March 1998

Final Report

BIOLOGICAL AND RECREATIONAL MONITORING OF THE IMPACTS OF THE 1997 OPENING OF THE BONNET CARRE' SPILLWAY SOUTHEASTERN LOUISIANA

Prepared for

U.S. Army Corps of Engineers
New Orleans District
New Orleans, Louisiana

Prepared by

Gulf Engineers & Consultants

Baton Rouge, Louisiana

and

Steimle & Associates, Inc.

March 1998

Final Report

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ORGANIZATION OF REPORT

This Biological and Recreational Monitoring report is published under two covers.

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SECTION 1 - INTRODUCTION

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The Bonnet Carre' Spillway is part of the comprehensive plan for flood control in the Lower Mississippi Valley. This multi-state plan, which is called the Mississippi River and Tributaries Project (MR&T), provides flood protection for the alluvial valley of the Mississippi River between Cape Girardeau, Missouri, and the mouth of the river. The MR&T project includes levees to contain flood flows, floodways such as the Bonnet Carre' to release excess flows from the river, channel improvement and stabilization works for efficient navigation and protection of the levee system, and reservoirs and pumping plants for flood control and drainage.

The Bonnet Carre' Spillway is the southernmost floodway in the MR&T system. It is located in St. Charles Parish, Louisiana, 33 miles above New Orleans (Figure 1.1). It protects New Orleans and other downstream communities by allowing water to be released from the river during major floods. This water is diverted into Lake Pontchartrain and thence into the Gulf of Mexico, thereby relieving pressure on the levees in the vicinity of New Orleans.

The Bonnet Carre' Spillway consists of a control structure along the east bank of the Mississippi river and a floodway that conveys the diverted flood waters into the lake. The control structure is a mechanically controlled concrete weir that extends for over a mile and a half parallel to the river and contains 350 bays (or gates) 20 feet long. The floodway is an old natural floodway of the Mississippi River and extends about six miles between the river and the lake. It contains about 8,000 acres of land and ponds confined between guide levees. The control structure was completed in 1931, and the guide levees were completed in 1932.

Over the years, the Bonnet Carre' Spillway has developed into an extensively used recreation area, with approximately 250,000 visitors annually. The public is provided access as long as its activities do not interfere with the operation of the project. Within the Spillway are open grasslands, wetlands, forested areas, and small to large bodies of ponded water. These lands and waters provide opportunities for fishing, crawfishing, hunting, shooting practice, dog training, birding, model airplane, boat, and rocket activities, and operating off-road vehicles. St. Charles Parish provides two boat launching sites that provide access to the Spillway's primitive grounds and waterways.

The Spillway has been opened eight times since its completion, with the number of gates open and the duration of openings depending on flood flows on the river:

Duration	Bays Open	Maximum Flow (cfs)
January 30 - March 7, 1937	285	211,000
March 23 - May 18, 1945	350	318,000
February 10 - March 19, 1950	350	223,000
April 8 - June 21, 1973	350	195,000
April 14 - April 26, 1975	225	110,000
April 18 - May 21, 1979	350	191,000
May 20 - June 23, 1983	350	268,000
March 17 - April 18, 1997	298	243,000

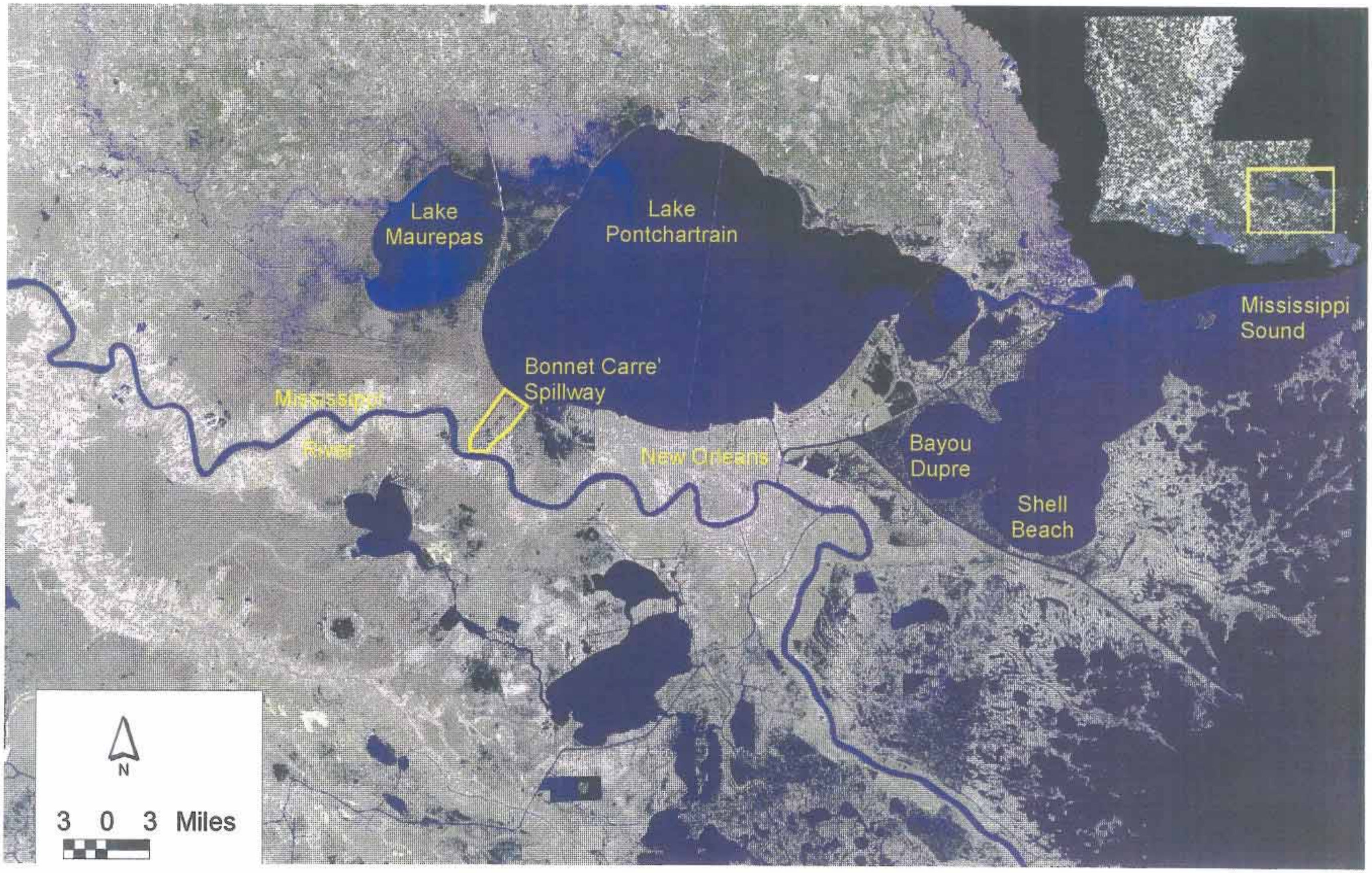


Figure 1.1. Project Vicinity

During openings, the Spillway is, of course, closed to recreational usage. A tremendous amount of sediments and fresh water is released into the brackish and saline waters of lakes Pontchartrain and Borgne. Spillway openings prior to 1997 have been strongly associated with increased oyster, crab, and other fisheries production in lakes Pontchartrain and Borgne for several years afterward.

During the first three months of 1997, heavy rains and rapidly melting snow in the Midwest flowed into the Mississippi River and its tributaries. The river rose to the highest level since the flood of 1983, and the Corps of Engineers decided to open the Bonnet Carre' Spillway. The first bays were opened on March 17, and the last bays were closed on April 18. During this period, 9.5 million acre-feet of water passed through the Spillway.

Although the opening was supported by some citizens, it was criticized by others who were concerned about the effects on Lake Pontchartrain and particularly its fisheries. Various agencies and organizations, including the Corps of Engineers, began studying the environmental effects immediately after the Spillway opening, making this the most extensively studied of all openings.

The present study addresses many aspects of the biological and recreational impacts of the 1997 opening. G.E.C., Inc., was tasked under Contract Number DACW29-96-D-9-0009 to complete the study. The recreational portion of the study was performed by G.E.C., and the biological portion of the investigation was provided by Steimle and Associates, Inc. The biological impact assessment was based on field sampling and includes water quality, oysters, shrimp, blue crabs, and finfish. Supporting data were obtained from Federal and State agencies. The recreational impact assessment was based on field interviews and observations. The relationship between biological impacts and recreational impacts is addressed to the degree permitted by the data.

SECTION 2 - RESULTS OF OYSTER SAMPLING IN MISSISSIPPI SOUND AND LAKE BORGNE DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

SECTION 2 - RESULTS OF OYSTER SAMPLING IN MISSISSIPPI SOUND AND LAKE BORGNE DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

INTRODUCTION

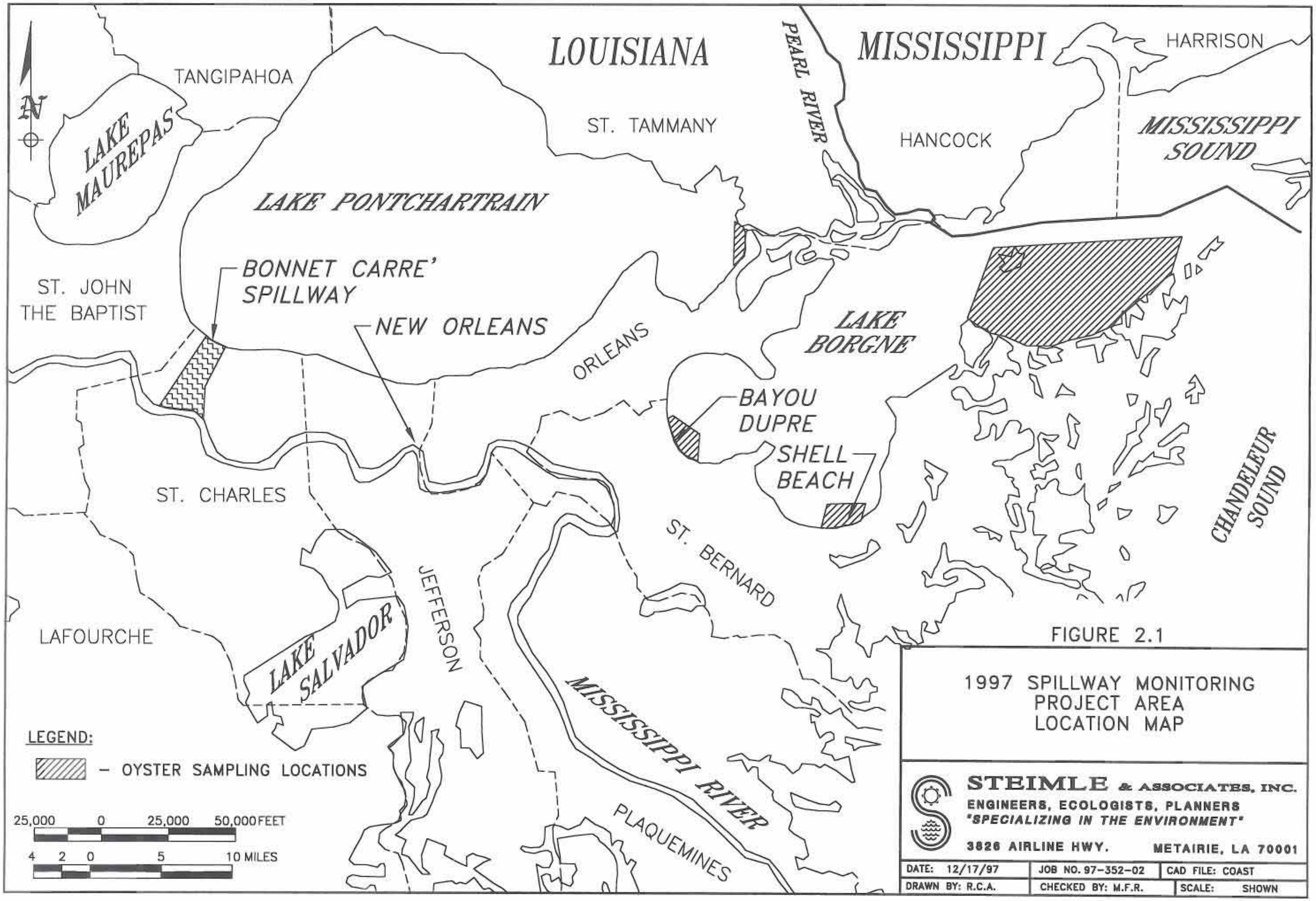
In a number of prior Bonnet Carre' Spillway openings, the impacts of the Spillway opening on the oyster resources of the Lake Borgne - Mississippi Sound portion of the Louisiana and Mississippi coastal waters have been documented in the scientific literature. Based primarily on testimony, Butler (1949), attributed 50-100 percent mortality in oysters from the Mississippi and Louisiana portions of Mississippi Sound to the March 23 - May 8, 1945, Spillway opening. Butler also indicated that high discharge rates from the Pearl River had adversely impacted oyster production from the western Mississippi Sound reefs. Butler and Engle (1950), predicted that continuing adverse conditions associated with both the February 10 - March 19, 1950, Spillway opening and Pearl River flooding would cause increased oyster mortalities in western Mississippi Sound. Gunter (1953), surveying much the same area as Butler and Engle, found mortalities ranging from 5.2-12.4 percent associated with the 1950 Spillway opening. He also found that a number of predators and shell pests of the oyster had been eliminated by the fresh water associated with the Spillway opening. Dugas and Perret (1976) found that the April 8 - June 1, 1973, Spillway opening caused 50 percent oyster mortalities in the Louisiana portion of Lake Borgne estuarine complex. Chatry (1983), reported 75-100 percent oyster mortalities in Lake Borgne and 50-100 percent mortalities in the Louisiana portion of Mississippi Sound associated with the May 20 - June 25, 1983, Spillway opening.

As part of a larger study to determine the effects of the March 17 - April 18, 1997, Bonnet Carre' Spillway opening, quantitative oyster samples were collected from public and private oyster reefs in western Lake Pontchartrain, Lake Borgne and Mississippi Sound in Louisiana. These data were collected in late March to mid-April after the opening of the Spillway and in mid to late September, 1997, approximately five months after the closure of the Spillway. Figure 2.1 is a map showing the oyster monitoring study area in relation to the Bonnet Carre' Spillway.

MATERIALS AND METHODS

Quantitative oyster sample data were collected from public oyster reefs in eastern Lake Pontchartrain and Mississippi Sound and several private oyster leases in Lake Borgne. Written permissions from the private lease holders/lease operators were obtained prior to sampling the private oyster leases. The quantitative oyster sample data were collected between March 25 and April 16, 1997, for the initial sampling and between September 18-29, 1997, for the post-opening sampling.

The public oyster reefs chosen for sampling were in the vicinity of oyster data collection stations historically monitored by the Louisiana Department of Wildlife & Fisheries (LDWF). The original intent was to sample the same locations as the LDWF. Field reconnaissance of those sites indicated that no oysters or exposed shell bottom were present in the vicinity of the station coordinates. Exposed shell bearing bottoms were often located within approximately a mile or more of the LDWF


LOUISIANA
MISSISSIPPI
HARRISON
TANGIPAHOA
ST. TAMMANY
PEARL RIVER
HANCOCK
MISSISSIPPI SOUND
LAKE MAUREPAS
LAKE PONTCHARTRAIN
BONNET CARRE' SPILLWAY
ST. JOHN THE BAPTIST
NEW ORLEANS
ORLEANS
LAKE BORGNE
BAYOU DUPRE
SHELL BEACH
CHANDELEUR SOUND
ST. CHARLES
ST. BERNARD
JEFFERSON
LAFOURCHE
LAKE SALVADOR
MISSISSIPPI RIVER
PLAQUEMINES
LEGEND:
- OYSTER SAMPLING LOCATIONS
25,000 0 25,000 50,000 FEET
4 2 0 5 10 MILES
N
FIGURE 2.1
1997 SPILLWAY MONITORING
PROJECT AREA
LOCATION MAP
STEIMLE & ASSOCIATES, INC.
ENGINEERS, ECOLOGISTS, PLANNERS
"SPECIALIZING IN THE ENVIRONMENT"
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CHECKED BY: M.F.R.
SCALE: SHOWN

station coordinates, and these locations were sampled. It should be noted that the original coordinates of the LDWF sampling locations and the extents of the historic reefs in Mississippi Sound were established in a geographically remote area well prior to the near universal availability of GPS positioning instruments. The original coordinates were meant to represent sampling vicinities not point location. Also, some reefs, such as Half Moon Reef, are currently present only as small relicts of their historic extents. For several sampling locations, the vicinity of working oyster boats in the area were used to find other suitable sites. In several cases, raised oyster reefs were detected using the fathometer.

All sampling was carried out on a 21-foot MonArk work boat drawing approximately 1.5 feet (ft) or an 18-foot flatboat drawing approximately 1.0 ft of water. Locations for the survey were determined using a Trimble NT100 six channel global positioning system (GPS) receiver. A Motorola MRB-1A MSK radiobeacon receiver and the U.S. Coast Guard (USCG) differential GPS (DGPS) broadcast transmitter at English Turn, Louisiana (29° 52.7' North Latitude, 89° 56.6' West Longitude) were used to provide real time differential correction (Type 9) of the GPS data. The differentially corrected position data accuracy is typically 50 ft (15 meter [m]) or better.

The topography of the surrounding marshes was obtained from digital maps of U.S. Geological Survey (USGS) 7.5' quadrangles and input to map form using a computer aided drafting program (AutoCAD). Where they were known, the Louisiana State Plane Coordinates (South Zone) of fixed points (survey monuments) were used to check the accuracy of the map and reference lease locations listed on the LDWF lease plats.

The bottom was sounded with an 8-14 ft long aluminum pole to confirm the presence of shell and/or oysters at a potential sampling location. Based on the poling confirmation of the presence of shell, oyster sampling points were chosen. Oyster samples were collected by a diver using a 0.5 m^2 (5.38 ft^2) quadrant frame. Prior to collecting the oyster samples, the diver would examine an approximately 50-foot radius of the sample location and then report first hand observations of the presence or absence of surface or buried shell, live oysters or any noteworthy features of the bottom. Based on the diver observations (primarily the presence and quantity of shell), the quadrat frame was placed on the bottom and all of the oysters and shell within the margins of the frame was placed in a mesh bag and brought to the surface. At each sample point, six replicate samples were collected by the diver. Each replicate sample was labeled and photographed immediately after collection.

All live or recently dead oysters were counted and measured, and observations about the presence or absence of fouling organisms or sediment on the shells were made. Recent death in an oyster was determined by examining the interior of the shells. Visible fouling of the interior of a recently dead oyster can take as long as approximately one month or slightly more during the winter and less than a week during the summer (Gunter, *et al.*, 1956). An oyster was considered recently dead if the shells were still attached at the umbo (hinge) and if the interiors of the shells were clean, unfouled and the shell margins were complete. Old boxes are oyster shells still attached at the umbo, but with fouled interiors and/or eroded shell margins. Market sized oysters were considered to be 7.6 cm (3.0 in) and larger. All calculations involving sacks were based on 200 market sized oysters per sack.

The oyster sample data were analyzed to determine if statistically significant differences existed between the numbers of live oysters from the initial samplings and final samplings. The data were grouped by sampling region (Lake Pontchartrain - Mississippi Sound, Lake Borgne - Bayou Dupre and Lake Borgne - Shell Beach). The oyster data were transformed using the square root transformation to ensure normality. For samples with zero counts, the value of 0.5 was used in the analysis. The Lake

Pontchartrain - Mississippi Sound data were analyzed using a two-way analysis of variance and the Lake Borgne - Bayou Dupre and Lake Borgne - Shell Beach data were each pooled and analyzed using a standard two sample t-test (Sokal and Rohlf, 1995). Two different statistical analyses were used due to the significant differences in the sampling areas. The individual sampling locations within the Lake Borgne - Bayou Dupre and Lake Borgne - Shell Beach sample areas, respectively, were close to each other and in areas that were similar environmentally. Since the individual sampling locations were collected from areas that were environmentally similar, data from the locations could be pooled to increase the sensitivity of the statistical analysis. The Mississippi Sound samples were collected from an area 18 miles (29 km) by 6.8 miles (11 km). The wide and continuous environmental variation (primarily salinity) across the area of Mississippi Sound sampled in this study and the likely differences between individual sampling sites due to this environmental variation precluded the use of a pooled sample t-test analysis for these data. The two-way analysis of variance was used to isolate the site - specific differences from the differences between sampling periods.

Water quality data were collected one ft (0.3 m) below the water surface and above the bottom. Salinity, conductivity, and temperature data were collected using YSI Model 30 or Model 33 S-C-T Meters.

RESULTS

Copies of the quantitative data from the individual 0.5 m^2 sample replicates for each sampling location and color copies of photographs of the individual sample replicates are included in Appendix A.

Initial Sampling, March-April, 1997

Figures 2.2 and 2.3 show the sampling locations in eastern Lake Pontchartrain and Mississippi Sound, respectively. For comparison purposes, these figures also show the historical LDWF oyster sampling locations.

Summaries of the oyster sample data collected in the spring of 1997 from the eastern Lake Pontchartrain and Mississippi Sound sampling stations are shown in Table 2.1. No live or recently dead oysters were collected at the Hospital Wall and Capt. Curtis sampling locations. At the other 10 sampling locations, the mean numbers of total live oysters per m^2 ranged from 6.00 at Reef 15 to 108.33 at Pelican Reef. The mean number of market sized (7.6 cm and larger) oysters per m^2 ranged from 3.33 at Reef 15 to 45.33 at Little Bayou Pierre. The percentage of market sized oysters in the samples ranged from 5-56 percent. The mean number of sacks (200 market sized oysters/sack) of market sized oysters per acre of productive (with shell) bottom at the sampling locations ranged from 67-918. None of the oysters collected exhibited obvious stress from low salinities (gaping, loosely closed valves, rotting oyster meats or numerous recently dead oysters). The incidence of recent mortality was low (0-3 percent) in all samples. The percentage of old boxes (shells still hinged together but with fouled interiors and/or eroded shell margins) ranged from zero percent at Reef 12 and Reef 15 to 18 percent at Capt. Nelson.

Surface and bottom water salinities at the 12 oyster sampling stations ranged from approximately 4-6 parts per thousand (ppt). No salinity data were collected for the bottom water at Grand Pass and for the surface and bottom water at Reef 8 and Pelican Reef due to an instrument malfunction.

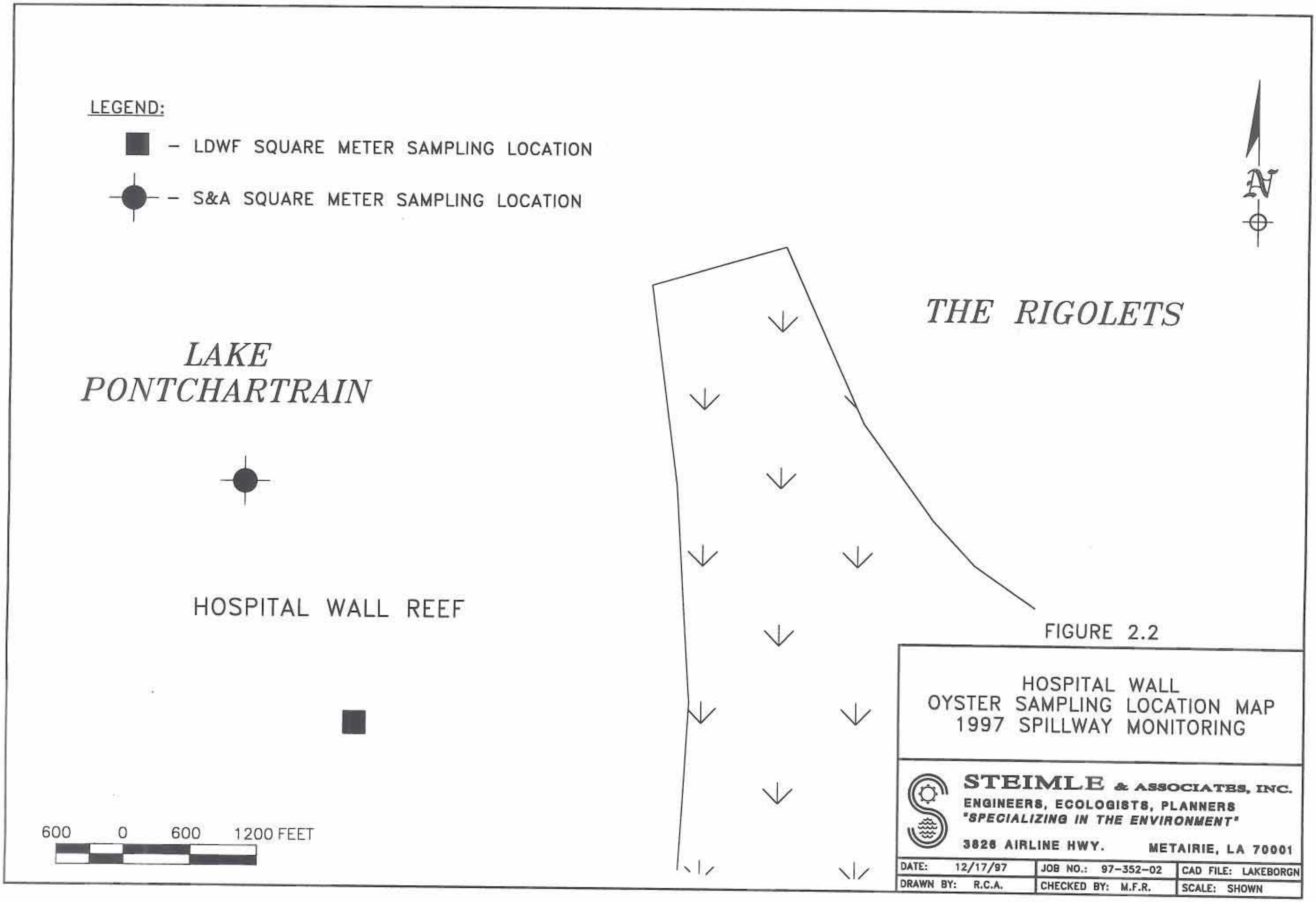


FIGURE 2.2

HOSPITAL WALL
OYSTER SAMPLING LOCATION MAP
1997 SPILLWAY MONITORING

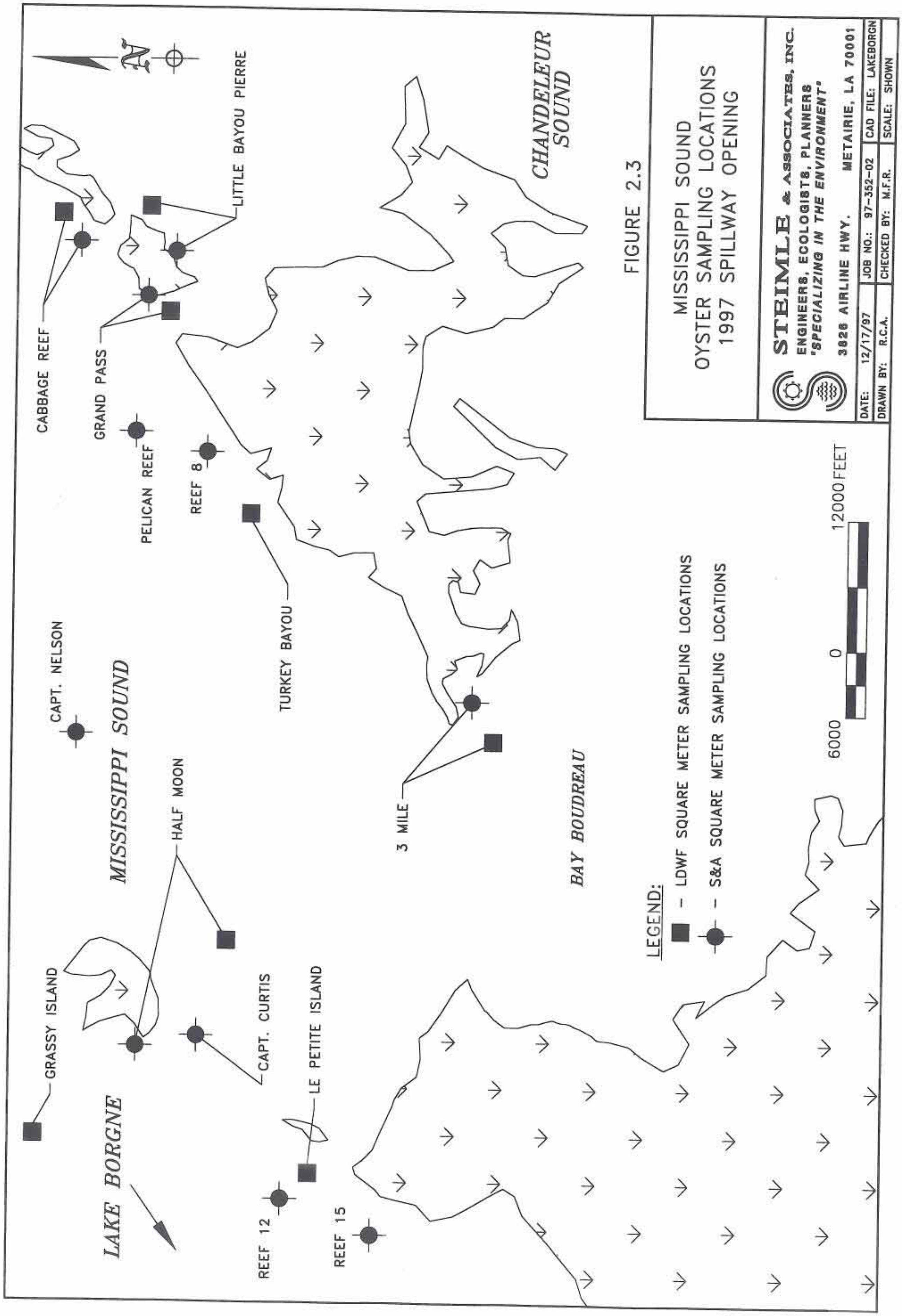


FIGURE 2.3
MISSISSIPPI SOUND
OYSTER SAMPLING LOCATIONS
1997 SPILLWAY OPENING

Table 2.1. Spring 1997 Lake Pontchartrain and Mississippi Sound Oyster Sample Data Summary

STATION	LITTLE BAYOU PIERRE	CABBAGE REEF	REEF 15	GRAND PASS	REEF 8	PELICAN REEF	CAPT. NELSON	THREE MILE	HALF MOON REEF	REEF 12	CAPT. CURTIS	HOSPITAL WALL
DATE	3/27/97	3/27/97	3/27/97	3/27/97	3/27/97	3/26/97	3/25/97	3/25/97	3/25/97	3/25/97	3/25/97	3/20/97
TOTAL LIVE	298	57	18	214	222	325	181	69	85	34	0	0
TOTAL RECENT DEAD	0	2	0	0	0	2	0	0	1	0	0	0
PERCENT RECENT MORTALITY	0%	3%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%
MARKET SIZED LIVE	136	10	10	19	11	36	26	14	21	11	0	0
MARKET SIZED RECENT DEAD	0	1	0	0	0	0	0	0	0	0	0	0
PERCENT MARKET MORTALITY	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
PERCENT MARKET SIZED	46%	19%	56%	9%	5%	11%	14%	20%	24%	32%	0%	0
OLD BOXES	35	4	0	8	13	11	39	7	1	0	0	0
PERCENT OLD BOXES	11%	6%	0%	4%	6%	3%	18%	9%	1%	0%	0%	0%
MEAN TOTAL OYSTERS/M2	99.33	19.00	6.00	71.33	74.00	108.33	60.33	23.00	28.33	11.33	0.00	0.00
MEAN MARKET OYSTERS/M2	45.33	3.33	3.33	6.33	3.67	12.00	8.67	4.67	7.00	3.67	0.00	0.00
MEAN TOTAL OYSTERS/FT2	9.23	1.77	0.56	6.63	6.88	10.07	5.61	2.14	2.63	1.05	0.00	0.00
MEAN MARKET OYSTERS/FT2	4.21	0.31	0.31	0.59	0.34	1.12	0.81	0.43	0.65	0.34	0.00	0.00
MEAN MARKET SACKS/ACRE	918	67	67	128	74	243	175	94	142	74	0	0
MARKET SACKS S.D.	389	55	80	136	94	140	212	101	117	83	0	0
No. OF REPLICATES	6	6	6	6	6	6	6	6	6	6	6	6
SURFACE WATER SALINITY (ppt)	4.4	5.2	4.9	6.0	N/A	N/A	4.0	3.8	4.8	4.5	4.8	4.2
BOTTOM WATER SALINITY (ppt)	4.4	5.2	5.0	N/A	N/A	N/A	4.0	3.9	4.8	4.5	4.7	4.2

The private oyster leases chosen for sampling were located near the junction of Bayou Dupre, the Mississippi River - Gulf Outlet (MRGO) and Lake Borgne and in lower Lake Borgne near Shell Beach and Bayou Yscloskey. Figures 2.4 and 2.5, respectively, show the oyster sampling locations in Lake Borgne near Bayou Dupre and Lake Borgne near Old Shell Beach.

Oyster data collected in the spring of 1997 from the Lake Borgne sampling stations are shown in Table 2.2. Live oysters were collected at all eight sampling locations. The mean numbers of total live oysters per m^2 ranged from 5.33 at L-28531/1 in Lake Borgne at Shell Beach to 99.67 on L-25714/O-12 in Lake Borgne at Bayou Dupre. The mean number of market sized (7.6 cm and larger) oysters ranged from 2.33-40.00 per m^2 at the same two sampling locations, respectively. The percentage of market sized oysters in the samples ranged from 10-54 percent. The mean number of sacks (200 market sized oysters/sack) of market sized oysters per acre of productive (with shell) bottom at the sampling locations ranged from 34-810. None of the oysters collected exhibited obvious stress from low salinities. The recent mortalities were low (0-2 percent) in all samples.

Surface and bottom water salinities at these stations during our sampling ranged from <0.5-2.1 ppt. No salinity data were collected from stations O-9 and O-10 due to high seas during that sampling on April 1, 1997.

Final Sampling - September, 1997

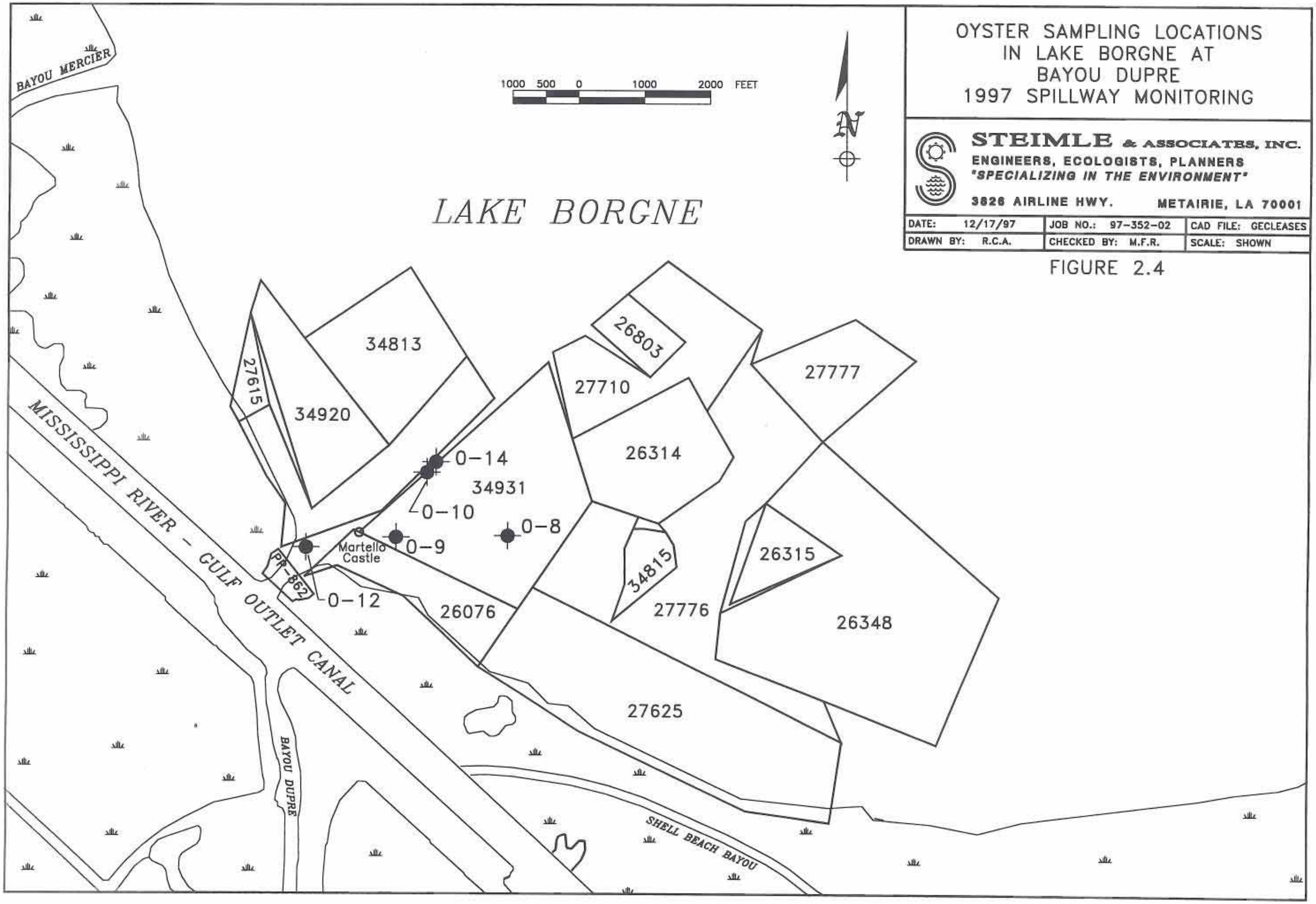
Due to the lack of live oysters at the Hospital Wall and Capt. Curtis sampling locations in the initial survey, these stations were not re-sampled in September, 1997. The oyster data from the remaining 10 sampling locations in Mississippi Sound are shown in Table 2.3.

At the 10 Mississippi Sound sampling locations, the mean numbers of total live oysters per m^2 ranged from 3.00 at Reef 12 to 100.33 at Pelican Reef. The mean number of market sized (7.6 cm and larger) oysters ranged from 0.00 to 15.67 per m^2 at the same two stations. The percentage of market sized oysters in the samples ranged from 0-33 percent. The mean number of sacks (200 market sized oysters/sack) of market sized oysters per acre of productive (with shell) bottom at the sampling locations ranged from 0-317. Recent mortality was relatively low (0-10 percent) in all samples. The percentages of old boxes ranged from zero percent at Cabbage Reef, Half Moon Reef and Reef 12 to 9 percent at Little Bayou Pierre.

Surface and bottom water salinities at these stations during our sampling ranged from approximately 8-24 parts per thousand (ppt) with the highest salinities occurring at the eastern-most sampling locations (Cabbage Reef, Little Bayou Pierre and Grand Pass) and the lowest salinities at the western-most stations (Reef 15, Reef 12 and Half Moon Reef).

Oyster data collected in the Fall of 1997 from the Lake Borgne sampling stations are shown in Table 2.4. Live oysters were collected at all eight sampling locations. The mean numbers of total live oysters per m^2 ranged from 6.67 at L-28351/1 to 118.67 at L-25714/O-12. The mean number of market sized (7.6 cm and larger) oysters per m^2 ranged from 3.33 at L-28351/1 to 18.33 at L-34931/O-10 and L-34931/O-14. The percentage of market sized oysters in the samples ranged from 11-60 percent. The mean number of sacks, (200 market sized oysters/sack) per acre of productive (with shell) bottom at the sampling locations ranged from 81-371.

Surface and bottom water salinities at these stations during our sampling ranged from 8.6-17.3 ppt. None of the oysters collected exhibited obvious stress.



OYSTER SAMPLING LOCATIONS
IN LAKE BORGNE AT
BAYOU DUPRE
1997 SPILLWAY MONITORING

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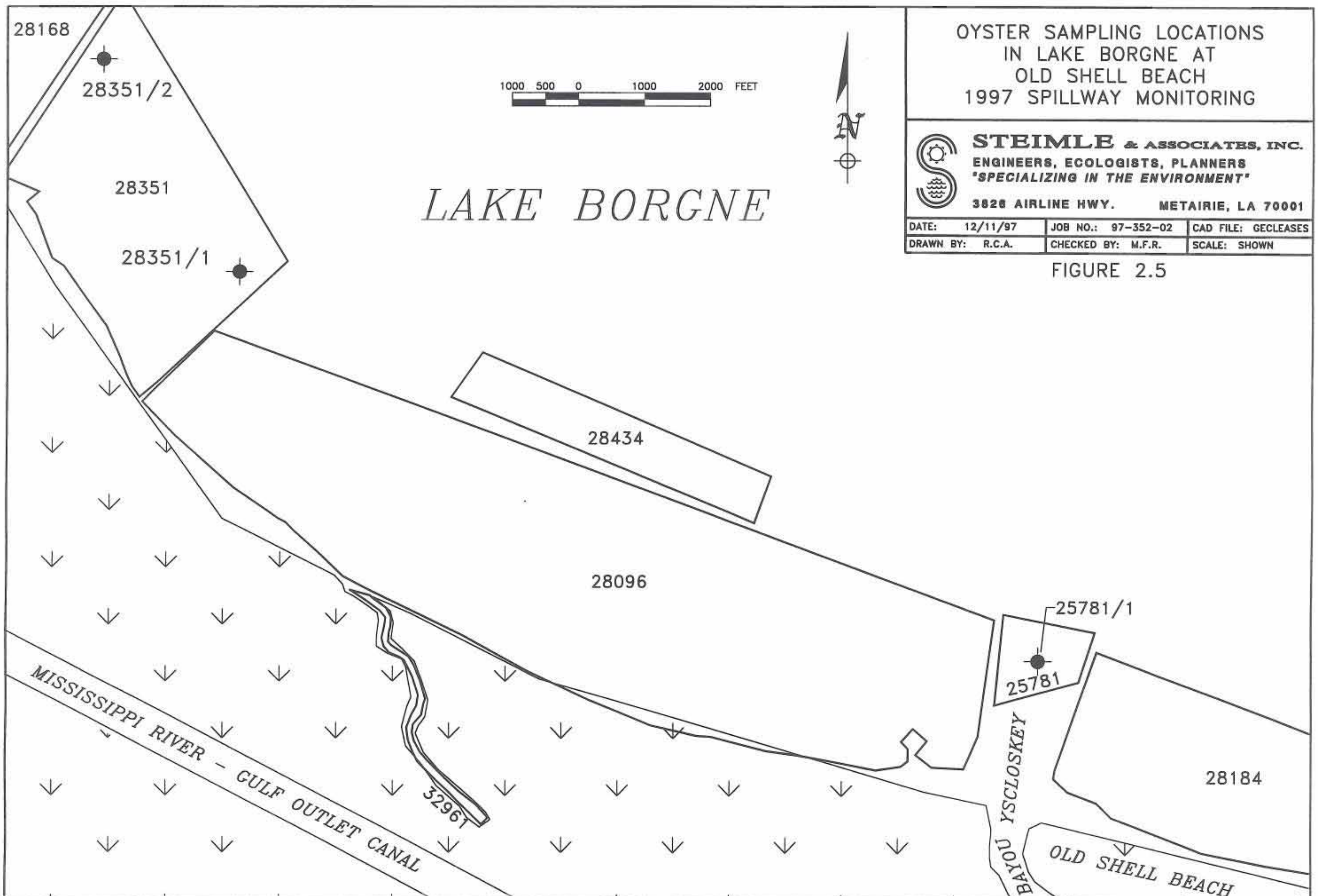
FIGURE 2.4


OYSTER SAMPLING LOCATIONS
IN LAKE BORGNE AT
OLD SHELL BEACH
1997 SPILLWAY MONITORING
STEIMLE & ASSOCIATES, INC.
ENGINEERS, ECOLOGISTS, PLANNERS
"SPECIALIZING IN THE ENVIRONMENT"
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METAIRIE, LA 70001
DATE: 12/11/97
JOB NO.: 97-352-02
CAD FILE: GECLEASES
DRAWN BY: R.C.A.
CHECKED BY: M.F.R.
SCALE: SHOWN
FIGURE 2.5
1000 500 0 1000 2000 FEET
N
LAKE BORGNE
28168
28351/2
28351
28351/1
28434
28096
25781/1
25781
28184
32961
MISSISSIPPI RIVER - GULF OUTLET CANAL
BAYOU YSCLOSKEY
OLD SHELL BEACH

Table 2.2. Spring 1997 Lake Borgne Oyster Sample Data Summary

LEASE NUMBER	L-34931	L-34931	L-34931	L-25714	L-34931	L-25781	L-28351	L-28351
SAMPLE IDENTIFICATION	O - 8	O - 9	O - 10	O - 12	O - 14	1	1	2
DATE	4/1/97	4/1/97	4/1/97	4/1/97	4/16/97	4/16/97	4/16/97	4/16/97
TOTAL LIVE	202	136	224	299	252	64	16	48
TOTAL RECENT DEAD	0	0	1	1	1	1	0	0
PERCENT RECENT MORTALITY	0%	0%	0%	0%	0%	2%	0%	0%
MARKET SIZED LIVE	34	74	50	120	43	13	7	5
MARKET SIZED RECENT DEAD	0	0	0	0	0	0	0	0
PERCENT MARKET MORTALITY	0%	0%	0%	0%	0%	0%	0%	0%
PERCENT MARKET SIZED	17%	54%	22%	40%	17%	20%	44%	10%
OLD BOXES	3	33	23	59	45	3	0	1
PERCENT OLD BOXES	1%	20%	9%	16%	15%	4%	0%	2%
MEAN TOTAL OYSTERS/M2	67.33	45.33	74.67	99.67	84.00	21.33	5.33	48.00
MEAN MARKET OYSTERS/M2	11.33	24.67	16.67	40.00	14.33	4.33	2.33	5.00
MEAN TOTAL OYSTERS/FT2	6.26	4.21	6.94	9.26	7.81	1.98	0.50	1.49
MEAN MARKET OYSTERS/FT2	1.05	2.29	1.55	3.72	1.33	0.40	0.22	0.15
MEAN MARKET SACKS/ACRE	229	499	337	810	290	88	47	34
MARKET SACKS S.D.	98	122	189	377	189	90	47	17
No. OF REPLICATES	6	6	6	6	6	6	6	6
SURFACE WATER SALINITY (ppt)	2.1	N/A	N/A	3.5	<0.5	<0.5	N/A	<0.5
BOTTOM WATER SALINITY (ppt)	2.1	N/A	N/A	3.8	<0.5	<0.5	N/A	<0.5

Table 2.3. Fall 1997 Lake Pontchartrain and Mississippi Sound Oyster Sample Data Summary

STATION	LITTLE BAYOU PIERRE	CABBAGE REEF	REEF 15	GRAND PASS	REEF 8	PELICAN REEF	CAPT. NELSON	THREE MILE	HALF MOON REEF	REEF 12
DATE	9/22/97	9/22/97	9/29/97	9/22/97	9/22/97	9/22/97	9/22/97	9/29/97	9/29/97	9/29/97
TOTAL LIVE	157	95	42	158	135	301	231	45	48	9
TOTAL RECENT DEAD	3	6	0	1	0	3	3	0	1	1
PERCENT RECENT MORTALITY	2%	6%	0%	1%	0%	1%	1%	0%	2%	10%
MARKET SIZED LIVE	30	3	14	12	14	47	9	10	10	0
MARKET SIZED RECENT DEAD	0	0	0	0	0	0	0	0	0	0
PERCENT MARKET MORTALITY	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PERCENT MARKET SIZED	19%	3%	33%	8%	10%	15%	4%	22%	20%	0%
OLD BOXES	16	0	3	6	2	20	3	2	0	0
PERCENT OLD BOXES	9%	0%	7%	4%	1%	6%	1%	4%	0%	0%
MEAN TOTAL OYSTERS/M2	52.33	31.67	14.00	52.67	45.00	100.33	77.00	15.00	16.00	3.00
MEAN MARKET OYSTERS/M2	10.00	1.00	4.67	4.00	4.67	15.67	3.00	3.33	3.33	0.00
MEAN TOTAL OYSTERS/FT2	4.86	2.94	1.30	4.89	4.18	9.32	7.16	1.39	1.49	0.28
MEAN MARKET OYSTERS/FT2	0.93	0.09	0.43	0.37	0.43	1.46	0.28	0.31	0.31	0.00
MEAN MARKET SACKS/ACRE	202	20	94	81	94	317	61	67	67	0
MARKET SACKS S.D.	96	22	61	68	87	287	71	130	91	0
No. OF REPLICATES	6	6	6	6	6	6	6	6	6	6
SURFACE WATER SALINITY (ppt)	22.5	24.2	8.2	21.8	16.2	17.5	15.0	13.2	8.6	8.9
BOTTOM WATER SALINITY (ppt)	22.5	24.2	8.2	21.8	19.2	18.5	17.8	13.0	9.7	8.9

Table 2.4. Fall 1997 Lake Borgne Oyster Sample Data Summary

LEASE NUMBER	L-34931	L-34931	L-34931	L-25714	L-34931	L-25781	L-28351	L-28351
SAMPLE IDENTIFICATION	O-8	O - 9	O-10	0-12	O-14	1	1	2
DATE	9/18/97	9/18/97	9/18/97	9/18/97	9/18/97	9/18/97	9/18/97	9/18/97
TOTAL LIVE	155	178	283	356	217	194	20	34
TOTAL RECENT DEAD	0	0	0	2	0	2	0	0
PERCENT RECENT MORTALITY	0%	0%	0%	1%	0%	1%	0%	0%
MARKET SIZED LIVE	26	50	55	39	55	37	12	10
MARKET SIZED RECENT DEAD	0	0	0	1	0	0	0	0
PERCENT MARKET MORTALITY	0%	0%	0%	3%	0%	0%	0%	0%
PERCENT MARKET SIZED	17%	28%	19%	11%	25%	19%	60%	29%
OLD BOXES	4	5	23	14	22	30	0	1
PERCENT OLD BOXES	3%	3%	8%	4%	9%	13%	0%	3%
MEAN TOTAL OYSTERS/M2	51.67	59.33	94.33	118.67	72.33	64.67	6.67	11.33
MEAN MARKET OYSTERS/M2	8.67	16.67	18.33	13.00	18.33	12.33	4.00	3.33
MEAN TOTAL OYSTERS/FT2	4.80	5.51	8.77	11.03	6.72	6.01	0.62	1.05
MEAN MARKET OYSTERS/FT2	0.81	1.55	1.70	1.21	1.70	1.15	0.37	0.31
MEAN MARKET SACKS/ACRE	175	337	371	263	371	250	81	67
MARKET SACKS S.D.	87	75	152	147	139	148	36	91
No. OF REPLICATES	6	6	6	6	6	6	6	6
SURFACE WATER SALINITY (ppt)	N/A	N/A	N/A	8.6	N/A	13.8	N/A	N/A
BOTTOM WATER SALINITY (ppt)	N/A	N/A	N/A	8.7	N/A	17.3	N/A	N/A

The recent mortalities were low (0-1 percent) in all samples. The percentages of old boxes in the samples ranged from zero percent at L-28351/1 to 13 percent at L-25781/1.

Comparison of Initial and Final Oyster Sample Data

The initial and final oyster data from each individual sampling location were compiled into a size-frequency histogram. These histograms compare the numbers of live and recently dead oyster per 3.0 m^2 total sample area by size class for the two sampling periods. The line in the approximate center of the graph separates the sub-market sized oysters (<7.6 cm or 3.0") from the market sized oysters (≥ 7.6 cm or 3.0"). In addition to comparing the relative numbers of oysters present in the individual size classes between sampling periods, the histograms show the distribution of the size classes in the samples. The distribution of the different size classes of oysters can be used to determine recruitment into the population, growth and relative mortality of individual year classes, and the numbers of year classes present in the population.

Lake Pontchartrain - Mississippi Sound

Figure 2.6 shows a size - frequency histogram of initial and final oyster data from the Cabbage Reef sampling location. The histogram shows that more oysters were present in the final samples than in the initial samples. Most of the additional oysters present in the final samples appear to be small (0.6-3.0 cm) oysters. The histogram also shows that most of the oysters present in both sample periods were less than market-sized.

Figure 2.7 shows the size - frequency histogram of the initial and final oyster data from the Little Bayou Pierre sampling location. The initial samples showed a substantial number of both sub-market and market-sized oysters that did not appear in the final samples. The final samples showed a new set of oysters in the 0.6-2.0 cm size classes.

Figure 2.8 shows the size - frequency histogram of the initial and final oyster data from the Grand Pass sampling location. The initial samples showed a substantial number of sub-market sized oysters that did not appear in the final samples. The final samples showed a new set of oysters in the 0.1-1.5 cm size classes.

Figure 2.9 shows the size - frequency histogram of the initial and final oyster data from the Pelican Reef sampling location. The initial and final samples showed substantial numbers of sub-market sized oysters, but relatively few market-sized oysters.

Figure 2.10 shows the size - frequency histogram of the initial and final oyster data from the Reef 8 sampling location. The initial samples showed substantial numbers of sub-market sized oysters, particularly in the 2.1 - 4.0 cm size classes. These size classes were not as abundant in the final samples. Relatively few market-sized oysters were present in the initial or final samples.

Figure 2.11 shows the size - frequency histogram of the initial and final oyster data from the Three Mile Reef sampling location. The initial samples contained more oysters than the final samples. Relatively few market-sized oysters were present in the initial or final samples.

Figure 2.6: Oyster Sample Data - Cabbage Reef - March and September, 1997

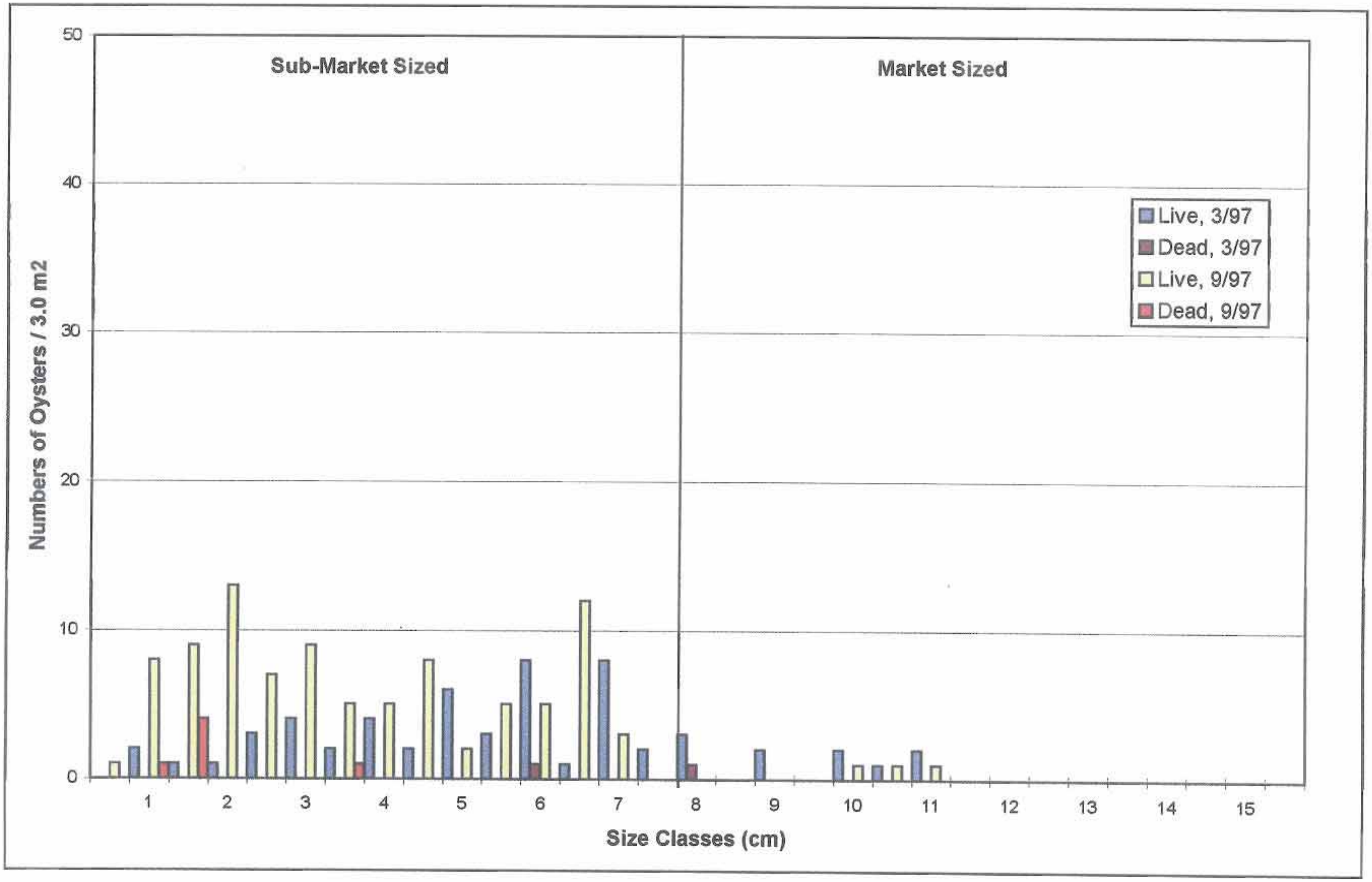
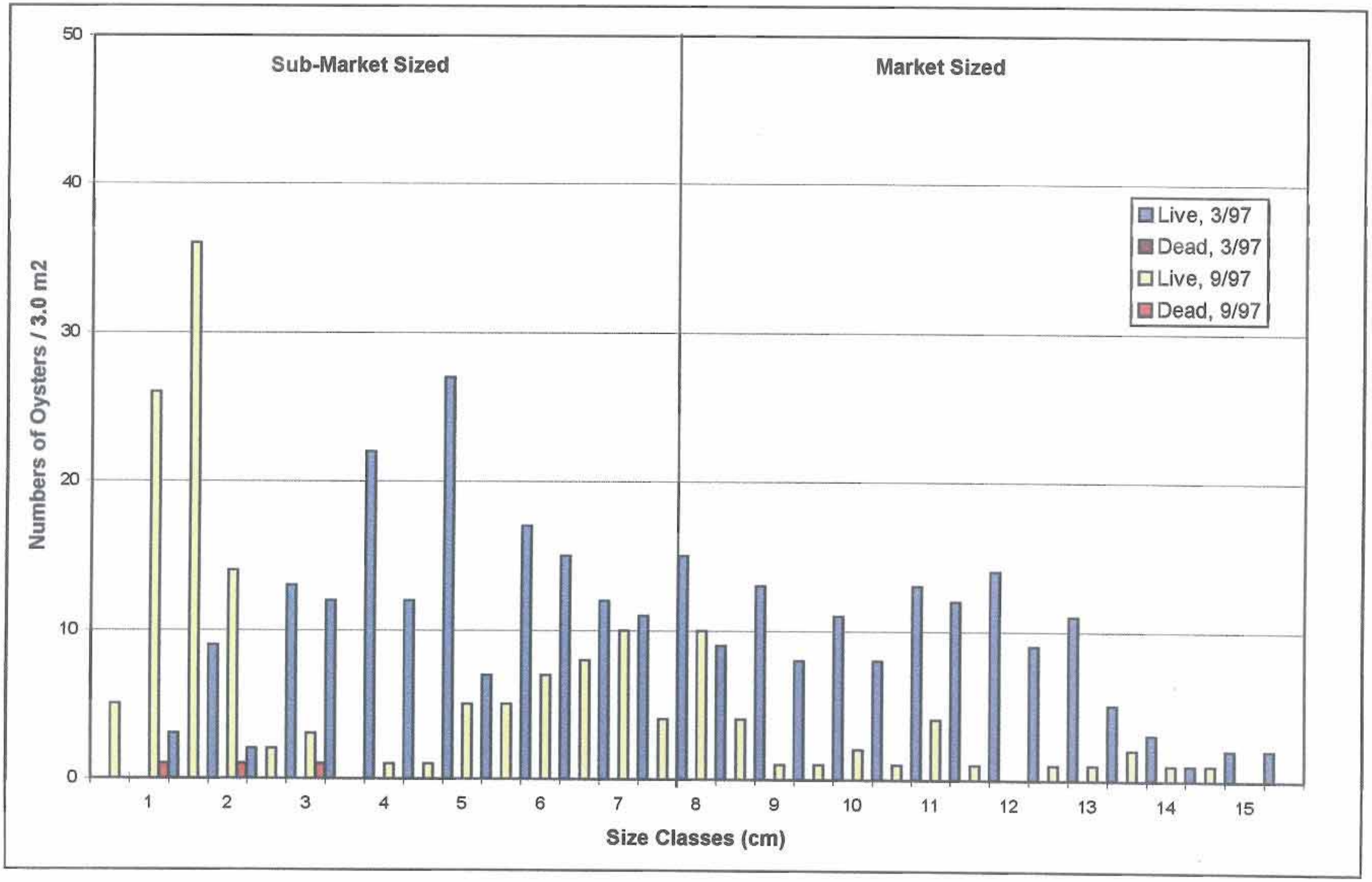


Figure 2.7: Oyster Sample Data - Little Bayou Pierre - March and September, 1997



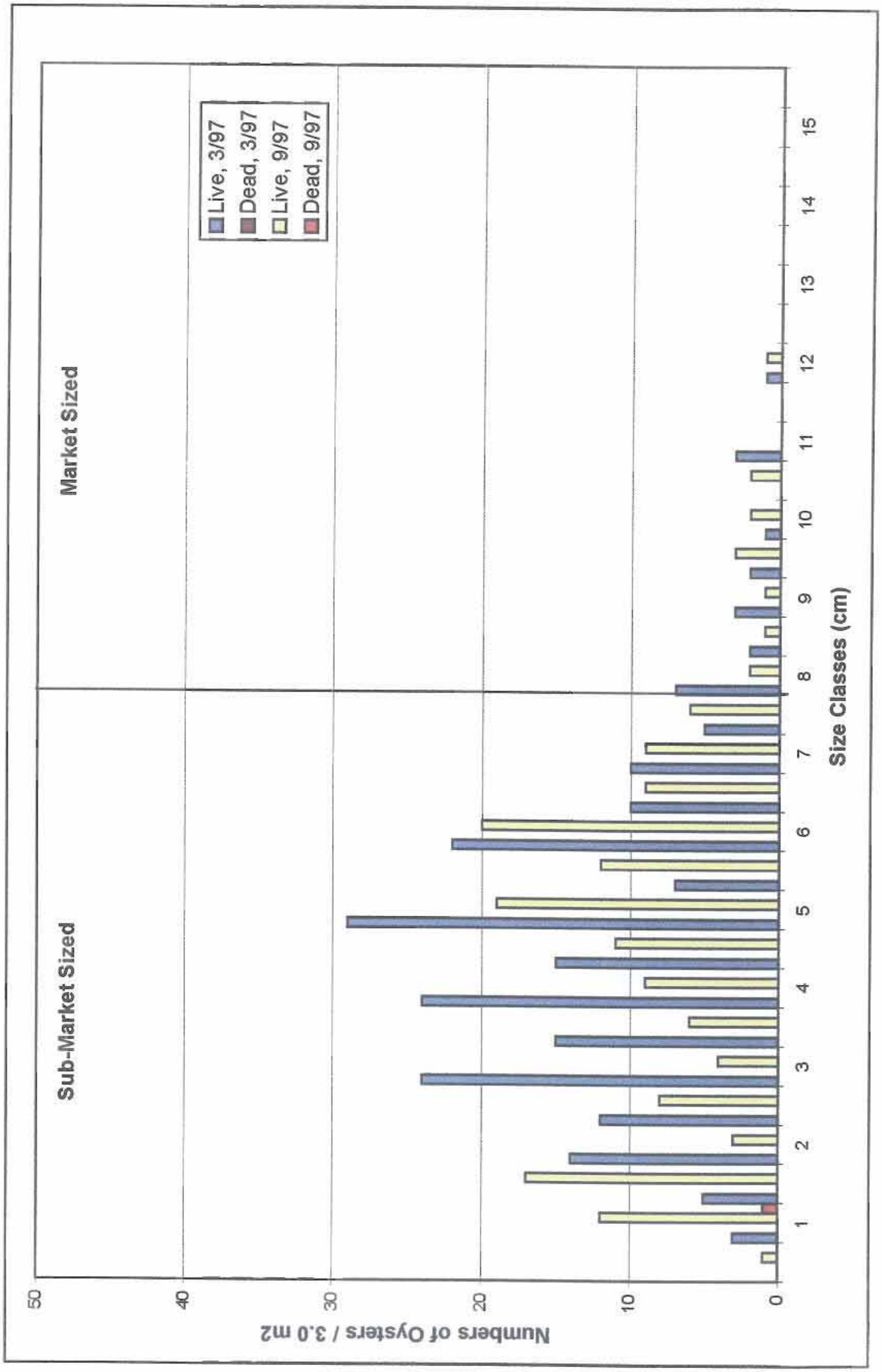


Figure 2.8: Oyster Sample Data - Grand Pass - March and September, 1997

Figure 2.9: Oyster Sample Data - Pelican Reef - March and September, 1997

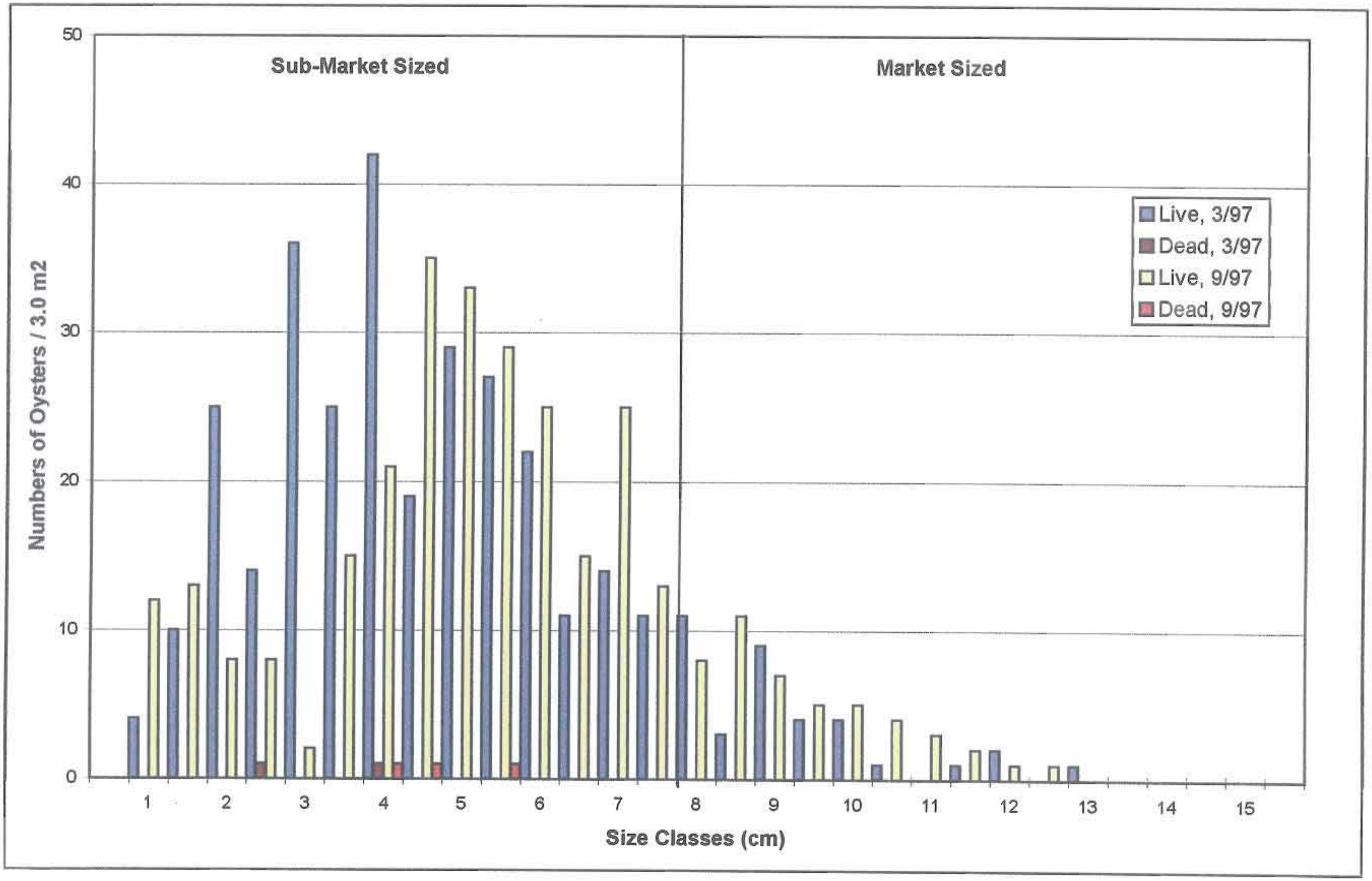


Figure 2.10: Oyster Sample Data - Reef 8 - March and September, 1997

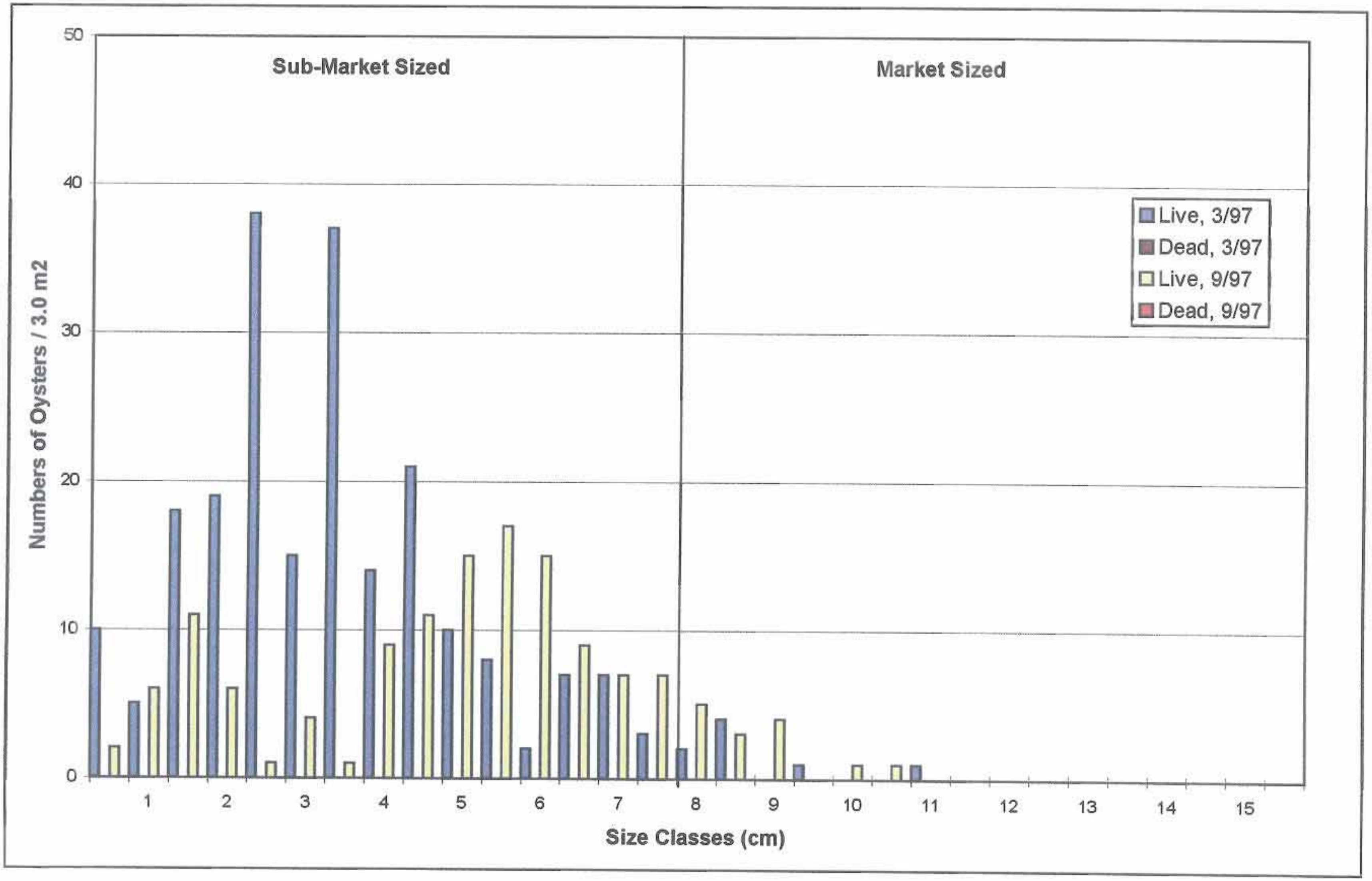


Figure 2.11: Oyster Sample Data - Three Mile Reef - March and September, 1997

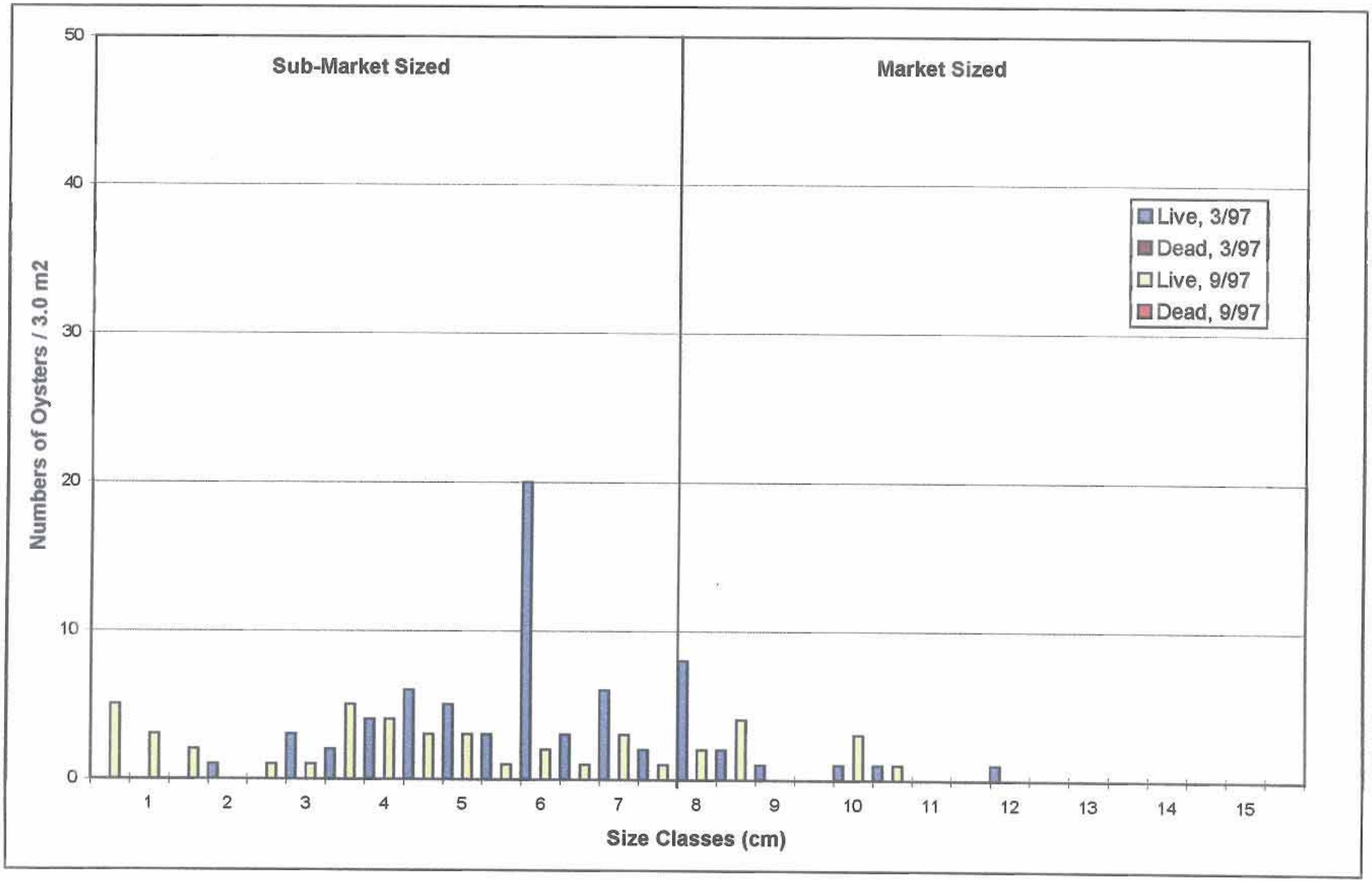


Figure 2.12 shows the size - frequency histogram of the initial and final oyster data from the Capt. Nelson sampling location. The initial samples showed substantial numbers of sub-market-sized oysters, particularly in the 3.1-5.5 cm size classes. These size classes were not as abundant in the final samples. The final samples contained numerous small oyster in the 0.1-3.0 cm size classes that were not present in the initial samples. Relatively few market-sized oysters were present in the initial or final samples.

Figure 2.13 shows the size - frequency histogram of the initial and final oyster data from the Half Moon Reef sampling location. The initial samples contained more oysters than the final samples. Relatively few market-sized oysters were present in the initial or final samples.

Figure 2.14 shows the size - frequency histogram of the initial and final oyster data from the Reef 12 sampling location. Both the initial and final samples contained few oysters. No market-sized oysters were found in the final samples.

Figure 2.15 shows the size - frequency histogram of the initial and final oyster data from the Reef 15 sampling location. More oysters were collected in the final samples than in the initial samples. Both the initial and final samples contained relatively few oysters.

Lake Borgne - Bayou Dupre

Figure 2.16 shows the size - frequency histogram of the initial and final oyster data from the L-34931/O-8 sampling location. More oysters were collected in the initial samples than in the final samples. Both the initial and final samples contained primarily sub-market-sized oysters.

Figure 2.17 shows the size - frequency histogram of the initial and final oyster data from the L-34931/O-9 sampling location. More oysters were collected in the final samples than in the initial samples. The final samples contained numerous oysters in the 5.1-6.5 cm size classes that were less abundant the initial samples.

Figure 2.18 shows the size - frequency histogram of the initial and final oyster data from the L-34931/O-10 sampling location. More oysters were collected in the final samples than in the initial samples. The final samples contained numerous oysters in the 5.1-6.5 cm size classes that were less abundant the initial samples. Additionally, no oysters in the 0.1-2.0 cm size classes were present in the initial samples, but, were present in the final samples.

Figure 2.19 shows the size - frequency histogram of the initial and final oyster data from the L-25714/O-12 sampling location. More oysters were collected in the final samples than in the initial samples. The final samples contained numerous small oysters in the 0.1-3.0 cm size classes that were absent or less abundant the initial samples.

Figure 2.20 shows the size - frequency histogram of the initial and final oyster data from the L-34931/O-14 sampling location. More oysters were collected in the initial samples than in the final samples. The final samples contained more market-sized oysters than the initial samples.

Lake Borgne - Old Shell Beach

Figure 2.21 shows the size - frequency histogram of the initial and final oyster data from the L-25781/1 sampling location. The final samples contained more oysters than the initial samples, primarily in the 3.6-8.0 cm size classes.

Figure 2.12: Oyster Sample Data - Captain Nelson - March and September, 1997

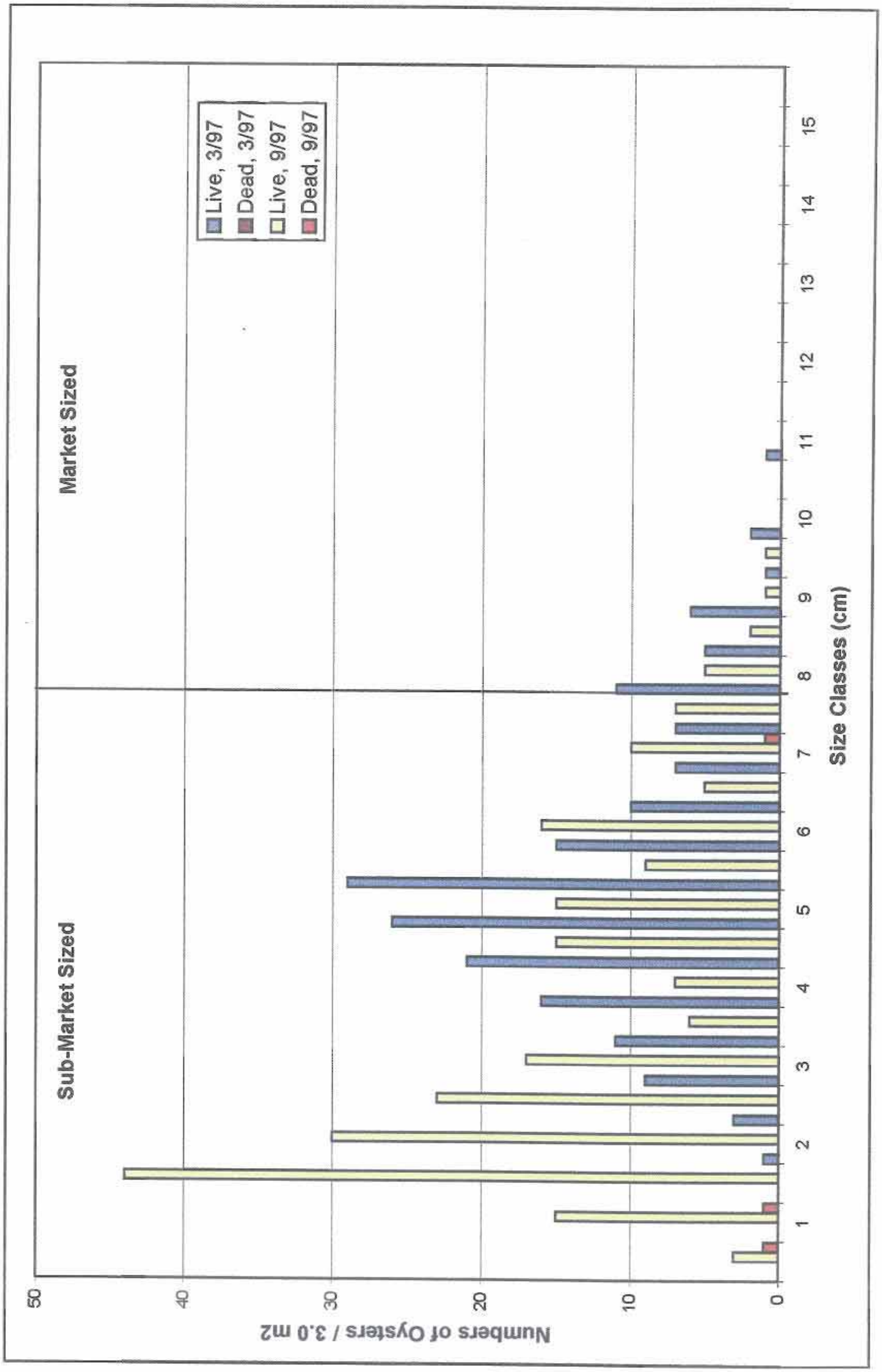


Figure 2.13: Oyster Sample Data - Half Moon Reef - March and September, 1997

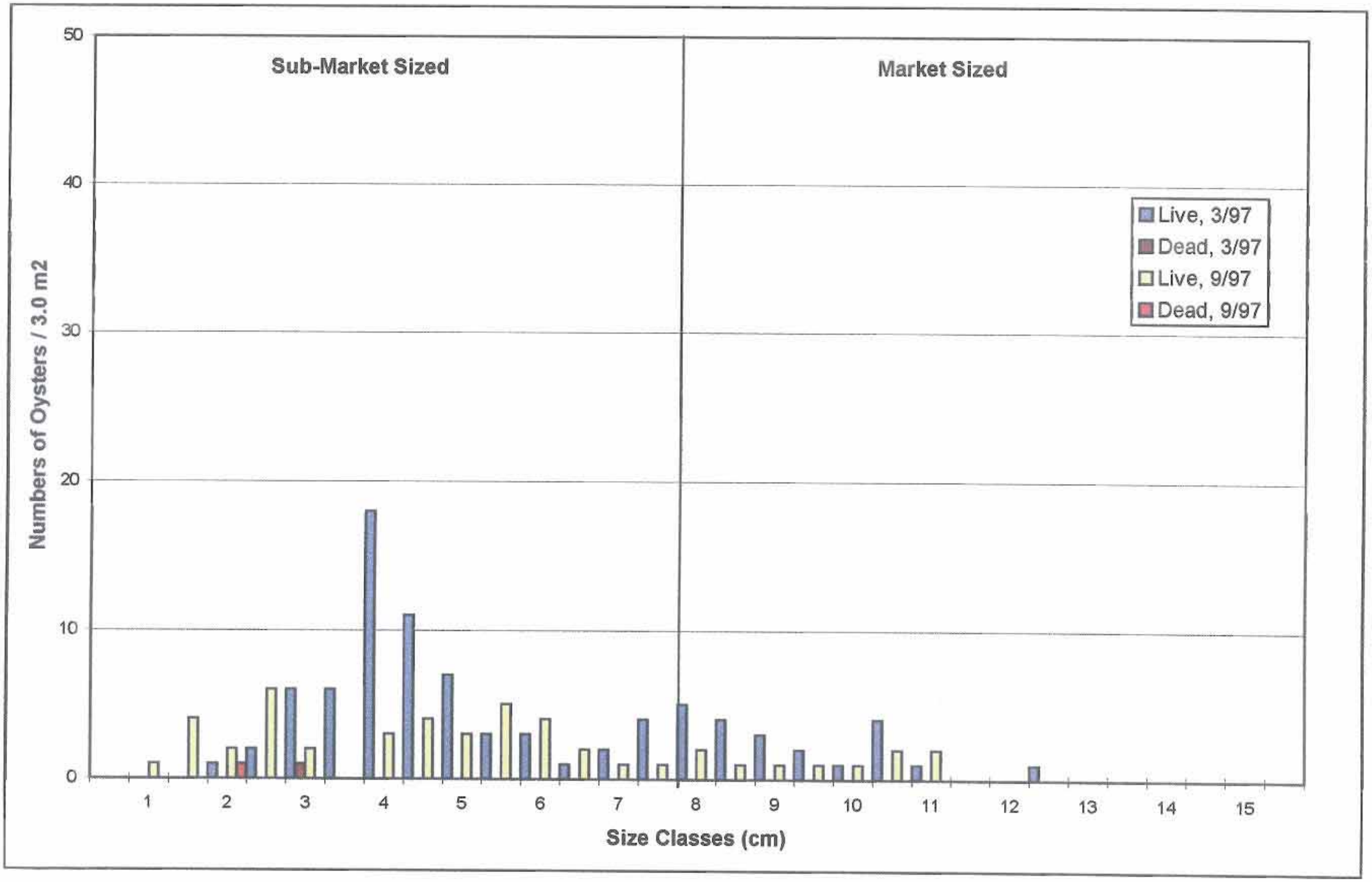


Figure 2.14: Oyster Sample Data - Reef 12 - March and September, 1997

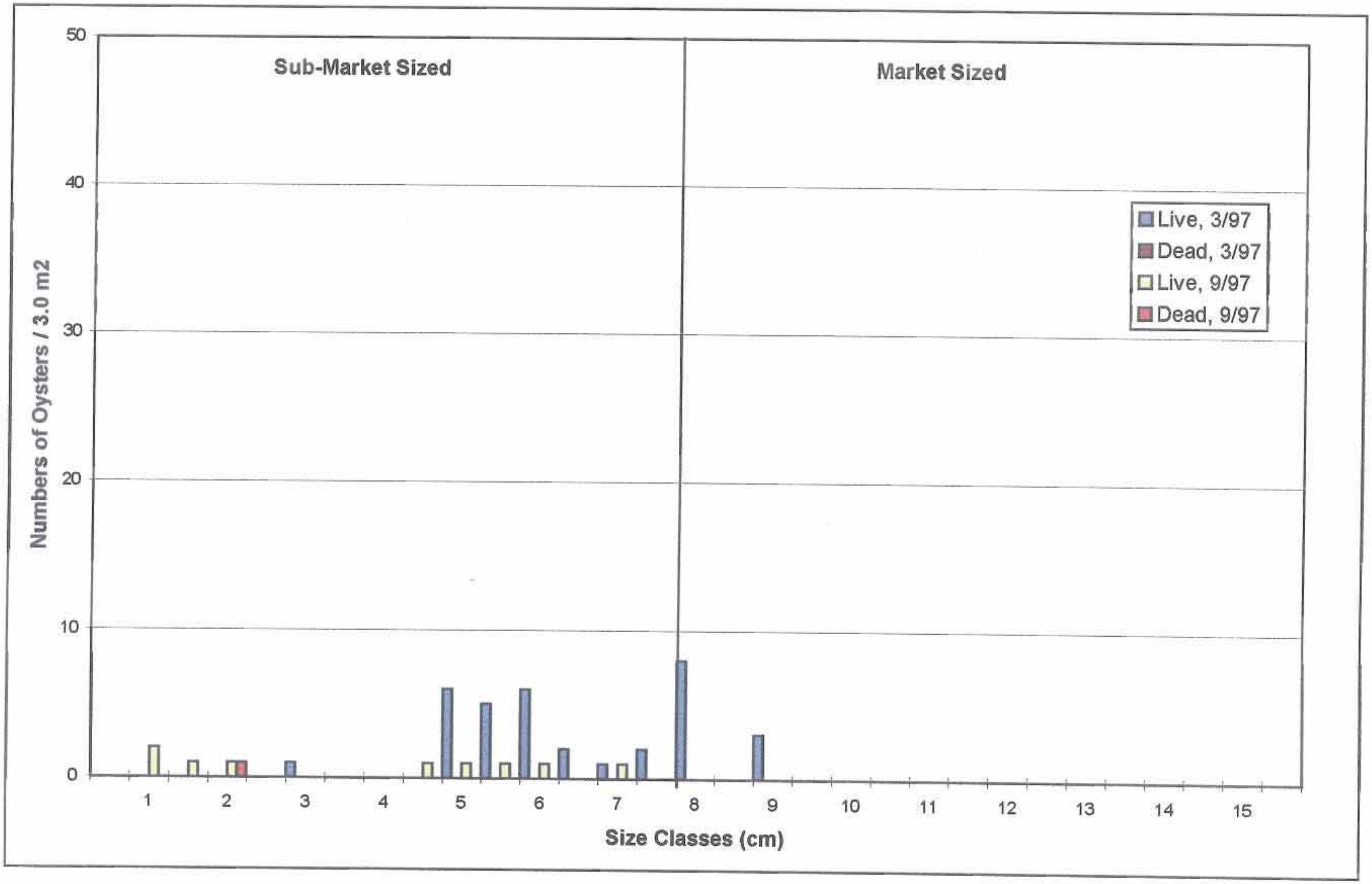


Figure 2.15: Oyster Sample Data - Reef 15 - March and September, 1997

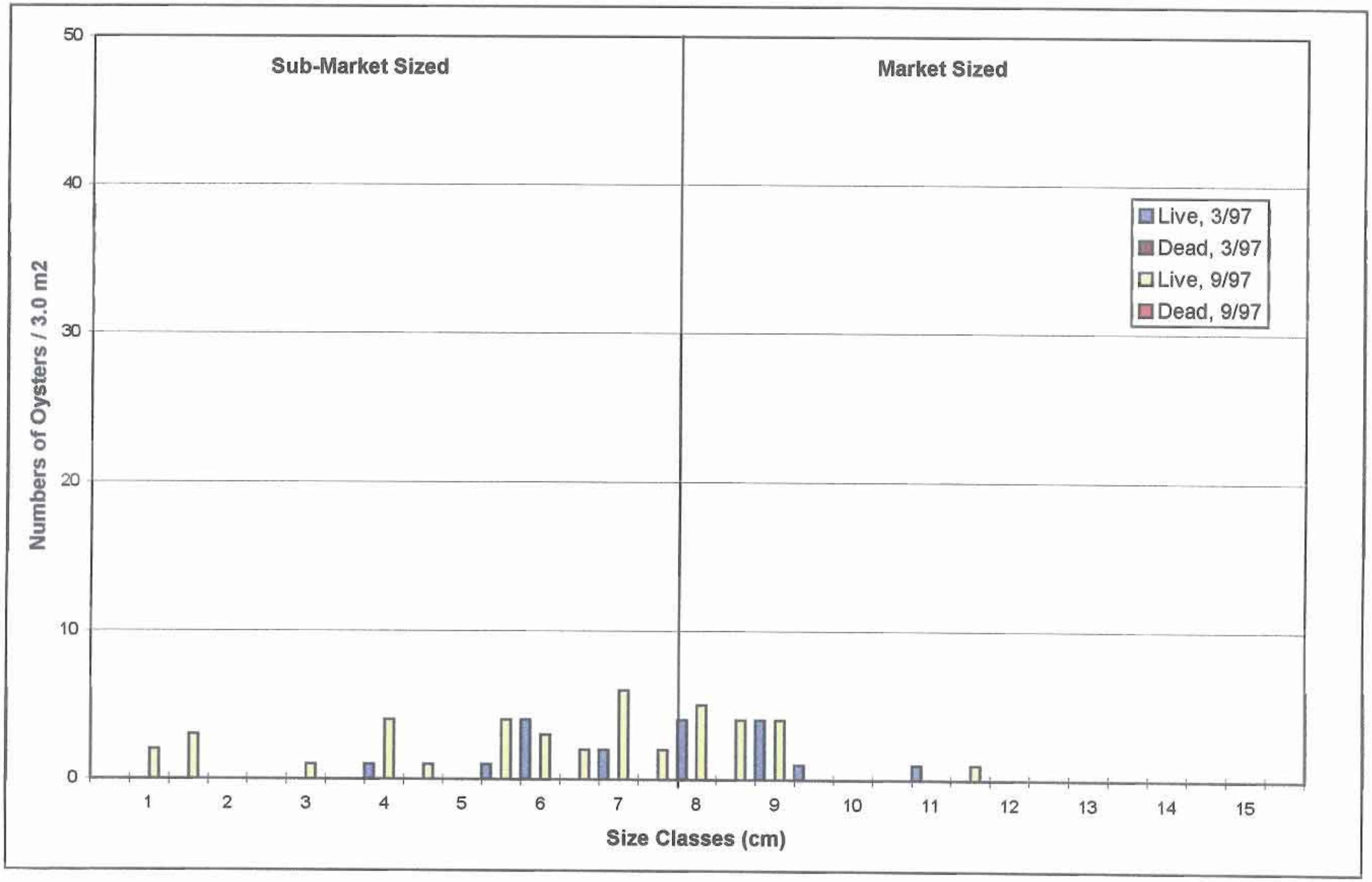


Figure 2.16: Oyster Sample Data - L-34941/O-8 - March and September, 1997

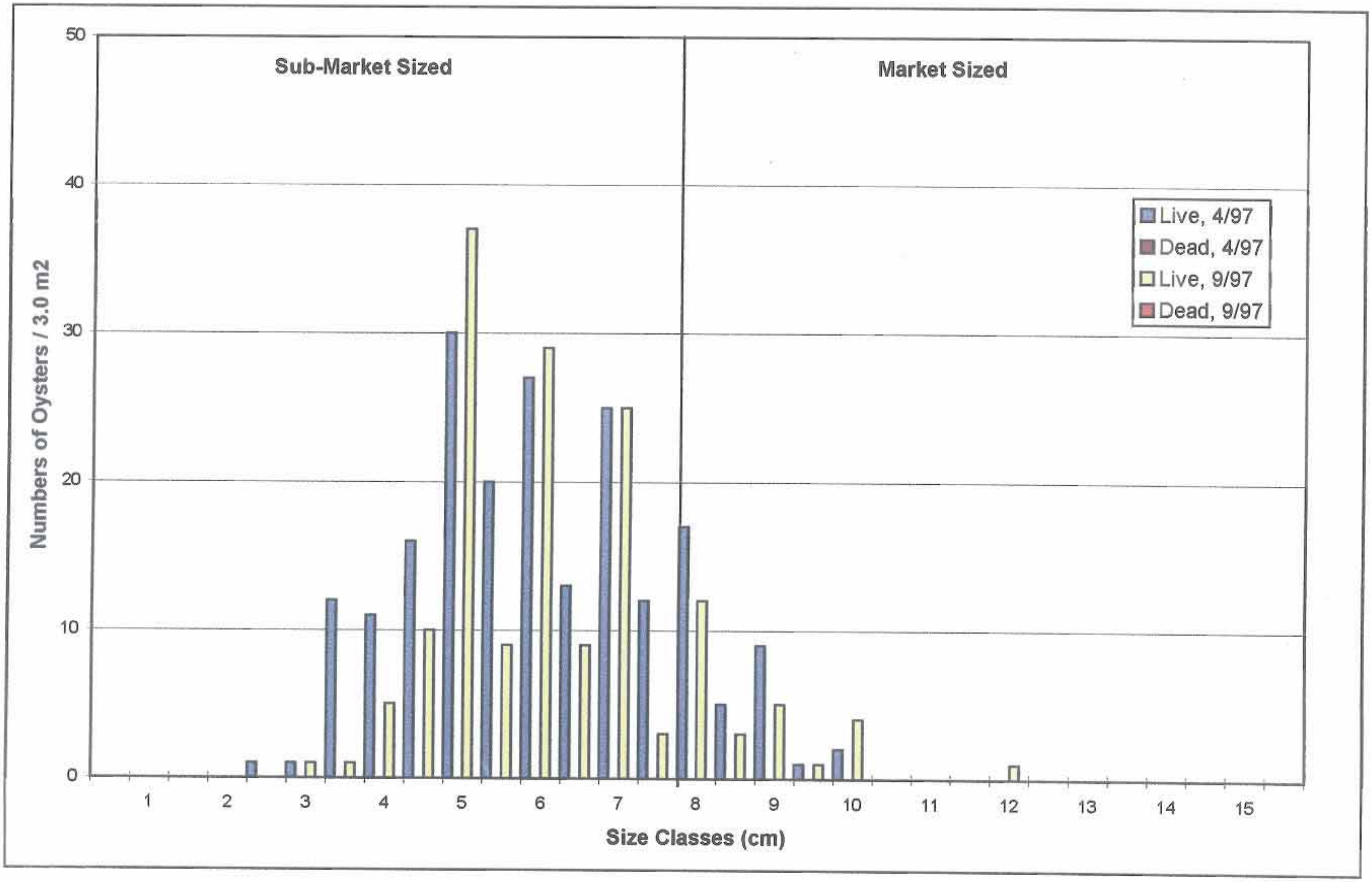


Figure 2.17: Oyster Sample Data - L-34931/O-9 - March and September, 1997

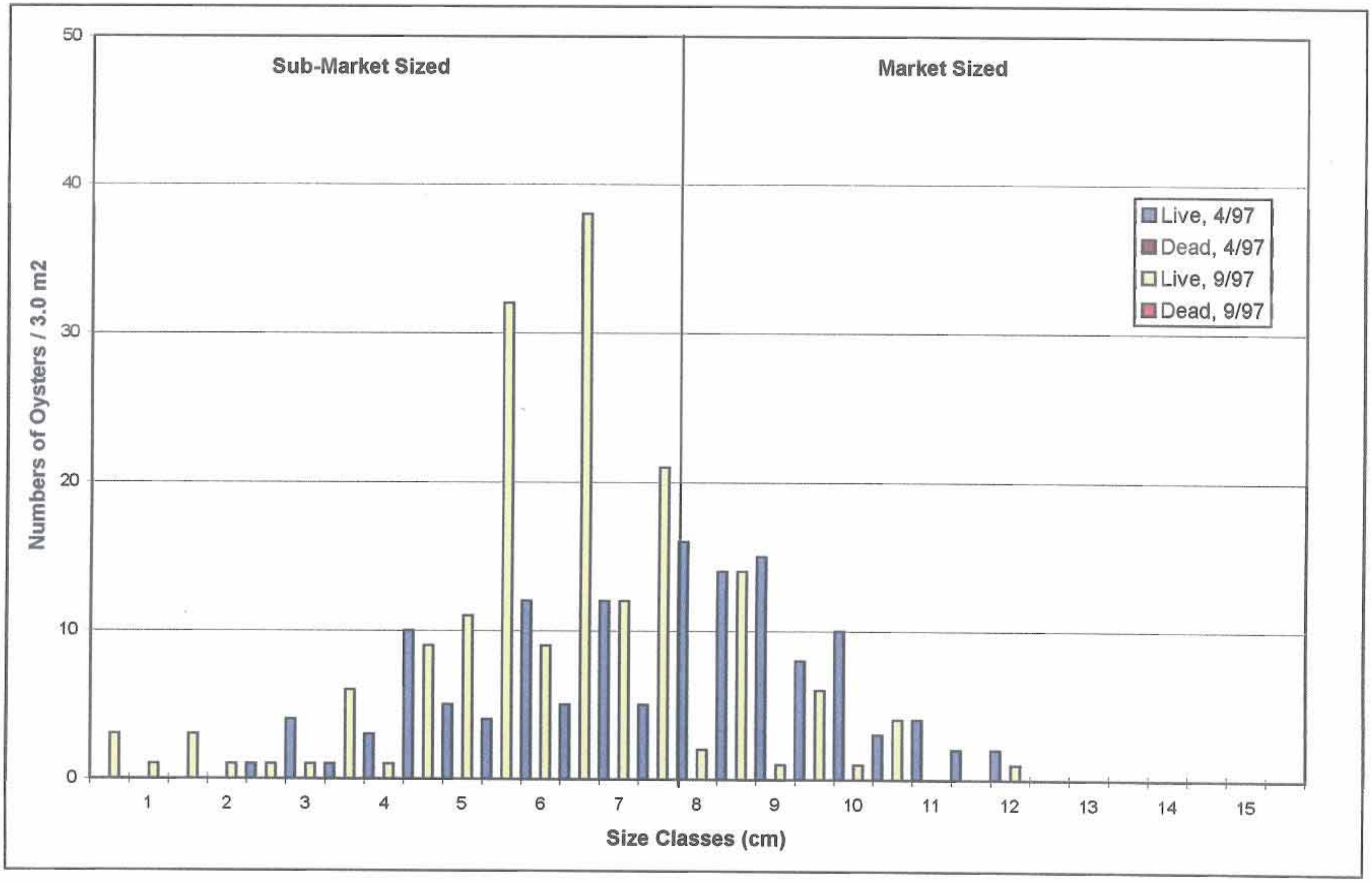


Figure 2.18: Oyster Sample Data - L-34391/O-10 - March and September, 1997

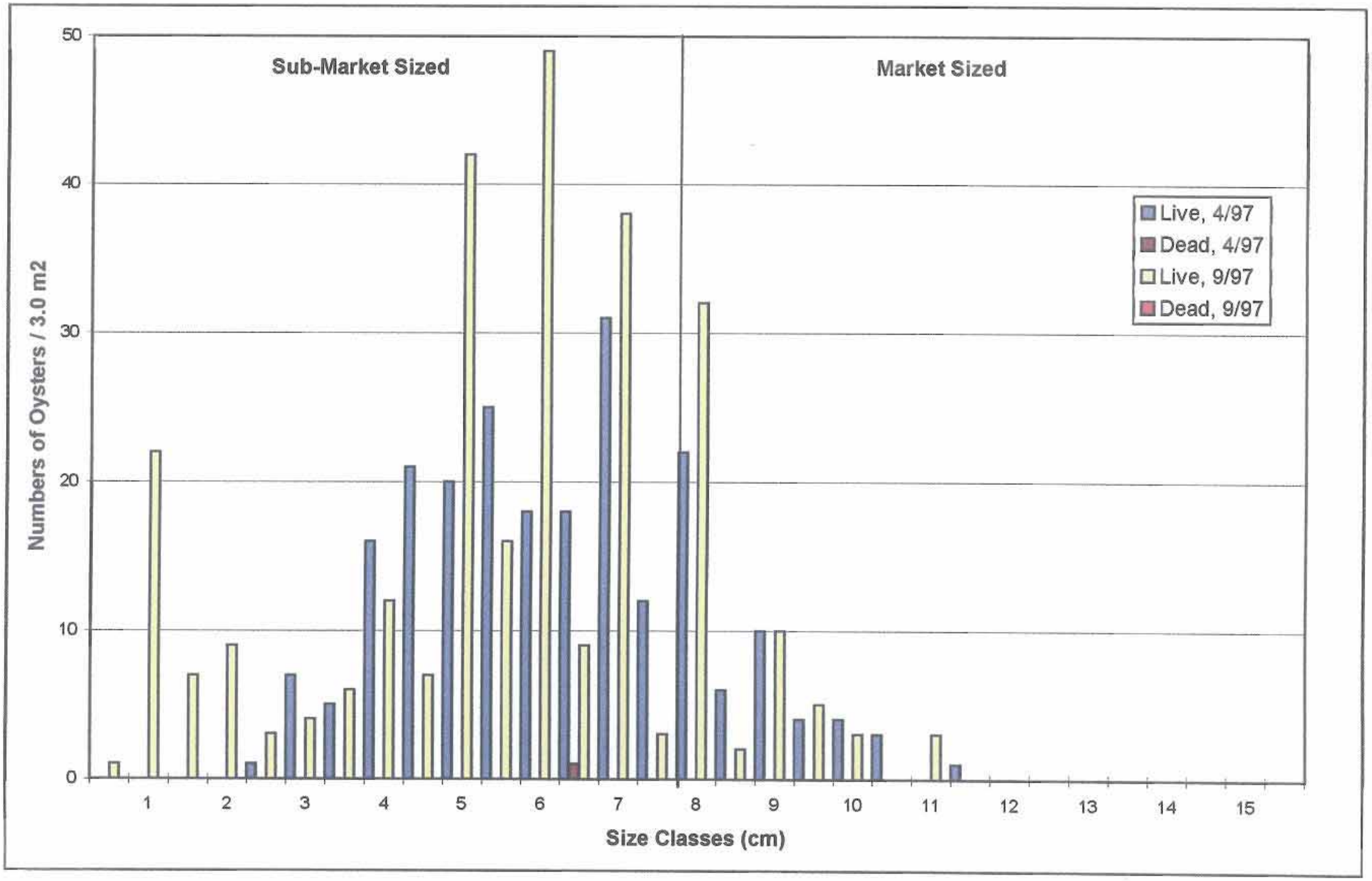


Figure 2.19: Oyster Sample Data - L-25714/O-12 - March and September, 1997

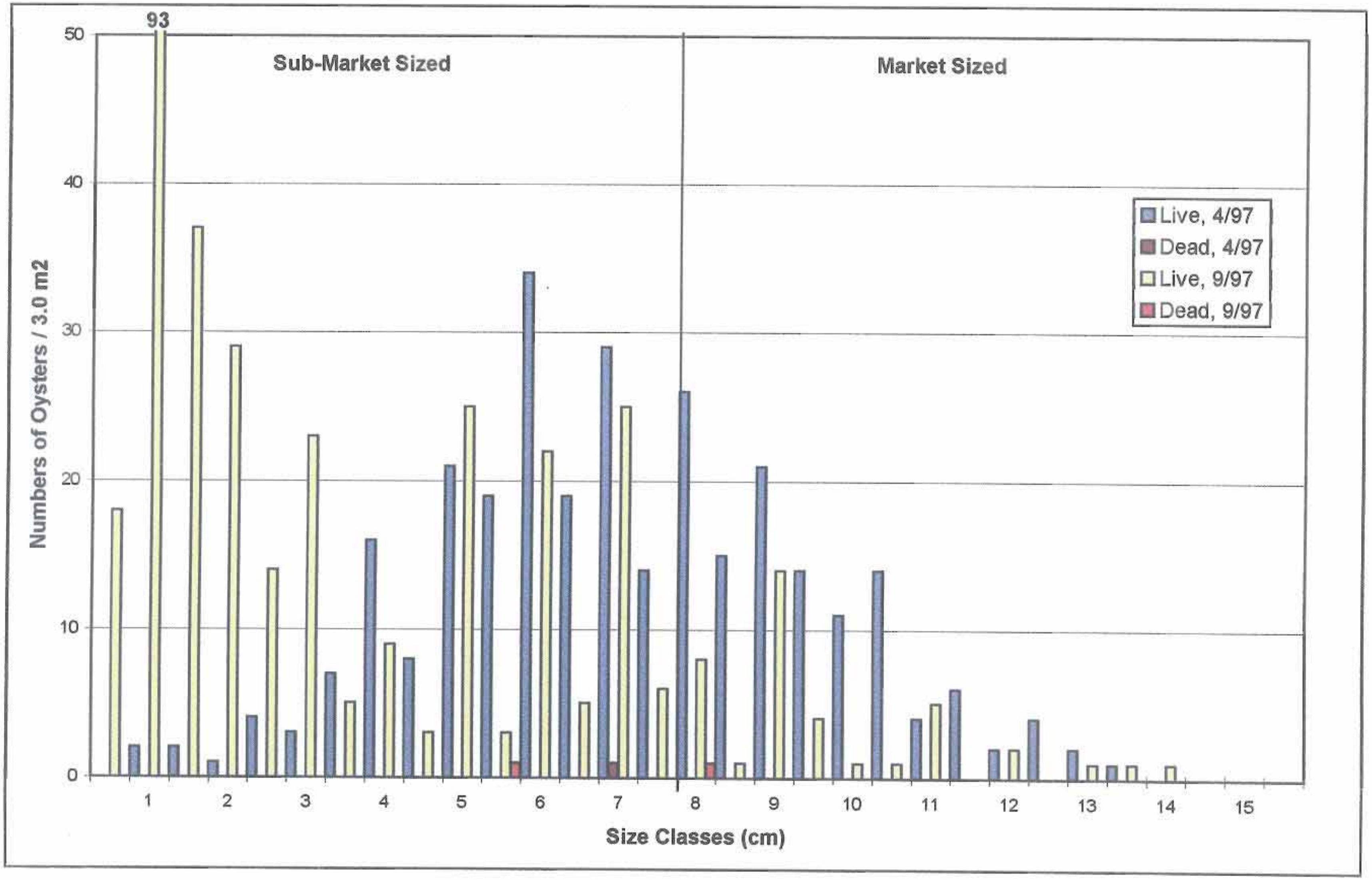


Figure 2.20: Oyster Sample Data - L-34391/O-14 - March and September, 1997

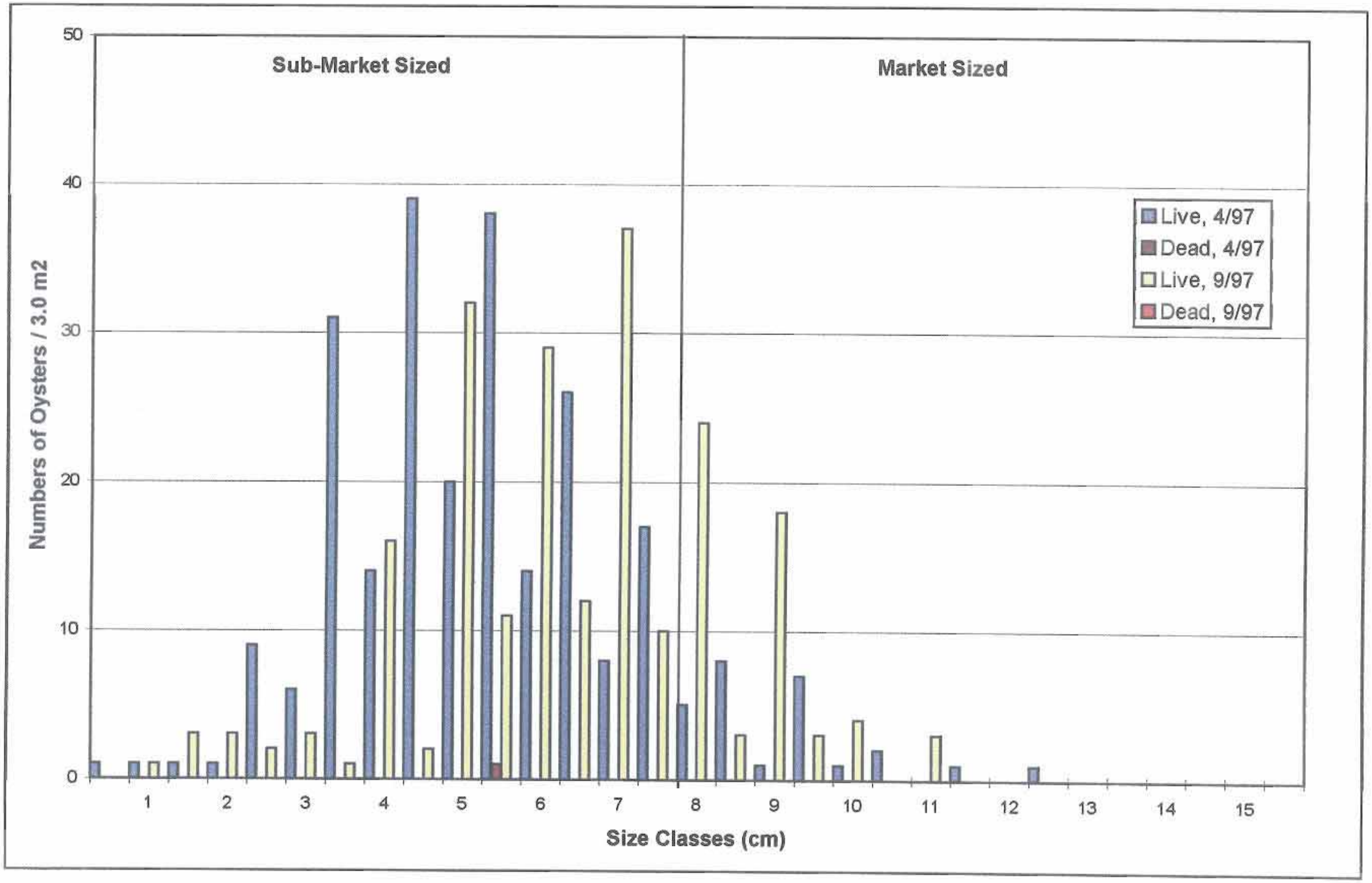


Figure 2.21: Oyster Sample Data - L-25781/1 - March and September, 1997

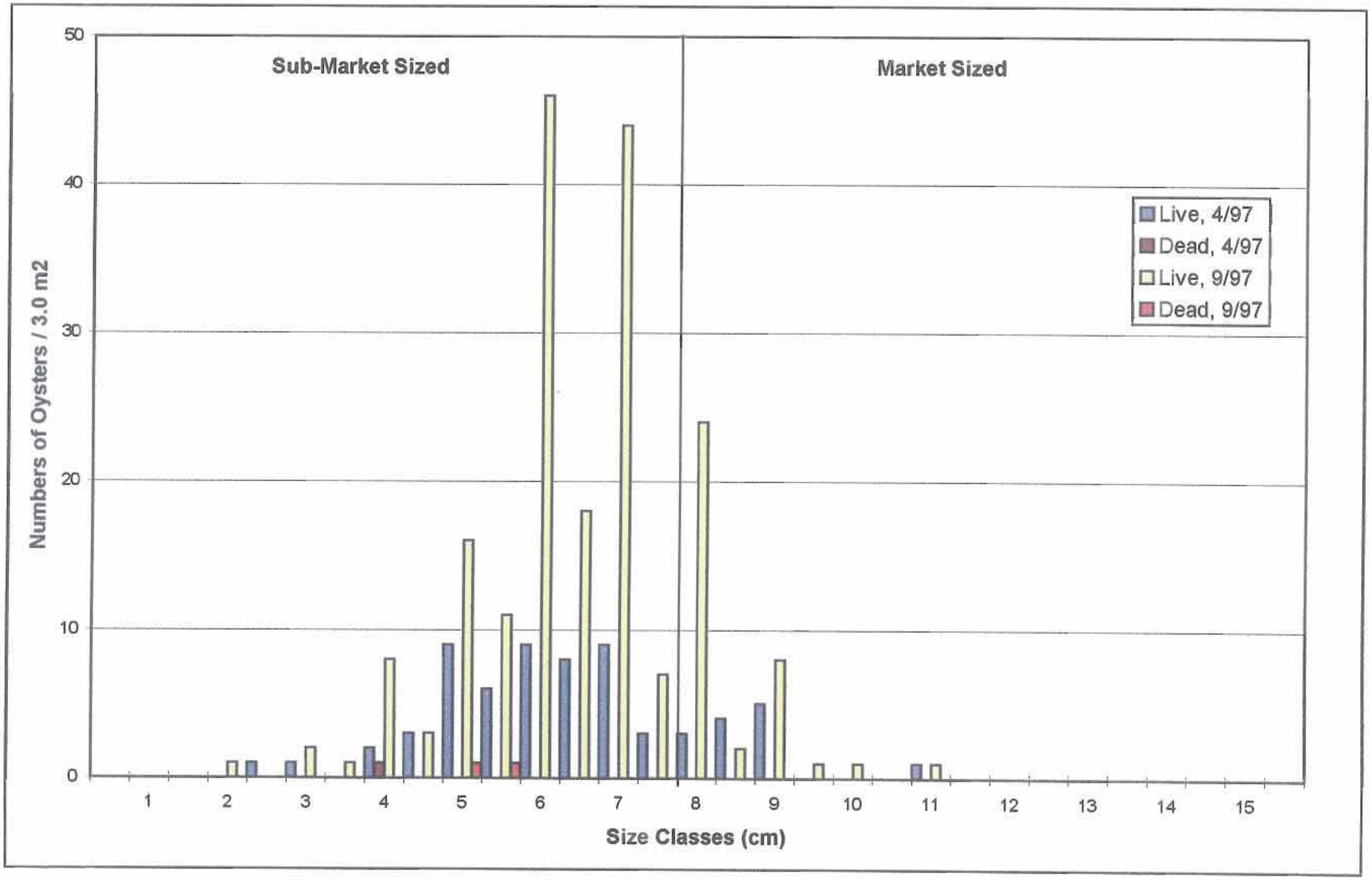


Figure 2.22 shows the size - frequency histogram of the initial and final oyster data from the L-28351/1 sampling location. Relatively few oysters were collected in both the initial and final samples at this location.

Figure 2.23 shows the size - frequency histogram of the initial and final oyster data from the L-28351/2 sampling location. More oysters were collected in the initial samples than in the final samples.

Statistical Analyses of Live Oyster Data

The oyster variable used in all analyses was the total number of live oysters. The square root transformation was used to ensure normality of the data. For zero counts, the value of 0.5 was used.

Lake Pontchartrain - Mississippi Sound

The Hospital Wall and Capt. Curtis sampling locations were excluded from the statistical analysis of the Lake Pontchartrain - Mississippi Sound oyster data set due to the lack of live oysters in the initial survey. These stations were not sampled in the final survey. The remaining 10 stations were sampled in each of the initial and final monitoring surveys, with six replicates per sample for a total of 120 observations.

The hypothesis under test was that the average number of live oysters present in the initial and final sampling periods were not significantly different. A two-way analysis of variance (ANOVA) was conducted for the factors sampling location (SITE) and sampling period (PERIOD). The two-way design permits the isolation of variation due to differences between sampling locations (SITE). The results of the analysis are presented in Table 2.5.

Table 2.5. Lake Pontchartrain-Mississippi Sound Live Oyster Data ANOVA Table

Source	Sum of Squares	df	Mean Square	F-Ratio	p
SITE	345.931	9	38.437	13.272	0.000
PERIOD	8.893	1	8.893	3.071	0.083
ERROR	315.672	109	2.896		

The statistic for significance testing is the ratio of sampling period (PERIOD) to error (ERROR) mean square. The hypothesis of no significant difference in the numbers of live oysters in the two periods cannot be rejected at the five percent level of significance, but, it can be rejected at the eight percent level (p=0.083). In other words, there were no significant differences in the numbers of live oysters between surveys at the five percent level of significance but there was a significant difference at the eight percent level of significance.

Lake Borgne - Bayou Dupre

Five stations, two sampling periods and six replicates per sample produced a total of 60 observations. Data were pooled within sampling periods because of the close geographic proximity of the sampling locations and compared by a standard two-sample t-test.

Figure 2.22: Oyster Sample Data - L-28351/1 - March and September, 1997

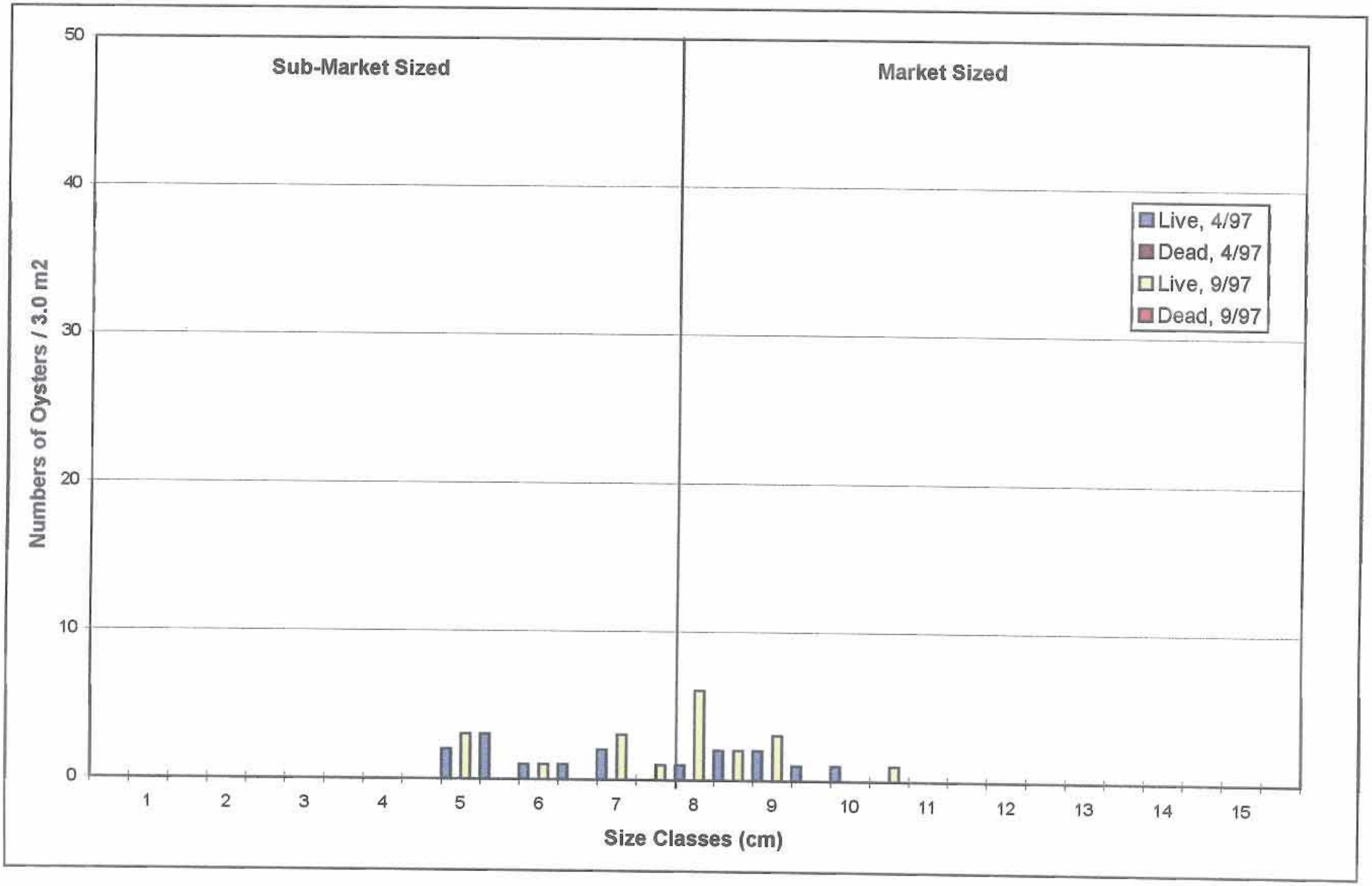
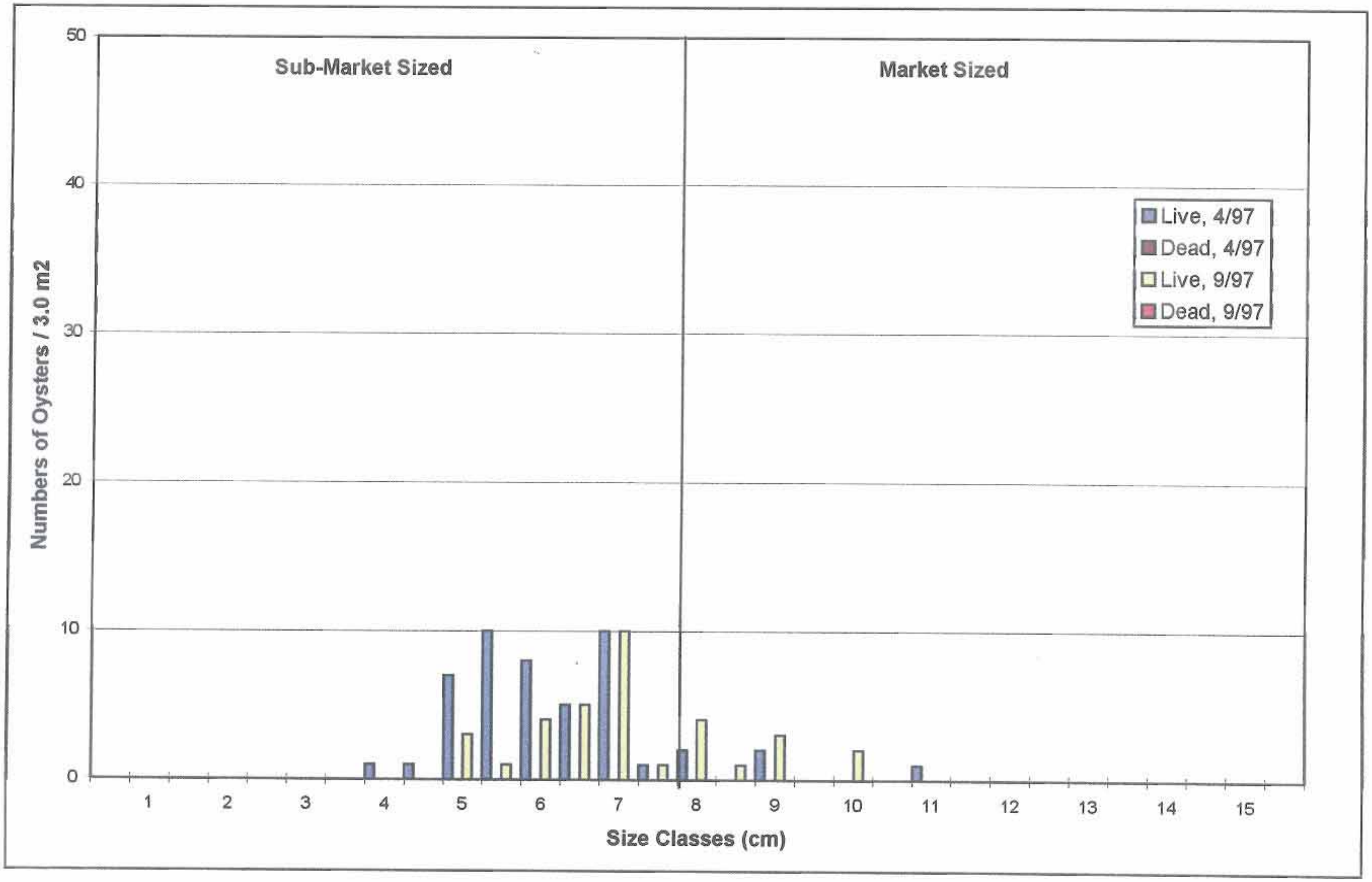


Figure 2.23: Oyster Sample Data - L-28351/2 - March and September, 1997



The hypothesis under test was that the average numbers of live oysters present in the initial and final sampling periods were not significantly different. Comparison of the means with a standard two-sample t-test indicates that this hypothesis cannot be rejected (p=0.589). In other words, there were no significant differences in the numbers of live oysters between surveys.

Lake Borgne - Old Shell Beach

Three stations, two sampling periods and six replicates per sample produced 36 observations. Data were pooled within sampling periods because of the close geographic proximity of the sampling locations and compared by a standard two-sample t-test.

The hypothesis under test was that the average number of live oysters present in the initial and final sampling periods were not significantly different. Comparison of the means with a standard two-sample t-test indicates that this hypothesis cannot be rejected (p=0.220). In other words, there were no significant differences in the numbers of live oysters between surveys.

DISCUSSION

Water Quality

Using a combination of satellite imagery, salinity and water level data, the Louisiana Department of Natural Resources (LDNR), Coastal Restoration Division (1997) found that the spillway water reached the Rigolets on March 25, 1997. Based on these data, by March 27, the spillway water had reached Alligator Point in Lake Borgne. By April 19, 1997, all of the study area including Lake Borgne and Mississippi Sound showed the presence of sediment-laden Mississippi River water. By May 3, 1997, little evidence of suspended sediments in the water column remained in Lake Borgne and the portion of Mississippi Sound with our oyster sampling locations. By May 6, 1997, salinities at Alligator Point in Lake Borgne had returned to near pre-spillway opening levels.

Salinity data collected during the initial sampling of the Hospital Wall sampling location near the Rigolets at the eastern end of Lake Pontchartrain on March 20, 1997, showed a salinity of 4.2 ppt at the eastern end of Lake Pontchartrain. Salinity data collected at the Mississippi Sound sampling locations on March 25-27, 1997 ranged from approximately 4-6 ppt and were relatively uniform across the approximately 18 linear miles of open sound separating the eastern and western most sampling locations. At this time, fresh water from the spillway opening had not reached the Mississippi Sound, but fresh water from the Pearl River had apparently lowered salinities across the study area. The salinity data collected in Lake Borgne at Bayou Dupre on April 1, 1997, showed salinities of 2.1-3.8 ppt. This indicates that the spillway water had not yet reached this area. The <0.5 ppt salinity data collected in Lake Borgne at Old Shell Beach on April 19, 1997, confirmed that by this date, the spillway water had reached all the way to the extreme southern end of the lake. Based on both the data collected for this study and the previously described LDNR data, the Lake Borgne and Mississippi Sound sampling locations were exposed to spillway related fresh water for 30-35 days.

The intensity and duration of lowered salinities is an important component to assess in determining the possible impact of a spillway opening on oyster resources. An equally important factor to consider is water temperature. During the late March to mid April oyster sample data collection period, water temperatures were generally 17-19°C, well below the 23°C threshold considered to be lethal to oysters when stressed by below 5 ppt salinities (Andrews, *et al.*, 1959; Dugas and Perret, 1976). In spillway openings where massive oyster mortalities have been documented (Dugas and Perret, 1976; Chatry, 1983), the spillway was open while water temperatures rose above 23°C in late May or early June.

No measurements were made of suspended sediments in the water column of the project areas during the initial or final oyster sampling surveys. None of the oyster samples collected in either survey showed evidence of significant siltation, such as dead epifauna (fouling organism such as barnacles and mussels) or buried oysters or old boxes (shells with fouled interiors still attached at the hinge, but with no live oyster inside). Evidence of recently (between surveys) set small oysters were found in some of the final samples from Mississippi Sound and Lake Borgne at Bayou Dupre. This indicates that suitable, relatively silt-free substrates were available.

Lake Pontchartrain - Mississippi Sound Oyster Data

In comparing the initial and final samples on an individual station by station basis, no clear trend is present in the data. Some stations showed substantially lower numbers of live oysters present in the final samples, when compared to the initial samples. This would include the Little Bayou Pierre, Grand Pass, Reef 8, Three Mile Reef, Half Moon Reef and Reef 12 sampling locations. Two stations had the opposite trend, with larger numbers of oysters in the final samples than in the initial samples at Cabbage Reef and Reef 15. Two sampling locations had similar numbers of live oysters in the initial and final samples. These were the Pelican Reef and Capt. Nelson sampling locations.

Based on the hydrology of Mississippi Sound, if impacts on oyster mortality associated with the spillway opening were responsible for the lower number of oysters present in the final samples, then the most significant decreases in live oyster should occur in the stations at the western end of the study area and the least significant decreases (or increase, possibly) should be at the eastern end of the sound. The largest percentage drop (74 percent) between the numbers of live oysters in the initial and final samples occurred at the Reef 12 sampling location, located near the western end of the study area (see figure 2.3). However, the Reef 15 station, located approximately 1.6 miles southwest of Reef 12, and the closest other sampling location in this study, had an increase of 133 percent in the numbers of oysters collected between sample periods. Given the proximity of the stations to each other, it is difficult to reconcile a drop of approximately 75 percent in the numbers of oysters at one station and an increase of 133 percent and be able to attribute both changes to impacts associated with the spillway opening. Both sampling locations had relatively few total live oysters in both sampling periods and small differences in the numbers of oysters collected in a given sample period produced large swings in the percentages of oysters "lost" or "gained" between sampling periods.

The numbers of live oysters present on the bottom at a given location at a given time is the result of a complex interaction of salinity, substrate, hydrology, natural mortality and, possibly, harvesting activity. It is variable from location to location, season to season, and year to year. The natural, patchy and clumped distribution of oysters on the bottom (Powell, *et al.*, 1987) is at least partly due to the way oysters set on suitable substrate. As oyster larvae set on suitable substrates, their presence attracts additional oyster larvae to settle in the vicinity (Hidu and Haskins, 1971). This non-random, contagious distribution of organisms on the bottom produces individual sample replicates with widely variable numbers of oysters.

The two-way ANOVA analysis of the live oysters data from Mississippi Sound showed that at a significance level of p=0.05, the number of live oysters present in the late March, 1997 samples was not significantly different from the numbers present in September, 1997. If a lower level of significance was chosen (p=0.083), then the differences between the numbers of live oysters in the two sampling periods were significantly different. The difference between the p=0.05 and p=0.08 significance levels is relatively small and the choice of a level of statistical significance is arbitrary. On this basis, the differences in numbers of live oysters between sampling periods is considered significant.

The statistical analysis of the data does not provide the reason for the significant differences in the numbers between the two sampling periods. Any one factor or combination of factors that would remove live oysters from the population between the March and September sampling periods could contribute to the observed differences in the numbers of live oysters. Those factors could include mortalities associated with the fresh water from the spillway opening, natural oyster mortalities and oyster harvesting that occurred between surveys. As discussed previously, while the Mississippi Sound portion of the study area was impacted by the freshwater from the spillway opening, the duration of the impact was relatively short and occurred while water temperatures were below the temperatures expected to cause significant oyster mortalities.

An important factor to consider is the timing of the oyster sampling periods relative to the annual cycle of oyster mortality. Oyster mortalities are not constant. They vary from season to season, year to year and location to location. Warmer temperatures and higher salinities produce higher oyster mortalities (Owen, 1953). Higher summer and early fall salinities and warmer water temperatures favor increased oyster predation and higher parasite loadings in the individual oysters, particularly the larger, older oysters. Supan, *et al.* (1997) found a mean weighted incidence of 2.0 of the endemic oyster parasite *Perkinsus marinus*, also known as Dermo, in market sized oysters from Cabbage Reef. They cautioned that oyster mortalities were likely when infection intensities exceed 1.0. The late March samples were collected when salinities were low, water temperatures were low and when oyster mortality rates were low. As water temperatures and salinities increased, predation and parasites increased and mortality rates increased, reducing the number of live oysters present at most of the sampling locations.

In addition to this natural mortality, fishing pressure can also affect the numbers of oysters per m^2 found in the samples. In both the March and September, 1997 samplings in Mississippi Sound, working oyster boats were visible on a number of the reefs that were sampled. It is not known to what extent the differences between initial and final samples from this study reflect this fishing pressure. The public reefs in the Louisiana portion of Mississippi Sound were opened to harvest prior to the Spillway opening in September 4, 1996 and remained open through April 30, 1997. They reopened to harvest on September 3, 1997.

The Louisiana Department of Wildlife and Fisheries (LDWF) collects annual oyster m^2 data from selected sites in the Lake Pontchartrain - Mississippi Sound area and other locations around the state as part of a long term oyster resource management plan. These data are used to manage the opening and closing of the public reefs in the state. To provide a historical comparison for the data collected in this study, the 1992-1997 m^2 data for sampling locations in our study area were obtained (Louisiana Dept. of Wildlife & Fisheries, 1997).

A summary of the 1992-1997 historical LDWF oyster m^2 data for the Lake Pontchartrain and Mississippi Sound sampling locations is presented in Table 2.6. These data were collected in the months of June and July at the Hospital Wall, Grassy Island, Half Moon Petite Island, Three Mile, Turkey Bayou, Grand Pass and Cabbage Reef sampling locations. For the 1992 oyster data, the results reflect the mean of three m^2 samples. The 1993 through 1997, the data are the means of two m^2 samples. For comparison purposes, the Spring (initial) and Fall (final) 1997 data from this study are also included in the table. Due to their geographic proximity, the data for the LDWF Le Petite Island station were compared to our Reef 12 station and the LDWF Turkey Bayou Station data were compared to our Reef 8 station. Figure 2.24 is a bar graph comparing the total numbers of live oysters per m^2 at the sampling locations for the 1992-1997 years individually, the 1992-1997 average and the initial (spring) and final (fall) data from this study.

The historical data for the one station in Lake Pontchartrain (Hospital Wall) show virtually no live oysters. In the six years of data presented, only one live oyster was collected. The oyster data collected in April 1997 for this study showed the same results (no live oysters) as the LDWF data collected from 1993 through 1997.

The 1992-1997 data from the LDWF stations (see Figure 2.3 for locations) in the western end of Mississippi Sound (Grassy Island, Half Moon, and Le Petite Island) typically had fewer oysters than the stations from the eastern sound (Three Mile, Grand Pass, Turkey Bayou, and Cabbage Reef). In some years, few to no oysters were present in the samples from the western sound stations. The 1997 post-spillway opening data show the same trend, with the Grassy Island, Half Moon and Le Petite Island stations showing fewer oysters than the Three Mile, Grand Pass and Cabbage Reef. For the 1997 sampling, the Turkey Bayou station showed no live oysters. The numbers of oysters present per m^2 at the 1997 LDWF sampling locations are generally similar to the 1992-1996 data.

The trend of fewer oysters in the western sound sampling locations was also reflected in the data collected for this study (Table 2.1 and Table 2.3). The Little Bayou Pierre, Reef 8, Pelican Reef, Capt. Nelson, Grand Pass, and Cabbage Reef stations from the eastern sound had substantially higher oysters per m^2 than the western sound sampling locations.

For comparable stations, the spring and fall 1997 live oyster data collected for this study showed similar or higher numbers of oysters per m^2 than the 1992-1997 LDWF averages for Half Moon Island, Petite Island, Three Mile Reef, Turkey Bayou, and Grand Pass. For the Cabbage Reef site, the spring samples were lower than the 1992-1997 average, and the fall samples were similar. Since the numbers of live oysters per m^2 in the fall samples were similar to or higher than the comparable LDWF 1992-1997 averages, it is unlikely that the Spillway opening had a significant adverse impact on live oyster numbers in Mississippi Sound.

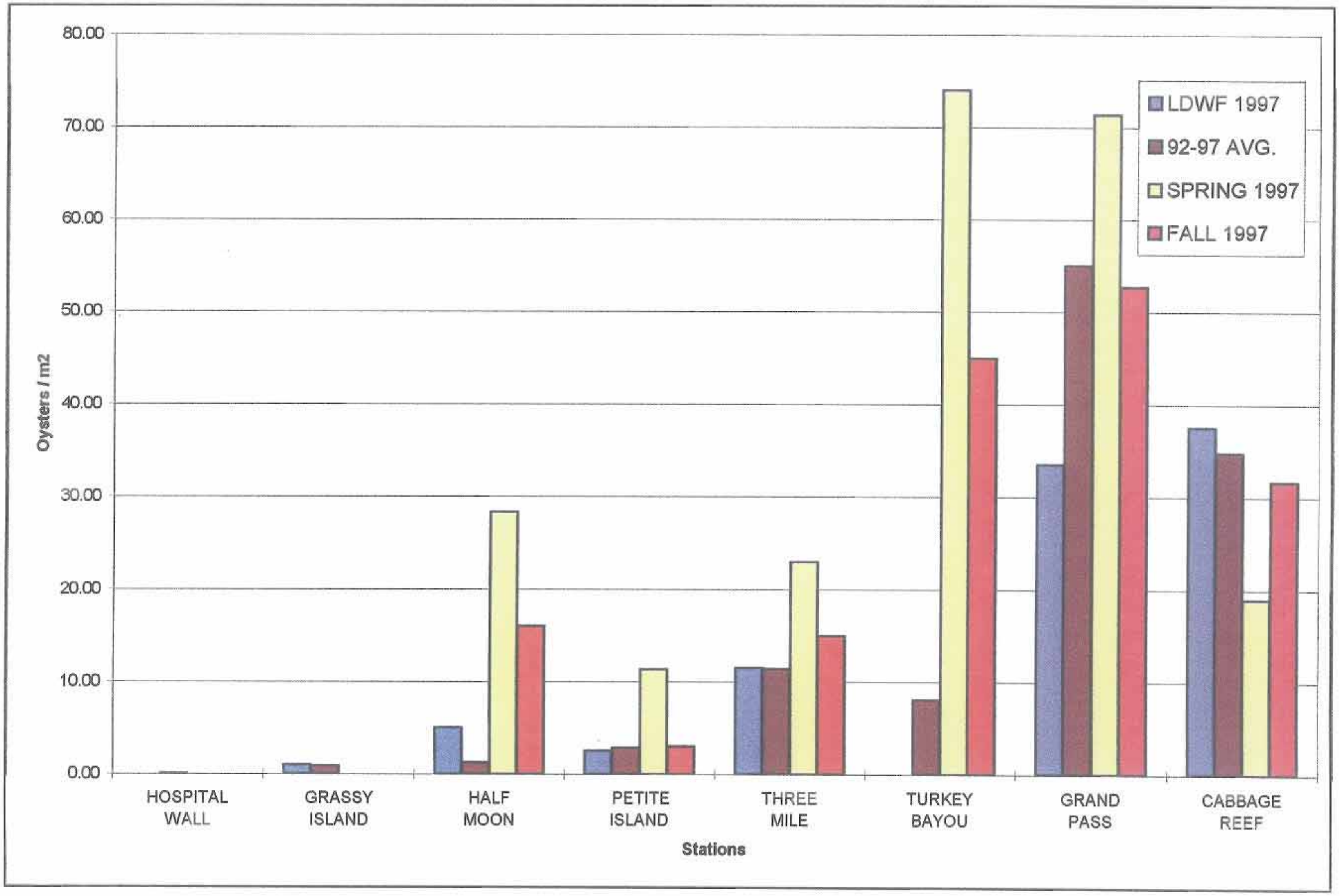
Lake Borgne - Bayou Dupre Oyster Data

The percent changes between the numbers of live oysters collected in the initial and final samples at the five stations located in Lake Borgne at Bayou Dupre were smaller than those found in the Mississippi Sound samples. Of the five stations, three stations (L-34931/O-9, L-34391/O-10 and L-25714/O-12) showed 19-30 percent increases in the numbers of live oysters between the two sampling periods and two stations (L-34931/O-8 and L-34931/O-14) had 14-23 percent decreases in the numbers of oysters between sampling periods. The increase in numbers of live oysters in the final samples from L-25714/O-12 is attributed to a heavy, recent set of small oysters at this location. The variability of the oyster sample data over short distances is underscored by the fact that sampling

Table 2.6. Comparison of LDWF and Spillway Monitoring Oyster m2 Data

YEAR / STATION	HOSPITAL WALL	GRASSY ISLAND	HALF MOON	PETITE ISLAND	THREE MILE	TURKEY BAYOU	GRAND PASS	CABBAGE REEF
LDWF 1992	0.33	N/A	N/A	0.00	1.33	2.67	23.33	33.67
LDWF 1993	0.00	N/A	0.00	2.00	0.50	18.50	21.50	19.00
LDWF 1994	0.00	1.50	0.00	0.00	13.00	4.50	44.00	34.50
LDWF 1995	0.00	0.00	N/A	12.50	12.00	10.00	184.00	49.50
LDWF 1996	0.00	1.00	0.00	0.00	30.00	12.50	23.50	34.50
LDWF 1997	0.00	1.00	5.00	2.50	11.50	0.00	33.50	37.50
92-97 AVG.	0.06	0.88	1.25	2.83	11.39	8.03	54.97	34.78
SPRING 1997	0.00	N/A	28.33	11.33	23.00	74.00	71.33	19.00
FALL 1997	N/A	N/A	16.00	3.00	15.00	45.00	52.67	31.67

Figure 2.24. Comparison of 1992-1997 LDWF and 1997 Spillway Monitoring Oyster Data



locations L-34931/O-10 and L-34931/O-14 are located immediately adjacent to each other and one showed a "gain" in live oysters between sampling periods and the other a "loss". The statistical comparison of the initial and final live oyster numbers using a standard two sample t-test showed that no statistically significant differences existed between the sampling periods. Based on the statistical analysis it is unlikely that the Spillway opening had a significant adverse impact on live oyster numbers in the Lake Borgne - Bayou Dupre area.

Lake Borgne - Old Shell Beach Oyster Data

Relatively small numbers of live oysters collected at the L-28351/1 and L-28351/2 sampling locations in both sampling periods. This was also true for the L-25781/1 initial sampling. The final samples from this location showed a significant increase (203 percent) in live oysters over the numbers in the initial samples. The difference between the sampling periods was not a recruitment event. It appeared to be due to the collection of samples in an area with substantially more oysters in the 4.0-8.0 cm size classes. The statistical comparison of the initial and final live oyster numbers using a standard two sample t-test showed that no statistically significant differences existed between the sampling periods. Based on the statistical analysis it is unlikely that the Spillway opening had a significant adverse impact on live oyster numbers in the Lake Borgne - Shell Beach area.

CONCLUSIONS

The fresh water impacts associated with the March 17 - April 18, 1997 Bonnet Carre' Spillway opening were of relatively short duration (30-35 days) in the Mississippi Sound and Lake Borgne portions of the project area. By early May 1997, satellite imagery showed little evidence of Spillway opening related visible suspended sediments, and salinity data showed salinities returning to near pre-Spillway opening levels. This return to pre-existing salinity levels occurred prior to water temperatures rising above the 23°C threshold expected to trigger mass oyster mortalities, as occurred in the 1973 and 1983 Spillway openings.

No catastrophic oyster mortalities were observed in the initial spring and final fall samples collected for this study or the mid-summer samples from the public reefs in Mississippi Sound by the Louisiana Department of Wildlife & Fisheries. Recent mortalities of oysters were low in all samples in both the initial and final surveys. The 50-100% oyster mortalities across the Louisiana portion of the Lake Borgne estuarine complex associated with the 1973 and 1983 Spillway openings were not observed in the data collected for this study.

Statistical comparison of oyster data from the Mississippi Sound stations showed a significant ($p=0.083$) reduction in the number of live oysters between the initial spring sampling and the final fall sampling. The statistical analysis of the data does not provide the reason for the differences in the numbers between the two sampling periods. Any one factor or combination of factors that would remove live oysters from the population between the March and September sampling periods could contribute to the observed differences in the numbers of live oysters between samplings. Those factors could include mortalities associated with the fresh water from the spillway opening, natural oyster mortalities associated with disease and predation and oyster harvesting that occurred between surveys. As discussed previously, the duration of the impact was relatively short and occurred while water temperatures were below the temperatures expected to cause significant oyster mortalities.

The spring samples were collected during a period when natural oyster mortalities are generally low. The fall samples were collected after five months of natural mortality, including the period when oyster mortalities are typically highest. Higher summer and early fall salinities and warmer water temperatures favor increased oyster predation and higher parasite loadings in individual oysters, particularly the larger, older oysters. Market-sized oysters from Cabbage Reef, one of the sampling sites in this study, were found by LDWF to have a mean weighted incidence of infection of the endemic oyster parasite *Perkinsus marinus*, also known as Dermo, high enough to cause oyster mortalities in 1997.

In addition to natural mortality, fishing pressure can also affect the numbers of oysters found in the samples. In both the March and September samplings in Mississippi Sound, working oyster boats were visible on a number of the reefs sampled. It is not known to what extent the differences between the initial oyster samples and the final samples from this study reflect this fishing pressure. Either individually or in combination, natural mortality and fishing pressure could account for the differences in the numbers of live oysters between surveys.

Live oyster data from Lake Borgne at Bayou Dupre showed no statistically significant differences between the initial and final surveys. Similarly, the Lake Borgne at Old Shell Beach oyster sample data showed no statistically significant differences between surveys.

RECOMMENDATIONS FOR FUTURE STUDIES

A major short-coming of the current study is the lack of water quality and oyster data from the period when oyster mortalities are most likely to occur. That period is when water temperatures approach or exceed 23 °C and salinities are at or below 5 ppt. It is recommended that future studies include an initial sampling survey, a second survey when water temperatures approach or exceed 23 °C, and a final survey in late September to early October.

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SECTION 3 - RESULTS OF TRAWL SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

SECTION 3 - RESULTS OF TRAWL SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

INTRODUCTION

The Bonnet Carre' Spillway control structure was opened on March 17, 1997, to direct fresh water from the Mississippi River into the estuarine waters of Lake Pontchartrain. It was widely anticipated that the influx of fresh water would impact the finfish and invertebrate fauna. Previous openings of the spillway have appeared to have had both negative and positive short term effects on the lake and its inhabitants. Perceived potential impacts for this spillway opening included fish kills, massive algal blooms, introduction of freshwater finfish and invertebrate species into the lake, decreased water quality, displacement of important commercial and recreational fisheries, as well as many others.

To address some of these perceived potential impacts, the collection and identification of finfish and invertebrate fauna was initiated the week of the spillway opening. The collection of the fauna would give some indication of the finfish and invertebrate species present in the lake prior, during, and after the passage of the fresh river water from the west end to the east end of the lake. These data could also be compared to previous studies on the lake species regarding presence and trends during the course of the data collection.

METHODS

Trawl Samples

Eight trawl sample locations were sited and plotted on a map of Lake Pontchartrain as shown in Figure 3.1. The locations in the Lake were attained by use of a Global Positioning Satellite (GPS) system. Each location was typically one to two miles from shore and near active recreational and/or commercial fishing activity. Water quality data were collected at each trawling station.

Trawl samples were taken with a 16 ft otter trawl. The first two weeks of the project, the trawl consisted of 0.75 in. bar mesh from mouth to tail. During that time, a 16 ft otter trawl comparable to that used by the Louisiana Department of Wildlife and Fisheries, Marine Fisheries Division, was constructed and delivered. This net had a body of 0.75 in bar mesh and a tail section approximately 54 to 60 in long of 0.25 in bar mesh.

The samples consisted of three-10 minute trawls. The contents of the net were placed into a wash tub and the large individuals identified, counted, measured and released. Small individuals were placed in 10 percent buffered formalin for identification, counting, and measuring at the workshop.

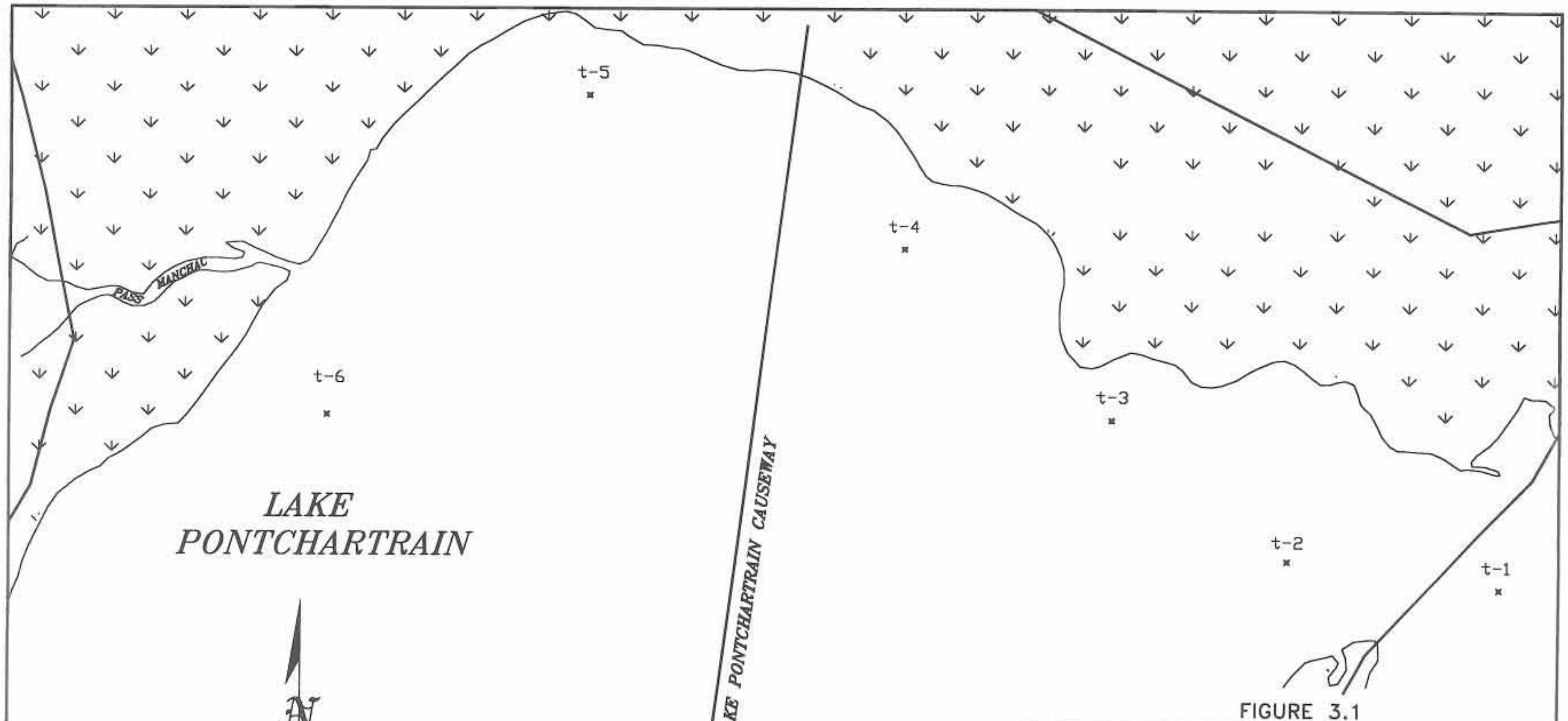


FIGURE 3.1

TRAWL LOCATIONS
BONNET CARRE SPILLWAY OPENING
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT

STEIMLE & ASSOCIATES, INC.
ENGINEERS, ECOLOGISTS, PLANNERS
"SPECIALIZING IN THE ENVIRONMENT"
3828 AIRLINE HWY. METAIRIE, LA 70001

DATE: 12-16-97	JOB NO.: 97-352-02	CAD FILE: LKPONTCHA
DRAWN BY: R.C.A.	CHECKED BY: M.M.M.	SCALE: SHOWN

Specimens were identified to genus and species in most cases. Up to 50 individuals were counted, measured and recorded for each species. Specimens were measured in 5 mm intervals for total length (fish), carapace width (crabs) and length from tip of rostrum to telson (shrimp).

Trawl samples were taken weekly for the period March 17 through June 30, 1997 and bi-weekly from July, 1 through October 31, 1997. All stations were sampled each week with the exception of the first week in April, when bad weather prevented sampling T-6, and the second week of April when bad weather prevented the sampling of Stations 6, 7 and 8. Trawl sample data summaries are provided in Appendix B.

DATA

Since the opening of the Bonnet Carre' Spillway on March 17, 1997 to the end of October 1997 there have been weekly and biweekly sampling events at the eight sampling stations established prior to the opening. A total of 540 trawl samples have been collected during that time period. Of the reported 129 species of finfish inhabiting the lake, 43 species (33 percent) have been collected in the trawl samples. Thirty-seven of the finfish species are primarily marine or estuarine while the other six are typical freshwater species. Table 3.1 contains a list of the finfish and invertebrate species collected through October, 1997. A graph of the numbers and types of organisms caught in trawl samples is shown in Figure 3.2.

An estimated total of 441,996 finfish specimens were collected during the period of March 17 to 31 October 1997. Of this total, 419,007 specimens (94 percent) were bay anchovy. Other common specimens included Atlantic croaker (three percent), Gulf menhaden (1.5 percent) and blue catfish (0.2 percent). Sportfish were not commonly represented in the trawl data. This was due in part to the type of sample equipment used and in part to the areas trawled not being ideal sportfish habitat. The sand seatrout, which comprised 0.2 percent of the total finfish caught, were the only sportfish frequently found in the samples.

The shrimp data from the trawl samplings show that the brown shrimp appeared in numbers during the month of June. The brown shrimp numbers began to increase near the end of May, peaked during mid-June, and then sharply decreased in July, although the numbers did increase slightly in October. Figure 3.3 presents a graph showing the brown shrimp catch. White shrimp were collected only occasionally in the trawls.

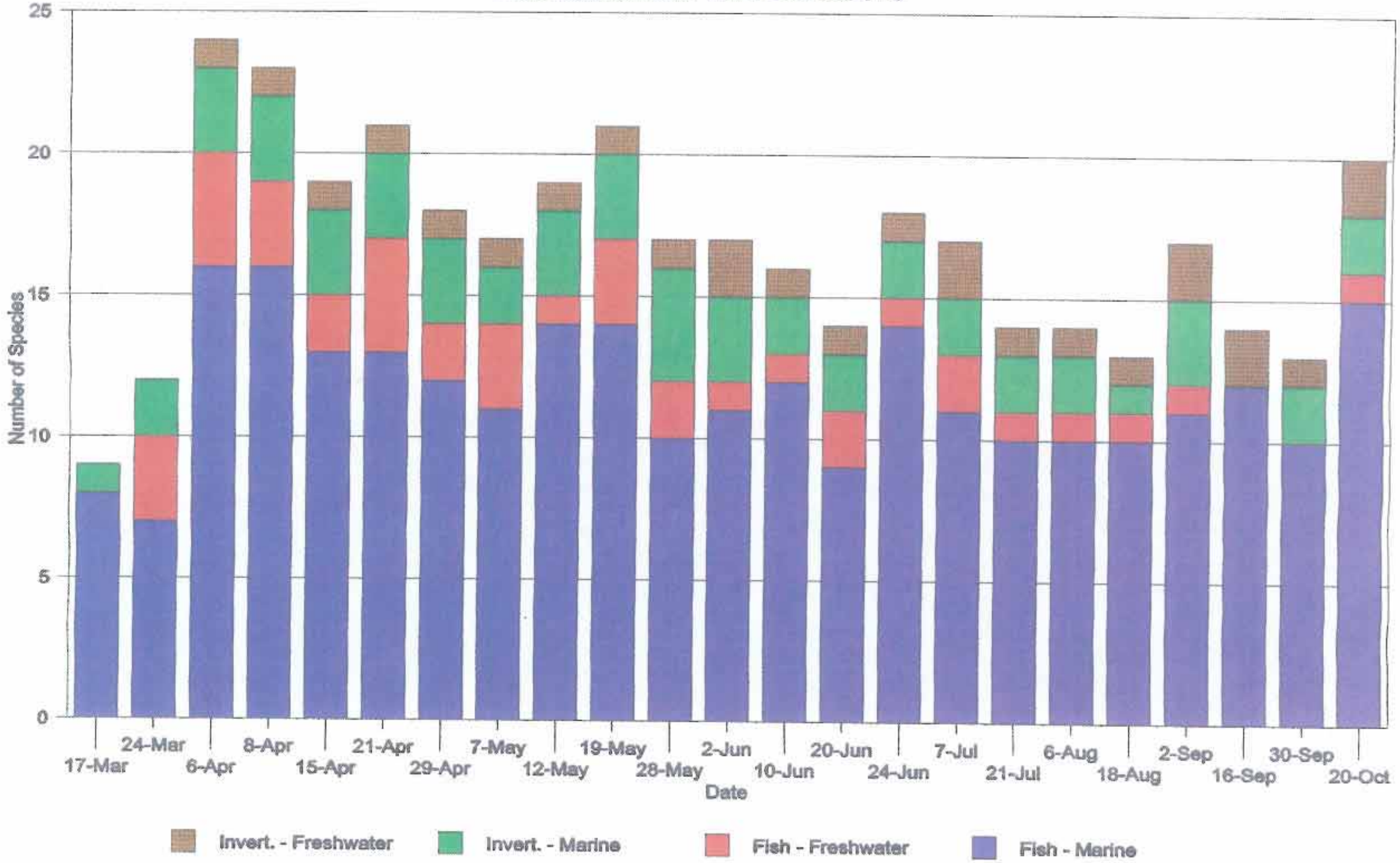
The peak number of brown shrimp collected coincided with the opening of the brown shrimp trawling season. Numerous trawl boats were observed in the lake during the mid portion of June. Trawling activity was particularly heavy near Station 8, which generally had higher bottom salinity readings than the other stations. The number of trawl boats decreased as markedly as the decrease in brown shrimp in the trawl samples at the end of July.

The largest number of fish and invertebrate specimens were collected at Station 7 (66,177 specimens), although Station 6 had the highest average number of specimens collected for each trip (average of 3,013 individuals) due to fewer sampling events. These stations were the closest to the Bonnet Carre' Spillway being located approximately 11 and 13 miles, respectively, from the spillway's connection to Lake Pontchartrain. Station 1 showed the greatest diversity of finfish and invertebrates collected. This station was located the farthest from the spillway at approximately 34 miles from the spillway's opening into the lake, although it was only 5 miles from the lake's connection to Lake Borne. Twenty-five species of finfish and five species of invertebrates were taken in the trawl samples at this

Table 3.1
Numbers and Types of Organisms in the Trawl Samples for Lake Pontchartrain
March to October 1997

Fishes	Total	% of Catch
Atlantic Bumper	4	0.000905
Atlantic Croaker	13,389	3.029213
Atlantic Cutlassfish	12	0.002715
Atlantic Needlefish	1	0.000226
Atlantic Stingray	1	0.000226
Atlantic Thread Herring	1	0.000226
Bay Anchovy	419,007	94.79882
Bay Whiff	28	0.006335
Bighead Searobin	1	0.000226
Black Drum	6	0.001357
Blackcheek Tonguefish	5	0.001131
Blue Catfish	816	0.184617
Bluegill	3	0.000679
Chain Pipefish	20	0.004525
Channel Catfish	105	0.023756
Clown Goby	21	0.004751
Freshwater Drum	3	0.000679
Gafftopsail Catfish	1	0.000226
Grey Snapper	1	0.000226
Gulf Menhaden	6,708	1.517661
Gulf Pipefish	11	0.002489
Hardhead Catfish	68	0.015385
Harvestfish	1	0.000226
Hogchoker	169	0.038236
Jack Crevalle	1	0.000226
Ladyfish	2	0.000452
Mosquitofish	7	0.001584
Naked Goby	39	0.008824
Pinfish	5	0.001131
Sand Seatrout	971	0.219685
Sheepshead	45	0.010181
Silver Perch	2	0.000452
Skipjack Herring	1	0.000226
Spadefish	1	0.000226
Southern Flounder	38	0.008597
Speckled Trout	3	0.000679
Speckled Worm Eel	2	0.000452
Spot	443	0.100227
Striped Anchovy	29	0.006561
Striped Mullet	1	0.000226
Threadfin Shad	21	0.004751
Tidewater Silverside	1	0.000226
Yellow Bass	6	0.001357
Total	441,996	100
Invertebrates		
Atlantic Brief Squid	1	0.107643
Blue Crab	328	35.30678
Brown Shrimp	163	17.54575
Mud Crab	61	6.5662
Mysid Shrimp	6	0.645856
River Shrimp	361	38.85899
White Shrimp	9	0.968784
Total	929	100
Grand Total	442,925	100

Figure 3.2: Number and Types of Organisms in Trawl Samples
Lake Pontchartrain Trawl Stations 1 - 8



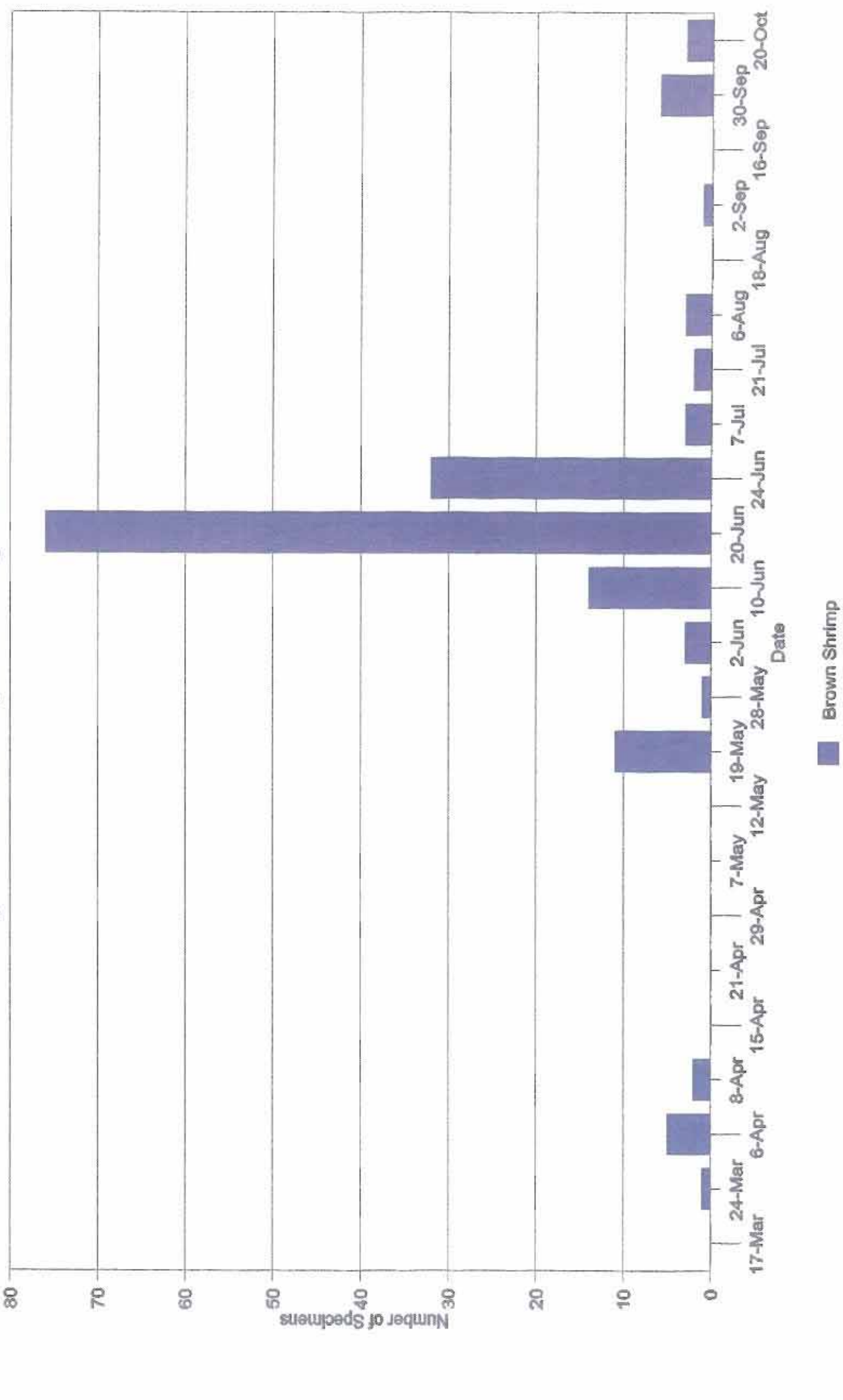


Figure 3.3: Number of Specimens Caught Each Week

location. This station was located on the easternmost portion of the lake near Lake Borgne and the Gulf of Mexico. Conversely, the least diverse station was Station 6 with 15 finfish species and three invertebrate species. This station was located on the westernmost portion of Lake Pontchartrain near Lake Maurepas.

There were nine species of finfish and three species of invertebrates that were collected at least once at each station during the sample period. The finfish species included Atlantic croaker, bay anchovy, blue catfish, channel catfish, Gulf menhaden, hogchoker, naked goby, sand seatrout and spot. The invertebrates included the blue crab, mud crab and river shrimp. Unusual finfish collected in the trawl included the gray snapper (Station 1) and the ladyfish leptocephalus (Station 2). Table 3.2 shows the finfish and invertebrate species collected, as well as the station where they were caught. Appendix B contains the summaries of the weekly and bi-weekly trawl samples.

DISCUSSION

The data collected from the trawl samples were compared to previous studies, some of which were performed during years of spillway openings. The trends exhibited by the data resemble patterns discussed in the previous studies and in studies of the life histories of the various organisms.

Overall there was a slow decline in the total number of marine and freshwater species of finfish and invertebrates after the third week of the spillway opening. In contrast to that trend, the total number of individuals steadily increased, peaking during the first week of August. The sharp rise in the number of individuals was due to the great abundance of bay anchovy collected at each station each sample period. These numbers began to decline during the month of August. The number of finfish versus the number of invertebrates caught in the trawl samples for Lake Pontchartrain Stations 1 through 8 is given in Figure 3.4.

The average number of individuals collected at each station was greater for the stations located on the northwest, west and south sides of Lake Pontchartrain (stations 5, 6, 7 and 8) than for the north and eastern end of the lake (stations 1, 2, 3 and 4). A graph of the average number of individuals collected at each station is presented in Figure 3.5. Station 1 had the lowest average number of individuals collected per week and the largest diversity of species. Station 6 showed the greatest average number of individuals collected per week, but had the lowest species diversity. Station 8 showed the bottom salinities that were generally higher than at the other stations which was most probably due to its proximity to the Mississippi River-Gulf Outlet and Industrial Canal. Station 8 did not show an increase in diversity and/or numbers of organisms compared to less saline areas of the lake. Table 3.2 shows the fish and invertebrate species collected for each station in Lake Pontchartrain.

During the initial weeks of the trawl sampling, large numbers of juvenile croaker were collected along with equal numbers of bay anchovy. As the summer approached, the numbers of croaker declined, while the numbers of bay anchovy increased. This correlates with the spawning periods of both species. The croaker typically spawns during the cooler months of the year (September through March), and small juvenile and post larval stages were collected in the trawl samples. Figure 3.6 shows the number of croaker caught each week. As these fish grow and develop, they migrate towards deep and higher salinity waters (Johnson, 1978).

The bay anchovy generally spawns during the summer months (May through November). Most of the bay anchovy collected in the trawl samples were post larval and juvenile forms. Bay anchovy spawn in low saline waters, typically between 1 and 15 ppt (Jones, *et al*., 1978). Figure 3.7 presents the number of individuals caught each week from March to October 1997. The bay anchovy is present in the lake year round, but may migrate to deeper waters in cooler months.

Table 3.2
Finfish and invertebrate species collected from Lake Pontchartrain

Fishes	Station							
	1	2	3	4	5	6	7	8
Atlantic Bumper			x	x				
Atlantic Croaker	x	x	x	x	x	x	x	x
Atlantic Cutlassfish								x
Atlantic Needlefish	x							
Atlantic Stingray	x							
Atlantic Thread Herring			x					
Bay Anchovy	x	x	x	x	x	x	x	x
Bay Whiff	x	x	x	x				
Bighead Searobin		x						
Black Drum			x				x	x
Blackcheek Tonguefish		x	x					
Blue Catfish	x	x	x	x	x	x	x	x
Bluegill			x		x		x	
Chain Pipefish		x		x	x	x		x
Channel Catfish	x	x	x	x	x	x	x	x
Clown Goby	x	x		x	x		x	x
Freshwater Drum					x	x		
Gafftopsail Catfish								x
Grey Snapper	x							
Gulf Menhaden	x	x	x	x	x	x	x	x
Gulf Pipefish	x		x	x	x	x		
Hardhead Catfish	x	x	x	x		x	x	x
Harvestfish	x							
Hogchoker	x	x	x	x	x	x	x	x
Jack Crevalle		x						
Ladyfish		x			x			
Mosquitofish		x	x	x			x	
Naked Goby	x	x	x	x	x	x	x	x
Pinfish	x	x						
Sand Seatrout	x	x	x	x	x	x	x	x
Sheepshead	x	x	x	x		x	x	
Silver Perch	x							
Skipjack Herring					x			
Spadefish	x							
Southern Flounder		x	x	x	x		x	
Speckled Trout				x	x			
Speckled Worm Eel	x						x	
Spot	x	x	x	x	x	x	x	x
Striped Anchovy	x	x	x					
Striped Mullet	x		x					
Threadfin Shad					x			
Tidewater Silverside	x							
Yellow Bass				x	x	x		
Invertebrates								
Atlantic Brief Squid								x
Blue Crab	x	x	x	x	x	x	x	x
Brown Shrimp	x	x	x	x	x		x	x
Mud Crab	x	x	x	x	x	x	x	x
Mysid Shrimp			x	x	x			
River Shrimp	x	x	x	x	x	x	x	x
White Shrimp	x	x						x

Figure 3.4: Number of Fishes vs. Number of Invertebrates Caught Each Week
Lake Pontchartrain Trawl Stations 1 - 8

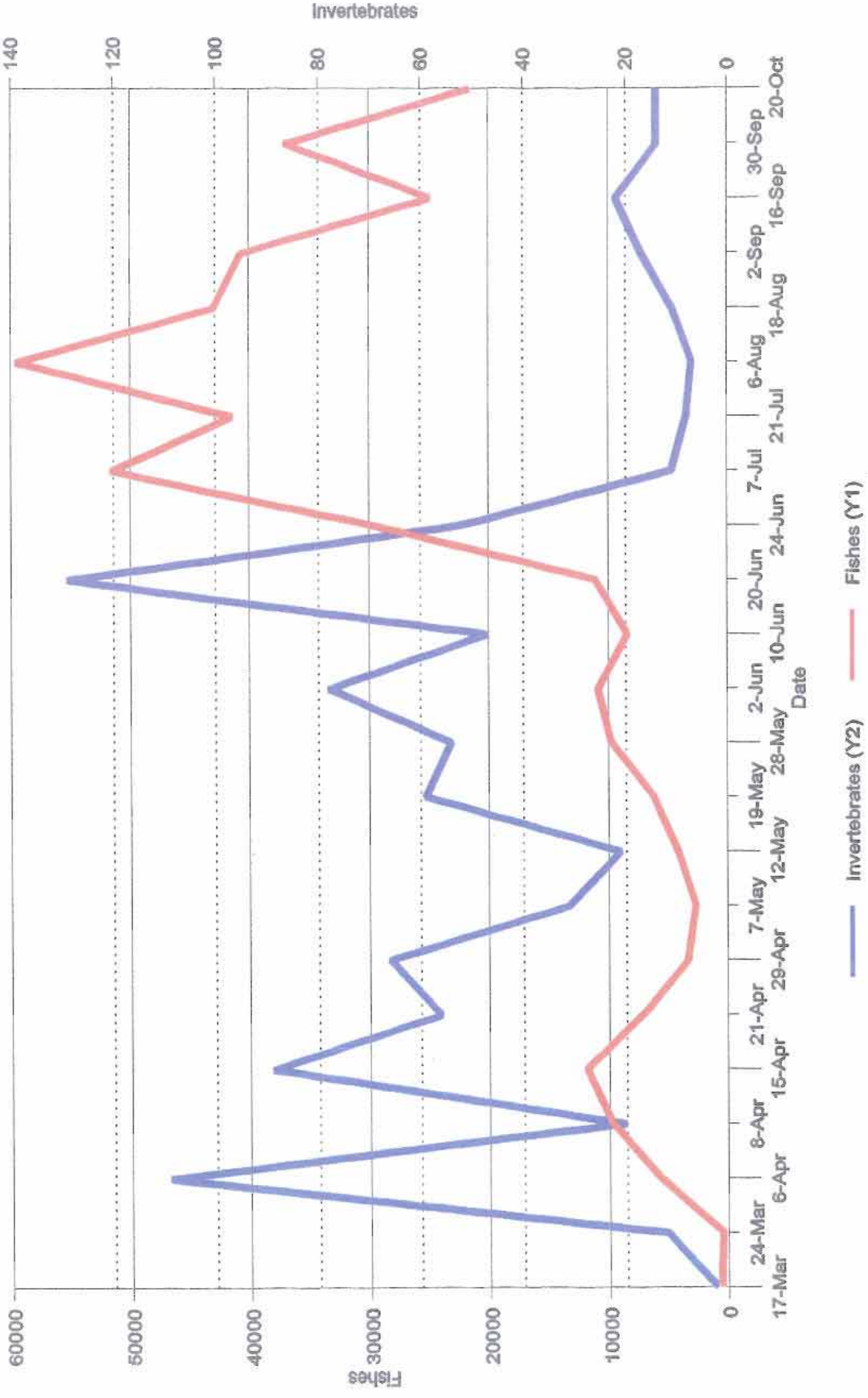


Figure 3.5: Average Number of Individuals Per Station Per Week
Lake Pontchartrain Trawl Stations 1 - 8

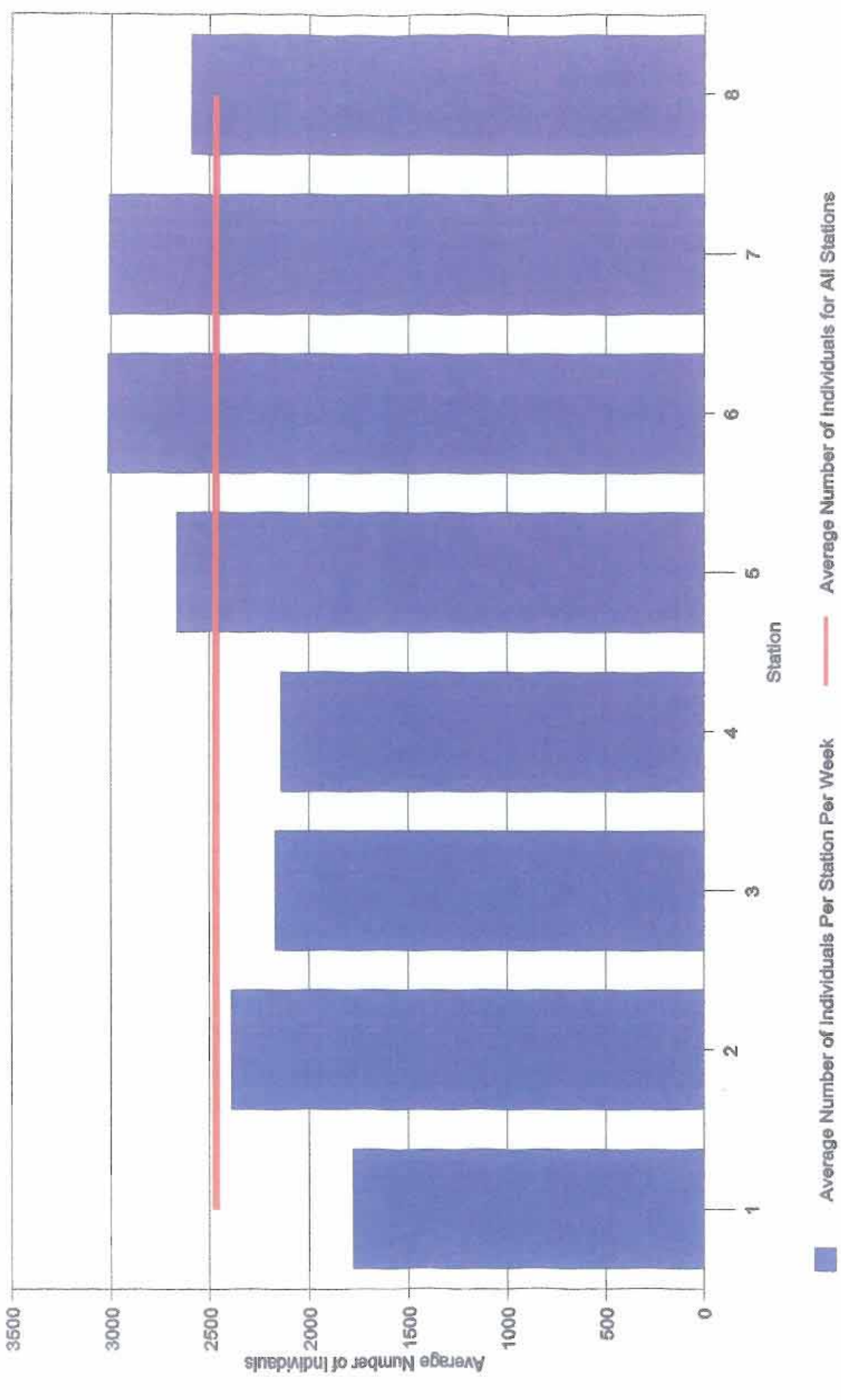


Figure 3.6: Number of Specimens Caught Each Week

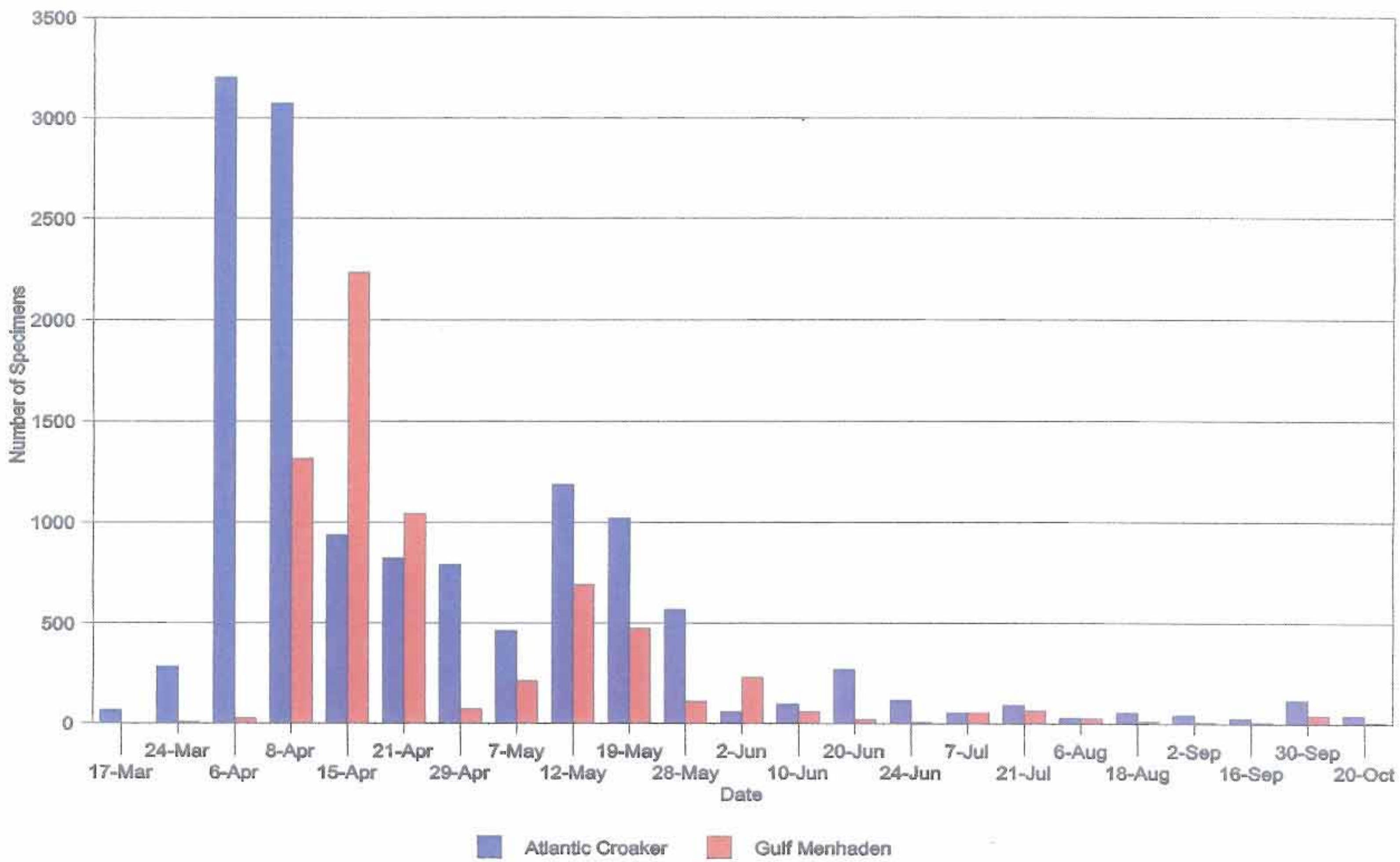
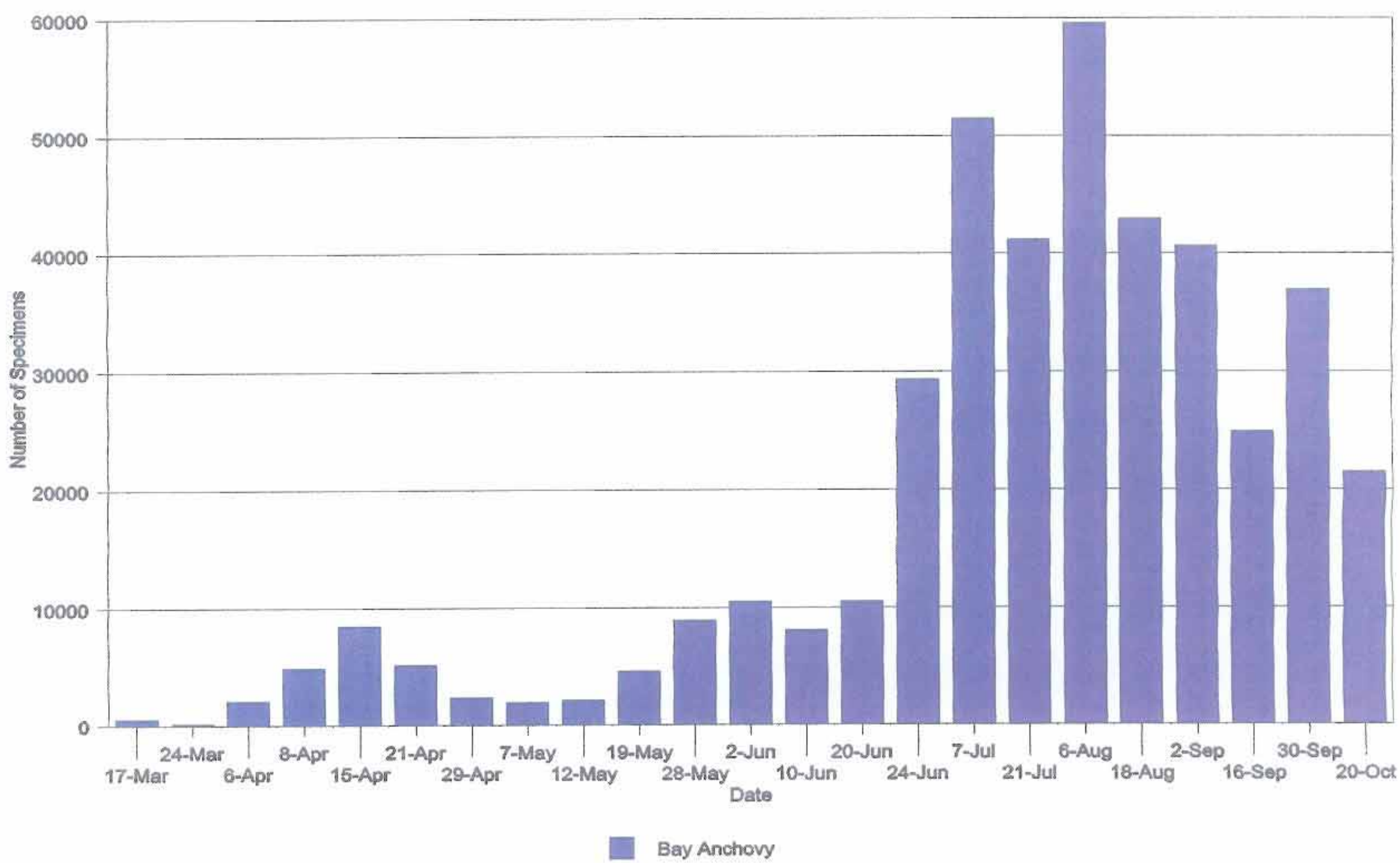


Figure 3.7: Number of Individuals Caught Each Week



The gulf menhaden is also a common resident of the lake. They typically spawn during the spring months and move offshore during the summer and early fall (Jones, *et al.*, 1978). Juvenile and post larval gulf menhaden numbered in the thousands during the early trawl sampling, but declined markedly the end of April and first of May. Figure 3.6 gives the number of individuals collected each week. Since the beginning of June, only a few individuals have been collected.

Relatively few examples of sportfish were collected in the trawl samples. One species found in the samples on a regular basis was the sand seatrout, which is closely related to the more popular spotted or speckled trout. Large numbers of larval, post larval, and juvenile sand seatrout were initially collected in mid-May and continued through the end of June. This correlates well with the reports that these fish generally spawn during the spring (March through May). Additional larvae and juveniles were encountered during the fall (August through September) when the sand seatrout has a second spawning period (Johnson, 1978), but not at the numbers of individuals seen during the earlier spawning period.

The opening of the Bonnet Carre' Spillway in past years has not been demonstrated to have an adverse affect on the finfish populations. Although the Spillway opening introduces fresh water and some freshwater finfish species into the Lake, many of the Lake's natural inhabitants are euryhaline and are able to withstand a decrease in the water salinity. It is likely that certain finfish in the Lake have been affected due to less than optimal spawning conditions (i.e., decreased salinity), unsuitable habitat, decrease in food sources, unfavorable water conditions, fishing pressures and other external forces. Several of the finfish species which most likely spawn in the lake include bay anchovy, the pipefish species, the seatrout and the freshwater catfish.

Brown shrimp were collected at each station (except Station 6) during the trawl sampling. The numbers of brown shrimp began to increase in mid-May, peaking in June and decreasing in July. This coincided with the brown shrimp season and shrimping activity in the lake. It was observed that during the peak catch of brown shrimp in the trawl samples in June that there were numerous shrimp boats in the vicinity of Station 1 and Station 8. The bottom salinities at Station 8 were generally higher than the rest of the Lake most probably due to its proximity to the Mississippi River-Gulf Outlet and the Industrial Canal.

The Louisiana Department of Wildlife and Fisheries (LDW&F) has a trawl station approximately 12 miles east of Station 1 at the intersection of the Rigolets and Lake Borgne. This station was sampled weekly during the same time period as the trawl sampling for the spillway opening. The trend shown for the brown shrimp monthly catch data from the LDW&F sampling is similar to the brown shrimp catch data for the Lake Pontchartrain trawl sampling. The catch per effort of brown shrimp for Lake Pontchartrain was much less than the catch per effort for concurrent sampling by LDW&F in Lake Borgne and the Biloxi Marsh.

White shrimp were collected sporadically during the trawl period. This was most likely due to the trawl equipment not being sufficient to adequately monitor the white shrimp population in the lake due to their habitat preferences. To collect representative data on the white shrimp in Lake Pontchartrain other sampling methods most likely will be necessary.

Previous studies by Thompson and Fitzhugh (1985), Stone (1980), Darnell (1961) and Suttkus *et al.* (1954) have documented finfish, invertebrates, and hydrological conditions in Lake Pontchartrain. These studies presented data regarding the finfish species composition and numbers along with their significance to the lake system. The trawl sample data was compared to the information provided in these studies to assess any potential impacts from the spillway opening.

The Stone (1980) report was completed after several studies of the Lake and its surrounding wetlands were completed. A review of the report regarding the fish data show that one of the conclusions included was "the number of fish increase during the spring, peak during July and then gradually decrease during late summer and fall." This pattern is consistent with the present trawl data as shown in Figure 3.3. Stone also concluded that "the anchovy is the most ubiquitous species in the Lake Pontchartrain area." This is illustrated by the trawl data and shown in Figure 3.6.

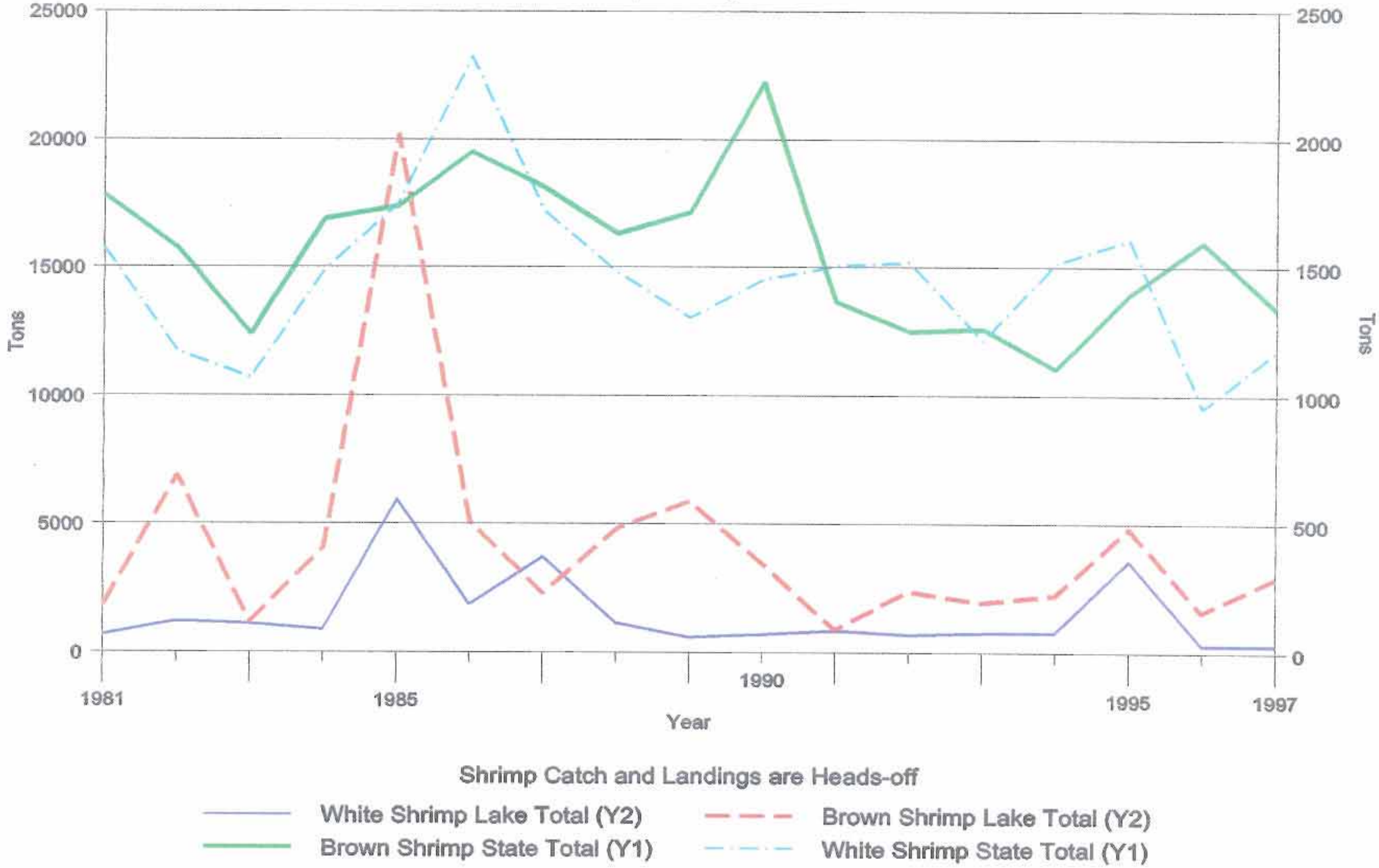
The Thompson and Fitzhugh report (1985) reviewed and assessed data collected during the 1950's and 1970's by several different sources. After evaluating the available information they concluded that "overall the relative abundance of the more abundant and common fish species in the lake has changed little between 1953 and 1978" and that "the major function of Lake Pontchartrain as utilized by fishes is a young-of-the-year and juvenile nursery and feeding area." One important conclusion from the Thompson and Fitzhugh report indicated an overall reduction in the total fish population related to the reduction of bottom dwelling fishes. The reduction of the bottom fishes is attributed to several factors including turbidity, nutrient levels, loss of preferred habitat, reduced amounts of food, fishing pressure, and other influencing factors. Some of the trawl data concurs with several of the findings of this report such as the number and types of species collected.

Some historic fisheries data for the Lake Pontchartrain area were made available by the Natural Marine Fisheries Service (NMFS). A graph of their data show that except for the 1973 spillway opening, the shellfish catch the year after the other openings (1975, 1979, and 1983) increased. This graph is given in Figure 3.8. According to data provided by the NMFS the landings for the catfish species typically increase after a spillway opening probably due to the reduced salinities in the lake.

Thompson and Fitzhugh (1985) report that shrimp landings generally decrease the year that the spillway is opened. This was true for the 1975 and 1979 openings. The year following the opening, they reported that the shrimp landings substantially increased. They attributed this to "increased recruitment and survival benefitting from nutrient input from the Mississippi River discharge." The exception to this was in 1974, which showed decreased overall landings. Thompson and Fitzhugh (1985) reported that the 1973 opening did not apparently introduce increased nutrient levels to the lake.

Preliminary data supplied by the NMFS for 1997 show that brown shrimp catch for Lake Pontchartrain and Lake Borgne increased 83% from the previous year and was the third highest total recorded since 1990. The white shrimp catch for Lake Pontchartrain and Lake Borgne was slightly less than the 1996 catch data, but the value of the white shrimp catch increased 36%. Statewide brown shrimp landings data show a decrease in the total landings since 1996, while the white shrimp landings increased since the 1996 data, although the total is the second lowest since 1983. This may indicate that the spillway opening may have had little negative impact on the brown shrimp and a greater negative impact on the white shrimp in the lake. If the trend exhibited by the historical shrimp catch data for the year after a spillway opening, both the brown and white shrimp catch for Lake Pontchartrain and Lake Borgne should increase for 1998.

Figure 3.8: Shrimp Catch for Lake Pontchartrain and Lake Borgne Versus Shrimp Landings for Louisiana



CONCLUSIONS

The opening of the Bonnet Carre' Spillway probably did have some affect on the finfish and invertebrate populations of Lake Pontchartrain. The addition of millions of gallons of fresh water into the lake ecosystem most likely altered spawning conditions for finfish species such as bay anchovy, pipefish, seatrout and freshwater catfish; preferred habitat; food sources; provided unfavorable water conditions; etc. Historically, shrimp catches are below normal during the year of the opening.

The collection of 540 trawl samples provided some information regarding the potential effect of the opening on finfish and invertebrates populations. Weekly trawls through June and bi-weekly trawls trough October yielded nearly 443,000 specimens. Forty-three finfish species and six invertebrate species were collected. The bay anchovy was the most dominant species caught comprising nearly 95 percent of the total catch.

Comparison of the trawl data to previous studies performed in the lake before, during and after spillway opening shows similar seasonal variation in the life history of the more common finfish species collected. Finfish as a whole increase their numbers as the summer approaches and decrease as the fall period arrives. Individual species such as the bay anchovy, Atlantic croaker and Gulf menhaden followed the trends established by the earlier studies of Thompson and Fitzhugh (1985), Stone (1980), Darnell (1961) and Suttkus *et al.* (1954).

Few shrimp were collected during the trawl period, although the numbers of brown shrimp did peak in June during brown shrimp season. Shrimping activity in the lake decreased rapidly as the number of shrimp in the trawl data decreased. Catch data for Lake Pontchartrain and Lake Borgne showed an 83% increase in the brown shrimp catch and a slight decrease in the white shrimp catch, but a 36% increase in the white shrimp catch value when compared to the data for 1996. Statewide the landings data for brown shrimp were down, while the white shrimp landings were greater than in 1996. Its possible that the spillway opening may have had a greater negative impact on the white shrimp than the brown shrimp.

Based on the trawl data and its comparison to the previous studies for the Lake, the opening of the Spillway did not appear to adversely affect the finfish species in the Lake. The number of shrimp inhabiting the Lake may have been reduced due to the Spillway opening, but based on previous studies, the year following the opening should provide much higher than normal numbers of shrimp in the lake.

RECOMMENDATIONS FOR FUTURE STUDIES

One drawback of the present study is the lack of comparable baseline data for the lake organisms and water quality. Information collected with similar sampling equipment and methodologies allows for easier comparison and determining the effect of a spillway opening or other natural and/or man-made influences on the lake. This baseline information would also be useful when discussing future Corps of Engineers projects for the lake with environmental groups and representatives. Therefore it is recommended that additional trawl sampling be performed during the spring, summer and fall months to collect finfish, shellfish and water quality data to establish baseline data.

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SECTION 4 - RESULTS OF CRAB TRAP SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

SECTION 4 - RESULTS OF CRAB TRAP SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

INTRODUCTION

One of the most important species fished commercially and recreationally in Lake Pontchartrain is the blue crab (*Callinectes sapidus*). Although blue crabs were collected in the trawl samples, the most efficient but strictly qualitative tool for sampling the population is the crab trap. Crab traps have been used almost exclusively for commercial harvest in Louisiana since about the mid-1960's (Roberts and Thompson, 1982). In order to qualitatively sample the crab population in the same manner as a commercial fisherman and to determine the effects of the spillway opening on this population, crab traps were deployed at three stations along the Lake Pontchartrain Causeway.

MATERIALS AND METHODS

Recreational crab trap samples were, with the permission of the Causeway police, initially suspended from three Causeway crossovers, the 20 mile crossover (CA-1), the 12 mile crossover (CA-2) and the 3 mile crossover (CA-3) as shown on Figure 4.1. Crab trap sampling was initiated March 25, 1997. Three traps were placed at each crossover. The traps were initially to be checked three times weekly. Samples were measured to the nearest 0.5 cm, and, beginning April 8, the sex of each specimen was recorded.

Some tampering with traps was anticipated since the traps were visible, but the level of tampering that occurred beginning on April 8 was not anticipated. Obvious tampering such as shortening the lines by tying knots in them to raise the traps above the bottom and emptying the traps of bait and filling them with cans and bottles occurred at least one station on 12 of the 13 days that the traps were checked between April 8 and May 8. On May 8, cable ties of various colors and sizes were used to determine if traps that had not been obviously tampered with had been emptied.

On May 13, checking the traps was begun approximately daily during the week. On 12 occasions between May 13 and June 19, some tampering was observed. Usually, the cable ties were removed or the bait was removed. On June 19, the traps were relocated to the 15 mile (CB-1), the 5.5 mile (CB-3) crossovers and the 8 mile turnaround (CB-2) as shown in Figure 4.1. Tampering continued at these locations and yield of crabs was very low through June 27. It was then arbitrarily decided to check the traps on the weekend of June 28 and 29, and the yield of crabs was found to be extremely high.

On July 3, traps were relocated to the original locations (CA-1, CA-2 and CA-3). Tampering continued and yield was low except on the most of the weekend days that the traps were checked. This pattern continued until, August 22 when discussions were held with the Corps of Engineers on crab sampling, the problems which had been encountered, and the fact that the yield of crabs was good on weekends. The following weekend, although the traps were checked at approximately 4:00 AM, all the traps had been obviously raided. Following this weekend, sampling was discontinued. A daily record of tampering is given in Appendix C.

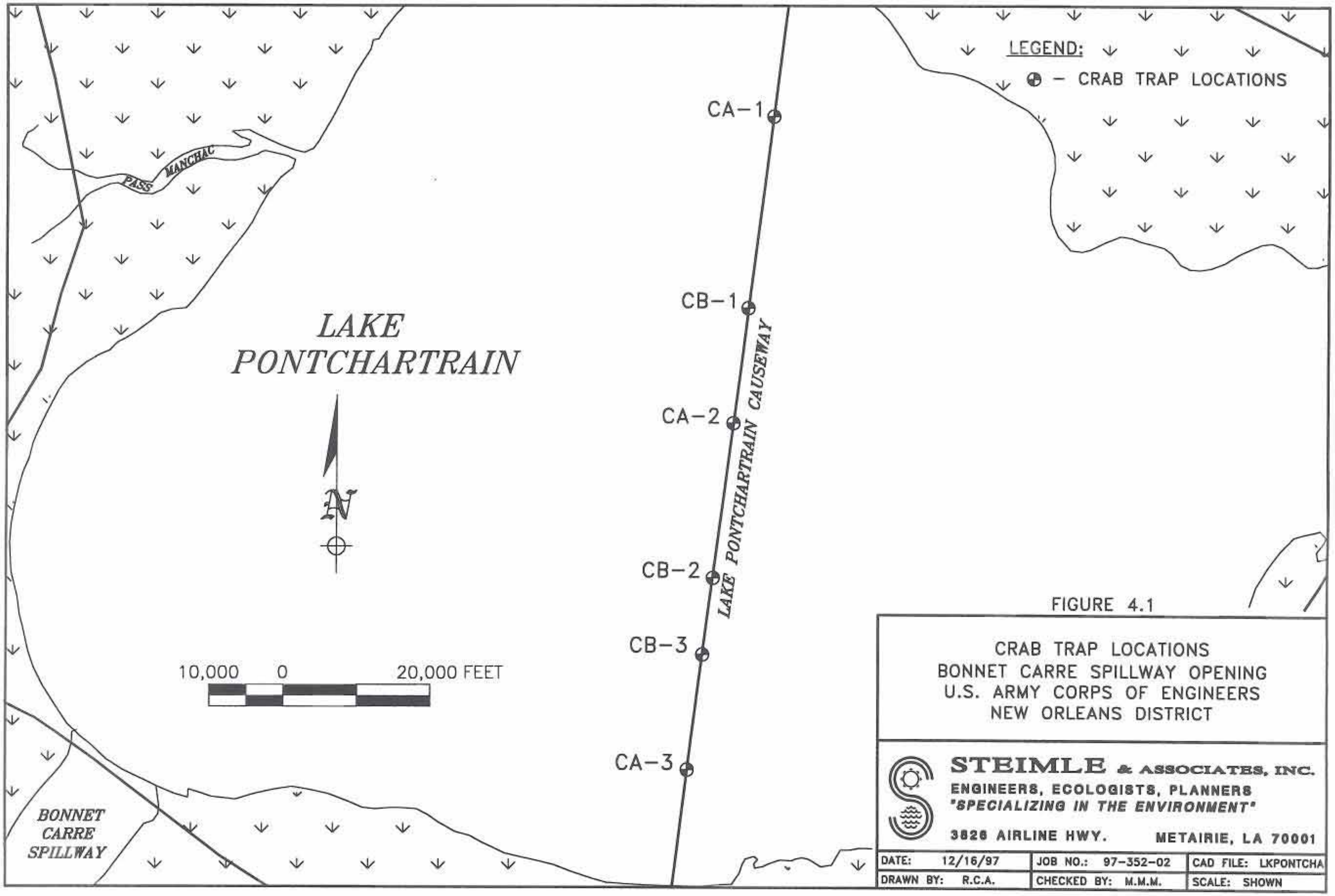


FIGURE 4.1

CRAB TRAP LOCATIONS
BONNET CARRE SPILLWAY OPENING
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT

RESULTS

Numbers and sizes of crabs sampled during the period March 25 through April 5, 1997 are shown in Figure 4.2. Sex was not recorded for the crabs taken during this period. Figures 4.3 through 4.7 present the sex, size and numbers of crabs taken monthly from the traps.

Forty-three crabs were taken in the nine traps during the period March 25 through April 5,1997, of which 13 (30 %) were above the 5 in (12.7 cm) commercially harvestable limit set by the Louisiana Department of Wildlife and Fisheries. During the remainder of April (April 8-April 30), a total of 69 crabs, 30 (43 %) females and 39 (57 %) males, were collected. Of these, 46 (66 %) were commercially harvestable.

During May, a total of 214 crabs were collected. Of the total, 91(43 %) were female and 214 (57 %) were male. Approximately 73 percent (156 crabs) were commercially harvestable. During June, a total of 160 crabs were collected. Of these, 61 (36 %) were female and 108 (64 %) were male, and 123 (73 %) of the total were harvestable.

Traps emptied during July yielded 221 crabs total, of which 86 (39 %) were female and 135 (61 %) were male. Eighty-nine percent (89 %) of the total were commercially harvestable. August samples yielded 233 crabs total, 130 (56 %) female and 103 (44 %) male. Two hundred eighteen (94 %) of the total collected were of commercially harvestable size.

Cumulative data for the period April 8 through August 24 are given in Figure 4.8. The percent of catch which was of harvestable size is shown by month in Figure 4.9.

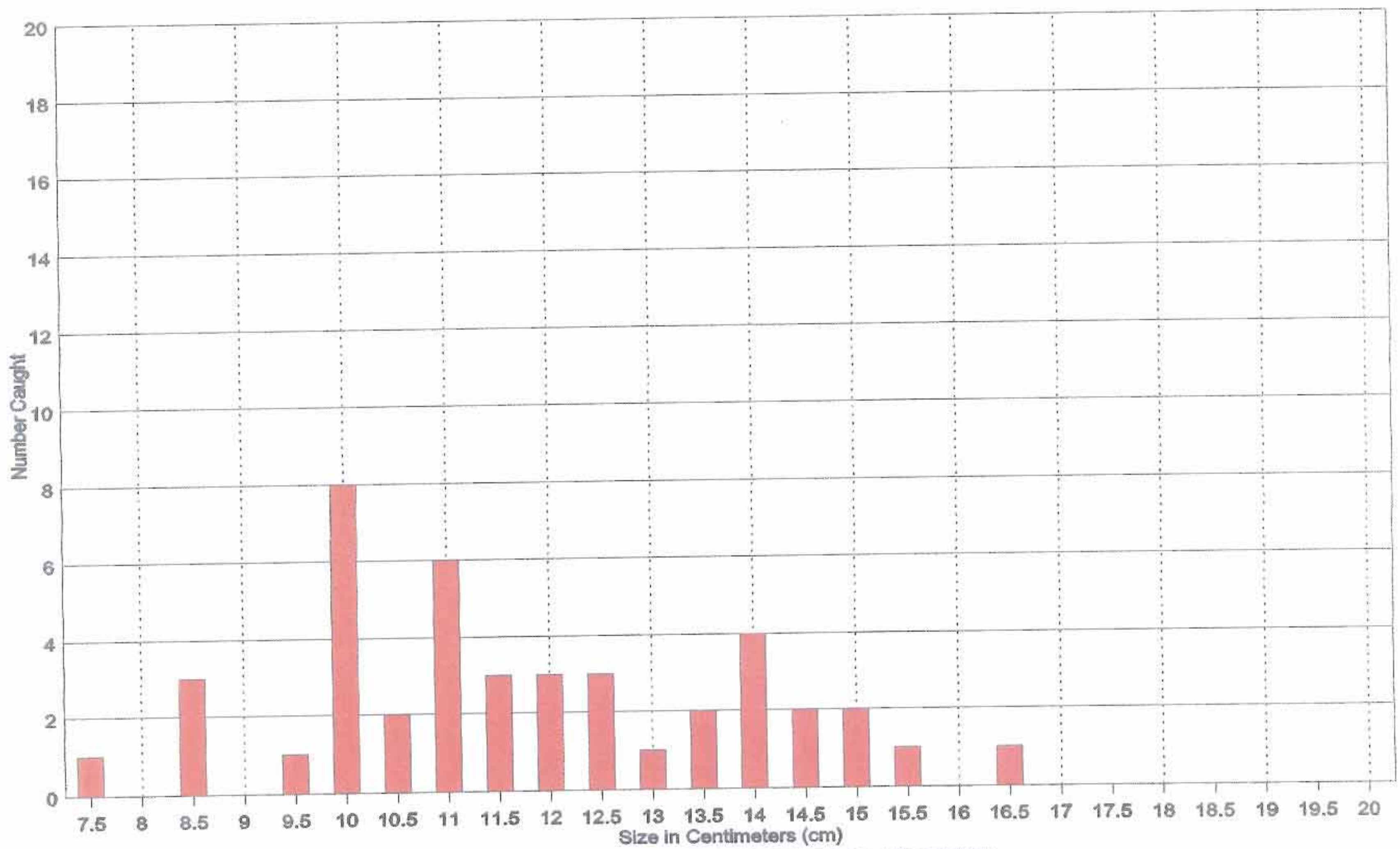
Preliminary and incomplete data from USGS Causeway monitoring stations show that salinities at the crossover three miles from South Shore dropped to near 0 ppt after the Spillway opening and rebounded to nearly 2 ppt by the end of June. At the midlake crossover surface salinities dropped to near 0 ppt and stayed there near the middle of April and did not rebound to 2 ppt until mid-August. At the monitoring station three miles from North Shore, salinity was <0.5 ppt by mid-April and did not reach 1.5 ppt by the end of August.

DISCUSSION

In spite of the tampering experienced with the traps, crabs were present in the traps most days. Crabs were often present in traps that had obviously been raided, even though yields were low. Weekend yields of traps were consistently high in July and August. The evidence from qualitative sampling is that crabs were abundant in Lake Pontchartrain during and after the period of the Spillway opening. The data collected also clearly show that the percent of the population of harvestable size crabs (5.0 in and longer) present in the traps increased throughout the summer.

The abundance of hard crabs in the lake harvested during the year in which the Spillway was opened is not unusual. Table 4.1 presents the historical landings data from Lakes Pontchartrain and Borgne for the period 1959 through 1985. These data are taken from the Final EIS Clam Shell Dredging in Lakes Pontchartrain and Maurepas (USACE, 1987). These data include the years of Spillway openings - 1973, 1975, 1979 and 1983. Data on the spillway openings during these years as provided by the USACE are as follows:

Figure 4.2: Lake Pontchartrain Blue Crabs (March 25 - April 5 1997 *)



* SEX OF CRABS WAS NOT RECORDED DURING THIS PERIOD

Figure 4.3: Lake Pontchartrain Blue Crabs (April 8 - 30 1997)

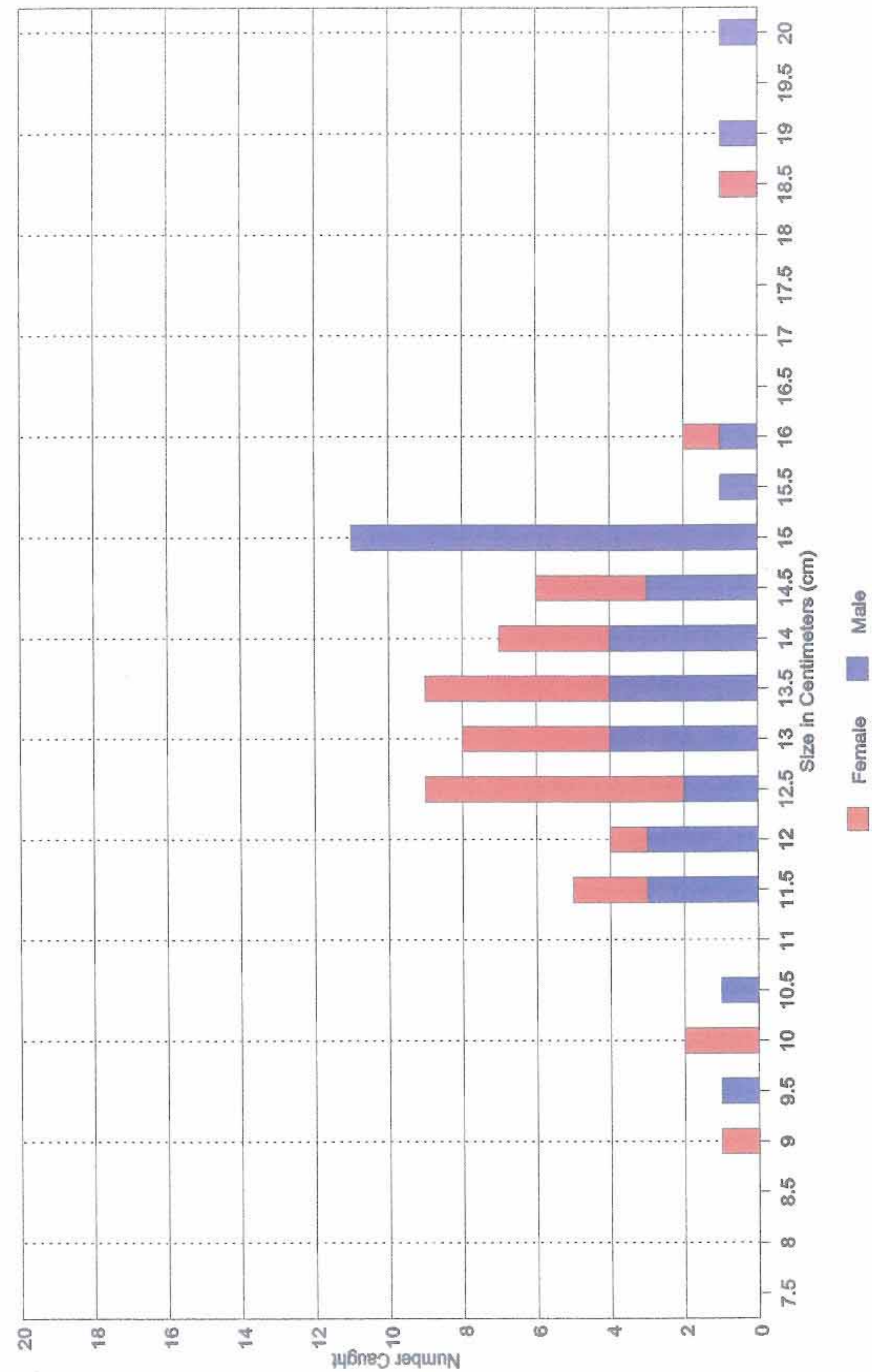


Figure 4.4: Lake Pontchartrain Blue Crabs (May 1 - 31 1997)

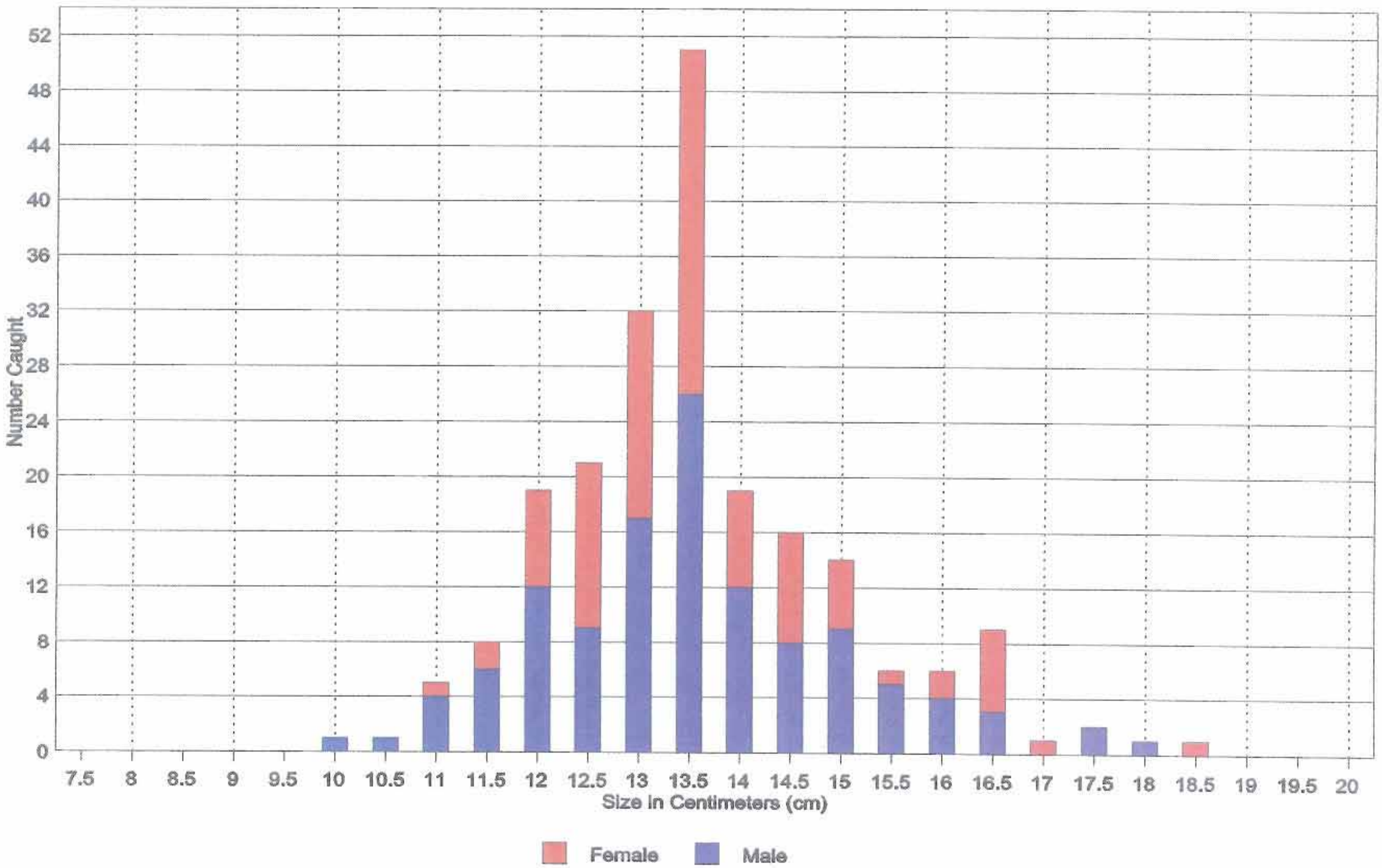


Figure 4.5: Lake Pontchartrain Blue Crabs (June 1 - 30 1997)

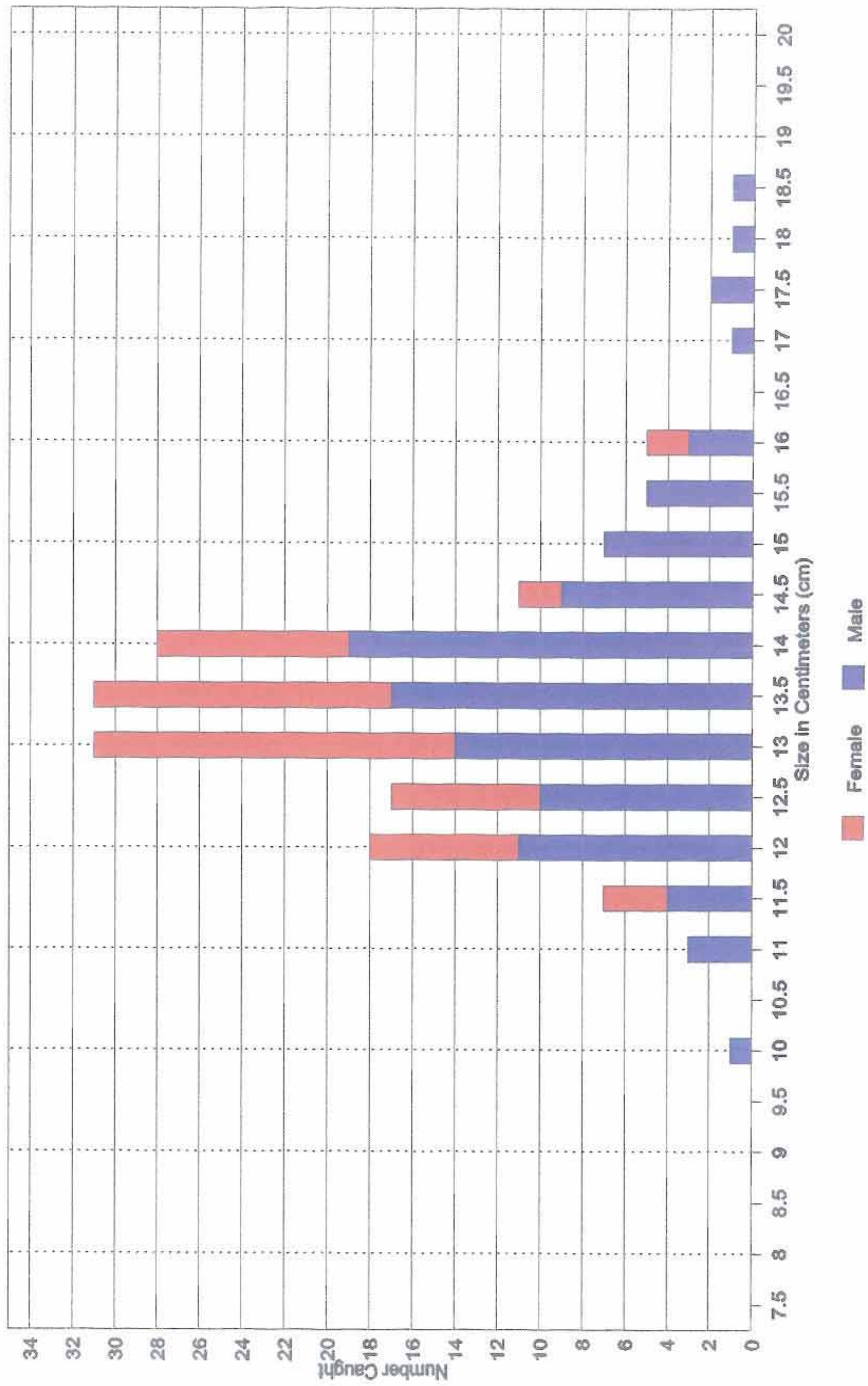


Figure 4.6: Lake Pontchartrain Blue Crabs (July 1 - 31 1997)

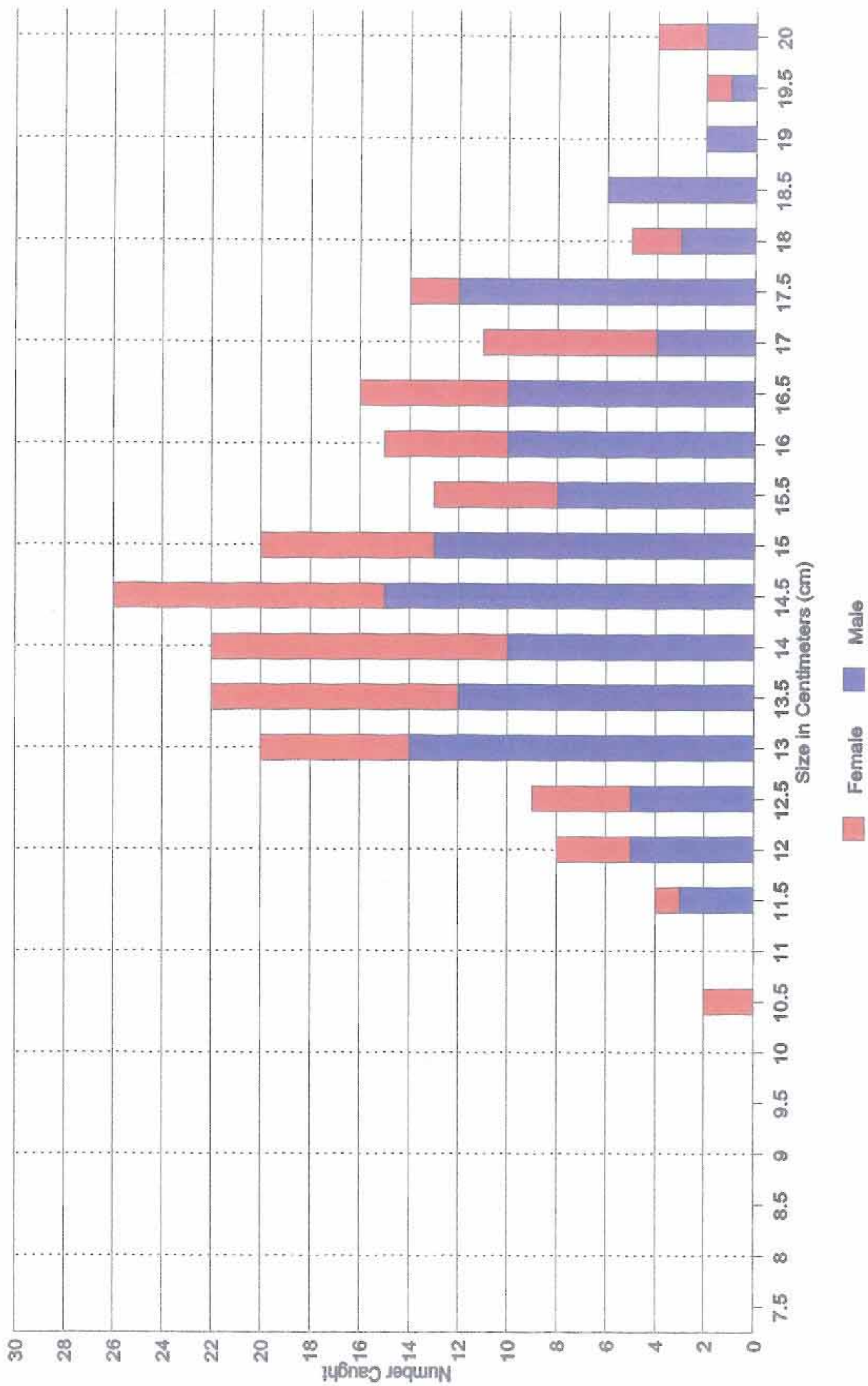


Figure 4.7: Lake Pontchartrain Blue Crabs (August 1 - 24 1997)

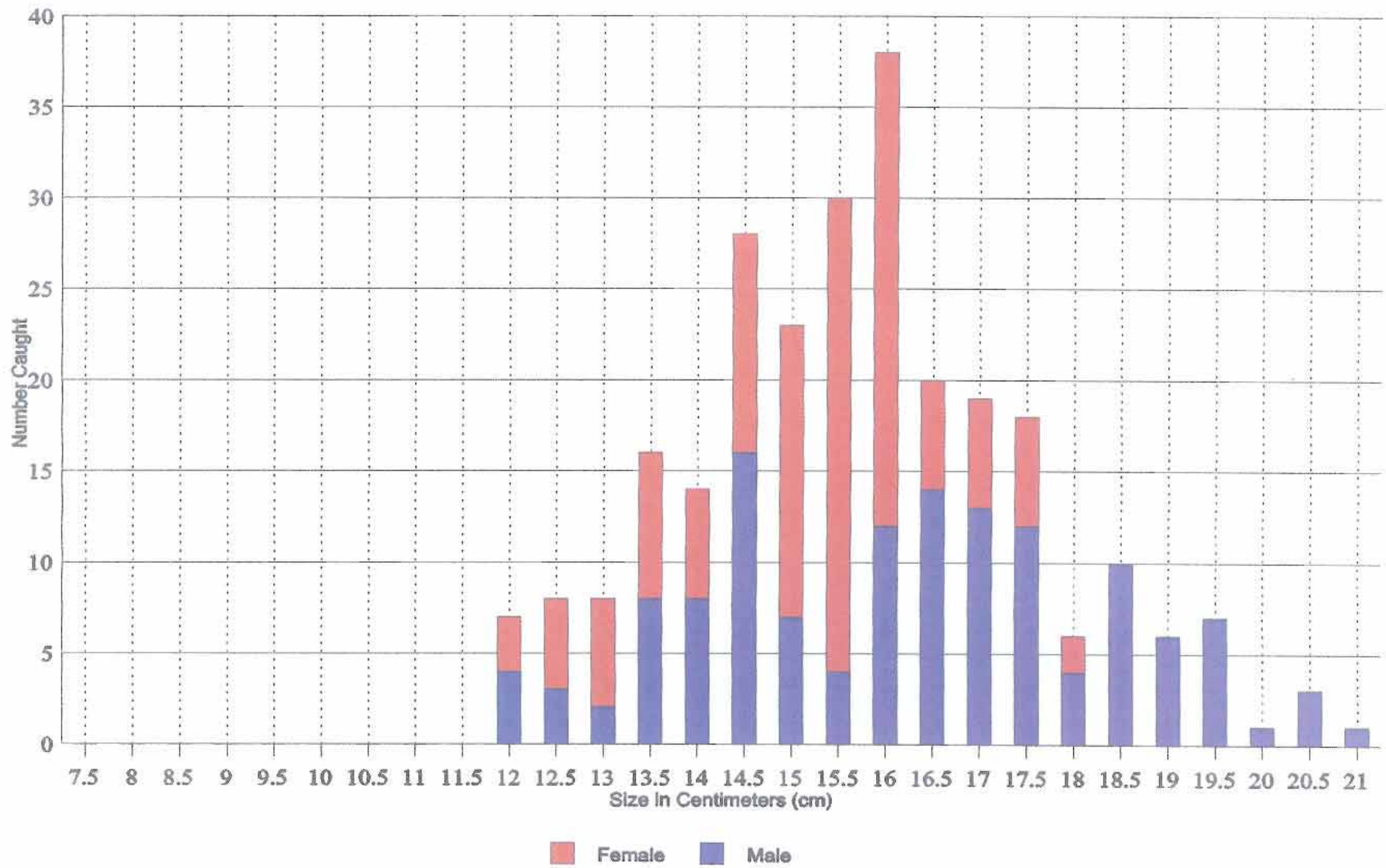


Figure 4.8: Lake Pontchartrain Blue Crabs (cumulative April 8 - August 24 1997)

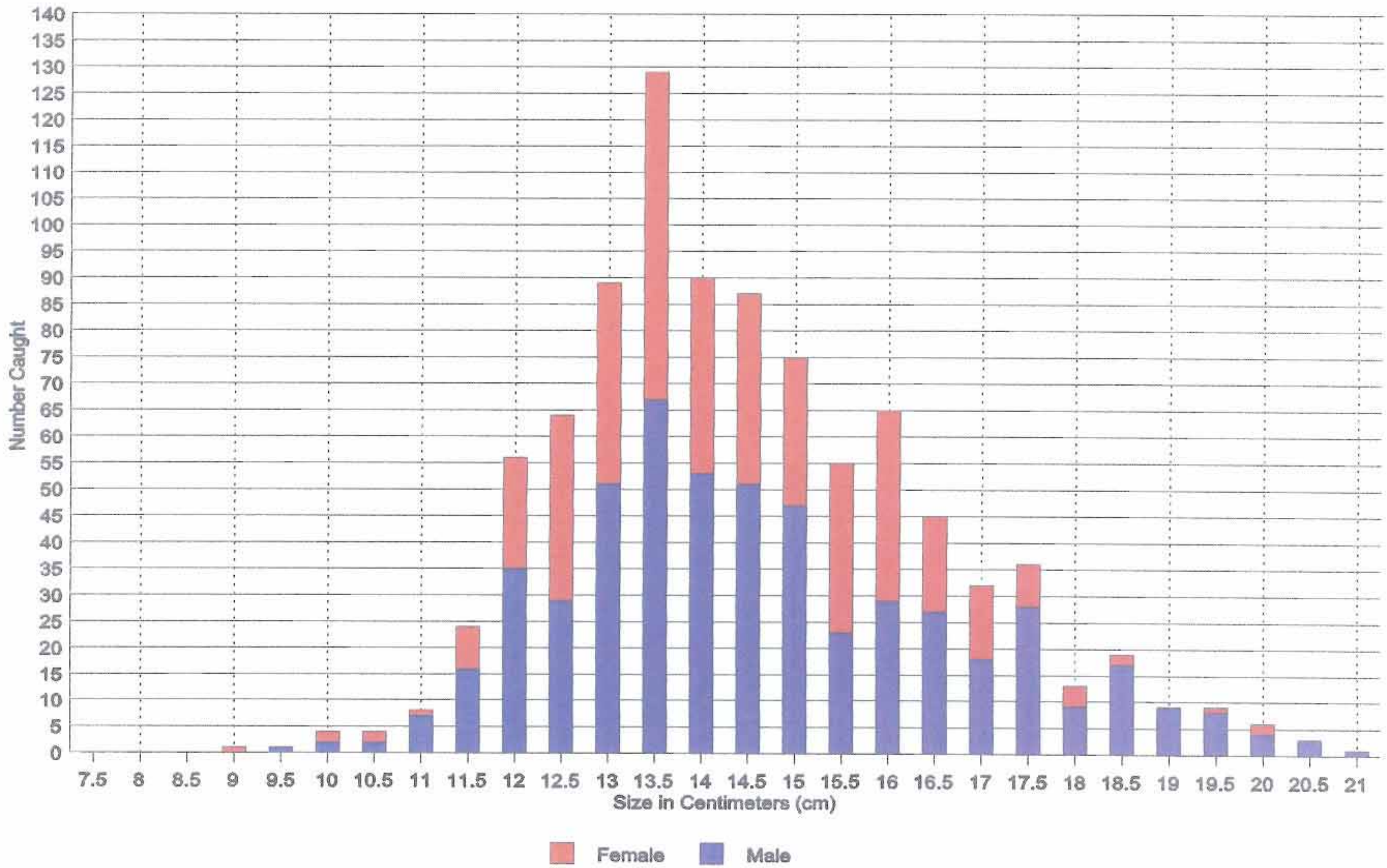
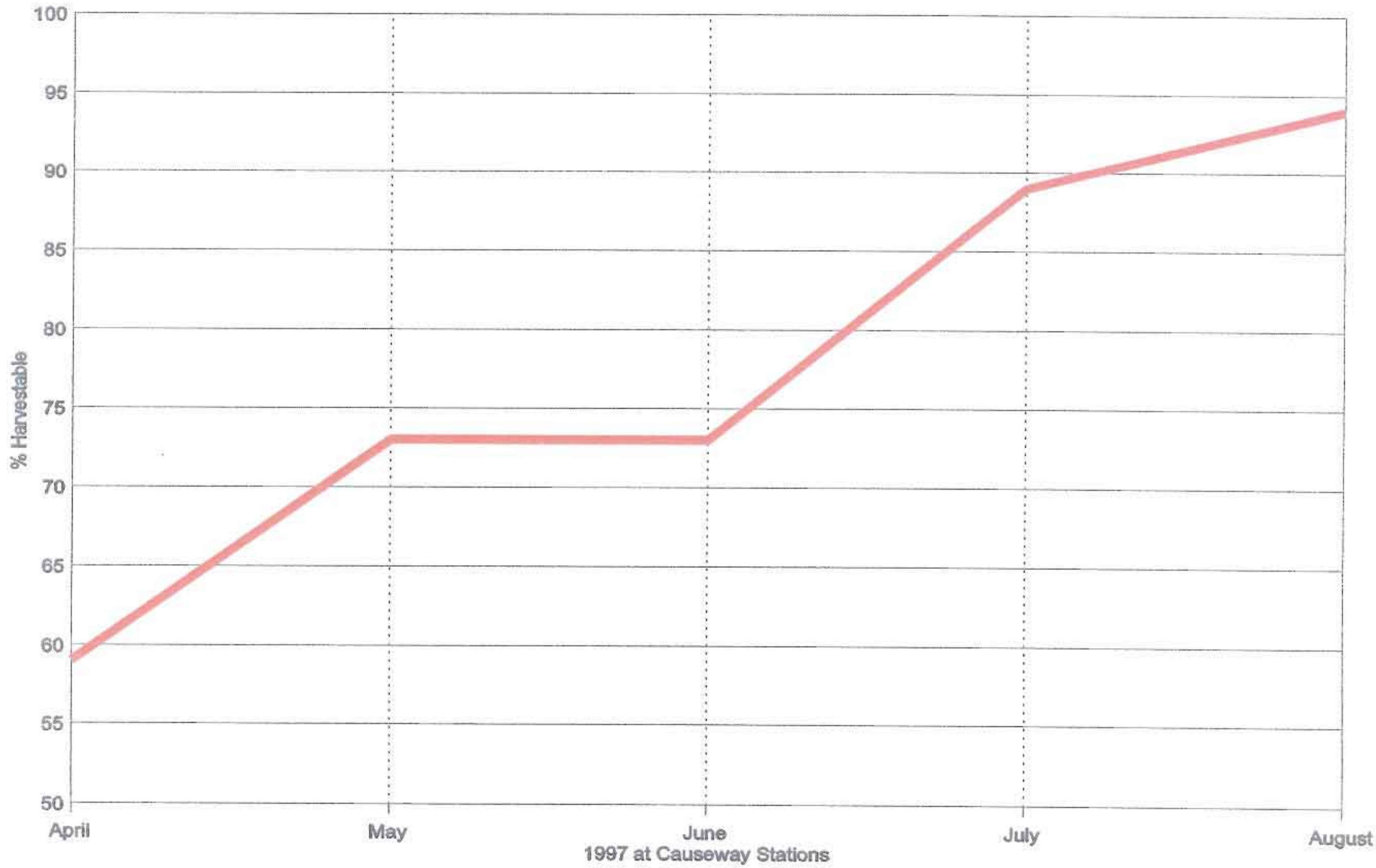


Figure 4.9: Percent of Catch of harvestable size by month



Date	Bays Open	Max flow (cfs)
1973 Apr 8 to June 21	350	195,000
1975 Apr 14 to Apr 26	225	110,000
1979 Apr 18 to May 21	350	191,000
1983 May 20 to June 23	350	268,000

During 1973 and 1983, hard crab landings in Lakes Pontchartrain and Maurepas increased significantly over the landings of the previous years. During 1979, there was also an increase over the previous year's crab landings. Only during 1975, which is the shortest of the spillway openings with the least flow and the fewest number of bays open, were the hard crab landings for the lakes slightly lower than those of the previous year Figure 4.10. Preliminary 1997 data provided by the Louisiana Department of Wildlife and Fisheries for the wholesalers in the parishes surrounding Lake Pontchartrain as well as comparable data for the years 1990-1996 are given in Table 4.1. These data for 1997 are preliminary and are not available for the entire season. Using these data, the landings for five of the six parishes surrounding the lake were higher than the 1996 landings.

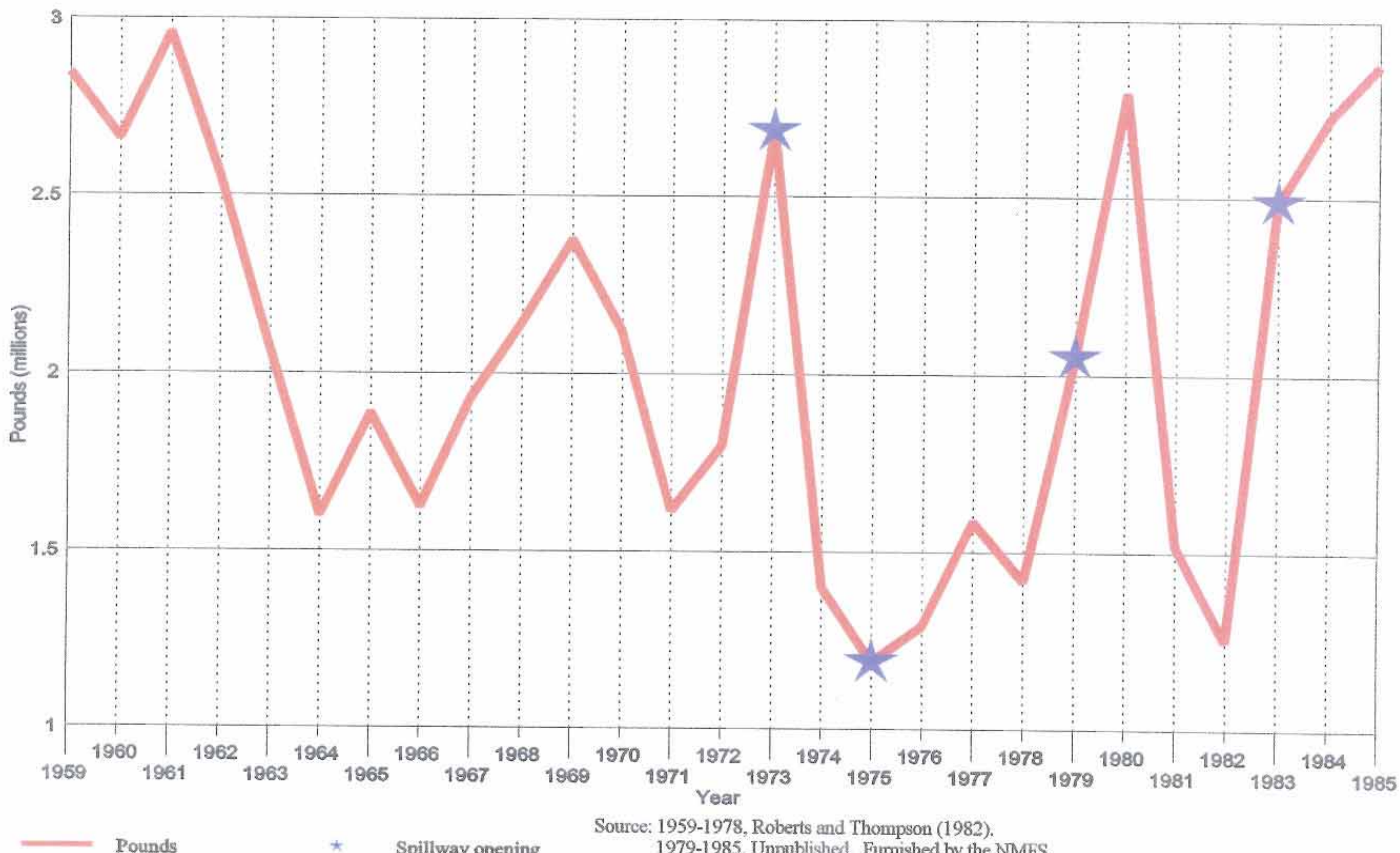
Table 4.1 Louisiana Landings of Blue Crab by Parish

Parish	1990	1991	1992	1993	1994	1995	1996	1997
Jefferson	936,752	2,094,960	3,923,692	2,978,148	2,505,137	1,719,510	1,853,058	2,255,540
Orleans	1,598,012	1,824,584	781,192	1,056,664	935,480	2,042,476	1,907,751	2,109,671
St. Charles	2,006,253	4,362,298	1,937,568	1,464,035	2,017,291	2,328,157	2,202,000	3,697,299
St. John	468	883,305	748,549	924,731	196,823	57,865	45,805	34,135
St. Tammany	1,156,111	2,182,057	752,153	542,590	872,747	661,104	1,032,442	1,387,794
Tangipahoa	452,170	226,817	15,662	24,750	580,094	456,829	24,450	82,968
TOTAL	6,149,766	11,574,021	8,158,816	6,990,918	7,107,572	7,265,941	7,065,506	9,567,407

Data Provided by the LDWF
1997 Landings are Preliminary and Subject to Change.
1997 Landings are Not for a Complete Year.

Thompson and Fitzhugh (1985) report that the suggestion has been made that extended periods of low salinity in the Lake, such as those experienced during a spillway opening, force blue crabs to become concentrated in pockets of higher salinity water. This enables fishermen to realize increased catch for decreased effort. The water quality data for the present study, however, taken at eight stations around the Lake indicate that during the months of maximum crab catch, most of the lake was experiencing salinities of 2 ppt or less. The blue crab does tolerate low salinities very successfully, although it does not reproduce at low salinities. Our findings are consistent with those of Tarver and Savoie (1976) who reported that *C. sapidus* was collected at a salinity range of 0.0-19.9 ppt during their 1973 study of the Lake Pontchartrain-Lake Maurepas Estuarine Complex. They further reported that the largest catch per unit effort was observed at very low salinities (0.0-0.2 ppt). Preliminary USGS salinity data from Causeway monitoring stations clearly show that salinities were very low, <2 ppt, and in most cases <1.0 ppt, during the period that crabs were abundant in our traps.

Figure 4.10: Hard Crab Landings from Lakes Pontchartrain and Borgne, 1959-1985



Source: 1959-1978, Roberts and Thompson (1982).
1979-1985, Unpublished. Furnished by the NMFS.
Published in Final EIS Clam Shell Dredging in Lakes Pontchartrain and Maurepas(USACOE, 1987).

CONCLUSIONS

The evidence from qualitative sampling is that crabs were abundant in sample traps in Lake Pontchartrain during and after the period of the spillway opening. This was evident in our samples in spite of consistent tampering with the traps.

The data collected also clearly show that the percent of the population of harvestable size crabs (5.0 in and longer) present in the traps increased throughout the summer.

Preliminary USGS salinity data collected along the Causeway during the summer of 1997 clearly show that salinities were very low, <2.0 ppt, and in most cases <1.0 ppt, during the period that crabs were abundant in our traps.

Historical data also show that crabs were more abundant during years of major spillway openings.

RECOMMENDATIONS FOR FUTURE STUDIES

Collection of data during years that the Spillway is not open would provide helpful background data for comparison with years when the Spillway is opened. Future studies should include funding for placing the crab traps in open water and checking periodically to avoid the tampering problems which we encountered.

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SECTION 5 - RESULTS OF WATER QAULITY SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

SECTION 5 - RESULTS OF WATER QUALITY SAMPLING DURING AND AFTER THE 1997 BONNET CARRE' SPILLWAY OPENING

INTRODUCTION

Lake Pontchartrain is a large, shallow estuarine body of water with a mean salinity from 1.2 ppt in the west to 5.4 ppt in the east (Sikora and Kierfve, 1985). Tidal fluctuations are slight, and salinity variations are probably more dependent upon wind velocity and direction and local rainfall and stream discharge (Tarver and Dugas, 1973; Poirrier, 1978). The opening of the Bonnet Carre' Spillway provides a large volume of fresh water into Lake Pontchartrain. As part of the trawl sampling in Lake Pontchartrain, basic water quality was monitored to determine the duration of the fresh water conditions.

METHODS

Water quality data were collected at each trawling station as shown in Figure 5.1. These data consisted of water temperature, dissolved oxygen (DO), salinity, conductivity, and Secchi disc visibility. The temperature, DO, salinity, and conductivity measurements were taken one foot below the surface and one foot above the bottom.

The water temperature and DO levels were taken with a YSI Model 95 Dissolved Oxygen meter while the salinity and conductivity were measured with a YSI Model 30 Salinity, Conductivity and Temperature meter. Secchi disc visibility measurements were taken with a standard 20 cm diameter, weighted, plastic disc.

Water quality measurements were made weekly for the period March 17 through June 31, 1997. All stations were sampled each week with the exception of the first week in April, when bad weather prevented sampling T-6, and the second week of April, when bad weather prevented sampling Stations 6, 7 and 8. Salinity measurements were made beginning the week of March 24, and Secchi disk measurements were made beginning the week of April 6.

From the period August 1 through October 30, water quality data were taken every two weeks. All water quality readings are summarized in Appendix D.

RESULTS

A summary of the water quality data collected at each of the eight trawling stations is given in Tables 5.1 to 5.8 and Figures 5.2 to 5.9. Salinity was not determined at trawling stations the first week of trawling (March 17).

At Station T-1, located in the eastern end of Lake Pontchartrain (east of the twin span bridge) surface and bottom salinities varied from 0.3 ppt on April 6 to 6.6 ppt on October 20 (Table 5.1 and Figure 5.2). Surface and bottom salinities fell from 4.4 ppt on March 24 to 0.3 ppt on April 6. Salinities rebounded in the last week of April to above 3 ppt and then dropped to between 1 and 2 ppt where they stayed until the end of June and beginning of July when they were below 1 ppt. Surface and bottom salinities were 5 ppt in the beginning of September and over 6 ppt at the end of October.

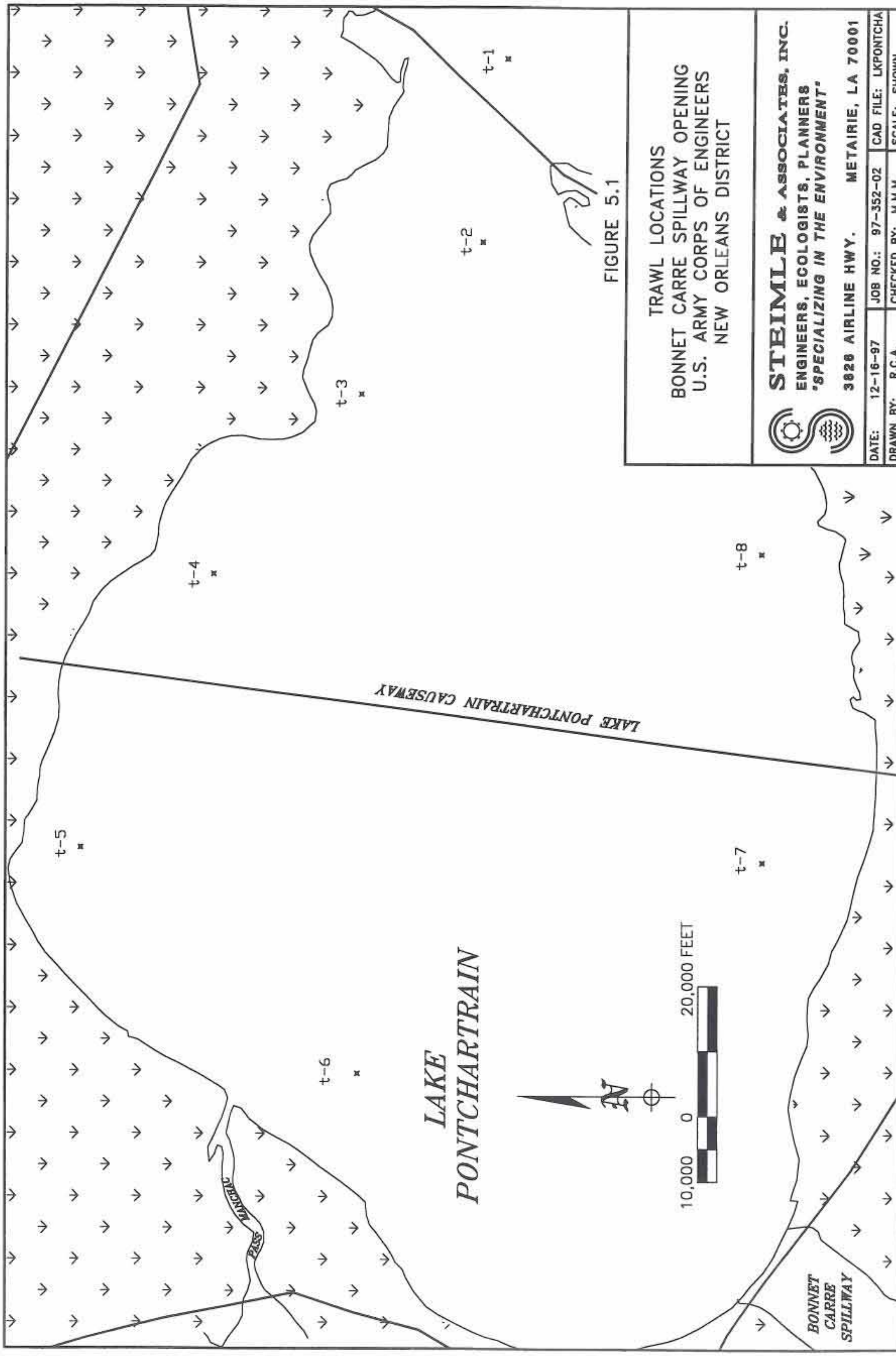

TRAWL LOCATIONS
BONNET CARRE SPILLWAY OPENING
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
FIGURE 5.1
STEIMLE & ASSOCIATES, INC.
ENGINEERS, ECOLOGISTS, PLANNERS
"SPECIALIZING IN THE ENVIRONMENT"
3828 AIRLINE HWY.
METAIRIE, LA 70001
DATE: 12-16-97
JOB NO.: 97-352-02
CAD FILE: LKPONTCHA
DRAWN BY: R.C.A.
CHECKED BY: M.M.M.
SCALE: SHOWN
t-1
t-2
t-3
t-4
t-5
t-6
t-7
t-8
LAKE PONTCHARTRAIN CAUSEWAY
LAKE PONTCHARTRAIN
10,000
0
20,000 FEET
N
MANCHAC PASS
BONNET CARRE SPILLWAY

Table 5.1. Station 1 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	(M)
17-Mar-97	17.1	17.1	NA	NA	3.3	8.8	33	90	NA
24-Mar-97	19.0	19.0	4.4	4.4	8.7	7.2	95	75	NA
6-Apr-97	19.4	19.4	0.3	0.3	8.4	8.4	90	90	0.3
8-Apr-97	17.9	17.9	0.6	0.6	8.7	8.8	90	90	0.5
15-Apr-97	17.8	17.5	1.6	1.7	9.0	9.1	95	90	0.6
21-Apr-97	18.8	18.8	1.7	1.7	8.7	8.7	95	90	0.9
29-Apr-97	18.9	18.9	3.5	3.5	8.5	8.8	90	95	0.4
7-May-97	21.7	21.7	1.3	1.3	8.3	8.1	95	90	1.2
12-May-97	23.8	22.6	1.6	1.6	7.7	7.7	90	90	1.1
19-May-97	24.9	24.9	1.6	1.6	7.4	7.4	90	90	1.4
28-May-97	27.4	27.4	1.5	1.5	7.2	7.2	95	90	1.2
2-Jun-97	25.1	25.1	1.3	1.3	7.5	7.3	90	90	2.4
10-Jun-97	26.5	26.5	1.5	1.5	7.6	7.6	95	90	0.5
20-Jun-97	28.1	27.7	0.7	0.7	6.0	5.9	80	75	0.6
24-Jun-97	28.4	28.5	0.6	0.6	6.5	6.5	85	80	1.0
7-Jul-97	29.7	29.0	0.9	0.9	6.6	6.1	90	80	NA
21-Jul-97	28.0	28.0	1.3	1.3	7.1	7.3	90	90	0.6
6-Aug-97	29.6	29.6	1.7	1.7	7.3	7.2	95	90	1.8
18-Aug-97	30.9	30.9	2.2	2.2	7.2	7.2	95	95	1.5
2-Sep-97	29.7	29.7	3.4	3.5	11.7	11.8	150	140	1.6
16-Sep-97	29.2	29.2	5.0	5.0	14.0	13.4	>150	150	1.6
30-Sep-97	26.4	26.4	2.6	2.7	10.3	11.2	125	135	0.9
20-Oct-97	19.4	19.1	6.6	6.6	13.7	13.8	120	140	2.3

Table 5.2. Station 2 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth (M)
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	
17-Mar-97	17.5	17.5	NA	NA	8.5	9.8	90	100	NA
24-Mar-97	19.0	19.0	4.0	4.0	7.0	7.4	80	80	NA
6-Apr-97	19.4	17.8	0.3	0.3	9.1	8.8	100	90	0.2
8-Apr-97	17.2	17.2	0.2	0.2	9.1	8.9	95	90	0.3
15-Apr-97	16.9	16.3	0.3	0.6	9.9	9.2	100	90	0.3
21-Apr-97	19.4	19.0	0.3	0.5	9.2	8.8	100	95	0.7
29-Apr-97	18.9	18.9	2.1	2.2	8.6	8.6	100	90	0.4
7-May-97	22.1	21.8	1.2	1.2	8.3	8.2	95	90	1.1
12-May-97	23.9	22.4	1.5	1.8	8.5	8.0	100	95	1.2
19-May-97	24.4	24.4	1.1	1.1	8.3	8.2	95	100	1.3
28-May-97	27.0	27.0	1.2	1.2	7.8	7.9	100	95	1.2
2-Jun-97	25.3	25.3	1.3	1.3	7.5	7.4	90	90	2.0
12-Jun-97	28.7	27.0	2.0	2.0	8.5	7.8	110	95	1.3
17-Jun-97	29.1	29.1	0.8	0.8	5.8	5.8	80	70	0.7
24-Jun-97	28.4	28.5	0.3	0.3	6.6	6.6	80	85	1.1
7-Jul-97	29.9	29.7	0.6	1.8	7.0	6.3	95	80	0.9
23-Jul-97	29.8	28.1	0.9	1.2	8.4	7.2	105	90	1.3
6-Aug-97	29.7	29.6	2.0	2.0	6.4	6.0	85	80	1.6
18-Aug-97	30.8	30.7	2.0	2.0	7.3	7.2	95	95	1.4
2-Sep-97	29.6	29.6	1.6	1.6	12.6	12.5	150	150	1.8
16-Sep-97	29.0	29.0	2.4	2.7	15.1	14.6	>150	>150	2.5
29-Sep-97	26.6	26.5	2.5	2.5	12.3	12.2	150	150	1.3
20-Oct-97	19.3	19.3	4.8	4.9	16.2	16.3	>150	>150	3.6

Table 5.3. Station 3 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	(M)
17-Mar-97	17.5	17.4	NA	NA	7.4	9.2	75	95	NA
25-Mar-97	20.5	19.5	4.1	4.5	11.4	9.8	125	105	NA
6-Apr-97	18.3	18.3	0.4	0.8	9.5	8.4	100	85	0.2
8-Apr-97	18.6	18.6	1.1	1.1	8.3	8.5	90	90	0.5
16-Apr-97	17.7	17.5	2.3	2.3	9.4	8.9	95	90	1.3
21-Apr-97	21.0	20.0	1.5	1.5	10.4	9.4	115	100	1.1
29-Apr-97	19.2	19.2	0.6	0.6	8.7	8.5	95	90	0.3
7-May-97	23.2	21.9	0.5	0.6	9.0	8.3	100	95	0.4
12-May-97	23.5	22.0	0.7	0.8	8.3	8.0	95	90	1.1
20-May-97	26.4	25.0	0.7	1.0	8.0	7.5	100	90	1.3
28-May-97	26.6	26.5	0.4	0.4	7.8	7.6	100	95	0.7
2-Jun-97	25.5	25.2	0.6	0.6	7.8	7.8	95	95	1.2
9-Jun-97	27.4	27.4	1.6	1.6	7.8	7.8	95	95	1.6
20-Jun-97	29.7	27.4	0.2	0.1	10.1	6.2	130	80	0.5
24-Jun-97	28.6	28.5	0.2	0.2	6.5	6.2	80	80	1.1
7-Jul-97	29.8	29.8	0.4	0.2	6.8	6.4	90	85	1.0
23-Jul-97	28.9	28.9	0.4	0.4	7.9	7.8	100	100	1.8
6-Aug-97	29.6	29.4	1.5	3.1	7.1	2.5	90	30	1.9
18-Aug-97	31.1	30.6	0.9	0.9	7.5	7.2	100	90	2.6
2-Sep-97	29.9	29.6	1.4	2.0	12.8	10.5	>150	135	2.4
16-Sep-97	29.4	28.7	2.0	2.1	13.6	13.2	>150	>150	2.8
29-Sep-97	26.9	26.4	1.7	1.7	12.2	12.6	150	150	3.0
20-Oct-97	18.9	19.8	5.6	6.9	13.8	14.8	140	150	2.0

Table 5.4. Station 4 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth (M)
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	
17-Mar-97	17.5	17.4	NA	NA	7.8	8.6	80	90	NA
25-Mar-97	21.0	19.9	3.5	3.5	10.3	9.2	115	100	NA
6-Apr-97	19.3	20.0	1.3	2.3	8.4	7.6	90	80	0.3
8-Apr-97	20.1	20.1	2.6	2.6	8.2	8.0	90	85	0.8
16-Apr-97	18.1	17.1	1.4	1.9	8.7	8.7	90	90	1.3
21-Apr-97	21.6	19.2	0.6	0.7	9.0	8.5	100	90	1.0
29-Apr-97	19.8	18.8	0.3	0.3	8.7	8.9	95	95	0.3
7-May-97	24.1	22.0	0.3	0.4	8.6	8.1	100	90	0.5
13-May-97	22.5	22.2	0.3	0.3	8.1	8.0	90	90	0.5
20-May-97	29.2	24.6	0.4	0.5	8.6	7.7	120	90	0.8
28-May-97	28.0	27.1	0.4	0.4	8.5	7.6	110	100	0.6
2-Jun-97	26.6	25.7	0.5	0.5	12.8	10.1	145	120	0.5
9-Jun-97	26.6	26.6	0.5	0.5	8.8	8.8	105	105	0.5
16-Jun-97	30.9	29.1	0.1	0.1	9.9	5.6	130	70	0.4
23-Jun-97	29.9	29.2	0.1	0.1	7.2	5.8	95	75	0.7
7-Jul-97	33.8	29.8	0.2	0.3	11.7	6.5	150	80	NA
22-Jul-97	28.9	28.9	0.4	0.4	8.7	6.8	110	85	1.1
6-Aug-97	31.2	29.7	0.7	2.2	8.4	3.4	110	45	1.7
18-Aug-97	31.9	30.9	0.8	0.8	7.8	7.1	100	90	2.1
2-Sep-97	30.6	29.4	0.6	1.1	13.5	10.7	>150	135	2.5
16-Sep-97	30.1	28.9	1.4	1.7	14.4	13.5	130	150	2.8
29-Sep-97	27.3	26.6	1.3	1.3	11.3	12.4	140	150	1.7
20-Oct-97	19.7	20.1	1.9	6.4	14.9	10.8	150	120	1.9

Table 5.5. Station 5 - Water Quality Readings - Bonnet' Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	(M)
18-Mar-97	21.6	17.4	NA	NA	7.3	8.3	80	85	NA
25-Mar-97	21.5	19.5	3.7	3.5	10.2	7.7	110	80	NA
3-Apr-97	17.6	17.6	0.7	0.7	9.2	8.9	90	90	0.4
8-Apr-97	19.5	19.5	1.6	1.6	8.2	8.9	90	95	0.4
16-Apr-97	19.0	16.6	0.6	0.8	8.8	8.6	95	85	0.6
21-Apr-97	21.4	20.3	0.2	0.2	8.7	8.3	100	90	0.6
29-Apr-97	21.6	18.7	0.4	0.4	8.9	8.7	100	90	0.2
5-May-97	22.4	22.0	0.2	0.2	8.0	7.9	95	90	0.4
13-May-97	25.4	22.5	0.1	0.1	7.6	7.4	90	85	0.5
19-May-97	25.2	25.1	0.1	0.1	7.4	7.7	90	90	0.4
29-May-97	26.8	26.8	0.1	0.1	7.4	7.1	90	85	0.4
2-Jun-97	26.4	25.5	0.1	0.1	7.8	7.2	95	85	0.5
9-Jun-97	28.2	26.1	0.1	0.1	7.9	7.1	100	85	0.4
16-Jun-97	30.3	29.6	0.1	0.1	8.2	7.0	110	90	0.5
23-Jun-97	30.9	28.9	0.1	0.1	9.0	7.2	115	70	0.8
8-Jul-97	29.2	28.7	0.1	0.1	6.9	6.2	90	80	NA
22-Jul-97	29.0	28.8	0.1	0.1	7.0	5.5	90	70	1.1
6-Aug-97	32.1	29.7	0.4	0.5	10.1	6.0	140	80	1.2
18-Aug-97	32.8	30.9	0.2	0.2	9.1	6.6	120	85	1.3
2-Sep-97	30.3	29.5	0.4	0.4	14.9	13.0	>150	150	2.6
16-Sep-97	29.8	28.7	0.9	1.1	14.4	12.2	>150	150	1.8
29-Sep-97	27.2	26.5	1.0	1.0	13.6	12.3	150	150	2.0
20-Oct-97	19.8	19.0	1.6	1.6	18.4	14.8	>150	150	1.8

Table 5.6. Station 6 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	(M)
19-Mar-97	18.2	17.6	NA	NA	6.0	5.4	65	55	NA
26-Mar-97	21.9	18.9	1.0	1.9	10.5	8.8	115	95	NA
15-Apr-97	16.3	16.3	0.4	0.4	8.8	8.7	85	85	0.4
24-Apr-97	19.5	19.5	0.3	0.3	9.0	8.9	100	95	NA
1-May-97	20.6	19.7	0.3	0.2	8.9	8.2	95	90	0.3
5-May-97	22.7	22.5	0.2	0.2	8.6	8.2	100	90	0.3
13-May-97	24.8	20.0	0.2	0.2	8.4	8.0	100	90	0.5
20-May-97	26.7	24.8	0.2	0.2	8.9	7.6	110	90	0.7
29-May-97	26.4	26.5	0.2	0.2	7.9	7.7	95	95	0.4
3-Jun-97	25.8	25.5	0.2	0.2	8.0	7.8	95	90	1.0
9-Jun-97	26.4	26.3	0.2	0.2	7.1	7.0	85	85	0.5
16-Jun-97	29.3	28.6	0.3	0.3	8.1	7.3	105	95	1.2
23-Jun-97	28.9	28.8	0.5	0.5	8.9	8.7	110	110	1.5
8-Jul-97	29.6	29.6	0.5	0.5	6.5	6.5	85	80	NA
22-Jul-97	30.3	29.0	0.2	0.4	7.5	6.7	100	85	0.7
6-Aug-97	32.0	29.4	0.6	0.4	9.6	6.3	130	80	1.5
18-Aug-97	33.1	30.5	0.5	0.5	8.4	6.8	120	85	2.1
2-Sep-97	30.8	29.6	1.0	0.9	14.8	13.0	>150	150	2.2
17-Sep-97	28.6	28.6	1.5	1.5	13.2	13.6	150	>150	2.9
1-Oct-97	26.9	26.8	2.3	2.3	10.8	11.2	135	135	3.5
21-Oct-97	19.1	19.6	2.3	2.9	18.2	18.0	>150	>150	2.2

Table 5.7. Station 7 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	(M)
18-Mar-97	19.8	18.1	NA	NA	8.5	9.6	90	100	NA
25-Mar-97	14.8	14.9	0.0	0.0	9.6	4.8	95	50	NA
4-Apr-97	15.8	15.7	0.1	0.1	9.0	8.8	90	90	0.2
15-Apr-97	14.8	14.4	0.2	0.2	9.9	9.5	95	95	0.2
24-Apr-97	19.4	19.3	0.2	0.2	9.3	9.7	100	105	0.4
1-May-97	20.3	19.8	0.2	0.3	8.9	8.7	100	95	0.4
5-May-97	21.1	21.1	0.4	0.4	8.7	8.7	100	95	0.3
12-May-97	22.0	22.0	0.4	0.4	7.7	7.7	90	90	0.6
20-May-97	25.3	25.1	1.4	1.4	8.0	7.5	100	90	0.7
30-May-97	26.0	26.0	1.0	1.0	8.1	7.7	100	95	0.9
3-Jun-97	26.4	25.5	0.8	0.7	8.7	7.4	105	90	0.9
10-Jun-97	26.6	26.6	0.6	0.6	7.8	7.8	95	95	1.1
16-Jun-97	29.5	29.3	1.5	1.5	7.2	6.2	95	80	1.3
24-Jun-97	29.3	28.4	1.6	1.7	8.7	6.1	110	75	0.8
9-Jul-97	30.0	29.5	1.4	1.4	6.6	6.6	90	85	NA
22-Jul-97	29.9	29.1	1.9	2.3	9.5	5.8	120	75	0.9
7-Aug-97	30.5	30.5	1.1	1.1	7.4	7.2	100	95	1.2
19-Aug-97	30.6	30.5	3.1	3.1	7.9	6.3	100	80	1.3
3-Sep-97	30.0	29.8	1.8	1.8	14.9	13.7	>150	>150	1.1
17-Sep-97	29.1	28.5	3.0	3.2	10.7	7.9	140	100	1.7
1-Oct-97	26.4	26.6	3.4	3.4	10.6	10.5	130	130	1.8
21-Oct-97	19.8	19.6	2.8	3.7	13.7	11.2	145	120	0.7

Table 5.8. Station 8 - Water Quality Readings - Bonnet Carre' Spillway Opening - 1997

Date	Temperature (C)		Salinity (PPT)		Dissolved Oxygen (MG/L)		Per Cent Saturation		Secchi Depth (M)
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	
18-Mar-97	18.0	17.5	NA	NA	9.2	8.8	95	90	NA
25-Mar-97	19.1	19.0	1.5	0.1	8.8	7.8	95	85	NA
4-Apr-97	16.8	16.7	0.1	0.1	9.3	9.2	90	90	0.2
15-Apr-97	17.7	15.9	0.2	0.2	9.5	9.2	100	90	0.2
24-Apr-97	20.5	19.5	0.7	9.4	10.0	6.4	110	70	0.4
1-May-97	20.4	19.8	1.8	2.4	9.3	8.6	100	95	0.7
5-May-97	21.7	21.7	2.2	2.3	10.8	10.1	110	110	0.6
12-May-97	22.0	22.6	2.4	4.2	9.6	7.8	105	90	0.6
20-May-97	25.2	24.5	1.4	3.6	10.2	6.0	120	70	0.8
29-May-97	26.9	26.2	1.9	4.6	8.6	4.6	105	55	1.1
3-Jun-97	27.3	26.0	1.9	5.9	11.7	5.8	145	95	0.7
10-Jun-97	26.8	26.7	1.3	1.5	9.0	8.7	110	105	0.9
20-Jun-97	27.6	27.4	1.7	4.1	6.0	4.3	75	55	0.7
24-Jun-97	28.5	28.1	1.3	4.2	7.6	4.6	95	60	0.8
7-Jul-97	30.2	29.9	1.5	7.3	8.1	3.8	110	50	NA
23-Jul-97	29.3	29.1	1.8	5.0	9.1	3.7	120	45	1.1
7-Aug-97	32.1	30.9	3.0	3.1	9.6	7.4	135	95	0.8
19-Aug-97	30.7	30.5	2.6	5.3	8.2	4.1	110	50	1.1
3-Sep-97	30.9	30.1	3.1	3.2	13.5	12.7	>150	>150	1.5
17-Sep-97	28.6	29.0	3.0	6.6	14.7	11.6	>150	145	1.8
1-Oct-97	27.9	27.0	3.9	4.6	12.3	10.9	150	135	1.3
21-Oct-97	19.7	19.8	4.9	5.6	14.7	16.0	150	150	1.0

Figure 5.2: Salinity
Station 1 - Bonnet Carre Spillway Opening - 1997

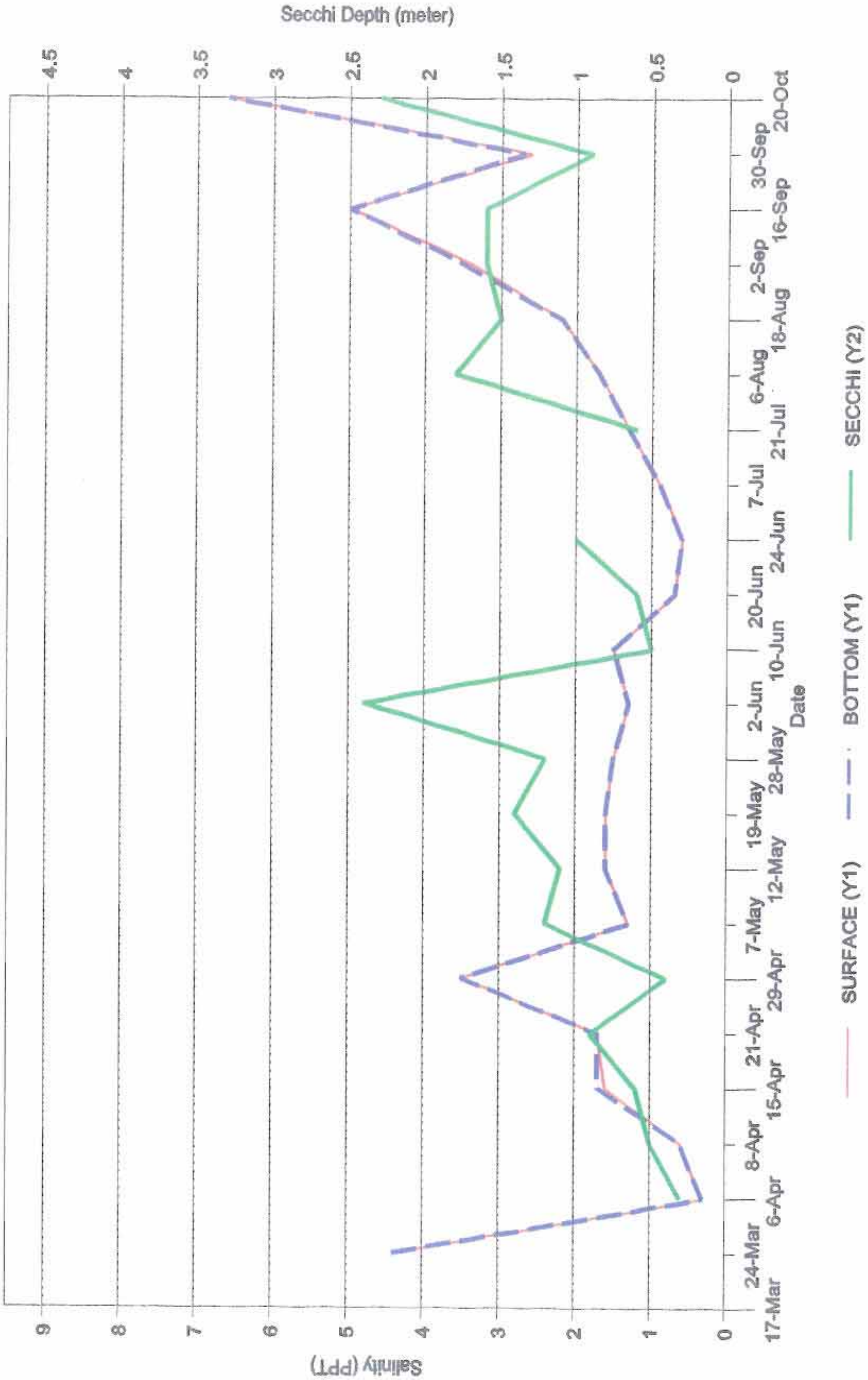


Figure 5.3: Salinity

Station 2 - Bonnet Carre Spillway Opening - 1997

Figure 5.4: Salinity

Station 3 - Bonnet Carre Spillway Opening - 1997

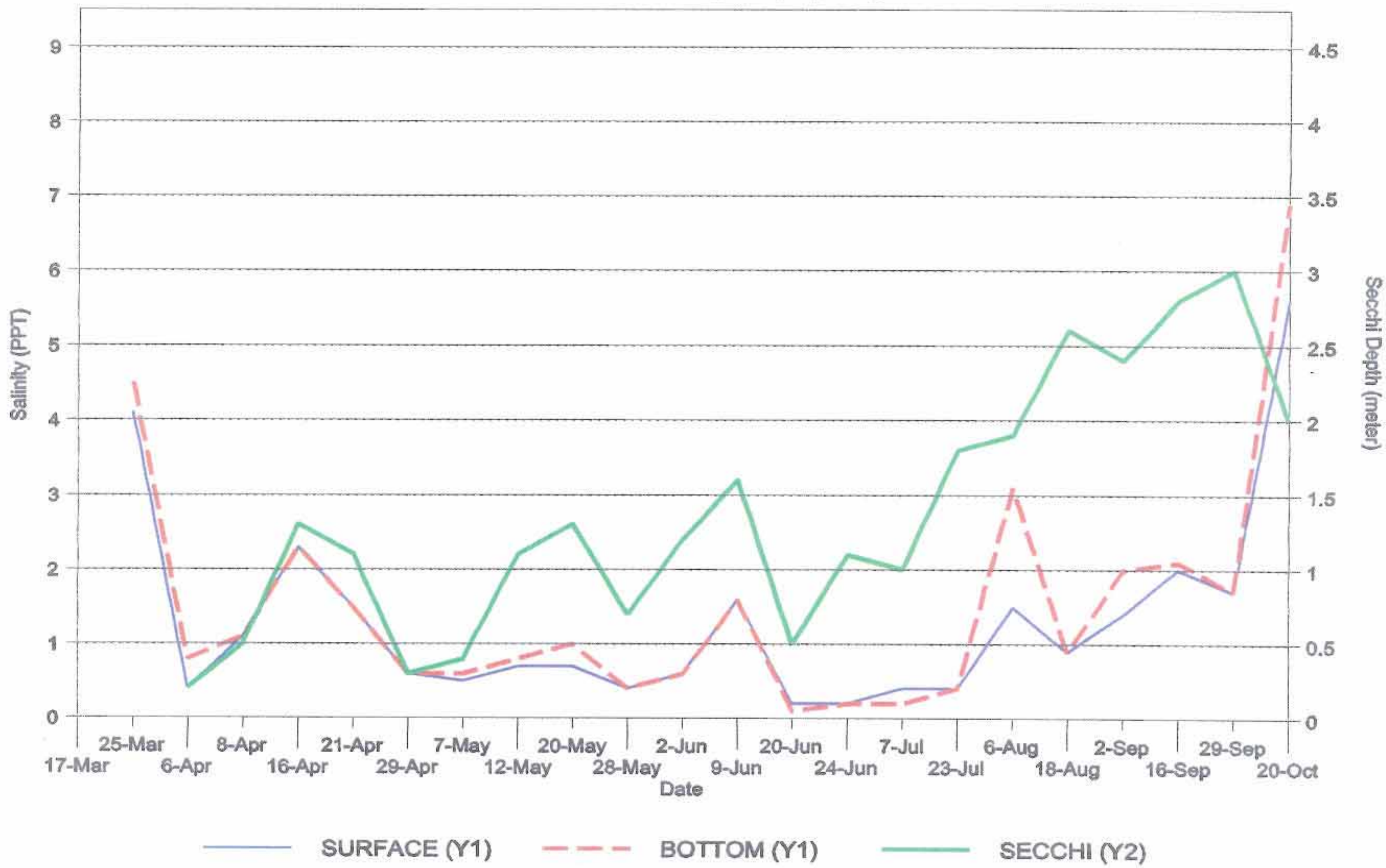


Figure 5.5: Salinity
Station 4 - Bonnet Carre Spillway Opening - 1997

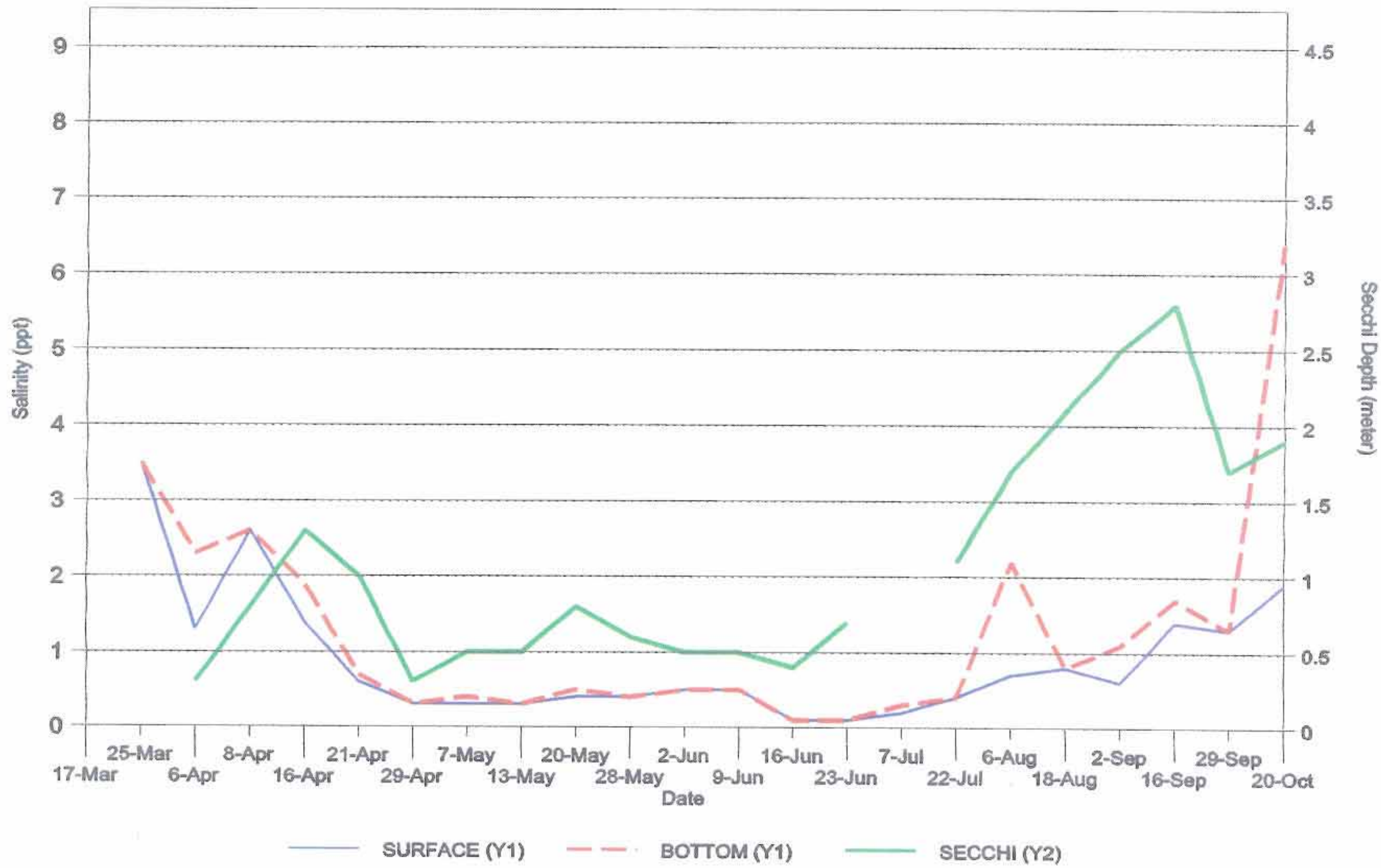


Figure 5.6: Salinity
Station 5 - Bonnet Carre Spillway Opening - 1997

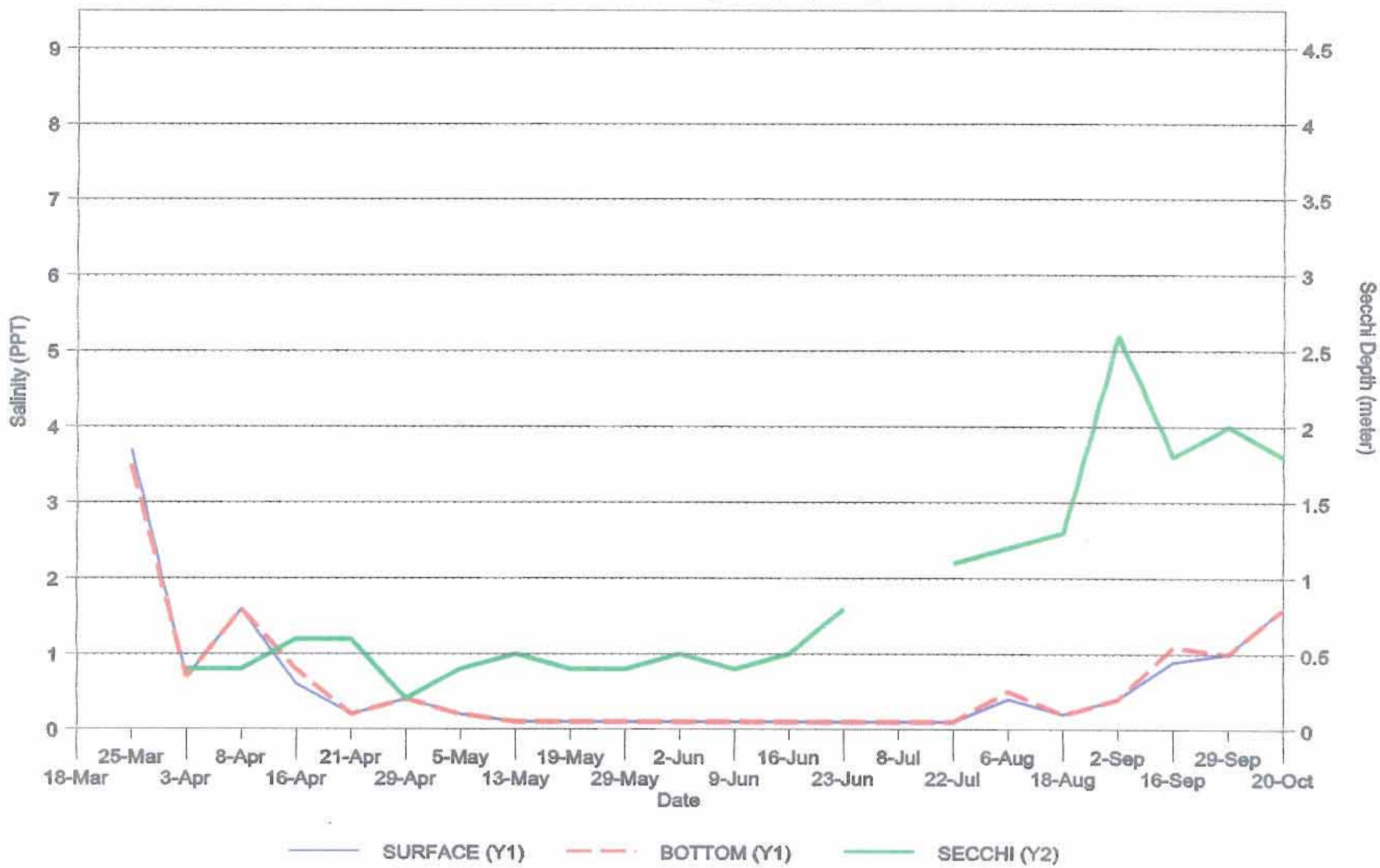


Figure 5.7: Salinity
Station 6 - Bonnet Carre Spillway Opening - 1997

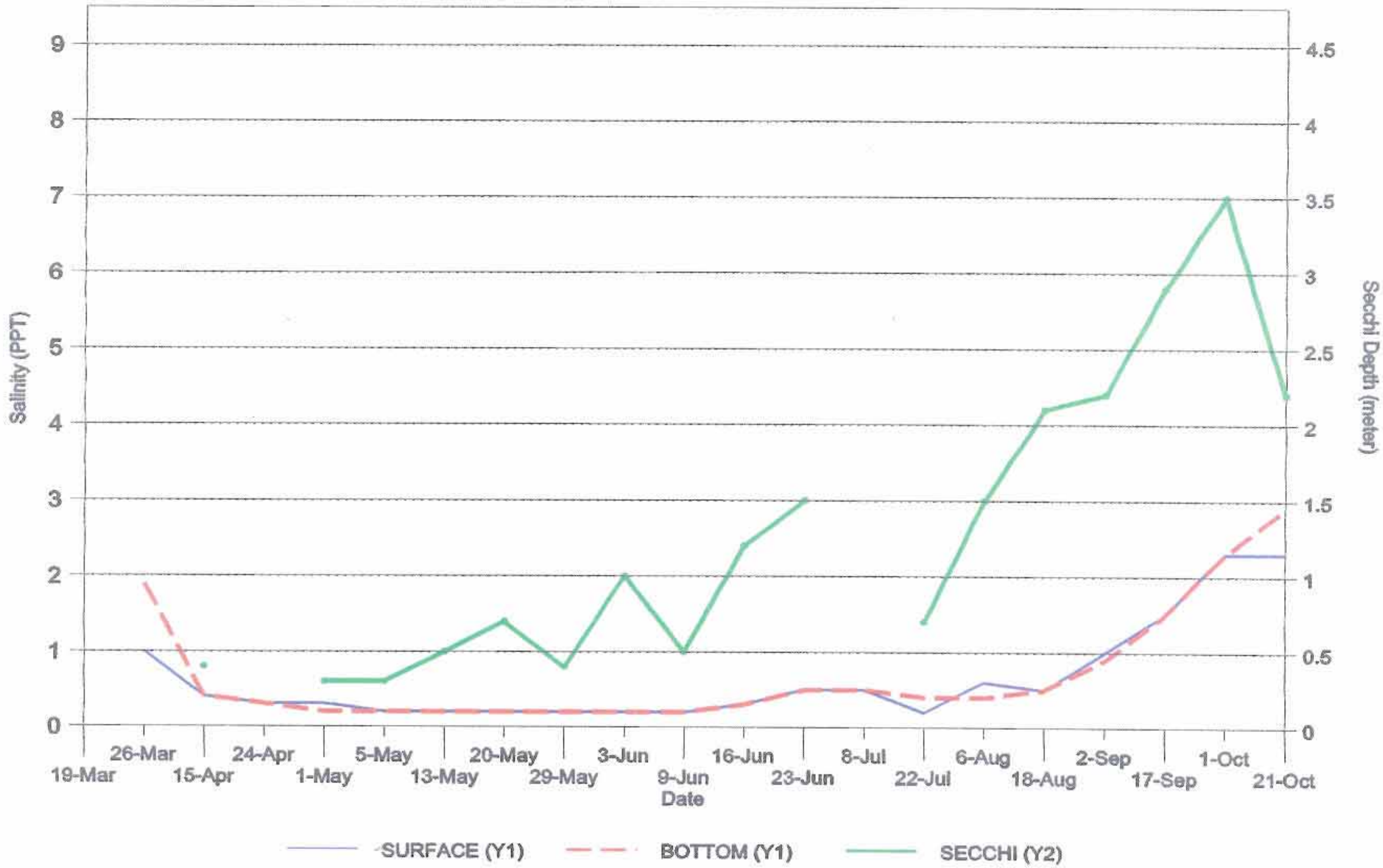


Figure 5.8: Salinity

Station 7 - Bonnet Carre Spillway Opening - 1997

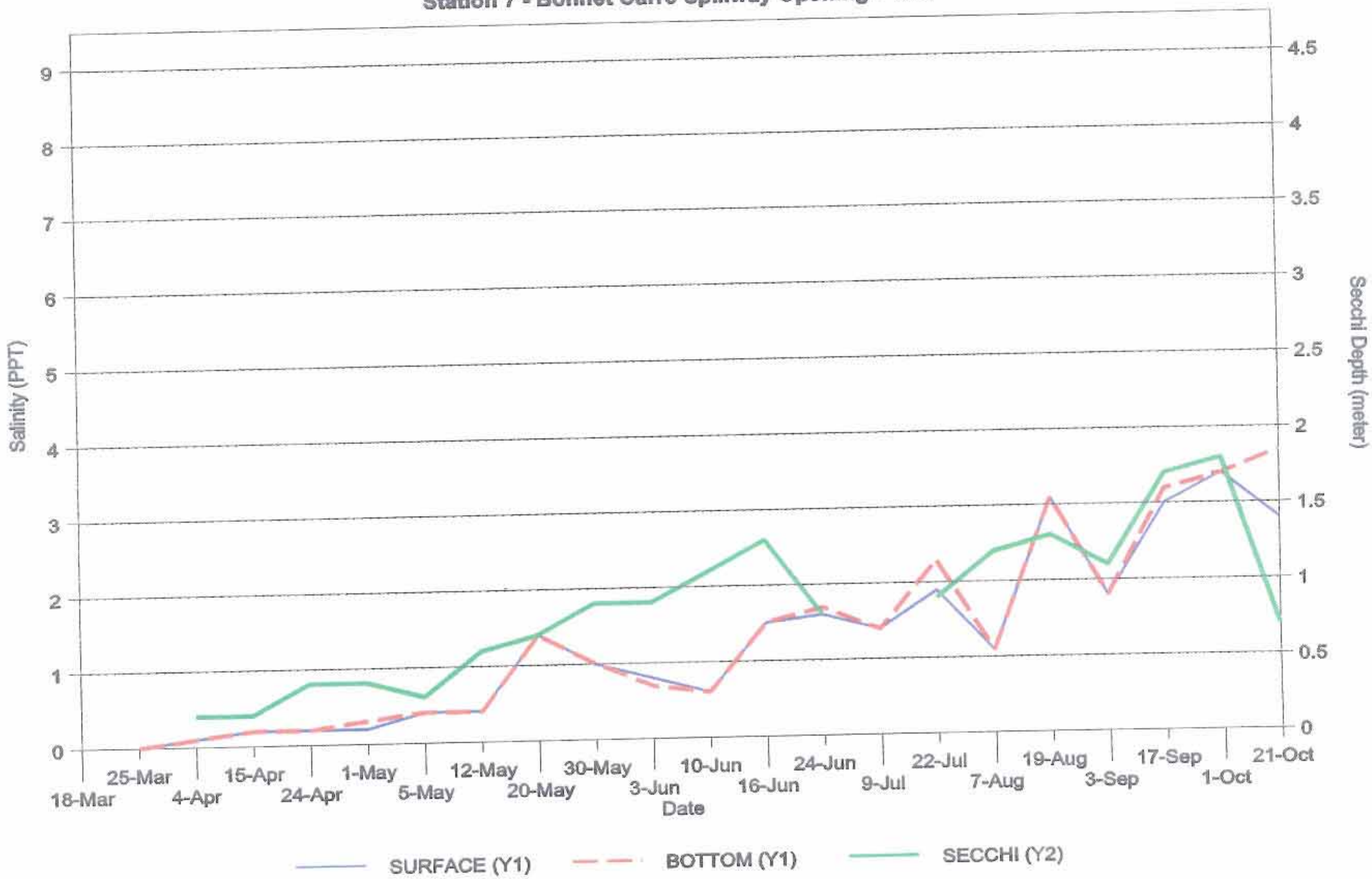
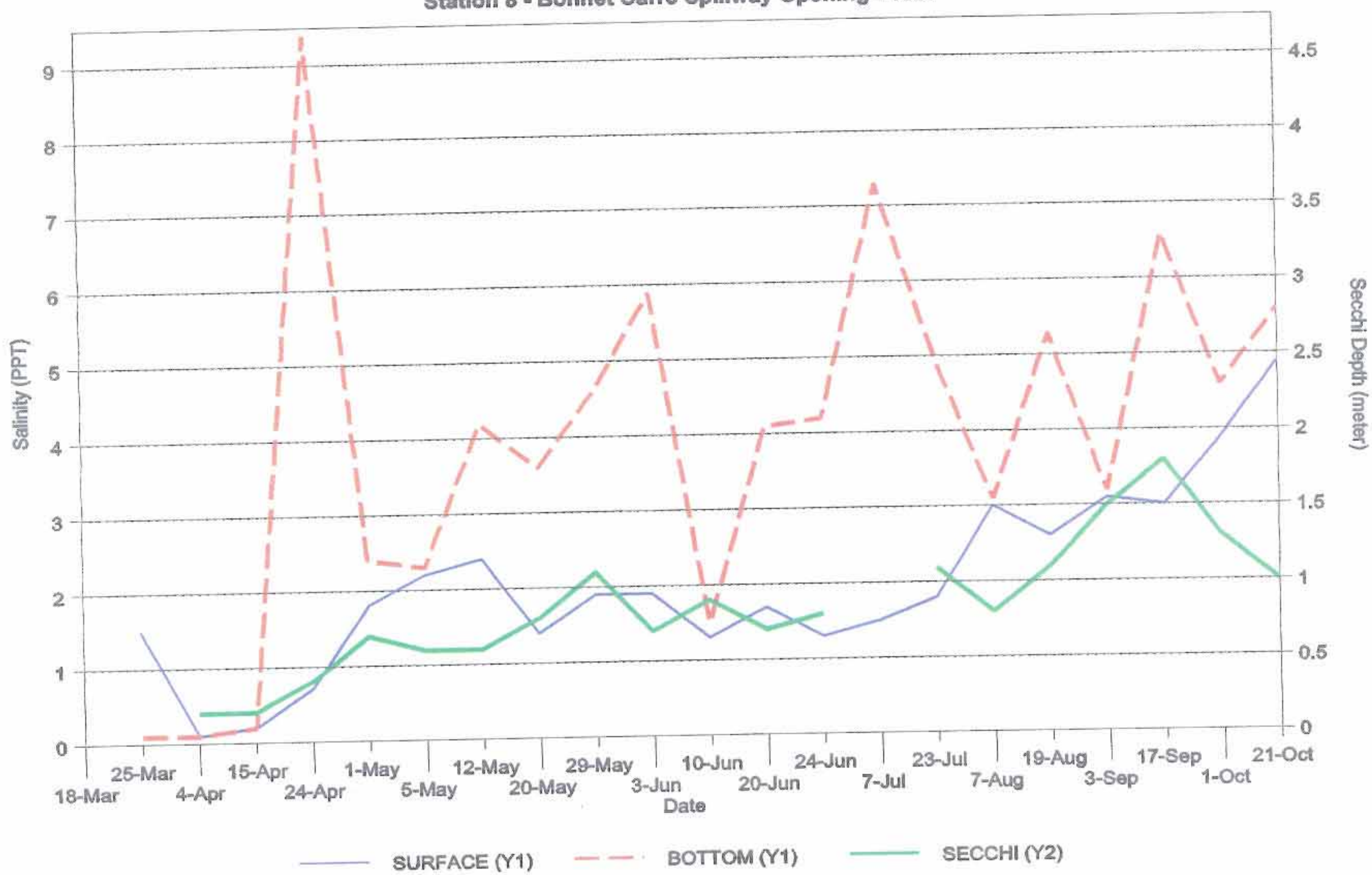


Figure 5.9: Salinity

Station 8 - Bonnet Carre Spillway Opening - 1997



Surface dissolved oxygen values at Station T-1 ranged from 3.3 ppm on March 17 to 14.0 ppm on September 16. Bottom dissolved oxygen values ranged from 5.0 ppm on June 20 to 13.8 ppm on October 20. Percent saturation of surface or bottom dissolved oxygen readings was below 75 percent on March 17.

Secchi disk visibilities varied from 0.3 m on April 6 to 2.4 m on May 28. No algae were observed at T-2 during the period of study.

Surface salinity at Station T-2, located in the northeastern lake, ranged from 0.2 ppt on April 8 to 4.8 ppt on October 20. Bottom salinities varied from 0.2 ppt on April 8 to 4.9 ppt on October 20 (Table 5.2). Salinities at this station fell below 1 ppt by the April 6 sampling and remained below 2 ppt until the September 16 sampling (Figure 5.3).

Surface dissolved oxygen values at Station T-2 ranged from 5.8 ppm on June 17 to 16.2 ppm on October 20. Bottom dissolved oxygen values at this station ranged from 5.8 ppm on June 17 to 16.3 ppm on October 20 (Table 5.2). No dissolved oxygen values below 70 percent saturation were recorded.

Secchi disk visibilities varied from 0.2 m on April 6 to 3.6 m on October 20. Surface algae were recorded at T-2 during the sampling of June 12. Secchi disk visibilities varied from 0.2 m on April 6 to 3.6 m on October 21.

Surface salinity values recorded at Station T-3, also located near Bayou Lacombe, varied from 0.2 ppt on June 20 and 24 to 5.6 ppt on October 20. Bottom salinity values varied form 0.1 ppt on June 20 to 6.9 ppt on October 20 (Table 5.3). Salinity values fell to less than 2 ppt by April 6 and remained there with only two exceptions (April 16 surface salinity of 2.3 and August 6 bottom salinity of 3.1 ppt) (Figure 5.4).

Surface dissolved oxygen values at T-3 varied from 6.5 ppm on June 24 to 13.8 ppm on October 20. Bottom dissolved oxygen values varied from 6.2 ppm on June 24 to 14.8 ppm on October 20 (Table 5.3). No dissolved oxygen below 75 percent saturation were recorded.

Secchi disk visibilities varied from 0.2 m on April 6 to 3.0 m on September 29. Surface algae were observed at this station on June 2 and June 20, and algae were picked up in the trawl although not visible on the surface on July 23.

Surface salinity values recorded at T-4, located near Mandeville, ranged from 0.1 ppt on June 16 and June 23 to 3.5 ppt recorded March 25. Bottom salinity values ranged from 0.1 ppt on June 16 and 23 to 6.4 ppt on October 20 (Table 5.4). Salinities fell from 3.5 ppt on March 25 to below 1 ppt by April 21. They stayed below 1 ppt with one exception (bottom salinity August 6 of 2.2 ppt) until September 16 (Figure 5.5).

Surface dissolved oxygen values at T-4 ranged from 7.2 ppm on June 23 to 14.9 ppm on October 20. Bottom dissolved oxygen values ranged from 3.4 ppm on August 6 to 13.5 ppm on September 16. The single saturation value below 70 percent was the 3.4 ppm bottom reading which was approximately 45 percent saturation.

Secchi disk visibilities varied from 0.3 m on April 6 to 2.8 m on September 16. Floating algae were observed at this station on June 2 and July 7, and dead algae were retrieved in trawl samples taken June 23.

At Station T-5 located near Madisonville, surface salinity values ranged from 0.1 ppt on all sampling dates from May 13 through July 22 to 3.7 ppt on March 25. Bottom salinity values ranged from 0.1 ppt on all sampling dates from May 13 through July 22 to 3.5 ppt on March 25 (Table 5.3). Surface and bottom salinities fell from approximately 3.5 ppt on March 25 to below 1 ppt by April 3. With the exception of salinities above 1 ppt (1.6 ppt) on April 8, salinities at this station stayed at or below 1 ppt until October 20 (Figure 5.6).

Surface dissolved oxygen readings at T-5 varied from 6.9 ppm on July 8 to 18.4 ppm on October 20. Bottom dissolved oxygen readings varied from 5.5 ppm on August 6 to 14.8 ppm on October 20. All readings were 70 percent saturation or above.

Secchi disk visibilities varied from 0.2 m on April 29 to 2.6 m on September 2. Floating algae were observed on June 16, and submerged algae were collected in trawl samples taken at T-5 on June 16, July 8, and July 22.

Station T-6 is located in the western part of Lake Pontchartrain near Manchac. Surface salinity readings varied from 0.2 ppt recorded all sampling days from May 5 through June 9 and July 22 to 2.3 ppt on October 1 and 21. Bottom salinity readings at T-6 varied from 0.2 ppt recorded on all sampling days from May 1 through June 9 to 2.9 ppt recorded on October 21 (Table 5.6). Salinity values fell from 1.0 (surface) and 1.9 ppt bottom on March 26 to below 1 ppt by April 15. Values remained below 1 ppt until the September 17 sampling. Values began a gradual rise in the beginning of September (Figure 5.7).

Surface dissolved oxygen readings at T-6 varied from 6.0 ppm on March 19 to 18.2 ppm on October 21. Bottom dissolved oxygen values varied from 5.4 ppm on March 19 to 18.0 ppm on October 21. With the exception of the March 19 sampling, all oxygen values were 80 percent saturation or above. March 19 sampling values were 65 percent saturation at the surface and 55 percent saturation on the bottom.

Secchi disk visibilities varied from 0.3 m on May 1 and 5 to 3.5 m on October 1. Algae were observed floating at T-6 during the June 16 and June 23 samplings.

Surface and bottom salinity values recorded at Station T-7 near Williams Blvd varied from 0.0 ppt on March 25 to 3.4 ppt on October 1(Table 5.7). Salinity values gradually rose from the 0.0 ppt level in March to near 3 ppt in October (Figure 5.8).

Surface dissolved oxygen levels at T-7 ranged from 7.2 ppm on June 16 to 14.9 ppm on September 3. Bottom dissolved oxygen values ranged from 4.8 ppm on March 25 ppm to 13.7 ppm on September 3. With the exception of the 4.8 ppm bottom dissolved oxygen reading which was approximately 50 percent saturation, all readings were at or above 75 percent saturation.

Secchi disk visibilities varied from 0.2 m on April 4 and 15 to 1.8 m on October 1. Floating algae were observed at this station during the June 16 sampling.

Surface salinity reading taken at T-8, located near the New Orleans Lakefront Airport, ranged from 0.1 ppt on April 4 to 4.9 ppt on October 21. Bottom salinity readings ranged from 0.1 ppt recorded on March 25 and April 4 to 9.4 ppt recorded April 24 (Table 5.8). Figure 5.9 shows a gradual increase in surface salinity over the sampling period and stratification in the bottom layer throughout the period (Figure 5.9).

Surface dissolved oxygen values ranged from 6.0 ppm on June 20 to 14.7 ppm on September 17 and October 21. Bottom dissolved oxygen values varied from 3.8 ppm on July 7 to 16.0 ppm on October 21. Per cent saturation values varied in the bottom samples, and were low (45 percent to 60 percent) in late May through July samples.

Secchi disk visibilities varied from 0.2 m on April 4 and 15 to 1.8 m on September 17. No algae were observed floating at this station, and no algae were collected in the trawls.

DISCUSSION

Sampling was begun during the week of March 16, the week the Spillway was opened. No salinities were recorded, however, until the following week. During the week of March 23, salinities were typical of Lake Pontchartrain at Stations 1 through 5, ranging from 3.5 ppt at Station 5 to 4.4 ppt at Station 1. Stations 6, 7 and 8, however were obviously influenced by the fresh water with surface readings which ranged from 0.0 ppt at Station 7 to 1.5 ppt at Station 8. These stations are located in the southern (Stations 6 and 7) and western (Station 8) areas of the Lake and were the first influenced by the Spillway input.

By the end of March/first week in April, the influence of the Spillway was evident at all stations sampled (Stations 1-5, 7 and 8). Surface readings ranged from 0.1 ppt at Stations 7 and 8 to 1.3 ppt at Station 4. Station 4 appears to have been one of the last areas affected by the fresh water. This is also evident in the Hydrographic Data Report issued by the Louisiana Department of Natural Resources Coastal Restoration Division. Satellite imaging which showed the extent of sediment laden Mississippi River water confirms that the western and southern portions of the lake were the first influenced by the fresh water.

Station 8 exhibited stratification during most of the days on which it was sampled. The most pronounced stratification was during the week of April 21 when the surface salinity was 0.7 ppt and the bottom salinity was 9.4 ppt. Stratification near this location and throughout the southeastern quadrant of the lake in the late spring, summer and fall as a result of the movement of a more saline, non-mixing bottom layer from the Inner Harbor Navigation Canal has been well documented by Poirrier (1978). During this study, however, no bottom dissolved oxygen reading at Station 8 was below 45% saturation.

The New Orleans District Corps of Engineers analyzed mean monthly salinity data at several stations in Lake Pontchartrain each for their period of record, 1951 - 1981, for the Clam Shell Dredging EIS (1987). Their analysis showed that salinities averaged 4.1 ppt in Lake Pontchartrain with the lowest mean monthly salinity in Lake Pontchartrain (2.6 ppt) occurring in May while the maximum occured in October (5.9 ppt). The salinity regime is subject to change with seasonal variations of freshwater inflow. The average of salinity readings at all eight stations during the period April/May/June in this study was 0.9 ppt. This average for the same stations during the period July/August/September increased to 1.5 ppt.

In a previous, unpublished analysis of the historical salinity of Lake Pontchartrain, Steimle and Associates averaged salinity data over seasons for each published data set. Salinity readings in each published data set were averaged over four seasons. The months were arranged into seasons as follows: Winter -January/February/March; Spring- April/May/June; Summer - July/August/ September; Fall - October/November/December.

In the spring of 1973, a year during which the spillway was open for 74 days, salinity readings taken by Tarver and Savoie (1976) throughout the lake averaged 0.4 ppt, lower than the average salinity found during this study. Similar seasonal (spring) data for years in which there were no spillway openings included lake wide average salinities of 3.4 ppt in 1954 (Suttkus *et al.*, 1954), 6.0 ppt in 1970 and 3.8 ppt in 1971 (Tarver and Dugas, 1973), 1.1 ppt in 1974 (Tarver and Savoie, 1976) and 2.4 ppt in 1978 (Stone, 1980). The average salinity found during this study for the spring is less than these averages although close to that recorded in 1974.

The average of all lake salinity readings taken by Tarver and Savoie (1976) in the summer of 1973, 2.9 ppt, was higher than the average of summer salinity readings taken during this study, 1.5 ppt. Summer data collected by Suttkus *et al.* (1954) averaged 3.7 ppt in 1953. Data collected by Tarver and Dugas (1973) for the summer of 1970 averaged 5.0 ppt. Summer data collected by Poirrier et al. for 1970 (south shore only) averaged 2.2 ppt. Summer data reported by Stone (1980) lakewide averaged 2.9 ppt.

The average Secchi disk visibility over the stations in this study for the spring was 72 cm. Historical average values calculated over spring samples were 41 cms in 1973 (Tarver and Savoie, 1976), 168 cm in 1954 (Suttkus *et al.*, 1954), 139 cm in 1970 and 138 cm in 1971 (Tarver and Dugas, 1973), 60 cm in 1974 (Tarver and Savoie, 1976), and 62 cm in 1978 Stone (1980).

Average Secchi disk visibility calculated over the fall months in this study was 166 cm. Historical averages calculated over summer samples were 79 cm in 1973 (Tarver and Savoie, 1976), 140 cm in 1953 (Suttkus *et al.*, 1954), 142 cm in 1970 (Tarver and Dugas, 1973), 106 cm in 1974 (Tarver and Savoie, 1976) and 89 cm in 1978 (Stone, 1980). Average Secchi visibility calculated for the summer of 1997 was higher than the average of any historical Secchi data reported.

Dissolved oxygen values were overall above 70 percent saturation in the data set with a few exceptions. The most notable exceptions to this were the supersaturation observed at Station 3 in mid-June, Station 4 from the last week in May until the first week in July, and Stations 5 and 6 during the last two weeks of June. These values are probably related to the algal blooms observed concurrent with these readings. Supersaturation was observed in other instances not seemingly related to the algal blooms especially in September and October.

Algal blooms were also observed at Station 5 throughout July, the first week in July at Station 6, and the week of June 16 at Station 7. Supersaturation did not occur at these stations during the sampling. At Station 4, lower dissolved oxygen readings (70-75 percent saturation) were recorded in bottom readings during the last two weeks of June when the algal bloom was apparent. This was also observed during the last week of July at Station 5.

The lowest dissolved oxygen values (and per cent saturation) occurred during stratification events at Station 8, particularly during June and July, but values at this station never fell below 45% saturation. Low bottom oxygen values were attributed by Poirrier (1978) to the organic loading in the non-mixing saline bottom layer.

CONCLUSIONS

The Spillway has, according to these data, affected the salinity of Lake Pontchartrain particularly during the spring, although the summer salinities were also somewhat lower than the historical reported. Similarly, spring Secchi disk visibilities were lower than most averages historically reported except during other years of spillway openings and during the summer of 1978. Summer visibilities, however, were higher than any historically reported averages for the same period.

The stratification that has historically been reported in the southern portion of the Lake during the spring and summer was evident only at Station 8 near the airport. These non-mixing pockets of more saline water, which often deoxygenate and historically move around the southeastern quadrant of the lake, were not evident in these data except at this station.

Oxygen values did not appear to have been negatively influenced by the Spillway opening. Per cent saturation values were high in most cases and extremely high in summer month data. Algal blooms were observed at six of the eight monitoring stations. Surface algae were observed, particularly during June. During July, submerged mats were collected in trawl samples at some stations. No algae were recorded or collected at any stations in August.

The effects of the spillway opening on water quality in Lake Pontchartrain, therefore, appear to have been maximum in the spring months of April, May, and June on salinity, and Secchi visibility. These effects appear to have decreased over the following summer months as salinity and Secchi visibility increased.

RECOMMENDATIONS FOR FUTURE STUDIES

General water quality parameters such as salinity, dissolved oxygen and Secchi disk visibility and pH need to be measured in conjunction with any future background studies of the lake conducted during years when the Spillway is not opened.

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SECTION 6 - 1997 BONNETT CARRE' SPILLWAY OPENING IMPACTS ON RECREATION

SECTION 6 - 1997 BONNET CARRE' SPILLWAY OPENING IMPACTS ON RECREATION

INTRODUCTION

This section of the report describes the recreational impact of the 1997 opening of the Bonnet Carre' Spillway. The area analyzed for impact was twofold, since Spillway openings affect recreational activities in the Spillway itself and in the lakes that receive the released waters.

The impact analysis involved four distinct but related data gathering efforts: (a) interviews with persons using the lakes Pontchartrain, Catherine, and Borgne areas (including Hopedale) for water based recreation relative to their activities and the possible impact of the spillway opening on their activity patterns; (b) observations and chronicling of activities and apparent numbers of recreationists at access sites in the study area; (c) interviews with persons/groups using the Spillway proper for recreation; and (d) observations of numbers of persons engaging in various recreational activities in different locations within the Spillway area.

METHODS

This section describes the procedures followed to select samples of: (1) locations/dates for the interviews with Lake users and for observations at Lake access sites; and (2) dates for interviewing Spillway users and observing activities at the Spillway.

The sampling process began with New Orleans District personnel determining the level of effort to be expended on field work, i.e., the number of days on which interviewing would be carried out. The level of effort was defined in terms of the effort necessary to yield an unbiased, comprehensive view of the Bonnet Carre' opening "event" and its attendant effects on recreation at the Spillway and in Lake Pontchartrain and waters to the east. Determinations were made for the lake use study and for the Spillway use study independently in terms of the number of days that would be required to obtain the needed information at least cost. It was also determined that holidays, holiday weekend days, and weekend days would be the most heavily sampled since these days have the highest usage. It was also judged that by the fall of the year most of the immediate effects of the opening would be past. Interviewing was scheduled from the opening in March through October. The number of days in each category are shown below for both the lake survey and the Spillway survey:

	Lake Survey	**Spillway Survey**
Holidays	18	3
Weekend Days	25	14
Weekdays	13	12
Special Days	6	3
Total Days(March-October)	62	32

Lake Users Survey

At the outset of the study, G.E.C. obtained recommendations from the New Orleans District with respect to the landings where interviews should be done. A list of landings/marinas was also obtained from the Louisiana Office of State Parks and combined with the District list. A field crew visited all the facilities on the combined lists and characterized them as to apparent relative usage and accessibility. Locations were judged to be high use, medium use, and low use based on the G.E.C. field survey and in consultation with District personnel. The initial list contained 33 proposed interview sites and the final list contained 39 identified sites. (A list of these sites is found in the attached lake interview coding instructions.).

The Spillway was opened on March 17 and Mississippi River water spread through Lake Pontchartrain, the Rigolets, and Chef Menteur area, and into Lake Borgne over an approximately two-week period. In order to establish a "base line" for lake usage and conditions prior to the time when Spillway waters reached certain areas, personnel began immediately to gather data using a draft survey form jointly devised by G.E.C. and District personnel. Interviews were carried out during four days of interviewing at 17 locations in the final two weeks of March.

A randomized sample of interview sites and dates was generated for the months of April through October. In a simple procedure, the initial 33 sites were listed according to their judged level of usage. Low use sites were listed once, medium use sites were listed three times, and high use sites were listed five times. Sequential numbers were assigned to the listings. A table of random numbers was used to select the interview sites, which were listed in the order drawn until enough draws had been made to cover the number of interview days remaining. The 18 holiday/holiday weekend interview days were assigned to the first 18 randomly drawn sites listed. All weekend dates in June through October were listed and sequential numbers assigned. Using a random number table, a sample of weekend dates was drawn and assigned to the next 25 sites listed. The weekday selection was made in the same manner and assigned to the next 13 sites listed. In order to make the sample of interviews more representative, a core time period of 10 AM - 2 PM or 2 PM - 6 PM was assigned for each interviewing day. Where time or opportunity were available, interviews were conducted before and after these core-time periods. This sampling plan was reviewed by District personnel and was the basis for the data gathering effort, which was conducted by a single interviewer at each site on each day.

The access/interview sites tended to group within fairly definable regions. For this reason, interviewers were instructed also to observe the activity at adjacent sites and to conduct interviews at sites in close proximity to the principal site selected for that day's interviewing effort. For example, if Fort Pike was the site selected for a given day, the interviewer was instructed to observe periodically activity at Rigolets Marina across the Rigolets Pass from Fort Pike and at Chef Harbor Marina, Venetian Isles Marina, and Tackle Box launch on Chef Menteur Pass.

Only minor departures were made from the sampling plan. Interviewing was canceled on one weekend because of stormy weather with coastal flood warnings. The only other departure from the sampling schedule was substituting Sundays for Saturdays on two occasions at the same site. Interviews and observations were conducted on all other scheduled days at the assigned areas. The two days missed were rescheduled at the direction of District personnel along with two remaining "special" days.

Spillway Users Survey

The procedure for developing the sampling plan for data collection in the Spillway was similar to that for the Lake use study. Two of the "special days" were scheduled on the first two weekends in May to capture the high crawfishing use expected. The holiday days were scheduled. The remaining weekend days from May through October were listed and assigned sequential numbers. As with the Lake use sampling procedure, the requisite number of days was then selected using a random number table. A similar procedure was used to draw the sample of weekdays on which to interview. The only difference from the Lake use study was that on holidays and weekends, two persons interviewed and made observations. On weekdays, one person covered the entire area.

All scheduled interview dates were covered, with the exception of Monday, June 16. Scheduling conflicts prevented the field researcher assigned from interviewing on that day, although some counts were made late in the day. On Sunday, June 22, one field researcher terminated the interview process after half a day because of a flat tire. The missed time was partially recovered on Sunday, July 20, when G.E.C. covered the annual 5K race through the mud, which was attended by more than 1,000 runners.

Interview Forms, Questionnaires, and Data Recording Forms

Questionnaires and survey directions were developed for both the Lake use survey and the Spillway use survey with the cooperation and input of District personnel. Interviewer instructions were incorporated into the Lake use survey form, but separate interviewer instructions were developed for the Spillway form. Forms for recording observation information for both the lake survey and the Spillway survey were also developed. Data bases and coding instructions were developed for data entry. Data coding and entry were verified by having two coders separately check each other's work. Edit routines were run to locate any out of range entries, logical inconsistencies, etc.

The Lake user survey form evolved through three versions early in the study. Core questions remained the same, but additional questions were added and the format was changed. All lake use surveys done since mid-June have used the final form. Information from all the surveys was coded to agree with the final survey form. Copies of the several survey forms, data recording forms, and coding instructions are included as attachments to this report.

LAKE USERS SURVEY

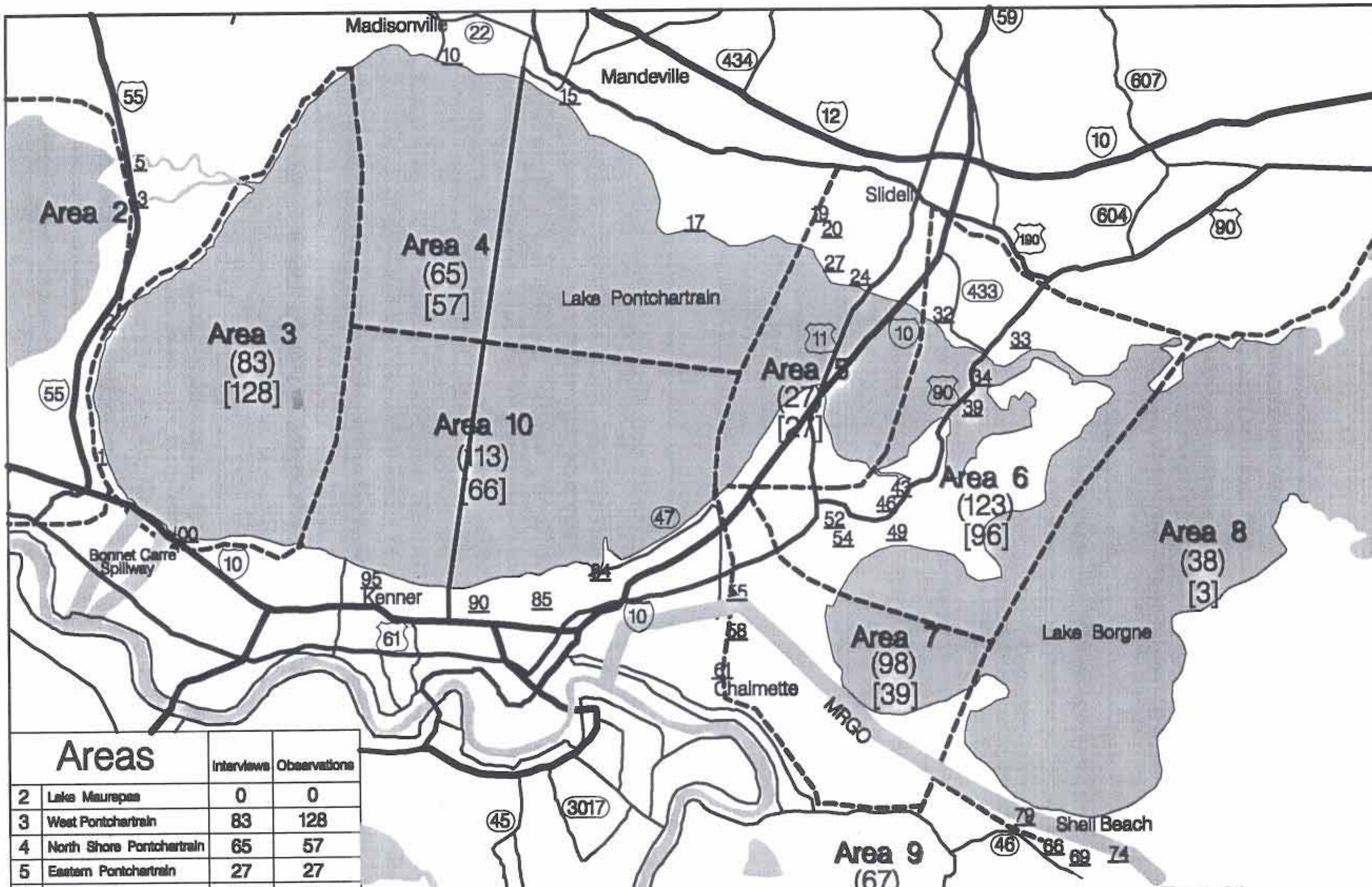
The data gathering efforts for the Lake users survey during the months of March through October resulted in 614 completed interviews. This included 73 in March, 19 in April, 121 in May, 73 in June, 74 in July, 100 in August, 117 in September, and 37 in October. The small number of interviews in April resulted from canceling two scheduled weekend interview efforts because of coastal storms and flooding. Field researchers were instructed to observe any water-based recreation activity in the vicinity of the interview sites. The number of vehicles and the number of boat trailers were also recorded. A total of 433 single day/single site observations were made. Some sites were observed more than once on a given day. These additional observations bring the total to 680 observations. Observations were often made at sites in one area while en route to the day's selected interview sites. Additionally, observations were made at lake interview sites if researchers passed them on their way to field work assignments in the Spillway itself. Table 6.1 shows the distribution of interviews by area. Figure 6.1 is a map of the study area showing subareas and the interview sites within the study area. The number of interviews in each area is shown as is the distribution of the 433 single day/single site observations. The lake survey intercept/interview sites follow.

Identification Code Number	Place Name
001	Frenier Beach (Peavine Road)
002	Ruddock Boat Launch
003	Pass Manchac
005	North Pass Boat Launch
010	Mouth of Tchefuncte Boat Launch
015	Mandeville Harbor
017	Mouth of Bayou Lacombe
018	Glockner/Highway 443
019	St. Genevieve church Boat Launch
020	Bayou Liberty Marina
024	Tite/Cousins Marinas
027	Harbor View Marina
031	Slidell Marina
032	Sammy's (Salt Bayou) Boat Launch
033	Rigolets Harbor Marina
038	Fort Pike Boat Launch
039	Lake Catherine Marina
043	Chef Harbor Marina
046	Venetian Isles Marina
047	Fort Macomb Marina
049	Tackle Box Boat Launch
054	Lombard's Boat Launch
055	Eddie Pinto's Boat Launch
058	Paradise/City Limits Marina
061	Gulf Outlet Marina
066	Dudenhefer's Marina
069	Pip's Marina
074	Breton Sound Marina
079	Blackie Campo's Marina
084	Seabrook Boat Launch
085	West End Boulevard Boat Launch
090	Bonnabel Boulevard Boat Launch
095	Williams Boulevard Boat Launch
100	Bonnet Carre' Lower Guide Levee Boat Launch

Table 6.1. Lake User Interview Efforts by Month and Area

	March		April		May		June		July		August		September		October		Total	
Area Name	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)	Number of Groups	Frequency (Percent)
West Pontchartrain	2	3%	9	47%	22	18%	19	26%	0	0%	6	6%	21	18%	4	11%	83	14%
North Shore Pontchartrain	7	10%	0	0%	30	25%	18	25%	6	8%	3	3%	0	0%	1	3%	65	11%
Eastern Pontchartrain	8	11%	5	26%	0	0%	0	0%	3	4%	6	6%	4	3%	1	3%	27	4%
Passes Area (Lake Catherine)	23	32%	1	5%	29	24%	12	16%	28	38%	12	12%	16	14%	2	5%	123	20%
Bayou Bienvenue	3	4%	4	21%	12	10%	0	0%	1	1%	35	35%	16	14%	27	73%	98	16%
Shell Beach /Lake Borgne	0	0%	0	0%	0	0%	0	0%	14	19%	17	17%	7	6%	0	0%	38	6%
Hopedale Area	12	16%	0	0%	18	15%	7	10%	9	12%	10	10%	11	9%	0	0%	67	11%
South Shore Pontchartrain	18	25%	0	0%	10	8%	17	23%	13	18%	11	11%	42	36%	2	5%	113	18%
	73	100%	19	100%	121	100%	73	100%	74	100%	100	100%	117	100%	37	100%	614	100%

Source: G.E.C., Inc., 1997.



	Areas	Interviews	Observations
2	Lake Maurepas	0	0
3	West Pontchartrain	83	128
4	North Shore Pontchartrain	65	57
5	Eastern Pontchartrain	27	27
6	Pass Area	123	96
7	Bayou Bienvenue	98	39
8	Shell Beach /Lake Borgne	38	3
9	Hopedale	67	17
10	South Shore Pontchartrain	113	66

** Numbers of interviews are in (parentheses)
Numbers of observations are in [brackets]
Interview site numbers are underscored; Site names are listed on first page of attachment

Figure 6.1

Lake Survey Study Area

Group Size and Makeup

Fifty-six percent of all groups interviewed were male only, and 43 percent were mixed male and female. The average and modal size of the male-only groups was two persons. The modal size of the mixed groups was also two persons, but larger groups, including families, brought the average size of the mixed groups to 3.4 persons. Only four female-only groups were encountered. Table 6.2 shows details of group size and makeup.

Table 6.2. Size and Makeup of Lake User Groups

Category	Number of Groups	Average Number Males	Average Number Females	Percent of Total
Male Only	341	2.10	0.00	56%
Male and Female	259	1.80	1.60	43%
Female Only	4	0.00	1.80	1%
Total	604			100%

Source: G.E.C., Inc., 1997.

Principal Activities

Consumptive recreation (i.e., fishing, crabbing, and trawling) was the principal activity by almost 70 percent of all groups interviewed. Saltwater fishing was the purpose of about 51 percent of all groups and 74 percent of the extractive groups. Freshwater fishing groups constituted 12 percent of all groups, whereas crabbing and trawling made up about five percent. Boating, jet skiing, water skiing, sailing, and windsurfing accounted for the remainder of the recreation groups.

Swimming was an expected activity that was notably lacking. According to some respondents, most of the reluctance to swim resulted from perceived poor water quality, either because the water was muddy or algae-laden or because people had heard that it was not healthy to have contact with the water. Table 6.3 shows a breakdown of the principal activities reported by the interviewed groups. The total number of groups shown is greater than the number of interviews because many groups engaged in more than one activity. Figure 6.2 represents these findings graphically.

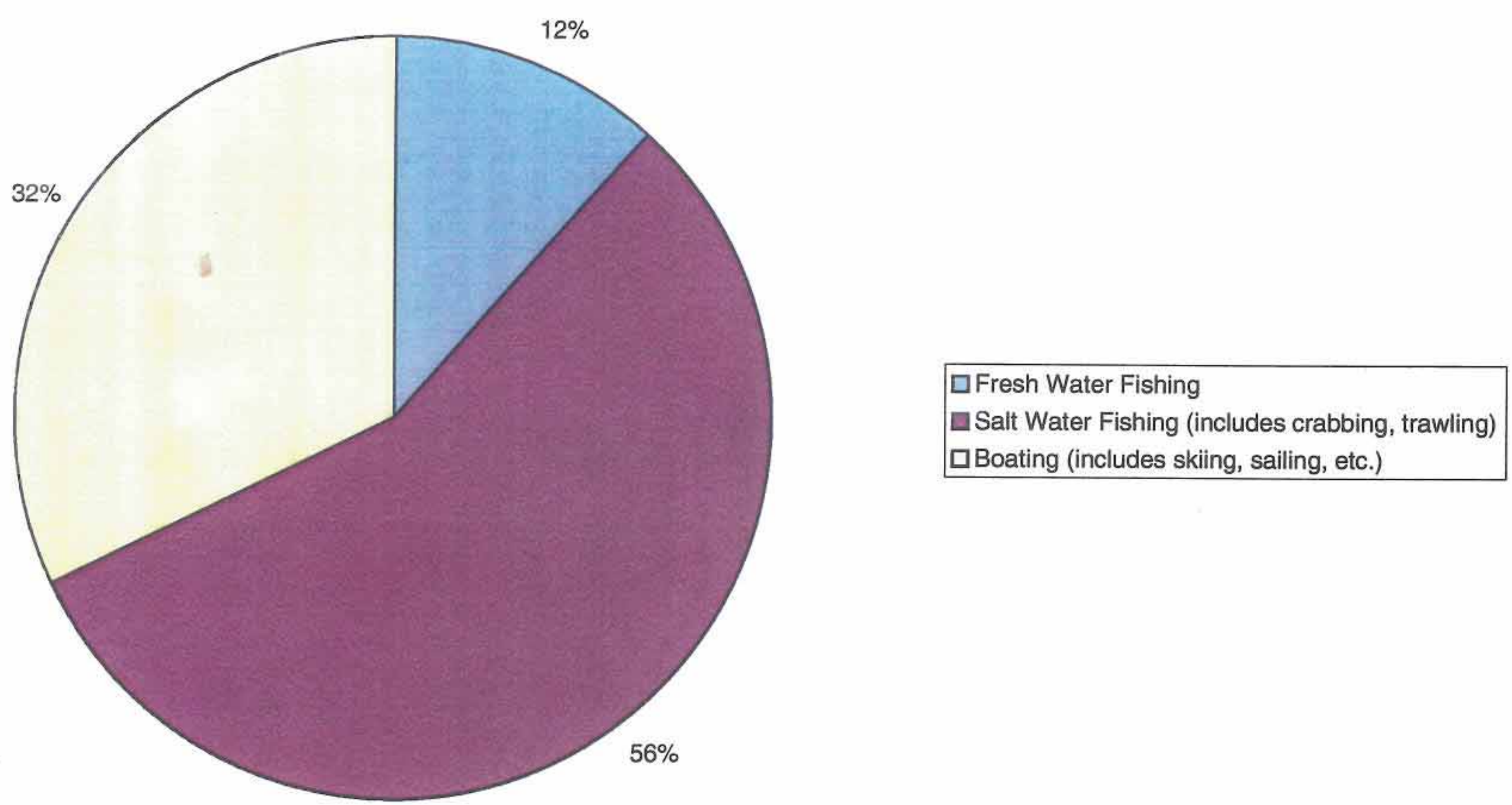
Observations of recreation activity at different interview sites was influenced by the nature of the sites themselves. At some sites much of the activity performed by persons launching there is in view from the site itself. These sites include the Madisonville site and those on the south shore of Lake Pontchartrain. At other sites, even though some of the activities are comparable, the activities are not performed in view of the interview site or landing. The sites in the Passes, Bayou Bienvenue, Shell Beach and Hopedale areas have limited views of areas where some of the recreation takes place.

Table 6.3. Activities Reported by Lake User Groups

Activity	Groups	Frequency (Percent)
Fresh Water Fishing	99	12%
Salt Water Fishing	418	51%
Crabbing	27	3%
Trawling	19	2%
Water Skiing	56	7%
Jet Skiing	28	3%
Pleasure Boating	134	16%
Sailing	32	4%
Other	5	1%
Total	818	100%

Source: G.E.C., Inc., 1997.

Figure 6.2. Activities Reported by Lake User Groups



Source: GEC Inc., 1997

The recreation activities recorded, for the 433 observations cited earlier are shown in Table 6.4. The number of participants for bankfishing and swimming represent persons. For boat fishing, sailing, boating, and skiing the number of boats observed was recorded.

Table 6.4. Activities and Estimated Number of Persons Observed

Activity	Number of Observations	Number of Persons Involved
Bank Fishing	89	381
Swimming	5	9
Boat Fishing	56	3,147 (1,049 boats)*
Sailing	33	543 (181 boats)*
Waterskiing	7	84 (21 boats)*
Pleasure Boating	145	1,362 (454 boats)*
Jet Skiing	45	260 (130 jet skis)*

*Average group size estimated from interviews of Lake users.

Source: G.E.C., Inc., 1998.

Three hundred and eighty-one persons were observed bankfishing in a total of 89 observations. Surprisingly few people (9) were observed swimming in five observations. A total of 1,049 boats was observed fishing on 56 occasions. Thirty-three observations recorded 181 sailboats in use, while 7 observations recorded 21 boats engaged in water-skiing. Pleasure boating was recorded for 454 boats in 145 observations. Forty-five observations of jet-ski activity yielded a total count of 130 jet skis in use at the time the observations were made. Table 6.4 presents this information with an estimate of persons observed engaged in various activities.

Fishing and Fishing Success

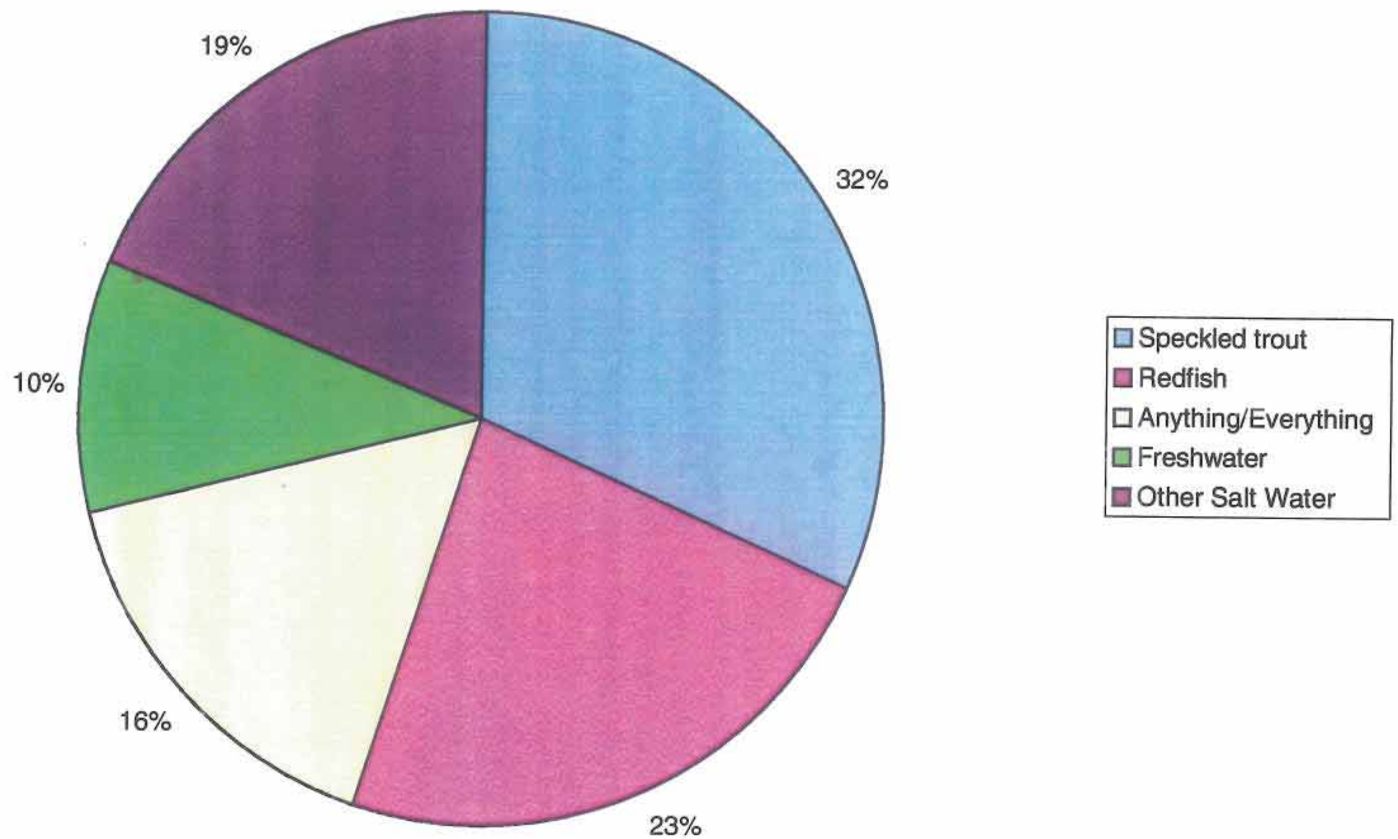
The most sought-after fish were speckled trout (269 groups) and redfish (197 groups). Most of the groups that targeted trout and redfish fished for both on the same trip. The second largest group (155) claimed to fish for all types of fish. The third largest group targeted (64) bass. Table 6.5 shows a breakdown of the reported targeted species. Most groups targeted more than one type of fish so the number of groups shown is greater than the number of interviews. The information in Table 6.5 is presented graphically in Figure 6.3.

Table 6.5. Fish Targeted by Respondent Groups

Sought	Groups	Frequency (Percent)
Speckled Trout	269	32%
Redfish	197	23%
Anything/Everything	135	16%
Bass	64	8%
Flounder	46	5%
Catfish	51	6%
Perch/Crappie	13	2%
Crabs	15	2%
Croakers	18	2%
Shrimp	6	1%
White Trout	11	1%
Drum	4	0%
Sheepshead	12	1%
Other	5	1%
Total	846	100%

Source: G.E.C., Inc., 1997.

Figure 6.3. Fish Targeted by Respondent Groups



Source: GEC Inc., 1997

Table 6.6 shows saltwater fishing success of the current or interview date trip detailed by month and in total for the period. As can be seen from Table 6.6, most fishermen were not very successful during the period of study. Of 362 saltwater fishing trips, only about 26 percent of the groups reported catches as "fair," and about 15 percent reported catches as "good." Almost 20 percent of all groups caught no fish. It should be noted that some groups enjoyed "good" or "very good" success throughout the study period.

Figure 6.4 shows the trend of fishing success for March through October. The graphs for the months of March, May, and July are based on roughly comparable numbers of saltwater fishing interviews. Higher numbers in August and September resulted in part from the inclusion of the Labor Day weekend. Lower numbers in April and June and October make individual cases in those months relatively more important and may be misleading. Inspection of the figure indicates that fishing success began to increase slightly toward the end of summer.

Field researchers interviewed groups on a "next available" basis. That is, when finished interviewing one group, the next available group was interviewed. No bias was exercised by the apparent activity the group had engaged in. Therefore, the representation of activities in the sample is considered to be a fair one for each site during the hours interviewing was carried out.

Table 6.7 shows the proportions of interviewed groups engaging in saltwater fishing as a prime activity in each of three regions during four time periods. The activity mix in each region is different and accounts for much of the difference in the proportion of groups that reported saltwater fishing as their prime activity. Lake Pontchartrain has a good deal of non-consumptive recreation as well as a large amount of fresh-water fishing from the Ruddock and North Pass launches and those on the north shore of the lake. Groups interviewed in the Bayou Bienvenue, Shell Beach and Hopedale areas were very largely interested in saltwater fishing.

However, inspection of Table 6.7 shows that for each region the proportion of saltwater fishing groups drops down in the April-May time period and then recovers. The decline in Lake Pontchartrain lasts through the summer (in part, perhaps, because of the algal bloom) and then increases substantially.

Respondents were queried about the number of trips they had taken out of the landing at which they were interviewed for periods before and after opening of the Spillway. They were also asked about trips during the past year. In addition, they were asked to judge if trips previous to the trip reported in the interview had been the same, better, or worse (i.e., if the number and quality of fish had generally been better or worse on previous trips).

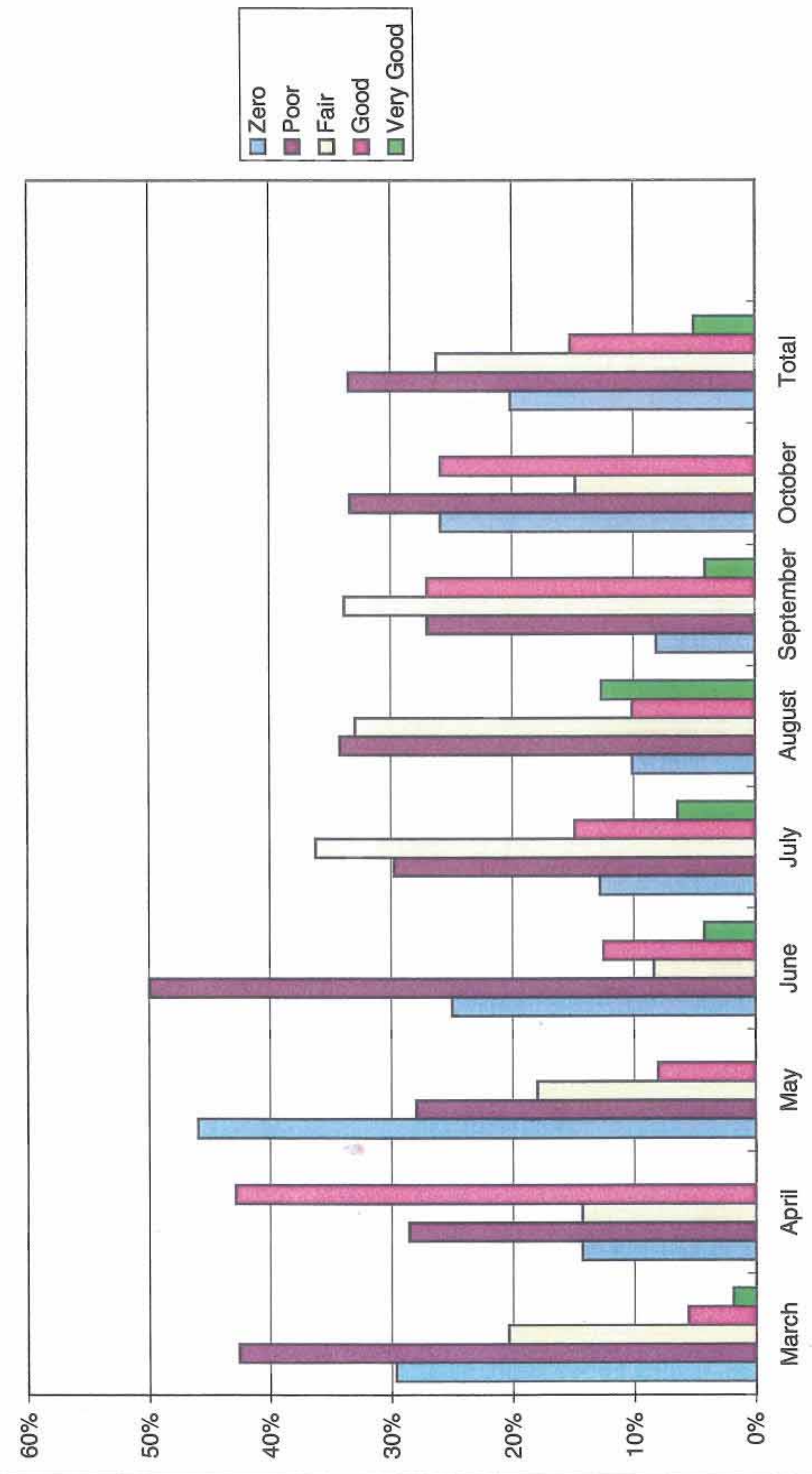
At the time they were interviewed, one quarter (27 percent) of the groups responding to the question said they were on their first trip since the Spillway was opened (Table 6.8). Table 6.9 shows the number of trips reportedly taken by responding groups between the first day of 1997 and the Spillway opening in mid-March. Almost half (49 percent) reported making no trips from the landing at which they were interviewed during the earlier period. Table 6.10 reports the responses to the question "How many other trips have you made from this landing since this time last year?" (i.e., in 1996 from the date of the interview). Forty-three percent reported ten or more trips, whereas 15 percent indicated no other trips.

Table 6.6. Success of Saltwater Fishing Efforts For Interview Date Trip

	March		April		May		June		July		August		September		October		Total	
Success	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)
Zero	16	30%	1	14%	23	46%	6	25%	6	13%	8	10%	6	8%	7	26%	73	20%
Poor	23	43%	2	29%	14	28%	12	50%	14	30%	27	34%	20	27%	9	33%	121	33%
Fair	11	20%	1	14%	9	18%	2	8%	17	36%	26	33%	25	34%	4	15%	95	26%
Good	3	6%	3	43%	4	8%	3	13%	7	15%	8	10%	20	27%	7	26%	55	15%
Very Good	1	2%	0	0%	0	0%	1	4%	3	6%	10	13%	3	4%	0	0%	18	5%
	54	100%	7	100%	50	100%	24	100%	47	100%	79	100%	74	100%	27	100%	362	100%

Source: G.E.C., Inc., 1997.

Figure 6.4. Success of Salt Water Fishing Efforts



Source: GEC, Inc., 1997

Table 6.7. Proportion of Interviewed Groups Reporting Saltwater Fishing by Region and Time Period

	Region		
Time Period	Lake Pontchartrain (Areas 3, 4, 5, 10)	Passes (Area 6)	Lake Borgne and East (Areas 7, 8, 9)
March	0.60	0.96	1.00
April-May	0.20	0.63	0.71
June-August	0.20	0.75	0.94
September-October	0.46	0.94	0.87

Source: G.E.C., Inc., 1997.

Table 6.8. Number of Salt Water Fishing Trips From Same Landing Since Opening

Number of Trips	Groups	Frequency (Percent)
First	96	27%
1 to 2	71	20%
3 to 5	70	20%
6 to 10	65	18%
Over 10	56	16%
	358	100%

Source: G.E.C., Inc., 1997.

Table 6.9. Number of Salt Water Fishing Trips From Same Landing Between First of Year and Opening

Number of Trips	Groups	Frequency (Percent)
None	171	49%
1 to 2	66	19%
3 to 5	50	14%
6 to 10	28	8%
Over 10	31	9%
	346	100%

Source: G.E.C., Inc., 1997.

Table 6.10. Number of Salt Water Fishing Trips From Same Landing Since Same Time Last Year

Number of Trips	Groups	Frequency (Percent)
None	53	15%
1 to 2	38	11%
3 to 5	49	14%
6 to 10	64	18%
Over 10	156	43%
	360	100%

Source: G.E.C., Inc., 1997

Table 6.11 characterizes reported trips that are first trips since the Spillway opening. Almost 70 percent of the trips were "poor," with 35 of the 67 groups catching no fish. Tables 6.12, 6.13, and 6.14 compare "today's" trip with trips since the Spillway opening, before the Spillway opening, and "since this time last year." The results are in the expected direction. Fishing was reportedly better in 1996 and somewhat better in the early part of 1997. Fishing from March 1997 onward had been fairly constant in quality but with some improvement as the summer progressed These results are shown graphically in Figure 6.5.

Table 6.11. Success for First Salt Water Fishing Trip Since Spillway Opening

Success	Groups	Frequency (Percent)
Poor	67	68%
Fair	21	21%
Good	7	7%
Very Good	3	3%
	98	100%

Source: G.E.C., Inc., 1997.

Table 6.12. Other Trips Since Opening Compared to Today's Trip

Success of Previous Trips	Groups	Frequency (Percent)
Same	151	63%
Better	68	28%
Worse	22	9%
	241	100%

Source: G.E.C., Inc., 1997.

Table 6.13. Other Trips From First of Year to Opening Compared to Today's Trip

Success of Previous Trips	Groups	Frequency (Percent)
Same	88	54%
Better	57	35%
Worse	18	11%
	163	100%

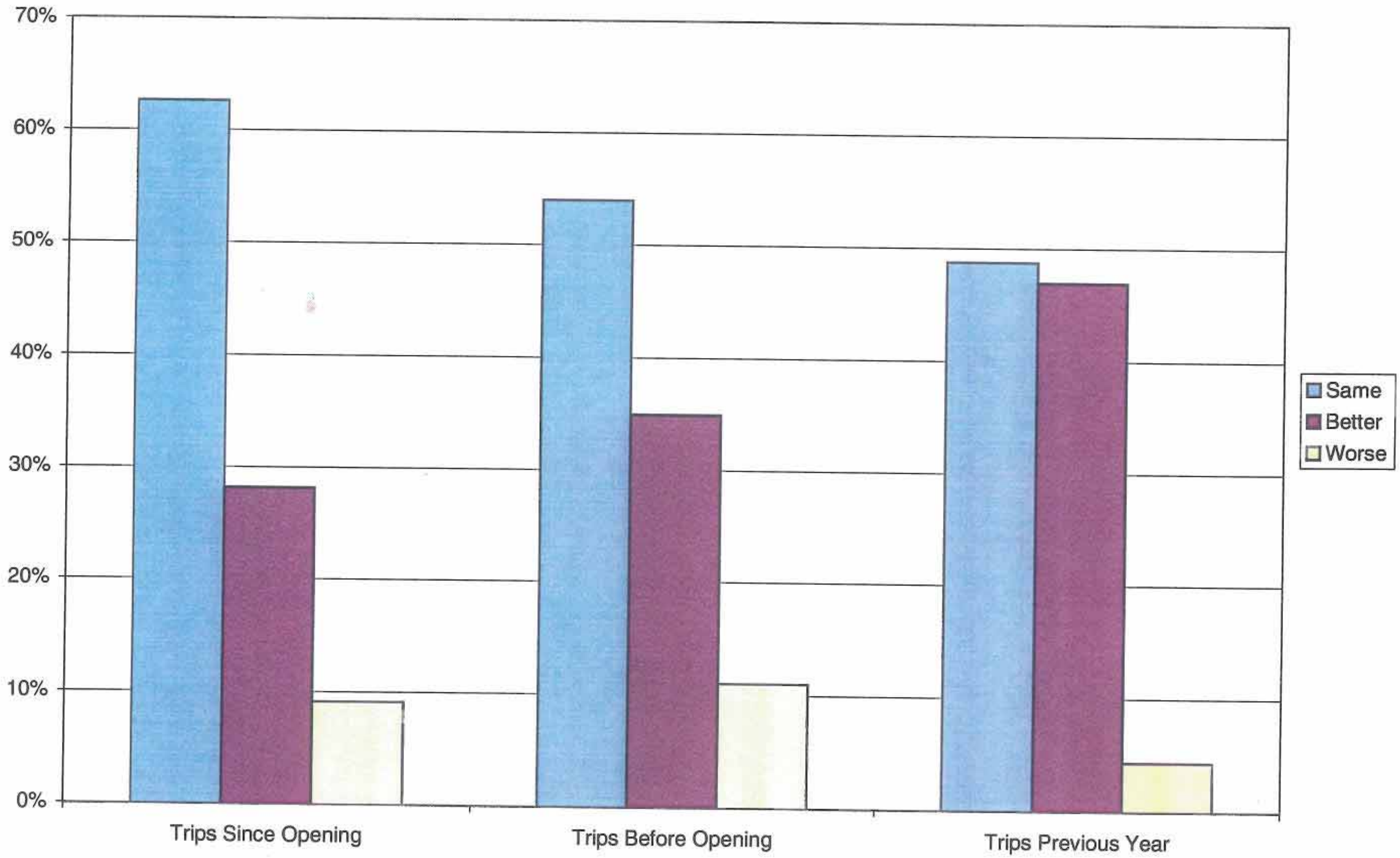
Source: G.E.C., Inc., 1997.

Table 6.14. Other Trips Last Year Compared to Today's Trip

Success of Previous Trips	Groups	Frequency (Percent)
Same	136	49%
Better	131	47%
Worse	12	4%
	279	100%

Source: G.E.C., Inc., 1997.

Figure 6.5. Success of Trips Compared to Today's Trip



Source: GEC Inc., 1997

The sum of the numbers of trips taken from the interview landing before and since the Spillway opening and in the year prior to the time of the interview was used as a measure of experience in the area and in fishing. This measure was compared to the success of the interview day's trip. Table 6.15 shows the effect on fishing success of experience in the area on the part of saltwater fishermen interviewed. A greater proportion of those groups who had made five or fewer trips had zero or poor success than those who had made 11 or more trips. Conversely, the proportion of groups making more than ten trips who had good or excellent success was markedly greater than those groups making fewer trips. This is what would be expected. Inspection of the table indicates that familiarity with a region, gained through a greater number of trips, plays a substantial (but not overwhelming) part in fishing success.

Table 6.15. Effect of Experience on Saltwater Fishing Success

Number of Trips			
Today's Trip	Five or Less Trips	6-10 Trips	11 or More Trips
Zero or Poor Success	0.68	0.57	0.46
Fair Success	0.23	0.22	0.30
Good or Excellent Success	0.10	0.21	0.25

Source: G.E.C., Inc., 1997.

Experience in Other Areas

Respondents were asked if they had fished or used any other landings on the lakes in the months just before the Spillway opening, since the opening, and in the prior year. As Table 6.16 shows, use of multiple landings is not uncommon; but most fishermen tend to launch from one landing in the area they have become familiar with.

Table 6.16. Experience in Other Areas

Use of Other	Since Opening		Before Opening		Since Last Year	
Landings	Groups	Frequency (Percent)	Groups	Frequency	Groups	Frequency (Percent)
Yes	221	36%	160	26%	266	43%
No	384	63%	423	69%	318	52%
Other	9	1%	31	5%	30	5%
	614	100%	614	100%	614	100%

Source: G.E.C., Inc., 1997.

Night Fishing or Trawling

Interviewees were asked if they had fished or trawled at night during the previous year. This question was added after almost 15 percent of the interviews had been done. Of the 614 groups queried, only about 12 percent had engaged in either of these activities.

Direct and Perceived Impacts

Interviewees were asked if they had come to the launch site at which they were interviewed because of effects of the Spillway opening. Only about two percent (13 groups) said they had. Of the 13 groups, nine were interviewed before the second week of June, two in July and two in August. Ten were interviewed in the Passes area or East Pontchartrain and three in the Shell Beach/Hopedale area. Ninety-eight percent (589 groups) said the Spillway opening had no influence on their choice of landing.

When asked if the Spillway opening had affected their use of the lakes up to the time of the interview, approximately 24 percent (144 groups) said yes, 72 percent (425 groups) said no, and about four percent (23 groups) said it was too soon to tell. Of those stating the Spillway opening had affected them thus far (144 groups), eight percent (46 groups) said they had changed activities or the kind of fishing to some extent. When asked about frequency of use, only four groups said they were using the lakes more, 18 percent (108 groups) said they had curtailed their use, and four percent (25 groups) said their use remained the same. Five percent did not respond to the question.

When the 144 groups said their use had been affected were asked if they had changed where they fished or recreated to another location in the study area, 23 percent (30 groups) said yes and 77 percent said no. When asked if they had changed to locations outside the study area, 23 percent (28 groups) said they had. Seven groups claimed to have changed to new locations both within and outside the study area.

Anticipated Future Impacts

Respondents were asked if they thought their use of the lakes would be affected in the future as a result of the Spillway opening. Overall, about 27 percent said yes and 72 percent said no. However, when broken down by month (Table 6.17), there was a steady decline in the percentage of respondents who felt that their use of the study area would be impacted in the future. This reflects a sentiment expressed by a number of interviewees and marina operators that any negative effects of the Spillway opening are past and that conditions are returning to normal. Figure 6.6 depicts the change in assessments of likely future impacts over the course of the study period.

When the 27 percent of those interviewed who said that their future use would be affected were asked if they would change future recreational activities, 45 percent (12 percent of all groups interviewed) said yes and 55 percent said no. When asked about future use of the lakes, 70 percent of this group (19 percent of those interviewed) said they would use the area less, 11 percent (about three percent of all groups interviewed) said they would increase their usage, and 19 percent (five percent of all groups) said their usage would stay the same.

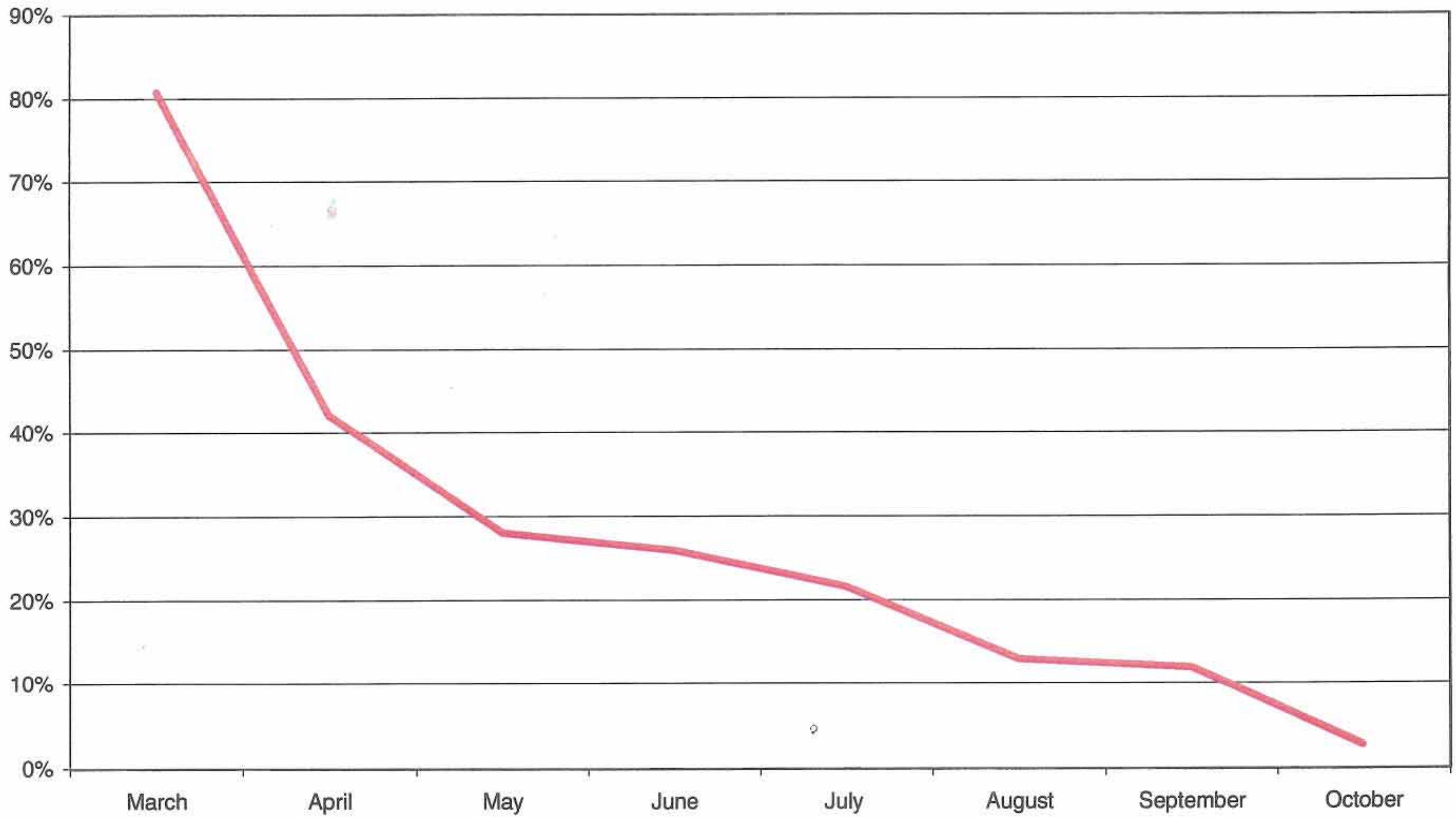
When the 27 percent of groups who thought their future use would be affected were asked if they would change where they fished or recreated to another location in the study area, 29 percent of this group (8 percent of total groups) said yes, and 71 percent said no. When asked if they would change to locations outside the study area, 40 percent (11 percent of all groups) said yes.

Table 6.17. Affect of Opening on Future Use

Answer	March		April		May		June		July		August		September		October		Total	
	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)	Groups	Frequency (Percent)
Yes	59	81%	8	42%	34	28%	19	26%	16	22%	13	13%	14	12%	1	3%	164	27%
No	14	19%	11	58%	82	68%	54	74%	58	78%	87	87%	102	87%	36	97%	444	72%
N/A-Other	0	0%	0	0%	5	4%	0	0%	0	0%	0	0%	1	1%	0	0%	6	1%
	73	100%	19	100%	121	100%	73	100%	74	100%	100	100%	117	100%	37	100%	614	100%

Source: G.E.C., Inc., 1997.

Figure 6.6. Affect of Opening on Future (% stating that the opening will afffect their use in the future)



Source: GEC Inc., 1997

ANECDOTES

Throughout the course of the study incidental observations and conversations shed light on some of the effects or non-effects of the Spillway opening. Some of this information came from interviewees describing a previous trip or experience. Some were from marina operators, some from conversations with residents nearby the landings where interviews took place or with acquaintances who volunteered information when they were told about the study. A lively discussion was held on the Internet at website www.rodnreel.com concerning real and imagined effects on Lake Pontchartrain. Many people reported catching fish even when the conditions were supposed to be at their worst.

For example, a lakeshore resident living next to the boat launch in the Frenier area (Peavine Road) reported that he and two others limited out on redfish along the powerline in western Lake Pontchartrain even though "the water dripping off the reels was bright green from slime (algae)."

March 21	Slidell — five boats came in — all had good catches.
May 17	Resident of Bayou Lacombe — said effect of Bonnet Carre' opening was mostly increased turbidity in Lake. Said crabs stopped running when Bonnet Carre' opened "but are doing well at present."
June 7	Chef Menteur — said things are getting back to normal — said shrimp are growing to a better size and fish are coming back.
June 7	End of Highway 443 — Commercial crabber and resident said crabbing held up well on northshore during Bonnet Carre opening. But, too many crabbers came into area from south side of Lake — caught all crabs out. Said if there were a few good storms to "push water into the Lake it will all straighten out."
June 8	Shrimper at Bonnabel landing said everyone was catching some shrimp. When asked where, he replied, "All over — they move — you just have to burn gas to find them."
June 20	Williams Boulevard landing — commercial crabber reported doing "pretty well."
June 29	Bonnabel Boulevard landing — said "the shrimp season was starting okay — better than last year — shrimp are large — 30 count with a few 12-15 count." Also said people were catching speckled trout around causeway and on south shore.
July 4	Frenier area launch (Peavine Road) — commercial crabber said the crab crop is the best it has been in about 10 years. Said brown shrimp were being caught in lake at ship channel — but that brown shrimp have never done really well in the Lake. Siad redfish were being caught along the powerline. Said a fellow he talked to had caught a number of 16-inch speckled trout in Pass Manchac in late June but no one has caught any since.

July 4	Frenier area launch (Peavine Road) — resident also reported catching redfish along the powerline and even a few small speckled trout.
July 5	Bayou Bienvenue area — launch manager said everything was back to normal with good catches of fish and shrimpers doing well — better than in last four years. Customer said he and partner both limited on 16-inch speckled trout the day before.
July 9	Slidell tackle and net store — said crabs are really plentiful and shrimp are running around the airport (Seabrook).
July 26	Frenier area launch (Peavine Road) — resident reported lots of boats going out from landing and big catches of redfish along the powerline.
July 27	Slidell — fishing reported spotty — "But, can go out and find clean water and catch fish — algae not as bad as it was but people are afraid of going out — afraid of getting sick or eating the fish."
August 7	Slidell — "redfish and sheepshead fishing has been good along the trestles and twin spans."
August 7	Slidell — reported limits on redfish along twin spans and Causeway — few trout as yet — water reported very clean.
August 10	Frenier area launch (Peavine Road) — resident reported algae reappearing after being gone in west end of the Lake.
August 31	Frenier area launch (Peavine Road) — resident reported big redfish had moved out and only little ones left — reported a few white shrimp being caught west of Causeway.
September 13	St. Genevieve — boat came in with an icebox of croakers and white trout and another boat with a hamper of crabs.
September 13	Slidell — man fishing from bank was catching stripers as fast as he could rebait and cast out — caught a rat red but thrown back because it was too small.
September 18	Internet — man reported catching two 150 pound tarpon and seeing many even larger in the Three Trees area of Lake Pontchartrain.
September 18	Internet — man reported limiting out on seven-pound stripers at Causeway. Said there were also redfish to be caught on cocahoes with a cork.

SPILLWAY USERS SURVEY

Group Numbers, Sizes, and Vehicles

Four-hundred-eighty-five groups using the Spillway were interviewed in May through October, representing a total of 1,686 persons, with an average of 3.5 persons per group. They entered the Spillway in 1,073 vehicles, or 2.2 vehicles per group. Numbers of groups, vehicles, average group size, and vehicles per group are shown below. The group size was largest in June and smallest in September. The number of vehicles per group was smaller in October by a considerable margin with no readily apparent explanation (see Table 6.18).

Table 6.18. Number of Groups, Persons and Associated Vehicles — Spillway Recreation

Month	No. of Groups	No. of Persons	Average Grp. Size	No. Of Vehicles	Veh. Per Group
May	99	317	3.2	276	2.8
June	79	330	4.2	209	2.6
July	70	266	3.8	198	2.8
August	89	313	3.5	117	2.7
September	105	323	3.1	226	2.2
October	43	137	3.2	47	1.1
Total	485	1,686	3.5	1,073	2.2

Table 6.19 shows the number of groups, the number of persons, and the relative frequency of participation in activities at the Spillway. The numbers of groups shown in each category reflect the fact that persons engage in more than one type of activity on a given outing (e.g., picnicking, fishing, and walking on the same day). In May, for example, the 99 interviewed groups engaged in 152 activities.

Each group interviewed was asked to rank the activities (up to total of five) they engaged in at Bonnet Carre'. Table 6.20 indicates the relative rankings given for various Spillway activities by the interviewed groups. Among the most important are bank fishing, ATV riding, picnicking, crabbing, crawfishing, and boating. The sociability component of many of the activities is demonstrated by the fact that "hanging out with friends" was most often ranked second in importance.

Activities While Spillway Was Flooded

While the Spillway was flooded, most (376 of 486) groups reported that they did not engage in other types of recreational activities. Almost two-thirds of the respondents said they had not come out to see the Spillway in flood. Those who did were about evenly divided between visiting on a week day or a weekend day.

Desired Facilities/Improvements

Forty-four percent of the groups interviewed said they preferred the Spillway to remain as it is. Thirty-one percent would like to see bathrooms/toilets put in place. About six percent mentioned picnic tables; five percent mentioned improved roads; and four percent mentioned trash cans. The remaining suggestions were scattered over a number of possibilities, but none were mentioned by more than one or two groups.

Table 6.19. Activities Reported by Spillway Interviewees

	May		June		July		August		September		October		Total	
Activity	Pers.	Vehs.	Pers.	Vehs.	Pers.	Vehs.	Pers.	Vehs.	Pers.	Vehs.	Pers.	Vehs.	Pers.	Vehs.
Sightseeing	179	107	166	46	92	40	118	51	130	55	38	18	723	317
Picnicking	127	52	363	132	418	231	458	188	345	132	165	60	1876	795
Camping	8	4	155	50	262	92	256	94	154	50	6	3	841	293
Motorcycling	88	73	133	116	155	111	111	82	82	75	98	53	667	510
ATV Riding	203	169	278	168	247	184	164	119	176	138	119	82	1187	860
4WD Riding	41	34	93	50	169	94	127	57	56	59	49	22	535	316
Swimming	13	3	198	64	239	114	44	21	53	28	0	0	547	230
Crawfishing	301	192	24	10	0	0	0	0	0	0	0	0	325	202
Crabbing	50	21	114	41	138	54	55	28	64	31	21	13	442	188
Bank Fishing	378	234	569	267	431	221	755	374	478	188	258	97	2869	1381
Boat Fishing	88	122	469	308	377	225	629	300	349	265	183	107	2095	1327
Dog Training	17	19	13	10	15	10	7	4	250	120	10	3	312	166
Hanging Out	88	45	419	193	333	45	471	188	239	96	84	40	1634	607
Total	1581	1075	2994	1455	2876	1421	3195	1506	2376	1237	1031	498	14053	7192

Source: GEC, Inc., 1997

Table 6.20. Counts of Rankings by Activity

Activity	1 Groups	Frequency	2 Groups	Frequency	3 Groups	Frequency	4 Groups	Frequency	5 Groups	Frequency
4-Wheel Drive	8	2%	3	1%	3	2%	2	3%	1	3%
ATV	60	14%	3	1%	1	1%	2	3%	1	3%
Catching Bait	1	0%	2	1%	2	1%	0	0%	1	3%
Bank Fishing	122	28%	24	10%	35	24%	7	9%	7	23%
Boat Fishing	54	12%	9	4%	6	4%	7	9%	1	3%
Camping	14	3%	3	1%	2	1%	1	1%	0	0%
Crabbing	23	5%	14	6%	10	7%	7	9%	1	3%
Crawfishing	17	4%	11	5%	9	6%	4	5%	3	10%
Motor Cycles	29	7%	10	4%	0	0%	2	3%	1	3%
Hanging Out With Friends	18	4%	92	39%	22	15%	6	8%	1	3%
Jet Skiing	4	1%	3	1%	3	2%	0	0%	1	3%
Picnicking	54	12%	41	18%	33	22%	12	16%	2	6%
Sightseeing/ Driving	6	1%	4	2%	3	2%	3	4%	1	3%
Boating and Water Skiing	15	3%	4	2%	5	3%	3	4%	1	3%
Sunbathing	1	0%	7	3%	11	7%	11	15%	4	13%
Swimming	8	2%	4	2%	2	1%	7	9%	5	16%
	434	100%	234	100%	147	100%	74	100%	31	100%

Source: G.E.C., Inc., 1997.

Observations and Counts of Spillway Activities

The counts shown in Table 6.21 are based on the observations of activities at certain time periods and in particular areas within the Bonnet Carre' Spillway. The counts are based on the judgment of the observer at the time of recording the apparent activity, the persons involved, and the probable vehicles associated with them. The counts within areas represent the number of time periods in which all of the activities observed within a given area were recorded. Areas designated within the spillway for study purposes are shown in Figure 6.7.

Table 6.21. Data Recording Periods by Spillway Area by Month

Areas	May	June	July	August	September	October	Total
1	12	11	4	6	9	4	46
2	18	14	6	7	10	6	61
3	10	10	8	4	5	5	42
4	14	20	16	13	13	10	86
5	11	17	19	33	29	11	120
6	15	21	18	29	26	17	126
7	9	11	9	9	12	8	58
8	8	7	8	6	5	5	39
9	9	8	9	9	11	6	52
	106	119	97	116	120	72	630

Source: G.E.C., Inc., 1997.

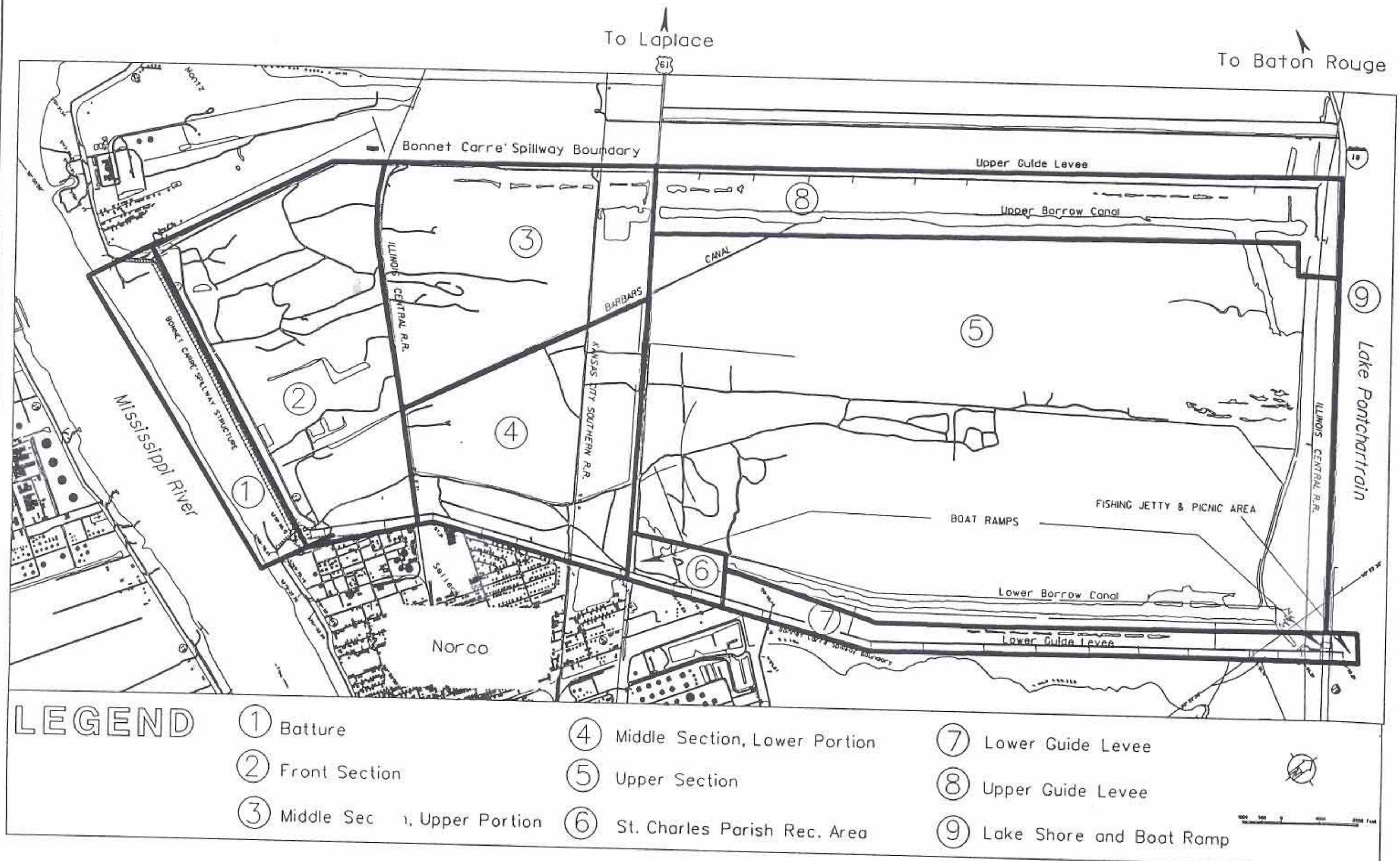


Figure 6.7. Bonnet Carre' Spillway Recreation Segments

Table 6.22 shows the numbers of persons and vehicles observed in the Spillway and judgementally assigned to various activities. In the case of boat fishing and dog training, the number of vehicles exceeds the number of persons. Vehicles with boat trailers parked in an area reserved for boaters were assigned to boat fishing even though the boat was not in the area and the people could not be counted. In the case of dog training, the handlers were often out in the field and could not be seen.

Table 6.23 shows the number of persons and vehicles observed in various spillway areas and judgementally assigned to various activities. It should be noted that tables 6.20, 6.21 and 6.22 reflect the "everyday" aspects of Spillway usage. The Spillway is also the site where a number of special events are held each year. For example, several major hunting dog field trials are held each year in Area 2. Usual attendance is between 150 and 250 persons. An annual 5K fun run "in the mud" drew over 1,000 runners and numerous observers to Area 6. An annual "beach sweep" trash pick-up saw approximately 150 persons out picking up trash in areas 6, 7 and 9 of the Spillway.

CONCLUSIONS

Lake Users Survey Conclusions

Based on surveys and observations of study area recreationists, it can be said that the opening of the Bonnet Carre' Spillway resulted in an apparent short-term reduction of the quantity and quality of fishing and other recreation activities in parts of the study area, notably in Lake Pontchartrain. The time period in which activities were curtailed was extended by the algal bloom in Lake Pontchartrain. Reports of potentially dangerous water quality conditions led some people to forego activities that they would otherwise have engaged in. By the end of the summer there was a general feeling that conditions were returning to normal.

Spillway Users Survey Conclusions

Flooding of the Spillway rendered it unusable for a number of activities for periods ranging from four to eight weeks. When access was restored, large numbers of people took advantage of greatly improved crawfishing and fishing. Other activities returned fairly soon to their pre-flood status. Basically, people have returned to doing what they used to do before the Spillway opening.

RECOMMENDATIONS FOR FUTURE STUDIES

Recommendations for future studies of recreation fall into two categories: those involving studies associated with future openings of the Spillway and those involving the gathering of data during years when the Spillway is not opened.

G.E.C. researchers modified the questionnaires and procedures for the lake use study during the first few weeks of the study. Once the sampling procedures and survey form modifications were in place no changes were made in order to maintain consistency and standardization in the data gathered. However, during the course of the study other approaches were identified which could be incorporated into future studies.

Table 6.22. Persons and Vehicles Observed by Activity by Month

Order	Activity	May-97 # of Group	May-97 Persons	May-97 Frequency	Jun-97 # of Group	Jun-97 Persons	Jun-97 Frequency	Jul-97 # of Group	Jul-97 Persons	Jul-97 Frequency
1	Sightseeing/Driving	4	6	3%	8	36	5%			
2	Picnicking	13	52	9%	24	166	15%	28	168	18%
3	Walking/Hiking				2	10	1%	8	25	5%
4	Sunbathing	6	18	4%	8	43	5%	9	26	6%
5	Camping	1	2	1%	4	26	3%	3	18	2%
6	Bird Watching							1	2	1%
7	Photography	1	1	1%	1	2	1%	3	3	2%
8	Bicycle	1	2	1%						
9	Motor Cycles	9	28	6%	7	15	5%	6	13	4%
10	All Terrain Vehicle	7	22	5%	20	64	13%	5	11	3%
11	4-Wheel Drive	2	6	1%	3	9	2%	2	7	1%
12	Swimming	3	18	2%	7	36	5%	9	44	6%
13	Crawfishing	18	50	12%	3	7	2%			
14	Crabbing	12	37	8%	5	19	3%	14	65	9%
15	Fishing from Bank	36	101	24%	29	109	18%	27	96	18%
16	Fishing from Boat	7	16	5%	10	26	6%	2	4	1%
17	Catching Bait	3	7	2%						
18	Boating & Skiing	10	33	7%				3	9	2%
19	Jet Skiing	2	11	1%	1	5	1%			
20	Dog Training/Playin	2	7	1%				1	3	1%
21	Remote Control Pla									
22	Remote Control Bo	1	2	1%						
23	Shooting	1	2	1%						
24	Hanging Out	8	24	5%	23	138	15%	26	136	17%
25	Horseback Riding	1	1	1%				5	21	3%
26	Hunting									
27	Duck Hunting									
28	Other	4	6	3%						
		152	452	100%	155	701	100%	152	641	100%

Order	Activity	Aug-97 # of Group	Aug-97 Persons	Aug-97 Frequency	Sept-97 # of Group	Sept-97 Persons	Sept-97 Frequency	Oct-97 # of Groups	Oct-97 Persons	Oct-97 Frequency	Totals # of Groups	Totals Persons	Totals Frequency
1	Sightseeing/Driving	4	10	2%							16	62	2%
2	Picnicking	36	176	27%	27	111	19%	6	27	13%	133	680	21%
3	Walking/Hiking										10	35	1%
4	Sunbathing	8	18	3%	6	15	3%				37	120	4%
5	Camping	4	23	4%	3	13	2%				15	82	3%
6	Bird Watching										1	2	0%
7	Photography							1	1	0%	6	7	0%
8	Bicycle	5	7	1%				1	1	0%	7	10	0%
9	Motor Cycles	16	28	4%	4	5	1%				42	89	3%
10	All Terrain Vehicle	15	34	5%	9	23	4%	6	14	7%	61	168	5%
11	4-Wheel Drive	3	13	2%							10	35	1%
12	Swimming	4	12	2%	1	10	2%				24	120	4%
13	Crawfishing										21	57	2%
14	Crabbing	5	20	3%	11	21	4%				47	162	5%
15	Fishing from Bank	41	138	21%	32	95	16%	18	61	30%	183	600	19%
16	Fishing from Boat	9	24	4%	23	67	10%	9	22	11%	60	149	5%
17	Catching Bait										3	7	0%
18	Boating & Skiing				2	9	1%	1	3	1%	16	53	2%
19	Jet Skiing				2	7	1%				5	23	1%
20	Dog Training/Playin				12	47	8%				15	57	2%
21	Remote Control Pla	1	4	1%	4	10	2%	2	4	2%	7	18	1%
22	Remote Control Bo							1	1	0%	2	3	0%
23	Shooting				2	6	1%	3	10	5%	6	18	1%
24	Hanging Out	30	143	22%	36	145	25%	16	61	30%	139	647	20%
25	Horseback Riding										6	22	1%
26	Hunting				1	2	0%				1	2	0%
27	Duck Hunting												
28	Other				2	10	2%				6	16	0%
		181	650	100%	177	585	100%	62	205	100%	879	3234	100%

Source: GEC, Inc., 1997

Table 6.23. Counts of Observed Activities by Spillway Area

	Area 1		Area 2		Area 3		Area 4		Area 5		Area 6		Area 7		Area 8		Area 9		Total	
Number of Observations	48		68		45		85		118		128		55		35		45		630	
Persons/ Venicles	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V
Sight/Driving	33	47	77	39	60	29	121	66	169	72	189	92	83	50	38	37	16	8	786	440
Picnicking	0	0	9	6	16	4	73	28	601	208	1,219	533	52	21	8	3	48	16	2,026	819
Walk/Hiking	0	0	0	0	0	0	0	0	0	0	10	3	0	0	1	1	5	2	16	6
Sunbathing	0	0	0	0	0	0	8	5	123	50	62	29	15	10	0	0	10	10	218	104
Camping	0	0	2	1	0	0	2	1	240	83	655	241	13	6	3	1	4	2	919	335
Bird Watching	4	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	6	4
Photography	3	3	2	1	0	0	0	0	17	15	22	20	0	0	0	0	0	0	44	39
Bicycles	0	0	16	11	3	3	8	5	53	43	87	61	1	1	18	18	0	0	186	142
Motor Cycles	9	6	92	72	15	8	290	223	125	104	116	99	21	15	3	2	4	2	675	531
ATV	6	2	48	32	33	21	673	499	164	114	226	168	27	20	20	14	5	3	1,202	873
4-Wheel Drive	2	1	17	7	15	9	286	160	138	63	103	44	7	5	3	2	0	0	571	291
Swimming	0	0	0	0	0	0	18	8	209	84	241	108	21	12	2	1	59	19	550	232
Crawfishing	4	1	57	30	92	58	76	52	50	36	0	0	13	8	62	35	0	0	354	220
Crabbing	0	0	0	0	13	6	0	0	65	27	157	65	39	16	20	10	167	63	461	187
Bank Fishing	39	29	328	191	115	64	63	27	919	427	1,065	498	259	121	126	78	164	69	3,078	1,504
Boat Fishing	7	4	21	15	12	6	30	24	327	152	1,758	986	214	144	6	5	86	65	2,461	1,401
Catching Bait	0	0	53	30	18	11	6	3	11	4	14	2	5	3	3	1	3	1	113	55
Boating & Skiing	0	0	0	0	0	0	0	0	23	10	40	15	0	0	0	0	12	3	75	28

	Area 1		Area 2		Area 3		Area 4		Area 5		Area 6		Area 7		Area 8		Area 9		Total	
Number of Observations	48		68		45		85		118		128		55		35		45		630	
Persons/ Venicles	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V
Jet Skiing	0	0	0	0	0	0	0	0	15	7	119	64	0	0	0	0	0	0	134	71
Dog Train/ Playing	0	0	121	266	0	0	2	2	0	0	10	8	0	0	16	14	4	2	153	292
RemtCntl Planes	0	0	84	50	2	1	0	0	0	0	0	0	0	0	8	7	0	0	94	58
RemtCntl Boats	0	0	37	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	30
Shooting	0	0	14	6	7	4	4	2	18	6	6	2	22	8	18	7	0	0	89	35
Hang w/ Friends	4	2	15	7	31	15	255	153	480	214	861	340	27	9	22	16	28	12	1,723	768
Other_1 (describe)	0	0	12	3	0	0	4	3	4	3	32	36	0	0	0	0	150	40	202	185
Other_2 (describe)	0	0	0	0	0	0	1	1	0	0	5	3	2	2	0	0	0	0	8	6
Horseback Riding	0	0	0	0	0	0	0	0	0	0	130	138	0	0	0	0	0	0	130	138
Hunting	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	4	2
Totals	111	97	1,005	747	432	239	1,920	1,262	3,755	1,724	7,129	3,557	821	451	377	252	765	317	16,315	8,696

P = Persons
V = Vehicles

NOTES: Number of observations represent the number of times activities were observed and recorded within a given area of the spillway.

Source: G.E.C., Inc., 1998.

A Plan of Study should be in place to guide research efforts during future openings. The Plan of Study should include contingencies to look into anomalous or unanticipated events that occur which could affect recreational activities such as the algae bloom in Lake Pontchartrain.

Based on the experience of this study the questionnaire should be modified to include more open-ended narrative-type questions. It is felt these would work better than some of the forced-choice questions.

In the course of the study it was discovered that marina operators were an excellent source of recreational fishery information. It is recommended that a systematic approach for contacting and interviewing marina operators be taken during future openings of the Spillway. This could include the preparation of such items as a checklist of topics to be discussed with marina operators on a periodic basis.

The randomized sample design used for the recreational portion of the study accompanied by a compartmentalization of the study elements resulted in a somewhat limited recreational analysis. For example, it was not known by the recreational investigatory team until after the fact that an area of saline water was present adjacent to the north shore of Lake Pontchartrain. Future studies should include periodic meetings to exchange technical information among the various investigators. At a minimum, participants should include recreational investigators, biologists, and hydrologists, and personnel from Federal and state agencies knowledgeable of Lake Pontchartrain. In addition, the recreational sampling plan should include more purposive elements to ensure that critical and crisis areas and times are adequately covered.

It may be beneficial to utilize internet resources to obtain recreational information. Existing "chat rooms" could be accessed to elicit the experiences of recreationists. Additionally, it may be possible to establish an internet site where people could report their comments or obtain information.

With no information on the recreation activity patterns during "normal" years it was difficult to know if observed and reported activities (or lack of activity) was associated with the Spillway opening or simply what would be expected in a usual year. It is recommended that limited monitoring of recreational activities be carried out each year to establish a base line for future comparisons.

SECTION 7 - TRENDS AND IMPACTS

SECTION 7 - TRENDS AND IMPACTS

COMPARISONS TO PREVIOUS STUDIES

The impacts of the opening of the Bonnet Carre' Spillway on the biota of Lake Pontchartrain exhibited both similarities to and differences from those of studies associated with previous Spillway openings. The primary difference is in the time at which the opening occurred: the four previous openings occurred later in the spring when water temperatures were higher than those recorded in the 1997 opening.

While previous openings of the Spillway have been accompanied by marked increases in the mortality of oysters, the 1997 opening did not exhibit such oyster mortality. A temperature of 23°C is generally considered to be the threshold of lethality to oysters stressed by salinities of 5 ppt or less (Andrews *et al.*, 1959; Dugas and Perret, 1976). The 1997 opening occurred in mid-March to mid-April, when water temperatures were generally 17-19°C. In previous openings with documented oyster mortality the water temperatures exceeded 23°C.

Spillway openings apparently have little influence on the predominant fishes collected in trawl samples, the bay anchovy, the gulf menhaden, and the Atlantic croaker. The patterns of abundance of these species were similar to those of previous studies (Suttkus *et al.*,1954; Darnell, 1961; Stone, 1980; Fitzhugh, 1985), whether or not there was an opening of the Spillway. These species appear to be sufficiently tolerant of a wide range of salinity not to be affected by short-term discharges of fresh water from the Mississippi River. Other than the occasional sand seatrout or flounder, gamefishes are seldom caught in trawls.

Thompson and Fitzhugh (1985) reported that shrimp landings generally decrease in years that the spillway is opened (e.g., 1975, 1979), with the year following the opening showing a substantial increase. They attributed this to "increased recruitment and survival benefitting from nutrient input from the Mississippi River discharge." The exception to this was in 1974, which showed decreased overall landings. Thompson and Fitzhugh (1985) reported that the 1973 opening did not apparently introduce increased nutrient levels to the lake. Brown shrimp were collected in trawls with the peak numbers coinciding with the opening of the brown shrimp season. Trawling activity was greatest at the eastern end of the Lake, where salinity was greatest. It appears that the Spillway opening may have displaced the brown shrimp toward the eastern end of the Lake. White shrimp were collected only occasionally.

The New Orleans District Corps of Engineers (1987) for the period of record 1951 - 1981 found that salinities averaged 4.1 ppt in Lake Pontchartrain with the lowest mean monthly salinity (2.6 ppt) occurring in May while the maximum occurred in October (5.9 ppt). The salinity regime is subject to change with seasonal variations of freshwater inflow. The average of salinity readings at all eight stations during the period April/May/June in this study was 0.9 ppt. This average for the same stations during the period July/August/September increased to 1.5 ppt.

In the spring of 1973, a year during which the Spillway was open for 74 days, salinity readings taken by Tarver and Savoie (1976) throughout the Lake averaged 0.4 ppt, lower than the average salinity found during this study. Similar seasonal (spring) data for years in which there were no Spillway openings included lake-wide average salinities of 3.4 ppt in 1954 (Suttkus *et al.*, 1954), 6.0 ppt in 1970 and 3.8 ppt in 1971 (Tarver and Dugas, 1973), 1.1 ppt in 1974 (Tarver and Savoie, 1976) and 2.4 ppt in 1978 (Stone, 1980). The average salinity found during this study for the spring is less than these averages although close to that recorded in 1974.

The average of all lake salinity readings taken by Tarver and Savoie (1976) in the summer of 1973, 2.9 ppt, was higher than the average of summer salinity readings taken during this study, 1.5 ppt. Summer data collected by Suttkus *et al.* (1954) averaged 3.7 ppt in 1953. Data collected by Tarver and Dugas (1973) for the summer of 1970 averaged 5.0 ppt. Summer data collected by Poirrier et al. for 1970 (south shore only) averaged 2.2 ppt. Summer data reported by Stone (1980) lake-wide averaged 2.9 ppt.

The average Secchi disk visibility over the stations in this study for the spring was 72 cm. Historical average values calculated over spring samples were 41 cms in 1973 (Tarver and Savoie, 1976), 168 cm in 1954 (Suttkus *et al.*, 1954), 139 cm in 1970 and 138 cm in 1971 (Tarver and Dugas, 1973), 60 cm in 1974 (Tarver and Savoie, 1976), and 62 cm in 1978 Stone (1980). Average Secchi disk visibility calculated over the fall months in this study was 166 cm. Historical averages calculated over summer samples were 79 cm in 1973 (Tarver and Savoie, 1976), 140 cm in 1953 (Suttkus *et al.*, 1954), 142 cm in 1970 (Tarver and Dugas, 1973), 106 cm in 1974 (Tarver and Savoie, 1976) and 89 cm in 1978 (Stone, 1980). Average Secchi visibility calculated for the summer of 1997 was higher than the average of any historical Secchi data reported.

Dissolved oxygen values were overall above 70 percent saturation in the data set with a few exceptions. The most notable exceptions to this were the supersaturation observed at Station 3 in mid-June, Station 4 from the last week in May until the first week in July, and Stations 5 and 6 during the last two weeks of June. These values are probably related to the algal blooms observed concurrent with these readings. Supersaturation was observed in other instances not seemingly related to the algal blooms especially in September and October. The lowest dissolved oxygen values (and per cent saturation) occurred during stratification events at Station 8, particularly during June and July, but values at this station never fell below 45 percent saturation. Low bottom oxygen values were attributed by Poirrier (1978) to the organic loading in the non-mixing saline bottom layer.

There have been no previous studies of recreational usage in either the Spillway or the Lake to serve as a basis of comparison.

COMPARISONS TO AGENCY DATA

1992-1997 historical oyster m^2 data for the Lake Pontchartrain and Mississippi Sound sampling locations were collected by LDWF in the months of June and July at the Hospital Wall, Grassy Island, Half Moon Petite Island, Three Mile, Turkey Bayou, Grand Pass and Cabbage Reef sampling locations. The historical data for the one station in Lake Pontchartrain (Hospital Wall) show virtually no live oysters. In the six years of data presented (1992-1997), only one live oyster was collected. The oyster data collected in April 1997 for this study showed the same results (no live oysters) as the LDWF data collected from 1993 through 1997.

The 1992-1997 data from the LDWF stations in the western end of Mississippi Sound (Grassy Island, Half Moon, and Le Petite Island) typically had fewer oysters than the stations from the eastern sound (Three Mile, Grand Pass, Turkey Bayou, and Cabbage Reef). In some years, few to no oysters were present in the samples from the western sound stations. The 1997 post-Spillway opening data show the same trend, with the Grassy Island, Half Moon and Le Petite Island stations showing fewer oysters than the Three Mile, Grand Pass and Cabbage Reef. For the 1997 sampling, the Turkey Bayou station showed no live oysters. The numbers of oysters present per m^2 at the 1997 LDWF sampling locations are generally similar to the 1992-1996 data.

The trend of fewer oysters in the western sound sampling locations was also reflected in the data collected for this study. The Little Bayou Pierre, Reef 8, Pelican Reef, Capt. Nelson, Grand Pass, and Cabbage Reef stations from the eastern sound had substantially higher oysters per m^2 than the western sound sampling locations.

For comparable stations, the spring and fall 1997 live oyster data collected for this study showed similar or higher numbers of oysters per m^2 than the 1992-1997 LDWF averages for Half Moon Island, Petite Island, Three Mile Reef, Turkey Bayou, and Grand Pass. For the Cabbage Reef site, the spring samples were lower than the 1992-1997 average, and the fall samples were similar. Since the numbers of live oysters per m^2 in the fall samples were similar to or higher than the comparable LDWF 1992-1997 averages, it is unlikely that the Spillway opening had a significant adverse impact on live oyster numbers in Mississippi Sound.

Some historic fisheries data for the Lake Pontchartrain area were made available by the National Marine Fisheries Service (NMFS). Their data show that except for the 1973 Spillway opening, the shellfish catch the year after the other openings (1975, 1979, and 1983) increased. According to data provided by the NMFS the landings for the catfish species typically increase after a Spillway opening probably due to the reduced salinities in the Lake.

Preliminary data supplied by the NMFS for 1997 show that brown shrimp catch for Lake Pontchartrain and Lake Borgne increased 83% from the previous year and was the third highest total recorded since 1990. The white shrimp catch for Lake Pontchartrain and Lake Borgne were slightly below the 1996 landings data, but the value of the white shrimp catch increased 36%. Statewide brown shrimp landings data show a decrease in the total landings since 1996, while the white shrimp landings increased since the 1996 data, although the total is the second lowest since 1983. This may indicate that the Spillway opening may have had little negative impact on the brown shrimp and a greater negative impact on the white shrimp in the Lake. If the trend exhibited by the historical shrimp catch data for the year after a Spillway opening is maintained, both the brown and white shrimp catch for Lake Pontchartrain and Lake Borgne should increase for 1998.

The abundance of hard crabs in the Lake harvested during the year in which the Spillway was opened is not unusual. Historical landings data from Lakes Pontchartrain and Borgne for the period 1959 through 1985 were taken from the Final EIS Clam Shell Dredging in Lakes Pontchartrain and Maurepas. These data include the years of Spillway openings - 1973, 1975, 1979 and 1983. During 1973 and 1983, hard crab landings in Lakes Pontchartrain and Maurepas increased significantly over the landings of the previous years. During 1979, there was also an increase over the previous year's crab landings. Only during 1975, which is the shortest of the Spillway openings with the least flow and the fewest number of bays open, were the hard crab landings for the Lakes slightly lower than those of the previous year. Preliminary 1997 data provided by the Louisiana Department of Wildlife and Fisheries for the wholesalers in the parishes surrounding Lake Pontchartrain as well as comparable data for the years 1990-1996 show that 1997 catch for five of the six parishes surrounding the Lake were higher than the 1996 catch.

COMPARISON OF RECREATIONAL DATA TO BIOLOGICAL SAMPLING DATA

As was experienced in previous studies, relatively few gamefish were collected in trawl samples. Most gamefish are quite fast and maneuverable, and generally able to avoid trawls. Additionally, they are not commonly found in the open water habitats where trawl samples are taken. The sand seatrout, a close relative of the more popular spotted or speckled trout, was the only gamefish collected in trawls on a regular basis. However the sand seatrout represented only 0.02 percent of the total finfish collected. Because trawling did not provide a good representation of fishes of recreational importance, no correlation between trends observed by recreational fishermen and biological observations is offered. However, interviews with fishermen showed that saltwater fishing declined immediately after the opening of the Spillway and improved during summer. By July redfish and speckled trout were being caught at several locations. By September tarpon were reportedly being caught in Lake Pontchartrain.

Trawl data showed the numbers of brown shrimp beginning to increase in mid-May, peaking in June and decreasing in July. This coincided with the brown shrimp season and shrimping activity in the Lake. It was observed that during the peak catch of brown shrimp in the trawl samples in June that there were numerous shrimp boats in the vicinity of Station 1 and Station 8. While interviews with recreational shrimpers and marina revealed mixed opinions, in general the recreational harvest of brown shrimp was judged to be lower than in previous years.

The evidence from qualitative sampling is that crabs were abundant in Lake Pontchartrain during and after the period of the Spillway opening. The data collected also clearly show that the percent of the population of harvestable size crabs (5.0 in and longer) present in the traps increased throughout the summer. This abundance of blue crabs was reflected by interviews with recreational crabbers. Shortly after the opening of the Spillway crabbers appeared to have somewhat cautious judgements. By July, however, anecdotal evidence confirmed that crabs were plentiful.

COMPARISON OF RECREATION DATA TO WATER QUALITY DATA

Alterations of the water quality of Lake Pontchartrain as a result of the opening of the Bonnet Carre' Spillway had definite effects on recreation in the Lake. As fresh water was introduced into the Lake through the Spillway, there were impacts on saltwater fishing, which was the principal activity of a majority of the recreational groups encountered in this study. Some saltwater gamefishes were initially confined to isolated pockets of salt water but these were later eliminated from much of the Lake. Although fishermen who discovered the isolated regions experienced temporary success, overall success at saltwater fishing was depressed throughout the spring. Fishing success began to improve toward the end of summer.

Another impact on recreation by water quality involved the occurrence of an algal bloom, apparently resulting from the introduction of nutrients present in the Mississippi River. Reports led potential recreationists to believe that, because of the algal bloom, the water of Lake Pontchartrain was dangerous. This led some people to forego activities in which they would otherwise have been engaged.

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SECTION 8 - CONCLUSIONS

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OYSTERS

The fresh water impacts associated with the March 17 - April 18, 1997 Bonnet Carre' Spillway opening were of relatively short duration (30-35 days) in the Mississippi Sound and Lake Borgne portions of the project area. By early May 1997, satellite imagery showed little evidence of Spillway opening related visible suspended sediments and salinity data showed salinities returning to near pre-Spillway opening levels. This return to pre-existing salinity levels occurred prior to water temperatures rising above the 23°C threshold expected to trigger mass oyster mortalities, as occurred in the 1973 and 1983 Spillway openings.

No catastrophic oyster mortalities were observed in the initial spring and final fall samples collected for this study or the mid-summer samples from the public reefs in Mississippi Sound by the Louisiana Department of Wildlife & Fisheries. Recent mortalities of oysters were low in all samples in both the initial and final surveys. The 50-100 percent oyster mortalities across the Louisiana portion of the Lake Borgne estuarine complex associated with the 1973 and 1983 Spillway openings were not observed in the data collected for this study.

Statistical comparison of oyster data from the Mississippi Sound stations showed a significant ($p=0.083$) reduction in the number of live oysters between the initial spring sampling and the final fall sampling. The statistical analysis of the data does not provide the reason for the differences in the numbers between the two sampling periods. Any one factor or combination of factors that would remove live oysters from the population between the March and September sampling periods could contribute to the observed differences in the numbers of live oysters between samplings. Those factors could include mortalities associated with the fresh water from the spillway opening, natural oyster mortalities associated with disease and predation and oyster harvesting that occurred between surveys. As discussed previously, the duration of the impact was relatively short and occurred while water temperatures were below the temperatures expected to cause significant oyster mortalities.

The spring samples were collected during a period when natural oyster mortalities are generally low. The fall samples were collected after five months of natural mortality, including the period when oyster mortalities are typically highest. Higher summer and early fall salinities and warmer water temperatures favor increased oyster predation and higher parasite loadings in individual oysters, particularly the larger, older oysters. Market-sized oysters from Cabbage Reef, one of the sampling sites in this study, were found by LDWF to have a mean weighted incidence of infection of the endemic oyster parasite *Perkinsus marinus*, also known as Dermo, high enough to cause oyster mortalities in 1997.

In addition to natural mortality, fishing pressure can also affect the numbers of oysters found in the samples. In both the March and September samplings in Mississippi Sound, working oyster boats were visible on a number of the reefs sampled. It is not known to what extent the differences between the initial oyster samples and the final samples from this study reflect this fishing pressure. Either individually or in combination, natural mortality and fishing pressure could account for the differences in the numbers of live oysters between surveys.

Live oyster data from Lake Borgne at Bayou Dupre showed no statistically significant differences between the initial and final surveys. Similarly, the Lake Borgne at Old Shell Beach oyster sample data showed no statistically significant differences between surveys.

It is concluded that the opening of the Bonnet Carre' Spillway had no adverse impact on the oyster populations sampled.

FINFISH AND SHRIMP

The opening of the Bonnet Carre' Spillway probably did have some affect on the finfish and invertebrate populations of Lake Pontchartrain. The addition of millions of gallons of fresh water into the lake ecosystem most likely altered spawning conditions for finfish species such as bay anchovy, pipefish, seatrout and freshwater catfish; preferred habitat; food sources; provided unfavorable water conditions; etc. Historically, shrimp catches are below normal during the year of the opening.

The collection of 540 trawl samples provided some information regarding the potential effect of the opening on finfish and invertebrates populations. Weekly trawls through June and bi-weekly trawls trough October yielded nearly 443,000 specimens. Forty-three finfish species and six invertebrate species were collected. The bay anchovy was the most dominant species caught comprising nearly 95 percent of the total catch.

Comparison of the trawl data to previous studies performed in the lake before, during and after spillway opening shows similar seasonal variation in the life history of the more common finfish species collected. Finfish as a whole increase their numbers as the summer approaches and decrease as the fall period arrives. Individual species such as the bay anchovy, Atlantic croaker and gulf menhaden followed the trends established by the earlier studies of Thompson and Fitzhugh (1985), Stone (1980), Darnell (1961) and Suttkus *et al.* (1954).

Brown shrimp were collected at all except the easternmost station during the trawl sampling. The numbers of brown shrimp began to increase in mid-May, peaking in June and decreasing in July. This coincided with the brown shrimp season and shrimping activity in the lake. It was observed that during the peak catch of brown shrimp in the trawl samples in June that there were numerous shrimp boats in the vicinity of eastern stations where bottom salinities were generally higher.

White shrimp were collected only sporadically during the trawl period. This was most likely due to the trawl equipment not being sufficient to adequately monitor the white shrimp population in the lake due to their habitat preferences. To collect representative data on the white shrimp in Lake Pontchartrain other sampling methods most likely will be necessary.

Preliminary data supplied by the NMFS for 1997 show that brown shrimp catch for Lake Pontchartrain and Lake Borgne rose 83% from the previous year and was the third highest total recorded since 1990. Catch data for Lake Pontchartrain and Lake Borgne showed a slight decrease in the white shrimp catch compared to the catch data for 1996, but the value of the white shrimp catch rose 36%. Statewide the landings data for brown shrimp were down, while the white shrimp landings were greater than in 1996. It appears that the impacts of the spillway opening were greater on white shrimp than on brown shrimp.

It is concluded, based on the trawl data and its comparison to previous studies of the Lake, that the opening of the Spillway did not adversely affect the finfish species in the Lake. The number of brown shrimp harvested from the Lake may have been somewhat reduced in the western portions of Lake Pontchartrain due to the Spillway opening displacing the shrimp easterly toward Lake Borgne and the Biloxi Marsh. Based on previous studies, the year following the opening should provide much higher than normal numbers of shrimp in the lake.

CRABS

The evidence from qualitative sampling is that crabs were abundant in sample traps in Lake Pontchartrain during and after the period of the spillway opening. This was apparent in spite of consistent tampering with the traps.

The data collected also clearly show that the percent of the population of harvestable size crabs (5.0 in and longer) present in the traps increased throughout the summer.

Preliminary USGS salinity data collected along the Causeway during the summer of 1997 clearly show that salinities were very low, <2.0 ppt, and in most cases <1.0 ppt, during the period that crabs were most abundant in our traps.

Historical data also show that crabs were more abundant during years of major spillway openings.

It is concluded that the opening of the Bonnet Carre' Spillway had no observable adverse impacts on blue crabs in Lake Pontchartrain.

WATER QUALITY

The Spillway has, according to these data, affected the salinity of Lake Pontchartrain particularly during the spring, although the summer salinities were also somewhat lower than the historical reported. Similarly, spring Secchi disk visibilities were lower than most averages historically reported except during other years of spillway openings and during the summer of 1978. Summer visibilities, however, were higher than any historically reported averages for the same period.

The stratification that has historically been reported in the southern portion of the Lake during the spring and summer was evident only at Station 8 near the airport. These non-mixing pockets of more saline water, which often deoxygenate and historically move around the southeastern quadrant of the lake, were not evident in these data except at this station.

Oxygen values did not appear to have been negatively influenced by the Spillway opening. Per cent saturation values were high in most cases and extremely high in summer month data. Algal blooms, observed at six of the eight monitoring stations, had no apparent adverse effects on any of the water quality parameters measured. Surface algae were observed, particularly during June. During July, submerged mats were collected in trawl samples at some stations. No algae were recorded or collected at any stations in August.

The effects of the spillway opening on water quality in Lake Pontchartrain, therefore, appear to have been maximum in the spring months of April, May, and June on salinity, and Secchi visibility. These effects appear to have decreased over the following summer months as salinity and Secchi visibility increased.

It is concluded that the opening of the spillway had its greatest influence on the water quality of Lake Pontchartrain by reducing salinity and Secchi visibility in the spring months of April, May, and June, and in providing nutrients for algal blooms.

RECREATION

Lake Recreation

Based on surveys and observations of study area recreationists, it can be said that the opening of the Bonnet Carre' Spillway resulted in an apparent short-term reduction of the quantity and quality of saltwater fishing and other recreation activities in parts of the study area, notably in Lake Pontchartrain. However, anecdotal reports indicated the presence of saltwater fish at various locations at the western end of the Lake. The time period in which activities were curtailed was extended by the algal bloom in Lake Pontchartrain. Reports of potentially dangerous water quality conditions led some people to forego activities that they would otherwise have engaged in. By the end of the summer there was a general feeling that conditions were returning to normal.

Spillway Recreation

Flooding of the Spillway rendered it unusable for a number of activities for periods ranging from four to eight weeks. When access was restored, large numbers of people took advantage of greatly improved crawfishing and fishing. Other activities returned fairly soon to their pre-flood status. Basically, people have returned to doing what they used to do before the Spillway opening.

It is concluded the opening of the Bonnet Carre' Spillway created a temporary interruption in the use of Lake Pontchartrain and associated areas for recreational use. Recreational activities in the Spillway returned to normal in mid-Spring, while recreation on the Lake, particularly saltwater fishing, did not return to normal until Summer.

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SECTION 9 - RECOMMENDATIONS

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The study of the biological and recreational impacts of the 1997 opening of the Bonnet Carre' Spillway revealed several aspects that could improve the quality of future investigations. These recommendations fall into two categories: those involving studies associated with future openings of the Spillway, and those involving the gathering of data during years when the Spillway is not opened.

ACTIONS DURING YEARS OF SPILLWAY OPENINGS

There was, to some extent, an evolution of both the biological and the recreational sampling associated with this project. Most of this evolution occurred during early phases of the project when investigators identified alternative methods that would provide better information with minimal additional effort and no additional cost. Because of the necessity in maintaining standardized approaches to data gathering, it was not possible to make changes in sampling methodology after the first few weeks of the study. There are other alternative methods identified in following paragraphs that could not be incorporated into the present study, but would be beneficial to future investigations. It is recommended that the present study be used as a basis for preparing a Study Plan that would be in place for conducting investigations associated with future openings of the Bonnet Carre' Spillway.

A major shortcoming of the current study was a lack of water quality and oyster data from the period when oyster mortalities are most likely to occur. That period is when water temperatures approach or exceed 23°C and salinities are at or below 5 ppt. It is recommended that studies include an initial sampling survey, a second survey when water temperatures approach or exceed 23°C and a final survey in late September to early October.

One of the weaknesses of this study was a lack of biological sampling for recreationally important sportfish. To rectify this situation we recommended the use of stationary nets in shoreline areas at a variety of locations around the Lake and the use of hook and line in the vicinity of such structures as bridges and platforms. Additionally, creel surveys should be done at boat launches around the Lake to verify the sampling data.

Future studies should include placing crab traps in open water and checking periodically to avoid the tampering problems which were encountered during this study.

During the course of the present study there were several anomalous events that were reported in the news media. The occurrence of an algal bloom and apparent fish kills received incidental attention in the study because field sampling procedures had already been established, and deviation from those procedures could have affected the standardization associated with the collection of data. However, in retrospect, it may have been useful to have performed a more thorough investigation of the algal bloom, particularly in its relationship to the water quality of Lake Pontchartrain. It is recommended that future studies include a capacity for contingency investigations of events that are potentially associated with the opening of the Spillway.

As the present study progressed, it became apparent that while some of the recreational questions worked well in obtaining the desired information, others were less effective. The restructuring of some questions could have provided more information. For example, more open-ended narrative-type questions would have worked better than some of the forced-choice questions. It is recommended that this study be used as a basis for a critical reevaluation of the recreational questionnaires to facilitate the collection of information in future investigations.

In the course of the study it was discovered that marina operators were an excellent source of recreational fishery information. It is recommended that a systematic approach for contacting and interviewing marina operators be taken during future openings of the Spillway. This could include the preparation of such items as a checklist of topics to be discussed with marina operators on a periodic basis. In addition, conducting interviews with shrimp buyers could provide ongoing information on the success of commercial shrimping in the Lake.

The randomized sample design used for the recreational portion of the study accompanied by a compartmentalization of the study elements resulted in a somewhat limited recreational analysis. For example, it was not known by the recreational investigatory team until after the fact that an area of saline water was present adjacent to the north shore of Lake Pontchartrain. Future studies should include periodic meetings to exchange technical information among the various investigators. At a minimum, participants should include recreational investigators, biologists, and hydrologists, and personnel from Federal and state agencies knowledgeable of Lake Pontchartrain. In addition, the recreational sampling plan should include more purposive elements to ensure that critical and crisis areas and times are adequately covered.

It may be beneficial to utilize internet resources to obtain recreational information. Existing "chat rooms" could be accessed to elicit the experiences of recreationists. Additionally, it may be possible to establish an internet site where people could report their comments or obtain information.

ACTIONS DURING YEARS OF SPILLWAY CLOSURE

To assess the impacts of opening the Spillway it is sometimes necessary to make comparisons to information gathered during years when the spillway remains closed. It became readily apparent that the evaluation of certain aspects of the present study would be quite difficult because of a lack of data to which the 1997 data could be compared. Information collected with similar sampling equipment and methodologies allows for easier and more accurate comparisons and determining the effect of a spillway opening or other natural and/or man-made influence on the lake. This baseline information would also be useful when discussing future Corps of Engineers projects for the lake with environmental groups and representatives. Therefore it is recommended that biological sampling be performed during the spring, summer and fall months to collect finfish and shellfish to establish baseline data.

General water quality parameters such as salinity, dissolved oxygen, Secchi disk visibility, and pH need to be measured in conjunction with any future background studies of the lake conducted during years when the Spillway is not opened.

The comparing of data obtained and compiled by a variety of Federal and state agencies is a necessary component of the present study. It is recommended that a repository be established to receive and store annual Lake Pontchartrain data of importance to future investigations of Spillway openings.

Bonnet Carre' Spillway Recreation Use Observation Form

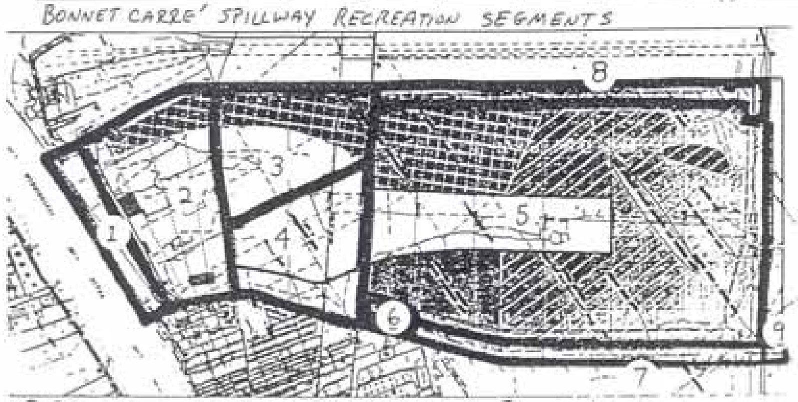
Time Span________ Day_____ Date_____ No.____

Weather Conditions____________________________ GroundConditions____________________

Activities — Areas within Spillway (See Map)
(Record No. of Persons/No. of Vehicles in each cell)

	Activities	Area1 P / V	Area2 P / V	Area3 P / V	Area4 P / V	Area5 P / V	Area6 P / V	Area7 P / V	Area8 P / V	Area9 P / V
1	Sight/Driving									
2	Picnicking									
3	Walk/Hike									
4	Sunbathing									
5	Camping									
6	Bird Watching									
7	Photography									
8	Bicycles									
9	Motor Cycles									
10	ATV									
11	4-Wheel Drive									
12	Swimming									
13	Crawfishing									
14	Crabbing									
15	Bank Fishing									
16	Boat fishing									
17	Catching Bait									
18	Boating&Skiing									
19	Jet Skiing									
20	Dog Train/Playing									
21	RemtCntl Planes									
22	RemtCntl Boats									
23	Shooting									
24	Hang w/ Friends									
25	Other_1(describe)									
26	Other_2(describe)									

BONNET CARRE' SPILLWAY RECREATION SEGMENTS



NOTES: (est. no. of Boat trailers each area. Note for observed Lake access.

① Batture
② Front section
③ middle section, upper portion
④ middle section, lower portion
⑤ upper section
⑥ St. Charles Parish Rec. Area
⑦ Lower Guide Levee (I = In, O = Out)
⑧ Upper Guide Levee (I = In, O = Out)
⑨ Launch, Pier, Lake

[illegible] LOCATION ____ DAY ____ DATE ____ TIME ____ ZIPCODE ____ TIME ARRIVED ____ TIME LEAVING ____

GROUP

FEMALES < 18 ____
FEMALES 18+ ____
MALES < 18 ____
MALES 18+ ____
VEHICLES ____

		(1) Today's Activities (No. of Persons)	(2) Map Areas (7,8,9 - 'T', 'O') (Lake - 'L')	(3) Activities/Areas Before Flooding (7,8,9 - 'T', 'O') (Lake - L)	(4) Times Per Year	(5) Visual Size of Group	(6) Rank Top Five (1 = top, etc.)	(7) Activities Since Flooding - Y - N Weeks	(8) Changed Frequency N,Y More, Less	(9) Changed Location Old Area - New Area
1	Sight/Driving									
2	Picnicking									
3	Walk/Hike									
4	Sunbathing									
5	Camping									
6	Bird Watching									
7	Photography									
8	Bicycles									
9	Motor Cycles									
10	ATV									
11	4-wheel Drive									
12	Swimming									
13	Crawfishing									
14	Crabbing									
15	Bank Fishing									
16	Boat Fishing									
17	Catching Bait									
18	Boating&Skiing									
19	Jet Ski									
20	Dog Train/Playing									
21	RemtCntl Planes									
22	RemtCntl Boats									
23	Shooting									
24	Hang w/ Friends									
25	Other_1(describe)									
26	Other_2(describe)									

(10) Fish, Crab, Crawfish, Shrimp (Before)
(Great, OK, Poor, Zero)

(11) Fish, Crab, Crawfish, Shrimp (Since)
(Great, OK, Poor, Zero)

(12) While Spillway was flooded?
____

(13) Sightsee at Spillway Y N
weekend weekday
times: ____ ____

(14) Additional Facilities
____

(15) Other Issues/Concerns
____ (Over)

(16) Comments:
____ (Over)