LAKE PONTCHARTRAIN ARTIFICIAL REEF EVALUATION PROGRAM

Final Report

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Michael A. Poirrier, Principal Investigator
James E. Sinclair, Research Associate

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

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INTRODUCTION

In the fall of 2001, an artificial reef was placed in Lake Pontchartrain approximately 3.4 km east of the Lakefront Airport in New Orleans. It was composed of limestone rubble and spanned a two-acre site (N 30^0 3.5208', W 89^0 59.6083'). A monitoring study was implemented by the University of New Orleans' Estuarine Research Laboratory to evaluate the performance of the artificial reef. This study was limited in time (seven months), scope (preliminary data collection), and resources (2.7 man months).

Monitoring was conducted January through July 2002. The following attributes were evaluated: (1) structural integrity, (2) water quality, (3) colonization of benthic macroinvertebrates, (4) use of the site for fishing and diving, and (5) creel survey information. This information was gathered to provide unbiased technical data to determine if the construction of additional reefs is warranted and to improve the design and performance of future reefs.

METHODS

Structural integrity was evaluated by comparing average relief of the reef over time. Average relief was calculated using multiple depth measurements over the reef and adjacent to the reef. This comparison allows the detection of subsidence if it occurs. A significant difference in relief was tested by using a Student's t-test at a critical value of $p = 0.05$.

Water quality was measured quarterly over the reef and adjacent to the reef. Measurements were taken at three sites on the reef at least 7 m apart and at least one site adjacent to the reef. Additional water quality measurements were taken in the summer to check for possible salinity stratification and hypoxia. Parameters measured included surface and bottom salinity, dissolved oxygen, and temperature readings as well as depth and Secchi disc transparency. A YSI model 85 SCT-DO meter was used for field measurements. Calibrations were checked routinely before field trips (dates in Table 2) against a similar probe, a calibrated thermometer, and a YSI Model 35 Laboratory conductivity meter, per Section B7 of the QAPP.

Benthic colonization of macroinvertebrates was evaluated by collecting three replicate samples of limestone rocks from the reef. Each sample contained ten rocks and the organisms were identified and counted. Samples were collected in June, the peak of the growing season. In addition, one small sample was taken in January to familiarize workers with the benthic community that was developing and one small sample was collected in July to identify small and soft-bodied organisms that may have been missed in the June sample. Organisms in these two samples were identified for supporting information purposes only, not quantified.

Recreational use of the reef was determined by counting boats anchored over the reef from shore and observing fishing activity on field trips. Creel surveys were conducted by interviewing anglers at Seabrook boat launch, at the Back to the Beach festival, and during boat trips to the reef.

Creel surveys were solicited at the Seabrook boat launch. Anglers were interviewed and given brochures with contact information at Seabrook and the Back to the Beach festival and asked to provide creel information.

Methods are in accordance with the Quality Assurance Project Plan (QAPP #02-040). All measurements were performed in accordance with the QAPP. For a detailed description of the methods employed, see the "Lake Pontchartrain artificial reef evaluation program quality assurance project plan", QAPP # 02-040. Modifications to the methods of the QAPP include the use of a calibrated aluminum pole for depth measurements, which insured that the line of measurement was vertical, even with some boat movement. It also allowed the worker to immediately distinguish between limestone bottom (over the reef) and sand, shell, or mud (off the reef). The schedule was also modified by a delay in the start date from November to January. This time was primarily dedicated to the preparation and approval of an accepted Quality Assurance Project Plan. In addition, this time was utilized to prepare necessary field equipment, particularly boat maintenance and overhaul. The period between initial depth measurements and second depth measurements was less than the intended six months because of the late start of the project. Bad weather on available trip dates delayed collection of initial depth measurements until March 2002.

RESULTS

Structural integrity was measured by using successive relief measurements. Thirty depth measurements over the reef and ten depth measurements adjacent to the reef were collected on 8 March and 12 June 2002. These depth measurements allow calculation of average relief on the reef at two points in time. Comparison of these averages shows that relief on the reef has not changed significantly over the period measured ($\alpha = 0.05$, $p = 0.18$). This demonstrates that the substratum has been stable and supported the reef without subsidence over the measured time. Table 1 gives the depth measurements, average relief for each measurement time, and t-value comparing relief at the two points in time. Relief measurements shown are the difference between the corresponding reef value and the average of the adjacent values.

No change in profile or damage from storms was apparent. Snorkeling on the reef revealed rows of limestone rocks per the original design. The appearance is similar to beach dunes with ridges and intervening swales. Surface sediment accumulation was slight. A thin layer of silt covered the rocks but crevices between the rocks did not fill.

Water quality measurements were taken each quarter from January through July 2002 (Table 2). Three replicate surface and bottom measurements, 7 m apart, over the reef and one adjacent to the reef were taken at least once each quarter. In July, four measurements were taken adjacent to the reef on four different sides as well as 0.5 km north and 0.5 km west of the reef. These were done to detect any possible salinity stratification or hypoxia in the area.

Accuracy of field instruments was checked against conductivity standards and calibrated thermometers in the laboratory before each field trip (15 Feb., 12 June, and 17 July 2002). Precision was assured in the field by taking triplicate measurements and checking variation against the accuracy limits presented in Table 3 of the QAPP. No excursions from accepted limits occurred. Maintenance and calibration of the YSI-85 SCT-DO meter followed methods in the manufacturers manual. Dissolved oxygen readings from the YSI Model 85 SCT-DO meter were periodically checked in the field against air calibration values.

No water quality problems or hypoxia were detected at the site during the course of the study. Salinity stratification was detected at the site only on the February trip (difference approximately 1.5 ppt). High salinity water from the Inner Harbor Navigation Canal reaches this area and occasionally causes salinity stratification and hypoxia (dissolved oxygen $\leq$ 2 ppm). Although salinity stratification was detected, bottom oxygen values remained relatively high (7-9 ppm). This stratification demonstrates that high salinity bottom water reaches the site, and the potential for hypoxia exists.

Benthic colonization data is summarized in Table 3. Organisms collected on 20 June 2002 were identified and counted. Samples in January and July were in addition to the planned replicates in June. These additional samples were examined live, allowing detection of some smaller soft-bodied organisms. January and July samples were examined only for presence or absence of taxa (X = present). Colonial species were identified only as present or absent.

The artificial reef benthos community is composed of species common to hard bottom substrates in the area. Sixteen different taxa were identified from the live rocks in January. Twenty-one taxa were identified from the three replicate samples of ten rocks in June. Eleven taxa were identified from the live samples collected in July. A total of 28 taxonomic groups were identified over the course of the study (Table 3). The average number of total individuals found in each of the three samples was 162.

Recreational use of the Artificial Reef for fishing and diving was assessed by shore and boat observations. A total of 37 observations were made from March through July 2002 (Table 4). Nine of these were actually on site via boat. The other 28 were from shore, approximately 1.5 km from the reef. Observations were made during reasonably fair weather, though travel around the northern end of the airport may have occasionally discouraged boaters in small craft. The majority of these (73%) were in the morning between 06:00 and 10:00 hours. Approximately 57% of these discovered no activity on the reef.

Forty-three percent of the observations identified boats and fishermen on the reef. Vessel type ranged from 14 ft. aluminum flat-bottom boats to 18 ft. fiberglass tri-hulls to a 25 ft. wooden “crabber’s” boat. Thirty-five percent of the boats carried only one fisherman. Others had up to four fishermen. Almost all fishermen used rod and reel tackle for cast fishing. A few also trolled the area. One boat carried four scuba divers with two spear guns. These divers were in the water about 15 minutes before moving away to look for clearer water.

During observations from shore, we occasionally were able to see fishermen landing a fish and even placing it in their ice chest. While this was sometimes possible, such information is an incomplete picture of the landings involved. Shore-side observations were intended for discerning the activity on the reef but were not designed to provide creel survey information.

Creel survey information was solicited from fishermen for the Artificial Reef. This was done via interviews in person at the Seabrook boat launch and at the Back to the Beach Festival. No fishermen were found who had fished on the Artificial Reef. About seventy brochures were handed out to fishermen, giving information on the reef and asking them to contact us with information about their fishing activity. No response has been received to date. The only direct creel information was obtained during boat trips to the reef when fishers were actually on the reef.

One boat trip to the reef found fishermen catching fish on the reef when we arrived but this was not considered a good time to approach them for a formal interview. Four fishermen in two boats caught 17 fish that were 12 inches or longer, all speckled trout, in a time of about 1.25 hours.

Researchers observed fish on the reef by snorkeling during reconnaissance and collection trips to the Artificial Reef. Two fish species were common: the naked goby (*Gobiosoma bosci*) and the sheepshead (*Archosargus probatocephalus*). The mussel, *Ischadium recurvum*, is a common food of the sheepshead and was frequently seen crushed from their feeding behavior. Other species on the reef, such as the speckled trout (*Cynoscion nebulosus)*, are harder to approach and were not observed directly.

Summer 2002 has been an active fishing season, especially for speckled trout. The area next to the Seabrook launch is a complex habitat with hard substrate, deep holes, and tidal currents from the Inner Harbor Navigation Canal. Saline water enters the lake here, producing stratification and episodic hypoxia in the summer (documented up to 100^2 mi.). Fish and shrimp entering from the Inner Harbor Navigation Canal may concentrate around Seabrook because of the complex habitat and low bottom dissolved oxygen offshore. When fishing is particularly good around Seabrook, reduced activity is expected at the Artificial Reef, which is 4 km farther away.

CONCLUSIONS

Structural integrity of the reef is unchanged. No significant differences were detected in the average relief of the Artificial Reef over the time March to June 2002. Visual observations while snorkeling confirmed that the reef remains in rows of limestone rubble per the original design.

Water quality is normal and follows expected patterns. Most of the time, no adverse conditions prevail. Occasionally, salinity stratification does occur, which may promote episodic hypoxia. Though stratification was detected on one occasion, no hypoxia was found.

Benthic colonization by macroinvertebrates has formed a community similar to other hard substrate communities in the area. This community is dominated by the mussel, *Ischadium recurvum*; the barnacle, *Balanus improvisus*; and the serpulid worm, *Ficopomatus miamiensis*. A similar community on the seawall is dominated by *I. recurvum* and *B. improvisus* (recent data; Jeandron 1996; Poirrier and Mulino 1977, 1975). The seawall community appears to be denser and species more evenly distributed. The current study on the Artificial Reef was limited to only one sampling event. More work needs to be done before any definitive comparisons can be attempted.

A number of factors could account for lower diversity and abundance. It may be as simple as the young age of the reef, with only one growing season. Mobile predators such as the crab, *Rithropanopeus harrisii*; and the fish, *Gobiosoma bosci*; live in interstices of the reef and feed on epifauna. New recruits may be limited this year because the low salinity species favored now were not favored during the two-year drought (1999-2000). The community shifted to higher salinity and is now shifting back to lower salinity species. Another reason for limited colonization is the possibility of undetected episodic hypoxia in the area (Abadie and Poirrier 2001, Poirrier 1978). Reduced diversity and abundance is commonly associated with hypoxic bottom waters (Diaz and Rosenberg 1995, Gaston 1985). This limestone rubble reef is the only such habitat in Lake Pontchartrain and comparisons to other habitats may be limited in value. This monitoring study needs to be continued to produce a more complete characterization of the reef.

Recreational use of the Artificial Reef was observed during forty-three percent of the 37 observations. Almost all fishermen used rod and reel tackle for cast fishing. A few also trolled or spear fished using scuba gear.

Creel survey information was solicited from fishermen for the Artificial Reef but no response was received. We observed fishermen catching fish (speckled trout, *Cynoscion nebulosus*) on the reef during one field trip. The naked goby (*Gobiosoma bosci*) and the sheepshead (*Archosargus probatocephalus*) were observed while snorkeling. Good fishing in the area close to the Seabrook launch may have reduced the number of fishermen traveling to the Artificial Reef.

RECOMMENDATIONS

Study of the Artificial Reef in Lake Pontchartrain needs to be continued. Work so far provides a snap shot of a developing reef community. Structural integrity is good so far but the time period examined is too short to serve as more than a baseline study. Water quality monitoring needs to span all seasons. Multiple measures should be taken at upper and lower depths of the reef during events of episodic hypoxia. If researchers could take measures during a hypoxic event, they could determine if the higher elevations of the reef remain above the stratified layer.

Assessment of benthic colonization should continue in order to characterize the developing community. A healthy, developing benthic community can be associated with increased utilization by fish species. More fish utilization leads to more fishing activity and more landings. Therefore, understanding benthic development is fundamental to understanding the value of the reef. This understanding is enhanced by assessment of fishing activity and creel landings.

Efforts to obtain creel landings were limited by resources and should be re-directed. Web sites and electronic bulletin boards may be utilized to discover fishermen who frequent the reef. Fliers may be placed in businesses that fishermen frequent. Utilization of the reef by fish could be measured directly using underwater cameras or video. Hydroacoustics assessment technology is also proving useful to survey fish assemblages (Bortone, Samoilys, and Francour 2000).

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Table 1. Depth measurements, relief, and t-test comparing relief on the Lake Pontchartrain Artificial Reef on 8 March and 12 June 2002. For each date, 40 depth measurements were taken over the reef and 10 were taken adjacent to the reef. Relief measurements shown are the difference between the corresponding reef value and the average of the adjacent values.

Depth Measurements						
	08-Mar-02			12-Jun-02		
	Reef (m)	Adjacent (m)	Relief (m)	Reef (m)	Adjacent (m)	Relief (m)
1	4.20	4.40	0.23	4.10	4.60	0.57
2	3.55	4.50	0.88	3.90	4.50	0.77
3	4.40	4.45	0.03	4.05	4.60	0.62
4	4.45	4.35	-0.02	4.45	4.75	0.22
5	4.45	4.45	-0.02	3.95	4.75	0.72
6	4.35	4.40	0.08	4.15	4.65	0.52
7	4.30	4.40	0.13	3.75	4.75	0.92
8	3.95	4.40	0.48	4.10	4.65	0.57
9	4.45	4.45	-0.02	3.50	4.65	1.17
10	4.20	4.45	0.23	4.30	4.75	0.37
11	4.25		0.18	4.50		0.17
12	3.65		0.78	3.95		0.72
13	4.30		0.13	4.45		0.22
14	4.15		0.28	4.10		0.57
15	4.25		0.18	4.50		0.17
16	3.80		0.63	4.55		0.12
17	4.45		-0.02	4.35		0.32
18	4.10		0.33	4.55		0.12
19	4.35		0.08	4.60		0.07
20	4.25		0.18	4.60		0.07
21	4.35		0.08	4.65		0.02
22	4.35		0.08	4.40		0.27
23	4.40		0.03	4.60		0.07
24	4.05		0.38	4.30		0.37
25	3.75		0.68	4.45		0.22
26	3.60		0.83	4.60		0.07
27	4.25		0.18	4.50		0.17
28	4.20		0.23	4.55		0.12
29	4.10		0.33	4.35		0.32
30	4.00		0.43	4.40		0.27
Average	4.16	4.43	0.27	4.31	4.67	0.36
SS						2.43
Variance						0.08392
Std. Dev.						0.28969
Confidence						0.10366
t-test						0.18123

Table 2. Water quality measurements from surface and bottom waters for the Lake Pontchartrain Artificial Reef. Three replicate measurements were taken over the reef and one adjacent to the reef for each sampling date. Additional measurements were taken on 17 July 2002 to for the detection of possible salinity and dissolved oxygen stratification.

Water Quality			DO% Saturation	DO (mg/L)	Salinity (ppt)	Temp. (^{O}C)	Secchi (ft.)
02/15/2002	On the Reef	Surface	98.6	10.33	4.7	11.9	3
		Bottom	73.5	7.58	6.7	12.2	
		Surface	96.7	10.13	4.7	11.9	3
		Bottom	80.2	8.47	6.4	12	
		Surface	96.5	10.12	4.7	11.9	3
		Bottom	85.7	8.95	6.3	12	
	Adjacent to the Reef	Surface	96.8	10.15	4.7	11.9	3
		Bottom	77.1	7.98	6.6	12.1	
06/12/2002	On the Reef	Surface	96.9	7.21	4.6	29.8	8.5
		Bottom	79.6	6.42	4.8	28.9	
		Surface	95.4	6.81	4.6	29.9	8.5
		Bottom	82.8	6.34	4.7	28.9	
		Surface	100.2	7.35	4.6	29.9	8.5
		Bottom	84.6	6.7	4.7	28.8	
	Adjacent to the Reef	Surface	100.5	7.29	4.6	30	7.5
		Bottom	77.7	5.68	4.8	28.9	
07/17/2002	On the Reef	Surface	112.1	8.08	5.2	30.6	4
		Bottom	106.5	7.77	5.1	30.3	
		Surface	112.5	8.12	5.1	30.8	4
		Bottom	85.8	5.34	5.2	29.9	
		Surface	112.5	8.11	5.2	31	4
		Bottom	82.2	6.02	5.2	30.1	
	Adjacent to the Reef	Surface	113.9	8.7	5.1	30.8	4
		Bottom	71.3	5.23	5.2	29.9	
		Surface	114.9	8.3	5.1	30.9	4
		Bottom	73.8	5.37	5.2	29.9	
		Surface	114.3	8.4	5.1	31.1	4
		Bottom	67.8	4.99	5.2	29.8	
		Surface	112.7	8.9	5.2	30.9	4
		Bottom	74.5	5.48	5.2	29.8	
	0.5 km North	Surface	113.6	8.3	5.2	30.6	4
		Bottom	77.5	5.59	5.3	29.8	
	0.5 km West	Surface	120.5	8.73	5.1	31.1	4
		Bottom	70.2	5.2	5.3	29.7	

Table 3. A taxonomic list of organisms found on the Artificial Reef from three sampling dates in 2002. Samples in January and July were in addition to the planned replicates in June. These additional samples were examined live, allowing detection of some smaller soft-bodied organisms. January and July samples were examined only for presence or absence of taxa (X = present). Colonial species were identified only as present or absent.

		10 Jan. 2002	20 June 2002 Rep. 1	20 June 2002 Rep. 2	20 June 2002 Rep. 3	17 July 2002
Protoza	Ciliated protozoans	X			X	X
Sarcodina	Foraminiferida					X
Platyhelminthes	Turbellaria	X				
Nemertea			1			
Nematoda		X	2			X
Rotifera		X				
Annelida						
Oligochaeta			3			
Polychaeta		X				
Nereidae	*Neanthes succinea*		5			
Spionidae	*Polydora websteri*	X	1			
	Streblospio benedicti		1			
	Boccardia hamata				2	
Serpulidae	*Ficopomatus miamiensis*	X	76	35	63	X
Phyllodocidae	*Eteone* sp.	X				

		10 Jan. 2002	20 June 2002 Rep. 1	20 June 2002 Rep. 2	20 June 2002 Rep. 3	17 July 2002
Mollusca						
Pelecypoda	*Ischadium recurvum*	X	68	36	50	X
	Clams < 5 mm	X				X
	Rangia cuneata		2			
	Crassostrea virginica					X
Opisthobranchia	*Tenellia pallida*	X				
Arthropoda						
Crustacea						
Branchiura	*Argulus*			1		
Copepoda		X				
Tanaidacea	*Hargeria rapax*			2		
Amphipoda	*Gitanopsis* sp.	X	5	1	3	
	Melita sp.		1	3		X
Cirripedia	*Balanus improvisus*	X	50	46	29	X
	Balanus subalbidus			2	2	
Decapoda	*Rhithropanopeus harrisii*		1			
Ectoprocta	*Conopeum*	X	X	X	X	X
	Victorella pavida	X	X	X	X	X
Entoprocta	*Barentsia* sp.	X	X			

Table 4. Observations from shore and boat of Artificial Reef fishing activity. NA = No Activity. SP = Still Present. Observations of the number of fish landed are reliable only for boat trips to the reef, not for observations from the shore. All times are in military time notation.

Date	Location	Observation Period	Fishing Time Start	End	Type of Boat	fishermen	# of fish
01/10/2002	Reef	10:30-14:30	NA	NA	NA	NA	NA
01/30/2002	Reef	09:30-12:00	NA	NA	NA	NA	NA
02/15/2002	Reef	10:00-13:00	NA	NA	NA	NA	NA
03/06/2002	Shore	7:13	NA	NA	NA	NA	NA
03/08/2002	Shore	08:00-10:30	NA	NA	NA	NA	NA
03/08/2002	Reef	09:00-12:15	NA	NA	NA	NA	NA
03/25/2002	Shore	6:48	NA	NA	NA	NA	NA
04/15/2002	Shore	7:30	7:30	SP 7:30	25 ft. wooden construction (crabber's)	4 w/rod and reel	0
04/18/2002	Shore	07:45-8:50	7:45	8:40	14 ft. Alum., flat bottom, outboard	1 w/rod and reel	0
04/18/2002	Shore	07:45-8:50	7:45	SP 8:50	16 ft. fiberglass, Tri-hull, outboard	1 w/rod and reel	0
04/19/2002	Shore	8:17	NA	NA	NA	NA	NA
04/25/2002	Shore	07:50-8:30	7:50	SP 8:30	16 ft. Alum., V-Hull outboard motor	1 w/rod and reel	1
04/29/2002	Shore	7:35	7:35	SP 7:35	16 ft. Alum., V-Bow, outboard motor	1 w/rod and reel	0
04/30/2002	Shore	10:25-11:00	10:25	NA 11:00	NA	NA	NA
05/10/2002	Shore	07:55-8:15	7:55	SP 8:15	18 ft. fiberglass, Tri-Hull, Mercury	2 w/rod and reel	0
05/23/2002	Shore	7:50	NA	NA	NA	NA	NA
05/27/2002	Shore	08:35-9:40	8:35	9:15	18 ft. fiberglass Tri-Hull, 200 hp Mercury	1w/2 trolling rods, rod and reel	0
05/27/2002	Shore	08:35-9:40	8:35	SP 9:40	16 ft. fiberglass, V-Hull	2 w/rod and reel	3
05/27/2002	Shore	08:35-9:40	8:50	SP 9:40	16 ft. fiberglass, Tri-Hull, Yamaha	2 w/rod and reel	0
05/27/2002	Shore	09:24-9:40	9:24	9:32	16 ft. fiberglass, V-Hull	1 w/rod and reel	0
05/27/2002	Shore	09:31-9:40	9:31	SP 9:40	18 ft. fiberglass, V-Hull, Yamaha	4 w/rod and reel	0
06/12/2002	Reef	10:30-14:00	10:30	11:25	18 ft. fiberglass, Tri-Hull	2 w/rod and reel	7
06/12/2002	Reef	10:30-14:00	10:40	11:20	16 ft. fiberglass, V-Hull	4 divers w/2 spearguns	0
06/12/2002	Reef	10:30-14:00	10:45		18 ft. fiberglass, V-Hull	2 w/rod and reel and trolling	10
06/20/2002	Reef	10:00-12:30	NA	NA	NA	NA	NA
06/26/2002	Shore	9:15	NA	NA	NA	NA	NA

Date	Location	Observation Period	Fishing Time Start	End	Type of Boat	fishermen	# of fish
06/27/2002	Shore	09:10-9:55	9:10	9:48	14' Alum., Flat bottom, outboard motor	2 w/rod and reel	0
06/28/2002	Shore	09:23-10:05	9:23	10:05	16 ft. fiberglass, Tri-hull, outboard	2 w/rod and reel	1
07/11/2002	Shore	09:56-10:00	NA	NA	NA	NA	NA
07/17/2002	Reef	09:46-14:00	NA	NA	NA	NA	NA
07/25/2002	Shore	13:30	NA	NA	NA	NA	NA
07/26/2002	Shore	08:30	NA	NA	NA	NA	NA
07/26/2002	Shore	17:00	NA	NA	NA	NA	NA
07/29/2002	Shore	8:30	NA	NA	NA	NA	NA
07/30/2002	Shore	9:40	NA	NA	NA	NA	NA
07/30/2002	Shore	17:10	NA	NA	NA	NA	NA
07/31/2002	Shore	8:40	NA	NA	NA	NA	NA