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2023 STOCK ASSESSMENT REPORT

of the Public Oyster Seed Grounds and Reservations of Louisiana

Oyster Data Report Series No. 29

LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES

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Introduction

Louisiana's vast coastal wetlands provide ample habitat where Eastern oysters (Crassostrea virginica), also known as the American oyster, thrive under a variety of environmental conditions. Louisiana's American 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 to market-size. In Louisiana, there are approximately 400,403 acres of private oyster leases. The public oyster areas also yield a supply of market-size oysters (greater than or equal to 3 inches in length), which may be taken directly to market during oyster seasons. Louisiana leads the nation in oyster production primarily due to this public/private oyster production system. Annual dockside sales have reached as much as $85,000,000 as recently as 2017, and the value of Louisiana's 2022 production was just over $75,000,000 (*Figure 2*).

Louisiana's public oyster areas are defined as either Public Oyster Seed Grounds or as Public Oyster Seed Reservations. The Louisiana Wildlife and Fisheries Commission (Commission) is entrusted with designating Public Oyster Seed Grounds (POSGs). Currently, the POSGs are comprised of Lake Borgne, Chandeleur/Breton Sound, 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 fishery's economic opportunity with the resource's biological sustainability. 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 their re-

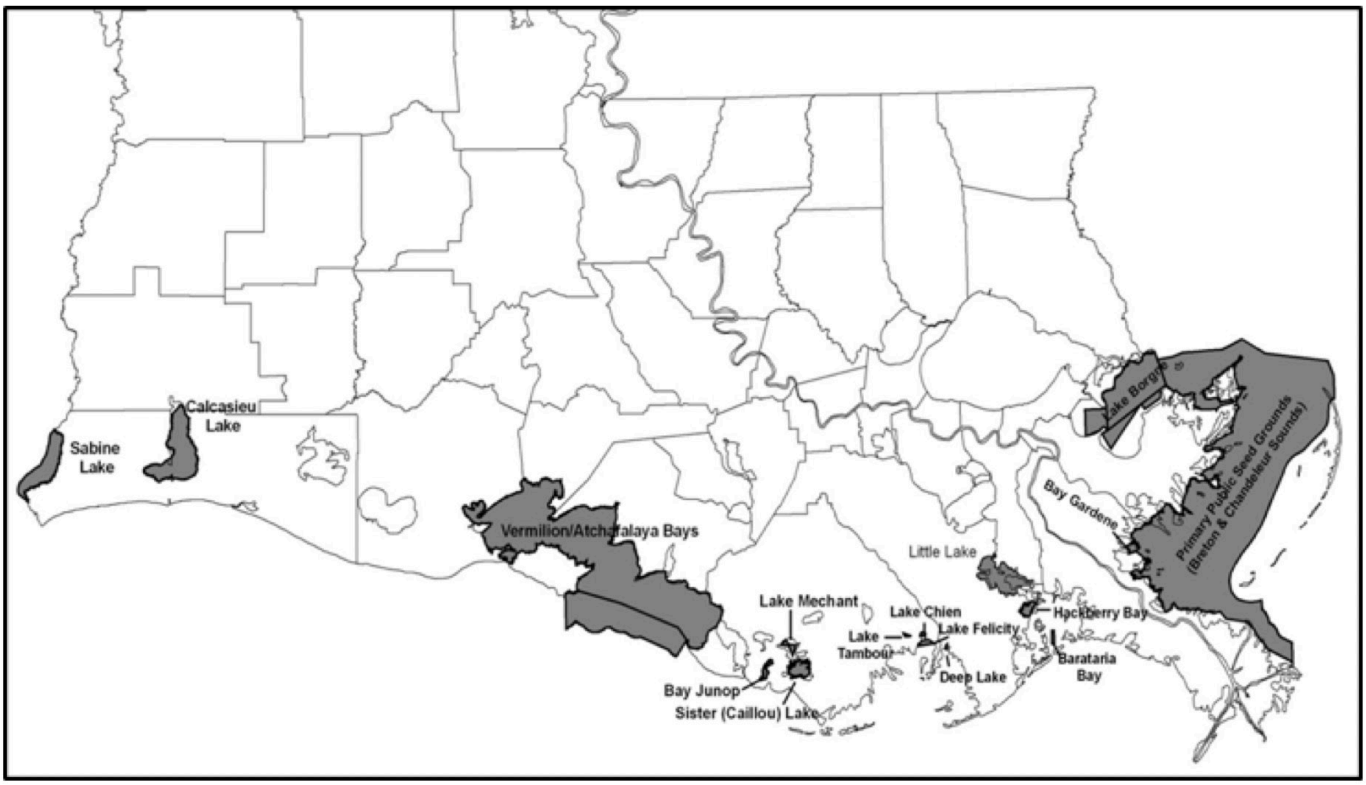

FIGURE 1. Public oyster areas of Louisiana.

spective basin. The information these data provide allows resource managers to effectively implement management changes to use the current resource and protect its long-term viability.

Oysters also play an essential 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 invertebrates and fish also use oyster reefs as shelter and forage habitat. In addition, oysters provide many ecosystem services, such as the oyster's filter-feeding activities that enhance estuarine water quality. Intertidal oyster reefs can also help stabilize shorelines and reduce habitat erosion.

Louisiana Oyster Landings

Louisiana regularly leads the nation in commercially harvested oyster landings. From 2003 through 2022, Louisiana accounted for 32.3% of the nation's oyster landings. In 2022, Louisiana produced 31.4% of annual landings by weight (*Figure 3*) and 31.8% by value (*Figure 2*) in the United States. Just out of the Gulf of Mexico states, Louisiana accounted for 77% of the oyster meat production in 2022. Of that production, approximately 235,000 pounds came from public oyster reefs, while private oyster reef landings totaled approximately 6,985,000 pounds. Total landings in 2022 were reported at approximately 7,220,000 pounds of meat (*Figure 4*) which led the nation for American oyster annual production.

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 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 the overall health of the oyster resource throughout the year. Approximately 1,700 dredge samples are collected statewide during each calendar year. Data are used to monitor the overall health of the oyster stock and assess recruitment of new age classes of oysters. Over 1,000 square-meter 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 square-meter data are 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 meter-square sample stations within each CSA (*Figure 5*). An aluminum square-meter frame (quadrat) is randomly placed at each sample station on the oyster reef. 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 for a total of five replicate samples taken per sample station. With the collected data a catch per unit effort (CPUE) for each reef is determined from the five replicates. Using the CPUE per square-meter, this data is extrapolated across each reef or reef complex to determine the abundance of oyster resource. Each reef acreage has been determined through departmental or contracted side-scan bottom assessments which are used for the CPUE extrapolation. Water temperature, dissolved oxygen, and salinity data are collected at each station and cultch material types are identified and weighed.

LDWF biologists visited sample stations during the Oyster Stock Assessment, gathering individual samples. The assessment presents sampling data by CSA. During assessment sampling, CSA 1

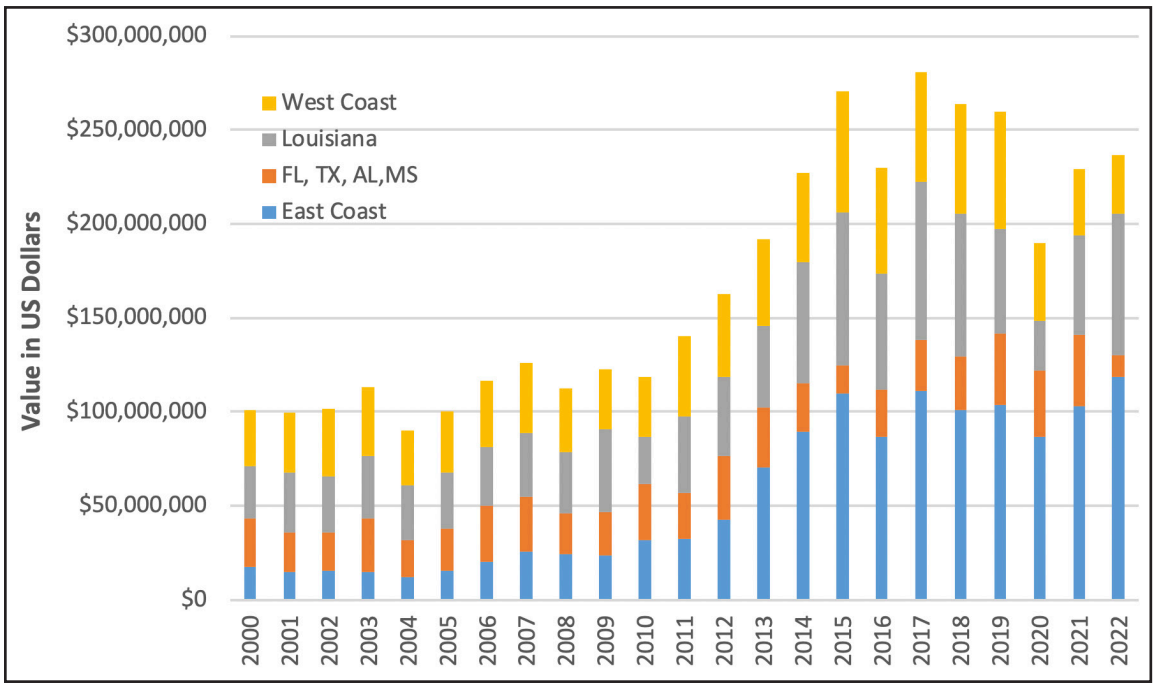

FIGURE 2. Annual commercial oyster landings (all species) in dockside value. Data provided by NOAA Fisheries.

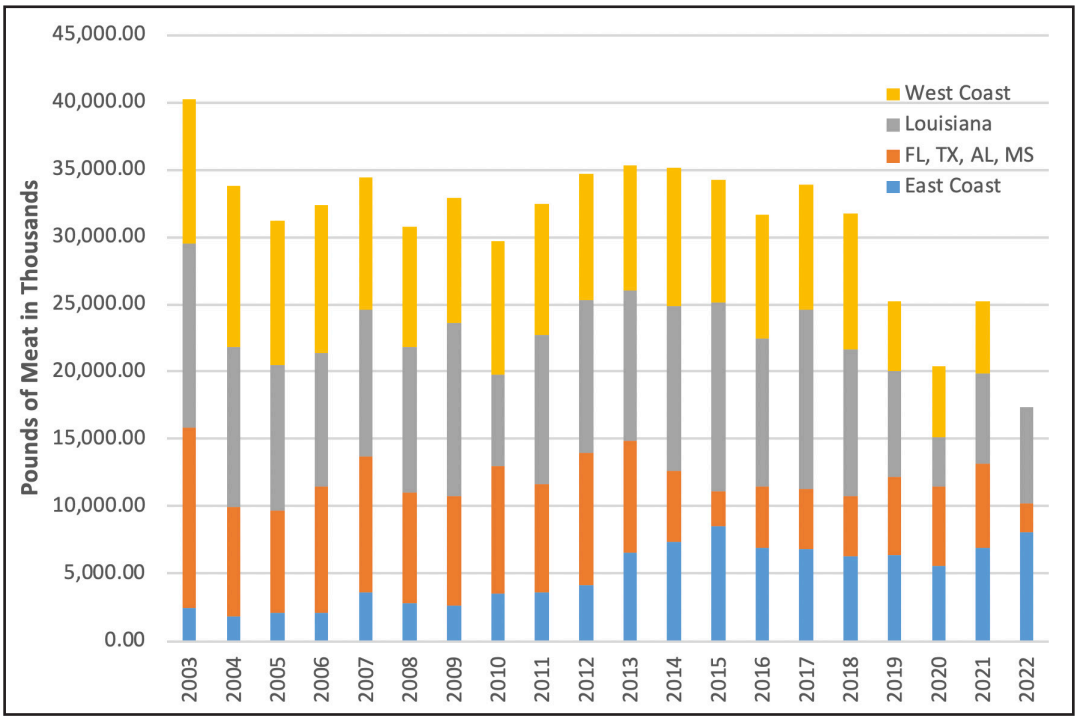

FIGURE 3. Annual commercial oyster landings (all species) in pounds of meat. Data provided by NOAA Fisheries.

South had the most sample stations (26), while CSA 5 East had the fewest (3). There is a higher sampling density in the Black Bay (CSA 1 South) and Sister Lake (CSA 5 West) areas due to their high oyster production in past years and historical importance to the oyster industry. Twenty-two of the sample stations were located on cultch plants constructed since 2004 by LDWF.

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. Oyster drills occur in coastal waters with a salinity gradient of 15 ppt or higher. Oyster drill numbers are documented during the stock assessment sampling to assess this predator's impacts to each reef complex.

Several crab species are also known predators of oysters. Mud crabs (*Family Xanthidae*), blue crabs (*Callinectes sapidus* and *Callinectes similus*), and stone crabs (*Menippe adina*) are known oyster predators along the Louisiana coast. These crabs will pry or crush oyster shells to access their softer inner tissues. Crab numbers are documented during the stock assessment sampling to assess their impacts to each reef complex.

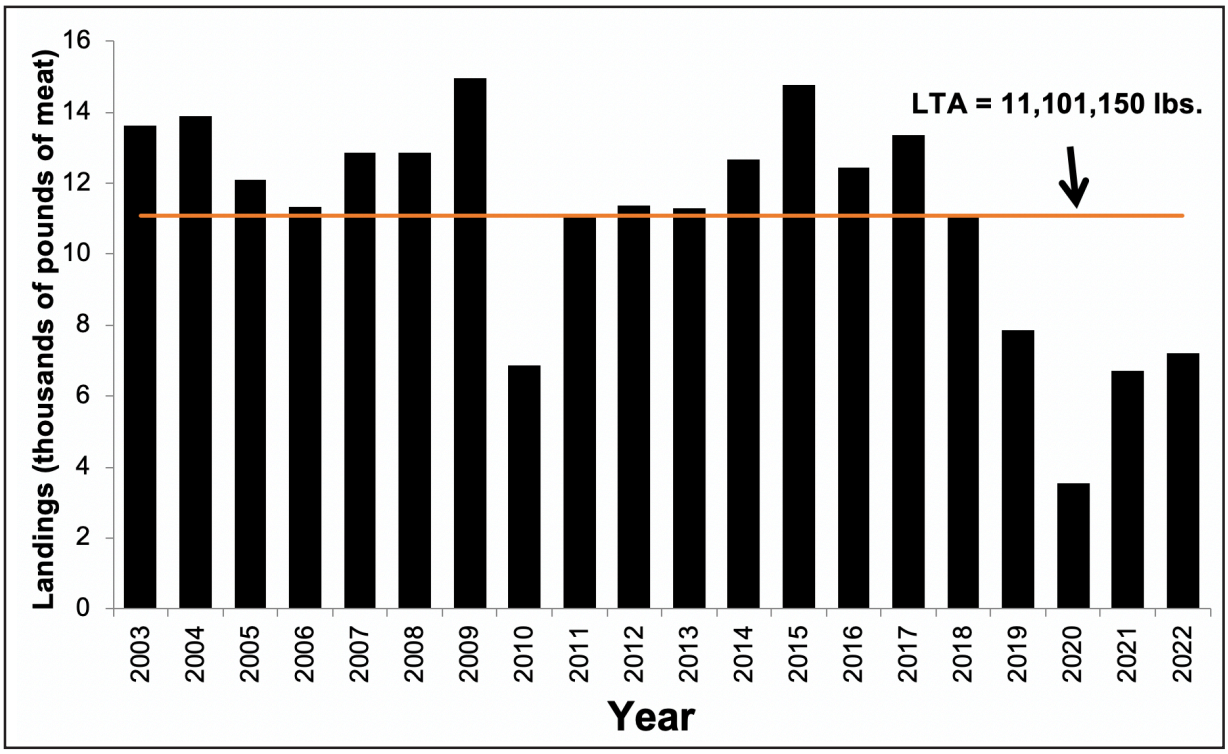

FIGURE 4. Louisiana oyster landings for public oyster areas and private oyster leases, 2003- 2022 (LDWF and NOAA Fisheries data). Long term average (LTA) is 20 years from 2003-2022.

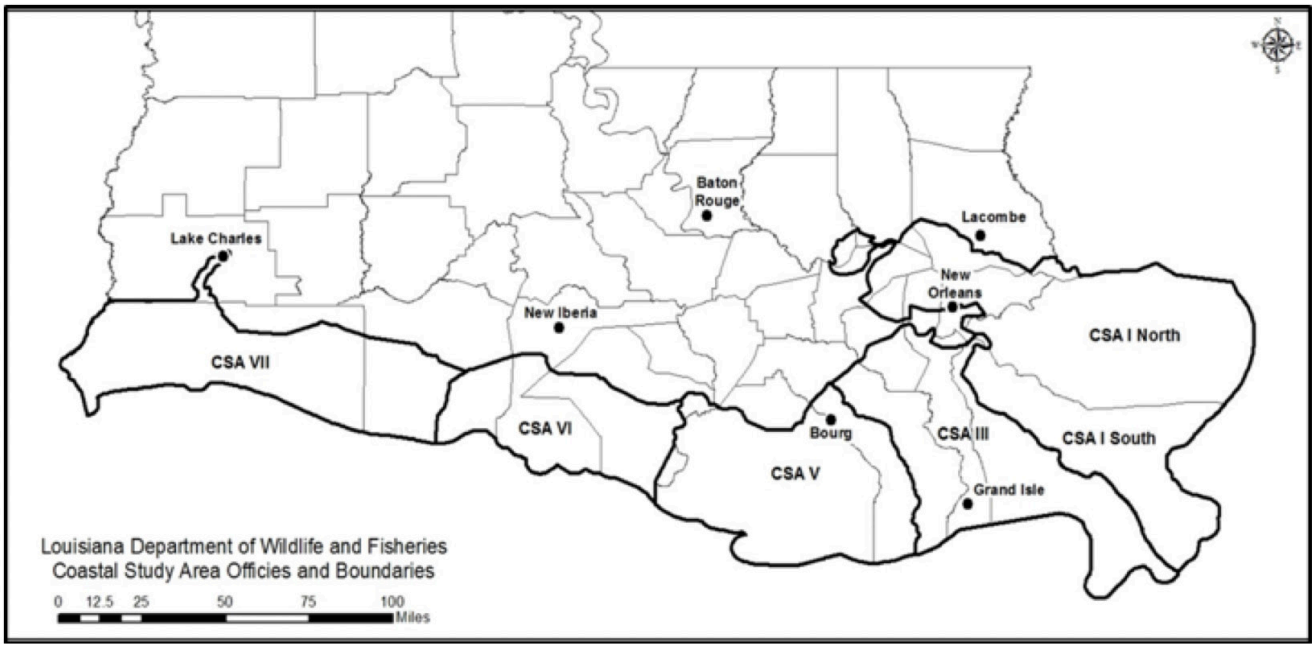

FIGURE 5. Louisiana Wildlife and Fisheries Coastal Study Areas (CSAs).

Perkinsus marinus, is a protozoan parasite, commonly called Dermo. Dermo infects live oyster tissue and is known to cause extensive oyster mortalities especially in high salinities and elevated water temperatures. Oysters are sent off to contracted laboratories to be tested for the prevalence of Dermo to help manage its impacts on reef populations. In recent years, the Dermo sampling schedule was pushed from the July square-meter assessment to September and October, due to a higher prevalence of Dermo infections occurring in oysters in the late summer. However, testing can take place after a mortality event, where oysters can be assessed for impacts by Dermo.

The hooked mussel (*Ischadium recurvum*) is a reef-associated benthic bivalve species that competes with oysters for food and settlement surfaces. Large numbers of hooked mussels on a reef can impact oyster growth, lower settlement rates of oyster larvae, and reduce meat yield of market-size oysters. Hooked mussel numbers are documented during the stock assessment sampling to assess this competitor's impacts to each reef complex.

Sampling conducted as part of the annual Oyster Stock Assessment plays a valuable role in predicting the success of the upcoming oyster season, which can open as early as September and

run through the end of 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 to the Commission regarding setting the oyster season.

In addition, the Sustainable Oyster Shellstock Model is being utilized to provide harvest thresholds for the public oyster areas of Louisiana. This model will help maintain reef material over time and was created in partnership with Dr. Thomas Soniat at The University of New Orleans (UNO). This computerized model guides fisheries management to conserve the oyster reef base. Oyster Stock Assessment sampling provides model input data such as estimates of reef mass (grams per meter-square) 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 allowed on each reef while preserving sufficient reef mass to keep the reef viable. The model outputs harvest rates based on three different conditions - low, medium, and high salinity patterns for each basin. The model has been tested statewide and showed promising results. At this time, the Sustainable Oyster Shellstock Model is applied to all reefs in the state. The model harvest thresholds are used by the oyster program manager to facilitate oyster season recommendations and can be used to close over-harvested reefs during the commercial public oyster season.

Annual Stock Size

The 2023 estimated oyster stock in Louisiana's public oyster areas is approximately 1,028,994 barrels (bbl) of oysters (*Table 1*), which is an approximate increase of 118% from the 2022 stock. Similar to recent years, most of the live oyster stock is in Calcasieu Lake (CSA 7), which holds 49.7% of the 2023 estimated availability (*Table 1*). Statewide, seed oysters increased by 148%, while market-size oysters increased by 95% compared to 2022. Most of Louisiana's oyster resource is concentrated on the western side of the state (*Figure 7*). While significant increases were observed in Lake Borgne/MS Sound, Sister Lake, East Side and West Cove of Calcasieu Lake, the 2023 public oyster area resource is still 21% below its 20-year (LTA) average (*Figure 6*) and is still recovering.

Harvest Monitoring Methods

During the oyster season, LDWF monitors commercial harvest through boarding surveys of vessels working the Public Oyster Seed Grounds, Reservations, and public oyster areas. Biologists record vessel location, past and current catch rates, and an estimate of future fishing effort. The boarding data is summarized weekly to maintain a cumulative harvest estimate for specific reef complexes. The data is projected over the number of fishable days (winds less than 25 mph) to determine a total harvest estimate of seed and market-size oysters for the week. Biologists also board vessels collecting seed oysters during the bedding season to determine if the fishermen are harvesting excessive amounts of non-living reef material. LDWF only permits up to 15% removal of non-living reef material. This regulation helps preserve the state's reefs and prevent excessive man-made degradation.

During the 2022-2023 oyster season, a daily reporting stipulation was put in place by the Commission for oyster harvesters to provide their harvest data to LDWF if collecting from the state's public oyster areas. Vessels had to provide the following information: Captain's name, oyster harvester number, boat number, the total number of sacks harvested that day, and the public oyster area fished. Each vessel had to call 1-800-442-2511, or send an email to oyster@wlf.la.gov, to submit harvest reports. This daily reporting did not substitute for trip ticket reporting.

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. Trip ticket reporting parameters allows for a large time delay in collection of data. This harvest data is routinely available two to three months after harvesting takes place.
LDWF collects fishery independent data via monthly oyster dredge sampling eleven months of the year to assess the health and condition of the resource. Data from those samples further inform management of the impact harvest activity has on the public grounds.

2022-2023 Oyster Season

The goal for the 2022-2023 oyster season was to allow for resource recovery, check the effectiveness of the new daily reporting requirement, determine if daily reporting provides better harvest estimates, and reduce fleet concentrations, with the intent to minimize reef degradation. The 2022-2023 Oyster Season opened on Oct. 17, 2022, and closed on April 30, 2023 (*Table 2*).

The estimated commercial harvest totaled 30,096 sacks (15,048 bbl) overall. This was a 37.8% increase from the 2021-2022 oyster season which only recorded 21,833 sacks harvested. Over the past 10 years, heavy localized harvest, high mortality events, strong tropical events, environmental changes, and lack of recruitment have contributed to an ongoing downturn in the oyster resource on the public seed grounds. The 2022 Oyster Stock Assessment showed a slight increase in oyster availability which resulted in opened seasons in CSA 1 North, CSA 1 South, CSA 3, CSA 6, and CSA 7. These areas have seen few openings in past years due to low oyster populations and on-going restoration efforts. The daily reporting requirement was evaluated by the total amount of reported harvest compared to the board run harvest reports produced by the biologists in the CSAs. Reporting compliance averaged 66% across the state with a low compliance rate of 56% in East Side of Calcasieu Lake and a high of 100% compliance during the bedding seasons in Hackberry Bay and Bay Junop.

Special Oyster Management Projects

LDWF biologists continue to participate in several important projects to increase oyster production on the POSG. Since 1917, LDWF has placed over 1.5 million cubic yards of cultch material on nearly 30,000 acres with positive results. Cultch material provides a substrate for oyster larvae to attach, this process is called settlement. Areas that are planted with cultch are referred to as "cultch plants." Recent cultch plants include: a 100-acre cultch plant in Calcasieu Lake (2017); a 100-acre addition to the 2012 Lake Fortuna cultch plant (2018); a 200-acre cultch plant in Sister (Caillou) Lake in 2021; four 10-acre brood stock reefs east of the Mississippi River in Petit Pass, Karako Bay, Lake Machias, and Mozambique Point, and two cultch plants totaling 231 acres in Drum Bay (2022).

The 2022-2023 projects were funded through Deepwater Horizon Natural Resource Damage Assessment (DWH NRDA) settlement dollars to restore for injuries to oysters that occurred as a result of the 2010 *Deepwater Horizon* Oil Spill. The Louisiana Trustee Implementation Group (LATIG) approved $26 million in oyster projects, including enhancing oyster recovery using brood reefs, cultch plants, oyster restoration, and hatchery-based oyster res-

TABLE 1. Estimated oyster stock (in bbl) on Louisiana's public oyster areas by basin. Percentages are change from previous year. Green indicates increase, red indicates decrease.

CSA	Basin	Seed	Seed % Change	Market-Size	Market-Size % Change	Total Stock	Total % Change
1N	Pontchartrain (Lake Borgne/MS Sound)	101,274	302%	24,842	207%	126,116	279%
1S	Pontchartrain (East of MS River, South of MRGO)	18,632	60%	21,436	84%	40,068	31%
3	Barataria (Hackberry Bay)	5,902	59%	1,349	50%	7,251	58%
5E	Terrebonne (East-Lake Chien/Felicity)	0	n/a	0	n/a	0	n/a
5W	Terrebonne (West-Sister Lake)	166,731	151%	175,485	508%	342,216	259%
7	Calcasieu (East Side)	26,499	83%	14,352	17%	40,851	52%
7	Calcasieu (West Cove)	181,223	510%	289,342	42%	470,565	101%
Statewide Totals		502,149	148%	526,845	95%	1,028,994	118%

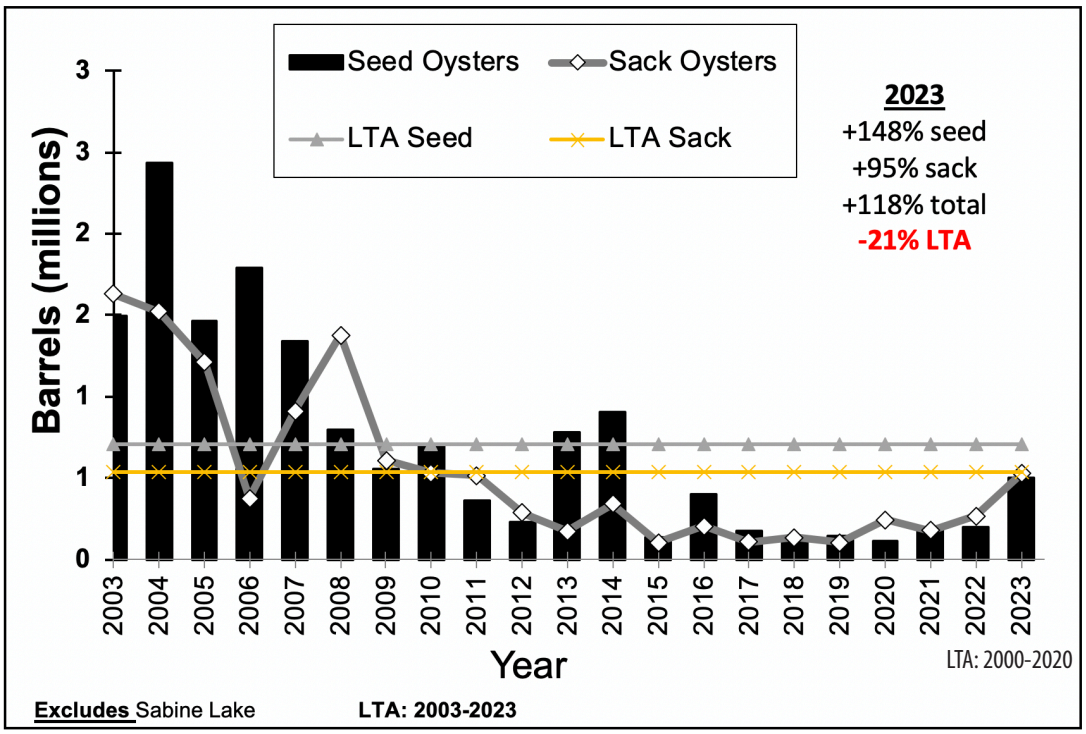

FIGURE 6. Seed and market-size oyster stock availability in Louisiana's public oyster areas. LTA denotes the long-term average from 2003 through 2022. Percentages indicate change from 2022.

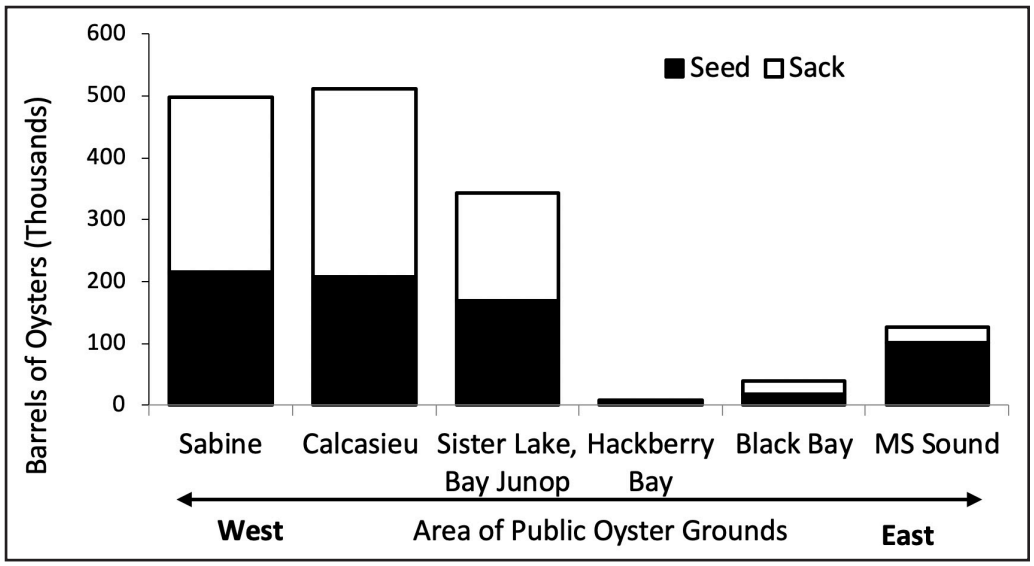

FIGURE 7. 2023 Oyster stock distribution in Louisiana's public oyster areas by basin; organized in a West to East direction.

TABLE 2. Harvest estimates for the 2022-2023 oyster season on Louisiana's public oyster areas. Harvest estimates, based on LDWF-conducted surveys of oyster harvesting vessels during the oyster season. Data derived from fishery dependent surveys of harvesting vessels.

2022-2023 LDWF OYSTER SEASON SUMMARY								
CSA	**Area**	**Season Opening**	**Season Closure**	**Season/Type**	**Days Open**	**Harvest (sacks)**	**2022 OSA Available (sacks)**	**% Harvested**
1	**PSOG East of Mississippi River and North of MRGO**	Oct. 18	April 1	Market Harvest	166	4,875	8,099	60%
	POSG East of Mississippi River and South of MRGO	Oct. 18	April 1	Market Harvest	166	3,265	11,648	28%
3	**Hackberry Bay**	Oct. 18	April 1	Market Harvest	166	60	2,698	2%
		Oct. 17	Oct. 17	Bedding Harvest	1	146	14,558	1%
	Little Lake, Barataria Bay	CLOSED						
5	**Deep Lake, Lake Chien, Lake Felicity and Lake Tambour**	CLOSED						
	Bay Junop, Lake Mechant	Oct. 18	April 1	Market Harvest	166	N/A	1,995	2%
		Oct. 17	Oct. 17	Bedding Harvest	1	45	5,865	1%
	Sister Lake	Feb 13	Feb 17	Market Harvest	5	5,976	28,877	21%
6	**Vermilion Bay/ East and West Cote Blanche Bay/ Atchafalaya Bay Public Oyster Seed Grounds**	Oct. 18	April 1	Market Harvest	166	0	N/A	N/A
		Oct. 17	Oct. 17	Bedding Harvest	1	0	N/A	N/A
7	**Calcasieu Lake**	Jan. 1	April 30	*East Side:* Market Harvest	120	2,526	12,318	21%
		Oct. 15	April 30	*West Cove:* Market Harvest	198	13,203	203,894	6%

toration. LDWF will monitor the performance of the reefs through regularly scheduled sampling events, and anticipates further enhancement of the reefs with hatchery-raised juvenile oysters as opportunities arise.

LATIG has funded a metapopulation modeling project starting in 2023. The project is titled Modeling to Inform Sustainable Oyster Populations in Louisiana Estuaries. The project will enable the LDWF to evaluate locations for oyster cultch plants and brood stock reefs. Generally, the model will enable managers to assess the impacts of enhanced or restored reef locations on recruitment to other existing or proposed reefs; larval survival; growth of oysters on existing and proposed reefs; and reef connectivity. This model will enable management of oysters to move from individual reef level to assessment of a network, or meta-population, of reefs under current and future predicted conditions.

The Michael C. Voisin Oyster Hatchery located on Grand Isle, Louisiana, is operated through a collaborative effort between LDWF and Louisiana Sea Grant (LSG). LSG assists with facility operations, provides technical guidance, manages the oyster brood stock, and supports the oyster industry through extension, outreach, and research projects. LDWF focuses on the production of diploid and triploid seed and larvae for state restoration projects, as well as commercial sales to support the oyster industry.

The hatchery produces diploid oyster larvae for setting on shell, which is then referred to as spat-on-shell and is used for State oyster restoration projects. To prepare for setting on shell, 3-ft mesh bags are filled with recycled oyster shell, which was previously obtained through a collaboration with the Coalition to Restore Coastal Louisiana's Oyster Shell Recycling Program (CRCL). In the spring 2023 season, the hatchery produced 121,843,832 larvae for LDWF restoration efforts. An estimated 10,000,000 larvae were deployed as Spat on Shell (SOS) to the Petit Pass brood stock reef in April 2023 with an estimated 1,190,952 oyster spat. An estimated 107,466,667 larvae were set on macro-cultch and deployed to Independence Island in, Barataria Bay during June 2023 with an estimated 4,648,263 seed oysters entering the water. An estimated 2,007,500 larvae were also set on macro-cultch and deployed to Independence Island in, Barataria Bay during August 2023 with an estimated 341,889 seed oysters deployed. Marine Fisheries contracted-out monitoring assessments on the Petit Pass deployment to assess the survival success. The six month monitoring of the Petit Pass deployment in November 2023 showed 52.2% living spat oysters and 46.8% living seed oysters in the sample.

Recent Legislation

In 2022, the Louisiana Legislature passed Act 380, which adjusted the member composition and appointment requirements of the Oyster Task Force. The changes indicate that of the four mem-

bers appointed by the Louisiana Oyster Dealers and Growers Association, two members shall be selected at-large and the other two members must consist of an individual from Jefferson Parish and the other member from either Lafourche or Terrebonne Parish. One member shall be appointed by the Cameron Parish police jury, who is a properly licensed oyster harvester or licensed seafood dealer with documented harvests or purchases from Calcasieu Lake during the current or preceding license year of the appointment. One member must be appointed by the Louisiana Oyster Aquaculture Association.

In 2023, the Louisiana Legislature passed two oyster-related bills. Act 404, was lobbied by CRCL which benefits oyster restoration efforts by giving tax credits to restaurants for participating in an oyster shell recycling program. Then Act 170, changed the language of R.S. 56:433.1 pertaining to oyster seed ground vessel permits. The revision changed the Public Oyster Seed Ground Gear License to a gear permit and made the new gear permit (Public Oyster Seed Ground Gear Permit) an extension of the permitted vessel allowing harvest on the public oyster seed grounds. This change allowed the permit holder the ability to hire or lease out the vessel to any properly licensed commercial oyster captain.

Conclusion and Acknowledgments

The biological stock assessment, historical oyster landings statistics, and a brief synopsis of each CSA's most recent oyster season are all included in the report that follows. 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 Carl Britt, Willie Cheramie, Denise Kinsey, Ty Lindsey, Jeff Marx, Josh Parks, and Troy Sehlinger. Biologists from each CSA spent extensive time gathering samples and producing the report. Additionally, Chris Schieble, and Christian Winslow assisted with editorial review and preparation of this document. Efforts of 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 comments to Robert Caballero, Oyster Program Manager, at 504-286-4054 or rcaballero@wlf.la.gov.

COASTAL STUDY AREA 1 NORTH
(East of Mississippi River and North of MRGO)

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 the state of 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 a 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. LDWF completed cultch plants in Three Mile Pass and Drum Bay in 2013 as part of the DWH NRDA Early Restoration Program. In early 2020, LDWF collaborated with Non-Governmental 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. In December 2021, LDWF oversaw the construction of four additional artificial reefs built exclusively for oyster brood stock production. Two of these were located in CSA 1 North at Petit Island and West Karako Bay. In July 2022, LDWF completed the construction of two cultch plants totaling 231 acres in Drum Bay (St. Bernard Parish). This project was also funded through DWH NRDA settlement dollars to restore for injuries to oysters that occurred as a result of the DWH spill. Drum Bay was chosen due to its more remote location from any Mississippi River outflow and its higher resiliency to recent stressors.

Methods
LDWF biologists collected field samples for this Oyster Stock Assessment between July 06 and July 18, 2023, from 18 stations within CSA 1 North, according to the methodology described in the Statewide Overview of this report. Sample stations included 17 historical stations, and the 2013 NRDA Early Restoration cultch plant at Three Mile Pass. Additionally, per cultch plant sampling protocols, a series of 10 (¼) square-meter samples were taken from each of the 2022 Drum Bay cultch plants (*Figure 1.1*).

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 these areas. 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 (*Table 1.1*). The 2023 CSA 1 North Oyster Stock Assessment is based on a reef assessment of 22,427 acres of water bottom, which includes the 231 acres of the 2022 Drum Bay cultch plants. In the previous years' Oyster Stock Assessments, there had been 449 acres of cultch plants noted as being included in the assessment. This acreage included the Round Island cultch plant in Mississippi Sound and the Three Mile Pass cultch plant (2013). These cultch plants are both over 10 years old and both were severely impacted by the 2019 Mississippi River flood event. Current biological sampling indicates that this acreage is no longer distinctively different from surrounding reef acreage. As such, they are no longer set apart as cultch plant acreage.

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 the annual Oyster Stock Assessment.

Results and Discussion
Seed- and Market-Size Stock
The 2023 estimated oyster stock size for CSA 1 North is 101,273.8 bbl of seed oysters and 24,842.4 bbl of market-size oysters, for 126,116.2 bbl of overall stock. This total assessed oyster stock for 2023 is up 280.6% from 2022. It is important to note that this year's oyster stock estimate is largely driven by the oyster densities observed on the two Drum Bay cultch plants completed in July 2022. These cultch plants accounted for an estimated 72,315.4 bbl (71.4%) of seed oysters, as well as 3,556.8 bbl (14.3%) of sack oysters. Compared to 2022, with the inclusion of the Drum Bay cultch plants (2022), there was a 302.3% increase in the seed estimate. The current estimated market-size stock is calculated to be 212.1% above the market-size estimate of 2022. Despite the large increases in predicted oyster stock in this year's assessment with the inclusion of oyster stock estimated on the Drum Bay cultch plants (2022), seed stock is down 40.4% from the previous 10-year average, while market-size stock fell to 57.7% below the previous 10-year average. Total assessed oyster stock for 2023 is 44.8% below the previous 10 years' average. As the Drum Bay cultch plants (2022) will not be available for harvest during a 2023-2024 oyster season, the following estimates outline oyster stock found on reefs that would be available for harvest. On reefs that were assessed in 2022, the 2023 stock estimates are 28,958.4 bbl of seed oysters and 21,285.7 bbl of market-size oysters. These figures represent a 79.7% increase in seed oyster stock and a 193.6% increase in market-size stock.

As mentioned above, the oyster densities observed on the Drum Bay cultch plants (2022) drove this year's stock estimate. Seed oyster densities on these two cultch plants were 46 per square-meter and 62 per square-meter. Market-size densities were observed to be 0.4 per square-meter and 2.0 per square-meter. When comparing 2023 oyster densities on North Pontchartrain Basin reefs that were assessed in 2022, the Three Mile Pass cultch plant (2013) accounted for 39.2% of the seed oyster stock in CSA 1 North, with a mean density of 12.8 seed oysters per square-meter. A large den-

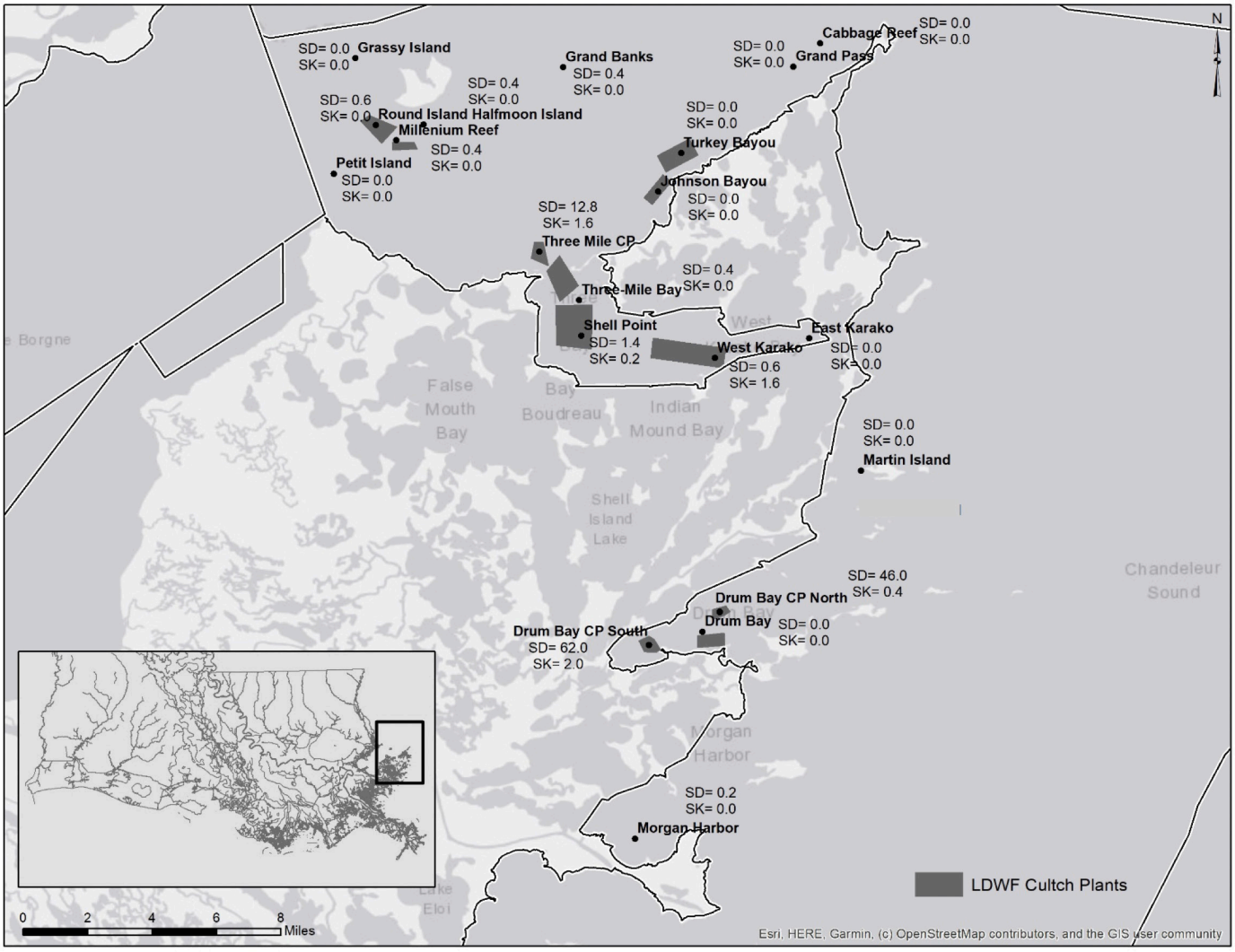

FIGURE 1.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-1 North).

sity of seed oysters was also observed on the Shell Point reef, with 1.4 seed oysters per square-meter, as well as the West Karako and Round Island reefs with 0.6 seed oysters per square-meter. In all, nine of the 18 stations sampled held seed oysters. This was an improvement from six of 18 stations during last year's assessment. The West Karako reef within the Three-Mile reef complex held the majority of available market-size oyster resource with 86.2% of the market-size oyster estimate. West Karako had a mean density of 1.6 market-size oysters per square-meter. Shell Point and the Three Mile Pass cultch plant (2013) were the only other reefs found to hold market-size oysters during this assessment.

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 only limited areas of significant resource availability are often identified.

Since 2013, CSA 1 North has experienced periods of heavy localized harvest, high mortality events, and strong tropical events such as Hurricane Nate in 2017, Hurricane Zeta in 2020, and Hurricane Ida in 2021. There have also been devastating spring flood events prompting the opening of the Bonnet Carré Spillway five times in the past 10 years (2016, 2018, twice in 2019, and 2020). 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-size oyster stocks continue to fall well below the previous 10-year average (*Figure 1.2*).

Spat Production

Live spat were observed at 13 of the 18 regular historic stations sampled during this assessment. At these sample stations, mean densities ranged from 0.2 to 10.6 individuals per square-meter, with the highest average occurring at Three Mile Pass cultch plant (2013). Occurrence of spat oysters was very similar to the previous year's assessment with only a slight 1.1% decrease in the total number of spat collected. This represented a 1.0% decrease in the number of spat occurring per square-meter samples taken. Additionally, spat oysters were found on both of the newly built Drum Bay cultch plants, with rates of 39.2 and 59.6 spat per square-meter. While the observed spat oyster numbers are encouraging, there continues to be a persistent trend of modest spat sets on most CSA 1 North reefs during spring spawning events. These periods of poor recruitment can be attributed to several different factors, such as freshets, hypoxia, overburden, dissolution of cultch, or a combination of these stressors. 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.

TABLE 1.1. 2023 Oyster availability by sample station or reef complex in CSA 1 North.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market- Size Oysters/m^2	Seed Oysters (bbl)	Market-Sized Oysters (bbl)
Grassy Island	5,328	0	0	7,187.2 (14,374.4 Sacks)	0.0
Halfmoon		0.4	0		
Petit		0	0		
Grand Banks		0.4	0		
Millennium		0.4	0		
Halfmoon Reef Complex Cumulative		0.2	0.0		
Three Mile Bay	3,059	0.4	0	5,730.5 (11,461.1 Sacks)	18,337.7 (36,675.5 Sacks)
East Karako		0	0		
West Karako		0.6	1.6		
3 Mile Bay Complex Cumulative		0.3	0.5		
Grand Pass	5,411	0	0	0.0	0.0
Cabbage Reef		0	0		
Turkey Bayou		0	0		
Cabbage Reef Complex Cumulative		0.0	0.0		
Martin Island	3,183	0	0	0.0	0.0
Johnson Bayou	200	0	0	0.0	0.0
Drum Bay	1,565	0	0	0.0	0.0
Drum Bay Cultch (2022) North	91	46	0.4	23,528.1 (47,056.1 Sacks)	409.2 (818.4 Sacks)
Drum Bay Cultch (2022) South	140	62	2	48,787.3 (97,574.6 Sacks)	3,147.6 (6,295.1 Sacks)
Drum Bay Reef Complex Cumulative		36	0.8	72,315.4 (144,630.8 Sacks)	3,556.8 (7,113.5 Sacks)
Morgan Harbor	2,954	0.2	0	3,320.7 (6,641.4 Sacks)	0.0
Shell Point	47	1.4	0.2	371.4 (742.8 Sacks)	106.1 (212.2 Sacks)
Round Island	291	0.6	0	981.4 (1952.8 Sacks)	0.0
Three Mile Pass Cultch (2013)	158	12.8	1.6	11,367.2 (22,734.4 Sacks)	2,841.8 (5,683.6 Sacks)
Total	***22,427***			***101,273.8 (202,547.6 Sacks)***	***24,842.4 (49,684.8 Sacks)***

	LTA(2013-2022)	2023	% Change
Seed	169,849.7	101,273.8	-40.37%
Market-Size	58,796.3	24,842.4	-57.75%
Total	***228,646.0***	***126,116.2***	***-44.84%***

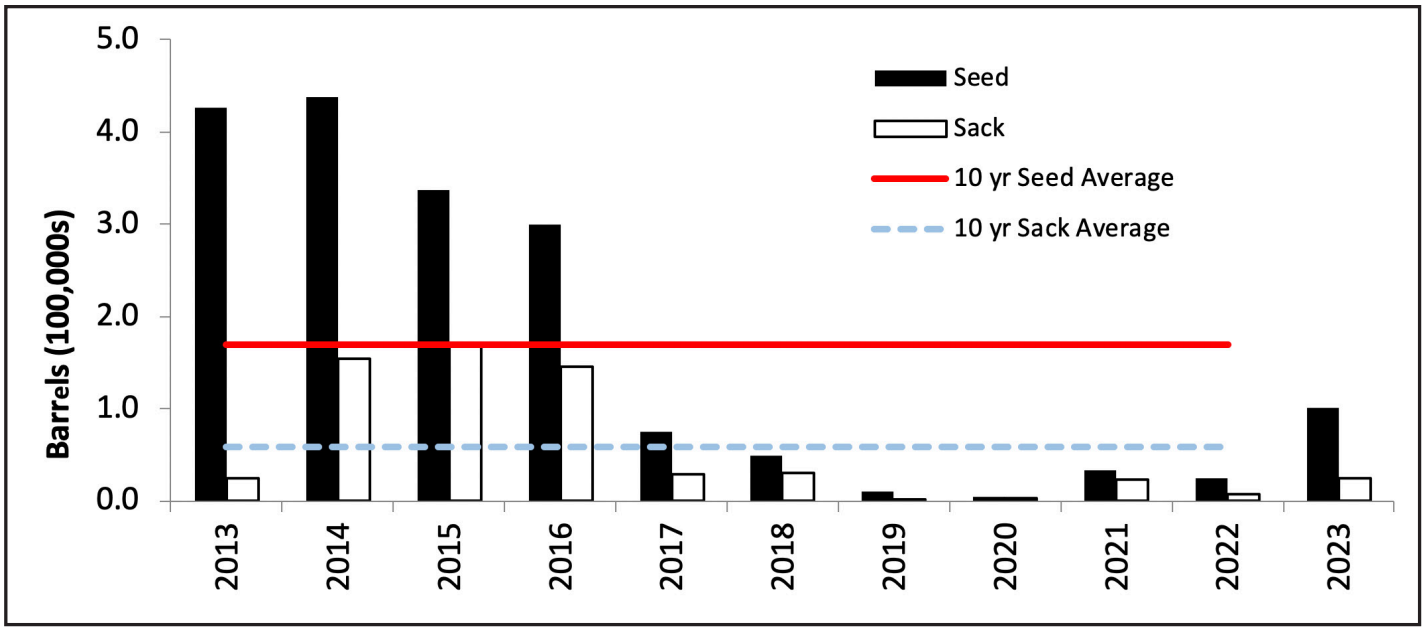

FIGURE 1.2. CSA 1 North historical oyster stock availability. Horizontal lines represent the previous 10-year average seed and market-size stock size estimate averages.

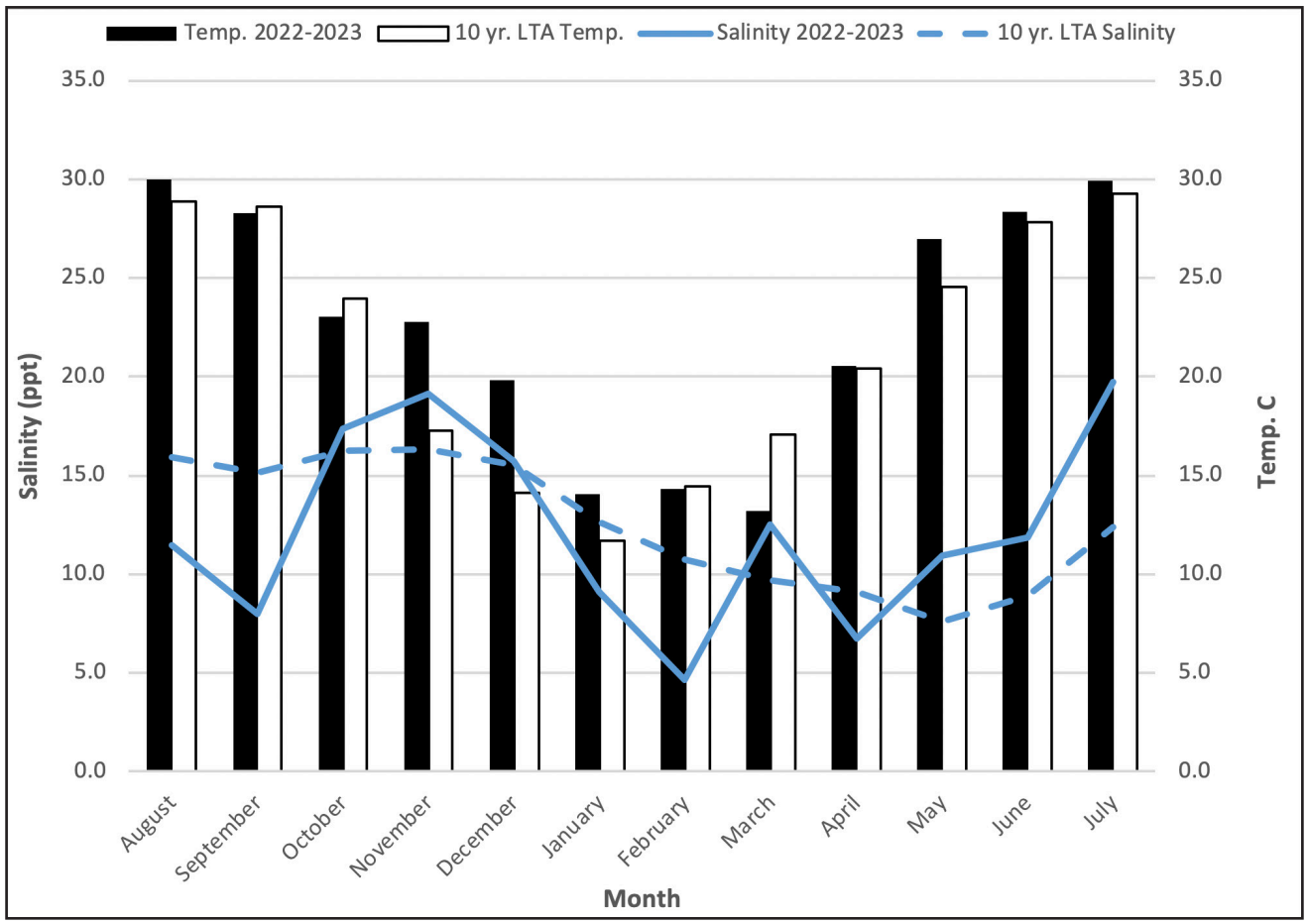

FIGURE 1.3. Mean salinity and temperature for Northern Lake Pontchartrain Basin Public Oyster Seed Grounds from August 2022 – July 2023.

Hydrological Data

During the period between August 2022 and July 2023, the North Pontchartrain Basin experienced a number of extremes related to hydrological conditions. Salinities across the Basin, and most notably in the western Mississippi Sound, were well below the previous 10-year average for the months of August-September 2022, January-February 2023, and April 2023. This was directly related to the Pearl River being at or above flood stage during these times, inundating the area with fresh water. Starting in spring 2023, the Pontchartrain Basin experienced extreme drought conditions. According to *Drought.gov*, 2023 was the second driest January through July time period recorded in 129 years. As drought conditions persisted through the summer months, the Basin experienced much higher than average salinity May-July 2023 and slightly higher water temperatures April-July 2023 (*Figure 1.3*). Spring 2023 marked the third consecutive year without a Mississippi River flood event necessitating the opening of the Bonnet Carré Spillway. Also, there were no notable impacts from tropical weather systems or hurricanes between August 2022 and July 2023.

Fouling Organisms

During 2023 Oyster Stock Assessment sampling, the hooked mussel was observed at eight of the 18 sample stations. The highest density of mussels was 46.2 per square-meter on the Three Mile Pass cultch plant (2013). There was a 29.6% decrease of the occurrence of hooked mussel when compared to the previous year's observations. All observations of hooked mussels during this year's assessment were on reefs located in the northern and western portions of Mississippi Sound and Three Mile Bay. This corresponds with more favorable growing conditions enhanced by drainage from the Pearl River. The Pearl River was at or above flood stage for much of the spring and early summer months in 2023. The area also held an abundance of mature animals from the previous year. Although there is no documentation of barnacle fouling on oyster shells in the assessment, there has been documentation of light to moderate barnacle fouling of oyster shells in the monthly samples prior to the assessment at a number of sample stations. In addition, there were no observations of bryozoans on the exposed substrate at any of the sample stations. All of these forms of fouling limit the ability of oyster larvae to attach to available cultch.

Oyster Predators and Disease

During this year's sampling event, oyster drills were observed at four of the 18 sample stations. The highest density of oyster drills was 1.0 per square-meter at Cabbage Reef and 0.6 per square-meter at Grand Banks. No stone crabs (*Menippe adinia*) or blue crabs (*Callinectes spp*.) were collected in the square-meter samples. Other (Xanthid) mud crabs were noted in numerous samples that contained shell for substrate.

Mortality

Oyster mortality estimates for this year's stock assessment showed marked increase above the previous year's stock assessment. This is mainly due to higher spat mortalities observed at eight of the 18 regular sample stations. Overall, there was an estimated 70.6% increase in spat mortality. Shell Point had the highest rate of spat mortality with 57.1%. High rates of spat mortality were also observed at Cabbage Reef and Grand Pass, both with 37.5%. There was observed seed oyster mortality at three stations; Grand Banks (33.3%), Shell Point (12.5%), and the Three Mile Pass cultch plant (3.0%). No market-size oyster mortalities were recorded during this sampling event. By comparison, there was no seed or market-size oyster mortality recorded during the previous year's stock 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.

2022-2023 Oyster Season

The 2022-2023 oyster season in the North Pontchartrain Basin opened on Oct. 18, 2022. Due to continued lack of seed stock observed on reefs in North Pontchartrain Basin, as well as continued recovery from losses during the spring and summer of 2019, the entire area opened as "sacking-only," with a 30 sack per day limit. Harvest was suspended on the Three Mile Pass cultch plant (2013) and Shell Point on Nov. 13, 2022. This was a result of observed harvest levels on these reefs. It was estimated that 96.6% of the assessed market-size resource on the Shell Point reef was harvested and well over 100% (164%) of the assessed market-size resource on the Three Mile Pass cultch plant (2013) had been harvested. The 2022-2023 oyster season on the remaining public oyster areas in the North Pontchartrain Basin came to a close on April 1, 2023.

Harvest totals for the North Pontchartrain Basin during the 2022-2023 oyster season were estimated at 4,879 sacks of market oysters. When harvest estimates within assessed areas are compared with the 2022 stock assessment, there was an estimated utilization of 30.6% of the market-size resource. The majority of market-size resource was observed to be harvested from the Three Mile Bay reef complex, which includes the Three Mile Pass cultch plant (2013). This reef complex accounted for 56.8% of the harvested market-size oyster resource. The Drum Bay reef complex also yielded notable harvest with 28.0% of market harvest.

COASTAL STUDY AREA 1 SOUTH
(East of Mississippi River and South of MRGO)

Introduction
The Public Oyster Seed Grounds and Reservation in CSA 1 South (South Pontchartrain Basin), formerly CSA 2, consist of approximately 300,000 acres of water bottom. The grounds are 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. These Public Oyster Seed Grounds include the Bay Gardene Public Oyster Seed Reservation. Historically, this area has provided seed and market-size oysters for oyster fishermen from Louisiana, Mississippi, and Texas. LDWF 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. The most recent cultch plants completed were in Bay Crabe and Lake Fortuna in 2012, as part of the DWH NRDA Early Restoration Program. In 2018, LDWF, NOAA, and the St. Bernard Parish Government worked together to enhance a 100-acre portion of the (~300 acre) 2012 Lake Fortuna cultch plant by deploying 16,154 cubic yards of oyster shell. In December 2021, LDWF oversaw the construction of four artificial reefs built exclusively for oyster brood stock production. Two of these were located in CSA 1 South at Lake Machias and Mozambique Point.

Mississippi River stages heavily influence hydrology in the South Pontchartrain Basin by discharges through gaps in the Mississippi River levee south of Pointe a la Hache and main-stem river distributaries. Most significant impacts to the Basin come through the unrestricted breaches of the Bohemia Spillway and Neptune Pass, Bayou St. Philip, and regulated discharge from the Caernarvon and Bayou Lamoque freshwater diversion structures. Additionally, since 2010, CSA 1 South has experienced numerous strong tropical events including Hurricane Isaac in 2012, Hurricane Nate in 2017, Hurricane Zeta in 2020, and Hurricane Ida in 2021. These events, coupled with the *Deepwater Horizon* oil spill and related spill response activities, periods of heavy localized harvest, and high mortality events, have severely reduced oyster abundance in the South Pontchartrain Basin.

Methods
LDWF biologists collected field samples for this Oyster Stock Assessment between July 11 and July 20, 2023, from 26 stations within CSA 1 South, according to the methodology described in the Statewide Overview. Sample stations included 25 regular sample stations and the 2012 Lake Fortuna cultch plant (*Figure 2.1*). With its enhancements, the 2012 Lake Fortuna cultch plant remains significantly different from the surrounding Lake Fortuna Reef Complex; therefore biologists 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. 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 2023 Oyster Stock Assessment has updated reef acreage of 27,762.3 acres of water bottom. Beginning with the 2013 Oyster Stock Assessment, oyster reefs within CSA 1 South merged into reef complexes based on location, hydrology, oyster productivity, and response to environmental stressors. There were 12 reef complexes, each with one to four representative square-meter sample stations (*Table 2.1*). Water bottom assessments have identified an additional 1,524 acres of oyster habitat (reef and scattered shell), but this acreage is not included in the total acres of water bottom or the annual Oyster Stock Assessment acreage, as no current oyster sample station adequately describes this acreage.

Results and Discussion
Seed- and Market-Size Stock
The 2023 estimated oyster stock for CSA 1 South consists of 18,631.7 bbl of seed oysters and 21,436.3 bbl of market-size oysters, for a total of 40,068.0 bbl of overall stock (*Figure 2.2*). Total estimated oyster stock for 2023 is down 30.7% from 2022. Compared to 2022, there was a 59.6% decrease in the seed stock estimate. The 2023 market-size oyster estimate increased 84% over the previous year's market-size stock estimate. Seed stock in CSA 1 South is now 54.7% below the previous 10-year average. The current market-size stock is up 44.2% from the previous 10-year average. Total assessed oyster stock for 2023 is 28.5% below the previous 10-year average. The Lake Fortuna reef complex accounted for 82.4% of all oyster stock in CSA 1 South during this year's assessment. The oyster densities observed at South Lake Fortuna drove this year's seed stock estimate, with a mean density of 1.2 seed oysters per square-meter. South Lake Fortuna also held the majority of the market-size oyster estimate, with a mean density of 1.0 market-size oysters per square-meter. The remaining seed oyster stock resource observed in CSA 1 South came from reefs at the Wreck. The Lake Fortuna cultch plant (2012) held the remainder of the market-size oyster resource.

Spat Production
All live spat observed in the 2023 Oyster Stock Assessment samples were found at the Curfew Island and Horseshoe Reef stations. Horseshoe Reef had the greatest average density of spat oysters at 1.2 per square-meter. Curfew Island had a density of 0.2 spat oysters per square-meter. Biologists noted no observation of recent spat mortality at any of the South Pontchartrain Basin sample stations. Overall, CPUE for spat in the area was extremely low, at just 0.1. This represents a 37.5% decrease from the previous year's assessment. Although these sampling events may occur outside of the peak spawning period, it is evident that there has been only minimal spat catch on these reefs. This marks a continuation of poor recruitment and survival within CSA 1 South. Long

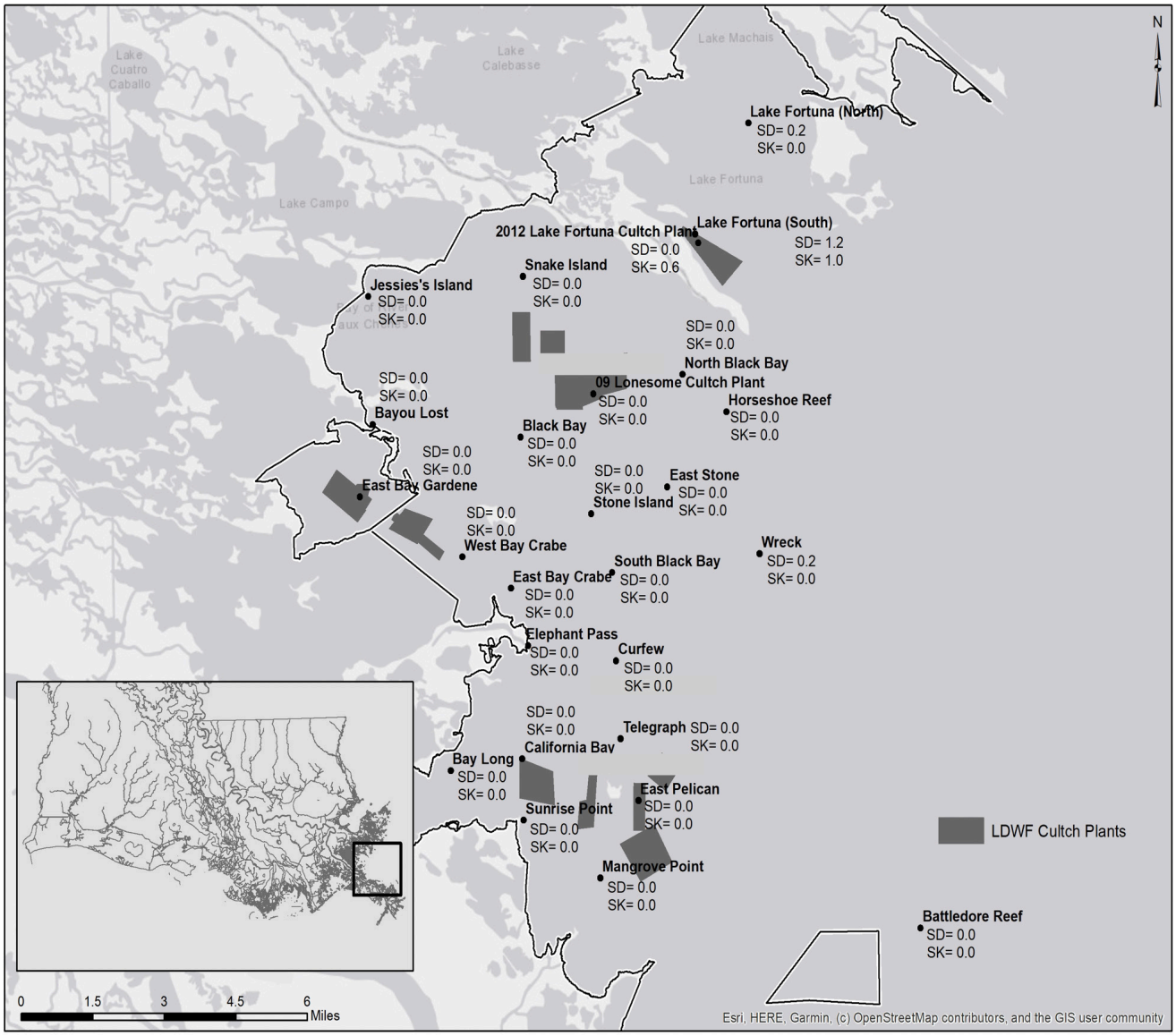

FIGURE 2.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-1 South).

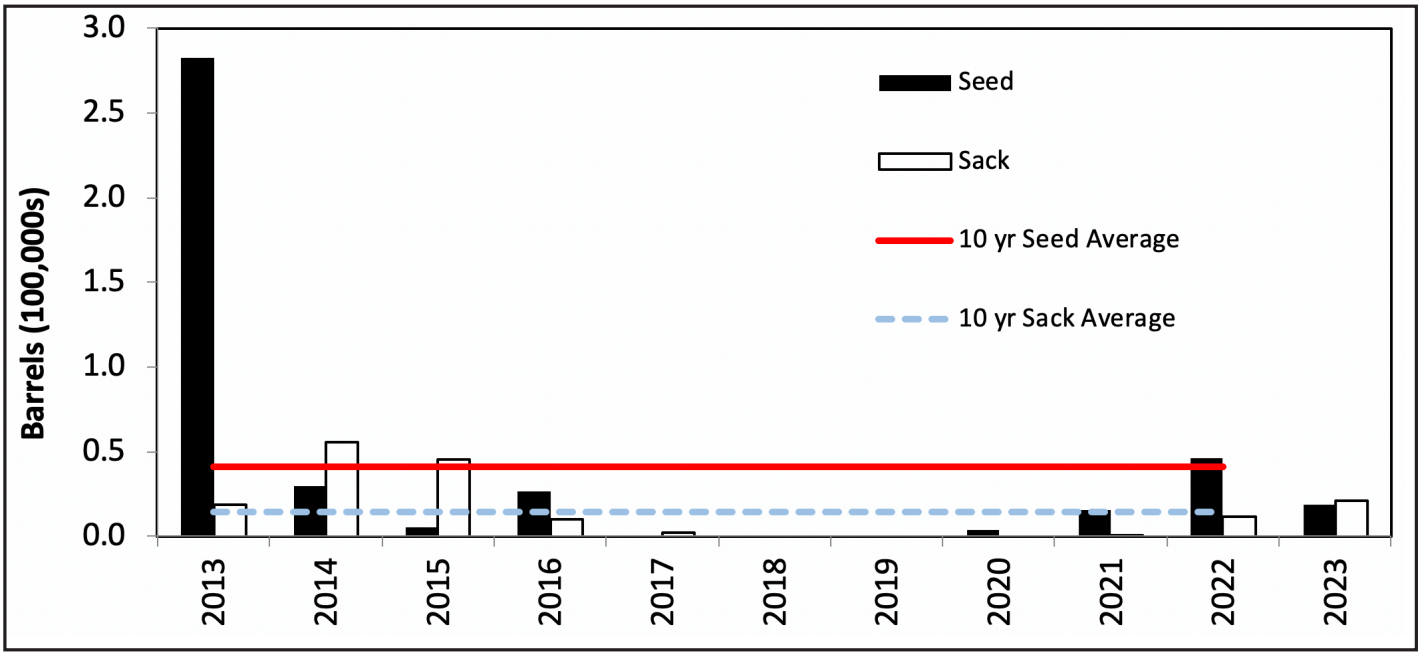

FIGURE 2.2. CSA 1 South historical oyster stock availability. Horizontal lines represent the previous 10-year average seed and market-size stock estimate averages.

TABLE 2.1. 2023 Oyster availability by sample station or reef complex in CSA 1 South.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-Sized Oysters/m^2	Seed Oysters (bbl)	Market-Sized Oysters (bbl)
Jessie's Island	549.9	0	0	0.0	0.0
Bayou Lost		0	0		
Reef Complex Cumulative		0.0	0.0		
East Bay Gardene	1,262.6	0.0	0.0	0.0	0.0
West Bay Crabe	1,732.0	0	0	0.0	0.0
East Bay Crabe		0	0		
Reef Complex Cumulative		0.0	0.0		
Elephant Pass	202.2	0	0	0.0	0.0
Sunrise Point	3,692.8	0	0	0.0	0.0
California Bay		0	0		
Bay Long		0	0		
Reef Complex Cumulative		0.0	0.0		
Mangrove Point	2,889.1	0	0	0.0	0.0
East Pelican		0	0		
Reef Complex Cumulative		0.0	0.0		
Stone Island	3,575.7	0	0	0.0	0.0
South Black Bay		0	0		
Curfew Island		0	0		
Telegraph Island		0	0		
Reef Complex Cumulative		0.0	0.0		
Snake Island	2,861.9	0	0	0.0	0.0
Lonesome CP (2009)		0	0		
Black Bay		0	0		
Reef Complex Cumulative		0.0	0.0		
South Lake Fortuna	3,453.9	1.2	1	13,589.0 (27,178.06 Sacks)	19,412.9 (38,825.82 Sacks)
North Lake Fortuna		0.2	0		
Reef Complex Cumulative		0.7	0.5		
North Black Bay	2,485.8	0	0	0.0	0.0
Horseshoe Reef		0	0		
East Stone Island		0	0		
Reef Complex Cumulative		0.0	0.0		
Wreck	4,485.8	0.2	0	5,042.6 (10,085.2 Sacks)	0.0
Battledore Reef	270.6	0	0	0.0	0.0
Lake Fortuna CP (2012)	300.0	0	0.6	0.0	2,023.4 (4,046.88 Sacks)
Total				***18,631.7 (37,263.3 Sacks)***	***21,436.3 (42,872.68 Sacks)***

	LTA (2013-2022)	2023	% Change
Seed	41,171.6	18,631.7	-54.7%
Market-Size	14,863.1	21,436.3	+44.2%
Total	56,034.6	40,068.0	-28.5%

periods of poor oyster production needed to replenish available shell stock, have largely degraded reef areas to mud and heavily fouled shell hash with mussels and other organisms. This lack of suitable substrate to enable spat attachment adds another stressor to the oyster population in this area. Eleven of the 26 stations sampled did not have any measurable reef material, and several were noted to have material almost completely buried under sediments.

Hydrological Data

During the period between August 2022 and July 2023, aside from the months of January, June and July, salinities in the South Pontchartrain Basin were below the long term average (*Figure 2.3*). Periods of excessively low salinities during the months of February through May coincided with multiple openings of the Caernarvon Fresh Water Diversion (CFWD) structure. Caernarvon was opened for 19 days from Jan. 30 - Feb. 17. Flows maxed out at near 6,000 cubic feet per second (cfs) during this period. The structure was opened again for 20 additional days from March 15 to April 3. Maximum flow rate during this opening reached 4,000 cfs. Water temperatures during the months of February through April were also well below the long term average. Starting in late spring 2023 and persisting into the summer, the Pontchartrain Basin experienced extreme drought conditions. According to Drought.gov, 2023 was the second driest January through July time period recorded in 129 years. As drought conditions persisted through the summer months, the water levels and flow rates in the Mississippi River reached historical lows. As a result, the South Pontchartrain Basin experienced much higher than average salinities during the months of June and July. Spring 2023 marked the third year in a row without a Mississippi River flood event necessitating the opening of the Bonnet Carré Spillway. Regular periods of low spring salinities and periods of hypoxia in the summer and fall decrease spawning success and increase risk of mortality, inhibiting oyster production in this area.

Fouling Organisms

During 2023 Oyster Stock Assessment sampling, the hooked mussel (*Ischadium recurvum*) was observed at 10 of the 26 sample stations. Hooked mussel densities ranged in density from 0.4 to 60.6 individuals per square-meter, with the highest density of mussels being observed at the Wreck reef. There was a 49.2% decrease in the occurrence of hooked mussels when compared to the previous year's observations. The vast majority of hooked mussels occurred at sample stations where the amount of available cultch material was the greatest. The largest decreases in hooked mussel densities were observed at the 2012 Lake Fortuna cultch plant (-97.6%), East Stone Island (-79.2%), and South Lake Fortuna (-66.6%). While hooked mussel density decreased at seven sample stations in 2023, there was an increase in hooked mussel density at five sample stations. Most notably, there was a 1,157.0% increase in hooked mussel fouling at South Black Bay and a 269.5% increase at the Wreck reef. Although there is no documentation of barnacle fouling on oyster shells in the assessment, there has been documentation of moderate to heavy barnacle fouling of oyster shells in monthly samples at a number of sample stations prior to the assessment. In addition, there were observations of bryozoans on the exposed substrate at many of

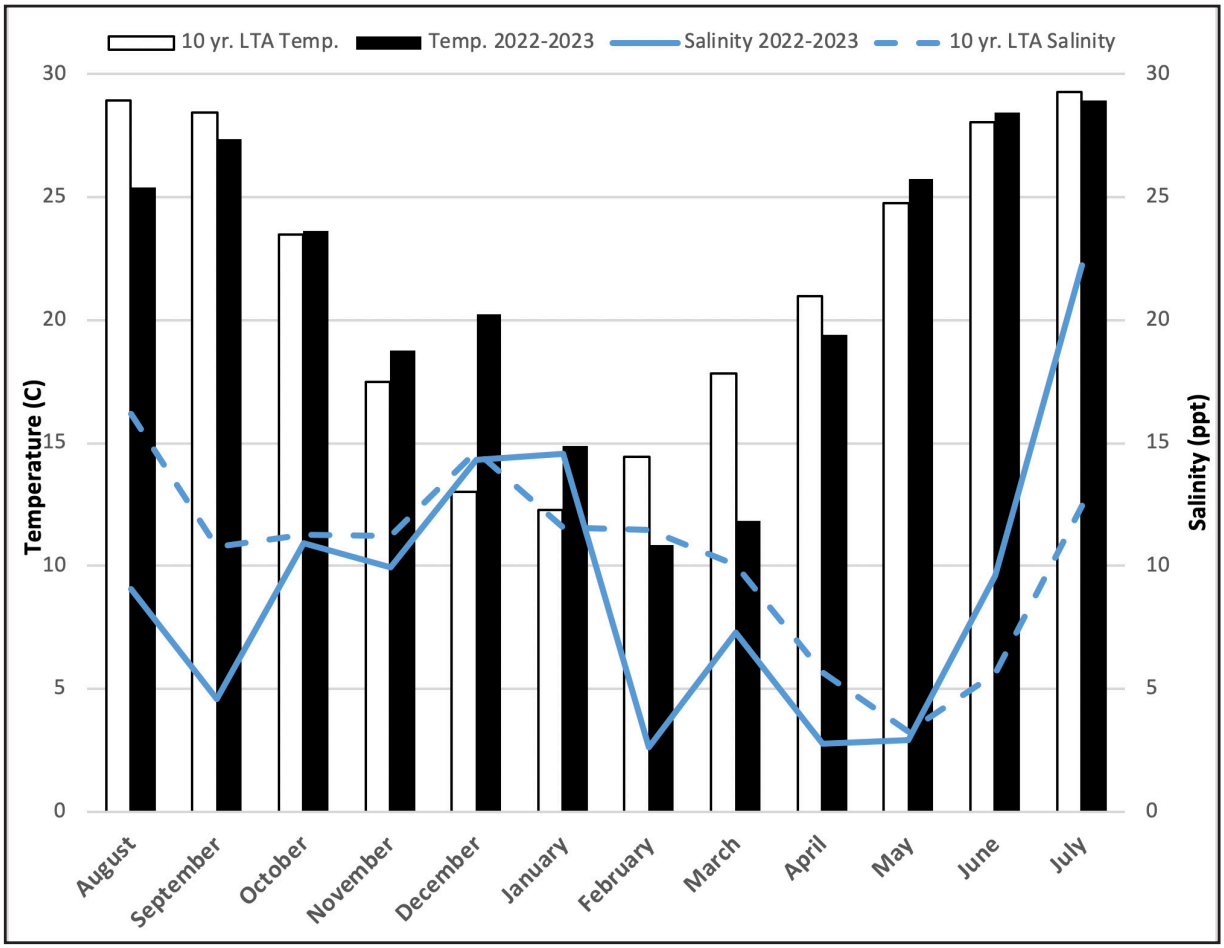

FIGURE 2.3. Mean salinity and temperature for Southern Lake Pontchartrain Basin Public Oyster Seed Grounds from August 2022 - July 2023.

the sample stations. All of these forms of fouling limit the ability of oyster larvae to attach to available cultch and continue to be a hindrance to recruitment in the South Pontchartrain Basin.

Oyster Predators and Disease

There were no observances of live oyster drills or stone crabs during the 2023 Oyster Stock Assessment sampling. Salinities across the area are generally not suitable for such oyster predators. Other (Xanthid) mud crabs were noted in numerous samples that contained shell for substrate.

Mortality

Overall, during the 2023 Oyster Stock Assessment, observed mortality estimates showed a marked decrease compared to the previous year's stock assessment. Biologists observed oyster mortality at just one of the 26 sample stations. A single recently dead seed oyster was noted at the 2012 Lake Fortuna cultch plant. There was no observed spat or market-size oyster mortality during this sampling event.

2022-2023 Oyster Season

Harvest totals for 2022-2023 were estimated at 3,265 sacks of market oysters. When harvest estimates within assessed areas are compared with the 2022 stock assessment, there was an estimated utilization of 14.2% of the sack resource. Observed harvest effort was exclusive to the Lake Fortuna Reef Complex. The vast majority of harvest came from within the Lake Fortuna cultch plant (2012), which accounted for 90.4% of the total estimated harvest of market oysters in the South Pontchartrain Basin. The remainder of observed sack harvest came from North Lake Fortuna. The amount of market oyster harvest from Lake Fortuna cultch plant (2012) was despite the reef not having market-size oysters found during the 2022 Oyster Stock Assessment. This reef did have 7,756 bbl of seed-size resource in 2022. The harvest from the Lake Fortuna cultch plant (2012) during the 2022-2023 oyster season accounted for 19% of the previously assessed resource for this reef. The observed harvest from the North Lake Fortuna reef during the 2022-2023 oyster season accounted for 1.3% of the 2022 market-size resource assessment for reefs.

COASTAL STUDY AREA 3
(Barataria Basin)

Introduction
Coastal Study Area 3 (CSA 3) consists of three public oyster areas distributed generally in a north-south direction within the Barataria Bay estuary: Little Lake Public Oyster Seed Grounds, Hackberry Bay Public Oyster Seed Reservation, and 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 governments prior to the opening of the Davis Pond diversion. The Davis Pond diversion has not been consistently used to its maximum capacity since it first opened in 2002, and environmental conditions during some years have allowed oysters to continue to exist in Little Lake. In an effort to have LDWF actively manage the public oyster grounds, and to allow the harvest of oyster by the public, the Commission designated this area as a Public Oyster Seed Ground in 2007. 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 from increased freshwater input can negatively impact oyster survival and availability. 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.

Hackberry Bay, in Jefferson and Lafourche Parishes, is a 4,402-acre mesohaline embayment with a primarily soft silt and clay bottom of which only 14.7 acres is naturally occurring reef material. The three historical sample stations within Hackberry Bay are the Upper, Middle, and Lower Hackberry sample stations. The Middle Hackberry Bay station is the only sample station located over 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, clamshell, 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 upon and reflective of when and where cultch plants are placed in the bay. 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, LDWF has constructed five cultch plants in Hackberry Bay. LDWF constructed two cultch plants totaling 35 acres in 2004 and one of 50 acres in 2008. Two additional plants, a 2012 cultch plant of approximately 200 acres, and a 2014 cultch plant of 30 acres, combined with the other three, have increased the reef acreage on the Hackberry Bay Public Oyster Seed Reservation to its current estimate of 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 might 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 reliable oyster production from this area until salinity regimes in the basin can remain at consistently lower ranges brought about by natural forces or by coastal restoration efforts.

Methods
For the 2023 Oyster Stock Assessment, biologists collected field samples according to the methodology described in the Statewide Overview of this report. Between July 10 and July 18, 2023, nine stations were sampled and 45 replicate samples were collected (*Figure 3.1*). Biologists did not conduct sampling efforts in 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 2023 stock assessment estimated the amount of oysters available for harvest on the Hackberry Bay Public Oyster Seed Reservation and the Barataria Bay cultch plant as 7,250.7 bbl, of which 5,901.7 bbl are seed oysters and 1,349.0 bbl are market-size (or sack) oysters. Seed oysters were only recorded at the 2008 and 2012 Hackberry Bay cultch plants. The seed availability in July 2023 was 59.5% lower than seed availability from July 2022 (14,557.5 bbl), and 42.7% below the 10-year average (2013-2022) (10,290.6 bbl) (*Figure 3.2*). The 2012 Hackberry cultch plant had the highest CPUE (4.8) and highest available barrels of seed (5,395.8 bbl) (*Table 3.1*).

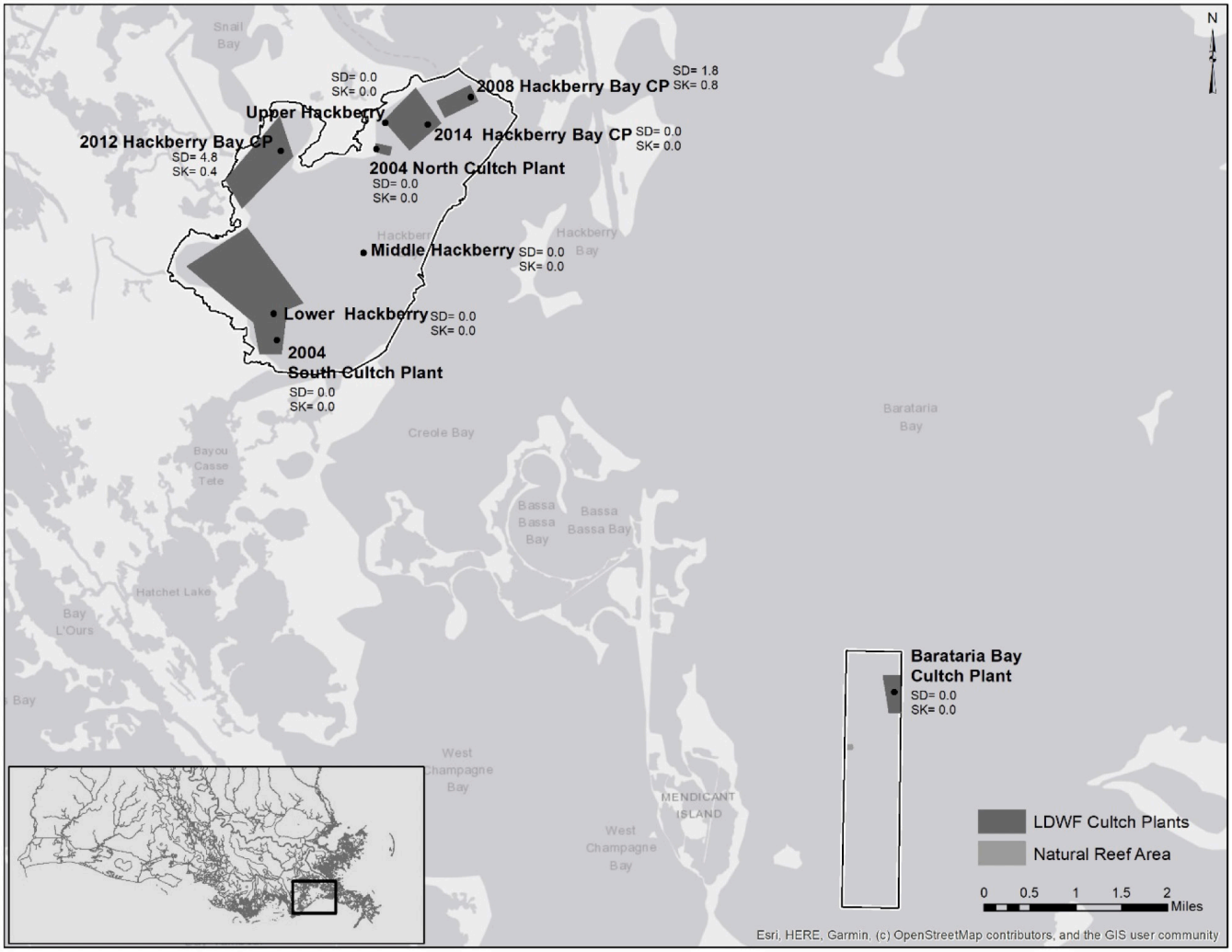

FIGURE 3.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-3).

TABLE 3.1. 2023 oyster availability by sample station in CSA 3.

Station	Reef (acres)	Average Number Seed Oysters/m²	Average Number Market-size Oysters/m²	Seed Oysters (bbl)	Market-Size Oysters (bbl)
Lower Hackberry	4.9	0.0	0.0	0.0	0.0
Middle Hackberry	4.9	0.0	0.0	0.0	0.0
Upper Hackberry	4.9	0.0	0.0	0.0	0.0
N. Hackberry Bay Cultch Plant	10.0	0.0	0.0	0.0	0.0
S. Hackberry Bay Cultch Plant	25.0	0.0	0.0	0.0	0.0
2008 Hackberry Bay Cultch Plant	50.0	1.8	0.8	505.9 (1,011.7 sacks)	449.7 (899.3 sacks)
2012 Hackberry Bay Cultch Plant	200.0	4.8	0.4	5,395.8 (10,791.7 sacks)	899.3 (1,798.6 sacks)
2014 Hackberry Cultch Plant	30.0	0.0	0.0	0.0	0.0
Barataria Bay Cultch Plant	40.0	0.0	0.0	0.0	0.0
Total	***369.7***			***5,901.7 (11,803.4 sacks)***	***1,349.0 (2,697.9 sacks)***

Sack oysters were only recorded at the 2008 and 2012 Hackberry Bay cultch plants. The sack availability in July 2023 was 50.0% lower than sack availability from July 2022 (2,697.9 bbl), and 61.2% below the 10-year average (2013-2022) (3,472.9 bbl) (*Figure 3.2*). The 2008 Hackberry cultch plant had the highest CPUE (0.8); however, the 2012 Hackberry cultch plant had the highest available barrels of seed (899.3 bbl) (*Table 3.1*). The combined stock of 7,250.7 bbl of seed and market-size oysters showed a 58.0% decrease from the 2022 estimate (17,255.4 bbl), and a 47.3% decrease from the 10-year average (13,763.5 bbl) (*Figure 3.2*). In Hackberry Bay, cultch material was collected at three of the eight sample stations, while at the other five sample stations, the only cultch material found was buried under 6 inches, or greater, of mud. Market-size oyster availability has not been documented in Barataria Bay since the creation of the Barataria Bay cultch plant station in 2004.

Spat Production

There was a marked decrease in spat CPUE in 2023 (5.7) compared to 2022 (23.6). In 2023, 255 total live spat were collected. The highest number of spat was found at the 2012 cultch plant (221). This was 86.7% of the total spat sampled. The only other station that had spat was the 2012 Hackberry Bay cultch plant (34). Spat numbers are considerably lower this year due to increased salinity levels (>12ppt) in Hackberry Bay during spawning season (April-June).

Hydrological Data

Oyster habitat suitability for the Barataria seed grounds is highly influenced by the Mississippi River discharge and the Davis Pond diversion discharge. The United States Army Corps of Engineers (USACE) Tarbert gauge recorded Mississippi River discharge from July 1, 2022 to June 31, 2023 averaging 417,300 cubic feet per second (cfs), reaching a peak discharge of 832,194 cfs during March 2023. The United States Geologic Survey (USGS) constant recorder located near the Davis Pond diversion structure recorded a monthly average discharge of 1,754.1 cfs of Mississippi River flow being diverted through the structure into Davis Pond (July 2022- June 2023). The highest monthly average discharge over this time period was 9,138.0 cfs during February 2023 (*Figure 3.3*).

Oyster habitat suitability is also highly influenced by the salinity and temperature of the surrounding water. Water quality was gathered from three USGS stations at Lake Cataouatche, Little Lake, and Grand Terre Island during July 2023. The USGS gauge in Hackberry Bay was damaged during Hurricane Ida and has not yet come back online. In an effort to compensate, the average temperatures and salinities from the square-meter sampling in Hackberry Bay was substituted for Hackberry USGS gauge in *Figures 3.4 and 3.5*. The water temperature in the Barataria area during July 2023 averaged 31.8° C, which was warmer than the July 10-year LTA 30.2° C (*Figure 3.4*). Salinity averaged 12.7 ppt and the 10-year LTA was 6.8 ppt (*Figure 3.5*).

The 2022 Hurricane Season generated 14 named storms, of which zero made landfall in Louisiana.

Fouling Organisms

A total of 11 hooked mussels were present at one of the nine sample stations. The average density (2.2 mussels per square-meter) was observed at the 2012 Hackberry Bay cultch plant. In comparison, during square-meter sampling in 2022, 16 hooked mussels were collected at two different stations, with 3.0 mussels occurring per square-meter.

Oyster Predators and Disease

For the 2023 stock assessment, two oyster drills were collected. In the last 10 years (2014-2023), biologists have collected 46 oyster drills during dredge and square-meter sampling; most of these have come from the 2004 Barataria Bay cultch plant. The low number of oyster drills found in LDWF samples can be correlated to the relatively low salinity levels typically found in Hackberry Bay. The 10-year average (2014-2023) for July salinity in Hackberry Bay is 7.2 ppt.

Mortality

Spat and seed mortality was documented at only one sample station, the 2008 Hackberry Bay cultch plant, and at this site only one dead individual was found for each size class. Mortality rates for spat and seed were 3% and 10%, respectively. No market-size oyster mortality was recorded at any station. The combined overall spat, seed, and market-size oyster mortality was 0.7%, which was a decrease from the 7.2% in the 2022 assessment.

Monthly dredge samples have provided an additional source of oyster mortality data. Between August 2022 and June 2023, dredge samples revealed an average monthly mortality of 3.7% for spat, seed, and market-size oysters (*Figure 3.6*). *Figure 3.6* shows high spat mortality rates in August 2022 and March 2023. This 3.7% average mortality was a decrease from the same timeframe for the prior year - August 2021 to June 2022 (9.3% mortality). No definitive cause was found for these unusual mortality events over a wide portion of the basin. Low Dissolved Oxygen and Red Tide were ruled out, but no other cause was ever determined.

2022-2023 Oyster Season

The Hackberry Public Oyster Seed Reservation was open for the 2022-2023 season. The bedding season was a 1-day season, open only on Oct. 17, 2022. Approximately 73 barrels of seed oysters were harvested. During the 2022-2023 sacking season, beginning Oct. 18, 2022, approximately 30 barrels of market-size oysters were harvested. CSA 3 biologists conducted oyster vessel observations in Hackberry Bay to survey active oyster boats, and field staff observed and surveyed a total of two boats working the grounds during the season. The 2022-2023 season had a low number of boats participating due to a perceived decreased amount of available resource. Of the surveyed boats, captains reported that they were not returning the next day, due to the low amount of available oysters. The oyster season closed on April 1, 2023.

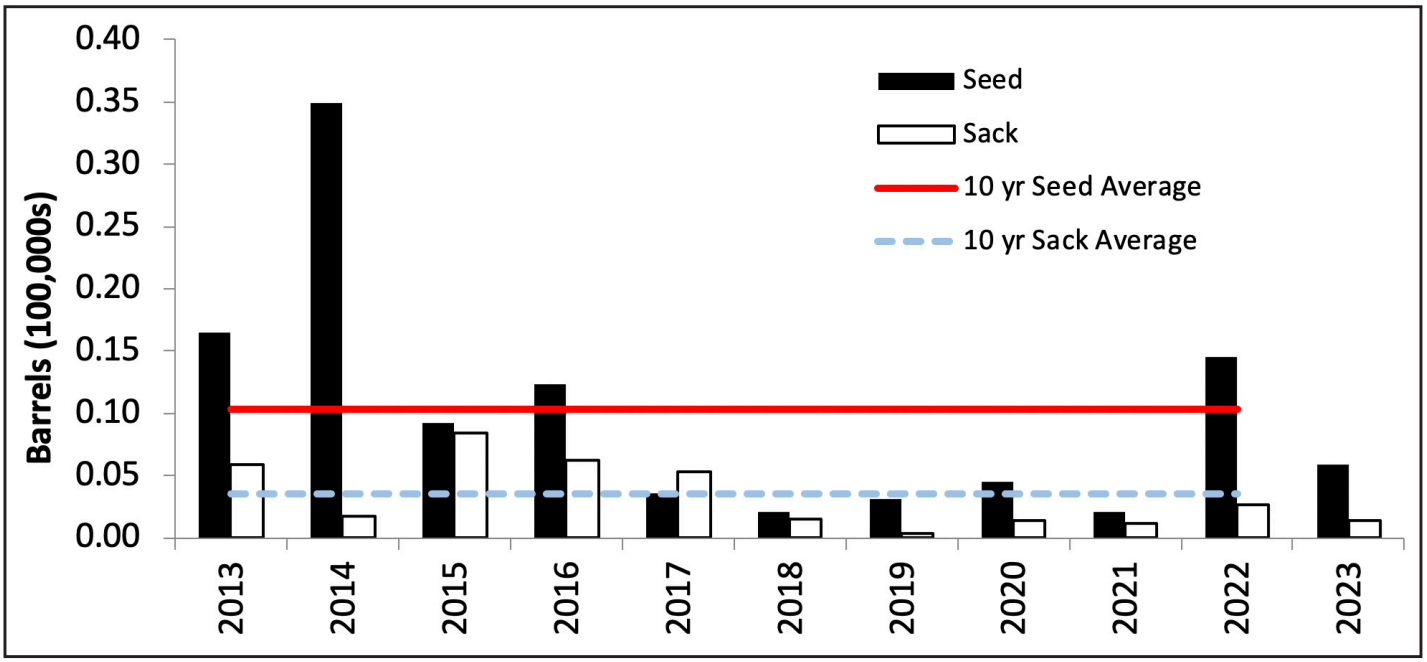

FIGURE 3.2. Hackberry Bay Oyster Seed Grounds historical oyster stock availability.

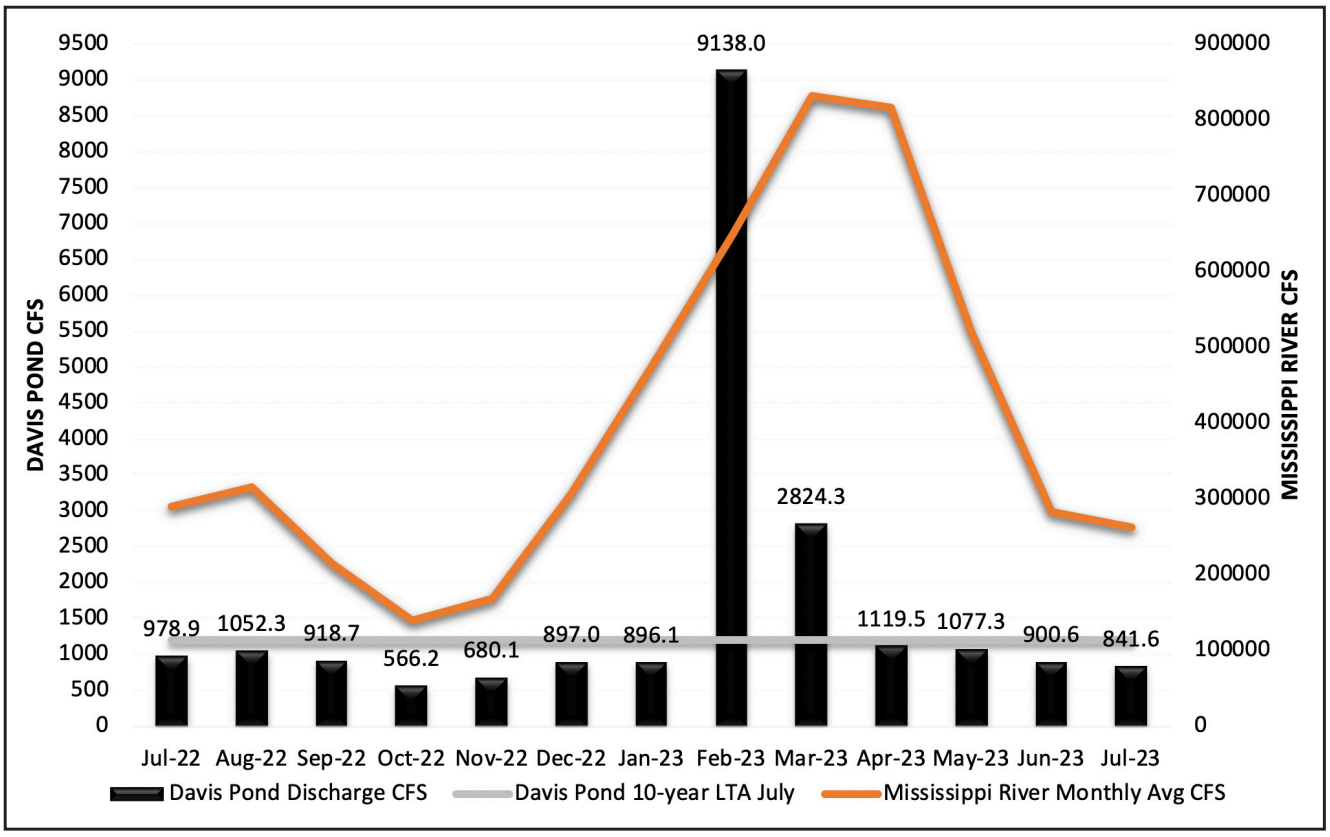

FIGURE 3.3. Davis Pond Diversion (cfs) and Mississippi River flow at Tarbert Landing (cfs).

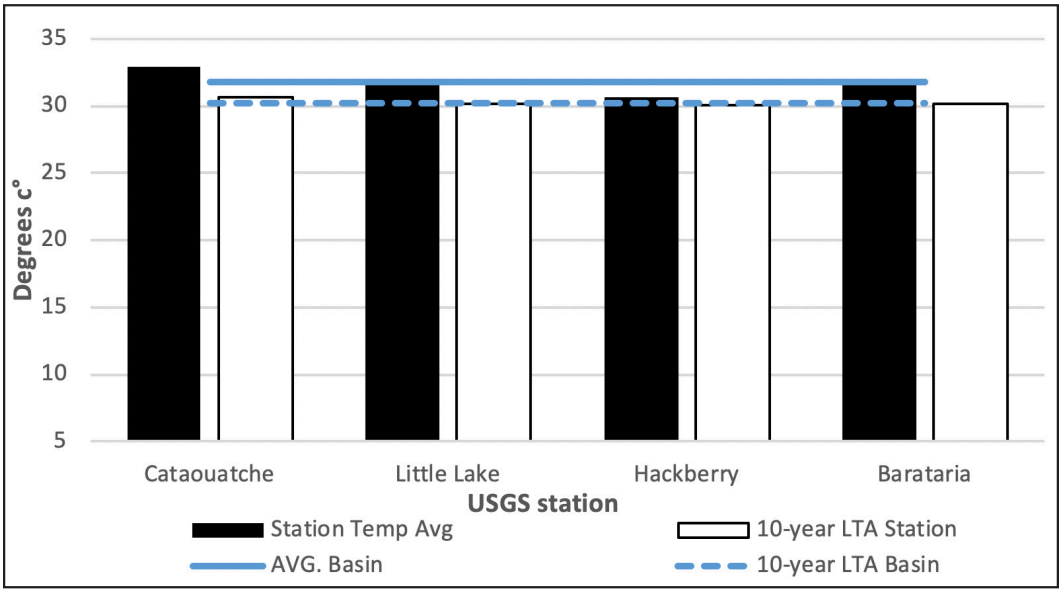

FIGURE 3.4. July 2023 water temperature averages in comparison to July 10-year LTA for the Barataria area from four USGS stations at Lake Cataouatche, Little Lake, Hackberry Bay*, and Grand Terre Island. (* the average temperature from the square-meter sampling in Hackberry Bay was substituted for Hackberry USGS gauge in July 2023 due to gauge currently being offline)

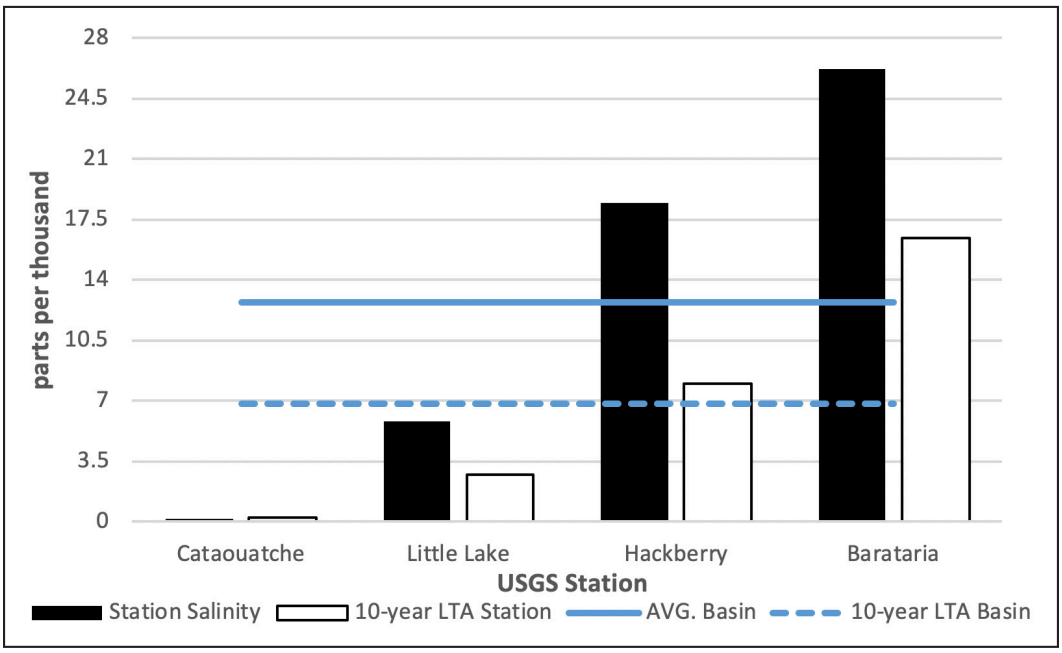

FIGURE 3.5. July 2023 water salinity averages in comparison to the July 10-year LTA for the Barataria area from four USGS stations at Lake Cataouatche, Little Lake, Hackberry Bay*, and Grand Terre Island. (* the average salinity from the square-meter sampling in Hackberry Bay was substituted for Hackberry USGS gauge in July 2023 due to gauge currently being offline)

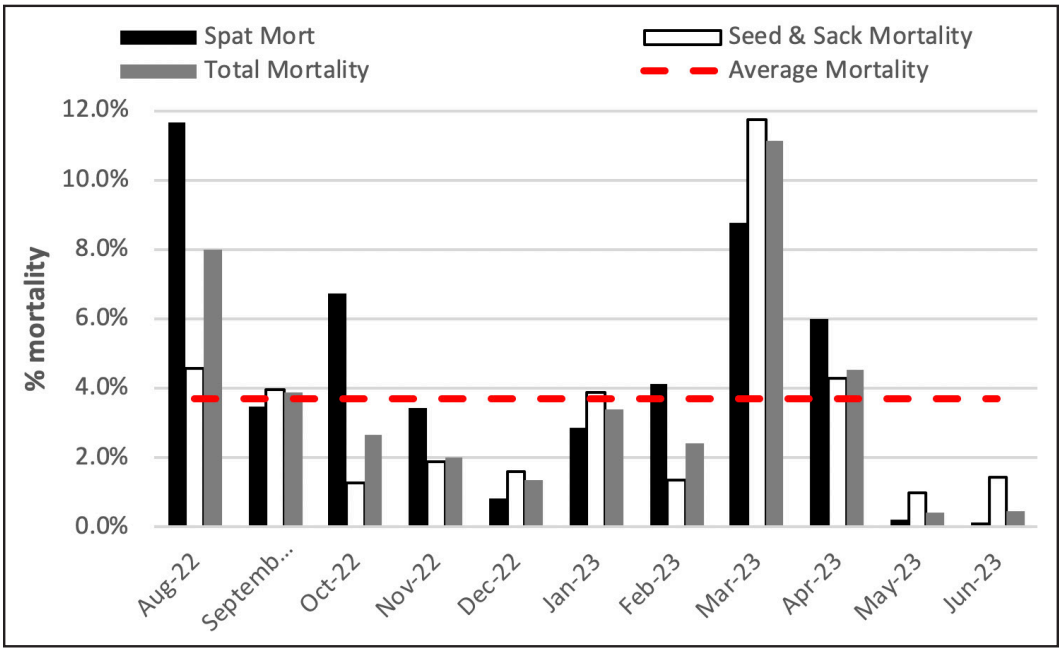

FIGURE 3.6. Oyster mortality from monthly dredge sampling in Barataria Basin - August 2022 to June 2023

COASTAL STUDY AREA 5
(Terrebonne Basin)

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 POSRs and POSGs within CSA 5. Sister Lake POSR, Bay Junop POSR, and Lake Mechant POSG are located in the western Terrebonne Basin (*Figure 5.1*). Deep Lake POSG, Lake Felicity POSG, Lake Chien POSG, and Lake Tambour POSG are found in the eastern Terrebonne Basin (*Figure 5.2*).

The Commission designated Sister Lake as a Public Oyster Seed Reservation in 1940; this area includes 9,150.5 acres of water bottom. (*Figure 5.1*). The most recent Sister Lake cultch plant was a 200-acre site in 2021. The 2021 Sister Lake cultch plant was funded through DWH NRDA settlement dollars to restore for injuries to oysters that occurred as a result of the spill. The current total reef acreage for Sister Lake is estimated to be 2,575.4 acres.

The Commission established the Bay Junop POSR (*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 the inability of barges and tugs to enter for cultch plants, LDWF has not been able to construct artificial reefs in this area to augment natural oyster reef production. Available public reef acreage in Bay Junop is estimated to be 252 acres.

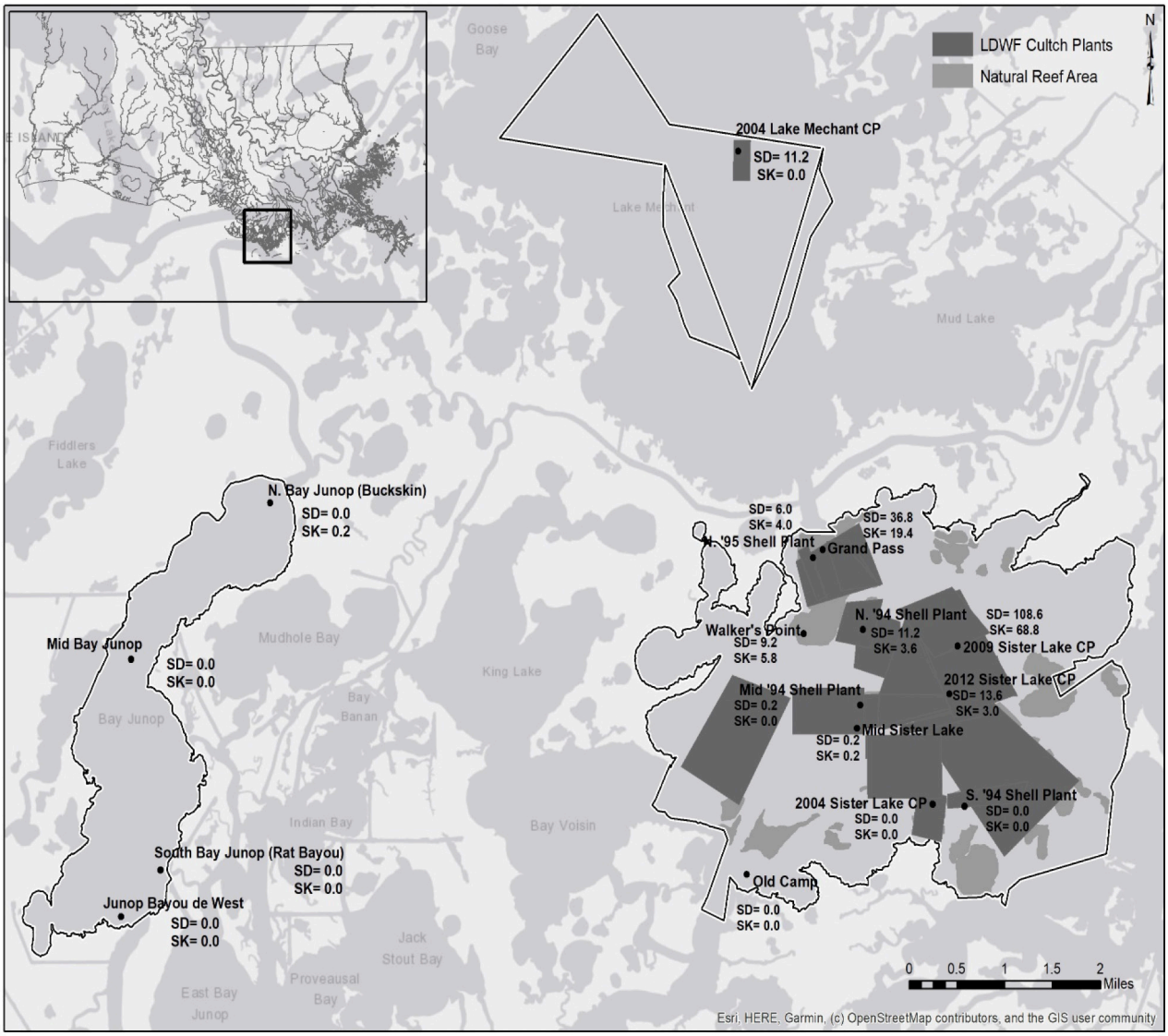

FIGURE 5.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-5 Western Terrebonne Basin).

FIGURE 5.2. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-5 Eastern Terrebonne Basin).

The Commission established the Lake Mechant Public Oyster Seed Grounds (*Figure 5.1*) in 2001, constructed a 30-acre cultch plant in 2004, and added acreage of unleased water bottoms between the designated Public Oyster Seed Grounds and private oyster leases in 2007. In total, the Lake Mechant POSG consists of 2,583 acres, with the 30-acre cultch plant as the only known reef acreage within the area.

The Commission established the Lake Tambour, Lake Chien, Lake Felicity, and Deep Lake POSGs in 2001; this area includes roughly 2,340 acres of water bottom in Lake Chien and Lake Felicity (*Figure 5.2*). Prior to the more current public seed ground establishment, the areas of and around Lake Felicity had been used as oyster seed reservations in the 1940s and early 1950s, but had been discontinued. Salinities in Lake Tambour, Lake Chien, Lake Felicity, and Deep Lake are consistently at a higher range than what is considered tolerable for oyster production, but future planned coastal freshwater diversion projects may return the area to a more favorable salinity regime.

Three cultch plants have been built within the Eastern portion of CSA 5: 1) a 16-acre cultch plant in Lake Chien completed in 2004, 2) a 40-acre cultch plant in Lake Felicity completed in 2004, and 3) a 22-acre cultch plant due east of the initial Lake Chien cultch plant completed in May 2009 (*Figure 5.2*). LDWF has not developed any reefs in Lake Tambour or Deep Lake.

Methods

LDWF biologists collected field samples for the 2023 Oyster Stock Assessment on July 10-12, 2023, from 19 sample stations within CSA 5 according to the methodology described in the Statewide Overview of this report. Sample stations included existing oyster reefs in Lake Felicity, Lake Chien, Sister Lake, Bay Junop, and Lake Mechant. Due to lack of live resource in the eastern Terrebonne Basin since 2019, it was decided in September 2022 to reduce square-meter sampling frequency for the three sample stations in Lake Felicity and Lake Chien to every other year, starting in July 2023, to follow the same schedule as Sabine Lake square-meter sampling.

Results and Discussion

Seed- and Market-Size Stock

The 2023 Oyster Stock Assessment estimated the stock for CSA 5 at 166,730.9 bbl of seed oysters and 175,484.7 bbl of market-size oysters in the western Terrebonne Basin, and 0 bbl of seed oysters and 0 bbl of market-size oysters in the eastern basin (*Tables 5.1-5.3*).

In Sister Lake, the most productive oyster area in CSA 5, estimated seed availability for 2023 was 95.8% above the long-term average (2013-2022), and the estimated market-size availability was 642.8% above the long-term average. The 2023 Oyster Stock Assessment estimated 166,730.9 bbl of seed and 175,484.7 bbl of market-size oysters on the Sister Lake Public Oyster Seed Reservation, of which 56.9% (94,929.5 bbl) of available seed and 68.5% (120,279.1 bbl) of available market-size oysters were located on the 2009 Sister Lake cultch plant sample station (*Figure 5.3; Tables 5.1 and 5.4*). Monthly oyster dredge sampling for the timeframe between the 2022 Oyster Stock Assessment and the 2023 Oyster Stock Assessment (August 2022-June 2023) indicated the highest spat count in October and the lowest in May in Sister Lake. Overall, seed and market-size oyster mortality was 2.6 and 0.4% for this same period, respectively. The southern shoreline of Sister Lake continues to erode, creating more sedimentation over once productive oyster reefs and causing increased salinities which introduce an increasing number of natural oyster predators. The

TABLE 5.1. 2023 Sister Lake oyster availability by sample station.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-Size Oysters/m^2	Seed Oysters (bbl)	Market- Size Oysters (bbl)
Grand Pass	320	36.8	19.4	31,206.0 (62,412.0 Sacks)	35,046.7 (70,093.4 Sacks)
Walker's Point		9.2	5.8		
N. '95 Shell Plant		6.0	4.0		
Grand Pass Reef Complex Cumulative		17.3	9.7		
Old Camp	140	0.0	0.0	0.0	0.0
Mid-Sister Lake	56	0.2	0.2	62.7 (125.4 Sacks)	125.4 (250.8 Sacks)
N. '94 Shell Plant	191	11.2	3.6	12,026.2 (24,052.4 Sacks)	7,731.1 (15,462.2 Sacks)
Mid '94 Shell Plant	552	0.2	0.0	621.0 (1,242.0 Sacks)	0.0
S. 94' Shell Plant	513	0.0	0.0	0.0	0.0
2004 Sister Lake CP	82	0.0	0.0	0.0	0.0
2009 Sister Lake CP	156	108.6	68.8	94,929.5 (189,859.0 Sacks)	120,279.1 (240,558.2 Sacks)
2012 Sister Lake CP	365	13.6	3.0	27,885.5 (55,771.0 Sacks)	12,302.4 (24,604.8 Sacks)
Total	***2,375***			***166,730.9 (333,461.8 Sacks)***	***175,484.7 (350,969.4 Sacks)***

TABLE 5.2. 2023 Bay Junop/Lake Mechant oyster availability by sample station.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-size Oysters/m^2	Seed Oysters (bbl)	Market- Size Oysters (bbl)
North Bay Junop (Buckskin)	17	0.0	0.2	0.0	38.7 (77.4 Sacks)
South Bay Junop (Rat Bayou)	67	0.0	0.0	0.0	0.0
Junop Bayou de West		0.0	0.0		
South Bay Junop Reef Complex Cumulative		0.0	0.0		
Mid Bay Junop	73	0.0	0.0	0.0	0.0
2004 Lake Mechant CP	30	11.2	0.0	1,888.5 (3,777.0 Sacks)	0.0
Total	***187***			***1,888.5 (3,777.0 Sacks)***	***38.7 (77.4 Sacks)***

TABLE 5.3. 2023 Lake Chien/Lake Felicity oyster availability by sample station.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-size Oysters/m^2	Seed Oysters (bbl)	Market- Size Oysters (bbl)
Lake Chien	16	0.0	0.0	0.0	0.0
Lake Felicity	40	0.0	0.0	0.0	0.0
2009 Lake Chien CP	22	0.0	0.0	0.0	0.0
Total	***78***			***0.0***	***0.0***

TABLE 5.4. 2023 Oyster availabilities and percent change from 2022 and from the 10-year long-term average for both regions of CSA 5.

Region	Area	Seed Oysters (bbl)				Market-size Oysters (bbl)			
		LTA	2023	Change from LTA	Annual Change	LTA	2023	Change from LTA	Annual Change
Western Terrebonne Basin	Sister Lake	85,143.9	166,730.9	95.8%	150.7%	23,623.8	175,484.7	642.8%	507.7%
	Bay Junop	887.1	0.0	-100.0%	-100.0%	1,111.0	38.7	-96.5%	-98.1%
	Lake Mechant	1,662.6	1,888.5	13.6%	-63.4%	0.0	0.0	0.0%	0.0%
Eastern Terrebonne Basin	Lake Chien	481.9	0.0	-100.0%	0.0%	161.3	0.0	-100.0%	0.0%
	Lake Felicity	80.9	0.0	-100.0%	0.0%	0.0	0.0	0.0%	0.0%

northern portion of Sister Lake remains productive due to less overburden and more exposed cultch material.

In Bay Junop, estimated seed oyster availability for 2023 was 100.0% below the long-term average and estimated market-size oyster availability was 96.5% below the long-term average (2013-2022). The 2023 Oyster Stock Assessment estimated 0.0 bbl of seed and 38.7 bbl of market-size oysters on the Bay Junop Public Oyster Seed Reservation. In Lake Mechant, estimated seed oyster availability for 2023 was 13.6% above the long-term average (2013-2022). The 2023 Oyster Stock Assessment estimated 1,888.5 bbl of seed on the Lake Mechant Public Oyster Seed Ground (*Figures 5.4 and 5.5; Tables 5.2 and 5.4*). Lake Mechant and the northern portion of Bay Junop, near Buckskin Bayou (Sample 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 oyster growth and productivity in this area due to high Atchafalaya River levels in recent years. From August 2022 through June 2023, the highest spat concentrations in monthly oyster dredge sampling were observed in October in Bay Junop and in December in Lake Mechant. Only one market-size oyster was recorded in Lake Mechant during the dredge sampling period. In Bay Junop, although having much exposed cultch material available, there is also a high presence of hash material which may be limiting oyster production. As in Sister Lake, the southern shoreline of Bay Junop is continuing to degrade, allowing salinities to fluctuate based on prevailing wind direction and river discharge.

Lakes Chien and Felicity in the eastern Terrebonne Basin had no available seed and no available market-size oysters for the 2023 Oyster Stock Assessment (*Figures 5.6 and 5.7; Tables 5.3 and 5.4*). Additionally, no spat, seed, or market-size oysters were recorded in Lake Chien and Lake Felicity in quarterly oyster dredge sampling for the timeframe between the 2022 Oyster Stock Assessment and the 2023 Oyster Stock Assessment.

Continued marsh degradation in the eastern Terrebonne Basin allows salinities to fluctuate based on prevailing wind direction. 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 the cultch plant has shown zero productivity of market-size oysters in the last 10 years.

Spat Production

In the 2023 Oyster Stock Assessment, the number of oyster spat ranged from zero to 158 per sample replicate. The 2009 Sister Lake cultch plant had the highest sample station average of 119 per square-meter. In the western Terrebonne Basin, Sister Lake had the most spat at 1,207 overall. Lake Mechant and Bay Junop had overall totals of 29 and three spat, respectively. No spat were collected at the Lake Chien and Lake Felicity sample stations.

June dredge data for Sister Lake, Lake Mechant, and Bay Junop averaged 53.0, 2.5, and 6.5 spat per dredge sample, respectively. Sister Lake spat mortality was 1.1%. There was no spat mortality observed in Lake Mechant and Bay Junop. No dredge samples were scheduled in Lake Chien and Lake Felicity in June.

Hydrological Data

The monthly average water temperature for Sister Lake ranged from 10.5 to 30.3°C and monthly average salinity ranged from 7.1 to 19.8 ppt, with the long-term average (2013-2022) being 22.3ºC and 12.0 ppt, respectively. Monthly average water temperature and salinity for Bay Junop ranged from 10.0 to 30.1°C and 7.0 to 19.4 ppt, with the long-term mean (2013-2022) being 22.3°C and 12.1 ppt, respectively. Monthly average water temperature and salinity for Lake Mechant ranged from 10.5 to 30.6°C and 2.0 to 15.6 ppt, with the long-term mean (2013-2022) being 22.1°C and 5.5 ppt, respectively. Biologists collected this data during dredge sample events from August 2022 through June 2023 and July 2022 square-meter samples. Temperature and salinity measurements collected concurrently with 2023 square-meter sampling in July averaged 30.3°C and 18.2 ppt in the eastern Terrebonne Basin, respectively. In the western Terrebonne Basin, average temperature and salinity measurements collected concurrently with July 2023 square-meter sampling in Sister Lake, Bay Junop, and Lake Mechant averaged 31.1°C and 17.1 ppt, 32.2°C and 13.6 ppt, and 31.1°C and 7.9 ppt, respectively. *Figures 5.8-5.10* contain hydrological data from the 2022-2023 sampling year with long-term averages of salinity and temperature.

Due to the change in sampling frequency in the eastern Terrebonne Basin, no hydrology data is presented in this report.

No tropical storm, hurricane, or high river events affected the Terrebonne Basin during the 2022-2023 oyster season.

Fouling Organisms

Hooked mussels were the most abundant incidental species and were more prevalent in western Terrebonne Basin samples with an overall average of 17.4 hooked mussels per square-meter. Of this overall average, Lake Mechant had the highest occurrence with 27.2 hooked mussels per square-meter.

June dredge data for Sister Lake, Lake Mechant, and Bay Junop averaged 102.0, 0.75, and 24.5 hooked mussels per dredge sample, respectively. No dredge samples were scheduled in Lake Chien and Lake Felicity in June.

Oyster Predators and Disease

Biologists collected two types of predator species (mud crab and stone crab) during 2023 square-meter sampling. Western Terrebonne Basin samples showed an average of 2.8 mud crabs and 0.01 stone crabs per sample. Zero oyster predators were collected in Eastern Terrebonne Basin samples.

June dredge data for Sister Lake averaged 5.9 mud crabs and 0.1 oyster drills per dredge sample, respectively. June dredge data for Bay Junop and Lake Mechant averaged 1.0 and 0.5 mud crabs per dredge sample, respectively. No dredge samples were scheduled in Lake Chien and Lake Felicity in June.

Mortality

Biologists observed no seed or market-size oyster mortality throughout square-meter samples. Spat mortality was noted in the western Terrebonne basin. Overall spat mortality in Sister Lake was 0.2%. No spat mortality was observed in Bay Junop and Lake Mechant. No market-size oysters were recorded in Lake Mechant.

For June 2023 dredge sampling, no market-size oyster mortality was observed in Bay Junop. Sister Lake market-size oyster mortality in June averaged 0.2% per dredge sample. Sister Lake seed and spat mortality was 1.6 and 1.1%, respectively; and there was no seed and no spat mortality in Bay Junop. Lake Mechant seed mortality was 1.7% with no spat mortality, respectively.

In Sister Lake, overall seed and market-size mortality for yearly dredge sampling (August 2022 through June 2023) was 2.6 and 0.4%, respectively. Overall seed mortality was 2.8% and no market-size oyster mortality was observed in Bay Junop during the sampling year. Overall seed mortality was 1.3% and only one market-size oyster was sampled and recorded in Lake Mechant during the sampling year.

2022-2023 Oyster Season

The Commission opened Sister Lake on Feb. 13-17 for sacking only season with a daily take not to exceed 20 whole sacks of market-size oysters per vessel. The estimated total market-size harvest during this oyster season was 5,976 sacks. Harvest data estimates were collected by biologists while performing daily boarding runs. There was no market-size harvest provided from trip ticket data for publication.

The Commission opened Bay Junop and Lake Mechant on Oct. 17 for bedding only and Oct. 18 through April 1 for a sacking only season. Estimated total harvest during the bedding and sacking seasons in Bay Junop was 45 and 33 sacks, respectively. There was no harvest data recorded for Lake Mechant. Harvest data estimates were collected by biologists while performing daily boarding runs. There was no market-size harvest provided from trip ticket data for publication.

The Commission did not open Lake Chien and Lake Felicity during the 2022-2023 oyster season.

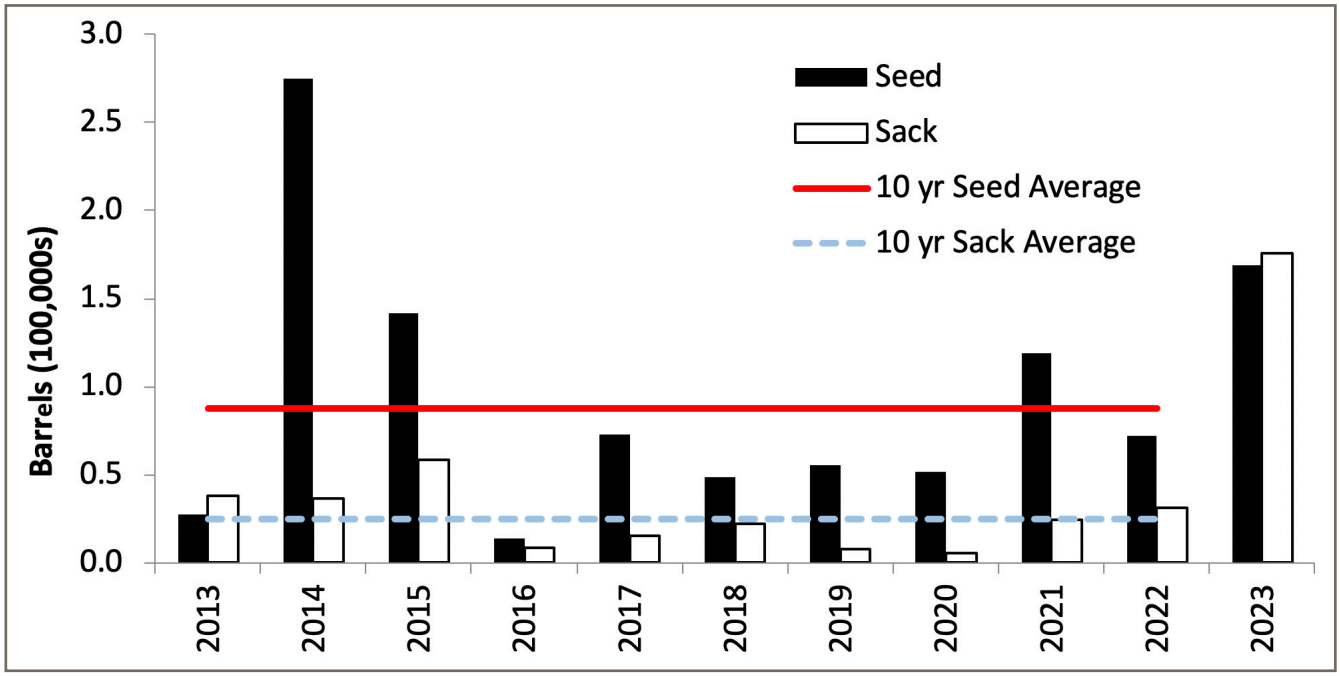

FIGURE 5.3. Sister Lake historical oyster stock availability.

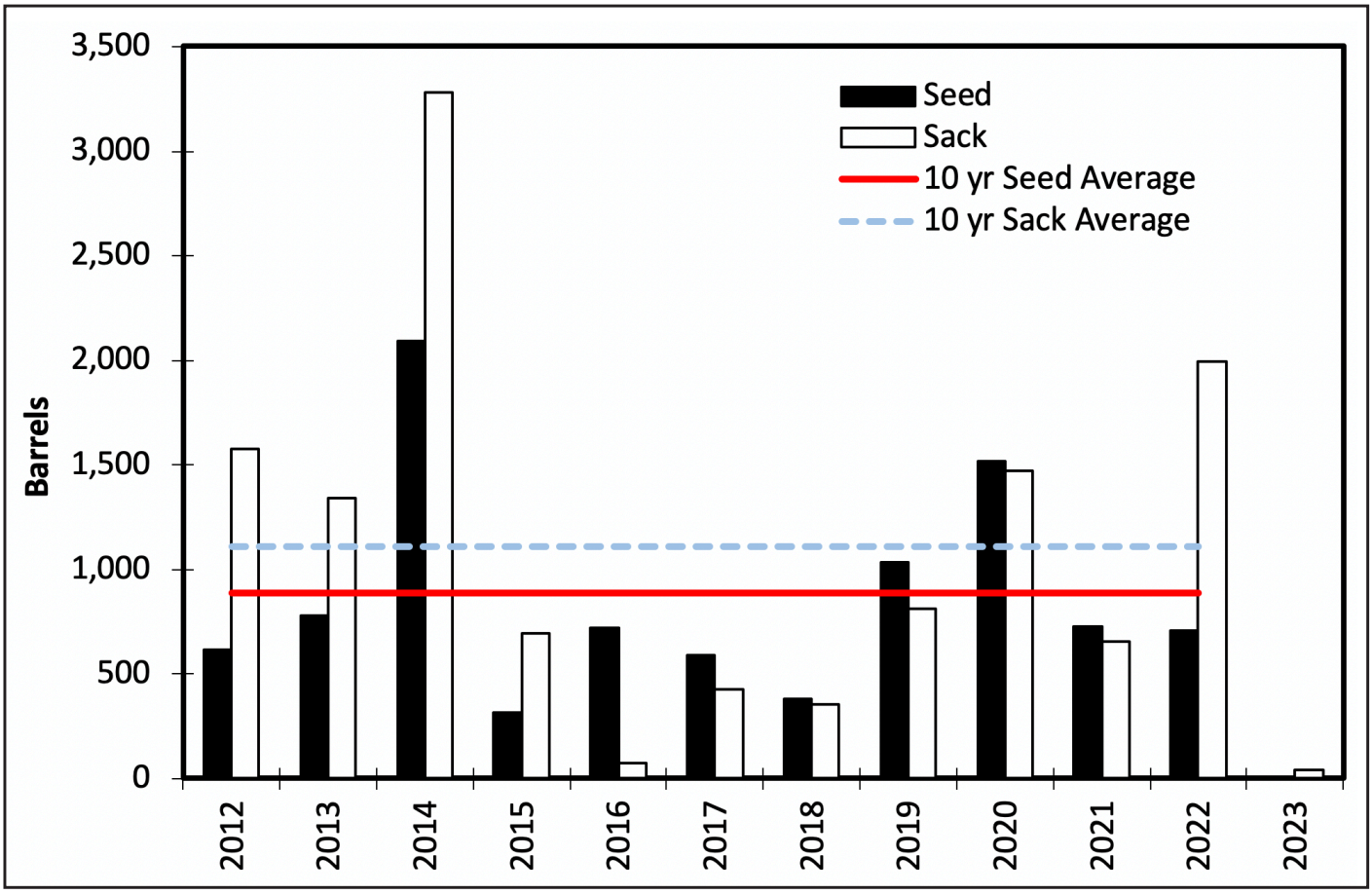

FIGURE 5.4. Bay Junop historical oyster stock availability.

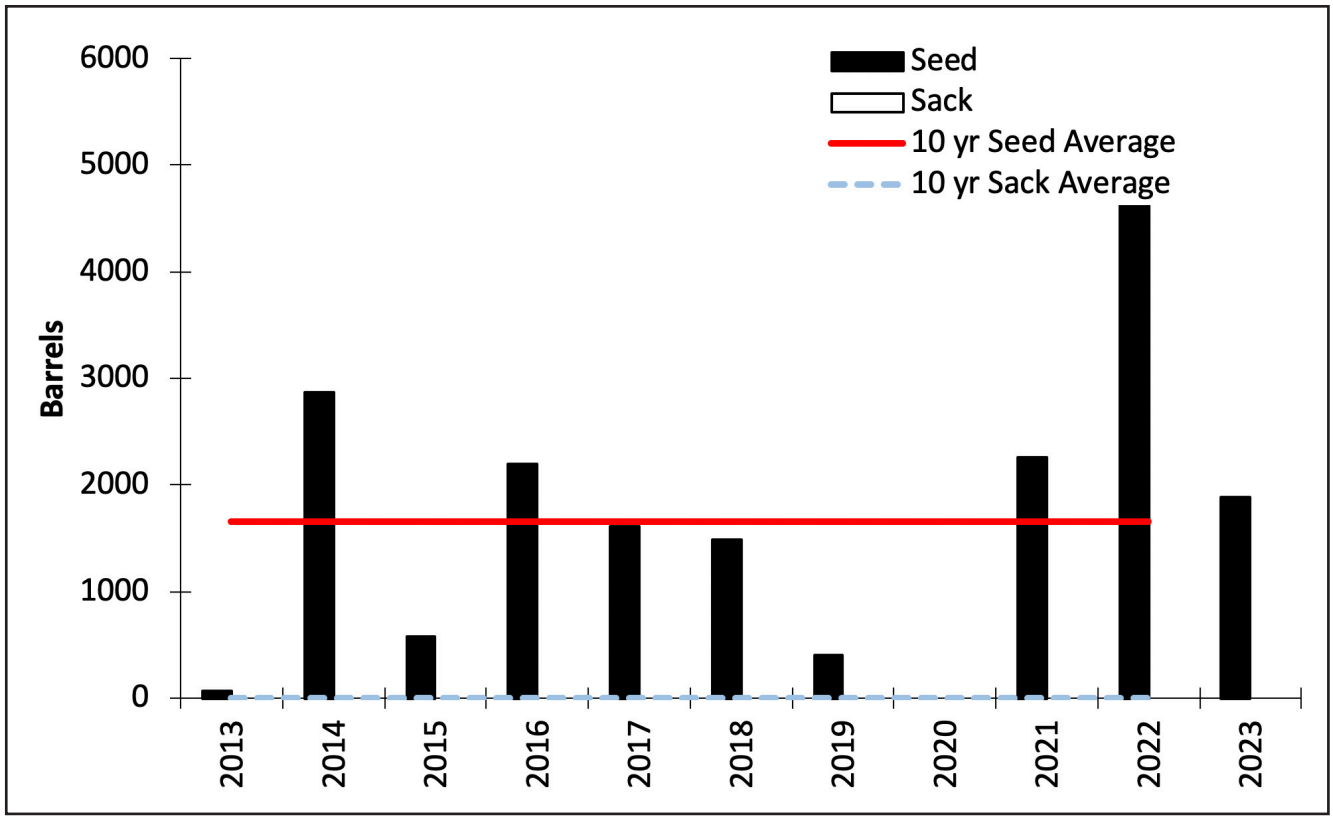

FIGURE 5.5. Lake Mechant historical oyster stock availability.

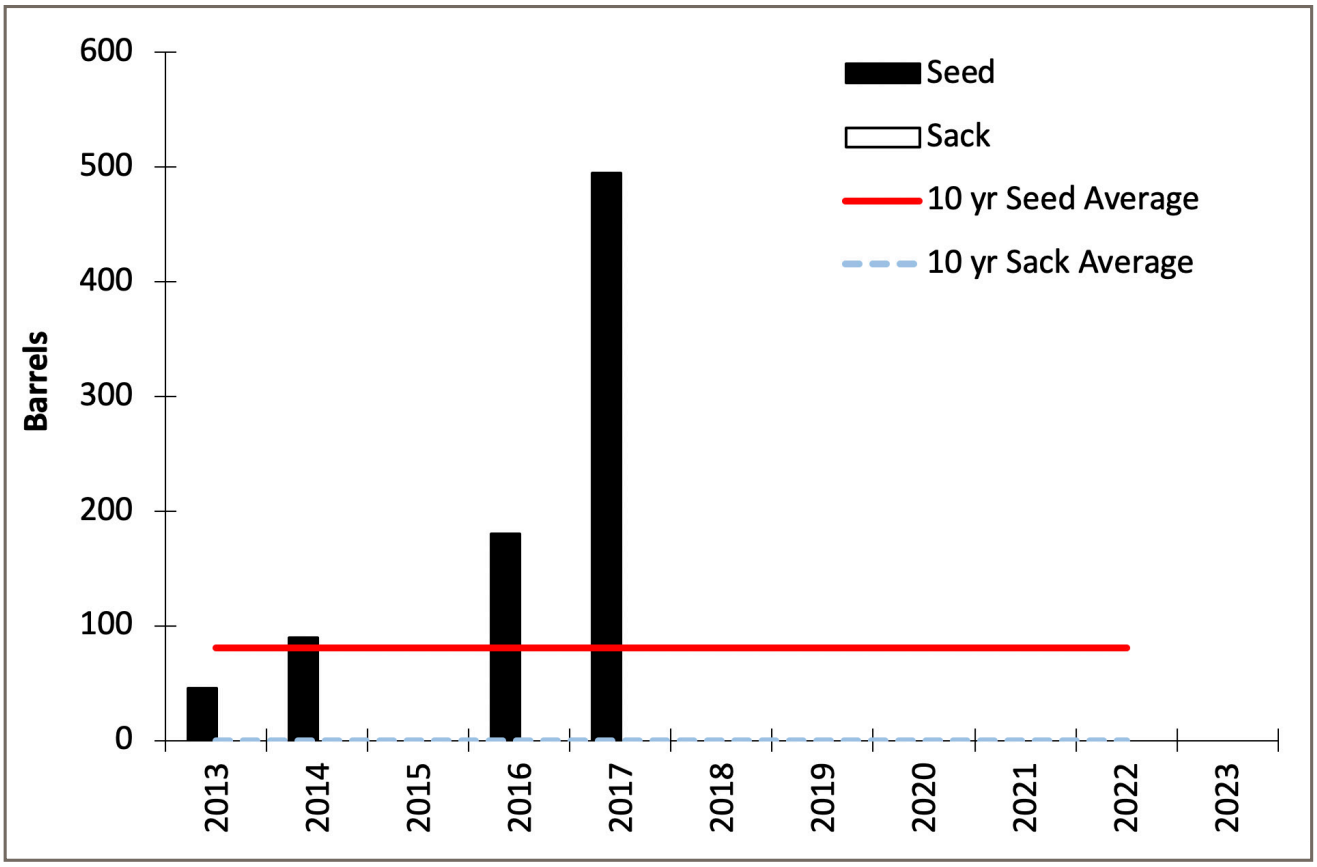

FIGURE 5.6. Lake Felicity historical oyster stock availability.

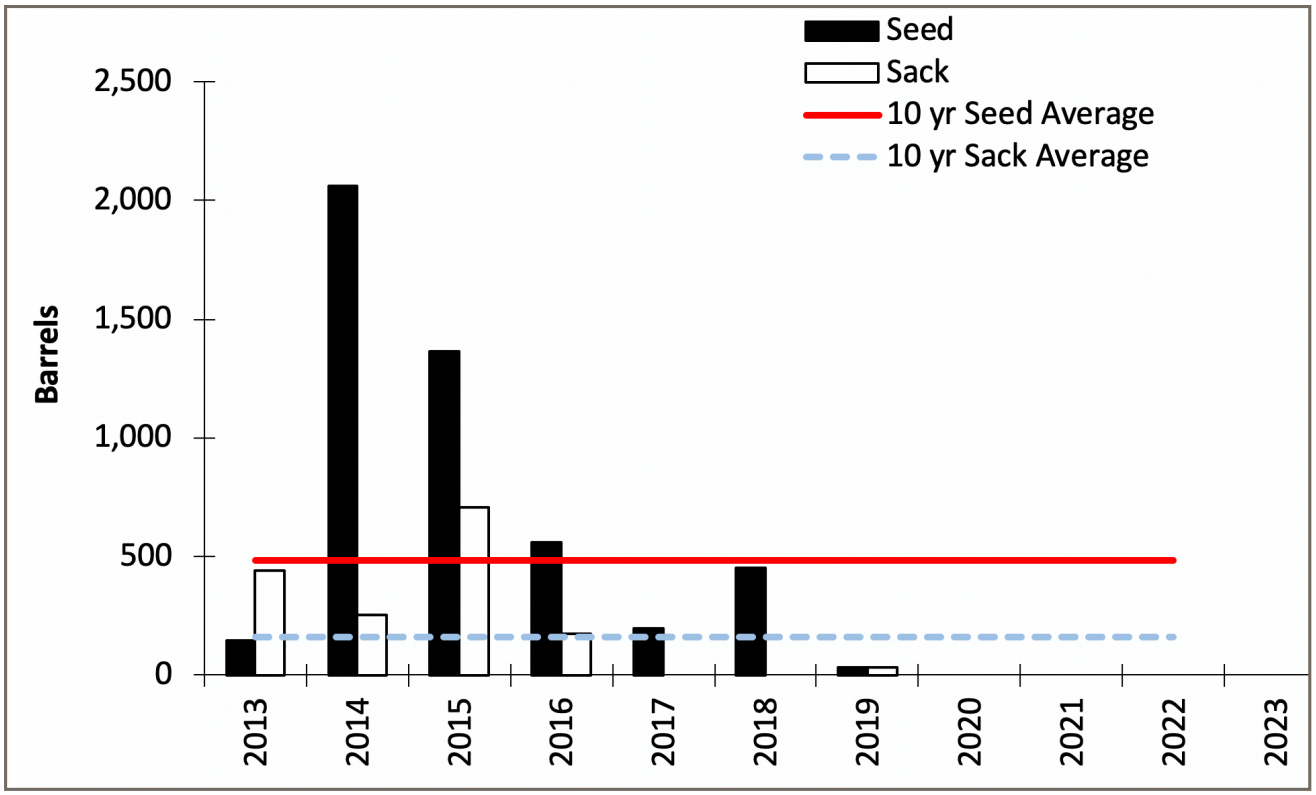

FIGURE 5.7. Lake Chien historical oyster stock availability.

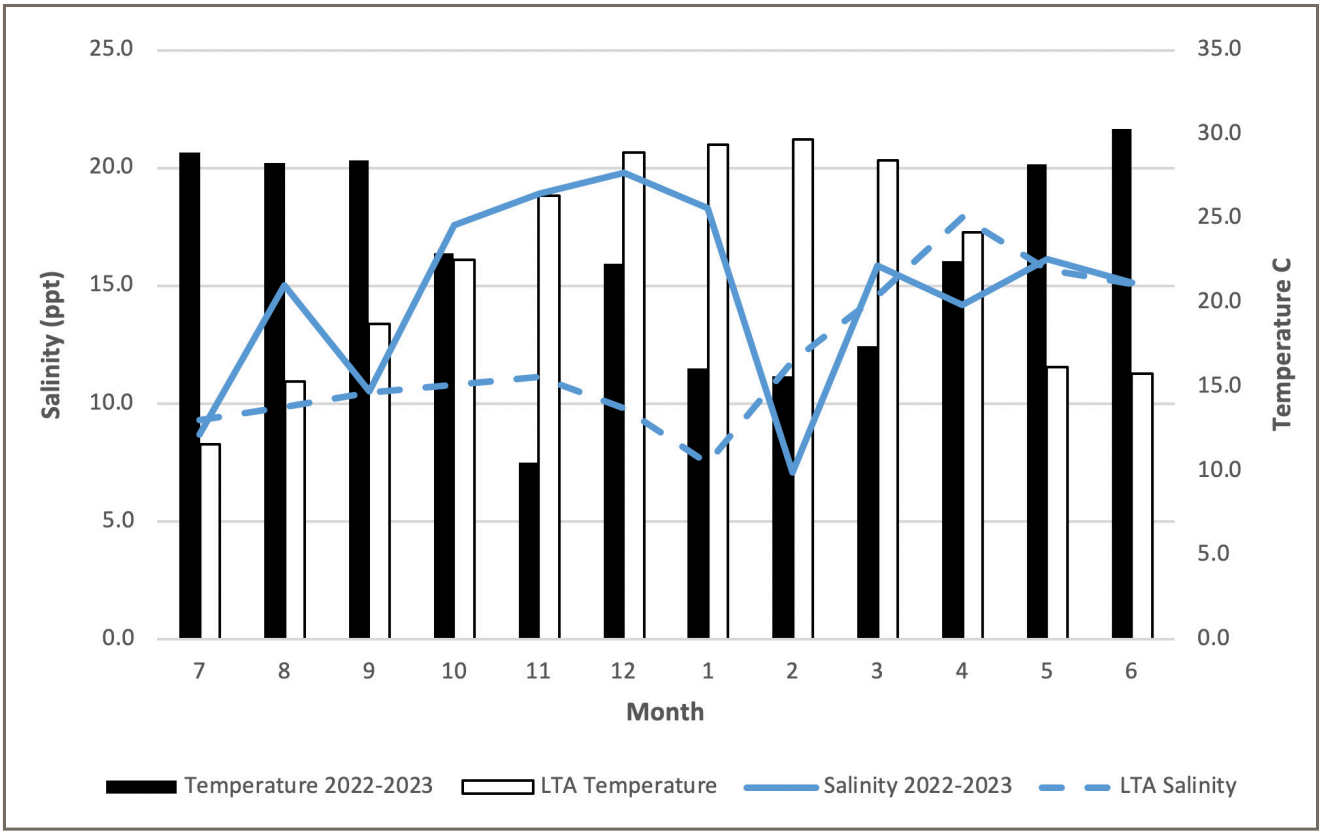

FIGURE 5.8. Salinity and temperature levels recorded during dredge and square-meter samples of the Sister Lake Public Oyster Seed Reservation in 2022-2023, with the long-term average (2013-2022).

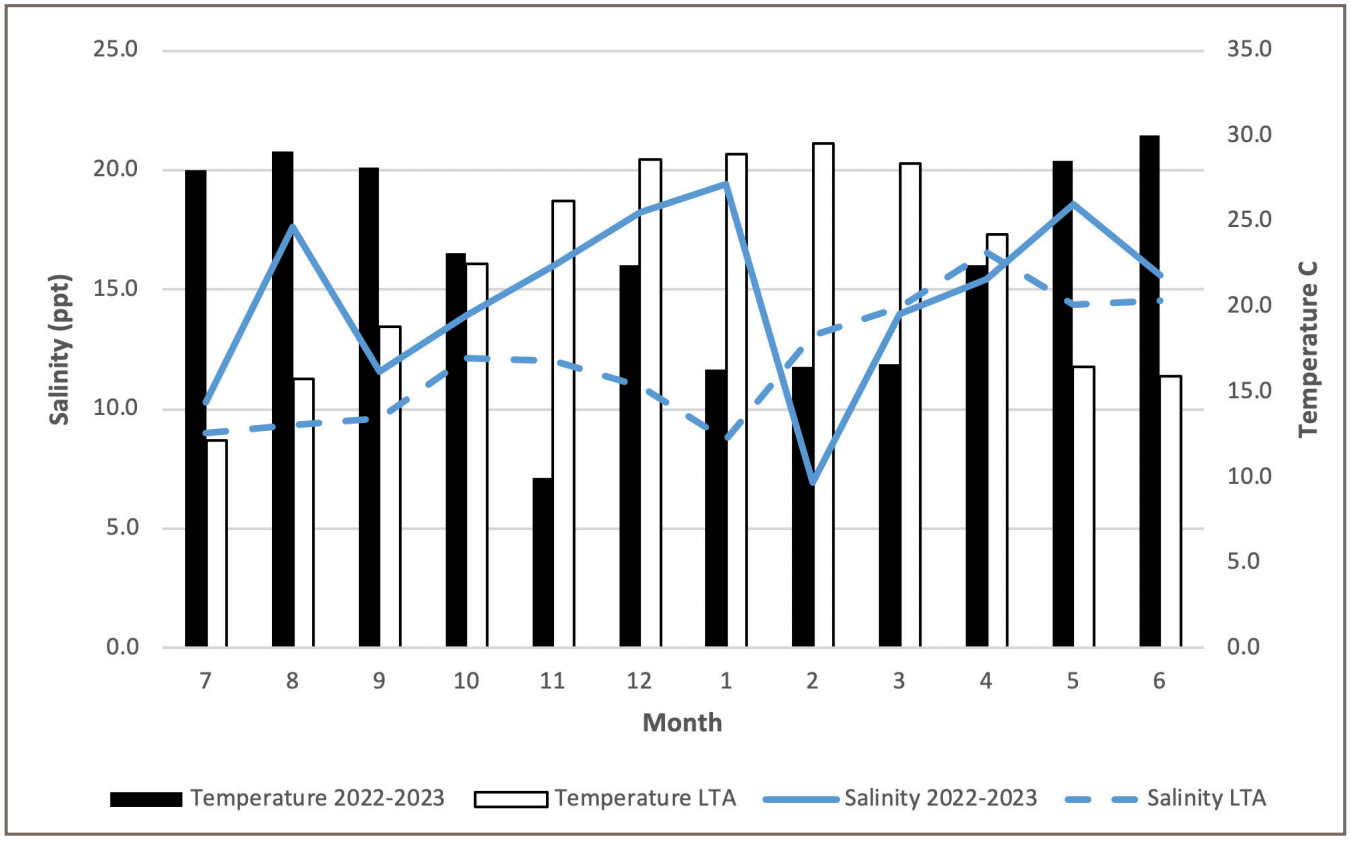

FIGURE 5.9. Salinity and temperature levels recorded during dredge and square-meter samples of the Bay Junop Public Oyster Seed Reservation in 2022-2023, with the long-term average (2013-2022).

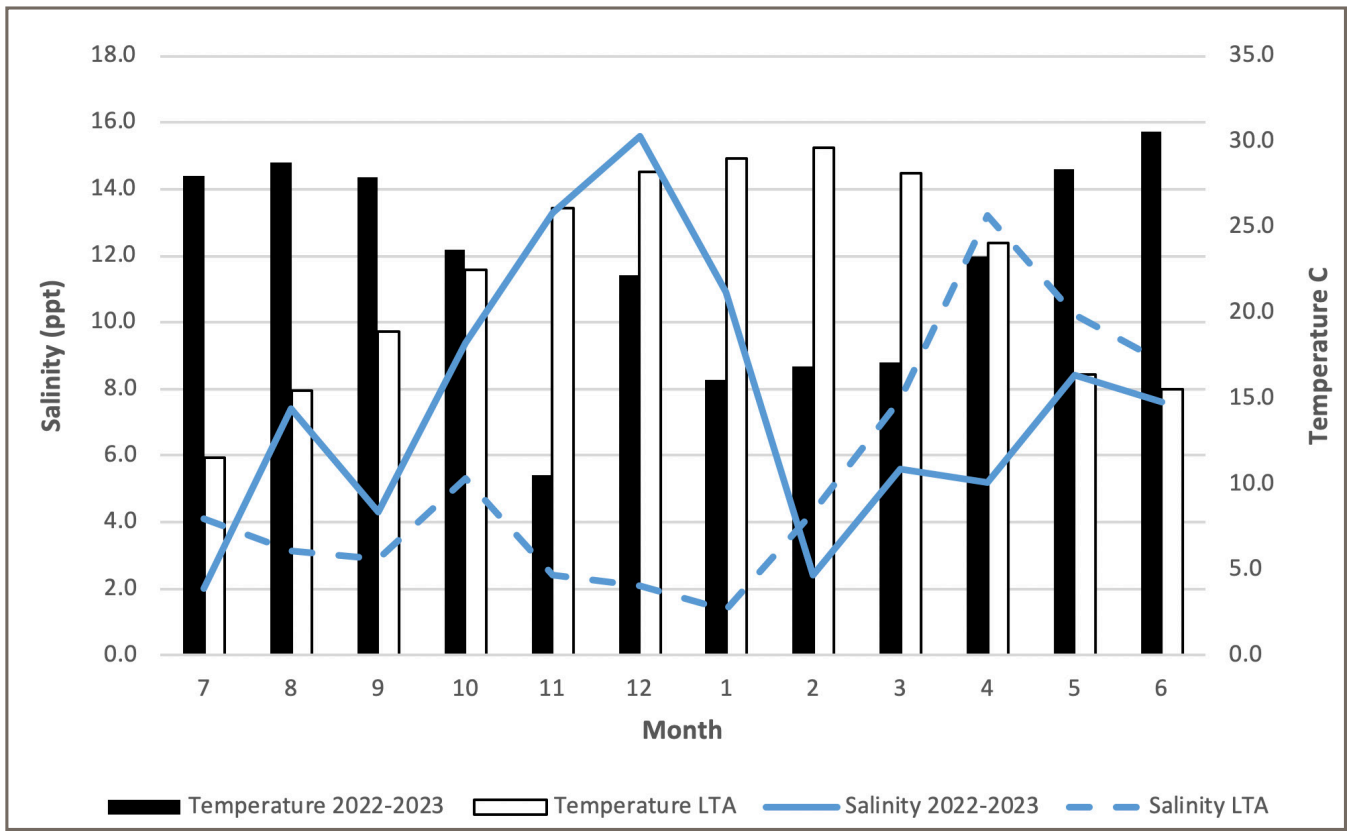

FIGURE 5.10. Salinity and temperature levels recorded during dredge and square-meter samples of the Lake Mechant Public Oyster Seed Ground in 2022-2023, with the long-term average (2013-2022).

COASTAL STUDY AREA 6
(Vermilion/Atchafalaya Basin)

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 POSGs 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 (*Figure 6.1*). 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 correlation between increasing Atchafalaya River flow and decreasing 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 2018 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 square-meter CPUE data collected from the 2023 Oyster Stock Assessment sampling to previous years' square-meter sampling data, with a look at hydrologic conditions, marine fouling, and oyster predators on sampled reefs. Observations of monthly dredge data collected during August 2022 through June 2023 are included. In addition, the report also presents information regarding the 2022-2023 oyster season on CSA 6 Public Oyster Seed Grounds.

Methods
LDWF biologists collected field samples for this report on July 10 and 11, 2023, from 11 sample 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 eight of the 11 sample stations (*Figure 6.1*). Densities of live seed ranged from 1.4 per replicate to 19.0 per replicate. Biologists collected market-size oysters at Bayou Blanc, Middle Reef, Lighthouse Point and Nickle Reef with densities of 0.2, 0.6, 1.6 and 3.4 oysters per replicate, respectively. There was a 378.4% increase in the mean density of seed oysters in 2023 square-meter samples compared to 2022 and a 550.0% increase compared to the 10-year average (2013-2022). There was a 783.3% increase in the mean density of sack oysters in 2023 compared to the 10-year average. Due to the lack of water bottom assessments in CSA 6, data is reported in mean density per sample shown in *Figure 6.2*.

Catch per unit effort (CPUE) of seed oysters in CSA 6 was highest during November 2022 dredges with a value of 46.8 per replicate. The lowest CPUE of seed oysters occurred in the June 2023 dredges with a value of 15.1 per replicate. The CPUE of sack size oysters in CSA 6 dredge samples was highest during April 2023 at 6.4 per replicate and lowest in October 2022 at 1.1 per replicate.

Spat Production
There was suitable substrate at all sample stations and biologists found live spat at nine of 11 sample stations. The density of spat there ranged from 0.2 per replicate to 39.4 per replicate. Low spat productivity during periods of low salinity conditions has been common in this bay system. However, this year was conducive for spat production. Spat were recorded in high numbers during routine dredge samples in September through November 2022 and again in June 2023. The CPUE of spat in CSA 6 dredge samples was highest in September 2022 with a value of 102.6 spat per replicate. The CPUE of spat dropped steadily to a low of 1.8 spat per replicate in May 2023 before jumping to 31.7 spat per replicate in June 2023.

Hydrological Data
The Atchafalaya River levels remained slightly below their 10-year average from August through November 2022. River levels were near average from December 2022 through April 2023 and well below average from May through July 2023 (*Figure 6.3*). The observed river levels during spring 2023 increased as expected and there was a decline in average salinities within the area of CSA 6. The average salinities during March and April of 2023 were similar to their LTA salinities (1.7 ppt and 1.3 ppt, LTA respectively). However, the Atchafalaya River levels dropped below average in

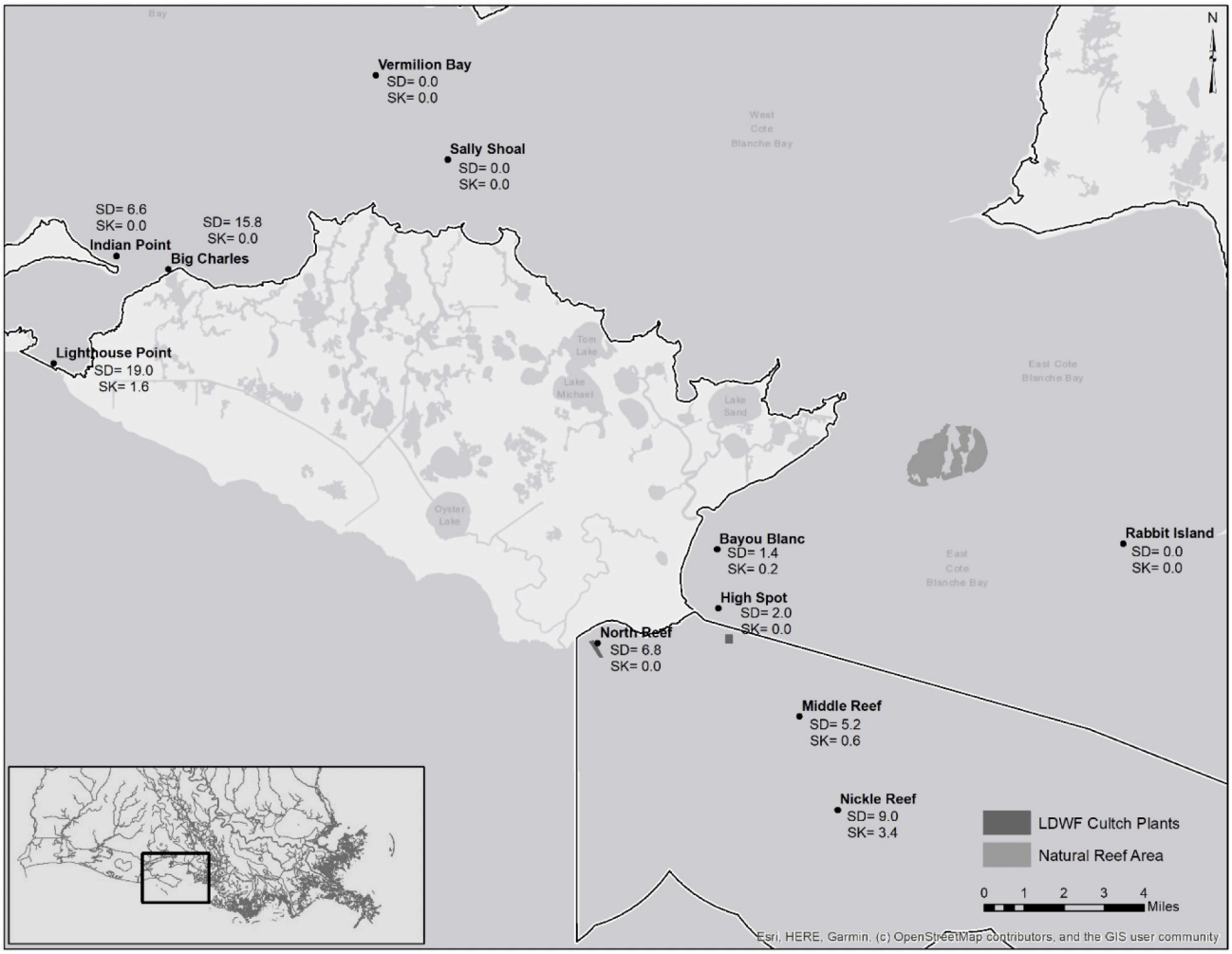

FIGURE 6.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-6).

May and kept receding through July. The low river levels created a corresponding spike in salinity levels with an average July 2023 salinity nearly five times the LTA.

Bottom dissolved oxygen recorded during July 2023 was in the normal range at all 11 stations and ranged from 5.1 to 6.9 milligrams per liter (mg/L). Even with above average water temperatures and normal dissolved oxygen levels, no significant mortality was observed. There were no significant hurricane/tropical storm events during the sampling period.

Fouling Organisms

Biologists documented an overall 104.0% increase in hooked mussel abundance at the sample stations compared to 2022 Oyster Stock Assessment. They noted an increase in density at all stations except Rabbit Island, Vermilion Bay, and Bayou Blanc. Rabbit Island had no change in hooked mussel abundance while Vermilion Bay and Bayou Blanc showed a decrease. The Lighthouse Point sample station showed the largest increase in hooked mussel density, jumping from an average of 1.4 per replicate in the 2022 Oyster Stock Assessment to 54.4 per replicate in the 2023 Oyster Stock Assessment.

Oyster Predators and Disease

Biologists found only one southern oyster drill during 2023 square-meter sampling. These marine snails are more often associated with high salinity waters where they are known to prey heavily on oysters and other bivalve species. It was sampled on the Nickle Reef site where salinities were usually the highest within CSA 6. The occurrence of mud crab on historically sampled reefs increased by 35.0% compared to the 2022 Oyster Stock Assessment. Vermilion Bay, Sally Shoal, High Spot, and Rabbit Island had no mud crabs sampled. However, mud crab density reached a high of 8.2 crabs per replicate at Lighthouse Point. This density was nearly twice the mud crab density sampled at the same site in 2022 (4.2 crabs per replicate). Biologists collected one blue crab at Middle Reef and two stone crabs at Nickle Reef during the 2023 square-meter sampling.

Mortality

There were no large-scale mortality events observed during 2022-2023 and conditions in the areas monitored by CSA 6 were favorable for oyster growth during most months. During most of 2022 and 2023, there were significant numbers of seed size oysters at Nickle, Middle, North, Lighthouse Point, Indian Point, Big Charles and High Spot reefs, as observed in monthly dredge samples collected throughout the year. Those seed oysters sampled in October, November and December were sampled as sack size oysters in March, April, and May. There were no notable mortality events observed during the 2022-2023 dredge sampling period. During spring 2023, freshwater conditions did not persist through spring into summer, when high water temperatures and low salinities can cause mortality. Nine of 11 stations sampled during the 2023 square-meter sampling event contained live oysters. Big Charles,

Indian Point, Bayou Blanc, Nickle Reef, Middle Reef, North Reef, and Lighthouse Point contained notable numbers of live oysters. The oyster stock found in CSA 6 is highly vulnerable to low salinity/high turbidity conditions, often seen as a result of extended freshwater conditions associated with high Atchafalaya River discharge.

2022-2023 Oyster Season

The Commission opened Vermilion/East and West Cote Blanche Bay/Atchafalaya Bay Public Oyster Seed Grounds for a one-day bedding season on Oct. 17, 2022. No vessels were observed harvesting oysters for bedding. The Commission opened Vermilion/East and West Cote Blanche Bay/Atchafalaya Bay Public Oyster Seed Grounds for sacking of market-size oysters on Oct. 18, 2022 through April 1, 2023. No vessels were observed harvesting sack oysters at any point during the season.

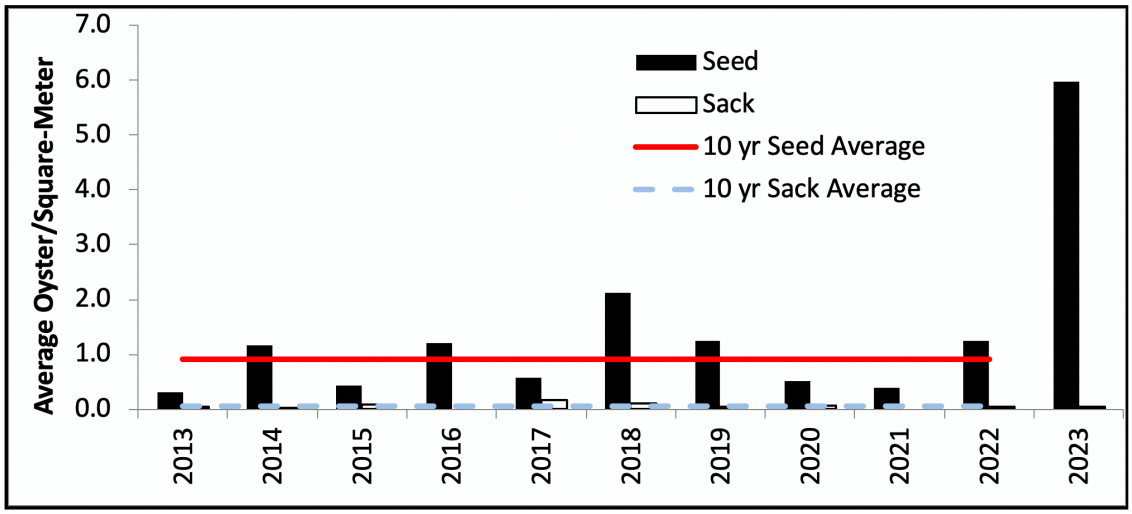

FIGURE 6.2. Mean density of live seed and market-size size oysters collected in Coastal Study Area 6 square-meter samples by year.

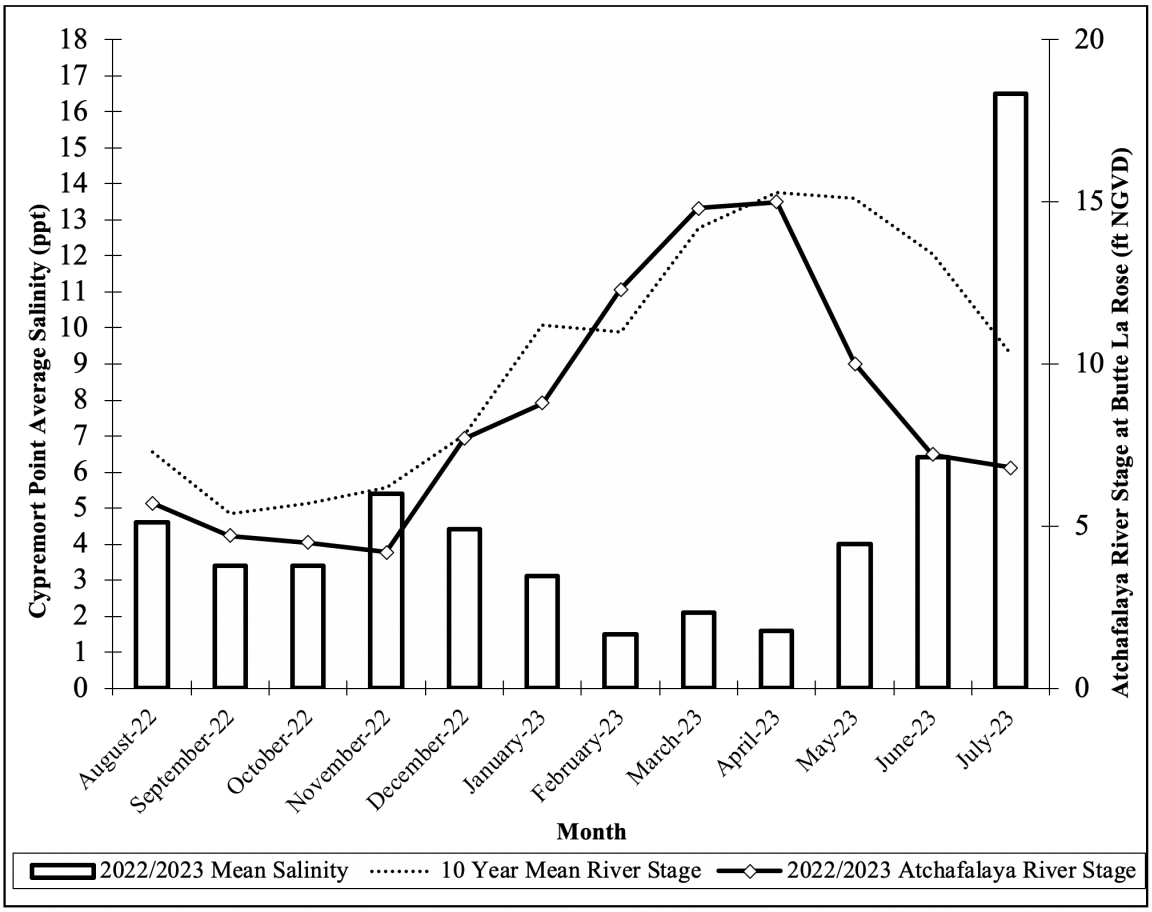

FIGURE 6.3. Atchafalaya River levels at Butte La Rose gauge and average salinity for Cypremort Point, LA during the period Aug. 1, 2022 through July 31, 2023. The 10-year average monthly river stage at Butte La Rose is included.

COASTAL STUDY AREA 7
(Calcasieu and Sabine Lakes)

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, but concentrated in the southern end (*Figure 7.1*). 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. The majority of oyster reefs on the Louisiana portion of Sabine Lake are located in the very southern portion of the lake (*Figure 7.2*).

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 river stage reaches 13.5 feet, and West Cove would close when the river stage reaches 9 feet. Once the river falls below these levels for 48 hours, 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 harvest oysters. Oysters can only be harvested in the southern portion of the Lake due to the location of the LDH closure line.

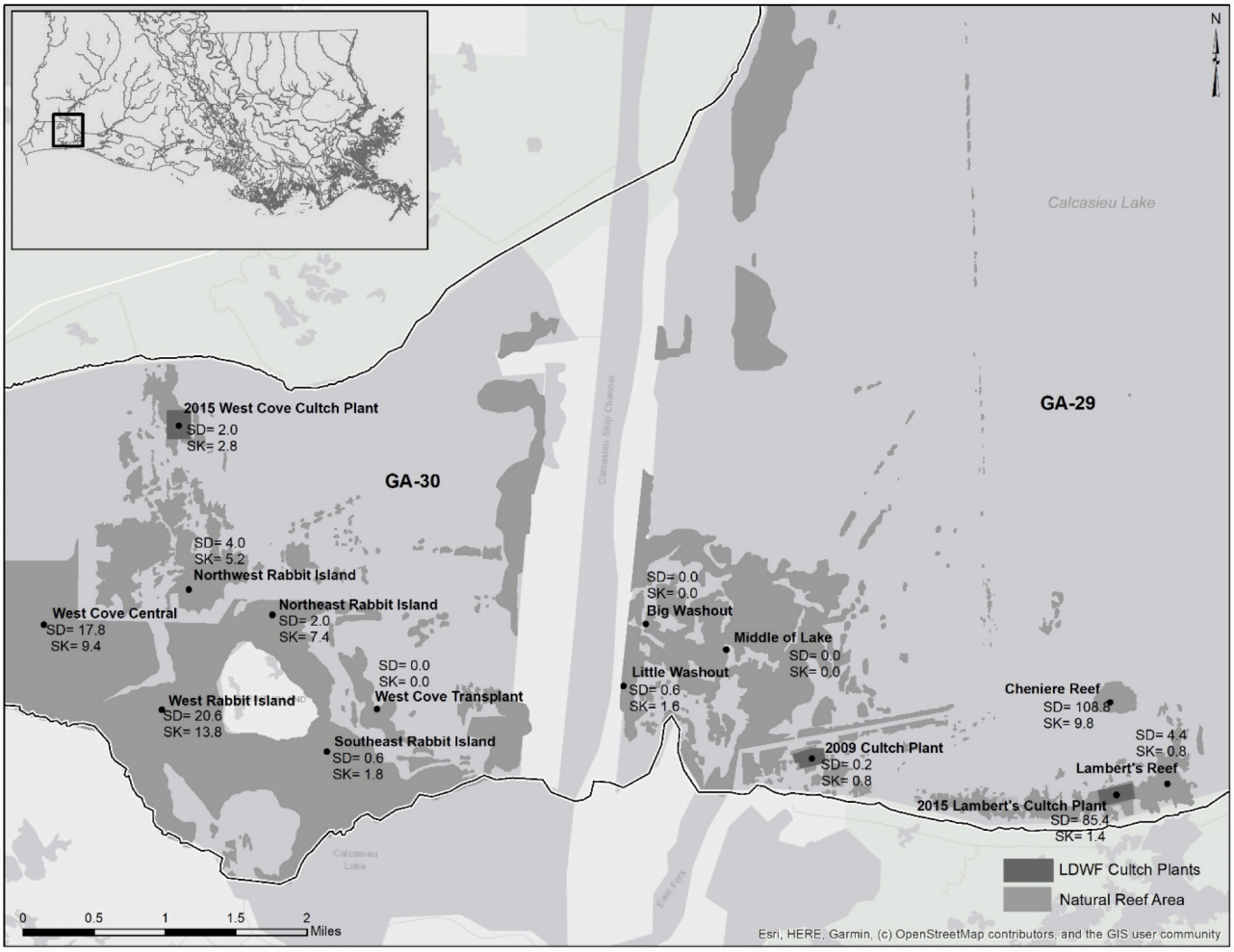

FIGURE 7.1. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-7 Calcasieu Lake).

LDWF Oyster Stock Assessments in Calcasieu and Sabine Lakes use acreage estimates, which have been determined by side-scan sonar water bottom assessments conducted in 2008, 2011, and 2022. LDWF identified all suitable oyster habitat 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 2,306.9 acres of suitable oyster habitat, including 1,732.4 acres of reef and 526.5 acres of scattered shell bottom. 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 (*Table 7.1*).

In 2018, additional surveying and sampling on the scattered shell bottom type in the East Side determined that no suitable bottom type material and no live oysters were present. Therefore, 526.5 acres of scattered shell was deleted from oyster habitat calculations. In 2023, 48 acres was removed from East Side reef acreage calculations to account for the Alternative Oyster Culture Park, which was established by the Cameron Parish Port, Harbor and Terminal District in the southern portion of Calcasieu Lake. Beginning in 2023, stock assessment availability calculations (East Side) are based using 1,732.4 acres of reef habitat. The acreage estimates generated from the side-scan sonar studies only include reef acreage of Calcasieu Lake that lie within the LDH allowed harvest areas.

The Louisiana portion of Sabine Lake (GA31) has approximately 34,067 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. 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. Due to this moratorium, LDWF currently conducts population stock assessments in Sabine Lake only during odd numbered years.

Methods

LDWF biologists collected field samples for the 2023 Oyster Stock Assessment on July 11, 2023, from 14 stations within Calcasieu Lake and six stations within Sabine Lake on July 12, 2023, according to the methodology described in the Statewide Overview of this report.

Considering there are no private oyster leases and no bedding (seeding) operations in Calcasieu Lake, all harvest is direct market and the unit of measure is in sacks. Historical data in this report (*Table 7.2*) is reported in sacks of market-size oysters. 2023 availability numbers (*Table 7.1*) are presented in barrels and sacks. One barrel of oysters equals two sacks of oysters.

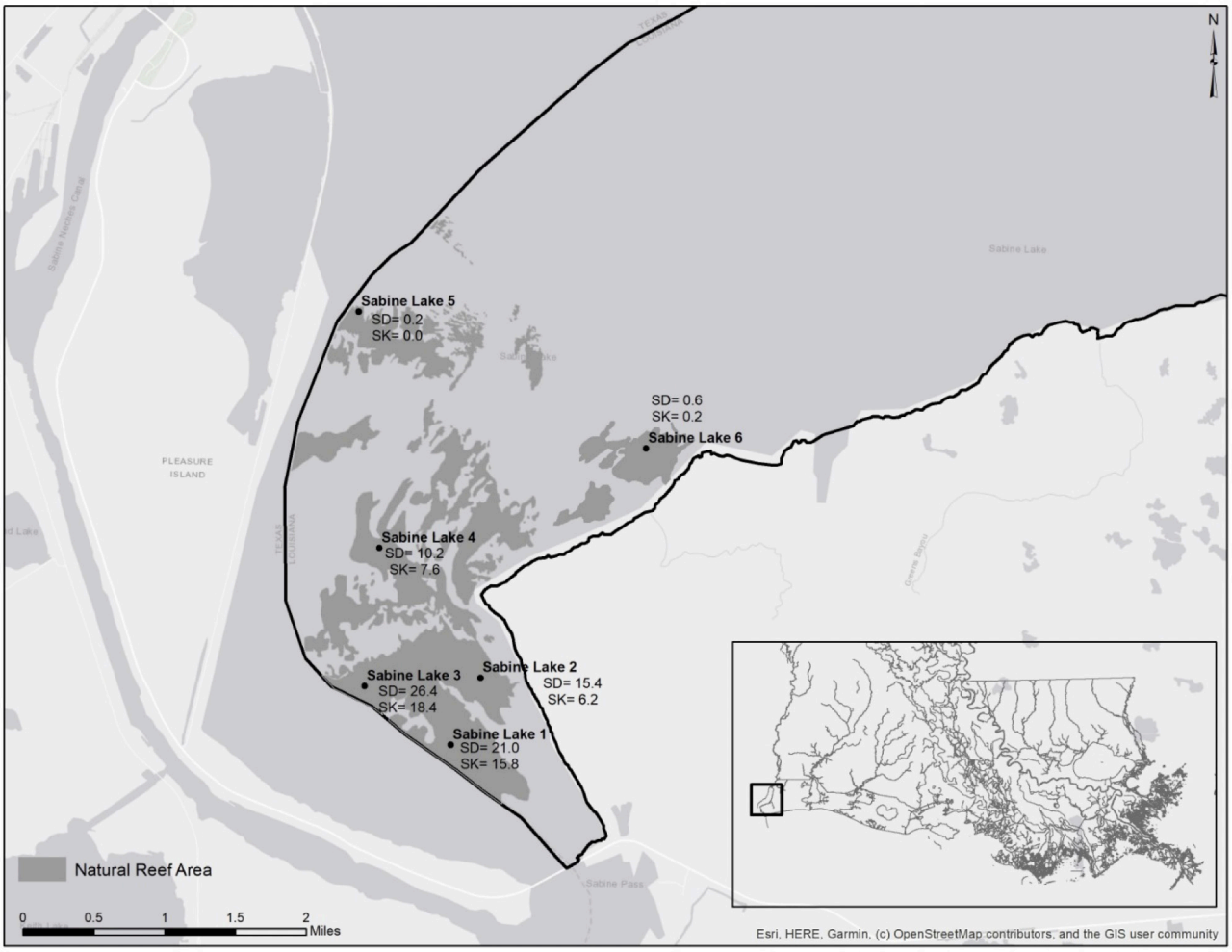

FIGURE 7.2. 2023 OSA average seed and market-size densities from square meter sample stations (CSA-7 Sabine Lake).

TABLE 7.1. 2023 estimated oyster availability between East Side and West Cove, Calcasieu Lake.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-Size Oysters/m^2	Seed Oysters (bbl)	Market- Size Oysters (bbl)
2015 Lamberts Cultch Plant	30	85.4	1.4	16,372.9 (32,745.8 sacks)	1,888.6 (3,777.1 sacks)
Chenier Reef		108.8	9.8		
Cultch Plant Reef Total		97.1	5.6		
2009 Cultch Plant	1,732.35	0.2	0.8	10,126.4 (20,252.8 sacks)	12,463.3 (24,926.5 sacks)
Big Washout		0	0		
Little Washout		0.6	1.6		
Middle of Lake		0	0		
Lamberts Reef		4.4	0.8		
East Side Reef Total		1.0	0.6		
East Side Total				***26,499.3 (52,998.6 sacks)***	***14,351.8 (28,703.6 sacks)***
NW Rabbit Island	1,097.20	4.0	5.2	9,456.0 (18,912.0 sacks)	28,779.2 (57,558.3 sacks)
SE Rabbit Island		0.6	1.8		
West Cove Transplant		0	0		
West Cove Reef 1 Total		1.5	2.3		
NE Rabbit Island	2,265.60	2.0	7.4	171,486.2 (342,972.3 sacks)	259,776.1 (519,552.1 sacks)
West Cove Central		17.8	9.4		
West Rabbit Island		20.6	13.8		
West Cove Reef 2 Total		13.5	10.2		
West Cove Cultch Plant	25	2.0	2.8	281.1 (562.1 sacks)	786.9 (1,573.8 sacks)
West Cove Total				***181,223.2 (362,446.4 sacks)***	***289,342.1 (578,684.2 sacks)***
Calcasieu Lake Total				***207,722.5 (415,445.0 sacks)***	***303,693.9 (607,387.8 sacks)***

Results and Discussion

Calcasieu Lake

Market-Size Stock

The 2023 stock assessment estimated the current oyster stock in Calcasieu Lake was approximately 303,693.9 barrels of market-size oysters and 207,722.5 barrels of seed oysters (*Table 7.1*). This represents a 40.5% increase in market-size oysters from the 2022 estimate. Seed oysters increased 364.8% from the previous year's assessment. The oyster resource in Calcasieu Lake is well over its 10-year long term average (*Figure 7.3*).

Spat/Seed Production

Seed oysters are typically used to estimate recruitment and predict future market-size oysters. Data collected during the 2023 stock assessment suggest a significant improvement in young oyster recruitment in Calcasieu Lake. Seed oysters on the East Side experienced a 76.3% increase and seed oysters in West Cove increased 509.8% compared to the 2022 assessment (*Table 7.2*). Seed oyster populations on the East Side are currently 114.4% above the 10-year average (2013-2022) and seed oysters in West Cove are 253.9% above the 10-year average (*Table 7.2*). Spat oysters in the East Side experienced a 99.6% reduction from 2022. However, it should be noted that spat estimates in 2022 were unusually large. It is estimated there are approximately 66,723.8 sacks of spat oysters in West Cove, representing a 110.3% increase from the previous year. The East Side of Calcasieu Lake has approximately 1,159 sacks of spat oysters. Spat oysters are the most vulnerable oysters to adverse environmental conditions, disease, and predation. They are typically the least abundant size-class group of oysters found during stock assessment sampling due the timing of sampling and the fact that late summer/early fall months are the major spawning period for Calcasieu Lake oysters. Warmer water temperatures and low rainfall in the late spring/early summer created optimum hydrologic conditions for an early spawning event. The highest density of spat oysters were found at cultch plant sample stations on the East Side of Calcasieu Lake. The densities in West Cove were found at sample stations south and west of Rabbit Island, reaching 6.4 and 11.4 spat per square-meter, respectively. Oyster recruitment in lower Calcasieu Lake has struggled for nearly a decade. Only in the last few years has there been any notable improvement. Hopefully, the large increase in seed oysters throughout the harvest area will translate in to an increase in market-size in the coming years. LDWF biologists will continue to sample oyster populations throughout the year to monitor recruitment and survival.

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

Year	Market Oysters (≥ 3")		Seed Oysters (< 3")	
	GA29	GA30	GA29	GA30
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	23,334	166,735	32,227	124,010
2020	46,105	419,460	12,836	100,698
2021	34,370	225,525	5,968	38,867
2022	24,592	407,789	30,067	59,433
2023	28,704	578,684	52,999	362,446
10 AVERAGE	***20,965***	***226,629***	***24,717***	***102,429***
% CHANGE FROM AVG.	*36.9*	*155.3*	*114.4*	*253.9*
% CHANGE FROM 2022	*16.7*	*41.9*	*76.3*	*509.8*

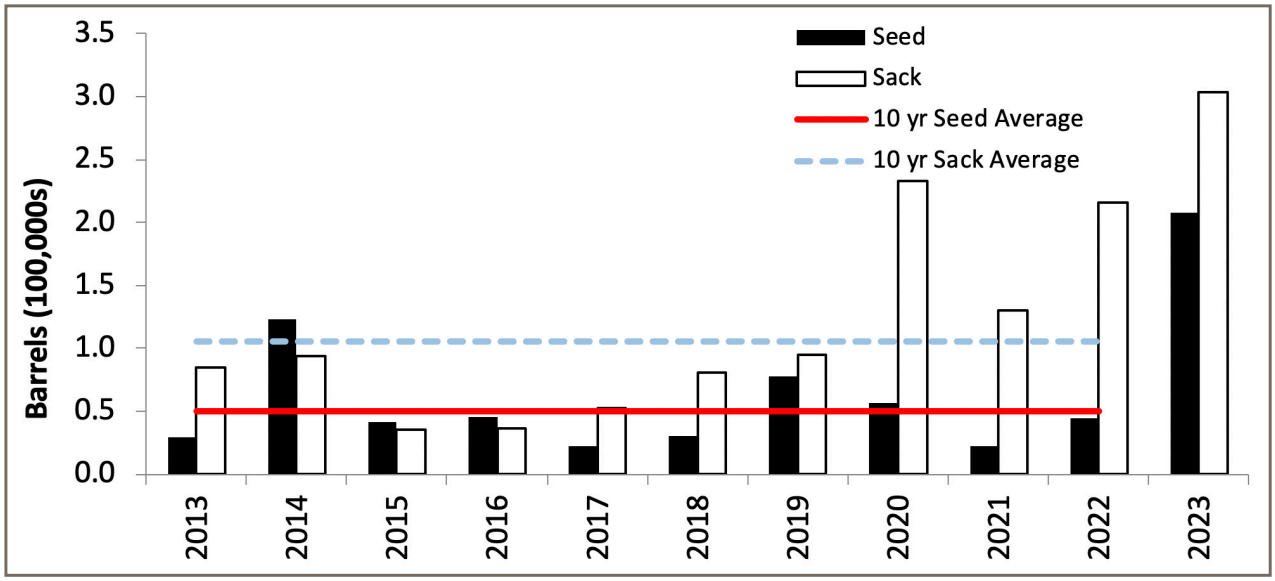

FIGURE 7.3. Calcasieu Lake historical oyster stock availability.

Hydrological Data

Average water temperatures recorded during dredge samples for Calcasieu Lake in May and June were 27.7 and 30.4°C, respectively. All months during 2023 saw temperatures higher than the long-term average (*Figure 7.3*). The average water temperature during the 2023 oyster assessment was 31.1oC, which is above the long-term average temperature of 29.7°C.

Average salinities recorded during dredge samples for Calcasieu Lake in May and June 2023 were 11.5 and 22.9 ppt, respectively. Salinity levels during May were near the long-term average, while salinities in June nearly double the long-term averages (*Figure 7.3*). The entire region of SW Louisiana was suffering from drought conditions from late winter to mid-summer, which is the likely cause of increased salinities. Average salinity at sample stations during the stock assessment was 24.3 ppt, which is nearly 58% higher than the long-term average.

Sabine Lake

Market-Size Stock

The 2023 stock assessment estimated that the current oyster stock in Sabine Lake was approximately 140,919.0 barrels of market-size oysters and 107,768.2 barrels of seed oysters (*Table 7.3*). This represents a 52.4% increase in market-size oysters from the 2021 estimate. Seed oysters increased 19.8% from the 2021 assessment, however, the estimated numbers remain 27.5% below the 10-year long-term average (*Figure 7.5*). The vast majority of market-size oysters in Sabine Lake continue to be found in the four southern-most sample stations.

Spat/Seed Production

Seed oysters are typically used to estimate recruitment and predict future market-size oysters. Data collected during the 2023 stock assessment suggests an improvement in young oyster re-

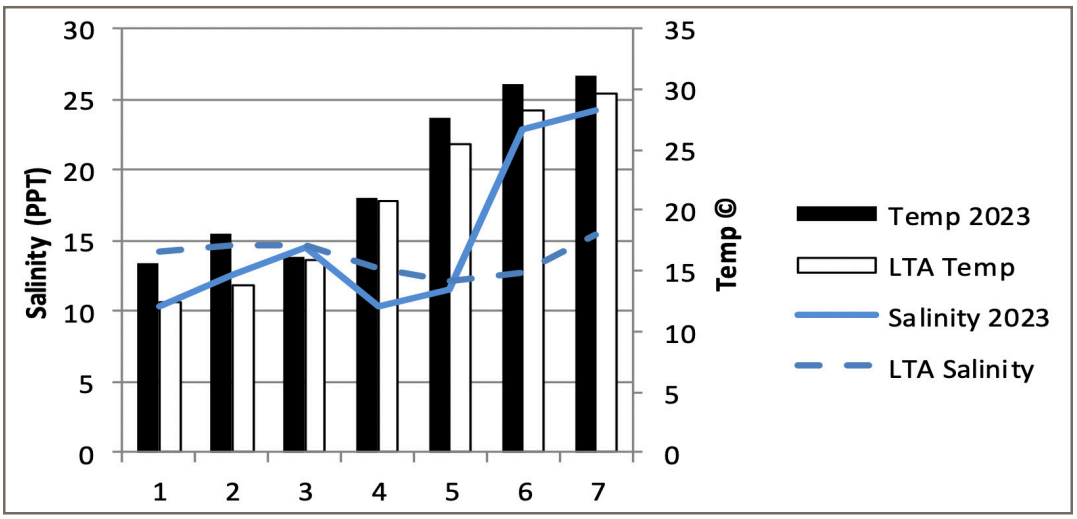

FIGURE 7.4. Salinity and temperature levels recorded during dredge and square-meter samples of the Calcasieu Lake public oyster areas in 2023.

TABLE 7.3. 2023 estimated oyster availability in Sabine Lake.

Station	Reef (Acres)	Average Number Seed Oysters/m^2	Average Number Market-Size Oysters/m^2	Seed Oysters (bbl)	Market-Size Oysters (bbl)
Sabine Lake 1	1,041.0	21.0	15.8	106,782.3 (213,564.6 Sacks)	140,426.0 (280,852.1 Sacks)
Sabine Lake 2		15.4	6.2		
Sabine Lake 3		26.4	18.4		
Sabine Lake 4		10.2	7.6		
Water Bottom Type- Reef		18.3	12.0		
Sabine Lake 5	438.5	0.2	0.0	985.9 (1,971.7 Sacks)	492.9 (985.9 Sacks)
Sabine Lake 6		0.6	0.2		
Water Bottom Type- Exposed Shell		0.4	0.1		
Sabine Lake Total				***107,768.2 (215,536.3 Sacks)***	***140,919.0 (281,837.9 Sacks)***

TABLE 7.4. Oyster Stock Assessments, in sacks, and percentage change of public oyster areas in Sabine Lake.

Year	Market Oysters (≥ 3″)	Seed Oysters (< 3″)
	GA31	GA31
2010	478,985.9	436,409.4
2011	1,031,976.2	406,141.1
2012	890,693.9	552,007.6
2013	1,110,940.9	391,261.2
2014	1,014,047.6	258,108.7
2015	361,597.1	155,454.5
2016	310,107.5	279,681.9
2017	422,448.3	238,880.5
2019	200,107.1	157,794.9
2021	184,894.3	179,936.9
2023	281,837.9	215,536.3
AVERAGE	***571,603.3***	***297,383.0***
% CHANGE FROM AVG.	*-50.7*	*-27.5*
% CHANGE FROM 2021	*52.4*	*19.8*

cruitment in Sabine Lake. Seed oysters in Sabine Lake experienced a 19.8% increase compared to the 2021 assessment; however, the estimated numbers remain 27.5% below the long-term average (*Table 7.4*). Of particular note from this year's stock assessment sampling was the tremendous increase in the number of spat oysters recorded. It is estimated there are approximately 33,058.63 sacks of spat oysters in Sabine Lake, which represent a 1,312.5% increase compared to the 2021 assessment. Spat oysters are the most vulnerable oysters to adverse environmental conditions, disease, and predation. Sabine Lake has historically experienced extended periods of low salinity, making it more difficult to project future market-size oysters based on recruitment. Warmer water temperatures and low rainfall in the late spring/early summer created optimum hydrologic conditions for an early spawning event. All spat oysters were found at the four southernmost sample stations. LDWF biologists will continue to sample oyster populations throughout the year to monitor recruitment and survival.

Hydrology

Average water temperature recorded during dredge samples for Sabine Lake in April was 20.7oC and average water temperature during the 2023 oyster assessment was 30.9oC, both of which are near the long-term averages (*Figure 7.4*).

Average salinity recorded during dredge samples for Sabine Lake in April was 2.45 ppt, which is less than half of the long-term aver-

age (*Figure 7.4*). The entire region of SW Louisiana was suffering from drought conditions during the late spring and summer of 2023, causing increased salinities during stock assessment sampling. The average salinity found during stock assessment sampling was 20.2 ppt, which is nearly double the long-term average of 11.2 ppt (*Figure 7.4*).

2022-2023 Oyster Season

The Commission opened the West Cove Area of Calcasieu Lake to oyster harvest on Oct. 15, 2022, with a daily sack limit of 15.

The East Side of Calcasieu Lake was opened to harvest on Jan. 1, 2023, with a daily sack limit of 5. The combined daily sack limit for the entire Calcasieu Lake was 15 sacks total.

The oyster harvest area is classified as a LDH conditionally managed area. The number of closures to oyster harvesting in Calcasieu Lake due to LDH health concerns was near normal for a typical oyster season. West Cove was open to harvest 58% of the total oyster season at 115 harvestable days (*Table 7.5*). The East Side was opened 78% of the oyster season for 93 days (*Table 7.5*).

TABLE 7.5. Public oyster season and number of days open to harvest by LDH as a percentage for East Side and West Cove in Calcasieu Lake.

Season		Season Dates	Total Days	CALCASIEU LAKE			
				Eastside		West Cove	
				Days	% Open	Days	% Open
2013-14	East Side	Closed	Closed	0	-		
	West Cove	Nov. 1- April 30	181			158	87
2014-15	East Side	Closed	Closed	0	-		
	West Cove	Oct. 26-April 30	187			111	59
2015-16	East Side	Closed	Closed	0	-		
	West Cove	Nov. 1- April 30	182			108	59
2016-17	East Side	Nov.1-Feb. 13	105	86	82		
	West Cove	Nov. 1- Jan. 24	85			54	64
2017-18	East Side	Closed	Closed	0	-		
	West Cove	Nov. 1- May 15	196			130	66
2018-19	East Side	Oct. 15- April 30	184	145	79		
	West Cove					88	48
2019-20	East Side	Nov.1-Jan 26	87	81	93		
	West Cove	Nov. 1- April 30	182			58	32
2020-21[1]	East Side	Oct. 30- April 30	132	107	81		
	West Cove	Oct. 30- April 30	132			49	37
2021-22	East Side	Nov. 1- April 30	181	168	93		
	West Cove					152	84
2022-23	East Side	Jan.1- April 30	120	93	78		
	West Cove	Oct.15-April 30	198			115	58

1. Weekday harvest only permitted during 2020-2021 harvest season

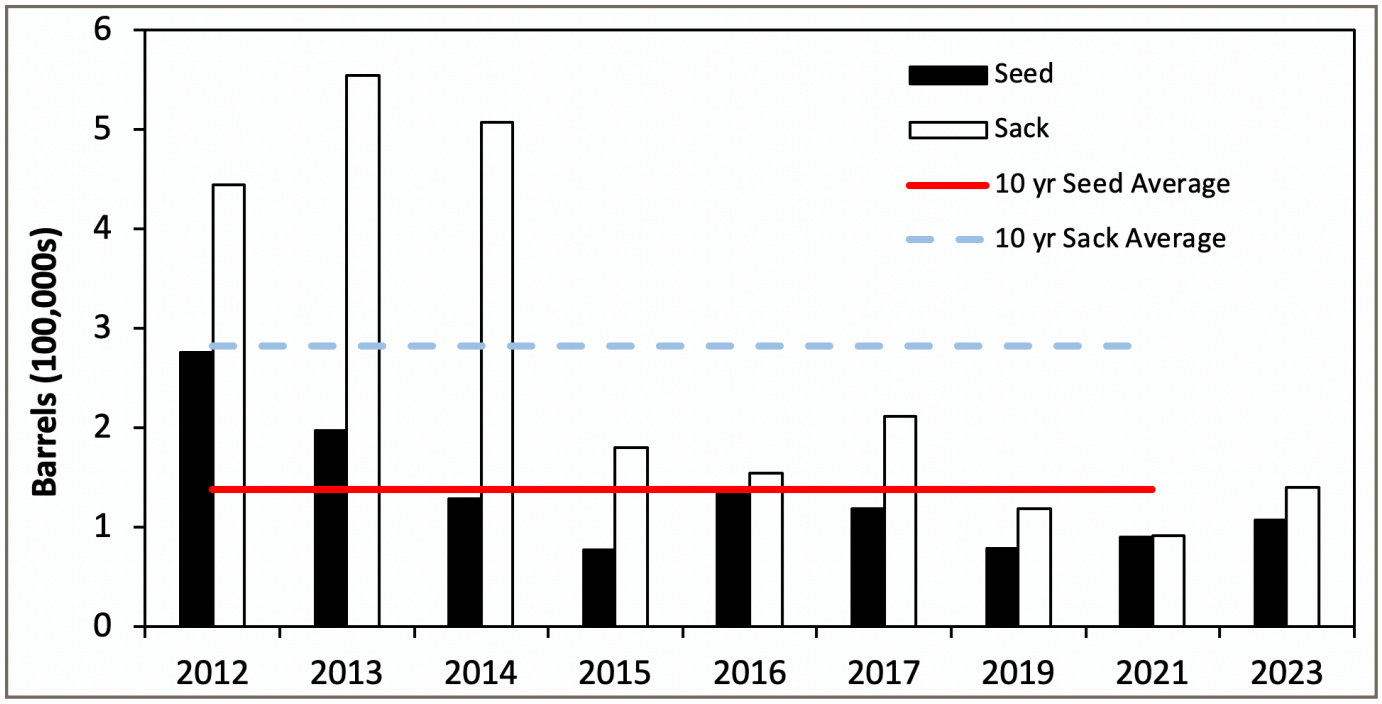

FIGURE 7.5. Sabine Lake historical oyster stock availability.

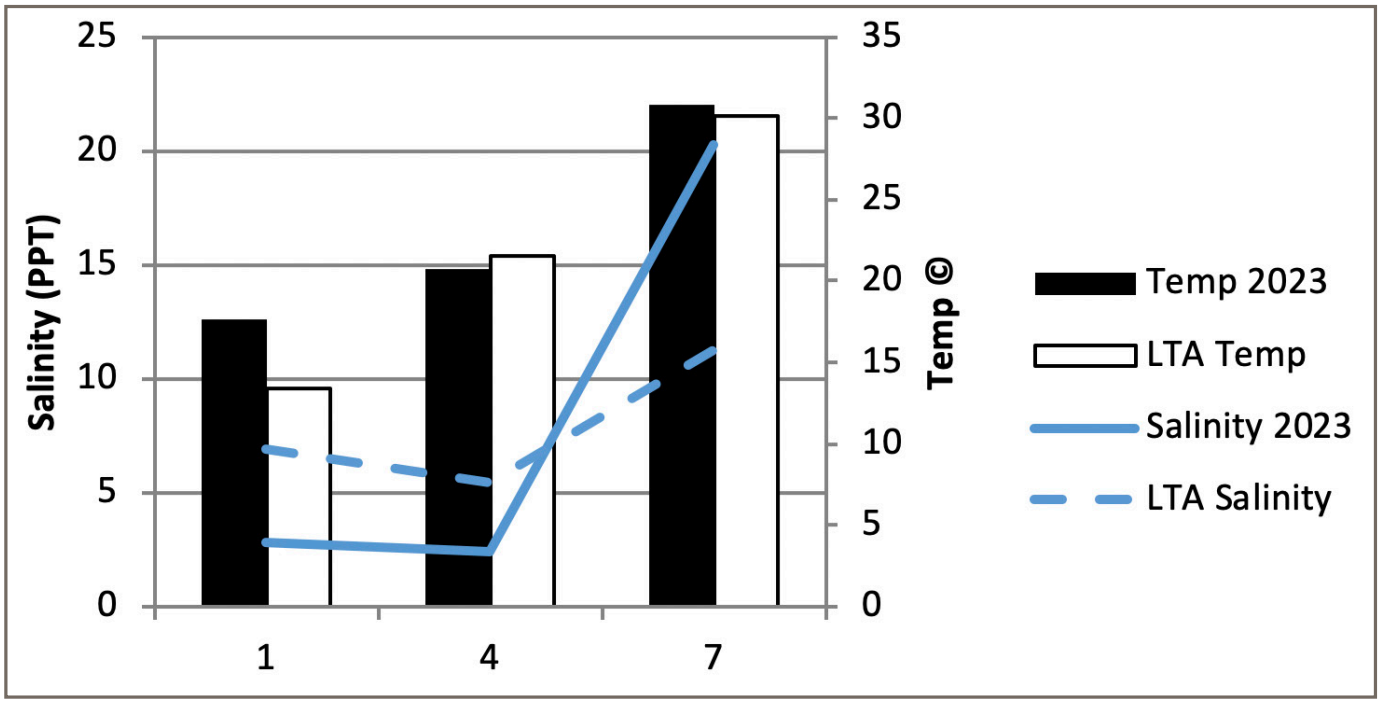

FIGURE 7.6. Salinity and temperature levels recorded during dredge and square-meter samples of Sabine Lake in 2023.