ~250 m NW of H3 reef Shell: N/A Reef: H3	15 min ea. x 2 sites x 1 team	30	A: 8:10 - 8:25	N/A	A: 9:40 - 9:55
6/3/2005	A - Kelly Whitmore & Chip Crews B - Willie Whitmore & Chad Ellinwood	Calm (<1 knot)	Mud: 6 Shell: 6 Reef: 6	Mud: 4.5 Shell: 5 Reef: 4.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H1	10 min ea. x 2 x 3 sites x 2 teams	120	A: 11:40 - 11:50 B: 11:51 - 12:01 A: 12:00 - 12:10 B: 12:12 - 12:22	A: 9:20 - 9:30 B: 9:11 - 9:21 A: 10:02 - 10:12 B: 9:49 - 9:59	A: 10:35 - 10:45 B: 10:40 - 10:50 A: 11:05 - 11:15 B: 11:11 - 11:21
6/23/2005	A - Kelly Whitmore & Chip Crews B - Willie Whitmore & Ashely Walker	Calm	Mud: 8.5 Shell: 9 Reef: 9	Mud: 7.5 Shell: 8 Reef: 8.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 2 x 3 sites x 2 teams	120	A: 12:28 - 12:38 B: 12:24 - 12:34 A: 12:39 - 12:49 B: 12:40 - 12:50	A: 10:06 - 10:16 B: 10:11 - 10:21 A: 10:23 - 10:33 B: 10:28 - 10:38	A: 11:16 - 11:26 B: 11:13 - 11:23 A: 11:29 - 11:39 B: 11:27 - 11:37
6/24/2005	A - Kelly Whitmore & Mark Schexnayde B - Ashley Walker & Ryan Poirrier	Calm	Mud: 8.5 Shell: 10 Reef: 9.5	Mud: 8 Shell: 9 Reef: 9	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 2 x 3 sites x 2 teams	120	A: 11:03 - 11:13 B: 10:52 - 11:02 A: 11:14 - 11:24 B: 11:06 - 11:16	A: 10:10 - 10:20 B: 10:00 - 10:10 A: 10:25 - 10:35 B: 10:12 - 10:22	A: 12:15 - 12:25 B: 12:02 - 12:12 A: 12:40 - 12:50 B: 12:16 - 12:26
6/30/2005	A - Kelly Whitmore & Beth Spalding B - Ashely Walker & Chip Crews	Calm	Mud: 7 Shell: 7.5 Reef: 7.5	Mud: 5.5 Shell: 6 Reef: 5.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 2 x 3 sites x 2 teams	120	A: 13:45 - 13:55 B: 13:42 - 13:52 A: 14:02 - 14:12 B: 13:59 - 14:09	A: 11:55 - 12:05 B: 11:49 - 11:59 A: 12:12 - 12:22 B: 12:06 - 12:16	A: 12:55 - 13:05 B: 12:50 - 13:00 A: 13:25 - 13:35 B: 13:07 - 13:17
8/4/2005	A - Kelly Whitmore & Ashley Walker B - Chip Crews & Ryan Poirrer	Light chop (~7 knots) Mostly sunny	Mud: 7.5 Shell: 7 Reef: 7	Mud: 6.5 Shell: 6.5 Reef: 6.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 2 x 3 sites x 2 teams	120	A: 9:56 - 10:06 B: 9:38 - 9:48 A: 10:08 - 10:18 B: 9:51 - 10:01	A: 10:30 - 10:40 B: 10:25 - 10:35 A: 10:46 - 10:56 B: 10:40 - 10:50	A: 11:28 - 11:38 B: 11:23 - 11:33 A: 11:41 - 11:51 B: 11:37 - 11:47
8/5/2005	A - Kelly Whitmore & Willie Whitmore B - Ashley Walker & Chip Crews	Light chop (~9 knots) Mostly sunny	Mud: 6.5 Shell: 11 Reef: 11	Mud: 5.5 Shell: 10.5 Reef: 8.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 2 x 3 sites x 2 teams	120	A: 9:15 - 9:25 B: 9:04 - 9:13 A: 9:30 - 9:40 B: 9:15 - 9:25	A: 10:09 - 10:19 B: 10:00 - 10:10 A: 10:22 - 10:31 B: 10:12 - 10:22	A: 10:37 - 10:47 B: 10:41 - 10:51 A: 10:51 - 11:01 B: 10:55 - 11:05
8/16/2005	A - Kelly Whitmore & Ryan Poirrier B - Ashely Walker & Chip Crews	Sunny, clam (~3-5 knots)	Mud: 5 Shell: 10 Reef: 10.5	Mud: 5 Shell: 11 Reef: 11.5	Mud: 30 04.864 N 090 11.953 W Shell: H Reef: H3	10 min ea. x 3 sites x 2 teams	120	A: 9:10 - 9:20 B: 9:15 - 9:25 A: 9:23 - 9:33 B: 9:26 - 9:36	A: 10:25 - 10:35 B: 10:35 - 10:45 A: 10:41 - 10:51 B: 10:48 - 10:58	A: 11:15 - 11:25 B: 11:13 - 11:23 A: 11:29 - 11:39 B: 11:27 - 11:37
8/18/2005	A - Kelly Whitmore & Chip Crews	Flat calm (0 knots) Night	N/A	N/A	Reef: H3	20 min x 1 site x 1 team	20	N/A	N/A	A: 22:30 - 22:50
8/21/2005	A - Kelly Whitmore & Willie Whitmore	Choppy (7-15 knots)	Reef: 6	Reef: 6	Reef: N1	10 min x 1 site x 1 team	10	N/A	N/A	A: 10:43 - 10:53
						Total =	900 min.			

Appendix D. Fishes and mobile macroinvertebrates sighted during dedicated visual surveys at the Lake Pontchartrain artificial reefs in 2005.

	Date	6/2/05			6/3/05									
	Replicate	1	1	1	1	1	2	2	1	1	2	2	1	1
	Team	A	A	A	A	B	A	B	A	B	A	B	A	B
	Site	REEF	SHELL	MUD	REEF	REEF	REEF	REEF	SHELL	SHELL	SHELL	SHELL	MUD	MUD
	Surface Secchi (vertical)	6	N/A	4.5	6	6	6	6	6	6	6	6	6	6
	Bottom Secchi (horizontal)	5	N/A	4.5	4.5	4.5	4.5	4.5	5	5	5	5	4.5	4.5
	Survey duration (min)	15	0	15	10	10	10	10	10	10	10	10	10	10
FISHES														
Gobiosoma bosc	naked goby	20	x		15		29	17			11			
Archosargus probatocephalus	sheepshead	3	x		1		5		1					
Hypsoblennius iothonas	freckled blenny		x		1									
Paralichthys lethostigma	Southern flounder		x								1			
Dasyatis sabina	Atlantic stingray	1	x											
Caranx hippos	Crevalle jack		x											
Mugil cephalus	striped mullet		x											
Ictalurus furcatus	blue catfish		x											
Anguilla rostrata	American eel		x											
Opsanus beta	oyster toad fish		x											
Lagodon rhomboides	pinfish		x											
Menidia beryllina	tidewater silverside		x											
Gobiesox strumosus	skilletfish		x											
Myrophis punctatus	speckled worm eel		x											
Micropogon undulatus	Atlantic croaker		x											
Trinectes maculatus	hogchoker		x											
Aplodinotus grunniens	freshwater drum		x											
MOBILE MACROINVERTEBRATES														
Callinectes sapidus	blue crab	1	x		1			1			1			
Farfantepenaeus aztecus	brown shrimp		x											
Rhithropanopeus harrisii	mud crab		x											

		6/23/05												6/24/05						
2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
MUD	MUD	REEF	REEF	REEF	REEF	SHELL	SHELL	SHELL	SHELL	MUD	MUD	MUD	MUD	REEF	REEF	REEF	REEF	SHELL	SHELL	SHELL
6	6	9	9	9	9	9	9	9	9	8.5	8.5	8.5	8.5	9.5	9.5	9.5	9.5	10	10	10
4.5	4.5	8.5	8.5	8.5	8.5	8	8	8	8	7.5	7.5	7.5	7.5	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		31	6	21	5	3		13	6					51	37	50	19	11	7	11
		3		13										2		7				
		1												1	3				3	
			1	1										2						
				1													1			
																	1			
				1																
														1		2				
		2	5			1		1	1					6	6	10	8	3	3	1
														2						
																			1	

					6/30/05												8/4/05			
2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2
B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
SHELL	MUD	MUD	MUD	MUD	REEF	REEF	REEF	REEF	SHELL	SHELL	SHELL	SHELL	MUD	MUD	MUD	MUD	REEF	REEF	REEF	REEF
10	8.5	8.5	8.5	8.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7	7	7	7	7	7	7	7
9	8	8	8	8	5.5	5.5	5.5	5.5	6	6	6	6	5.5	5.5	5.5	5.5	6.5	6.5	6.5	6.5
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
14	1	1	2	4	7	1	18		1	3		3					13	4	29	4
																	3			
2						1	1										2			1
																	1			
																				1
																		1		
																	1		1	
2		2			1	1	1			3	1	3					3		3	
			1																	

								8/5/05												8/16/05
1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1	2	2	1
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
SHELL	SHELL	SHELL	SHELL	MUD	MUD	MUD	MUD	REEF	REEF	REEF	REEF	SHELL	SHELL	SHELL	SHELL	MUD	MUD	MUD	MUD	REEF
7	7	7	7	7	7	7	7	11	11	11	11	11	11	11	11	6.5	6.5	6.5	6.5	10.5
6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	8.5	8.5	8.5	8.5	10.5	10.5	10.5	10.5	5.5	5.5	5.5	5.5	11.5
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
5	2	6						18	6	26	9	6	4	6	2					21
										1			2							2
								3												
																				6
								2												
70																				
1		1											1							
		1																		
										1										
		2							3	2	1	2	1	1	3					1

											8/18/05	8/21/05	TOTALS	
1	2	2	1	1	2	2	1	1	2	2	1	1		
B	A	B	A	B	A	B	A	B	A	B	A	A		
REEF	REEF	REEF	SHELL	SHELL	SHELL	SHELL	MUD	MUD	MUD	MUD	REEF	REEF		
10.5	10.5	10.5	10	10	10	10	5	5	5	5	Night	6		
11.5	11.5	11.5	11	11	11	11	5	5	5	5	Night	6		
10	10	10	10	10	10	10	10	10	10	10	20	10	900	
														FISHES
4	5		4	3		1						18	614	*G. bosc*
			1									1	40	*A. probatocephalus*
		1			2							1	25	*H. iothonas*
						1							6	*P. lethostigma*
													1	*D. sabina*
													4	*C. hippos*
													6	*M. cephalus*
													3	*I. furcatus*
1											3	1	6	*A. rostrata*
													1	*O. beta*
1													7	*L. rhomboides*
													70	*M. beryllina*
				1	1	3					3		13	*G. strumosus*
													1	*M. punctatus*
													1	*M. undulatus*
						1							1	*T. maculatus*
												1	1	*A. grunniens*
													800	**INVERTEBRATES**
1	3	3	3		2	5					23		127	*C. sapidus*
													2	*F. aztecus*
						1							3	*R. harrisii*
													132	

Appendix E – Lake Pontchartrain Artificial Reef recreational fishing and diving survey.

Lake Pontchartrain Artificial Reef Recreation Survey

This survey is designed to collect information on the success of the artificial reefs in Lake Pontchartrain. Information on fisher and diver utilization of the reefs will be used to monitor the progress of the reefs and to develop recommendations for future reef efforts. Respondent contact information will remain confidential and responses will be pooled with those of others.

If you have recently fished or dived at any of the reef sites, please complete the form below and submit it via **email to: khoule@uno.edu** or print and mail the form to:

Lake Pontchartrain Artificial Reef Program, Estuarine Research Laboratory, Department of Biological Sciences, University of New Orleans, New Orleans, LA 70148.

Please complete and submit the form after each visit to the artificial reefs!

1. What was the date of your most recent trip to a Lake Pontchartrain artificial reef?
   MM/DD/YY ____ /____ /____

2. Which reef site(s) did you visit that day? (check all that apply)
   South shore - Jefferson Parish sites (H1, H3, H4), west of the Causeway Bridge: ☐
   North shore - St. Tammany Parish site (N1), south of Mandeville: ☐
   South shore - Orleans Parish site (L1) northeast of the Seabrook Bridge launch: ☐

3. What activities did you conduct there?
   ☐ Hook and line fishing
   ☐ Spear fishing
   ☐ Charter fishing
   ☐ Diving
   ☐ Other _____

4. How many hours did you spend fishing or diving at the reef sites that day? Specifically, how many hours did you actually spent with your gear in the water?
   Total hours: ☐☐

5. How many other people were fishing or diving from <u>your</u> boat at the reef sites that day?
   Number of Adults (18+ yrs): ☐ Number of Children: ☐

6. How many people did you see fishing or diving from <u>other</u> boats at the reef sites that day?
   Number of Adults (18+ yrs): ☐ Number of Children: ☐

7. If you were fishing, what types of gear did you use to fish at the reef site(s) that day?
   ☐ Hook and line
   ☐ Dip net, A-frame
   ☐ Cast net
   ☐ Trawl
   ☐ Trap
   ☐ Spear
   ☐ Hand
   ☐ Other _____
   ☐ Unknown
   ☐ None, did not fish

8. If you were fishing, what type of fish were you fishing for at the artificial reef(s) that day?
   1st target species _____
   2nd target species _____
   ☐ No particular target species

9. Where else in the lake did you fish or dive from a boat that day?
   ☐ Standing oil & gas structure
   ☐ Causeway pilings
   ☐ Other structure (specify) _____
   ☐ None/ No other areas

10. What fish did you catch, or if diving, what fish did you see at the reef sites that day?

Species	Number	Range of Length/Weight	Gear	Bait	Taken/Released

11. Since **January 2004**, how many days have you fished or dived at the artificial reefs in Lake Pontchartrain?
    Total days: ☐☐☐

    Of those days, how many were spent at each of the following artificial reef locations?
    Days at Jefferson Reefs: ☐☐☐
    Days at St. Tammany Reef: ☐☐☐
    Days at Orleans Reef: ☐☐☐

12. Within the past **2 months**, how many days have you fished or dived at the artificial reefs in Lake Pontchartrain?
    Total days: ☐☐☐

    Of those days, how many were spent at each of the following artificial reef locations?
    Days at Jefferson Reefs: ☐☐☐
    Days at St. Tammany Reef: ☐☐☐
    Days at Orleans Reef: ☐☐☐

13. Within the past **2 months**, how many days have you fished or dived anywhere in Lake Pontchartrain proper (including reef visits)?

    Total days: ☐☐☐

14. Do you feel that the artificial reefs have enhanced recreational fishing and/or diving opportunities in Lake Pontchartrain?

    ☐ Yes – enhanced fishing ☐ No

    ☐ Yes – enhanced diving ☐ Other _____

15. Have you fished or dived more often this year than last year as result of the presence of the Lake Pontchartrain artificial reefs?

    ☐ Yes – fished more

    ☐ Yes – dived more

    ☐ No

    ☐ Other _____

16. Did you experience any problems at the artificial reefs that day? What were they?

    ☐ Trouble anchoring

    ☐ Lost anchor

    ☐ Lost fishing tackle

    ☐ Difficulty finding reef site due to format of listed coordinates

    ☐ No buoy at the reef site

    ☐ Other _____

17. What is your state and county of residence?

    State: _____ County: _____

18. If you are a frequent user of the artificial reefs and would like to participate in a more regular, formal survey and have logged your reef use, or would like to start, please check this box, and provide your contact information below: ☐

19. OPTIONAL:

    Please provide your name, address, phone number, and email address if you would like to receive more information about the Lake Pontchartrain Artificial Reef Project:

    _____

20. Any comments you have about the Lake Pontchartrain Artificial Reef Program:

If you have any questions about this survey or about the Lake Pontchartrain Artificial Reef Program, please email the Lake Pontchartrain Basin Foundation at info@saveourlake.org, or contact the Estuarine Research Laboratory at the University of New Orleans, LA, 504-284-3490, khoule@uno.edu. Thank you for your participation.

Appendix F. Observations of recreational fishing and diving activity at the Lake Pontchartrain artificial reefs in 2004 and 2005.

Date	Day	Observation Period	Vessel's Location	Number of Vessels	# of People	Activity	Method	Fish Caught?	Species	Notes
2004										
07/01/04	Th	11:00 - 13:30	H1	0	0					
07/01/04	Th	11:00 - 13:30	H3	0	0					
07/01/04	Th	11:00 - 13:30	H4	0	0					
07/05/04	Mo	10:30 - 12:20	H1	1	Unknown	Fishing	Rods w/ line in water	Unknown		
07/05/04	Mo	10:30 - 12:20	H4	1	Unknown	Fishing	Rods w/ line in water	Unknown		
07/05/04	Mo	10:30 - 12:20	H3	1	Unknown	Fishing	Rods w/ line in water	Unknown		
07/10/04	Sa	10:15 - 12:10	H3	1	Unknown	Diving		No		
07/10/04	Sa	10:15 - 12:10	H1	1	Unknown	Fishing	Rods w/ line in water	Unknown		
07/10/04	Sa	10:15 - 12:10	H4	0	0					
07/11/04	Su	09:50 - 12:30	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
07/11/04	Su	09:50 - 12:30	H3	0	0					
07/11/04	Su	09:50 - 12:30	H4	0	0					
07/22/04	Th	10:00 - 14:20	H4	0	0					
07/22/04	Th	10:00 - 14:20	H1	0	0					
07/22/04	Th	10:00 - 14:20	H3	0	0					
07/28/04	We	09:15 - 10:15	H3	0	0					
07/28/04	We	09:15 - 10:15	H1	0	0					
07/28/04	We	09:15 - 10:15	H4	0	0					
08/04/04	We	09:45 - 14:30	H3	0	0					
08/04/04	We	09:45 - 14:30	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
08/04/04	We	09:45 - 14:30	H4	0	0					
08/27/04	Fr	11:00 - 13:10	H4	1	Unknown	Fishing	Rods w/ line in water	Unknown		
08/27/04	Fr	11:00 - 13:10	H3	0	0					
08/27/04	Fr	11:00 - 13:10	H1	0	0					
10/28/04	Th	08:00 - 15:00	H4	0	0					
10/28/04	Th	08:00 - 15:00	H1	0	0					
10/28/04	Th	08:00 - 15:00	H3	5	Unknown	Fishing	Rods w/ line in water	Yes	Speckled trout	
2005										
04/27/05	We	13:13 - 13:28	N1	1	Unknown	Fishing	Rods w/ line in water	Yes	Trout & croaker	
04/27/05	We	13:50 - 14:56	H4	2	Unknown	Fishing	Rods w/ line in water	Unknown		
04/27/05	We	13:58 - 14:05	H3	0	0					
04/27/05	We	14:05 - 14:10	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
05/14/05	Sa	9:50 - 10:15	H3	8	17	Fishing	Rods w/ line in water	Yes	Trout & flounder	
05/14/05	Sa	9:50 - 10:15	H1	5	13	Fishing	Rods w/ line in water	Unknown		
05/14/05	Sa	9:50 - 10:15	H4	3	5	Fishing	Rods w/ line in water	Unknown		

05/17/05	Tu	7:00 - 7:50	H3	1	4	Fishing	Rods w/ line in water	No		
05/17/05	Tu	7:00 - 7:50	H1	2	4	Fishing	Rods w/ line in water	Unknown		
05/17/05	Tu	7:00 - 7:50	H4	1	2	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:20 - 9:30	H3	2	4	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:20 - 9:30	H4	1	3	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:20 - 9:30	H1	1	2	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:20 - 9:30	near H3	1	1	Checking traps	Crab pots	Unknown	Blue crabs	Crab pots set near H3 site
06/02/05	Th	9:40 - 9:50	H3	1	Unknown	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:40 - 9:50	H4	1	Unknown	Fishing	Rods w/ line in water	Unknown		
06/02/05	Th	9:40 - 9:50	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	9:15 - 9:25	H3	3	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	9:15 - 9:25	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	9:15 - 9:25	H4	3	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	10:10 - 10:15	H3	2	Unknown	Fishing	Rods w/ line in water	Unknown		Crab pots set near H3 & H4
06/03/05	Fr	10:10 - 10:15	H4	4	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	10:10 - 10:15	H1	2	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	12:20 - 12:25	H3	2	Unknown	Fishing	Rods w/ line in water	Unknown		
06/03/05	Fr	12:20 - 12:25	H1	0						
06/03/05	Fr	12:20 - 12:25	H4	3	Unknown	Fishing	Rods w/ line in water	Unknown		
06/09/05	Th	9:10 - 9:15	H3	3	4	Fishing	Rods w/ line in water	No		Caught 50 trout 6/8 at H4, 12 on 6/6
06/09/05	Th	9:10 - 9:15	H1	1	2	Fishing	Rods w/ line in water	Unknown		
06/09/05	Th	9:10 - 9:15	H4	1	1	Fishing	Rods w/ line in water	Unknown		
06/09/05	Th	12:12 -12:17	H3	0	0					
06/09/05	Th	12:12 -12:17	H4	2	3	Fishing	Rods w/ line in water	Unknown		
06/09/05	Th	12:12 -12:17	H1	0	0					
06/18/05	Sa	14:32 - 14:45	H3	2	7	Fishing	Rods w/ line in water	Unknown		Crab pots set around H3 & H4
06/18/05	Sa	14:32 - 14:45	H1	2	2	Fishing	Rods w/ line in water	Unknown		
06/18/05	Sa	14:32 - 14:45	H4	2	4	Fishing	Rods w/ line in water	Unknown		
06/23/05	Th	09:28 - 09:35	H3	2	3	Fishing	Rods w/ line in water	Unknown		Crab pots set around H3
06/23/05	Th	09:28 - 09:35	H1	1	2	Fishing	Rods w/ line in water	Unknown		
06/23/05	Th	09:28 - 09:35	H4	2	3	Fishing	Rods w/ line in water	Unknown		
06/23/05	Th	11:00 - 11:05	H3	2	3	Fishing	Rods w/ line in water	Unknown		
06/23/05	Th	11:00 - 11:05	H4	1	2	Fishing	Rods w/ line in water	Unknown		
06/23/05	Th	11:00 - 11:05	H1	0	0					
06/24/05	Fr	09:45 - 09:54	H3	3	5	Fishing	Rods w/ line in water	Unknown		Crab pots set b/w H1, H3, & H4
06/24/05	Fr	09:45 - 09:54	H1	0	0					
06/24/05	Fr	09:45 - 09:54	H4	2	3	Fishing	Rods w/ line in water	Unknown		
06/30/05	Th	11:30 - 11:40	H1	0	0					Crab pots set b/w H1, H3, & H4
06/30/05	Th	11:30 - 11:40	H4	0	0					
06/30/05	Th	11:30 - 11:40	H3	0	0					

06/30/05	Th	14:45 - 14:50	H1	0	0					Crab pots set b/w H1, H3, & H4
06/30/05	Th	14:45 - 14:50	H4	0	0					
06/30/05	Th	14:45 - 14:50	H3	0	0					
07/22/05	Fr	8:40 - 9:40	H1	0	0					
07/22/05	Fr	8:40 - 9:40	H3	1	2	Fishing	Rods w/ line in water	Unknown		Crab pots set b/w H1,H3 & H4
07/22/05	Fr	8:40 - 9:40	H4	0	0					
07/22/05	Fr	10:15 - 10:30	H1	2	2	Fishing	Rods w/ line in water	Unknown		
07/22/05	Fr	10:15 - 10:30	H3	2	1	Fishing	Rods w/ line in water	Unknown		
07/22/05	Fr	10:15 - 10:30	H4	2	3	Fishing	Rods w/ line in water	Unknown		
07/26/05	Tu	8:09 - 8:15	H1	1	2	Fishing	Rods w/ line in water	Unknown		Crab pots set b/w H1, H3 & H4
07/26/05	Tu	8:09 - 8:15	H3	0	0					
07/26/05	Tu	8:09 - 8:15	H4	1	4	Fishing	Rods w/ line in water	Unknown		
08/03/05	We	11:59 - 14:10	H1	0	0					
08/03/05	We	11:59 - 14:10	H3	0	0					
08/03/05	We	11:59 - 14:10	H4	0	0					
08/04/05	Th	9:09 - 9:15	H1	0	0					Crab pots set b/w H1, H3 & H4
08/04/05	Th	9:09 - 9:15	H3	0	0					
08/04/05	Th	9:09 - 9:15	H4	0	0					
08/04/05	Th	10:32 - 10:40	H1	0	0					
08/04/05	Th	10:32 - 10:40	H3	0	0					
08/04/05	Th	10:32 - 10:40	H4	0	0					
08/05/05	Fr	9:15 - 9:30	H1	1	2	Fishing	Rods w/ line in water	Unknown		Crab pots set b/w H1, H3 & H4
08/05/05	Fr	9:15 - 9:30	H3	0	0					
08/05/05	Fr	9:15 - 9:30	H4	0	0					
08/05/05	Fr	9:50 - 10:10	H1	0	0					
08/05/05	Fr	9:50 - 10:10	H3	0	0					
08/05/05	Fr	9:50 - 10:10	H4	0	0					
08/16/05	Mo	8:50 - 9:20	H1	0	0					
08/16/05	Mo	8:50 - 9:20	H3	0	0					
08/16/05	Mo	8:50 - 9:20	H4	2	4	Fishing	Rods w/ line in water	Unknown		Crab pots set near H1
08/16/05	Mo	10:09 - 10:15	H1	0	0					
08/16/05	Mo	10:09 - 10:15	H3	0	0					
08/16/05	Mo	10:09 - 10:15	H4	0	0					
08/18/05	We	19:10 - 19:30	H1	1	2	Fishing	Rods w/ line in water	Unknown		Crab pots set near H1
08/18/05	We	19:10 - 19:30	H3	0	0					
08/18/05	We	19:10 - 19:30	H4	0	0					
08/18/05	We	19:45 - 20:50	H1	0	0					
08/18/05	We	19:45 - 20:50	H3	0	0					
08/18/05	We	19:45 - 20:50	H4	0	0					
08/21/05	Su	10:15 - 10:45	N1	2	4	Fishing	Rods w/ line in water	No		North shore reef

Appendix G. Responses collected from the Lake Pontchartrain Recreational Fishing and Diving Survey in 2004 and 2005.

2004

Respondent #	1. Date	2. Site	3. Activity	4. Hours	5. People in boat		6. People in other boats		7. Gear	8. Target species		9. Other fishing sites
					Adults	Children	Adults	Children		1st	2nd	
1	9/12/2004	St. Tammany reef (N1)	Hook & line	0.5	1	0	0	0	Hook & line	Speckled trout	Flounder	Causeway pilings
2	9/29/2004	Jefferson reefs (H1)	Hook & line	2	3	0	15	0	Hook & line	Trout	Redfish	Standing oil & gas structure

2005

Respondent #	1. Date	2. Site	3. Activity	4. Hours	5. People in boat		6. People in other boats		7. Gear	8. Target species		9. Other fishing sites
					Adults	Children	Adults	Children		1st	2nd	
1	5/15/2005	Jefferson reefs (H1, H3, H4)	Hook & line	3.5	2	0	30	0	Hook & line	Speckled trout	none	None
2	5/22/2005	Jefferson reefs (H1, H3, H4)	Hook & line	5	1	1	35	5	Hook & line	Speckled trout	none	None
3	5/21/2005	Jefferson reefs (H1, H3, H4)	Hook & line	4	2	0	20	7	Hook & line	Speckled trout	Croaker	Causeway pilings
4	5/14/2005	Jefferson reefs (H1, H3, H4)	Hook & line	1	1	0	1	0	Hook & line	Trout	none	None
5	6/9/2005	Jefferson reefs (H1, H3, H4)	Hook & line	4	3	0	15	0	Hook & line	Speckled trout	Redfish	Standing oil & gas structure
6	6/4/2005	Jefferson reefs (H1, H3, H4)	Hook & line	4	2	0	30	0	Hook & line	Trout	none	Standing oil & gas structure
7	6/24/2005	Jefferson reefs (H1, H3, H4)	Spear fishing	0.5	0	0	0	0	Spear	none	none	None
8	6/26/2005	St. Tammany reef (N1)	Spear fishing	0.5	2	0	0	0	Spear	Catfish	Drum	Fountain Blue pilings, Bayou Jordan, Green Point pilings, Mandeville shack
9	6/9/2005	Orleans reef (L1)	Hook & line	0.1	0	1	0	1	Hook & line	Speckled trout	Flounder, redfish, black drum	Lakefront Airport/ship channel
10	6/28/2005	Jefferson reefs (H1, H3, H4)	Hook & line	4	2	0	6	0	Hook & line	Speckled trout	Redfish	Standing oil & gas structure, Causeway pilings
11	7/9/2005	Jefferson reefs (H1, H3, H4)	Hook & line	1	1	0	0	0	Hook & line	Speckled trout	none	Standing oil & gas structure, Causeway pilings
12	5/26/2005	Jefferson reefs (H1, H3, H4)	Hook & line	2	3	0	15	2	Hook & line	Speckled trout	Flounder	None
13	5/27/2005	Jefferson reefs (H1, H3, H4)	Hook & line	2	2	0	18	0	Hook & line	Speckled trout	Redfish	None
14	5/28/2005	Jefferson reefs (H1, H3, H4)	Hook & line	2	2	0	50	15	Hook & line	Speckled trout	Redfish	Standing oil & gas structure, Causeway pilings
15	7/31/2005	Jefferson reefs (H1, H3, H4)	Hook & line	3	1	0	5	0	Hook & line	Speckled trout	none	Standing oil & gas structure, Causeway pilings
16	7/28/2005	Orleans reef (L1)	Hook & line	0.5	4	0	0	0	Hook & line	Trout	none	Seabrook, Train trestles
17	7/2/2005	Jefferson reefs (H1, H3, H4)	Diving	2	2	0	1	1	Did not fish	none	none	
18	8/13/2005	Jefferson reefs (H1, H3, H4)	Spear fishing	3	2	0	2	0	Spear	Redfish	Sheepshead	Causeway pilings
19	8/20/2005	St. Tammany reef (N1)	Hook & line	2.5	1	1	2	0	Hook & line	Speckled Trout	Sheepshead	Mandeville Pier

10. Fish caught/seen						11. Days fished at reefs			12. Past 2 months at reefs			13. Past 2 months	14. Enhanced
Species	Number	Length/Weight	Gear	Bait	Taken/Released	Jefferson	St. Tammany	Orleans	Jefferson	St. Tammany	Orleans	Lake P anywhere	opportunities?
None	0					0	6	0	0	2	0	8	No
Speckled trout	30	14" to 22"	Spin	Soft plastic	0	5	0	0	5	0	0	5	Yes - enhanced fishing

10. Fish caught/seen						11. Days fished at reefs			12. Past 2 months at reefs			13. Past 2 months	14. Enhanced
Species	Number	Length/Weight	Gear	Bait	Taken/Released	Jefferson	St. Tammany	Orleans	Jefferson	St. Tammany	Orleans	Lake P. anywhere	opportunities?
Speckled trout Flounder	16 1	12" to 4.5 lbs 13"	Hook & Line Hook & Line	Plastic lures Plastic lures	15 T/ 1 R 1 T/ 0 R	2	0	0	2	0	0	10	Yes - enhanced fishing
Speckled trout	15	13" to 24", 1 to 4 lbs	Pole	Beetle	15 T	2	0	0	1	0	0	4	Yes - enhanced fishing
White trout	2	22", ~2 lbs	Sliding cork rig	Market shrimp	Released	6	0	0	4	0	0	6	Yes - enhanced fishing
Flounder	1	15"	Spinning	Jig	Released	1	0	0	1	0	0	1	Yes - enhanced fishing
Speckled trout	14	1lb to 3 lb		Live shrimp		25	0	0	25	0	0	28	Yes - enhanced fishing
Speckled trout	10	2.5 to 3 lbs	Rod & reel	Shrimp	10 T	8	0	0	8	0	0	3	Yes - enhanced fishing
Sheepshead	7	8'-12'	Spear	none	2 T	8	0	0	8	0	0	12	Yes - enhanced fishing Yes - enhanced diving
none	0					0	2	0	0	2	0	5	Yes - enhanced fishing Yes - enhanced diving
none	0					0	0	0	0	0	0	30	Don't know
Catfish	6	small	Hook & line	Plastic/cut	6 T	? Many	0	0	6	0	0	12	Yes - enhanced fishing
none	0					2	0	0	1	0	0	1	Yes - enhanced fishing
Speckled trout Sheepshead Croaker	35 3 2	16-20 in. / 2-4 lbs. 20 in. / 3 lbs. 15-16 in. / 1 lb.	Bottom Bottom Bottom	Live shrimp Live shrimp Live shrimp	25 T / 10 R 2 T / 1 R 2 T / 0 R	20	0	0	10	0	0	15	Yes - enhanced fishing
Speckled trout	21	14-20 in. / 1-3 lbs.	Bottom	Live shrimp	16 T / 5 R	20	0	0	10	0	0	15	Yes - enhanced fishing
Speckled trout Flounder Croaker	24 1 10	12-19 in. / 1-3 lbs. 16 in. / 1 lb. 6 in.	Bottom Bottom Bottom	Live shrimp Live shrimp Live shrimp	17 T / 7 R 1 T / 0 R 0 T / 10 R	20	0	0	10	0	0	15	Yes - enhanced fishing
none	0					12	0	0	12	0	0	15	Yes - enhanced fishing Yes - enhanced diving
none	0			Live shrimp/ sliding cork		0	0	1	0	0	1	15	No
Naked gobies Sheepshead						1	0	0	1	0	0	3	Yes - enhanced diving
none						5	0	0	2	0	0	2	Yes - enhanced fishing Yes - enhanced diving
Hardhead catfish Gafftop catfish	1 1					0	1	0	0	1	0	4	Yes - enhanced fishing

15. Fished/dived more often?	16. Problems	17. State, county of residence	18. Log	19. Respondent Contact Info.
Yes - fished more	None	Louisiana, St. Tammany	Yes	(removed)
Yes - fished more	Lost fishing tackle	Louisiana, Jefferson	Yes	(removed)

15. Fished/dived more often?	16. Problems	17. State, county/parish of residence	18. Log	
No	Lost fishing tackle Could not find edges of reefs	Louisiana, Orleans	Yes	(removed)
Yes - fished more	Lost fishing tackle	Louisiana	No	(removed)
Yes - fished more	Other - see Comments	Louisiana, Orleans	Yes	(removed)
Yes - fished more	None	Louisiana, Orleans	No	(removed)
Yes - fished more	Lost fishing tackle	Louisiana, Jefferson		(removed)
Yes - fished more	Trouble anchoring	Louisiana, Jefferson	Yes	(removed)
Yes - dived more	Had other boats tied up to buoy	Louisiana, Orleans	No	(removed)
Yes - dived more	A little deep would like to see one shallower	Louisiana, East Baton Rouge	Yes	(removed)
No	Difficulty finding reefs due to format of coordinates	Louisiana, Orleans	Yes	(removed)
Yes - fished more	Difficulty finding reefs due to format of coordinates	Louisiana, Jefferson	Yes	(removed)
Yes - fished more		Louisiana, Orleans	Yes	(removed)
Yes - fished more	Lost fishing tackle Too crowded with boats	Louisiana, Orleans	Yes	(removed)
Yes - fished more	Lost fishing tackle Too crowded with boats	Louisiana, Orleans	Yes	(removed)
Yes - fished more	Lost fishing tackle Too crowded	Louisiana, Orleans	Yes	(removed)
Yes - fished more Yes - dived more	Lost fishing tackle	Louisiana, Metairie	Yes	(removed)
No	Very, very, very small in size	Louisiana, St. Tammany	Yes	(removed)
	SE buoy drifted off site, spent lot of time swimming over muddy bottom looking for reef	Louisiana, Jefferson	Yes	(removed)
Yes - fished more Yes - dived more	None	Lousisiana, St. Charles	No	(removed)
No	Difficulty finding reefs due to format of coordinates Found buoy but not reef	Louisiana, St. Tammany	No	(removed)

20. Comments	Respondent #
The reefs are not in the best place to attract fish.	1
I hope that more reefs are planned for the future as they are great for fishing. I would support such an effort and would encourage my friends to do so.	2

20. Comments	Respondent #
I would like to know if the yellow buoys at the Jefferson Reefs mark the edges of the reefs or the centers. I find the best fishing to be at the edges of the reefs rather than the centers. If possible could you send me information regarding this question.	1
I LOVE IT!!!!! I would like one closer to Bonnabel, but that's just greedy.	2
1) Because the reef pads cover a relatively small area, I would like to see clear diagrams (posted online and/or at local boat launches) which explain the relationship of the shell pads, reef balls, and marker buoys. There might be less crowding & animosity around the reefs if boaters had a better understanding of the reef placement in relation to the marker buoys. 2) I have only observed divers at the artificial reefs one time, and I did not fish that reef structure out of concern for the divers' safety. If diving is to be encouraged at the artificial reefs, I would hope that divers take extra precautions and understand the concerns of anglers on the surface.	3
	4
	5
We need more reefs to handle all the boats that fish them.	6
	7
I would love to see more locations and a few oyster reefs rebuilt and spread across greater areas of lake floor. As well as multiple depths to dive and fish.	8
A few weeks ago, I attempted to locate the reef (L1) which used to have a bowie at it's location marking the spot. I watched the construction to get a visual fix, however, there's no more bowie marking the spot, nor is it visable athigh tide. When constructed it peaked above the surface approximately two feet. Now no visibility or bowie. Can you have a bowie replaced at that site. I would love to fish there as I am an avid fisherman in Lake Pontchartrain.	9
Keep up the good work!!!	10
Kee up the good work.	11
The fish seem to accumulate in small portions of the reefs. Theses areas get crowded with boats, other boats outside these spots don't catch many, or don't catch at all. Additional reefs would help. Would smaller, but more numerous reef sites work as well, offering more opportunity?	12
The fish group in small portions of the reef. Fishermen crowd these small pockets. Other boats catch very few, or none. Additional reefs will help. Would more numerous, even if smaller reefs be an advantage?	13
The fish congregate in small pockets of the reef. The bite well for short periods of time. Boats crowd these small areas. Boats outside these small areas don't do as well, only catching few or none. More reef locations would help. Would smaller, but more numerous reef locations work as well, offering more opportunities to more boats, while conserving reef material?	14
	15
I tried to find the reef by Lakefront Airport using the coordinates on he SaveOurLake website map (yes, I can use a GPS). The only thing I found was a very small spot abut the size of a car. Is this the size of the reef, as big as a car? I motored around in ever-widening circles to find any other structure around the GPS coordinates, but I could only find one small area.	16
	17
I've had success fishing there in the past, but haven't had any this year.	18
	19