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LOUISIANA OYSTER

2020 Stock Assessment Report of the Public Oyster Seed Grounds and Reservations of Louisiana

Oyster Data Report Series No. 26

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Introduction

Louisiana's vast coastal wetlands provide ample habitat where Eastern oysters (Crassostrea virginica) thrive under a variety of environmental conditions. Louisiana's Eastern oyster stock is one of the largest oyster stocks in the nation, supporting one of the state's largest and most valuable fisheries, and providing important ecological services to the state. The Louisiana Department of Wildlife and Fisheries (LDWF) is charged with managing the state's oyster resource by closely monitoring the size and health of oyster populations on nearly 1.7 million acres of public oyster areas (*Figure 1*) as well as setting oyster seasons, monitoring harvest levels, and enhancing habitat (e.g., cultch planting, reef building, etc.).

The oyster industry has historically used Louisiana's public oyster areas as a source of seed oysters (less than 3 inches in length) to transplant to private oyster leases and grow out to market size. In Louisiana, there are approximately 404,000 acres of private oyster leases that are managed by leaseholders. The public oyster areas also yield a supply of market-size oysters (greater than or equal to 3 inches length), which may be taken directly to market. Louisiana leads the nation in oyster production largely due to this public/private oyster production system. Annual dockside sales have reached as much as $85 million in recent years.

Louisiana's public oyster areas are defined by one of two ways. The Louisiana Wildlife and Fisheries Commission (Commission) designates Public Oyster Seed Grounds (POSG) which include Lake Borgne, Chandeleur/Breton Sound (primary Public Oyster Seed Grounds), Barataria Bay, Little Lake, Deep Lake, Lake Chien, Lake Felicity, Lake Tambour, Lake Mechant, and Vermilion/Cote Blanche/Atchafalaya Bays. The Louisiana Legislature designates Public Oyster Seed Reservations (POSR) which include Bay Gardene, Hackberry Bay, Sister (Caillou) Lake, and Bay Junop. Other public oyster areas designated by Louisiana Legislature include Calcasieu and Sabine Lakes.

LDWF manages public oyster areas to balance the economic opportunity of the fishery with the biological sustainability of the resource. Management depends on obtaining the best fishery dependent and independent data available through monitoring harvest and resource availability throughout the oyster season and performing yearly stock assessments. The annual individual Coastal Study Area (CSA) oyster stock assessment reports help fulfill these data needs as they provide estimates of the current stock size of the oyster resource within each CSA. The information these data provide allow resource managers to implement management changes to both effectively use the current resource and protect its long-term viability.

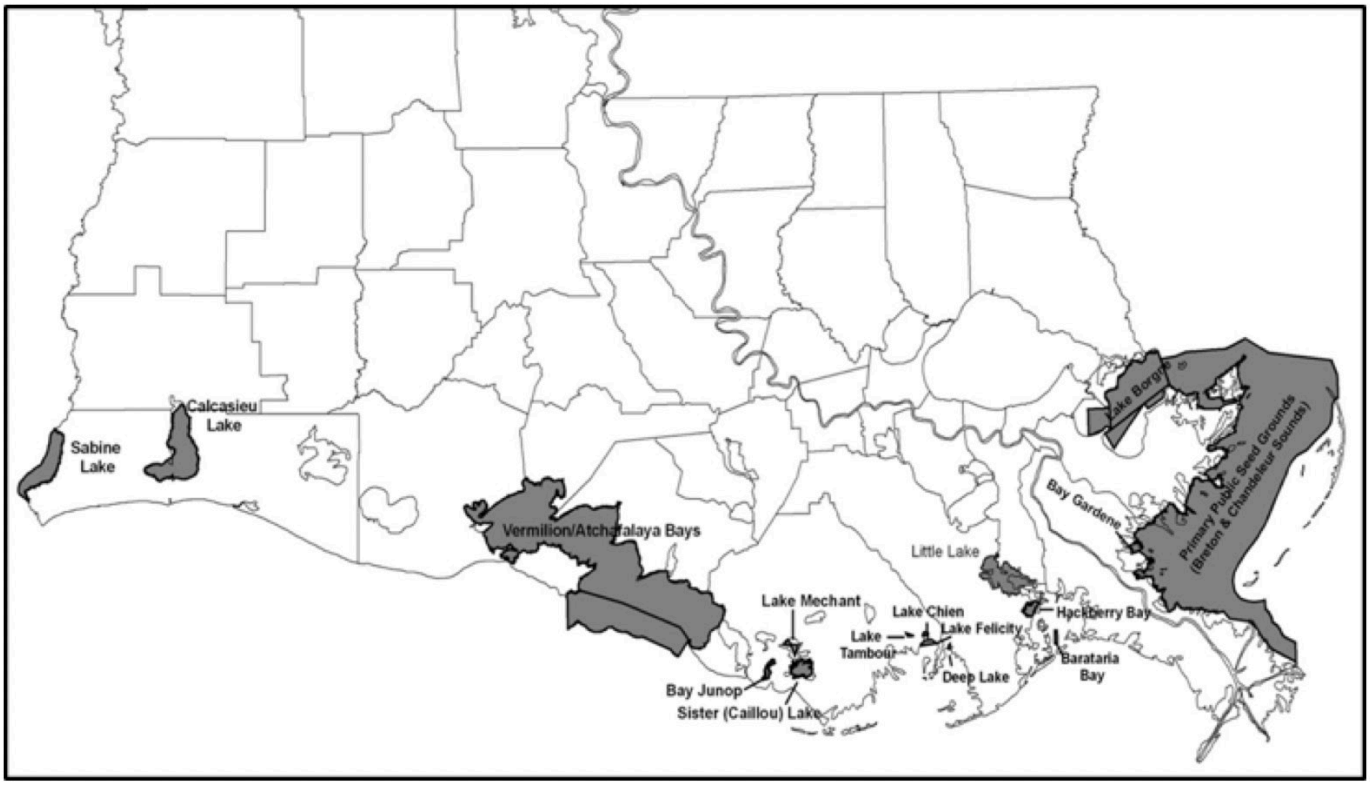

FIGURE 1. Public oyster areas of Louisiana.

Oysters also play an important ecological role in the estuarine ecosystem. Oyster reefs provide the majority of hard substrate required by other sessile invertebrate species such as barnacles, bryozoans, tunicates, and anemones. Many species of invertebrates and fish also use oyster reefs as shelter and forage habitat. The oyster's filter-feeding activities enhance estuarine water quality, and reefs can also help stabilize shorelines.

Louisiana Oyster Landings

Oysters have been part of the Louisiana economy since the 1800s. Louisiana regularly leads the nation in the production of oysters and historically accounts for approximately 50% of the nation's oyster landings. Among Gulf of Mexico states, Louisiana consistently ranks first in landings (pounds of meat) (*Figure 2*). Additionally, Louisiana averages 36% of the annual landings (market value) of all oysters nationally from 2000-2019 (*Figure 3*). *Figures 2 and 3* also show that the value of landed oysters follows differing regional trends. For the same time period (2000-2019), Louisiana harvested 11 million pounds on average every year with a recent high of 13.9 million pounds in 2015. In 2019, however, was a noted exception to the landings trend, landing only 6.9 million pounds. Public oyster reef landings totaled approximately 149 thousand pounds and had a dockside value of approximately $1.1 million. Private oyster reef landings totaled approximately 7.7 million pounds (*Figure 4*) and had a dockside value of approximately $54 million (Source: LDWF Trip Ticket data).

Historically, public oyster areas were considered the backbone of the Louisiana oyster resource. In the past, these areas were a valuable contributor to overall Louisiana oyster landings each year. The trend from 1970-1992 showed the majority of Louisiana oyster landings came from private reefs. From 1992 to 2001, the public ground stock size generally increased, and landings from the public grounds increased as well. In 2009, harvest levels significantly decreased on the public grounds from 2008 levels, with the public grounds producing only 22% of all oyster landings for the calendar year. The available resource on the public grounds has not recovered since 2009, and harvest data showed that only 2.0% of all oysters landed in Louisiana came from public grounds in 2019 (*Figure 4*).

Stock Assessment Methods

Management of the public oyster grounds and reservations relies heavily upon data gathered through a comprehensive biological monitoring program. State biologists use two gear types when

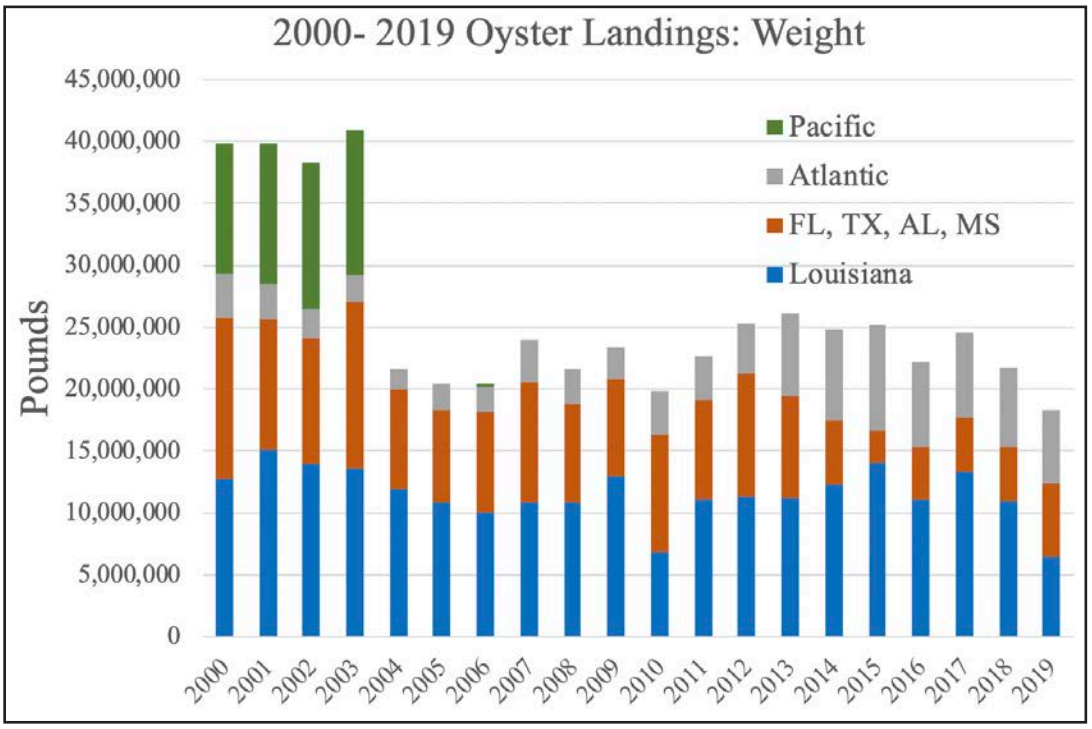

FIGURE 2. Annual commercial oyster landings (all species) in pounds of meat. Data provided by NOAA Fisheries. Pacific oyster landings data is not included in some years due to confidentiality.

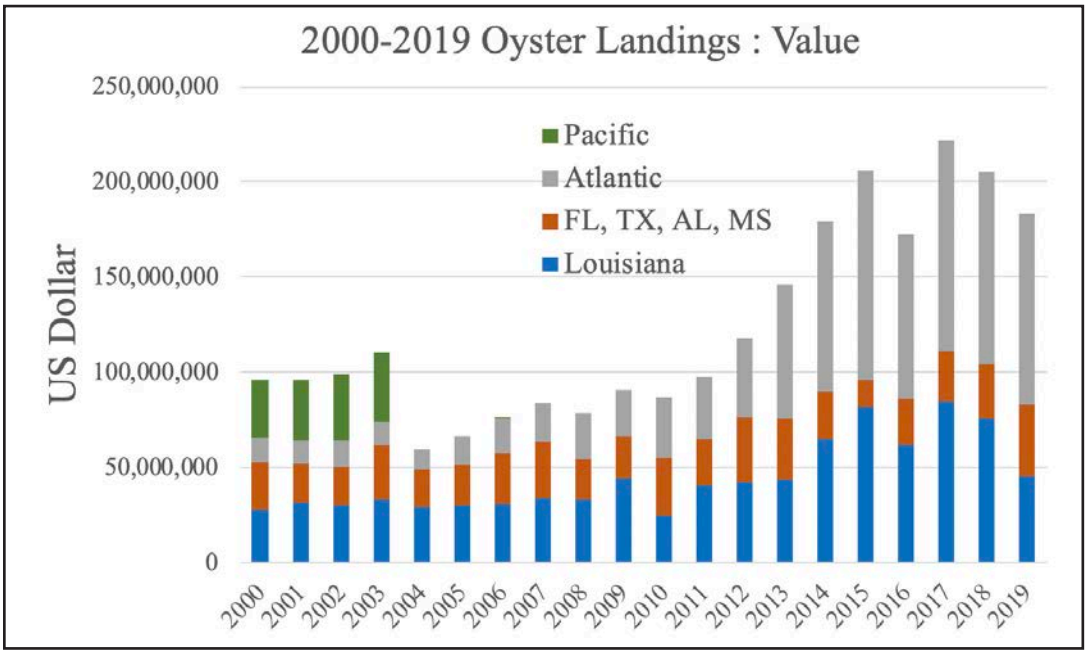

FIGURE 3. Annual commercial oyster landings (all species) in dockside value. Data provided by NOAA Fisheries. Pacific oyster landings data is not included in some years due to confidentiality.

sampling the public reef areas. One is a 24-inch hand dredge and the other is a square-meter (m^2) frame. Data is analyzed to determine overall health of the oyster resource throughout the year. Approximately 1,800 dredge samples are collected statewide during each calendar year and data are used to monitor the overall health of the oyster stock and to assess recruitment of new age classes of oysters. Over 1,000 m^2 samples are collected per calendar year. That includes samples collected as part of the Coastal Protection and Restoration Authority (CPRA) System-Wide Assessment and Monitoring Program (SWAMP). Collected m^2 data set is used to measure the annual oyster stock size, which is the basis on which yearly oyster season recommendations are made to the Commission. Additionally, field biologists routinely gather hydrological data on public oyster areas and develop harvest and fishing effort estimates by conducting boarding report surveys of oyster boats during open oyster seasons.

Sampling for annual stock assessments occurs in July. LDWF biologists SCUBA dive on designated m^2 sampling stations within each CSA (*Figure 5*). At each sampling station, an aluminum square-meter frame (quadrat) is randomly placed on the oyster reef, and

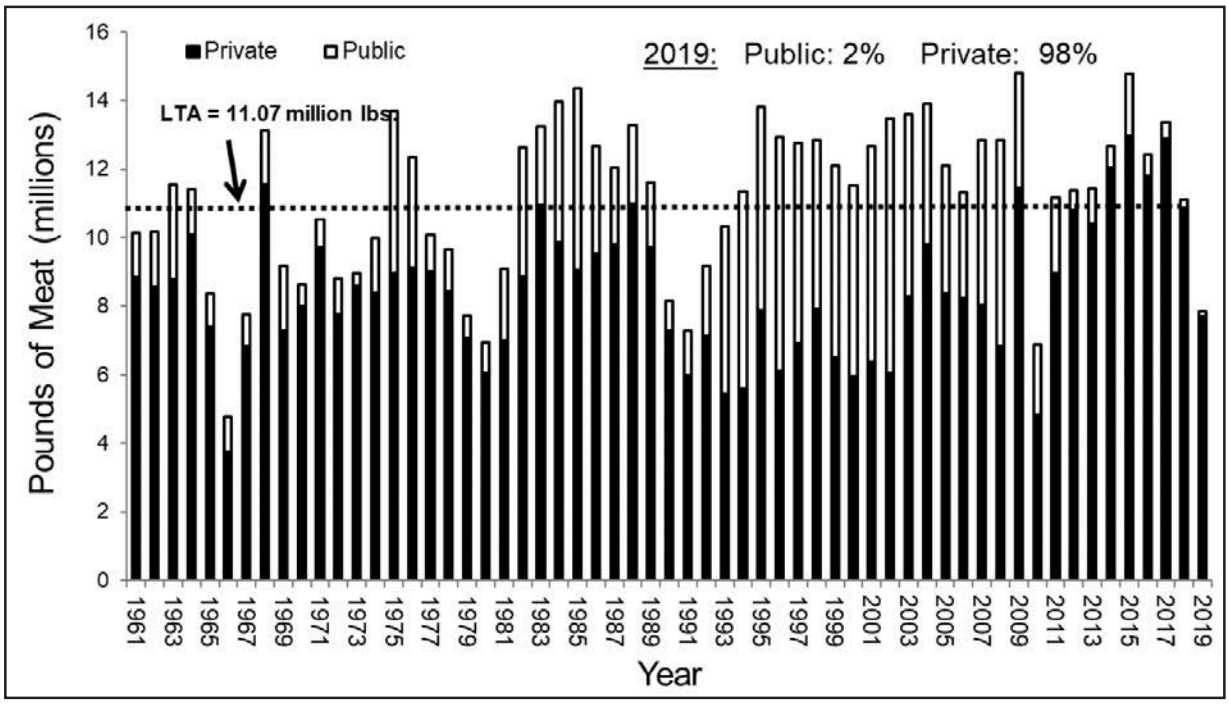

FIGURE 4. Louisiana oyster landings for public oyster areas and private oyster leases, 1961-2019 (LDWF and NOAA Fisheries data).

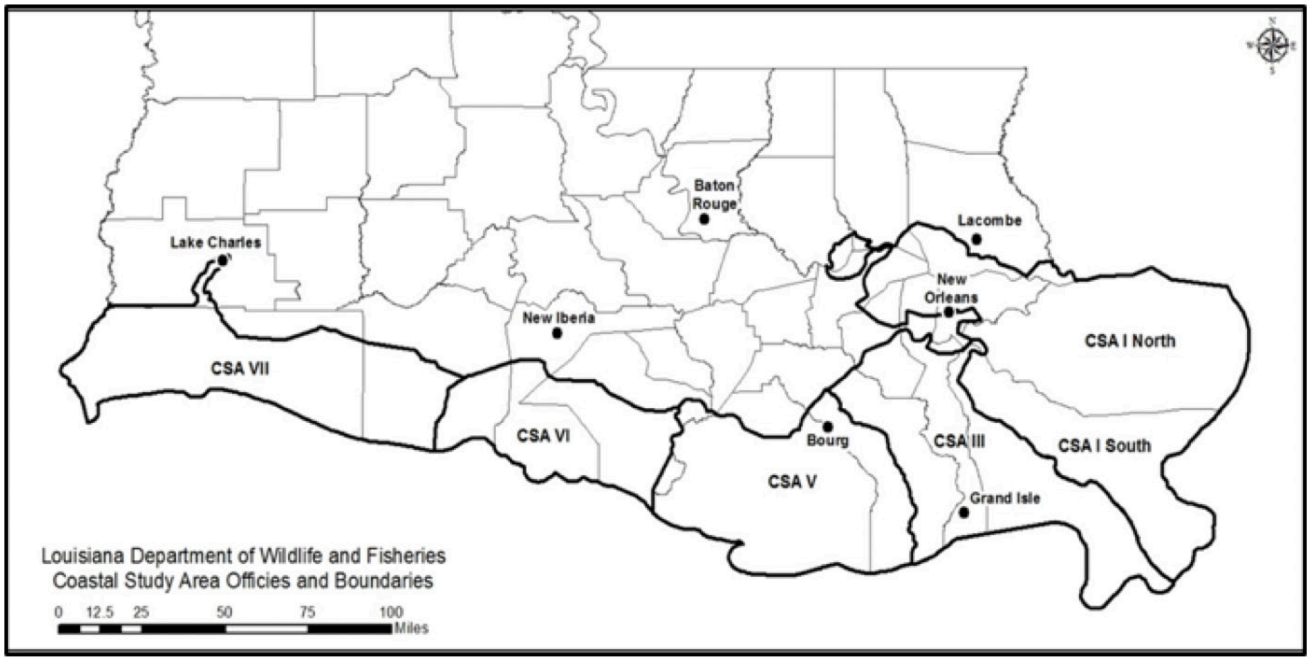

FIGURE 5. LDWF CSAs.

all live and dead oysters, reef-associated organisms, and exposed reef material are collected by hand from the upper portion of the substrate within the quadrat. This process is replicated four times for a total of five samples taken per sampling station. Water temperature, dissolved oxygen, and salinity data are collected at each station and cultch material types are identified and weighed.

LDWF biologists visited 105 sampling stations during the 2020 oyster stock assessment, gathering 525 individual samples. The assessment presents sampling data by CSA. During 2020 assessment sampling, CSA 1 South had the most sampling stations (26) while CSA 5 East had the fewest (3). There is a higher density of sampling in the Black Bay (CSA 1 South) and Sister Lake (CSA 5 West) areas due to their high level of oyster production in past years and historical importance to the oyster industry. Twenty-one of the 105 sampling stations were located on cultch plants constructed since 2004 by LDWF.

Sampling conducted as part of the annual oyster stock assessment plays a valuable role in predicting the success of the upcoming oyster season, which generally opens in early September and runs through April of the following year. However, the season may be closed or delayed if biological concerns or enforcement problems are encountered. LDWF uses oyster stock assessment information to make recommendations regarding setting the oyster season to the Louisiana Wildlife and Fisheries Commission (Commission).

In addition, Sustainable Oyster Shellstock Models, also called Shell Budget Models, are being improved and utilized to provide harvest thresholds for the public oyster areas of Louisiana. These models will help maintain reef material over the course of time and were created in partnership with Dr. Thomas Soniat at The University of New Orleans (UNO). This computerized model provides guidance for fisheries management with the goal of conserving the oyster reef base. Oyster stock assessment sampling provided model input data such as estimates of reef mass (grams per m^2) and size-frequency of oysters. Utilizing additional data on oyster growth, mortality, salinity and estimated commercial harvest rates, the model estimates the amount of oyster harvest that can be allowed on each individual reef while preserving sufficient reef mass to keep the reef viable. The models simulate based on three different conditions - low, medium, and high salinity patterns for each basin. The model was tested statewide and showed promising results. At this time, Sustainable Oyster Shellstock Models are applied to reefs in CSA 1N, 1S, 3, 4, and 5. CSA 6 has no known reef acreage to apply to model outputs and CSA 7 is managed as a separate entity from the remainder of the state. That is due to the Sabine Basin being closed to oyster harvest by Act 159 (2018 Regular Legislative Session) and the only allowable method of harvest in the Calcasieu basin is tonging.

Annual Stock Size

The 2020 estimated oyster stock on Louisiana's public oyster areas is approximately 362,783 barrels (bbls, 2 sacks = bbl) of oysters (*Table 1*), an approximate increase of 44% from the 2019 stock, but an 83% decrease from the long-term average (2000 through 2019) (*Figure 6*). Similar to 2018, most of the live oyster stock is located in Calcasieu Lake (CSA 7), which holds 69% of 2020 estimated availability (*Figure 7*). An additional 178,951 bbls of oysters are located in Sabine Lake, that stock is not reflected in overall statewide availability due to the harvest ban. Statewide, seed oysters increased by 12%, while market-size oysters decreased by 24% compared to 2019. Only Calcasieu Lake showed increases in both seed and market-size oyster stocks. Sister Lake (CSA 5) showed a 53% increase in seed oysters but overall availability in the area is on a decline. The estimated oyster stock in CSA 1 North and CSA 1 South, which encompasses water bottoms east of the Mississippi River, decreased 86% from 2019 and is at an all-time low of 11,214 bbls. The 2019 extreme flood event clearly reflected in the 2020 oyster stock availability.

Harvest Monitoring Methods

During the oyster season, LDWF monitors commercial harvest through boarding surveys of vessels working the Public Oyster Seed Grounds. Biologists record vessel location and past and current catch rates as well as an estimate of future fishing effort. The boarding data is summarized weekly to maintain a cumulative estimate of harvest for specific reef complexes. The data is projected over the amount of fishable days (winds less than 25 mph) to determine a total harvest estimate of seed and market-size oysters for the week. Biologists routinely board vessels collecting seed oysters to determine if they are removing excessive amounts of cultch (non-living reef material).

LDWF also obtains harvest data via its trip ticket system. However, trip ticket data provide limited resolution as they are consolidated by geographic region and are considered preliminary until well after the season concludes.

LDWF collects fishery independent data via monthly oyster dredging year round to assess the health and condition of the resource. Data from those samples further inform management of the impact harvest activity is having on the public grounds.

2019/2020 Oyster Season

The goal for the 2019-2020 oyster season was to allow for recovery of 2019 Flood Event, to protect open areas from fleet concentrations, and to close areas as recommended by the shell budget model thresholds; all of which should help minimize reef degradation. The 2019-2020 Oyster Season opened Nov. 1, 2019 and closed April 30, 2020 (*Table 2*).

A provision was incorporated since 2018 into the seasonal rule passed by the Commission to limit the amount of non-living material removed from seed grounds to be no more than 15%. Similar to the prior season, the harvest of seed oysters was allowed for just one day for the 2019-2020 season. In collaboration with Enforcement, LDWF biologists documented forty-five bedding vessels on opening day. Two citations were issued by Enforcement.

Data derived from fishery dependent surveys of harvesting vessels, estimated commercial harvest to be 1,250 bbls of seed oysters and 9,580 bbls (19,160 sacks) of market oysters for an overall total of 10,830 bbls oysters (*Table 2*). This is a 46% decrease from the 2018/2019 oyster season (19,913 bbls). There were decreases in both seed and market-size oyster harvest. The decrease in harvest

TABLE 1. Estimated oyster stock (in bbls) on Louisiana's public oyster areas by basin. Percentages are change from previous year; n/a represents no change from previous year. Green indicates increase, red indicates decrease.

Area	Seed	Seed % Change	Market-Size	Market-Size % Change	Total	Total % Change
Lake Borgne/MS Sound	4,426	-59%	2,248	400%	6,674	41%
East of MS River, South of MRGO	3,726	n/a	0	0	3,726	n/a
Hackberry Bay	4,479	44%	1,437	327%	5,916	72%
Lake Chien/Felicity	0	n/a	0	n/a	0	n/a
Sister Lake/Bay Junop	51,291	-7%	5,629	-27%	56,920	-10%
Calcasieu - East Side	6,417	-58%	23,052	99%	29,469	10%
Calcasieu - West Cove	50,348	-19%	209,730	152%	260,078	79%
Statewide Totals	*120,687*	*-18%*	*242,096*	*134%*	*362,783*	*44%*

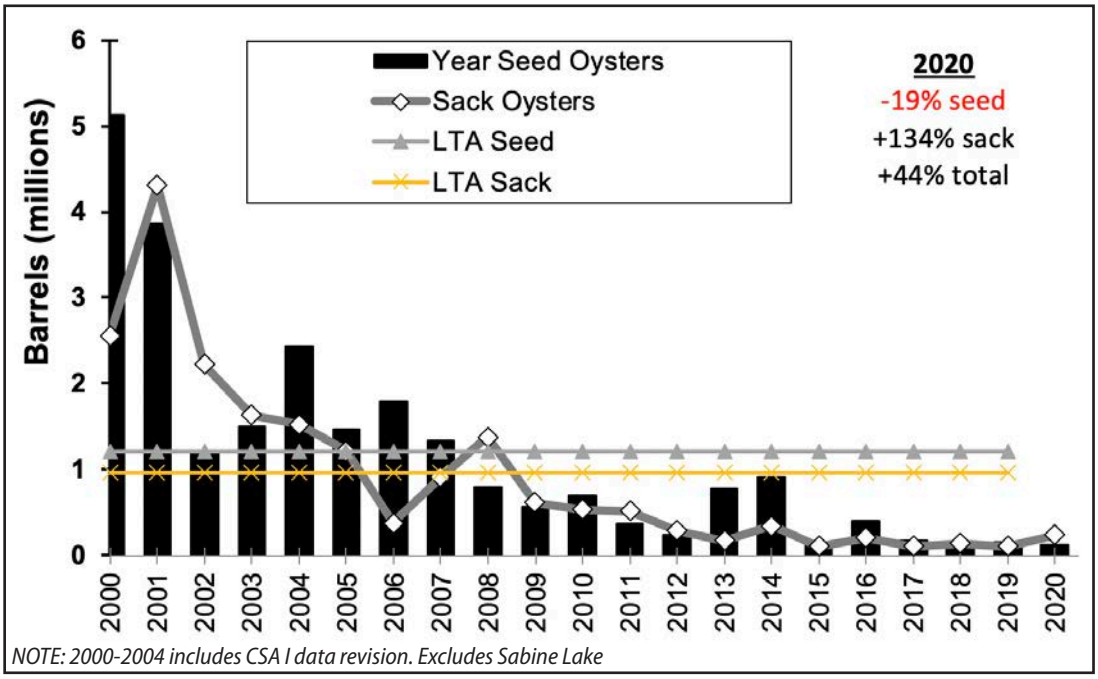

FIGURE 6. Seed and market-size oyster stock availability on Louisiana's public oyster areas. LTA denotes the long-term average from 2000 through 2020. Percentages indicate change from 2019.

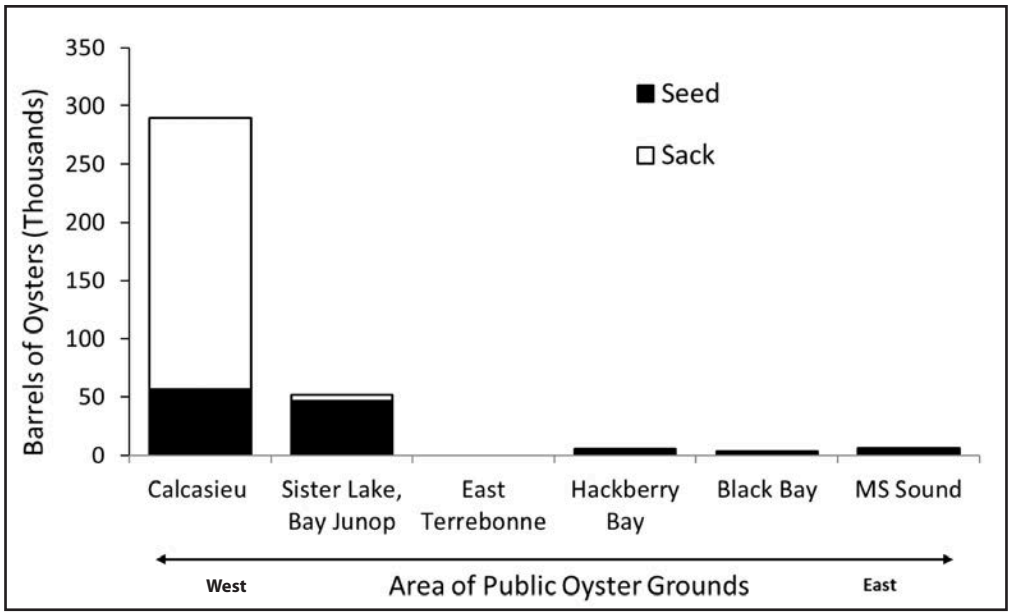

FIGURE 7. 2020 oyster stock distribution by basin.

reflects declining oyster availability in recent years compounded by the flooding of 2018-2019, which reduced and stressed the resource. Over the past 10 years, extreme freshwater, heavy localized harvest, high mortality events, strong tropical events, environmental changes, and lack of recruitment have contributed to an ongoing downturn in the oyster stock in the public grounds. Scarce oyster availability resulted in lowest harvest on record.

Special Oyster Management Projects

LDWF biologists continue to participate in several important projects aimed at increasing oyster production on the POSG. Cultch planting is a reef rehabilitation method employed by LDWF since 1917. Two cultch plant projects have been completed in recent years. A 100-acre limestone cultch plant in Calcasieu Lake was completed in the fall of 2017. In Lake Fortuna, LDWF worked with the St. Bernard Parish Government to place additional cultch material onto 100 acres of the existing 2012 Lake Fortuna cultch plant. This process was performed in order to increase reef height, minimizing the chances of sedimentation and hypoxia-induced mortality. In April 2018, an additional 16,000 cubic yards of dry oyster shell was deposited. Funding for this project came from NRDA early restoration oyster funds. An additional six acres within the 100-acre 2018 Lake Fortuna Cultch plant was supplemented with spat on shell (SOS) sourced from a private hatchery. This restoration strategy was chosen due to the lack of natural spat setting in the area over the last 10 years, even though suitable hydrology for oyster growth and reproduction was prevalent. Early

TABLE 2. Harvest estimates for the 2019/2020 public oyster areas oyster season. Data derived from fishery dependent surveys of harvesting vessels.

2019-2020 LDWF OYSTER SEASON SUMMARY						
Area	**Season Opening**	**Season Closure**	**Season/Type**	**Days Open**	**Harvest**	**CSA**
PSOG East of Mississippi River and North of MRGO	CLOSED					**1**
POSG East of Mississippi River and South of MRGO	CLOSED					
Hackberry Little Lake, Barataria Bay	CLOSED					**3**
Deep Lake, Lake Chien, Lake Felicity and Lake Tambour	CLOSED					**5**
Lake Mechant and Bay Junop	CLOSED					
Sister Lake	Nov. 18	Nov. 18	*1-day Seed Harvest*	1	1,250 bbls	
	Nov. 19	Nov. 25	Market Oyster Harvest	7	10,314 sacks	
Vermilion Bay	CLOSED					**6**
Calcasieu Lake	Nov. 1	Jan. 20	*East Cove:* Market Oyster Harvest	80	3,861 sacks	**7**
	Nov. 1	April 30	*West Cove:* Market Oyster Harvest	210	4,985 sacks	

sampling showed promise; however, the freshwater input from the 2019 flood event, including the opening of the Bonnet Carré Spillway, caused 100% oyster mortality in the Lake Fortuna area.

Since the 2010 Deepwater Horizon oil spill, Louisiana's POSG have experienced significantly lower levels of successful oyster reproduction (oyster spat set). Spat set is a key indicator of the overall oyster population's stability because it illustrates the recruitment of young oysters into the population. In response, LDWF developed the Remote Setting Program to increase oyster production levels.

The Michael C. Voisin Oyster Hatchery, located in Grand Isle, Louisiana, is operated through a collaborative effort between LDWF and Louisiana Sea Grant (LSG). LSG assists with facility operations and provides recommendations to LDWF for hatchery operations. The hatchery produces diploid and triploid oyster larvae and seed for restoration projects and to incentivize the alternative oyster culture (AOC) industry. The hatchery also produces algae to feed oyster larvae, has a breeding program, and conducts research projects. The hatchery produced approximately 229 million oysters in 2018, and LDWF began managing larval and seed sales in January 2018 with the majority of orders received being for triploid larvae to be used by the AOC industry. In 2019, in collaboration with the Michael C. Voisin Oyster Hatchery, LDWF developed a spat on shell protocol to investigate and monitor survival and growth with hatchery-raised animals by following protocols developed in a 2014 remote setting pilot project. Diploid oyster larvae were produced and set on recycled oyster shells in a concerted effort to deploy to the public seed grounds across the state.

The Oyster Remote Setting Facility in Buras has been operational since November 2017. A trial run proved successful and the spat on shell were transported to and deployed in Lake Machias in late 2017. However, SOS operations at Buras have been discontinued due to water conditions on site, and its remote location. LDWF continues smaller spat on shell trial runs at the Michael C. Voisin Oyster Hatchery in Grand Isle which are more manageable, less remote, and able to be completed with staff on hand. LDWF continued transporting recycled oyster shells from Buras to the Michael C. Voisin Oyster Hatchery in Grand Isle to continue smaller spat on shell trial runs that are more manageable, less remote, and able to be completed with staff. The recycled oyster shell used for SOS trials had been acquired through a partnership between LDWF and Coalition to Restore Coastal Louisiana (CRCL). Oyster shell is the material of choice for setting larval oysters. This program began in 2013-2014, when CRCL began delivering shell to the Buras site for curating purposes.

Recent Legislation

Senate Resolution (SR) 56 was passed during the 2020 regular session. SR 56 urges and requests CPRA and LDWF to cooperate in developing projects and programs to rehabilitate the oyster resource, promote the viability of the oyster industry in Louisiana, assist the oyster industry with responding to a changing coast, and address competing uses for coastal water bottoms, including integrated coastal protection.

Conclusion and Acknowledgments

The following report includes both the biological stock assessment and historical oyster landings data from each CSA in Louisiana, as well as a brief summary of the most recent oyster season in each area. Biological data were generated from quantitative square-meter sampling, while landings data were generated from boarding surveys and trip ticket information. This report was prepared by Carolina Bourque, Denise Kinsey, Carl Britt, Willie Cheramie, William Hano, Jeff Marx, and George Melancon. Biologists from each CSA spent extensive time gathering samples and producing the report. Additionally, Bryan Alleman, Becky Redmond-Chapman, Ty Lindsey, Chris Schieble, and Christian Winslow assisted with editorial review and preparation of this document. Efforts of both the field and office staff are greatly appreciated, as this report could not be produced without their hard work and dedication. Please direct questions and/or comments to Carolina Bourque, Oyster Program Manager, at 337-735-8726 or cbourque@wlf.la.gov.

CSA 1 NORTH

Introduction

The Public Oyster Seed Grounds in CSA 1 North (North Pontchartrain Basin) consist of approximately 690,000 acres of water bottom located within Lake Borgne, the Louisiana portion of Mississippi Sound, Chandeleur Sound, the Biloxi Marsh, and adjacent waters. Louisiana, Mississippi, and Texas fishermen harvest oysters from this area, which has historically been an area of high oyster production within the state of Louisiana. Although Louisiana has managed this area as Public Oyster Seed Grounds for many decades, the Commission did not designate the majority of this area by rule until 1988. The Commission designated much of Lake Borgne as public oyster seed ground in 1995 and expanded the grounds in 2004. LDWF expands and enhances the public oyster reefs through the placement of cultch material (e.g., shell, limestone, crushed concrete) on suitable water bottoms. Most recently, LDWF completed cultch plants in Mississippi Sound (Round Island) in 2011 and Three Mile Pass and Drum Bay in 2013 as part of the *Deepwater Horizon* oil spill Natural Resource Damage Assessment (NRDA) Early Restoration Program.

In early 2020, LDWF collaborated with Non-Government Organizations (NGOs) to complete construction of four artificial reefs in CSA 1 North. Limestone, oyster shell, and reef balls were deployed at sites near Cabbage Reef, Grand Banks, eastern Lake Borgne and West Karako Bay, with the intention of creating habitat for oyster brood stock. These reefs are protected from oyster harvest and data from them are not presented in this report.

Methods

LDWF biologists collected field samples for this oyster stock assessment between July 1 and 9, 2020, from a total of 19 stations within CSA 1 North according to the methodology described in the Statewide Overview of this report. Sampling stations included 16 historical stations, as well as the 2011 cultch plant in Mississippi Sound (Round Island) and the two 2013 NRDA Early Restoration cultch plants in Three Mile Pass and Drum Bay (*Figure 1.1*).

Before the 2013 CSA 1 North oyster stock assessment, LDWF estimated acres of reef based upon water bottom surveys completed in the mid-1970s. To better locate and assess the oyster stock in the Public Oyster Seed Grounds, LDWF has conducted a number of side-scan sonar studies of water bottoms in these areas in recent years. These studies, coupled with historical reef and cultch plant information, resulted in a more up-to-date and realistic designation of productive water bottoms for use in the annual oyster stock assessment (*Figure 1.1; Table 1.1*). The 2020 CSA 1 North oyster stock assessment is based on the updated reef assessment of 22,427 acres of water bottom, which includes 649 acres of recent cultch plants. As those cultch plants are distinctly different from the surrounding existing reef in terms of oyster productivity, LDWF assesses cultch plant acreages separately from the surrounding reef complex.

Only productive Public Oyster Seed Grounds, for which an accurate acreage can be determined, are included in the oyster stock assessment. For this reason, some areas, such as Public Oyster Seed Grounds located within Lake Borgne, are not included in this oyster stock assessment due to a lack of reef acreage information.

Results and Discussion

Seed and Market-Size Stock

The 2020 estimated oyster stock size for CSA 1 North is 4,426.4 bbls of seed oysters and 2,248.3 bbls of market-sized oysters, for a total of 6,674.6 bbls of overall stock (*Table 1.1*). Compared to 2019, there was a 58.8% decrease in the seed estimate. Last year's extremely low market-sized estimate increased 400% in 2020. This year's assessed seed stock is down 97.7% from the previous 10 years' average, while assessed market-sized stock is down 97.0% from the previous 10 years' average (*Figure 1.2*). Total assessed oyster stock for 2020 is down 40.5% from 2019 and is 97.5% below the previous 10 years' average. The Drum Bay cultch plant accounted for all assessed market-sized oyster stock in CSA 1 North during this year's assessment, with an average density of 1.0 market-sized oyster per square meter. Three Mile Pass cultch plant held 80.3% of the seed oyster estimate, with an average density of 4.0 seed oysters per square meter. The remainder of the assessed seed stock was found on the Shell Point and Drum Bay cultch plants.

It is important to note variability both within and among stations when comparing estimates. This variability is magnified when extrapolating small sample sizes to large areas. In short, changes between annual assessments can be dramatic on an individual reef basis, and oftentimes only limited areas of significant resource availability are identified.

Since the mid-2000's, CSA 1 North has experienced heavy localized harvest, high mortality events, strong tropical events, the *Deepwater Horizon* oil spill and related spill response activities, and devastating spring flood events prompting the opening of the Bonnet Carré Spillway. These continual limits to recruitment and survival have severely reduced oyster resources across the Pontchartrain Basin. As a result, both the estimated seed- and market-sized oyster stocks continue to fall well below the previous 10 years' average and the long-term average (2005-2019; *Figure 1.2*).

Spat Production

Live spat were observed at seven of the 19 sites sampled during this assessment. At these sites, average densities ranged from 0.2 to 22.2 individuals per square-meter, with the maximum value occurring at Shell Point. The occurrence of spat oysters greatly increased from the previous year's assessment. This halts a persistent trend over several years of a lack of spat set on most CSA 1 North reef areas during spring spawning events. These periods of poor recruitment can be attributed to several different factors, such as freshets, hypoxia, overburden or dissolution of cultch, or

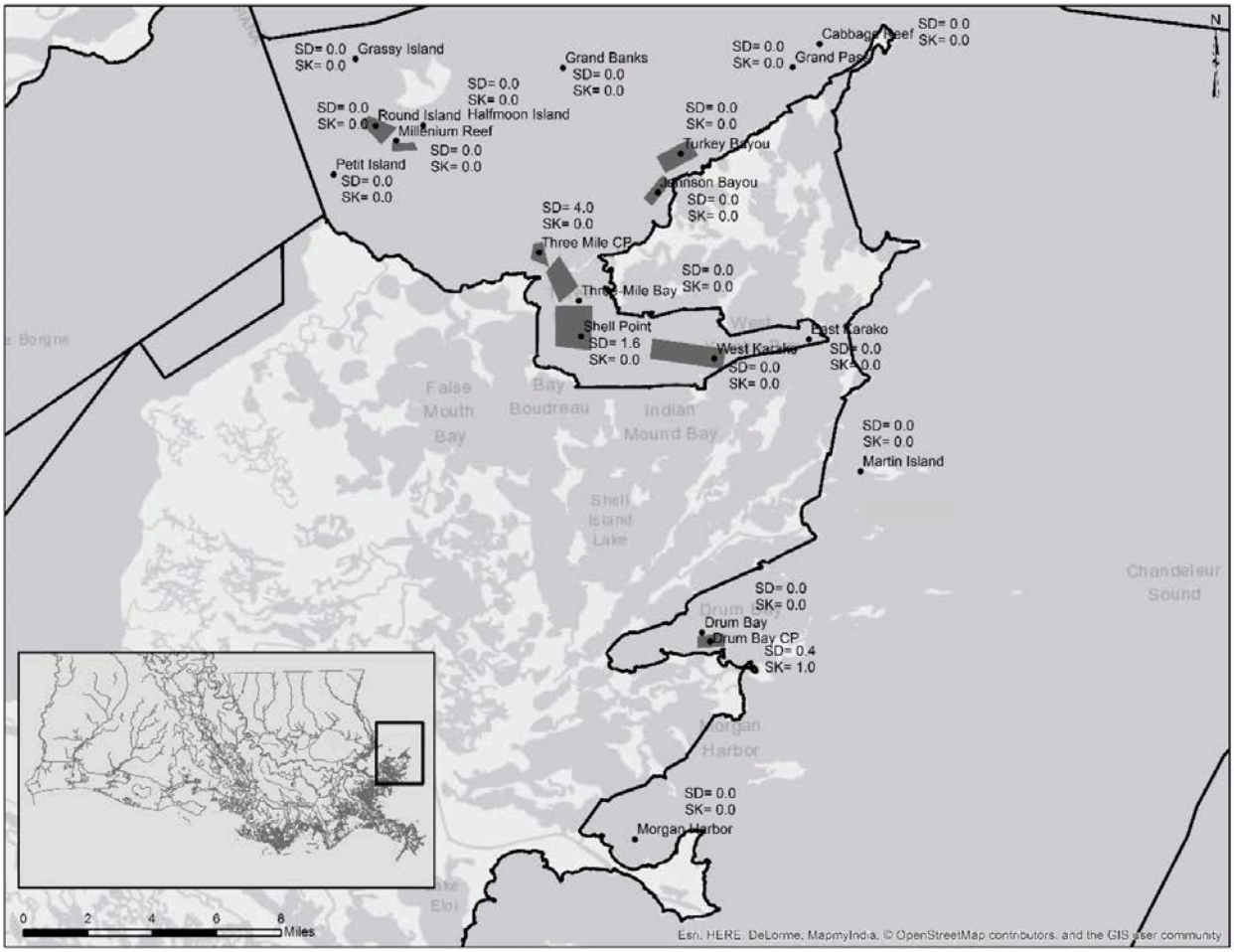

FIGURE 1.1. 2020 CSA 1 North oyster stock assessment sampling stations. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

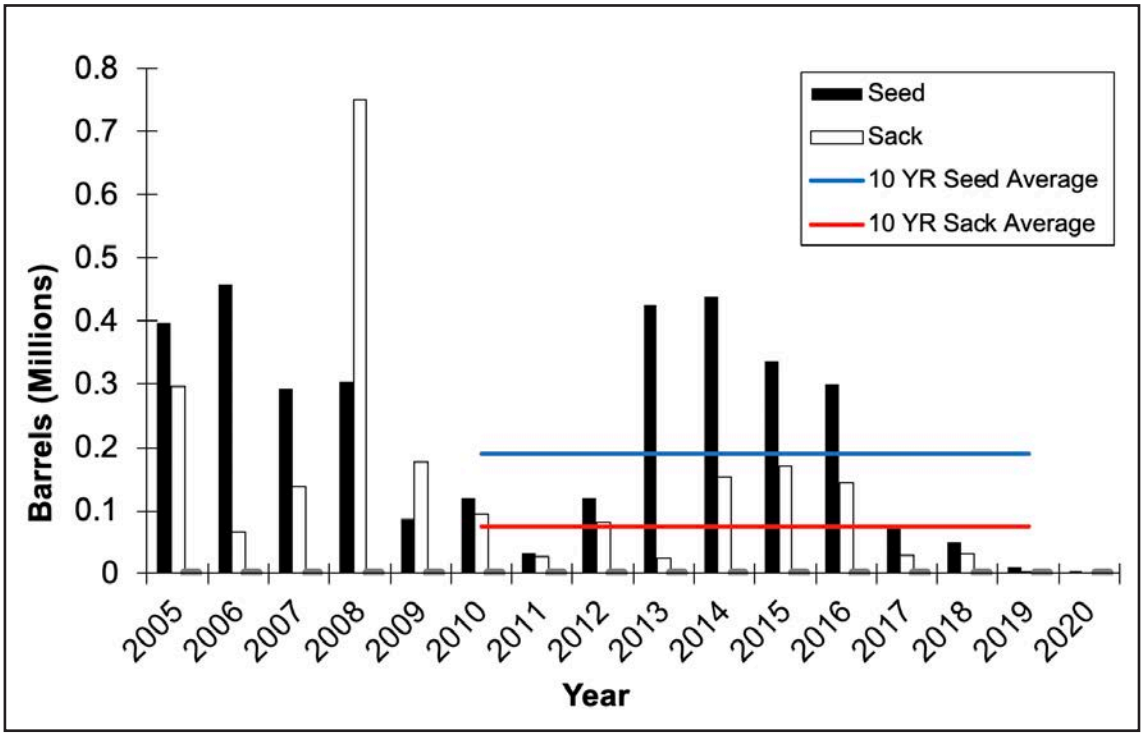

FIGURE 1.2. Current and historical seed and market-sized stock size estimates in CSA 1 North. Horizontal lines represent the previous 10-year' seed and market-sized stock size estimate averages.

TABLE 1.1. Average densities of oysters collected at each sampling station in CSA 1 North.

Station Name	Station Number	Reef Acreage	Seed/ m^2	Market-Size/ m^2	Seed Oysters (bbls)	Market-Size Oysters (bbls)
Grassy Island	3005		0.0	0.0		
Halfmoon Island	3010		0.0	0.0		
Petit Island	3009	5,328.0	0.0	0.0	0	0
Grand Banks	3044		0.0	0.0		
Millennium Reef	3011		0.0	0.0		
Three Mile Bay	3008		0.0	0.0		
East Karako Bay	3041	3,058.7	0.0	0.0	0	0
West Karako Bay	3040		0.0	0.0		
Grand Pass	3007		0.0	0.0		
Cabbage Reef	3006	5,411.0	0.0	0.0	0	0
Turkey Bayou	3004		0.0	0.0		
Martin Island	3046	3,183.3	0.0	0.0	0	0
Shell Point	3052	47.2	1.6	0.0	424.5	0
Johnson Bayou	3051	200.0	0.0	0.0	0	0
Drum Bay	3049	1,596.0	0.0	0.0	0	0
Morgan Harbor	3050	2,954.0	0.0	0.0	0	0
Round Island	3056	291.0	0.0	0.0	0	0
Drum Bay Cultch		200.0	0.4	1.0	449.6	2,248.3
Three Mile Pass Cultch		158.0	4.0	0.0	3,552.3	0
2020 Total					***4,426.4***	***2,248.3***

a combination of these stressors. Reefs in the Pontchartrain Basin have been subjected to the introduction of tremendous amounts of freshwater as a result of heavy spring flooding on area rivers. It is noted that annual square-meter samples may occur between seasonal spawning events in some areas. It is further noted that spat numbers can be somewhat biased by the amount of substrate collected in a given sample.

Fouling Organisms

The hooked mussel, a sessile bivalve often associated with oyster reefs that likely competes with oysters for food and settlement surfaces, was observed at eight of the 19 sampling stations during this sampling event (*Table 1.2*). The highest density of mussels was 90.2/m^2 at the Three Mile Pass cultch plant. There was a marked increase in hooked mussel densities across most of CSA 1 North when compared to the previous year's observations. This was likely due to the amount of freshwater inundation of the Basin during most recent spring flood events. It was noted that bryozoans were found on exposed substrate at several sampling stations, in addition to moderate to heavy barnacle fouling of oyster shells at a few sampling stations. All of these forms of fouling limit the ability of oyster larvae to attach to available cultch.

Oyster Predators and Disease

The southern oyster drill (*Stramonita haemastoma*) is a marine gastropod known to prey on oysters using a small tooth-like scraping organ called a radula to bore a hole through the oyster shell. During this year's sampling event, oyster drills were observed at just the Grand Banks station. No stone crabs, Menippe adinia, or blue crabs, Callinectes spp., were collected in the square-meter samples. Other Xanthid crabs were noted in numerous samples that contained shell for substrate.

Mortality

Overall, observed mortality estimates showed an increase compared to the previous year's stock assessment. Recent mortalities were recorded at four of the 19 sample sites. Prior to last year's stock assessment, heavy spring flooding had devastated much of the oyster population within the Study Area. Although evidence of mortality was observed, it was not deemed to be recent for the purposes of the stock assessment. During this sampling event spat oyster mortalities were recorded at Grand Banks (17.9%), Shell Point (5.1%), and Grand Pass (16.7%). Three Mile Pass cultch plant had the only seed mortality at 4.8%. There was no observed sack oyster mortality during this assessment. It is important to consider that mortality estimates are often based on an extremely small number of animals. Further, for some annual stock assessments, samples may be taken shortly after large mortality events that have either diminished or severely depleted abundances, so that neither the mortality nor the prior abundance is fully captured in the assessment sampling.

Tropical and Climatic Events

As mentioned in the previous section, spring 2019 had seen an unprecedented flooding event. The Mississippi River approached flood stage by the end of February, elevating river stage and prompting the U. S. Army Corps of Engineers to open the Bonnet Carré Spillway structure for a total of 123 days. Due to the duration

TABLE 1.2. Average density of the hooked mussel, *Ischadium recurvum*, and the southern oyster drill, *Stramonita haemastoma*, at each station.

Station Name	*I. recurvum* density/(m²)	*S. haemastoma* density/(m²)
Grassy Island	9.0	0
Petit Island	0	0
Half-moon Island	0	0
Grand Banks	0	0.2
Millennium Reef	0	0
Three Mile Bay	47.2	0
East Karako Bay	0	0
West Karako Bay	0	0
Grand Pass	0	0
Turkey Bayou	0	0
Cabbage Reef	0.2	0
Johnson Bayou	0	0
Shell Point	0.4	0
Drum Bay	0	0
Morgan Harbor	2.8	0
Martin Island	0	0
Round Island	3.4	0
Drum Bay Cultch	1.2	0
Three Mile Pass Cultch	90.2	0

of this flooding event, salinities on oyster growing areas throughout CSA 1 North decreased to below what is required for effective oyster growth and viability. The low salinity conditions in CSA 1 North were further exacerbated by the rising of the Pearl River to above flood stage four different times between December 2018 and May 2019. Oysters, because of their sessile nature, are especially susceptible to such low salinity conditions. The ramifications of the rate of resource loss during the spring 2019 mortality event are still being observed during this year's stock assessment. This is evidenced by the 40.5% reduction of total available oyster stock across CSA 1 North. During the spring of 2020, this area experienced yet another flooding event. High water on the Mississippi River again necessitated the opening of the Bonnet Carré Spillway, making this the third year in a row that the structure has been operated. LDWF biologists noted widespread low salinity rates brought on by the introduction of Mississippi River water into the Basin through the Bonnet Carré Spillway (*Figure 1.3*). Additionally, CSA 1 North received heavy discharge from the Pearl River as it also experienced spring flooding.

2019/2020 Oyster Season

No portion of CSA 1 North public oyster seed grounds was made available for commercial harvest during the 2019/2020 oyster season. The 2019 oyster stock assessment estimated there was only minimal market-size resource found in CSA 1 North.

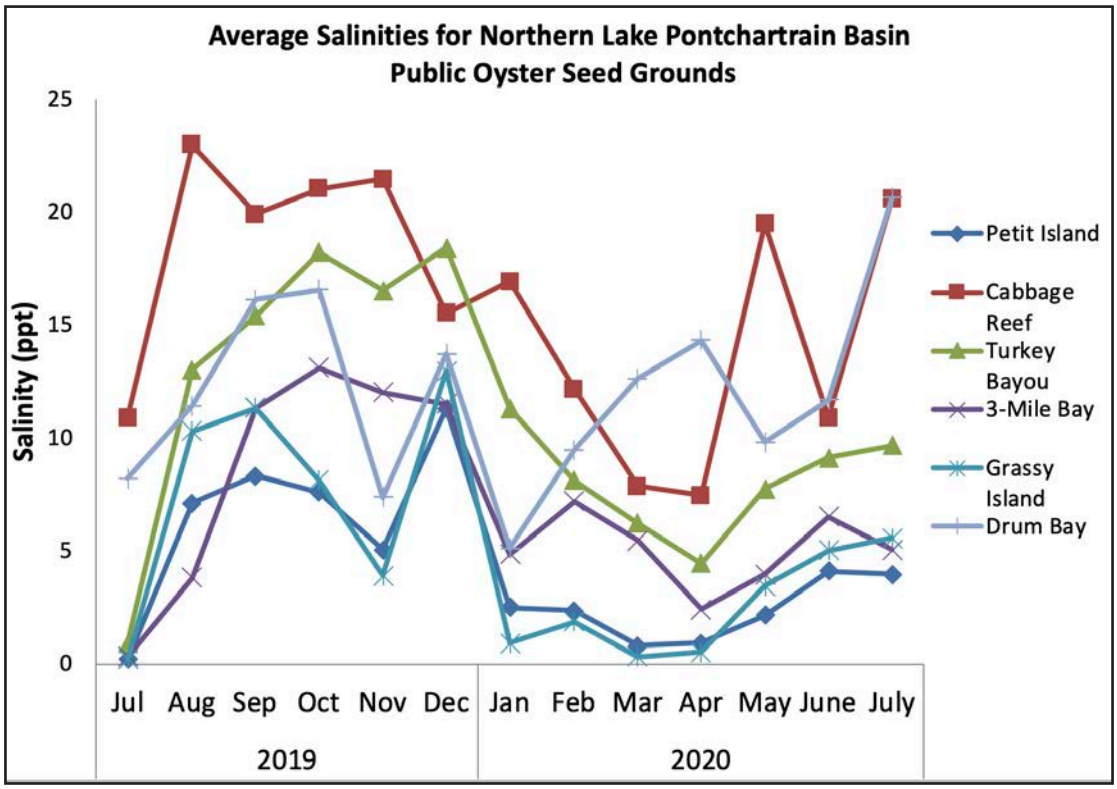

FIGURE 1.3. Average salinity for Northern Lake Pontchartrain Basin Public Oyster Seed Grounds from July 2019 - June 2020.

CSA 1 SOUTH

Introduction

The Public Oyster Seed Grounds in CSA 1 South (South Pontchartrain Basin), formerly CSA 2, consist of approximately 300,000 acres of water bottom located from the Mississippi River Gulf Outlet (MRGO) southward to South Pass in the Mississippi River delta and eastward from the eastern extent of private oyster leases east of the Mississippi River to the Breton National Wildlife Refuge. Historically, this area has provided seed and market-sized oysters for oyster fishermen from Louisiana, Mississippi, and Texas. Hydrology in the area is influenced at high Mississippi River stages by discharges through gaps in the Mississippi River levee south of Pointe a la Hache and through the Bohemia Spillway, discharge from the Caernarvon and Bayou Lamoque freshwater diversion structures, and main-stem river distributaries in the southern portion of the Basin.

LDWF continually expands and enhances public oyster reefs through the placement of cultch material (e.g., shell, limestone, crushed concrete) on suitable water bottoms. Numerous cultch plants have been constructed throughout CSA 1 South since 1917, including sites in Bay Gardene and Black Bay. Most recently, cultch plants were completed in Bay Crabe and Lake Fortuna in 2012 as part of the Deepwater Horizon oil spill NRDA Early Restoration Program. In April 2018, LDWF collaborated with NOAA and the St. Bernard Parish Government to enhance a 100-acre portion of the 2012 Lake Fortuna Cultch Plant with the deployment of 16,154 cubic yards of oyster shell on the site.

Methods

Using the methodology described in the Statewide Overview of this report, LDWF biologists collected field samples from 26 stations within CSA 1 South between July 1 and 13, 2020, for this oyster stock assessment. Sampling stations included 24 historical sampling stations, the 2009 Lonesome Island cultch plant, and the 2012 Lake Fortuna cultch plant (*Figure 2.1*). Biologists consider the 2012 Lake Fortuna Cultch Plant to be significantly different from surrounding water bottoms and assess this area separately as a result (*Table 2.1*).

To better locate and assess the oyster stock in the public oyster seed grounds, LDWF has conducted a number of side-scan sonar studies of water bottoms in CSA 1 South in recent years. These studies, coupled with historical reef and cultch plant information, have resulted in a more up-to-date and realistic designation of productive water bottoms for use in the annual oyster stock assessment. The 2020 oyster stock assessment is based on the updated reef acreage of 27,662.3 acres of water bottom (*Table 2.1*).

Beginning with the 2013 oyster stock assessment, oyster reefs within CSA 1 South were grouped into reef complexes based on location, hydrology, oyster productivity, and response to environmental stressors. There were a total of 12 reef complexes, each with one to five representative m^2 sampling stations (*Table 2.1*). Recent water bottom assessments identified an additional 1,524 acres of oyster habitat (reef and scattered shell), but this acreage is not included in the annual oyster stock assessment acreage, as no current oyster sampling station adequately describes this acreage.

Results and Discussion

Seed and Market-Size Stock

The 2020 estimated oyster stock for CSA 1 South consists of 3,725.8 bbls of seed oysters. All seed stock was found at Horseshoe Reef, which had an average oyster density of 0.8 seed oyster per square-meter. There was no market-sized resource observed during this sampling event; however, this does not mean there is a complete absence of market-size oysters from reefs within the Basin (*Table 2.1*). During last year's stock assessment, no live oysters were observed at any sampling station. As actual sampling locations are random and include only a small percentage of the total Public Oyster Seed Ground, it is plausible that pockets of oyster resource are present in portions of the area. When compared to the previous 10 years' average, this year's assessed seed stock is down 86.4% (*Figure 2.2*). The total assessed oyster stock for 2020 is 91.4% below the previous 10 years' average and 99.5% below the long-term average (2005-2019). Recent mortality was noted at only Horseshoe Reef, which accounted for all observed oyster resource in the 2020 stock assessment. At this station, there was 16.7% spat mortality and 33.3% seed oyster mortality. The results of this stock assessment point to an extremely low abundance of oyster stock across CSA 1 South, a trend that has persisted for a number of years.

Over the past 10 years, CSA 1 South has experienced periods of heavy localized harvest, high mortality events, strong tropical events, the *Deepwater Horizon* oil spill and related spill response activities, and increasing freshwater influence from the Mississippi River. All of these appear to have severely reduced oyster abundance. As a result, the oyster stock size estimate continues to be critically below both the 10 years' and long-term (2005-2019) averages (*Figure 2.2*). Aside from occasional extreme events (oil spills, tropical storms), extended periods of low spring salinities and periods of hypoxia in the summer and fall decrease spawning success and increase risk of mortality, further inhibiting oyster production in this area. Past harvest pressure, combined with poor hydrology for oyster production, have largely degraded reef areas to shell hash and mud that is heavily fouled with mussels and other organisms; this lack of suitable substrate to enable spat settlement adds another stressor to the oyster population in CSA 1 South.

Spat Production

All spat measured during the 2020 CSA 1 South stock assessment was found at Horseshoe Reef, which had an average density of 1.0 spat oyster per square-meter. Although these sampling events

TABLE 2.1. Average densities of oysters collected at each sampling station in CSA 1 South.

Station Name	Station Number	Reef Acreage	Seed/m²	Market-Sized/m²	Seed Oysters (bbls)	Market-Sized Oysters (bbls)
Jessies Island	3013	549.9	0.0	0.0	0.0	0.0
Bayou Lost	3016		0.0	0.0		
East Bay Gardene	3033	1262.6	0.0	0.0	0.0	0.0
West Bay Crabe	3019	1732.0	0.0	0.0	0.0	0.0
East Bay Crabe	3032		0.0	0.0		
Elephant Pass	3022	202.2	0.0	0.0	0.0	0.0
Sunrise Point	3027	3692.8	0.0	0.0	0.0	0.0
California Bay	3025		0.0	0.0		
Bay Long	3001		0.0	0.0		
Mangrove	3000	2889.1	0.0	0.0	0.0	0.0
East Pelican	3028		0.0	0.0		
Stone Island	3020	3575.7	0.0	0.0	0.0	0.0
South Black Bay	3021		0.0	0.0		
Curfew Island	3023		0.0	0.0		
Telegraph Island	3026		0.0	0.0		
Snake Island	3012	2861.9	0.0	0.0	0.0	0.0
2009 Lonesome CP	3086		0.0	0.0		
Black Bay	3018		0.0	0.0		
Lake Fortuna South	3036	3453.9	0.0	0.0	0.0	0.0
Lake Fortuna North	3003		0.0	0.0		
North Black Bay	3015	2485.8	0.0	0.0	3725.8	0.0
Horseshoe Reef	3039		0.8	0.0		
East Stone Island	3055		0.0	0.0		
Wreck	3054	4485.8	0.0	0.0	0.0	0.0
Battledore Reef	3035	270.6	0.0	0.0	0.0	0.0
Lake Fortuna CP (2012)		200.0	0.0	0.0	0.0	0.0
Total					***3725.8***	***0.0***

may occur outside of the peak spawning period, it is evident that there has been only minimal spat catch on these reefs, marking a continuation of poor spat catches and survival within CSA 1 South. Inadequate cultch material for spat attachment is definitely a limiting factor for the Basin. Seven of the 26 stations sampled did not have any measurable reef material, while another eight were noted to have material that was either reduced to shell hash or completely buried under sediments.

Fouling Organisms

The hooked mussel is a sessile bivalve often associated with oyster reefs that likely competes with oysters for food and settlement surfaces. During the 2020 oyster stock assessment, hooked mussels were present at nine of the 26 sampling stations and ranged in density from 0.8 to 113.8 individuals per m² (*Table 2.2*). Overall, hooked mussel density was slightly decreased since the previous assessment, with the largest decrease in density observed at the South Black Bay station. Decreases in hooked mussel density were observed at eleven sampling stations where mussels were observed during the 2019 assessment. Conversely, there were three stations that had increases of hooked mussel fouling by more than 10 times what was observed during last year's assessment. These were North Lake Fortuna, Horseshoe Reef and the Wreck. There was notably moderate to heavy barnacle fouling of oyster shells at sampling stations throughout CSA 1 South. All of these forms of fouling limit the attachment of oyster larvae to an available substrate.

Oyster Predators and Disease

The southern oyster drill (*Stramonita haemastoma*) is a marine gastropod known to prey on oysters using a small tooth-like scraping organ called a radula to bore a hole through the oyster shell. Live oyster drills were found at two locations during this sampling effort, Stone Island and North Lake Fortuna. Recent extended periods of low salinity may help to limit oyster drill abundance in the area. No stone crabs or blue crabs were observed in the samples.

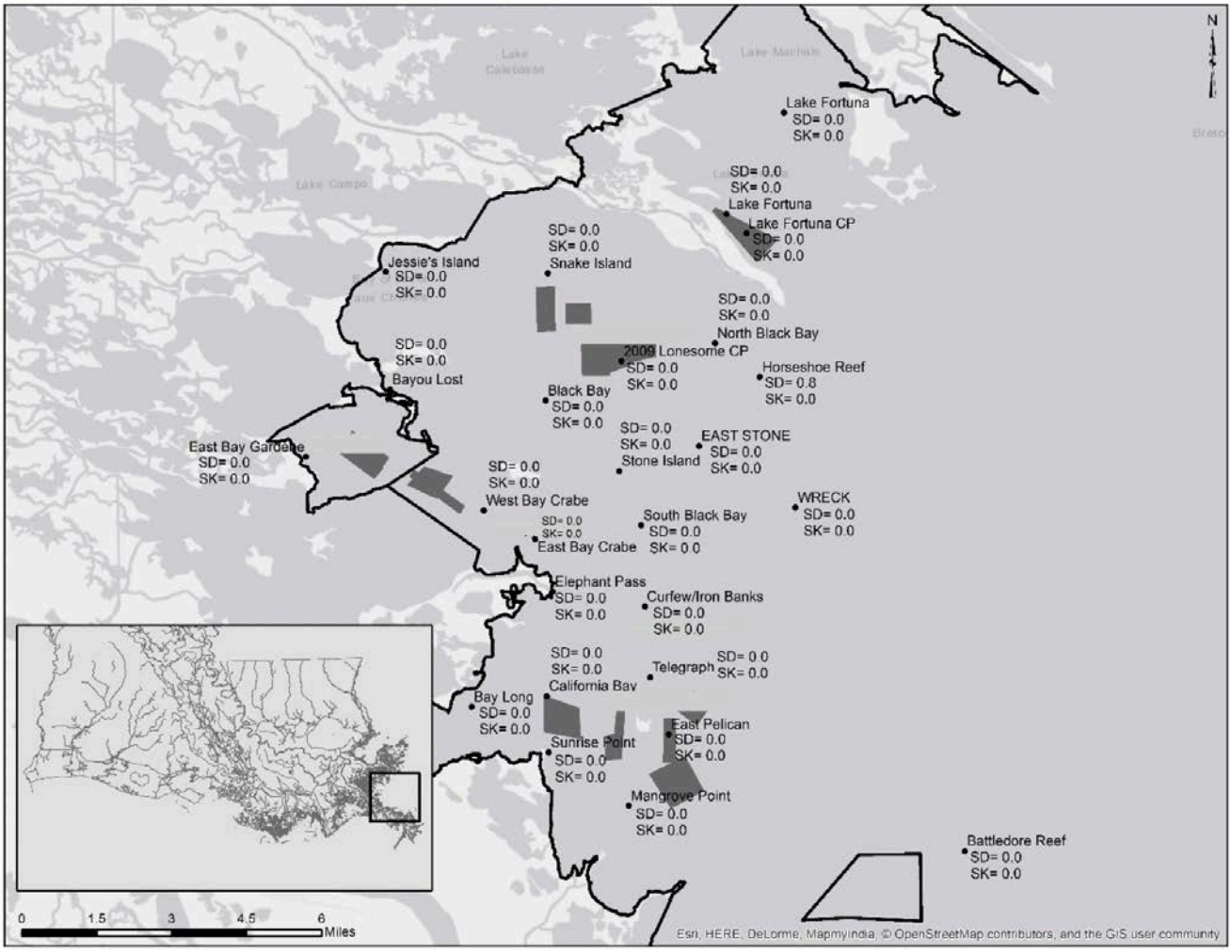

FIGURE 2.1. CSA 1 South oyster stock assessment sampling stations. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

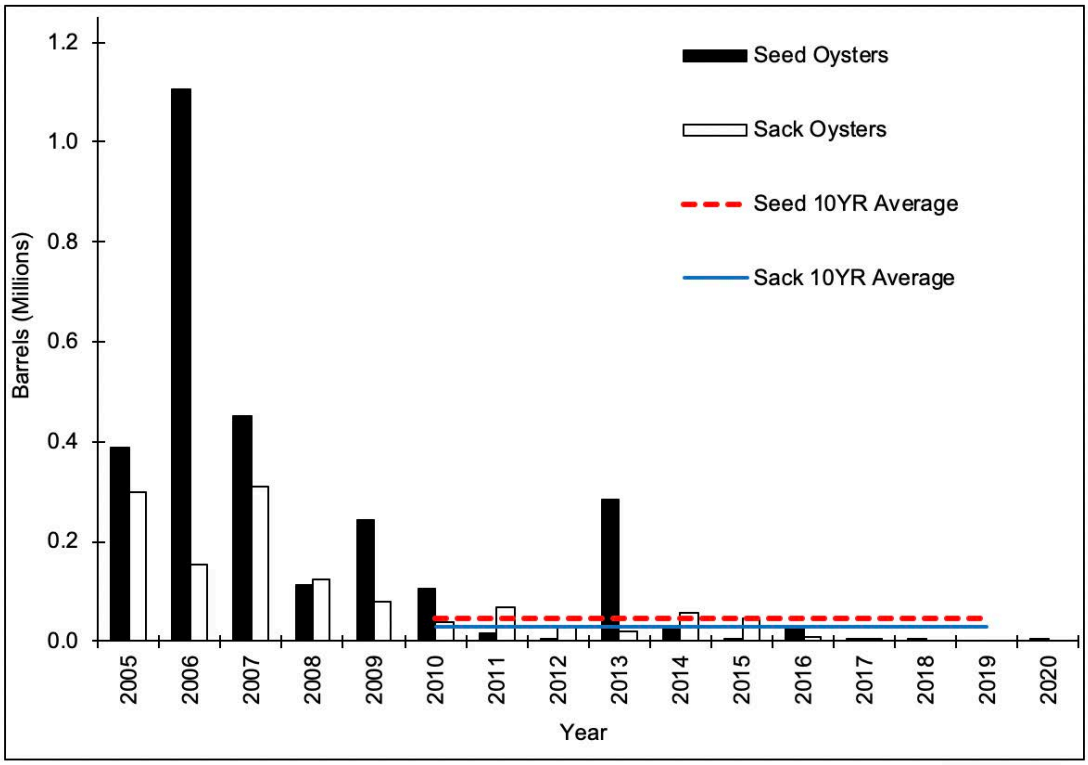

FIGURE 2.2. Current and historical seed and market-size stock size estimates in CSA 1 South. Horizontal lines represent the previous 10-year seed (red) and market-size (blue) stock size estimate averages.

Tropical and Climatic Events

In spring and summer 2019, oyster grounds in CSA 1 South were impacted by an unprecedented flooding event. Driven by heavy winter snowfall and torrential rains across the mid-western United States, the Mississippi River exceeded flood stage for over five months from February through July. The elevated river stage greatly increased freshwater introduction from the main stem river flow, as well through distributaries and levee breaches within the southern portion of the Basin. As a result of the intensity and duration of this flooding event, salinities on oyster growing areas throughout CSA 1 South decreased to below what is required for effective oyster growth and viability. During the spring of 2020, this area experienced yet another flooding event. High water on the Mississippi River again flooded across CSA 1 South oyster growing grounds during the months of February through April. LDWF biologists noted widespread low salinity rates brought on by the introduction of Mississippi River water (*Figure 2.3*).

2019/2020 Oyster Season

No portion of CSA 1 South public oyster seed grounds was made available for commercial harvest during the 2019/2020 oyster season. This was the second consecutive season that public reefs south of the MRGO remained closed. The 2019 oyster stock assessment estimated there was no marketable resource found in CSA 1 South.

TABLE 2.2. Average density of the hooked mussel, *Ischadium recurvum*, and the southern oyster drill, *Stramonita haemastoma*, at each station.

Complex Name	Station Name	*I. recurvum* Density/(m²)	*S. haemastoma* Density/(m²)
East Black Bay	Jessie's Island	0.0	0.0
	Bayou Lost	0.0	0.0
Bay Gardene	East Bay Gardene	0.0	0.0
Bay Crabe	West Bay Crabe	0.0	0.0
	East Bay Crabe	0.0	0.0
Elephant Pass	Elephant Pass	0.0	0.0
California Bay	Sunrise Point	0.0	0.0
	California Bay	0.0	0.0
	Bay Long	0.0	0.0
Mangrove	Mangrove	0.0	0.0
	East Pelican	**0.8**	0.0
South Black Bay	Stone Island	**2.2**	**1.2**
	South Black Bay	0.0	0.0
	Curfew Island	0.0	0.0
	Telegraph Island	0.0	0.0
Lonesome Island	Snake Island	0.0	0.0
	2009 Lonesome Island CP	0.0	0.0
	Black Bay	0.0	0.0
Lake Fortuna	Lake Fortuna South	**36.6**	0.0
	Lake Fortuna North	**18.0**	**1.4**
	Lake Fortuna CP (2012)	**113.8**	0.0
Horseshoe Reef	North Black Bay	0.0	0.0
	Horseshoe Reef	**95.6**	0.0
	East Stone Island	**0.0**	0.0
Wreck	Wreck	**19.6**	0.0
Battledore Reef	Battledore Reef	**1.6**	0.0

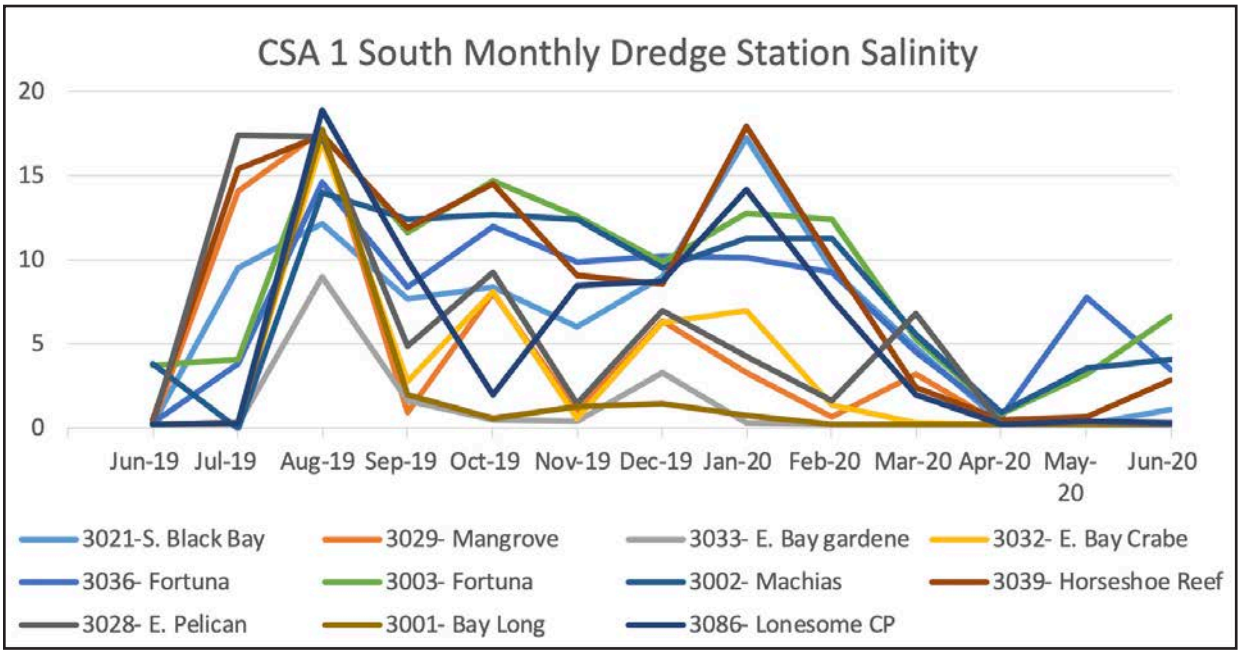

FIGURE 2.3. Average salinity for Northern Lake Pontchartrain Basin Public Oyster Seed Grounds from July 2019 through June 2020

CSA 3

Introduction

CSA 3 consists of three public oyster areas distributed generally in a north-south direction within the Barataria Bay estuary:

1. Little Lake Public Oyster Seed Grounds.
2. Hackberry Bay Public Oyster Seed Reservation
3. Barataria Bay Public Oyster Seed Grounds

The Little Lake Public Oyster Seed Grounds had previously been used as a temporary natural reef area and once contained private oyster leases. These leases all fell within the Davis Pond freshwater diversion impact area and were either purchased or moved by the state and federal government prior to the structure's opening. The Davis Pond diversion has not been consistently used to its maximum capacity since it first opened in 2002. Environmental conditions during some years have allowed oysters to continue to exist in Little Lake. Therefore, the Commission designated this area a public oyster ground so fishermen could harvest oysters and LDWF could actively manage the reefs. The location of the Little Lake Public Oyster Seed Grounds makes it vulnerable to depressed salinities from rainfall, inflow from the Intracoastal Waterway, and discharge from the Davis Pond diversion. Reduced salinities can negatively impact oyster survival. However, when salinities are higher, the Little Lake Public Oyster Seed Grounds have provided the oyster industry with additional seed and market-size oysters in Barataria Basin. Although there is no information on the reef acreage on the Little Lake Public Oyster Seed Grounds, LDWF hopes to better survey the area in the future.

Hackberry Bay, in Jefferson and Lafourche parishes, is a 4,402-acre mesohaline embayment with primarily soft silt and clay bottom, of which only 14.7 acres is naturally occurring reef material. The three historical sampling stations within Hackberry Bay are the Upper, Middle, and Lower Hackberry sampling stations. The Middle Hackberry Bay station is the only sampling station located over the existing natural reef, while the Upper and Lower stations are located over former cultch plants placed on top of historical reefs. The Upper Hackberry Bay station was the result of a 1994 cultch plant using federal disaster funds from Hurricane Andrew in 1992. The 1994 Cultch plant totaled 145 acres and was comprised of six different sections of substrate including crushed concrete, shucked shell, reef shell, clam shell, Kentucky limestone, and Bahamian limestone. This station was also the location of cultch plants in 1943 (140 acres), 1945 (70 acres),1946 (92 acres), and 1981 (67 acres). The Lower Hackberry Bay station is on a reef that was part of a 450-acre 1973 Cultch plant. Since very little natural reef exists on the Hackberry Bay Public Oyster Seed Reservation, production is highly dependent on cultch plants. It is unknown how much, if any, cultch material from the 1994 and earlier cultch plants remains exposed above the surface of the mud. Therefore, the acreage of these previous cultch plants is not factored into the annual oyster stock assessment.

Since 2004, the Louisiana Department of Wildlife and Fisheries (LDWF) has constructed five cultch plants in Hackberry Bay. Two cultch plants totaling 35 acres were built in 2004 and one of 50 acres in 2008. A 2012 Cultch plant of approximately 200 acres, and a 2014 Cultch plant of 30 acres, combined with the other three, have increased the estimated reef acreage on the Hackberry Bay. These recent cultch plants have increased the estimated reef acreage on the Hackberry Bay Public Oyster Seed Reservation from 99.7 to 329.7 acres.

The Commission designated the Barataria Bay Public Oyster Seed Grounds as such in response to possible changes in the salinity regime of the estuary stemming from the Davis Pond freshwater diversion project. Davis Pond is a large Mississippi River diversion that aims to reintroduce freshwater and nutrients into the Barataria Bay estuary to help restore the Louisiana coast. As this diversion was anticipated to reduce salinities in the estuary, LDWF estimated that additional public oyster seed grounds farther down-estuary may be productive during years with high freshwater input. The only known existing reef on the Barataria Bay Public Oyster Seed Grounds is a 40-acre cultch plant constructed of 7,536 cubic yards of crushed concrete in the northeast section of the area in May 2004. The reef is vulnerable to predators such as oyster drills and the protozoan parasite Dermo during periods of higher salinities. LDWF does not expect consistent production from this area until salinity regimes in the basin change due to natural forces or coastal restoration efforts.

Methods

LDWF biologists collected field samples for the 2020 oyster stock assessment between July 1 and July 15, 2020, from a total of nine stations within CSA 3 according to the methodology described in the Statewide Overview of this report. Biologists did not sample the Little Lake Public Oyster Seed Grounds due to a lack of information on reef acreage.

Results and Discussion

Seed and Market-Size Stock

The 2020 oyster stock assessment estimated the stock on the Hackberry Bay Public Oyster Seed Reservation, including the productive cultch plants, at 4,479.2 bbl. of seed oysters and 1,437.5 bbl. of market-sized oysters for a total of 5,916.7 bbl. oyster stock (*Table 3.1*). Seed oysters were not present at the 2004 Barataria Bay Cultch plant, Lower Hackberry Bay, and 2008 Hackberry Bay Cultch Plant sampling stations. There was an overall 44.1% increase in seed availability from July 2019. Seed availability (4,479 bbl.) is 61.1% below the 10-year average of 11,562 bbl. (*Figure 3.1*).

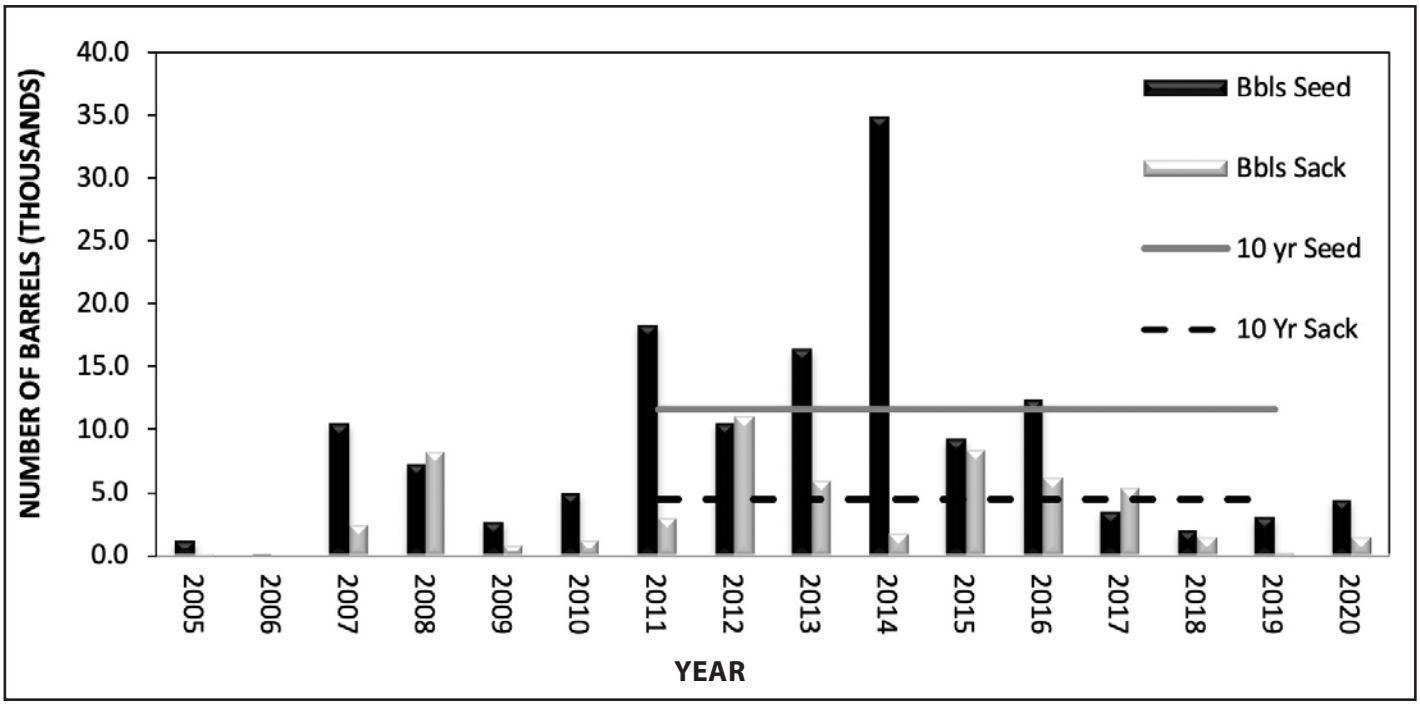

FIGURE 3.1. Estimated seed and market-sized oyster availability on the Hackberry Bay Public Oyster Seed Reservation.

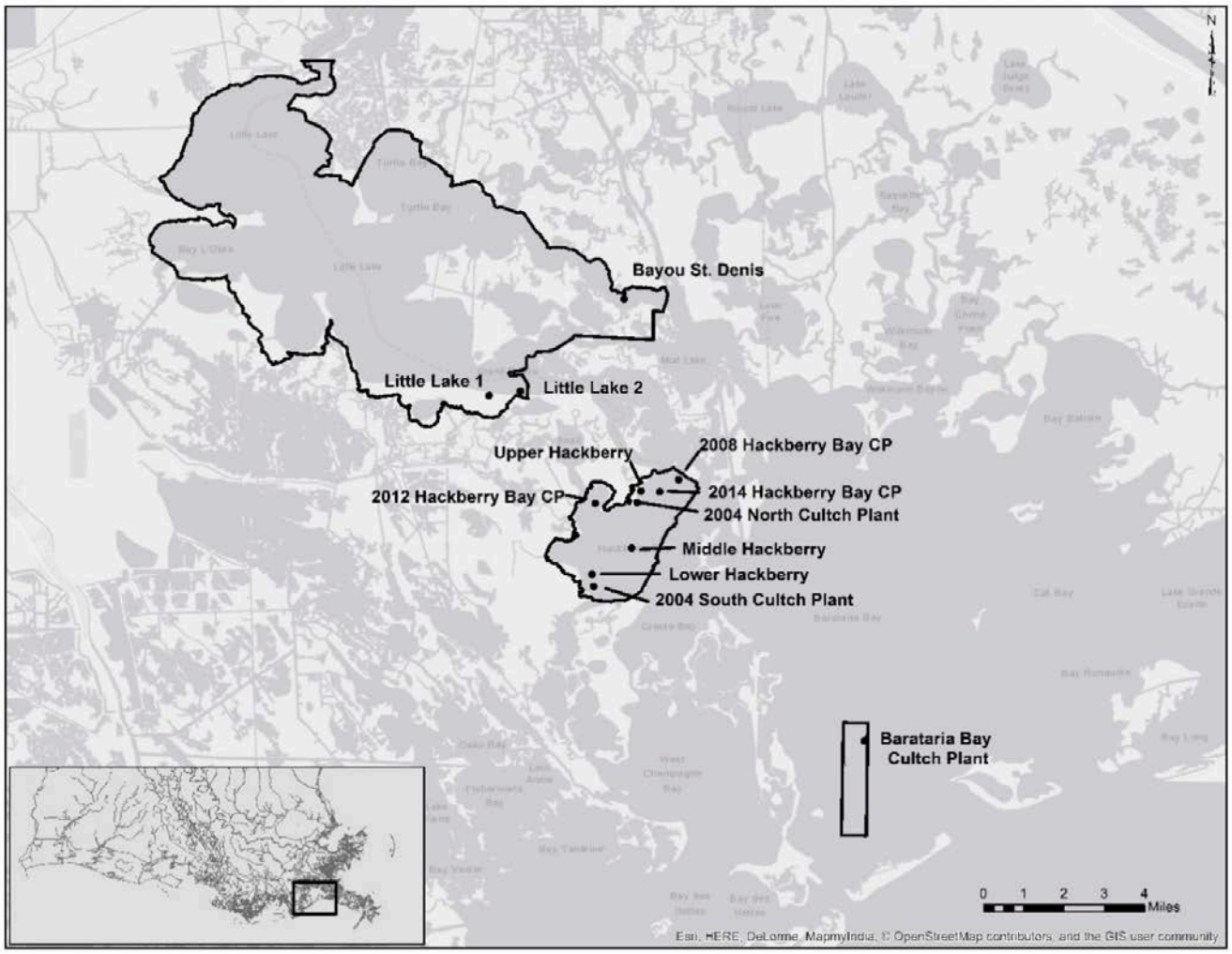

FIGURE 3.2. 2020 CSA 3 sampling stations. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

TABLE 3.1. 2020 square-meter sampling results for CSA 3.

Station Name	Approx. Reef Acreage	Average Live Seed Oysters/ m²	Average Live Market-Size Oysters/m²	Bbl. of Seed Oysters Available	Bbl. of Market-Size Oysters Available	Oysters Spat/m²
Hackberry Bay North Cultch Plant (2004)	10.0	0.6	0	33.7	0	22
Hackberry Bay South Cultch Plant (2004)	25.0	0.2	0	28.1	0	0
Hackberry Bay Cultch Plant (2008)	50.0	0	0.2	0	112.41	0.2
Hackberry Bay Cultch Plant (2012)	200.0	3.4	0.2	3,822.1	449.7	0.2
Hackberry Bay Cultch Plant (2014)	30.0	3.4	2.4	573.3	809.4	3
Lower Hackberry Bay	4.9	0	0	0	0	0
Middle Hackberry Bay	4.9	0.6	1.2	16.5	66.1	14
Upper Hackberry Bay	4.9	0.2	0	5.5	0	0
Barataria Bay Cultch Plant (2004)	40.0	0	0	0	0	0
Little Lake	Unknown	Unknown	Unknown	Unknown	Unknown	
Total	***369.7***			***4,479.2***	***1,437.5***	

Market-size oysters were present at four stations: Middle Hackberry Bay sampling station, the 2008, 2012, and 2014 Cultch plants. The 2014 Hackberry Bay Cultch plant had the highest density at 2.4 per m² (*Figure 3.2; Table 3.1*). The market-size oyster stock (1,437.5 bbl.) was up 326% from 2019 (336.8 bbl.), and down 68% from the 10-year average (4,465 bbl.).

The combined stock of 5,916.7 bbl. is 71.8% above the 2019 estimate (3,444.8 bbl.), 63.0% below the 10-year average (16,027 bbl.). The highest available bbl. of market-size oyster were 449.7 bbl. at the 2012 Hackberry Bay Cultch plant and 809.4 bbl. at the 2014 Hackberry Bay Cultch plant. The progressive decline in available oyster stock over time appears to be an artifact of loss of production on aging reefs within the Hackberry Bay Public Oyster Seed Reservation. Researching the potential for rehabilitating older reefs and cultch plants should be considered to augment production. Only four of the eight sites in Hackberry had most of the cultch above the mud line. No live seed or market-size oysters were observed on the Barataria Bay Public Oyster Seed Grounds. Market-size oyster availability has not been documented in this area since it was created in 2004.

The July 2020 average size of seed and market-size oysters was 0.79 inches. The overall average size, from combined dredge and m² samples, from July 2019 to July 2020 was 2.2 inches, ranging from 0.7 to 2.7 inches. Two large spat samples resulted in a size decrease in June and July 2020 (*Figure 3.3*).

Spat Production

Two hundred total live spat were collected in 2020 stock assessment sampling. Spat abundance was 4.4 spat/m², which is 40.5% below the long-term average (2005-2019) of 7.4 spat per m². The highest spat numbers were found at the North Hackberry Bay Cultch plant and Middle Hackberry sampling sites; 90.5% of the 200 total spat came from these sampling stations. No spat was collected on the Barataria Bay, Lower Hackberry, or Southern Hackberry Seed Ground sampling sites.

	2019	2020	% Change
Seed	3,108.0	4,479.2	44.1
Market-Size	336.8	1,437.5	326.8
Total	***3,444.8***	***5,916.7***	***71.8***

Hydrological Data

Data from the United States Army Corps of Engineers (USACE) Tarbert gauge shows Mississippi River discharge from July 2019 through July 2020 averaged 844,966 cubic feet per second (cfs), reaching a peak discharge for the time period of 1,268,567cfs in April (*Figure 3.4*). During the same time period, discharge levels were above the 10-year average (2009-2019) of 602,161cfs from November 2019 through June 2020.

Data from the United States Geologic Survey (USGS) constant recorder located near the Davis Pond diversion structure shows a monthly average discharge of 1,372cfs from July 2019 through July 2020, which was below the 10-year average (2009-2019) of 1,808cfs (*Figure 3.5*). The maximum monthly average discharge over this time period was 3,272cfs during March 2020. Oyster habitat suitability for area seed grounds is highly influenced by Mississippi River and Davis Pond diversion discharge, on which freshets assist decreasing salinities in the southern area of the basin, therefore pushing predators away, and decreasing Dermo disease, however excessive freshets cause lower salinities in the upper Barataria basin (e.g. Little Lake).

According to USGS data, salinities in the Hackberry Bay Public Oyster Seed Reservation and the Barataria Bay and Little Lake Public Oyster Seed Grounds from July 2019 through July 2020 were lower than or equal to the 10-year average (*Table 3.2*). The average salinity for June 2020 in all three water bodies was far below the corresponding 10-year average.

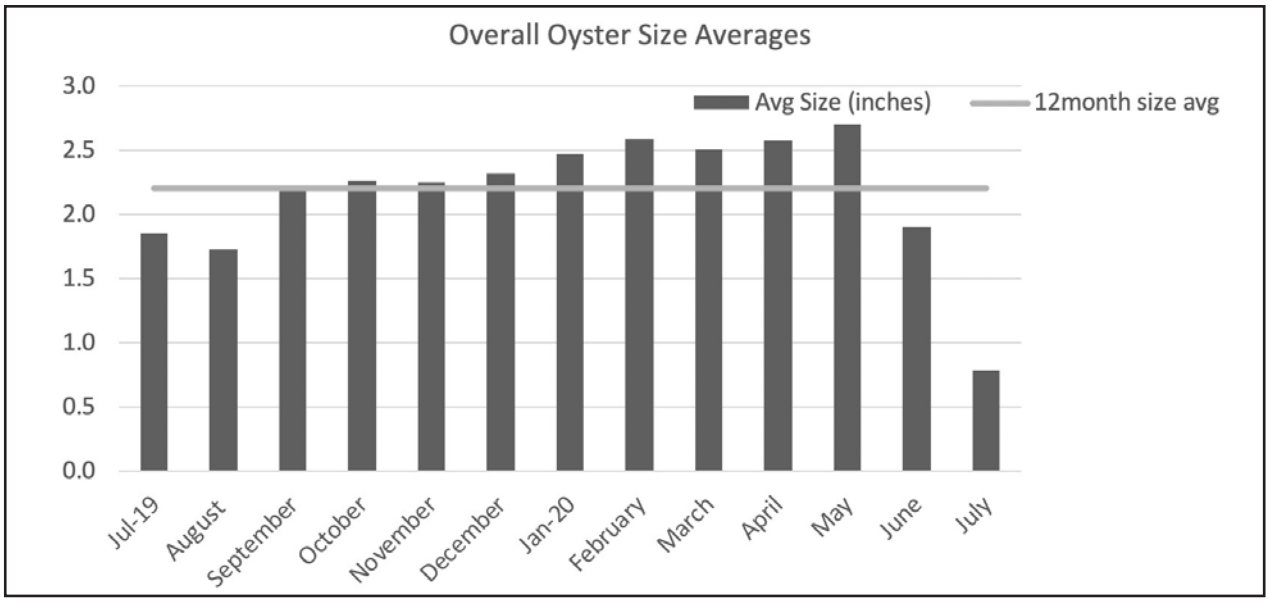

FIGURE 3.3. 2019-2020 Average oyster size from monthly dredge sampling and annual square meter sampling in CSA 3.

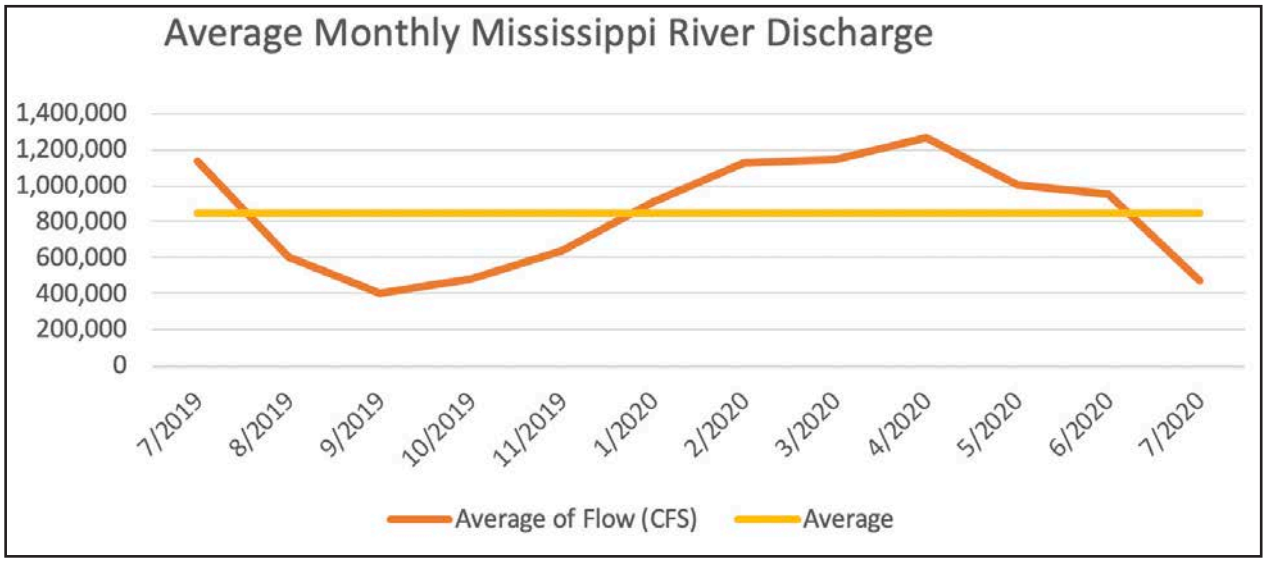

FIGURE 3.4. Average monthly Mississippi River discharge at Tarbert Landing in cubic feet per second (cfs).

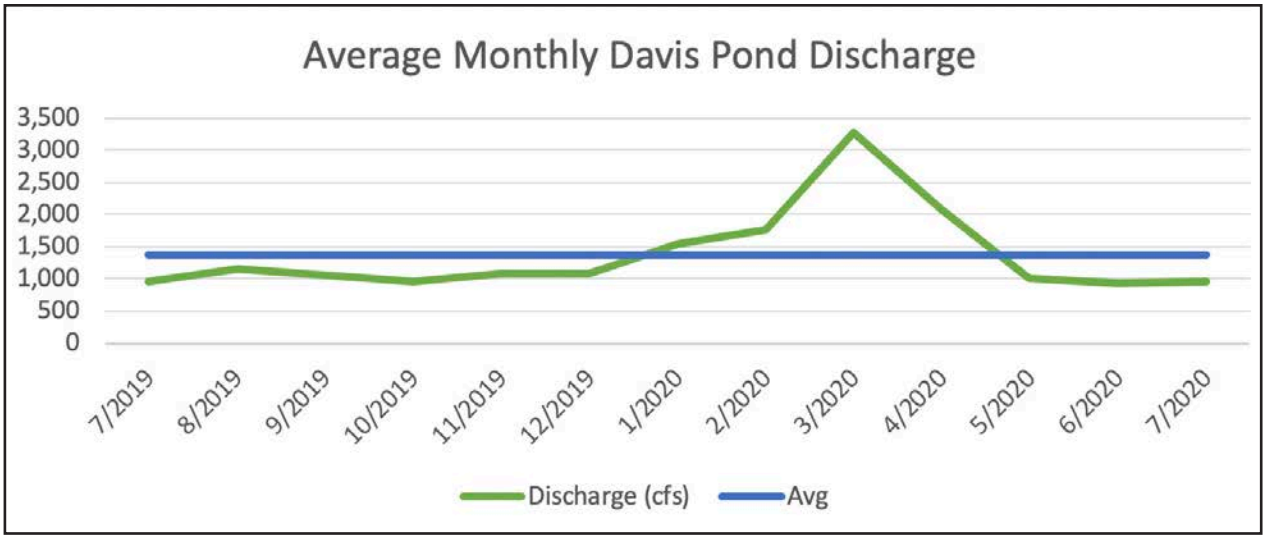

FIGURE 3.5. Average monthly Davis Pond discharge in cubic feet per second (cfs).

TABLE 3.2. Salinity values (ppt) between July 2019 to July 2020.

Body of Water	July 2019 - July 2020 Average	July 2019 - July 2020 Range	June 2020 Average	2009-2019 Average
Hackberry Bay	8.4	0.3 – 29	4.3	9.4
Barataria Bay	15.4	1.8 – 33	10.6	17.8
Little Lake	1.8	0.1 – 17	0.7	1.8

Fouling Organisms

The hooked mussel is a reef-associated benthic bivalve species that competes with oysters for food and settlement surfaces. Hooked mussels were present at four of the nine sampling stations, the 2004 Hackberry Bay North Cultch plant, Middle Hackberry, and the 2012 and 2014 Hackberry Bay Cultch plants. The highest density (36.8/m^2) was observed at the 2014 Hackberry Cultch sampling station. The average number of hooked mussels observed at the eight sample stations in the Hackberry Bay Public Oyster Seed Reservation, was 6.0 per m^2, an increase from last year's 4.9 per m^2.

Oyster Predators and Disease

The southern oyster drill is a marine snail that preys on oysters using a radula (a small tooth-like rasping organ) to bore a hole through the oyster shell. During sampling for the 2020 stock assessment, no oyster drills were collected. Since 2009, biologists have collected only 21 oyster drills during dredge and square meter sampling; most of these have come from the Barataria Bay Public Oyster Seed Grounds. The absence of oyster drills from almost all 2019 and 2020 samples is most likely due to the low overall average salinities throughout CSA 3.

Mortality

For July square-meter sampling, spat mortality at each station on the Hackberry Bay Public Oyster Seed Reservation averaged 2.9% overall, a decrease from the 11.1% overall average in 2019. Seed mortality at each station averaged 2.3%, while market-size oyster mortality was 0%. The combined overall spat, seed, and market-sized mortality was 2.6% (*Figure 3.6*). No spat-sized oysters were observed on the Barataria Bay Public Oyster Seed Grounds.

Since the 2019 oyster stock assessment, monthly dredge samples have provided an additional source of oyster mortality data. Dredge samples revealed an overall average monthly mortality of 2.5% for spat, seed, and market-size oysters combined between July 2019 and July 2020 (*Figure 3.6*). This was similar to the 2.7% overall monthly mortality observed during the same time period prior to the 2019 stock assessment sampling.

Tropical and Climatic Events

The 2020 tropical system Cristobal affected CSA 3 with high water and high salinity for two days in early June.

2019/2020 Oyster Season

The Little Lake, Barataria Bay Public Oyster Seed Grounds, and the Hackberry Public Oyster Seed Reservations remained closed for the 2019/2020 oyster season. However, historical harvest data is presented in *Figure 3.7* for reference.

The 2019-2020 season closure may account for the increase in the number of seed and sack oysters available for this year's season. The high spat numbers recorded in the July stock assessment may also be an indicator of additional seed populations becoming available for the 2020/2021 oyster season.

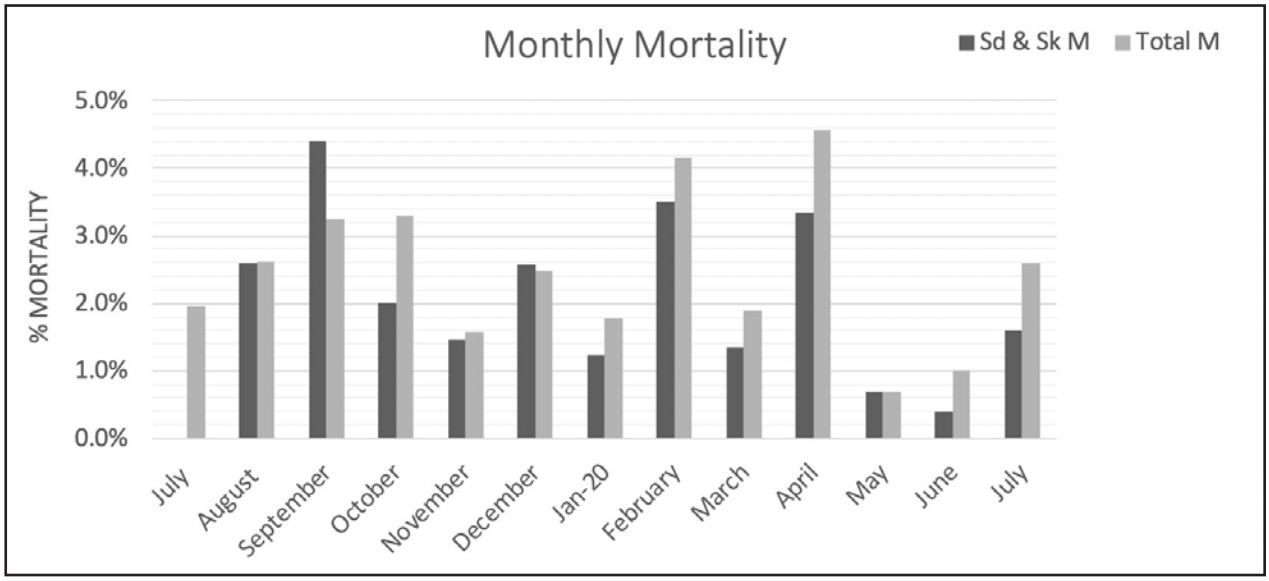

FIGURE 3.6. Total oyster (Total M) and combined seed/market-sized (Sd. & Sk. M) mortality by the percentage of total monthly catch in CSA 3.

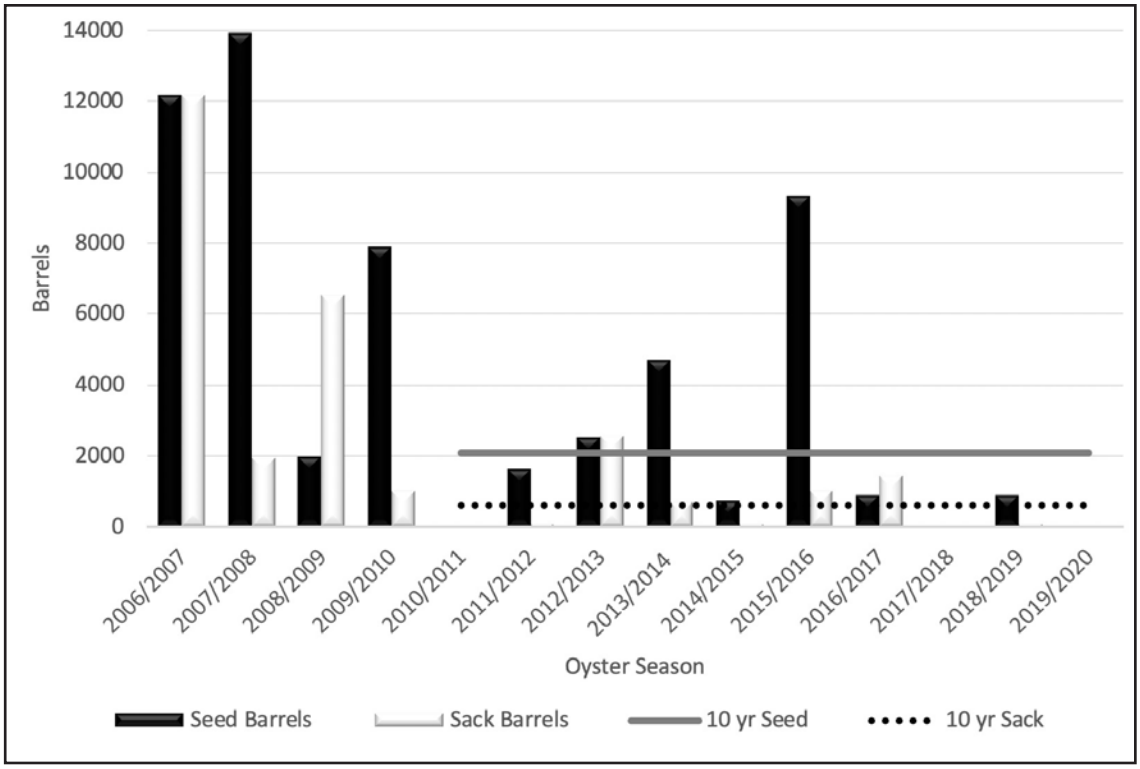

FIGURE 3.7. Estimated oyster harvest compiled from boarding surveys for CSA 3 Public Oyster areas. 2014/2015 estimates are for the Little Lake Public Oyster Seed Grounds only.

CSA 5

Introduction

CSA 5 is comprised of the Terrebonne Basin from Bayou Lafourche west to the Atchafalaya River, including Terrebonne Bay, Timbalier Bay, Sister Lake, Lake Mechant, and Caillou Bay. CSA 5 oyster stock assessments are divided into eastern and western portions of the Terrebonne Basin.

There are currently seven different Public Oyster Seed Reservations (POSR) and Public Oyster Seed Grounds (POSG) within CSA 5:

1. Sister Lake (Caillou Lake) Public Oyster Seed Reservation
2. Bay Junop Public Oyster Seed Reservation
3. Lake Mechant Public Oyster Seed Grounds
4. Deep Lake Public Oyster Seed Grounds
5. Lake Felicity Public Oyster Seed Grounds
6. Lake Chien Public Oyster Seed Grounds
7. Lake Tambour Public Oyster Seed Grounds.

Sister Lake, Bay Junop, and Lake Mechant are located in the western Terrebonne Basin; Deep Lake, Lake Felicity, Lake Chien, and Lake Tambour are found in the eastern Terrebonne Basin (*Figures 5.1 and 5.2*).

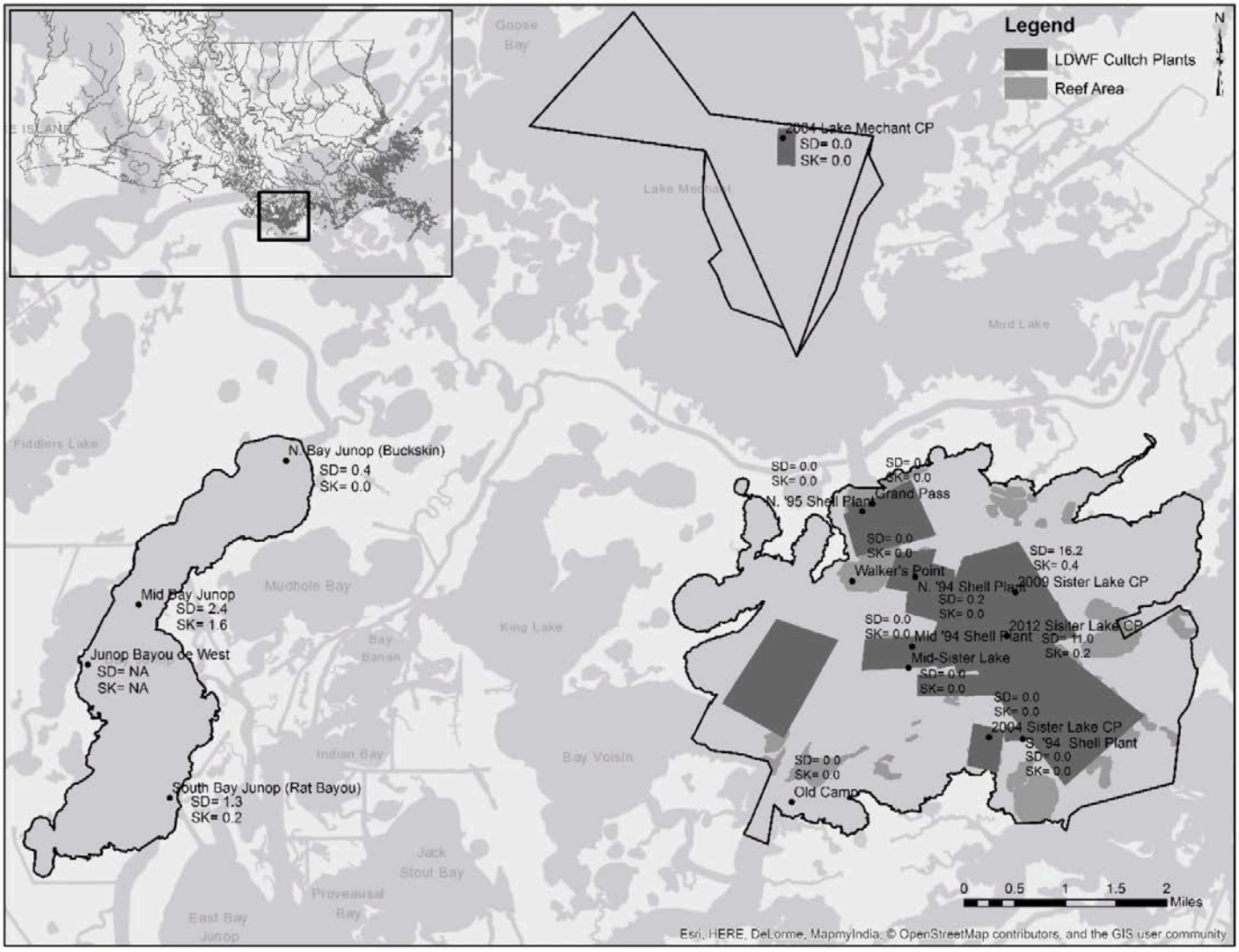

FIGURE 5.1. Public oyster areas within the western portion of CSA 5. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

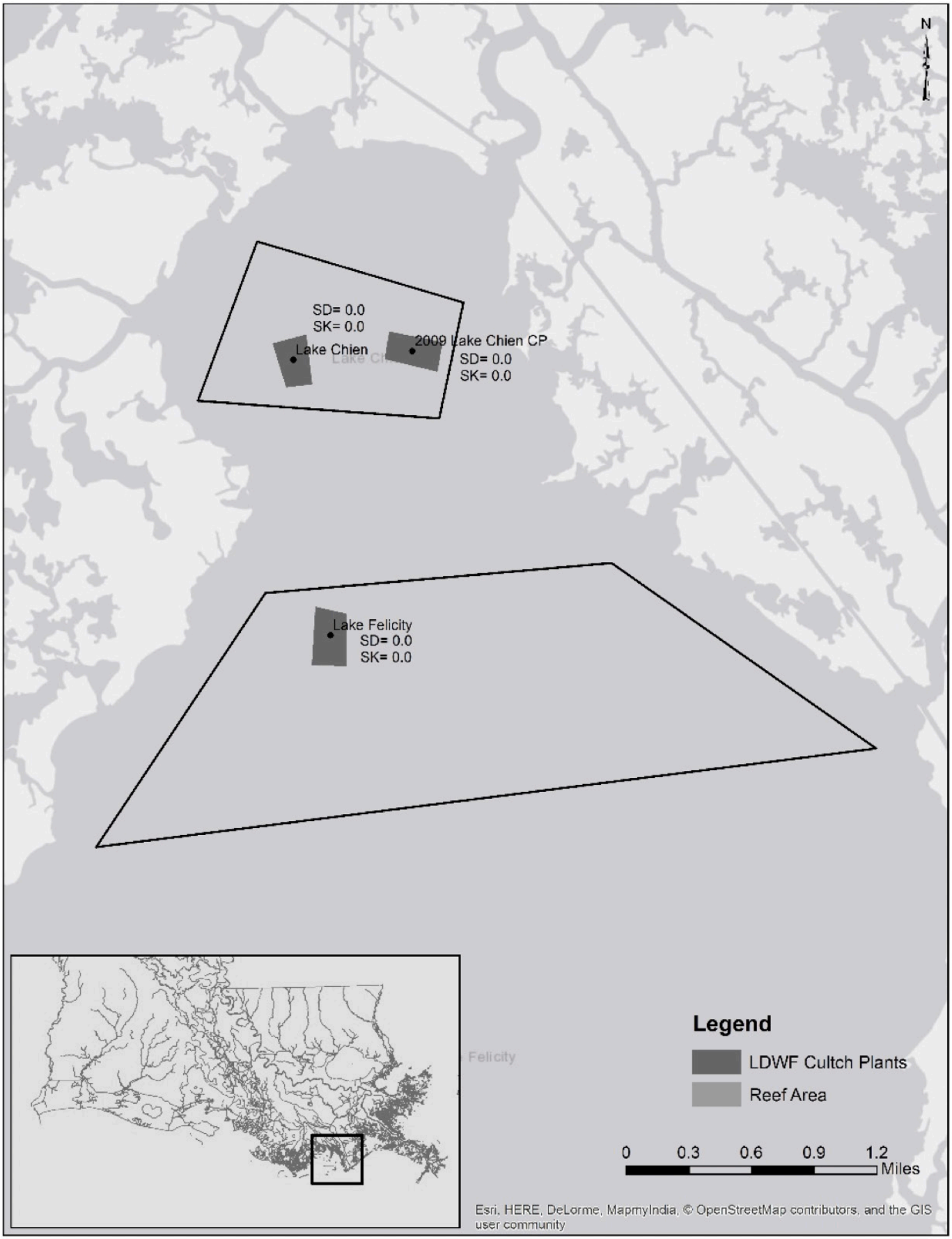

FIGURE 5.2. Public oyster areas within the eastern portion of CSA 5. Numbers below stations are average numbers of seed (SD) and market-size (SK) oysters per square meter.

The Commission designated Sister Lake (*Figure 5.1*) as a public oyster seed reservation in 1940; this area includes 9,150.5 acres of water bottom. Recent Sister Lake cultch plants include a 67-acre site in 2004, a 156-acre site in 2009, and a 358-acre site in 2012. The most recent (2012) was funded as part of the Deepwater Horizon oil spill NRDA Early Restoration Program. For oyster stock assessment purposes, the current total reef acreage for Sister Lake is estimated to be 2,375.4 acres.

The Commission established the Bay Junop Public Oyster Seed Reservation (*Figure 5.1*) in 1948; it consists of approximately 2,646.5 acres of water bottom. Due to the shallow water depth of the bay and inability of barges and tugs to enter for cultch plants, LDWF has not been able to construct any reefs in this area to augment natural oyster reef production. Available public reef acreage in Bay Junop is estimated at approximately 252 acres.

The Commission established the Lake Mechant Public Oyster Seed Grounds (*Figure 5.1*) in 2001 with approximately 2,100 acres of water bottom. In 2004, LDWF constructed a 30-acre cultch plant in this area. In 2007, the Commission added unleased water bottoms between the designated public oyster seed grounds and private oyster leases, increasing water bottom acreage within the Lake Mechant Public Oyster Seed Grounds to 2,583 acres. The total reef acreage outside of the 2004 cultch plant is unknown.

The Commission established the Lake Tambour (not shown), Lake Chien, Lake Felicity, and Deep Lake (not shown) Public Oyster Seed Grounds (*Figure 5.2*) in 2001. The upper portion of Lake Felicity was used as a Public Oyster Seed Reservation during the 1940s and early 1950s, but this was discontinued because salinities were usually too high for oyster production. However, future planned coastal freshwater diversion projects may return the area to a salinity regime that is more favorable for oyster production.

There are three cultch plants between the Lake Chien and Lake Felicity Public Oyster Seed Grounds including a 16- acre cultch plant in Lake Chien completed in 2004, a 40-acre cultch plant in Lake Felicity completed in 2004, and a 22-acre cultch plant due east of the initial Lake Chien cultch plant completed in May 2009. Outside of these cultch plants, there is no known reef in between the Lake Chien and Lake Felicity Public Oyster Seed Grounds. LDWF has not developed any reefs in Lake Tambour or Deep Lake.

Methods

LDWF biologists collected field samples for the 2020 oyster stock assessment on July 7-8 2020, from a total of 19 stations within CSA 5 according to the methodology described in the Statewide Overview of this report. Sampling stations included existing oyster reefs in Lake Felicity, Lake Chien, Sister Lake, Bay Junop, and Lake Mechant.

Beginning in 2013, biologists adjusted acreage in Sister Lake due to the footprint of the 2012 Cultch Plant and the combination of stations on overlapping reefs. They have maintained this adjustment for all assessments since then. There are additional details on stations and reef complexes affected in the 2013 Oyster Stock Assessment Report.

Results and Discussion

Seed and Market-Size Stock

The 2020 oyster stock assessment estimated the stock for CSA 5 at 51,291 bbls of seed oysters and 5,629 bbls of market-sized oysters in the western basin (Sister Lake, Bay Junop, and Lake Mechant), and 0 bbls of seed oysters and 0 bbls of market-sized oysters in the eastern basin (Lake Felicity and Lake Chien; *Tables 5.1-5.4; Figures 5.3-5.7*).

In Sister Lake, the most productive oyster area in CSA 5, estimated seed and market-size oyster availability for 2020 were 48% and 92% below long-term averages (2005-2019), respectively. The 2020 oyster stock assessment estimated 49,772 bbls of seed and 4,160 bbls of market-size oysters on the Sister Lake Public Oyster Seed Reservation, of which 45% (22,554 bbls) of available seed and 19% (820 bbls) of available market-size oysters were located on the 2012 Cultch Plant (*Figure 5.3*).

Bay Junop estimated seed and market-size oyster availability for 2020 were 48% and 54% below long-term averages (2005-2019), respectively. The 2020 oyster stock assessment estimated 1,519 bbls of seed and 1,469 bbls of market-size oysters in Bay Junop. No

TABLE 5.1. 2020 Sister Lake oyster availability by sampling station

Station Number	Reef (Acres)	Reef (square-meters)	Average Number Seed Oysters/ m^2	Average Number Market-size Oysters/ m^2	Bbls Seed Oysters	Bbls Market-Size Oysters
3020	320	1,296,253	7.1	0.7	12,842.5	2,640.5
3028	140	568,302	0.0	0.0	0.0	0.0
3015	56	225,694	0.0	0.0	0.0	0.0
3021	191	773,114	0.2	0.0	214.8	0.0
3022	552	2,235,653	0.0	0.0	0.0	0.0
3023	513	2,075,194	0.0	0.0	0.0	0.0
3026	82	332,896	0.0	0.0	0.0	0.0
3042	156	629,369	16.2	0.4	14,160.8	699.3
Cultch Plant (2012)	365	1,476,298	11.0	0.2	22,554.5	820.2
Total	***2,375***	***9,612,773***	***34.5***	***1.3***	***49,772.5***	***4,160.0***

**Average of stations 3020/200, 3010/202, and 3024/216 to represent the Grand Pass reef complex.*

TABLE 5.2. 2020 Bay Junop/Lake Mechant oyster availability by sampling station.

Station Number	Reef (Acres)	Reef (square-meters)	Average Number Seed Oysters/ m^2	Average Number Market-size Oysters/ m^2	Bbls Seed Oysters	Bbls Market-Size Oysters
3038	17	69,606	0.4	0.0	38.7	0.0
3035	67	272,598	1.3	0.2	492.2	151.4
3036	73	296,474	2.4	1.6	988.3	1,317.7
3029	30	121,406	0.0	0.0	0.0	0.0
Total	***187***	***760,083***	***4.1***	***1.8***	***1,519.1***	***1,469.1***

**Average of stations 3035 and 3037 to represent the South Bay Junop reef complex.*

TABLE 5.3. 2020 Lake Chien/Lake Felicity oyster availability by sampling station.

Station Number	Reef (Acres)	Reef (square-meters)	Average Number Seed Oysters/ m^2	Average Number Market-size Oysters/ m^2	Bbls Seed Oysters	Bbls Market-Size Oysters
3040	16	64,750	0.0	0.0	0.0	0.0
3039	40	161,875	0.0	0.0	0.0	0.0
3041	22	90,245	0.0	0.0	0.0	0.0
Total	***78***	***316,870***	***0.0***	***0.0***	***0.0***	***0.0***

TABLE 5.4. Oyster availability and percent change from the 2019 to 2020 assessment for both regions of CSA 5.

Region	Area	Bbls of Seed Oysters			Bbls of Market-Size Oysters		
		2019	2020	Change	2019	2020	Change
Western Terrebonne Basin	Sister Lake	53,758.0	49,772.5	-7.4%	6,852.1	4,160.0	-39.3%
	Bay Junop	1,035.5	1,519.1	46.7%	809.2	1,469.1	81.6%
	Lake Mechant	404.7	0.0	-100.0%	0.0	0.0	0.0%
Eastern Terrebonne Basin	Lake Chien	36.0	0.0	-100.0%	36.0	0.0	-100.0%
	Lake Felicity	0.0	0.0	0.0%	0.0	0.0	0.0%

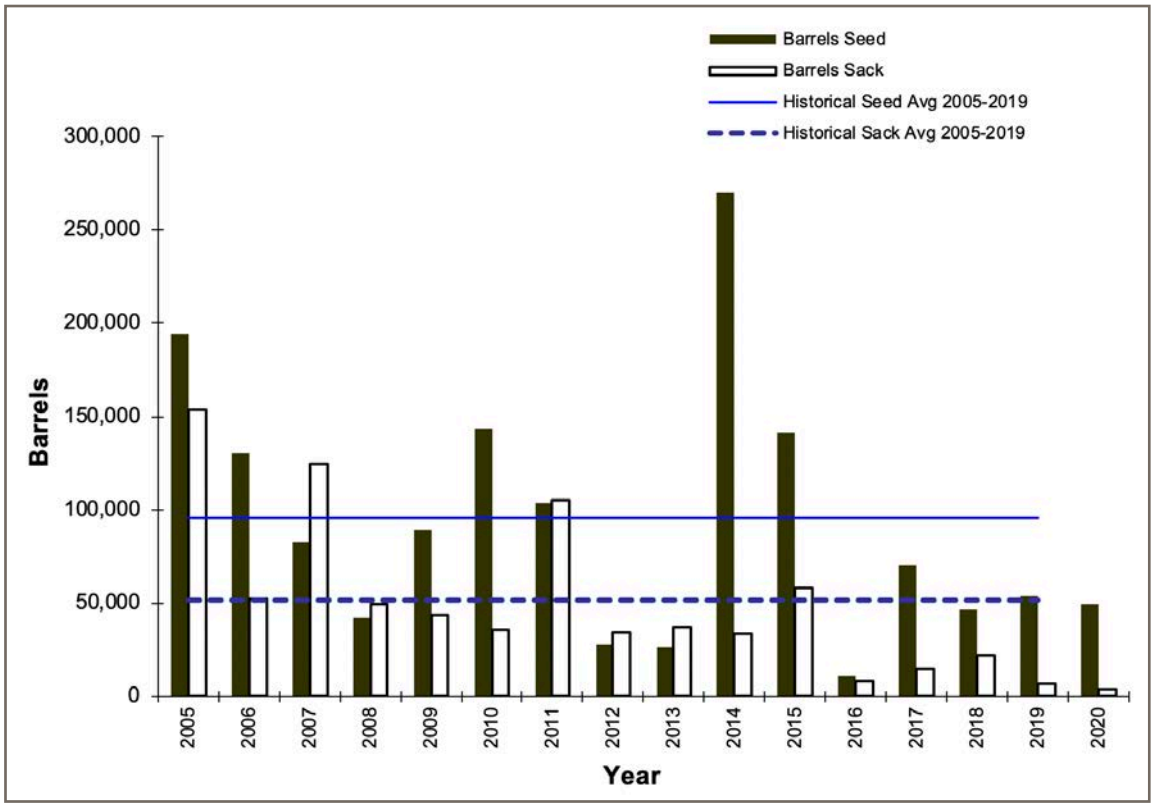

FIGURE 5.3. Sister Lake historical oyster stock availability.

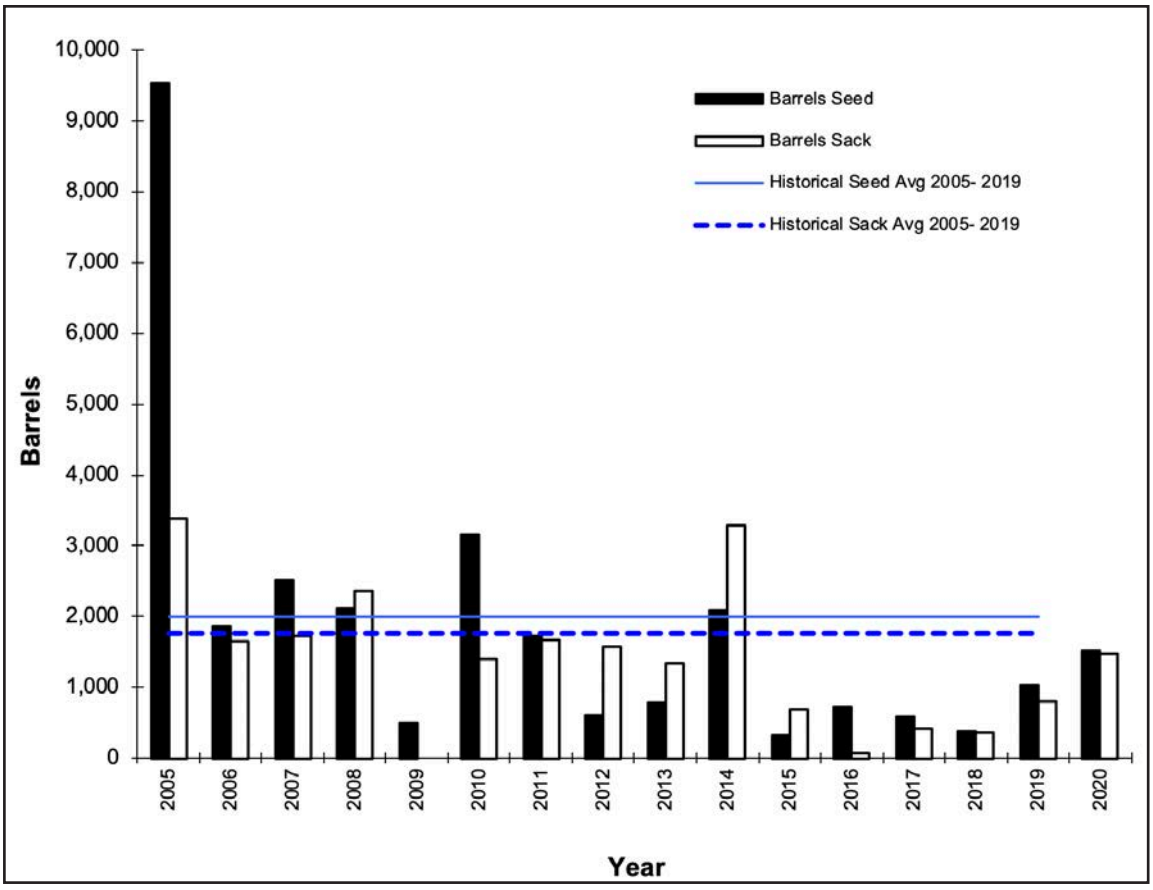

FIGURE 5.4. Bay Junop historical oyster stock availability.

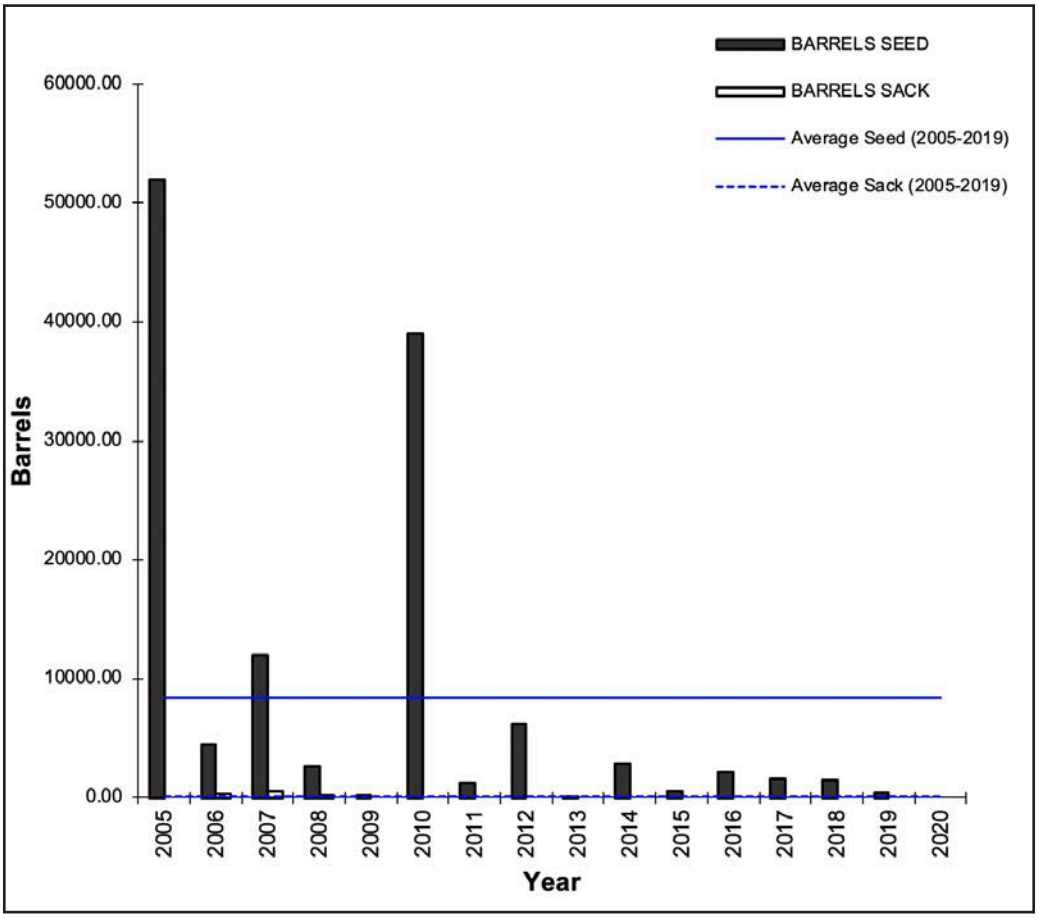

FIGURE 5.5. Lake Mechant historical oyster stock availability.

resource was collected in Lake Mechant (*Figures 5.4 and 5.5*).

Continued marsh degradation in the eastern Terrebonne Basin allows salinities to fluctuate widely based on prevailing wind direction, and the constant erosion added sediment to the system, which can increase reef burial. The majority of the Lake Felicity cultch plant was covered with sediment and has shown zero productivity of market-size oysters in the last eight years.

Spat Production

Average number of oyster spat ranged from 0 to 50.2 per sampling station in 2020. Rat Bayou complex, within Bay Junop POSG had the highest number per sample, with an average of 50.2. In the western Terrebonne Basin, most samples showed an increase in the number of spat present; in the eastern Terrebonne Basin, Lake Felicity remained with no recovered spat while Lake Chien had a decrease in spat collection than in the previous year.

Hydrological Data

Average water temperatures for May and June 2019 (the two months prior to sampling) on each public oyster area in CSA 5 ranged from 23.9 to 25.2°C, below the long-term mean of 27.8°C (2005-2019). Average salinities for May and June ranged from 0.5 to 16.6 ppt.

Eastern Terrebonne average salinity was 16.4 ppt, below the long-term mean of 18.2 ppt. Sister Lake, Bay Junop and Lake Mechant average salinities were 7.4, 8.0, and 0.5 ppt, respectively, below the long-term means of 13.2, 13.9, and 4.7 ppt, respectively.

Lake Mechant and the northern portion of Bay Junop, near Buckskin Bayou (Sampling station 3038), receive input from the Atchafalaya River via Blue Hammock Bayou on an annual basis. This continues to have a large influence on salinity levels, which inhibits and affects oyster growth and productivity in this area.

Biologists collected these data during dredge samples. Temperature and salinity measurements collected concurrently with square-meter sampling in July averaged 26.9°C and 10.1 ppt, respectively in the eastern Terrebonne Basin, and 28.1°C and 3.6 ppt in the western Terrebonne Basin.

Mortality

Biologists observed no market-sized oyster mortality throughout CSA 5 during 2020 square-meter samples. Seed and spat mortality was noted in Sister Lake and Bay Junop. Overall seed mortality in Sister Lake was 1.2% and spat mortality was 1.7%. Overall seed mortality in Bay Junop was 3.6% and spat mortality was 3.6%.

Fouling Organisms, Predators and Disease

Biologists collected three types of incidental species (hooked mussel, mud crab, and oyster drill) during 2020 square-meter sampling. Hooked mussels were the most abundant incidental species and were more prevalent in western Terrebonne Basin samples, with an overall average of 5.3 hooked mussels per sample. Of this overall average, Bay Junop had the highest occurrence with 17.0 hooked mussels per sample and 0.4 oyster drills per sample; Eastern Terrebonne Basin samples showed an average of 0.2 oyster drills per sample.

Tropical and Climatic Events

Tropical Storm Cristobal made landfall in the Southeast Louisiana on June 7, 2020. The storm had little to no impact on all POSR/POSG within the Terrebonne Basin.

2019/2020 Oyster Season

The commission opened Sister Lake for harvest of both seed and market-sized oysters on Nov. 18, 2019, and closed on Nov. 25, 2019. Seed harvest was only open for one day; with an estimated 1,250 bbls of seed harvested. A daily take and possession limit of 25 sacks was imposed during the 2019/2020 market-size season. An estimated yield of 10,314 sacks of market-size oyster were harvested in Sister Lake.

The Commission did not open Bay Junop, Lake Mechant, Lake Chien or Lake Felicity during the 2019/2020 season.

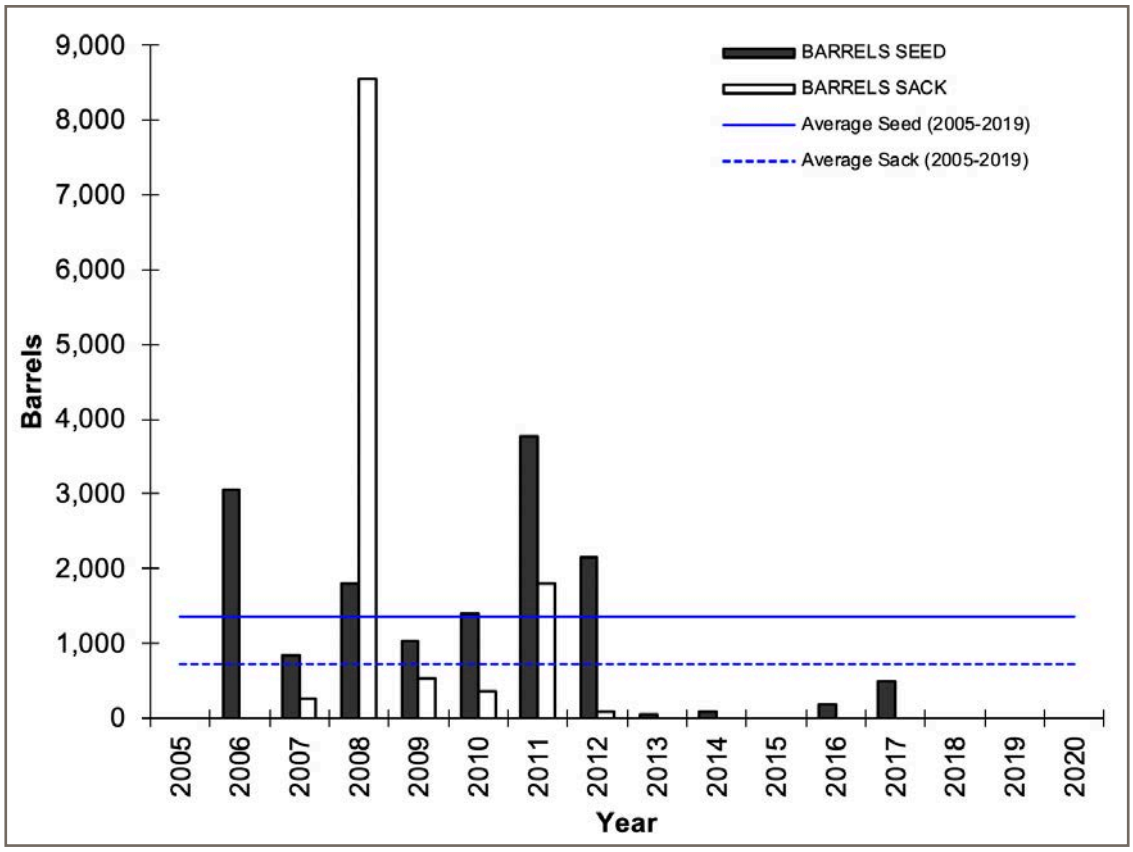

FIGURE 5.6. Lake Felicity historical oyster stock availability

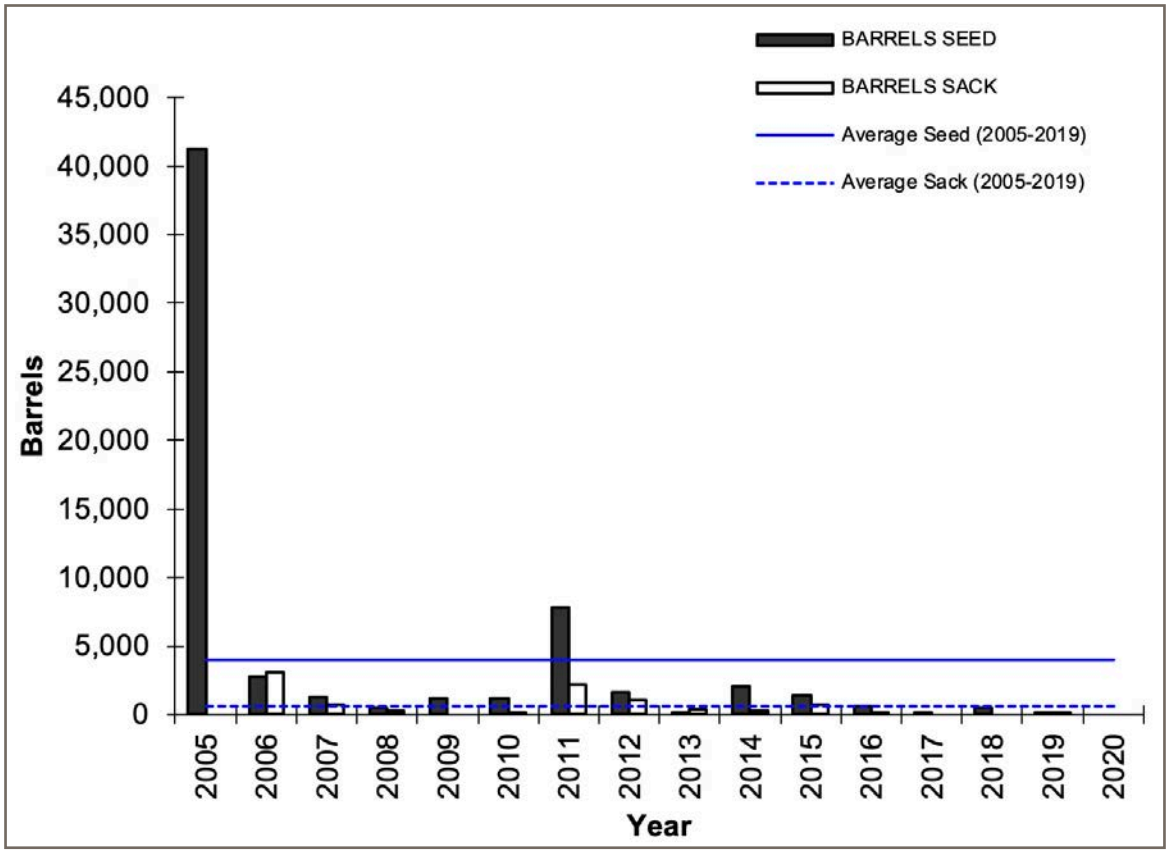

FIGURE 5.7. Lake Chien historical oyster stock availability.

CSA 6

Introduction

CSA 6 includes oyster reefs found in the Vermilion/East and West Cote Blanche/Atchafalaya Public Oyster Seed Grounds. The Commission established the inside portion of these Public Oyster Seed Grounds in 1990; this area consists of state water bottoms found generally north of a line from the western shore of Vermilion Bay and Southwest Pass eastward to Point Au Fer. The Commission established the outside portion of these Public Oyster Seed Grounds in 1988; this area consists of Louisiana State Territorial Waters from the private oyster lease boundary near Mound Point/Marsh Island eastward to Point Au Fer. LDWF managed the oyster resources found on local state water bottoms in a manner similar to current management procedures for public oyster seed grounds. Management allowed limited harvest/relays from the Vermilion Bay area reefs when oyster abundance and distribution permitted.

The Vermilion/East and West Cote Blanche/Atchafalaya Bays complex is a large, primarily open-water brackish system; the Public Oyster Seed Grounds in this area consist of approximately 541,787 acres of water bottom. Primary influences on the bays' dynamic salinity regime are the Gulf of Mexico, Atchafalaya River and the adjacent Wax Lake Outlet, and the Vermilion River. In general, freshwater discharge from the Atchafalaya River highly influences the Public Oyster Seed Grounds within CSA 6. Independent of local rainfall, biologists have noted a historical negative correlation between increased Atchafalaya River flow and reduced salinity levels in the bay system. Typically, oyster reproduction occurs in the fall after the river stage abates, with oysters growing to seed size (1 inch to less than 3 inches) by the following spring. However, spring and early summer floodwaters depress salinities, placing extreme physiological stress on the organisms. These low salinities, coupled with high water temperatures through the summer months, typically result in extensive oyster mortalities on the public grounds. Occasionally, however, reduced freshwater inflow from the Atchafalaya River leads to higher-than-normal salinities, and the normal annual cycle of extensive oyster mortalities is broken, leading to a harvestable population of seed oysters during the following oyster season (September through April). Such was the case in 2000, 2001, 2005, 2006, 2007, 2013, 2014, and 2017 when sizable quantities of seed oysters were available for harvest. LDWF manages these seed grounds similar to other areas allowing limited harvest and relays when oysters are in abundance.

An overall oyster stock assessment for CSA 6 is not possible at this time, as figures relative to oyster reef sizes are not available. This report compares data collected from the 2020 oyster stock assessment sampling to previous years' sampling data, with a look at hydrologic conditions, marine fouling, and oyster predators on sampled reefs. In addition, the report also presents information regarding the 2019/2020 oyster season harvest on CSA 6 Public Oyster Seed Grounds.

Methods

LDWF biologists collected field samples for this report on July 8, 13 and 14, 2020, from a total of 11 stations (*Figure 6.1*) within CSA 6 according to the methodology described in the Statewide Overview of this report.

Results and Discussion

Seed and Market-Size Stock

Biologists found live seed oysters at six of the 11 sampling stations (*Figure 6.1*). Densities of live seed ranged from 0.2 per replicate at three different sites to a high of 2.8 at Nickle Reef. Biologists collected no market-size oysters at any sample site within CSA 6.

Low production years associated with extended periods of high Atchafalaya River output are not uncommon on the seed grounds of this bay system; 10 of the previous 12 years, biologists noted close to 100% oyster mortality on the grounds. During the second half of 2019 and first half of 2020, Atchafalaya River levels were above the 10 year average. The result of a high river was depressed salinities and less than favorable conditions to promote oyster production. No market size oysters were found and the average density of seed oysters per sample was the lowest seen since 2015 which was another high river year (*Table 6.1; Figure 6.1*).

Spat Production

Despite the presence of suitable substrate at all sampling stations, biologists found live spat at only five of the 11 sampling stations. Densities of spat ranged from 0.2 per replicate at Big Charles, Lighthouse Point and High Spot to a high of 2.8 per replicate at Nickle Reef. Low spat productivity during periods of high Atchafalaya River flow (with associated low salinity conditions) are common in this bay system.

Fouling Organisms

Biologists documented an overall 42% decrease in hooked mussel abundance at the sampling stations compared to the 2019 oyster stock assessment. They noted an increase in density at two stations while density decreased at six stations. Three stations experienced no change in hooked mussel abundance. The Indian Point sample station showed the largest decrease in hooked mussel density per replicate dropping to an average of 0.8 in the 2020 oyster stock assessment compared to 8.2 in the 2019 oyster stock assessment. Nickle Reef showed the largest increase in hooked mussel density jumping from 0.0 mussels per replicate in 2019 to 4.2 mussels per replicate in 2020.

Oyster Predators

Biologists found only one southern oyster drill during square-meter sampling at the Lighthouse Point sample site. These marine snails

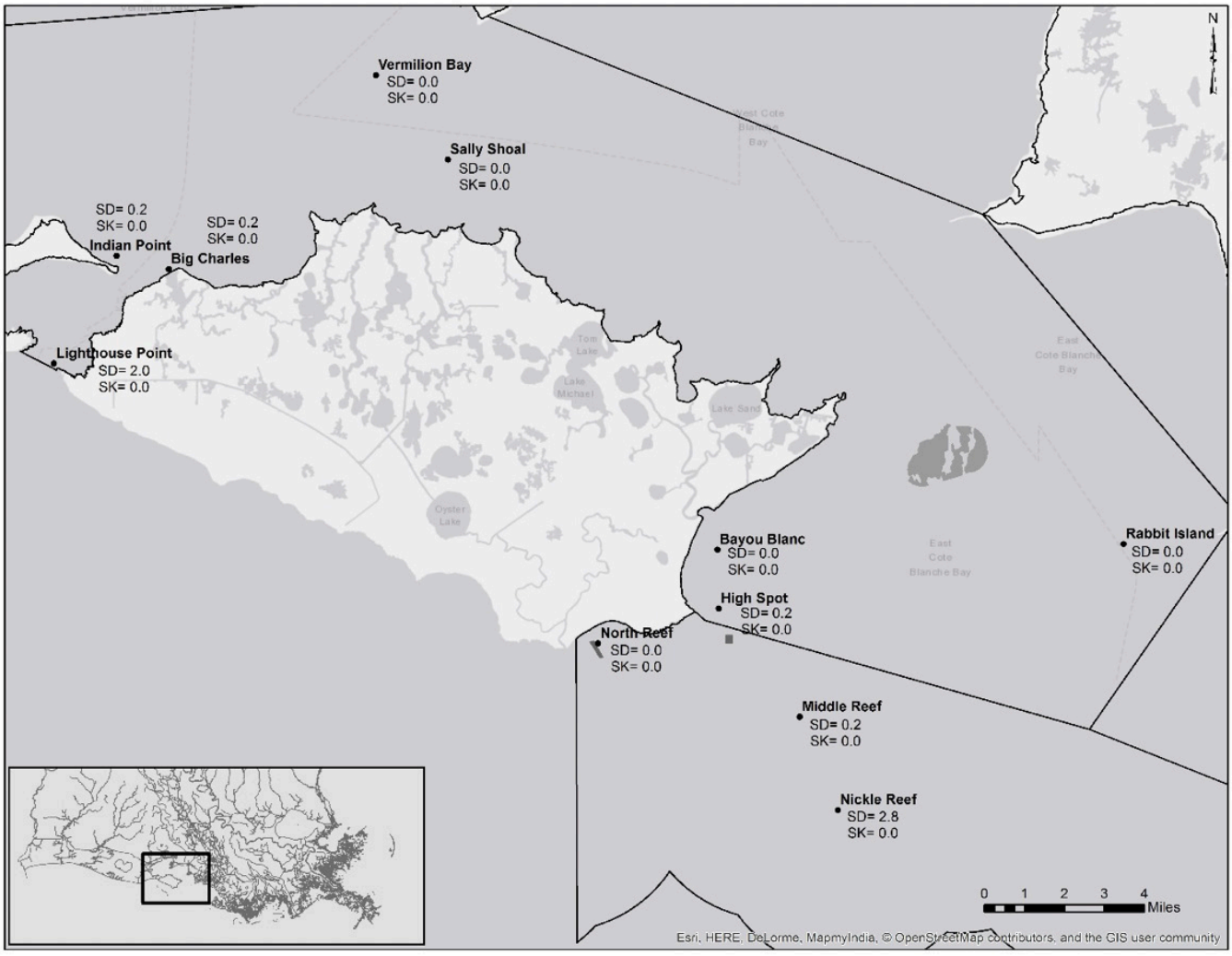

FIGURE 6.1. 2020 Coastal Study Area 6 oyster square-meter sampling stations of the Vermilion/East and West Cote Blanche/ Atchafalaya Bays Public Oyster Seed Grounds. (SD = average number of seed and SK = average number of sack or market-size oysters per square meter).

TABLE 6.1. Average density of live seed and market-size oysters collected in Coastal Study Area 6 square-meter samples by year.

Year	Average density seed/sample	Average density market-size/ sample	Seed/market-size ratio
2005	14.8	0	No Market-size Oysters
2006	16.1	0.5	32:1
2007	11.6	0.8	15:1
2008	1.3	0	No Market-size Oysters
2009	3.4	0	No Market-size Oysters
2010	0.8	0.12	7:1
2011	0.32	0.02	16:1
2012	1.78	0.04	45:1
2013	0.3	0.02	15:1
2014	1.12	0.08	14:1
2015	0.44	0	No Market-size Oysters
2016	1.2	0.16	8:1
2017	0.58	0.11	5:1
2018	2.13	0.05	43:1
2019	1.25	0.07	18:1
2020	0.51	0	No Market-size Oysters

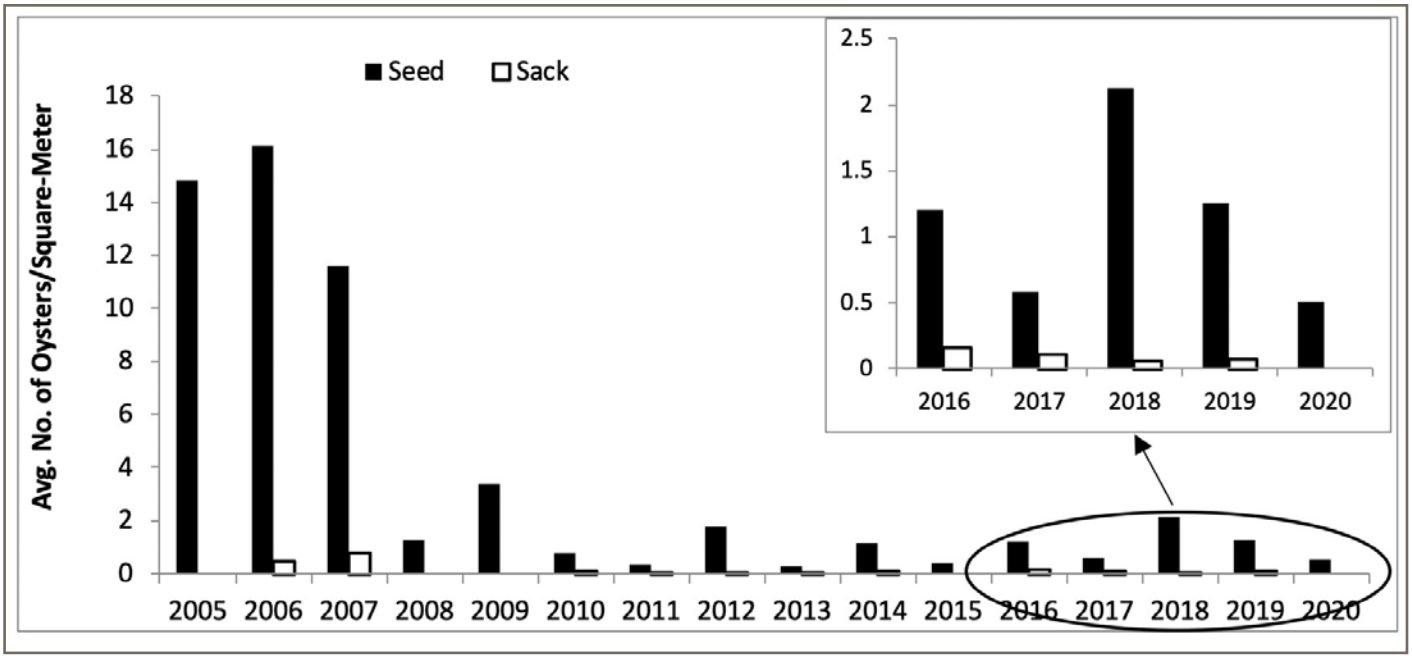

FIGURE 6.2. Average density of live seed and market-size size oysters collected in Coastal Study Area 6 square-meter samples by year.

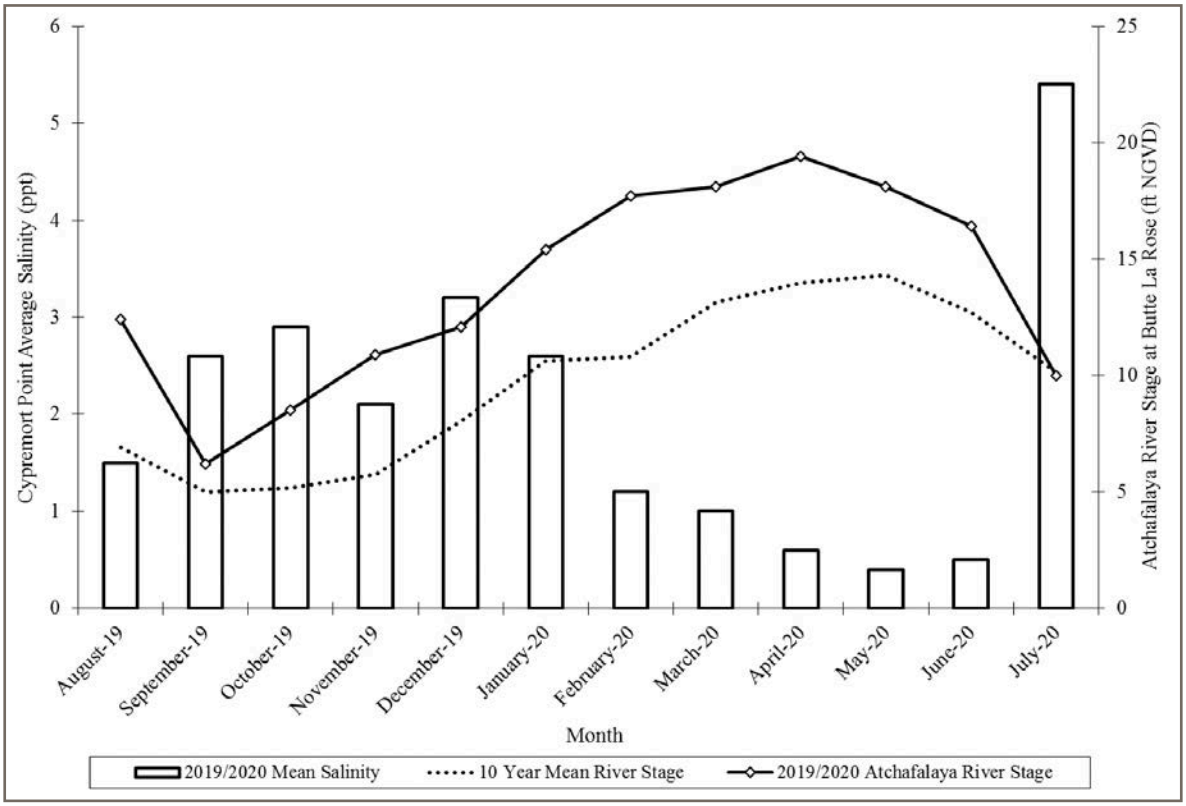

FIGURE 6.3. Atchafalaya River levels 10 year mean river stage at Butte La Rose gauge and average monthly salinity at Cypremort Point.

are more often associated with high salinity waters where they are known to prey heavily on oysters and other bivalve species. The occurrence of mud crab on historically sampled reefs increased by 767% compared to 2019 oyster stock assessment. Eight of the 11 sampled reefs had mud crabs, and mud crab density reached a high of 5.2 crabs per replicate at Lighthouse Point. Biologists collected three blue crabs and one stone crab during the 2020 square-meter sampling.

Mortality

In the second half of 2019, the high Atchafalaya River levels kept mortality high, as observed in monthly dredge samples collected throughout the year. While salinities in the area were depressed and the temperatures were high during August, September and October, oyster mortalities were high. Supplemental oyster dredge samples were collected at the end of August at Nickle Reef, Big Charles and Lighthouse Point to monitor effects of the Mississippi River/Atchafalaya River flooding that was occurring at the time. These samples were collected on Aug. 27, 2019 and showed total mortalities of 83.7% at Nickle Reef, 77.1% at Big Charles, and 79.7% at Lighthouse Point. Even when bottom salinity levels started to return to normal in September, eastern dredge sites still showed high total mortalities. September 2019 dredge samples taken at Bayou Blanc, High Spot, Middle Reef and Nickle Reef showed total mortalities of 100, 71.4, 71.4 and 77.8%, respectively. Dredge samples collected in October of 2019 showed that total survival was beginning to improve due to higher salinities and lower water temperatures. However, only six of the 10 dredge sample sites contained live oysters. Oyster mortalities remained relatively low during the end of 2019 and through the first half of 2020. Only six of eleven sites sampled during the 2020 square-meter sampling event contained live oysters. The oyster stock found in CSA 6 is highly vulnerable to depressed salinity/high turbidity conditions often seen as a result of extended freshwater conditions associated with high Atchafalaya River discharge. Independent of local rainfall, biologists have noted a historical negative correlation between Atchafalaya River flow and salinity levels in the bay system (*Figure 6.3*).

Tropical and Climatic Events

Atchafalaya River levels were elevated since the beginning of September 2018 and the river stage remained well above the 10-year monthly average river stage through August 2019 and dipped to near-average in September 2019 (*Figure 6.3*). The Atchafalaya River level remained above average until July 2020 when a sharp decline occurred resulting in a rebound in salinity levels.

Tropical Storm Cristobal was a fast moving tropical storm that made landfall on June 7, 2020 at 10:10 p.m. east of Grand Isle, Louisiana. Top wind speeds were 50 mph and most of the storm activity was east of center, affecting SE Louisiana, Mississippi, Alabama and the Florida panhandle. No damage to fisheries infrastructure was noted within CSA 6.

2019/2020 Oyster Season

The Commission kept the Vermilion/East and West Cote Blanche/Atchafalaya Bay public oyster seed grounds closed for the entire 2019/2020 oyster season. The LDH Shellfish Harvest Areas that were "OPEN" during October 2019 consisted only of partial Area 28. Areas 25, 26, and 27 were not open to harvest.

CSA 7

Introduction

CSA 7 is located in Southwest Louisiana, from the Louisiana/Texas state line to Freshwater Bayou in Vermilion Parish. It is comprised of the Calcasieu and Mermentau River basins and the eastern portion of the Sabine River Basin. Calcasieu Lake is located at the southern end of the Calcasieu River Basin in Calcasieu and Cameron parishes; the lake consists of approximately 58,260 acres of water bottom with oyster reefs located throughout, especially in the southern end. There are no oyster harvesting areas in the Mermentau River Basin. Sabine Lake, located at the southern end of the Sabine River Basin in Cameron Parish, consists of approximately 55,057 acres of water bottom. Approximately 34,067 acres are located in the Louisiana portion of the lake; the remainder is in the Texas portion. Oyster reefs are mainly found in the very southern Louisiana portion of the lake.

For assessment purposes, Calcasieu Lake has always been divided into two areas – East Side and West Cove (with the Calcasieu Ship Channel being the dividing line). The Louisiana Department of Health (LDH) classified the areas as conditionally managed giving LDH the authority to close the areas to oyster harvest based on health-related concerns due to poor water quality. It has been established that health related closures of oyster harvest in Calcasieu Lake (East Side) occur when the Calcasieu river stage reaches 13.5 feet, and the West Cove closes when the river stage reaches 9 feet. Once the river falls below these levels for 48 hours, the LDH reopens the areas for harvest. Additionally, the East Side of Calcasieu Lake and West Cove are classified as Growing Area 29 (GA29) and Growing Area 30 (GA30), respectively (*Figure 7.1*). LDH seasonal closure lines also limit the amount of acreage available to oyster harvest on the East Side due to water quality standards

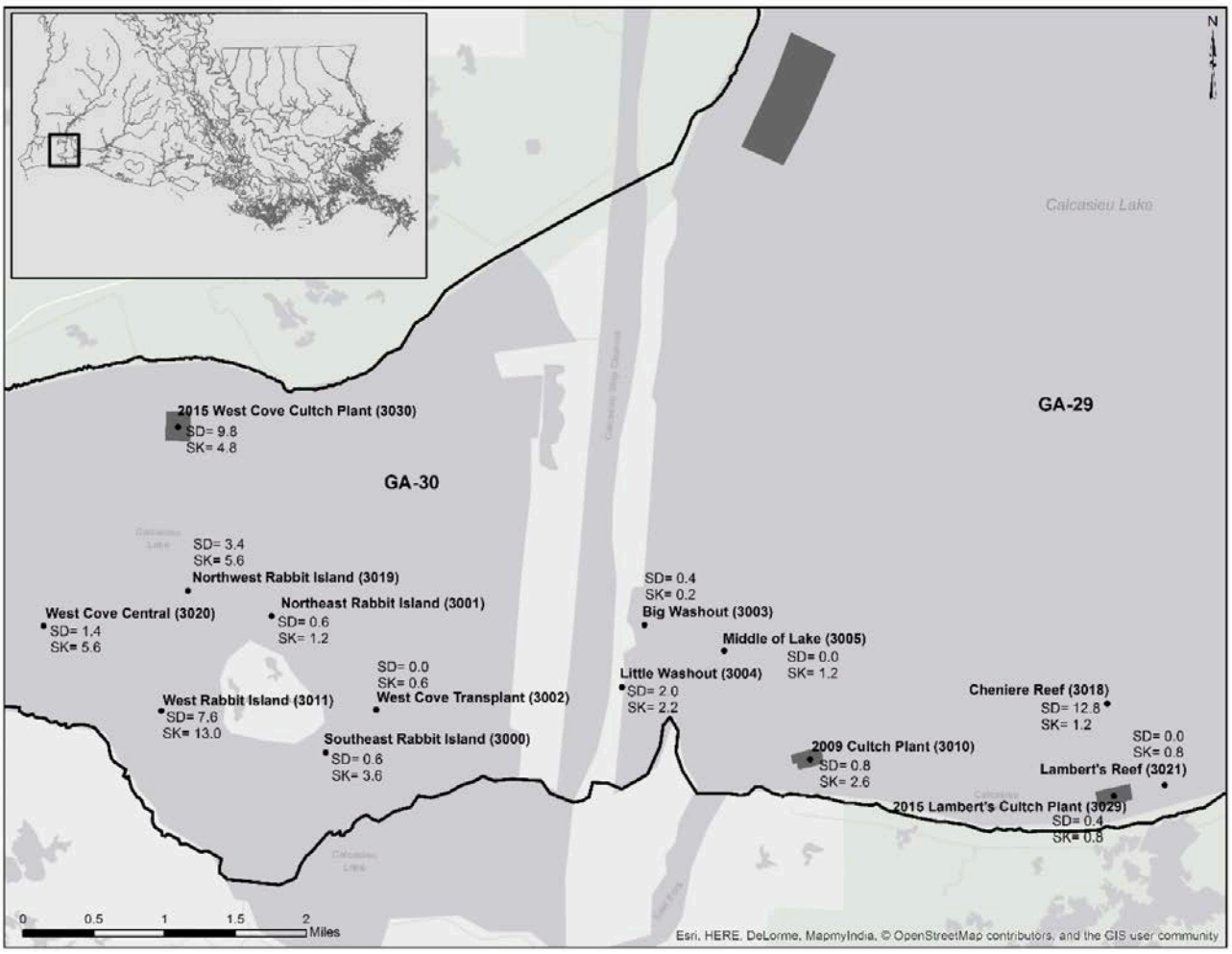

FIGURE 7.1. 2020 Coastal Study Area 7 oyster stock assessment sampling stations in Calcasieu Lake with average seed (SD) and sack (SK) oyster densities for each sampling station.

(prohibited area in the northern part of the lake). Oysters can only be harvested in the southern portion of the area (GA29) where water quality meets minimum standards.

Since 2011, LDWF oyster stock assessments in Calcasieu and Sabine Lakes have used acreage estimates determined by side-scan sonar water bottom assessments conducted in 2008 and 2011. LDWF identified all suitable oyster habitat (Bottom Type IIIB) within the LDH Public Oyster Growing Areas in Calcasieu Lake and classified this habitat into one of two bottom types: reef or scattered shell. The results of the side-scan studies estimated that East Side has a total of 1,962.3 acres of suitable oyster habitat, including 1,435.8 acres of reef and 526.5 acres of scattered shell bottom, and that West Cove has a total of 3,387.8 acres of suitable oyster habitat, including 1,119.6 acres of reef and 2,268.2 acres of scattered shell bottom (*Figure 7.2*). After extensive poling and sampling done by CSA 7 staff between 2018 and 2019 of the scattered shell bottom type in the East Side it was determined that no suitable bottom-type material and no live oysters were present. Therefore, the 526.5 acres of scattered shell was deleted from oyster habitat calculations. 2020 stock assessment availability calculations are based using 1,435.8 acres of reef habitat. The acreage estimates only include those areas of Calcasieu Lake that lie within the LDH allowed harvest areas.

The Louisiana portion of Sabine Lake (GA31) has approximately 34,067.0 water bottom acres; 1,479.5 acres of oyster habitat which includes 1,041.0 acres of Reef and 438.5 acres of Scattered Shell bottom type (*Figure 7.3*). Oyster seasons in Sabine Lake have not occurred since the early 1960's based on anecdotal information; neither Texas nor Louisiana can document concrete harvest data from Sabine Lake. LDWF has monitored oyster populations in Sabine using established monitoring stations and conducting annual oyster stock assessments, but in the 2018 regular legislative session, Act 159 was passed placing a permanent moratorium on the harvest of oysters in Sabine Lake. LDWF currently conducts population stock assessments every other year. No stock-assessment sampling was conducted on Sabine Lake in 2020.

Methods

LDWF biologists collected field samples for the 2020 oyster stock assessment on July 8 and 9, 2020 from a total of 14 stations within Calcasieu Lake according to the methodology described in the Statewide Overview of this report.

As there are no bedding (seeding) operations in Calcasieu and Sabine Lakes, and all harvest is for direct market. Biologists report the data collected in sacks of market-size oysters rather than in barrels (bbls), the standard unit of measure used for oysters in other parts of coastal Louisiana. For market-size oysters, 180 oysters equals one sack. Two sacks equal one barrel (bbl).

Results and Discussion

Seed and Market-Size Stock

Calcasieu Lake

The 2020 stock assessment estimated that the current oyster stock in Calcasieu Lake was approximately 465,565 sacks (232,782.5 bbls) of market-size oysters and 113,533 sacks (56,766.50 bbls) of seed oysters (*Table 7.1*). As in previous years, the majority of Calcasieu Lake's market-size oysters were located in West Cove.

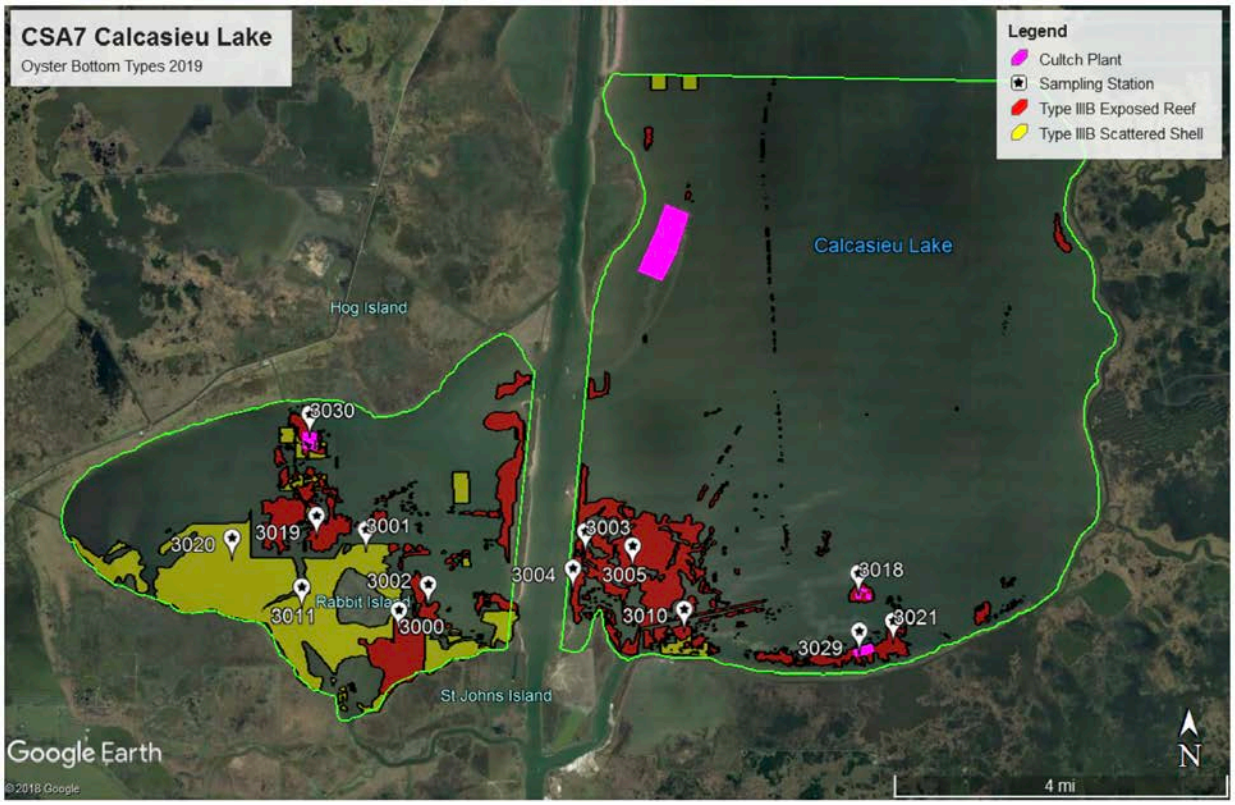

FIGURE 7.2. Estimated high quality oyster habitat (updated in 2019) coverage in Calcasieu Lake as delineated by side-scan sonar water bottom studies along with poling and sampling.

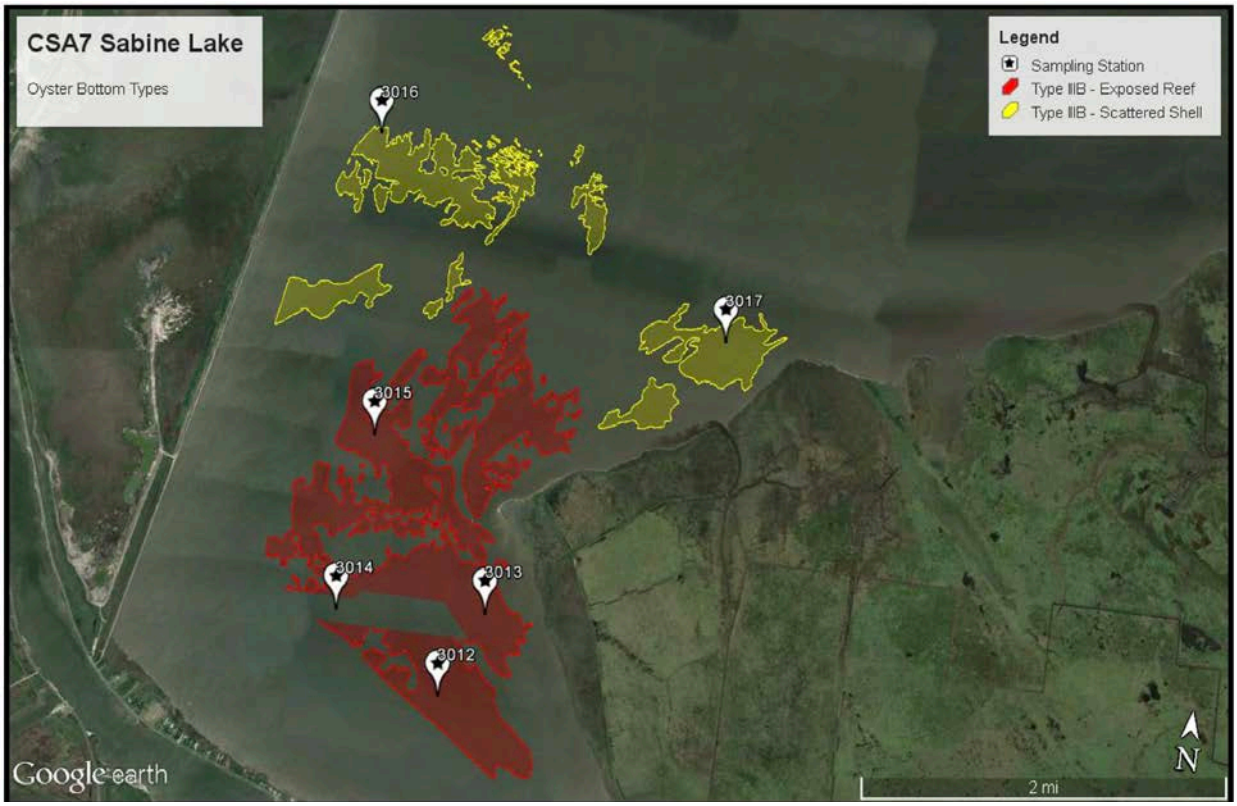

FIGURE 7.3. **Estimated high quality oyster habitat (Bottom type IIIB) coverage as delineated by side-scan sonar water bottom studies in Sabine Lake.**

The population of market-size oysters on the East Side of Calcasieu Lake grew 98.9% from 2019 to 2020 (*Table 7.2*). Market-size oyster numbers have increased from the 2019 oyster stock assessment; however, oyster populations remain 63.4% below the long-term average for this area. After many years of low oyster populations, it appears that some recovery is occurring in some of the historic reef areas near the "Washouts" on the East Side.

There was continued increase in numbers of market-size oysters in West Cove from 2019 to 2020. The estimated populations increased 151.6% from 2019. This is a remarkable increase from the previous year and also marks the fourth year in a row that market-size oysters have increased in West Cove. The population of oysters in this area is 49% above the long-term average (*Table 7.2*).

Seed Production

LDWF biologists continue to be concerned about low numbers of seed oysters in Calcasieu Lake. Despite the large increase in market-sized oysters in the East Side, seed-sized oyster numbers fell 57.8% to 12,836 sacks (6,418.00 bbls) compared to 2019 (*Table 7.2*). This is the lowest assessment of seed-sized oysters in this area since 2013.

Similar to the East Side, seed-size oyster numbers were lower in West Cover than last year. Based on our estimates, West Cove has approximately 100,698 sacks (50,349.00 bbls) of seed oysters (*Table 7.2*). This results in an 18.8% reduction from the previous year.

Hydrological Data

Average water temperatures recorded during dredge samples for Calcasieu Lake in May and June were 24.8 and 27.1oC respectively. These temperatures are slightly below the long-term average for these months (*Figure 7.4*). The average water temperature during the 2020 oyster assessment (July) was 28.9oC, slightly lower than the long-term average temperature of 29.9oC.

Average salinities recorded during dredge samples for Calcasieu Lake in May and June 2020 were 11.0 and 10.3 ppt, respectively. The salinity for May and June was considerably lower than the long term average for these months (*Figure 7.4*). During our July stock assessment sampling we recorded salinities that averaged 15.4ppt. This salinity is slightly lower than the long term average of salinities typically observed during this month.

Sabine Lake

Due to the legislation that was passed during the 2018 Regular Legislative Session, Sabine Basin has been closed to oyster harvest by Act 159, therefore, it was decided that a complete population assessment would only be conducted on a biennial basis in Sabine Lake. The last assessment was in 2019; the next assessment will be in 2021.

2019/2020 Oyster Season

The Commission opened East Side and West Cove beginning Nov. 1, 2019, with a daily sack limit of 10 sacks/vessel/day (*Table 7.3*). The East Side closed Jan. 26, 2020, while the West Cove closed April 30, 2020.The only allowable method of harvest in the Calcasieu Basin is tonging.

Based on LDWF seafood dealer interviews, approximately 8,289 sacks of market-size oysters were landed from East Side and West Cove combined during the 2019/2020 season (*Figure 7.5*),

TABLE 7.1. 2020 estimated oyster availability between East Side and West Side in Calcasieu Lake.

Public Oyster Area	Sacks of Seed Oysters	Sacks of Market Oysters
East Side	12,836	46,105
West Cove	100,698	419,460
Total Harvest Area	***113,533***	***465,565***
Seed/Market Total (sacks)		***579,098***

TABLE 7.2. Oyster stock assessments, in sacks, and percentage change of public oyster areas of East Side and West Cove in Calcasieu Lake.

Year	Market Oysters (≥ 3")		Seed Oysters (< 3")	
	East Side	West Cove	East Side	West Cove
2008	752,062	142,200	449,720	212,483
2009[1]	612,687	711,614	191,436	422,521
2010[1]	23,540	689,376	8,545	605,984
2011[2]	27,008	594,744	52,832	308,927
2012	0	236,440	0	85,171
2013	0	169,038	0	59,511
2014	0	188,616	24,210	213,951
2015	16,862	54,509	47,763	36,075
2016	27,024	45,576	34,398	57,131
2017	11,236	92,884	13,776	31,322
2018	18,390	144,101	17,647	43,270
2019	23,176	166,735	30,417	124,010
2020	46,105	419,460	12,836	100,698
AVERAGE*	***126,012***	***281,176***	***72,713***	***183,363***
% Change from average	*-63.4*	*49.2*	*-82.3*	*-45.1*
% Change from 2019	*97.6*	*151.6*	*-60.2*	*-18.8*

1 - Assessed using updated reef acreage from ENCOS (3,907.1) in 2008.
2 - Assessed using updated reef acreage from ENCOS (2008) and Bio-West (2011).

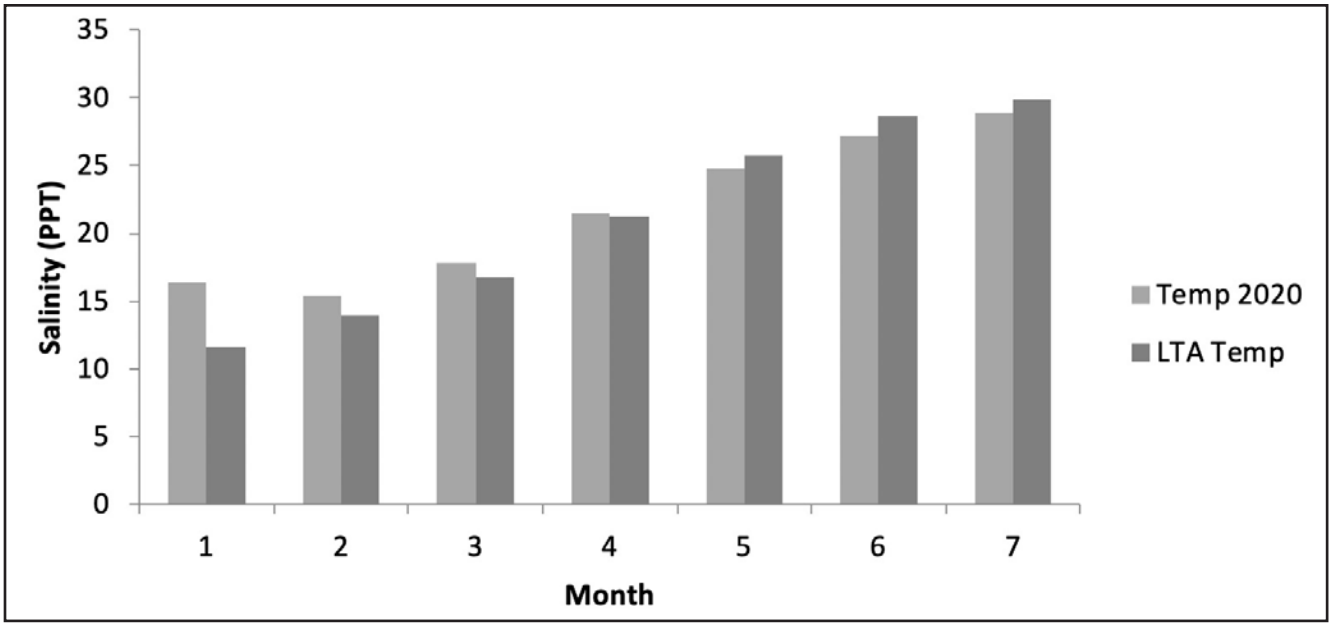

FIGURE 7.4. Average salinity and temperature recorded during dredge and square-meter samples of the Calcasieu Lake public oyster areas in 2020.

representing a 9.7% decrease over 2018/2019 season. Daily harvest effort declined significantly from the previous harvest season. Based on LDWF seafood dealer interviews, approximately five boats per day were actively harvesting oysters in Calcasieu Lake during the open days of the 2019-2020 season.

The number of closures to oyster harvesting in Calcasieu Lake due to LDH health concerns was slightly below normal for a typical oyster season with 64% of the total oyster season open to harvest in West Cove, while East Side was opened 93% of the time during the oyster season based on LDH health closures/openings (*Table 7.3*).

Comparing LDWF seafood dealer interview data with results from 2019 stock assessment, approximately 4.0% of the standing crop of market-size oysters in Calcasieu Lake was harvested last season (*Figure 7.4*).

TABLE 7.3. Public oyster season and number of days open to harvest as a percentage for East Side (GA-29) and West Cove (GA-30) in Calcasieu Lake.

Season		Season Dates	Total Days	CALCASIEU LAKE			
				Eastside		West Cove	
				Days	% Open	Days	% Open
2005-06[1]	GA29	Oct.15 - April 30	198	187	94		
	GA30	Oct. 8 - April 30	205			165	80
2006-07	GA29	Nov. 1 - April 30	181	118	65		
	GA30	Oct. 16 - April 30	197			70	36
2007-08	GA29	Nov. 1 - April 30	182	165	91		
	GA30	Oct. 15 - April 30	199			131	66
2008-09	GA29	Oct. 15 - April 30	198	183	92		
	GA30					125	63
2009-10	GA29	Oct. 15 - April 30	198	157	79		
	GA30					80	40
2010-11[2]	GA29	Nov. 15 - March 25[4]	131	131	100		
	GA30[3]	Oct. 15 - April 30	198			186	94
2011-12[5]	GA29[6]	Closed	-	0	-		
	GA30	Nov.1 - April 30	182			92	51
2012-13	GA29	Closed	Closed	0	-		
	GA30	Nov. 1 - April 30	181			82	45
2013-14	GA29	Closed	Closed	0	-		
	GA30[7]	Nov. 1 - April 30	181			158	87
2014-15	GA29	Closed	Closed	0	-		
	GA30	Oct. 26 - April 30	187			111	59
2015-16	GA29	Closed	Closed	0	-		
	GA30	Nov. 1 - April 30	182			108	59
2016-17	GA29	Nov.1 - Feb. 13	105	86	82		
	GA30	Nov. 1 - Jan. 24	85			54	64
2017-18	GA29	Closed	Closed	0	-		
	GA30	Nov. 1 - May 15	196			130	66
2018-19	GA29	Oct. 29 - April 30	184	145	79		
	GA30					88	48
2019-20	GA29	Nov.1-Jan 26	87	81	93		
	GA30	Nov. 1- April 30	182			58	67

1. Starting with the 2005-06 season, the lake was divided into two conditional managed areas (CMA), were managed separately and may have different length seasons.
2. Starting with the 2010-11 season the conditional managed areas were changed to growing areas (GA).
3. From 10/15 through 11/14, the daily sack limit in GA30 was 20, daily limit reverted to 10 sacks for the remainder of the year
4. GA29 closed due to heavy pressure of the resource, see LDWF news release 3/22/11.
5. Oyster harvesting on Calcasieu Lake for the 2011-12 season was by special permit only, see new release from 7/7/11 and 9/15/11.
6. GA29 was closed see news release 9/1/2011.
7. LDH closure threshold changed from 7.0 to 9.0 ft. at kinder gauge.

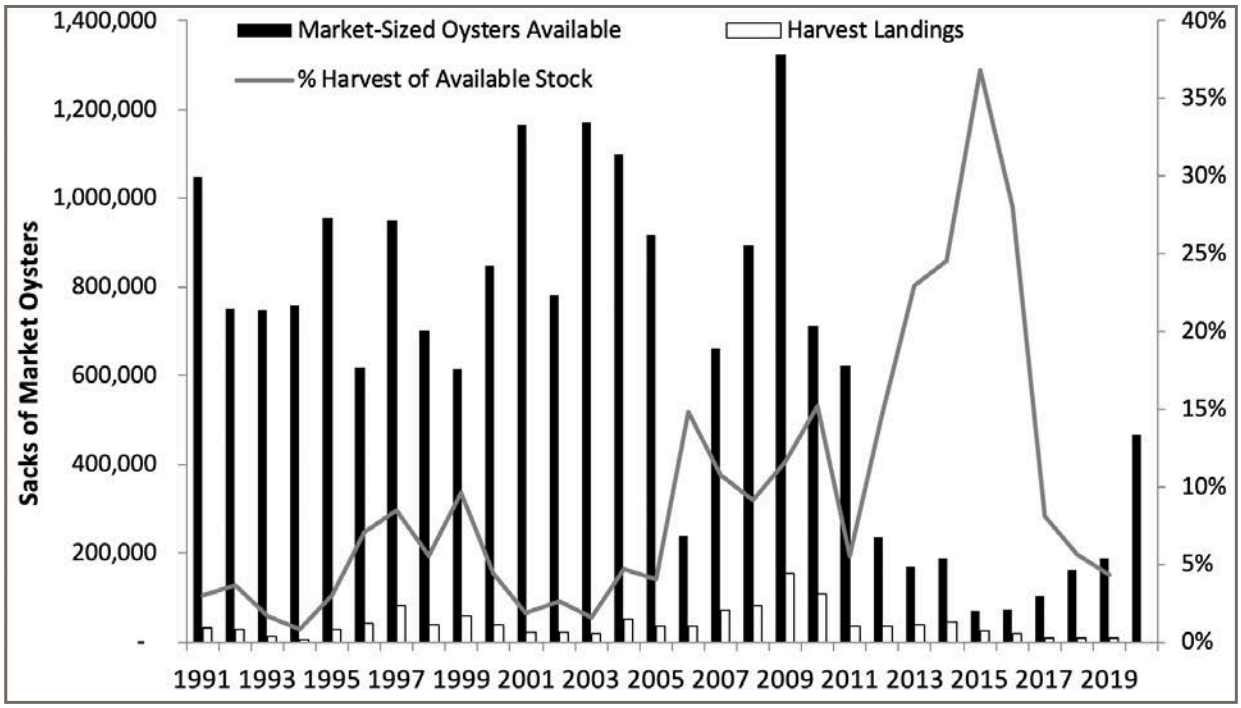

FIGURE 7.5. Historical stock assessments and landings (in sacks) of oysters from public oyster areas of Calcasieu Lake.