Coast 2050 Region 2

WEST POINTE A LA HACHE FRESHWATER DIVERSION (BA-04)
BA-04-MSPR-0596-2
PROGRESS REPORT No. 2
for the period
May 28, 1992 to May 27, 1996

Project Status

The following data collection and analysis activities have been conducted since the previous progress report:

Biweekly hydrologic variables were collected for 16 stations on August 30, September 12 and 28, October 17, November 2 and 14, and December 12, 1995, and January 17, February 13, March 12, and April 16, 1996. The standing data set was updated with these data and used to statistically evaluate project effectiveness. Data from April and May 1996 were not collected in time for the statistical analyses and will be included in the next report. Hourly hydrologic data were recorded at 5 stations for the entire time period. However, because of equipment malfunctions, various periods of missing data exist.

Project Description

The West Pointe a la Hache project area contains approximately 9,300 acres of open water and 7,600 acres of brackish marsh and is located within the Barataria Basin in Plaquemines Parish, Louisiana. The area includes Lake Judge Perez to the northwest, and is bound to the south by Bayou Grand Cheniere, to the southeast by the Socola Canal, and to the north by the Mississippi River back protection levee (figure 1). The freshwater diversion structure is located at river mile 48.9 (above head of passes) at West Pointe a la Hache and consists of eight 72-in. diameter siphon tubes with a combined maximum discharge of 2,144 cfs. The siphon empties into a designated discharge pond, maintained by 2,500 yd^3 of riprap, with four outfall channels (Brown & Root, Inc. 1992). All operational changes are performed by Plaquemines Parish government (PPG) (table 1). These changes are directed by an operations scheme (table 2) developed in 1992 by Brown and Root, Inc., based on an environmental model and subsequently revised by PPG and the Louisiana Department of Natural Resources, Coastal Restoration Division (LDNR/CRD). This revision calls for the siphon to be operated at 8 pipes in January and February, 2 pipes in March and April, and 8 pipes from May through December.

The project area, as is true with the rest of the Barataria Basin, suffers from a lack of fresh water and sediment resulting from construction of the flood control levee along the Mississippi River. The main project objective is to protect the project area from continued degradation by introducing fresh water into the area through the west bank of the Mississippi River. The river water will bring sediment and nutrients into the project area to improve growing conditions for the target plant species (*Spartina patens*).

Specific measurable goals were established to evaluate project effectiveness and include: (1) increase marsh to open-water ratios, (2) reduce and stabilize mean salinity, and (3) increase relative abundance of the target plant species (*S. patens*).

Monitoring Design

All monitoring station locations were chosen to allow for an equitable distribution throughout the project area. Hydrologic variables are monitored biweekly at 16 stations and hourly at 5 stations (figure 1). Biweekly hydrologic variables include salinity and water temperature (surface and bottom) and water level at 5 staff gauges surveyed to the New Cairo or the National Geodetic Vertical Datum (NGVD). Data collected from those stations surveyed to the New Cairo datum are mathematically converted to NGVD. Hourly hydrologic data are recorded by Hydrolab "Datasonde 3" continuous dataloggers that record salinity, specific conductivity, water temperature, and water level. Health-related water quality (fecal coliform) is monitored in concurrence with biweekly hydrologic monitoring.

Plant species composition and abundance are measured at 21 stations (figure 2). Color-infrared aerial photography (1:12,000) is used to calculate marsh to open-water ratios and for vegetation delineations. Change in marsh to open-water ratios from preoperation (1992) to year 5 postoperation will be evaluated in 1997. Fisheries sampling was limited to brown shrimp (*Penaeus aztecus*) and was sampled at five stations (figure 2) in April, May, and June of 1994 and 1995.

The extent of the turbidity plume resulting from siphon operation is evaluated using aerial photographs and by looking at water color and water transparency with an 8-in. Secchi disc. Daily siphon discharge in cubic feet per second is formulated from the head differential between the river and the marsh staff gauges and the number of pipes operating. Any missing values for daily gauge or operational status are interpolated from known values.

Nine sediment accretion stations were established in December 1995 using feldspar marker horizons (Steyer et al. 1995). Accretion will be measured at these stations using a cryogenic coring device (Knaus and Cahoon 1990) in the fall of 1996 when water level in the immediate outfall area is reduced. Station locations and data collected will be included in the next progress report.

All biweekly biological monitoring is performed by PPG with LDNR/CRD accompanying PPG on every other trip. On the monthly joint monitoring trips, PPG obtains fecal coliform samples and LDNR/CRD records all hydrologic variables and downloads hourly data from the continuous recorders. PPG independently monitors the project on a monthly basis two weeks after the joint monitoring trip. During those trips, PPG obtains fecal coliform samples and records all biweekly hydrologic variables. LDNR/CRD performs all vegetation, brown shrimp, and sediment accretion monitoring.

Since true preconstruction hydrologic data are minimal, and since there was an extended period that the siphons were not operating, data were grouped into "operating" versus "nonoperating" rather than "before" and "after." The primary method of analyses for hydrologic variables is to determine siphon operating versus nonoperating differences in mean values as evaluated by an analysis of variance (ANOVA, $p \leq 0.05$). In addition, regression analyses are performed to evaluate if relationships exist between siphon flow and hydrologic variables.

Results/Discussion

Approximately 4 yrs of biweekly and 3.5 yrs of hourly hydrologic data have been accumulated since monitoring was initiated in May 1992. Moreover, results related to project effectiveness have been encouraging. Vegetation species composition and abundance was assessed in 1992 and 1995, and fisheries were evaluated in 1994 and 1995. No definitive conclusions can be drawn from fisheries monitoring and it may be too early to speculate on results obtained from vegetation monitoring.

Color-infrared aerial photographs (1:12,000) from February 1993 were used to delineate the extent of the turbidity plume caused by siphon flow (Plaquemines Parish Government 1993). The plume covers the northern half of the project area and extends from station 12 in the west to station 7 in the east. The southernmost extent of the plume is bound by the east-west running pipeline canal that contains stations 4 and 7 (figure 1). This plume was confirmed to cover the same extent in February 1996 through visual inspection of water color. The Mississippi River water is a distinct light brown color that is easily distinguishable from the clearer marsh water. The color results from a heavy sediment load carried by the river in late winter and spring when flow is increased. During both time periods, the siphon was operating at all 8 pipes. Average daily flow for February 1993 and 1996 was estimated at 1461.7 and 1217.6 cfs, respectively.

Hourly hydrologic monitoring was initiated on January 8, 1993, and time periods of available data are summarized in table 3. As might be expected, the freshwater inflow has its most rapid and/or pronounced influence on the continuous recorder stations located closest to the immediate outfall pond. Salinity was reduced almost immediately at station 2 when the siphon was first opened on January 12, 1993 (figure 3). Station 2 is located directly on Grand Bayou where it meets the Jefferson Lake canal (figure 1). Both channels are conduits for the fresh water that the siphon introduces into the project area. At station 4, the influence of fresh water was not as immediate or pronounced as at station 2. In fact, a 2-day lag exists between when the siphon is primed and begins flowing and when its effects are observed at station 4 (figure 4). This station is located near the center of the project area and, unlike station 2, is not along a direct conduit from the siphon discharge pond. As a result, the fresh water requires a longer time period to reach this area and the effects are not as pronounced as they are closer to the siphon discharge. It appears that a 4-day lag period exists before fresh water reaches station 55, located at the southeastern corner of the project area (figure 5). Both stations 55 and 7 exhibit large salinity fluctuations that are closely tied to water level when the siphon is operational (figures 5 and 6). This pattern is not evident when the siphon is nonoperational (figure 7). There is generally well-defined salinity stratification at these stations during siphon operation. Water level increase is due to tidal influences that bring higher saline water into the area as a deep salt wedge. The dataloggers may be at positions in the water column that come into contact with the salt wedge when water levels are high. As the water level decreases with the outgoing tide, the salt wedge is reduced and the dataloggers record the salinity of the fresher surface water introduced into the area from the siphon structure. While the preceding discussion of hourly hydrologic data uses specific temporal instances, the general trends are consistent regardless of period of record. It should, however, be noted that various factors (i.e., weather events or river stage) may periodically influence siphon effects on stations.

Biweekly hydrologic and health-related monitoring was initiated on May 28, 1992. Monthly means, calculated from biweekly salinity data, indicate a general decrease in mean project area salinity immediately following the opening of the structure on January 12, 1993. A gradual increase in overall salinity usually begins in the fall of each year (figure 8) when periods of low river stage cause the structure to loose prime and stop flowing. Low river stage reduces the head differential between the siphon intake on the river and the outfall area in the marsh, which in turn reduces flow through the structure. The reduced flow cannot flush the air from the structure that is entering via faulty butterfly stop valves. The usual fall salinity increase was reduced in 1993 because the atypically high river stages, caused by the extreme flooding in the Midwestern United States, kept head differential high. The salinity increase from fall 1994 extended longer into 1995 than usual; the siphon was not restarted until July 1995 because of pending lawsuits against PPG and the State of Louisiana by several oyster fishermen. A regression analysis indicates that a significant ($p=0.0001$, $R^2=0.2542$) inverse relationship exists between siphon flow and mean project area salinity (i.e., as siphon flow increases, mean project area salinity decreases; and conversely, if siphon flow decreases, mean project area salinity increases).

Overall, mean salinity throughout the area has been significantly ($p=0.0001$) reduced from 10.46 ppt ($\pm$0.15 SE) (nonoperating) to 4.67 ppt ($\pm$0.13 SE) (operating). Localized mean salinity has been reduced in varying degrees as a result of siphon flow (figure 9). The greatest salinity reduction occurs at those stations located closest to the immediate outfall pond or on major freshwater conduits. Salinity has been reduced by approximately 7.0 ppt at stations 1, 2, 3, 4, and 5, while salinity at stations 9, 10, and 55 has been reduced by approximately 3.5 ppt. The 9 ppt isohaline line has shifted south from a diagonal southeast to northwest line passing through station 5 to a more east-west running line passing in the northern vicinity of station 56.

With the exception of the immediate outfall pond, there is no significant ($p=0.0560$) relationship between siphon flow and mean water level. Nonoperating mean water level (including the outfall pond) was 1.16 ft NGVD ($\pm$0.03 SE), compared to an operating mean water level of 1.25 ft NGVD ($\pm$0.04 SE). If the immediate outfall pond is removed from consideration, as it is directly affected by siphon flow, then nonoperating mean water level was 1.17 ft NGVD ($\pm$0.03 SE) and operating mean water level was 1.11 ft NGVD ($\pm$0.03 SE). This slight change is attributable to the error associated with reading the staff gauges. One possible explanation for water level remaining unchanged, despite the input of large amounts of fresh water, is the location of the immediate outfall pond in relation to the Jefferson Lake canal and Grand Bayou. These channels are relatively deep conduits for the fresh water introduced into the project area and immediately receive the fresh water after it passes over the relatively small immediate outfall area. In addition, the large volume of water that these channels can carry may promote channelized flow over sheet flow. As a result, a portion of the fresh water introduced may be exiting the project area via these conduits instead of flowing over the marsh and depositing valuable sediment and nutrients. The outfall management plan will address this possibility.

Nonoperating mean water temperature was 21.42°C ($\pm$0.21 SE), compared to an operating mean of 22.26°C ($\pm$0.19 SE). Although a significant (p=0.0001) relationship between mean water temperature and siphon flow exists, it is very weak (R^2=0.0381) and may be a result of seasonal differences in flow. The siphon is usually not flowing in late fall and early winter when water temperature is typically low. This may affect the analysis by skewing nonoperating water temperature lower. Future analyses will address this possibility.

Fecal coliform analysis is regulated by the National Shellfish Sanitation Program (NSSP) under the U.S. Department of Health and Human Services, Food and Drug Administration. Fecal coliform data are recorded as most probable number (MPN) per 100 ml of sample and can range from 0 to over 1600. The NSSP has determined that fecal coliform data must be normalized to reduce any skewness that may occur in mean MPN/100 ml data. This is accomplished by taking the geometric mean instead of arithmetic mean of a series of samples. Any area where the geometric mean exceeds 14 MPN/100 ml is considered polluted (Brown and Root, Inc. 1991). The geometric mean of the fecal coliform samples collected by PPG during periods of nonoperation was 36.4 MPN/100 ml. That number increased to 61.4 MPN/100 ml during operation. While it seems that fecal coliform values have increased in response to siphon operation, it should be noted that according to NSSP guidelines, the area was considered polluted prior to operation. This is also apparent from an analysis performed by Brown and Root, Inc. (1991) of several Louisiana Department of Health and Hospital (LDHH) Oyster Water Monitoring stations located within the Barataria Basin. Of the 32 stations they evaluated from 1986 to 1990, 7 were located directly within the West Pointe a la Hache project area. According to their report, 5 of the 7 stations were classified as polluted based on geometric means. In addition, all 7 stations within the project area were considered polluted, based on two other evaluation techniques (Brown and Root, Inc. 1991).

An initial vegetation delineation of the project area using ocular estimates was performed by Allan Ensminger (1992) of Wetlands and Wildlife Management Co. under contract with the LDNR/CRD. The original 21 vegetative sampling stations were revisited in July 1995 and species composition and percent cover estimates were again measured (table 4). Both the 1992 and 1995 studies found the area to be dominated by marshhay cordgrass *(Spartina patens)*, smooth cordgrass *(Spartina alterniflora)*, and saltgrass *(Distichlis spicata)*. While Ensminger found no black needle rush *(Juncus roemerianus)*, the 1995 studies found it present at 11 stations with percent cover ranging from a trace to 25%. Black needle rush is found in fresh-to-saline marshes but is most common in saline marshes. This increase in occurrence of a saline marsh plant species may suggest that the freshwater input is not yet affecting the vegetation in those areas where black needle rush is present. The possibility also exists that high salinity events during nonoperating time periods potentially may be causing those areas to become more saline.

Conversely, there were several stations where the 1995 study found less smooth cordgrass and more marshhay cordgrass than the 1992 study, (e.g., stations 1, 2, 18, & 19) suggesting a freshening effect. Although marshhay cordgrass can occur in saline marsh, it is more common in brackish marsh, while smooth cordgrass is more common in saline marsh. In 1995, station 1 (figure 2) also contained two species most common in fresh-to-intermediate marsh that were not present in 1992: waterhyssop (*Bacopa monnieri)* and elephant ear *(Colocasia esculenta)*. This observation may also suggest that the fresh river water may be affecting vegetation around station 1. However, the flow of the siphon to date has been highly variable, including a 9-mo period of no flow. As a result, it may be too early to speculate on the effects that the diversion is having on the vegetation.

To assess the impacts of the freshwater diversion to the brown shrimp (*Penaeus aztecus*) fishery, trawl samples were collected monthly in April, May, and June in both 1994 and 1995. Five stations were established within the project area (figure 2) and compared to 10 Louisiana Department of Wildlife and Fisheries (LDWF) stations for the same time periods. The LDWF stations were located in various bays around the Barataria Bay proper and sampled by LDWF personnel from their Area III office located on Grand Terre island. To ensure comparability of data, a 6-ft trawl was rigged and deployed according to LDWF specifications. Catch per unit effort (CPUE, as raw number of shrimp per trawl) and size (as length from tip of rostrum to tip of telson) were measured. Average CPUE between LDWF and LDNR/CRD for all three time periods was similar in 1995 but greater for LDWF in 1994 (table 5). While LDWF had greater overall CPUE in 1994, LDNR/CRD caught a greater number of larger size class shrimp than did LDWF (figure 10). Based on the 2-yr study, a significant ($p=0.0241$) relationship exists between salinity and CPUE, however, the relationship is weak ($R^2=0.1128$). It should be noted that direct comparison of LDWF data to LDNR/CRD data is suspect because of the large geographical distance between the two sampling areas. As a result, it is difficult to make any conclusions regarding this monitoring effort. The brown shrimp sampling will be discontinued in 1996 because of the aforementioned questions regarding sampling strategy. If concerns about the brown shrimp fishery arise in the future, a new sampling protocol will be developed and monitoring will be reinstated. A report was generated on the acquired data and is available from LDNR/CRD.

To date, the siphon appears to be effective at reducing overall mean salinity within the project area while not adversely affecting water temperature or level. However, it is too early to speculate on project effectiveness related to the marsh to open-water ratio or general vegetation community. Fecal coliform data indicate a possible negative effect of siphon operation, but this may not be environmentally significant considering the fact that the area had high fecal coliform levels prior to siphon operation. Because of questions related to the brown shrimp sampling strategy, no conclusions based on brown shrimp monitoring can be made at this time.

References

Brown and Root, Inc. 1991. LaReussite and West Pointe a la Hache prediversion water monitoring report. Unpublished final report prepared for Plaquemines Parish government, Department of Health and Hospitals. Belle Chasse, La.: Brown and Root, Inc. 22 pp.

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Ensminger, A. B. 1992. Vegetative delineations for the West Pointe a la Hache freshwater diversion outfall area project No. BA-04. Unpublished final report prepared for the Louisiana Department of Natural Resources/Coastal Restoration Division. Belle Chasse, La.: Wetlands and Wildlife Management Co. 26 pp.

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Construction Start:	January 28, 1991	
Construction End:	April 15, 1992	

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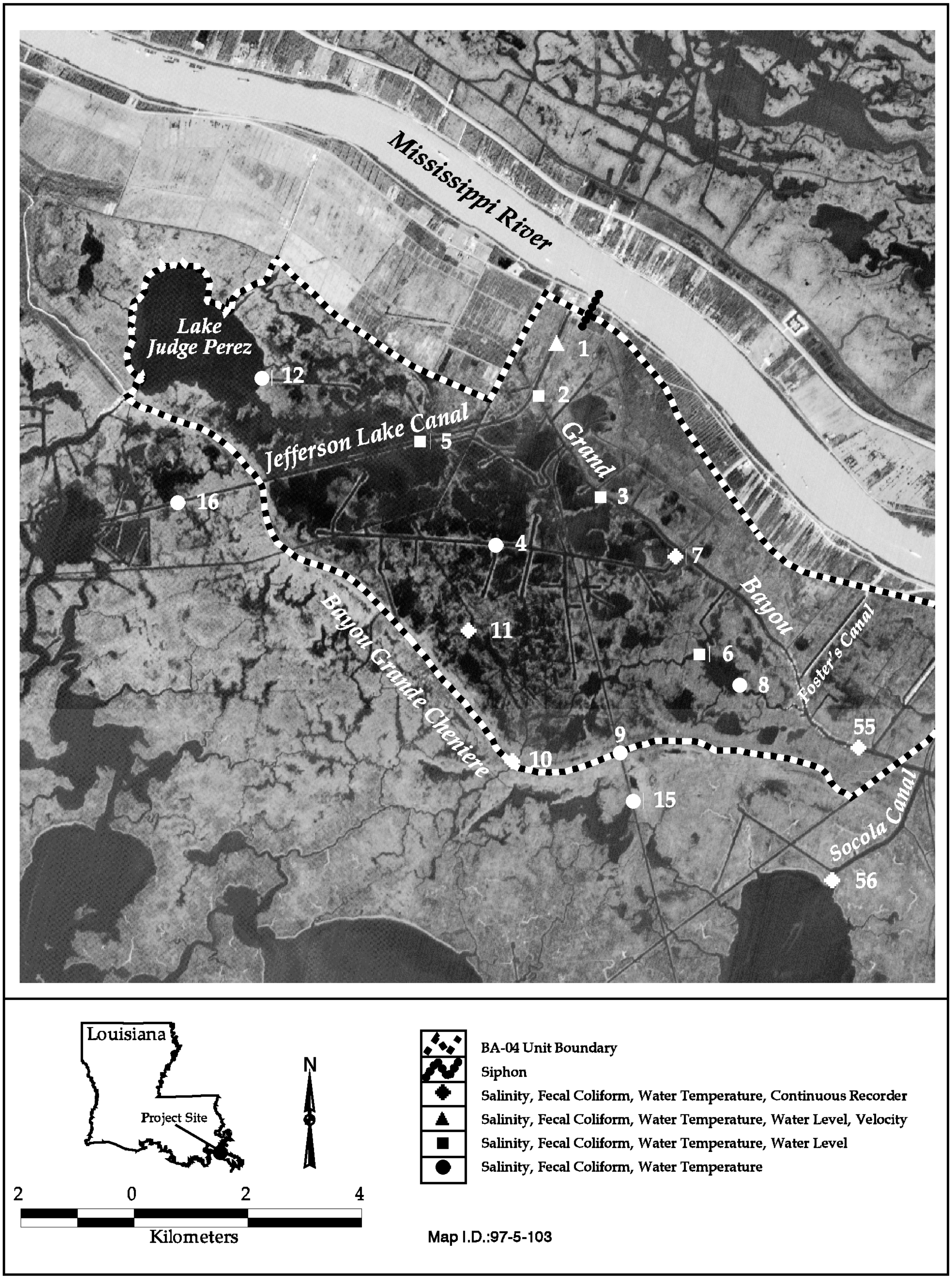

Figure 1. West Pointe a la Hache project area location illustrating hydrologic and health-related water quality sampling stations.

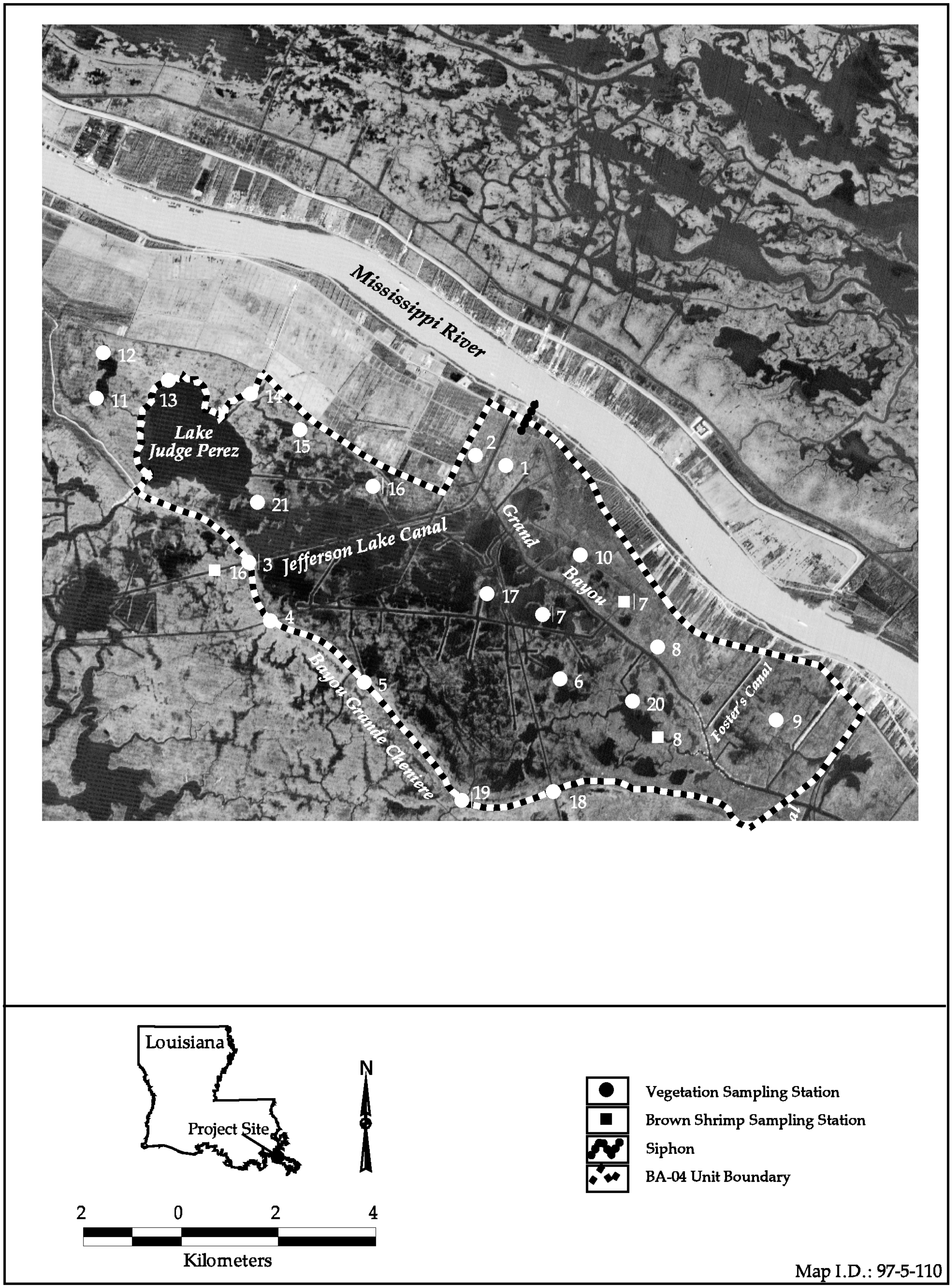

Figure 2. West Pointe a la Hache project area location illustrating locations of vegetation and brown shrimp sampling stations.

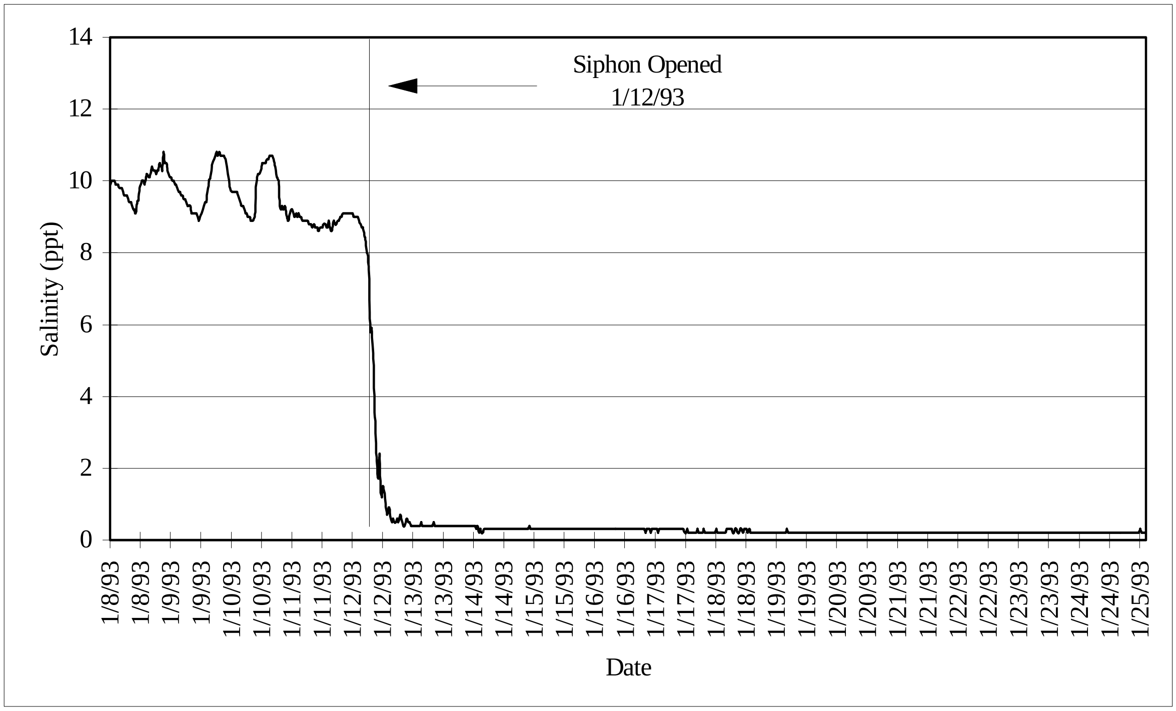

Figure 3. Hourly salinity data for the first month of siphon operation from station 2. Salinity was reduced immediately.

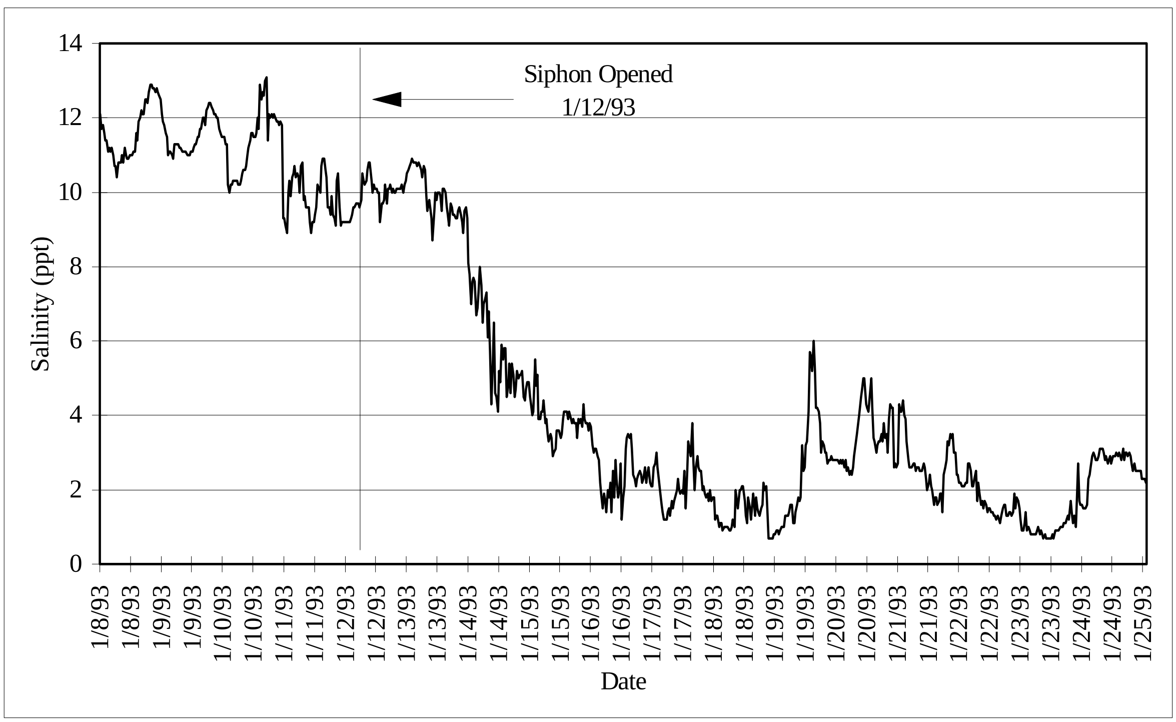

Figure 4. Hourly salinity data for the first month of siphon operation from station 4. A 2-day lag exists before salinity is reduced.

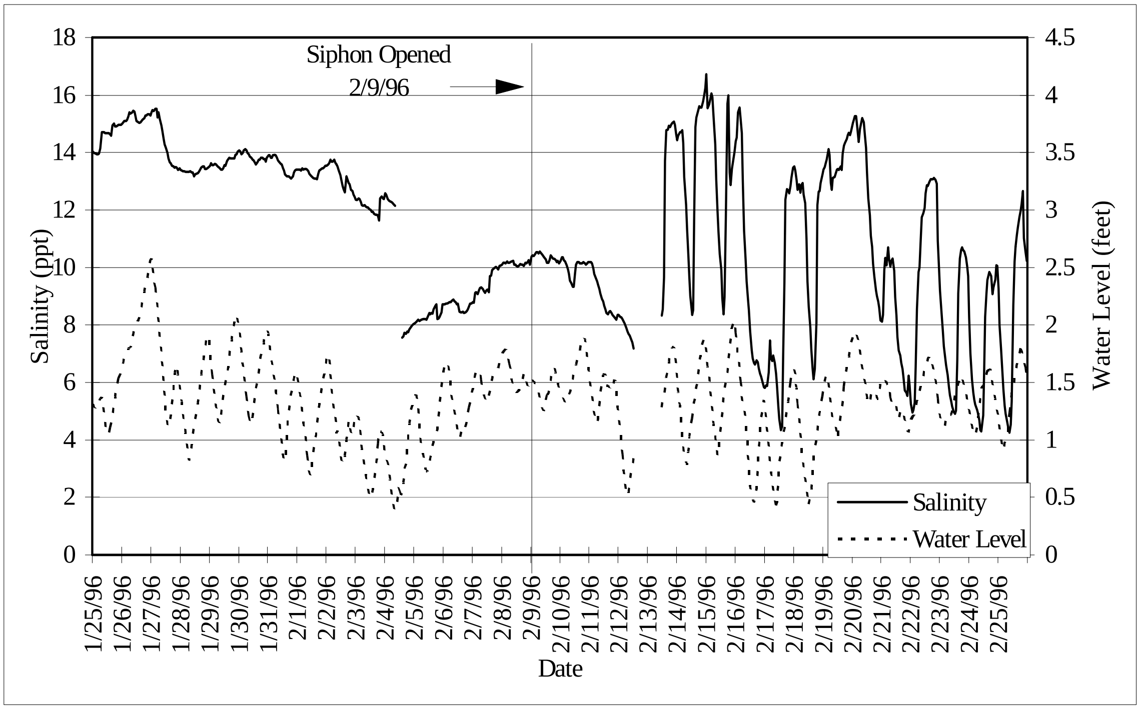

Figure 5. Hourly salinity and water level data from station 55. A 4-day lag exists before salinity is reduced. Note that during siphon operation, salinity fluctuations are closely tied to water level.

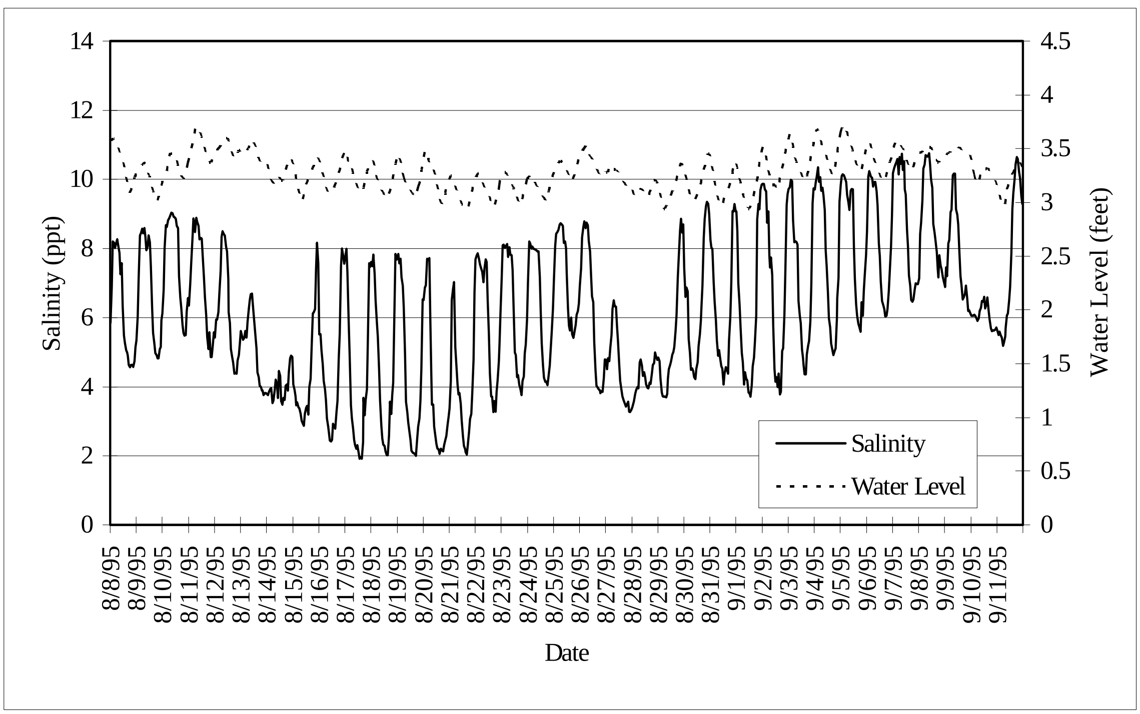

Figure 6. Hourly salinity and water level data during siphon operation from station 7. Salinity fluctuations are closely tied to water level.

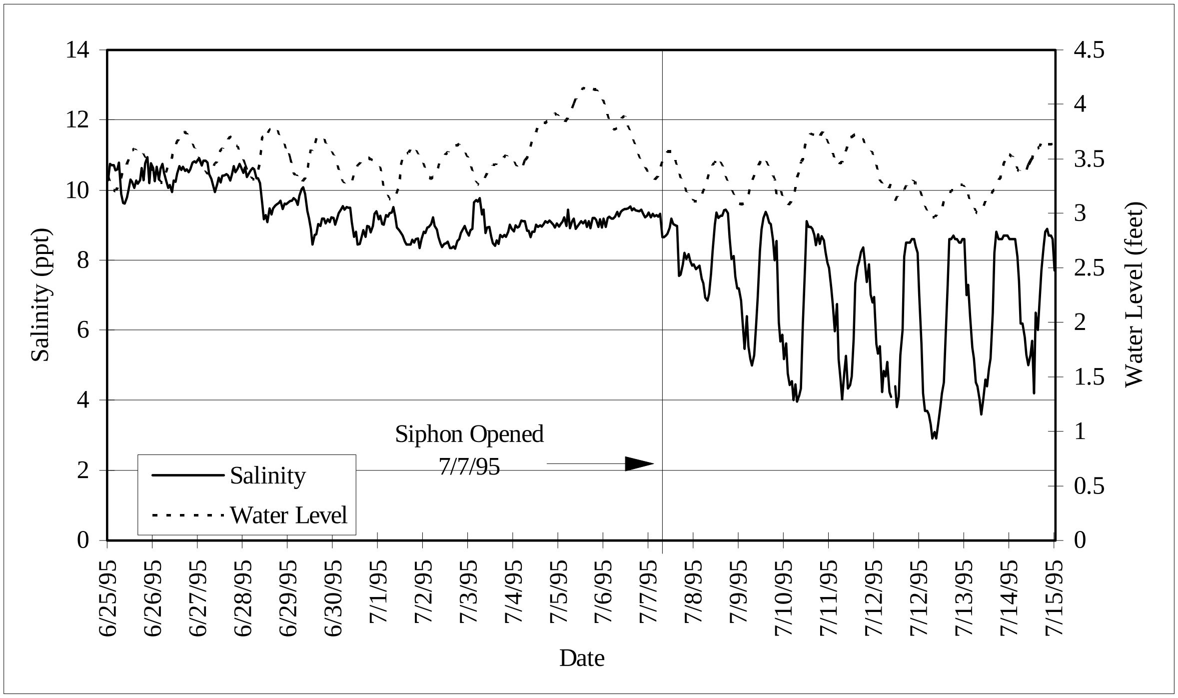

Figure 7. Hourly salinity and water level data from station 7. Note the change in salinity pattern that results from siphon operation.

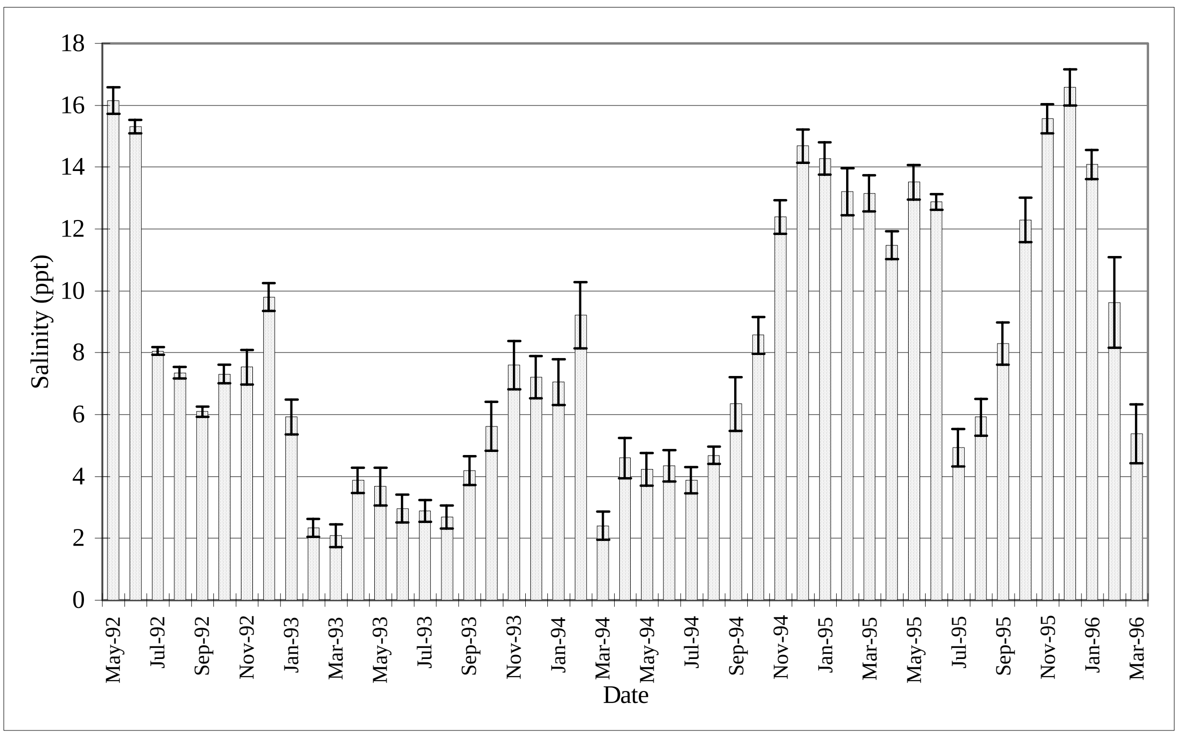

Figure 8. Monthly mean of biweekly salinity data for all project area stations collectively.

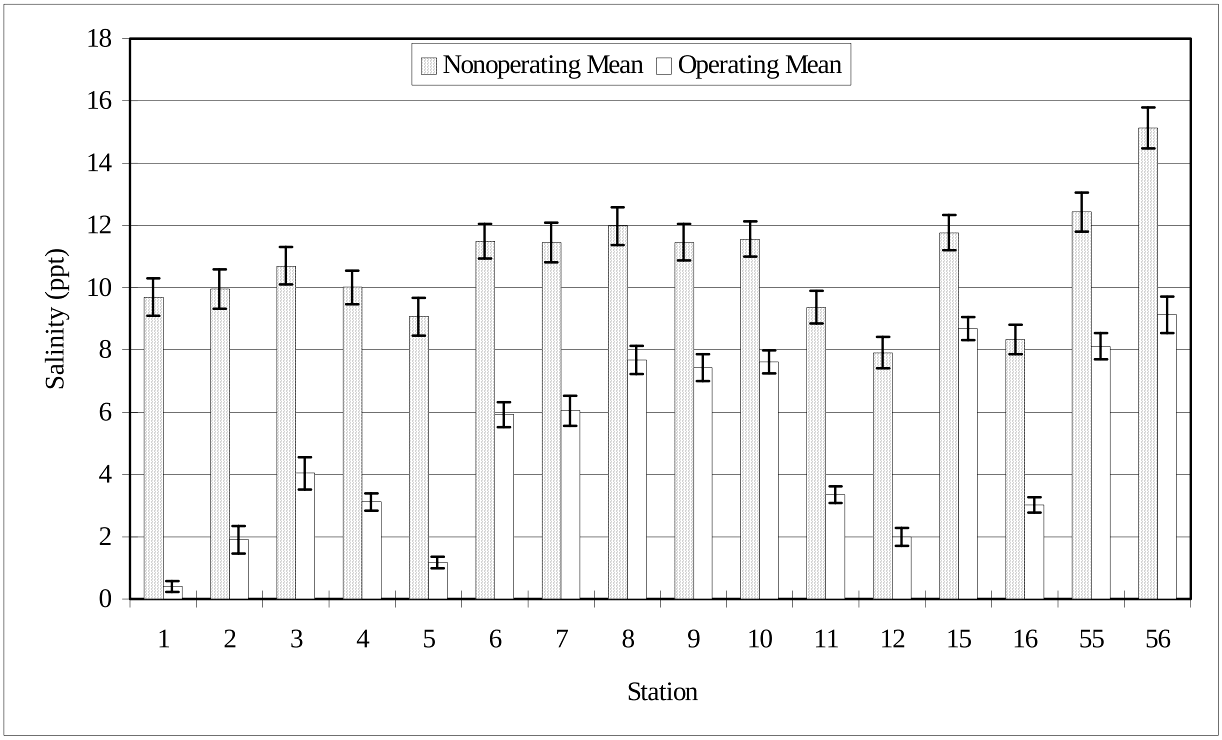

Figure 9. Comparison of nonoperating and operating mean biweekly salinity by station.

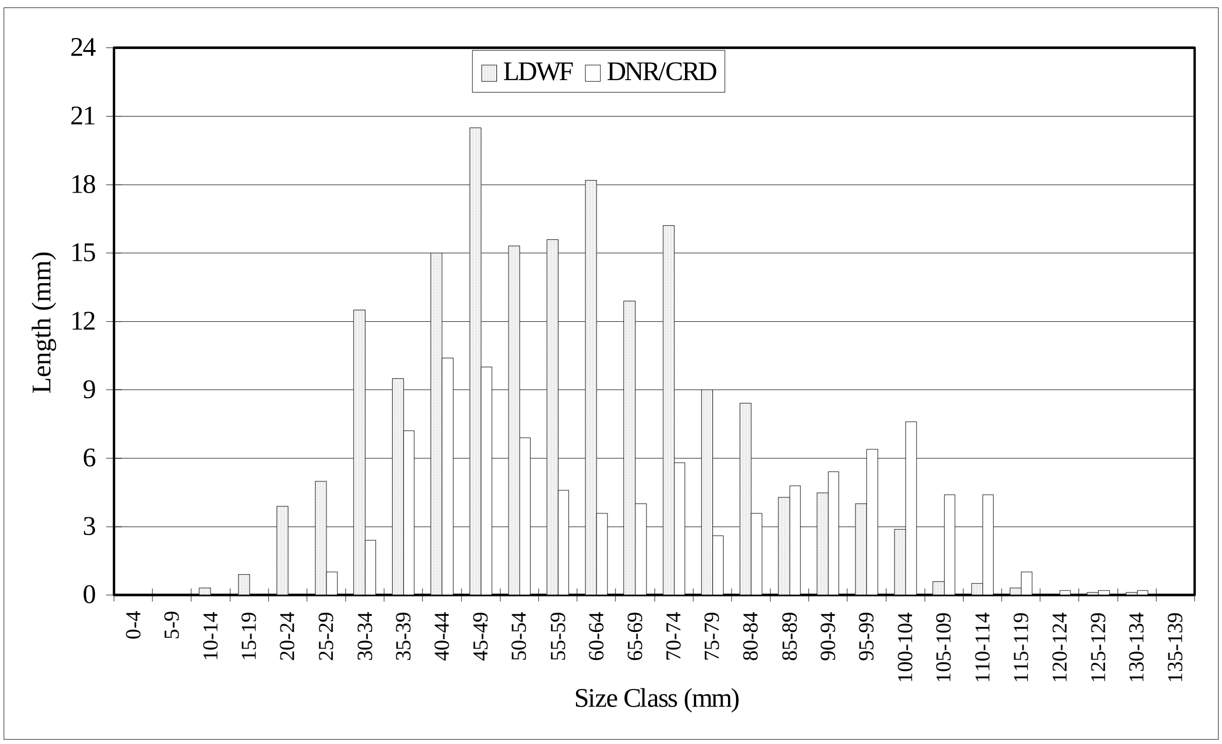

Figure 10. Comparison of brown shrimp size class distribution between data collected by LDWF and LDNR/CRD in 1994.

Table 1. Operations of the West Pointe a la Hache Freshwater Diversion siphon.

Date	Operation
12-Jan-93	West Point a la Hache opened for the first time - all 8 pipes
2-Mar-93	Down to 2 pipes
9-Apr-93	Closed because of oil spill
19-Apr-93	Up to 2 pipes
29-Apr-93	Up to 6 pipes
10-Aug-93	Down to 2 pipes
20-Sep-93	Up to 8 pipes
12-Apr-94	Down to 2 pipes
14-Jun-94	Up to 8 pipes
19-Jul-94	Found by PPG to be operating at 1 pipe
30-Aug-94	Up to 8 pipes
30-Sep-94	Found by PPG to be nonoperational because of low river stage
7-Jul-95	Up to 8 pipes
3-Aug-95	Closed because of hurricane threat
10-Aug-95	Up to 8 pipes
6-Sep-95	Found by PPG to be operating at 7 pipes
11-Sep-95	Found by PPG to be operating at 6 pipes, brought up to 8 pipes
25-Sep-95	Found by PPG to be operating at 7 pipes
1-Oct-95	Closed because of low river stage
9-Feb-96	Up to 7 pipes
15-Feb-96	Up to 8 pipes

Table 2. Operations scheme for the West Pointe a la Hache Freshwater Diversion siphon.

		Brown and Root Scheme		LDNR/CRD and PPG Scheme	
Month	Duration Period	Number of Pipes	Estimated Flow (cfs)*	Number of Pipes	Estimated Flow (cfs)*
January	Full Month	8	1795	8	1795
February	Full Month	8	1795	8	1795
March	Full Month	8	1795	2	448
April	3 weeks	2	500	2	500
	1 week	4	1000	full month	
May	3 weeks	2	500	8	2000
	1 week	4	1000	full month	
June	3 weeks	2	500	8	2000
	1 week	4	1000	full month	
July	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	
August	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	
September	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	
October	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	
November	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	
December	2 weeks	4	670	8	1340
	2 weeks	8	1340	full month	

* Flow may vary depending on head differential.

Table 3. West Pointe a la Hache Freshwater Diversion available hourly hydrologic data.

Date \ Station	1	2	4	5	6	7	10	11	12	13	55	56
1993												
Jan	X	X	X			X				X		
Feb												
Mar					X		X	X	X		X	
Apr				X		X	X	X			X	
May						X	o	X	X		X	
Jun						X		X	X		X	
Jul						X	X	X			X	
Aug						X	X	o			X	
Sep						X	X	X			X	
Oct						X	X	X			X	
Nov						X	X	X			X	
Dec						X	X	X			X	X
1994												
Jan						X	X	X			X	X
Feb						X	o	o			X	X
Mar						X	X	o			X	o
Apr						X	X	X			X	X
May						o	o	o			o	o
Jun							X	X			X	X
Jul						o	X	X			X	X
Aug						X	X	X			X	o
Sep						X	X	o			X	o
Oct						X	X	o			X	X
Nov						X	X	X			X	X
Dec						X	X	X			X	X
1995												
Jan						X	o	o			o	X
Feb						o	o	o			o	o
Mar						X	o	o				X
Apr						X	o	o			o	X
May						X	X	X			X	X
Jun						X	X	X			o	o
Jul						X	X	X				
Aug						X	o	o				
Sep						X	o	o			o	
Oct						o	o	o			X	o
Nov						X	X	X			X	X
Dec						X	X	X			X	X
1996												
Jan						X	X	X			X	o
Feb						X	X	X			X	o
Mar						X	X	X			X	X
Apr						o	o	o			o	o
May												

X=full month available, o=partial month available

Table 5. Salinity and CPUE for LDWF and LDNR/CRD brown shrimp sampling for 1994-95 comparative months.

STATION	1994						1995					
	April		May		June		April		May		June	
LDWF	Salinity	CPUE	Salinity	CPUE	Salinity	CPUE	Salinity	CPUE	Salinity	CPUE	Salinity	CPUE
Grand Bank	19.8	23	10.4	108	18.2	34	12.7	30	10.8	76	9.8	17
Bay Long	19.3	15	8.6	125			13.0	35	9.9	27	8.9	8
Lake Grande Ecaille	13.4	0	8.7	3			12.7	0	11.9	0	7.0	0
Bay Batiste	8.9	9	8.9	1	3.5	3	11.7	2	12.5	17	9.4	1
Wilkinson Bay	3.8	6	6.2	58	2.6	6	8.6	6	8.4	21	2.5	2
Mud Lake	4.5	33	3.9	27	0.5	6	6.5	0	6.0	6	1.0	6
Bay l'Ours	11.3	8	11.3	88	8	9	9.2	19	13.1	23	9.0	10
Bay Jacque	16.2	62	14.2	101	13.2	4	11.9	53	14.6	9	12.7	0
Airplane Lake	20.2	307	15.5	100			15.7	117	17.7	25	15.4	13
Porpoise Bay	20.4	223	14.9	383	11.9	21	14.5	21	17.1	22	12.7	2
MEAN	**13.8**	**68.6**	**10.3**	**99.4**	**8.3**	**11.9**	**11.7**	**28.3**	**12.2**	**22.6**	**8.8**	**5.9**
DNR												
7	2	30	3.5	148	5	6	12.2	45	12.8	21	13.6	14
8	5	44	6	39	5	3	13.0	44	16.3	47	13.4	0
11	2.5	0										
15	5	35	3.3	43	7	5	11.4	28	13.6	27	13.1	8
16			3.3	84	3	5	6.9	10	10.4	8	8.3	9
56			8	14	7	0	12.6	6	16.5	14	13.1	0
MEAN	**3.6**	**27.3**	**4.8**	**65.6**	**5.4**	**3.8**	**11.2**	**26.6**	**13.9**	**23.4**	**12.3**	**6.2**